2019년 대한흉부심장혈관외과학회
제12차 전공의 연수교육

일자: 2019년 5월 23일(목)~5월 25일(토)

장소: 세인트존스호텔 볼룸 바부다

대한흉부심장혈관외과학회

2019년 대한흉부심장혈관외과학회 제12차 전공의 연수교육 프로그램

일시: 2019. 5. 23(목) 장소: 세인트존스호텔 볼룸 바부다

12:30～13:00 등록 및 숙소배정

13:00～13:05 개회사 박계현 교육위원장 (분당서울대학교병원)

13:05～13:15 격려사 오태윤 이사장 (성균관대학교 강북삼성병원)

13:15～16:30 일반흉부파트 좌장: 이성수

13:15～13:45 Diagnosis and Management of Mediastinal Diseases
조정수 (부산대학교병원) ····· 3

13:45～14:15 Diagnosis and Management of Pleural Diseases 조석기 (분당서울대학교병원) ····· 15

14:15～14:45 Chest wall Diseases / Reconstruction, Hyperhidrosis
이성수 (강남세브란스병원) ····· 31

14:45～15:00 Coffee Break

15:00～15:30 Lung Transplantation 함석진 (아주대학교의료원) ····· 44

15:30～16:00 Imaging in Thoracic Disease 박성용 (연세대학교 세브란스병원) ··· 54

16:00～16:30 Pain Control After Thoracic Surgery 전재현 (분당서울대학교병원) ····· 62

16:30～17:00 Coffee Break

17:00～17:15 흉부외과 추천 도서 소개 조석기 (분당서울대학교병원) ····· 73

17:15～18:45 특 강 (패널 토론)

의사와 환자의 소통 박계현 (교육위원장) ····· 77

패널: 문병주(Southlake Regional Health Center),
김동중(분당서울대학교병원), 김길원(연합뉴스)

18:45～19:00 기념 촬영

19:00～21:00 저녁 식사 및 친교의 시간 장소: 건도리횟집 ☏ 033-644-9700
호텔 로비 건도리횟집 45인승 차량으로 이동

일시 : 2019. 5. 24(금) 장소: 세인트존스호텔 볼룸 바부다

일시: 2019. 5. 25(토) 장소: 그랜드볼룸 안티구아 I (4층)

07:00～08:00 **아침식사** **장소: 뷔페 플레이버 (3층)**

08:00～12:00 **Hands-on & Simulation** **김재범 (계명대학교 동산의료원)**

1. Echocardiography — 임주영 (고려대학교 안암병원) ····· 214
   김재범 (계명대학교 동산의료원)

2. US-guided Vascular Procedure/ECMO Cannulation
   김동중 (분당서울대학교병원)

3. ECMO Decannulation (Device Closure) — 정인석 (전남대학교병원)

4. ECMO Priming - EBS & PLS — 송승환 (부산대학교병원)

조양현 (성균관대학교 삼성서울병원), 강민형 (부산대학교병원 체외순환사),
이광일 (전남대학교병원 체외순환사), 황현주 (부산대학교병원 간호사)

Hands-on & Simulation 시간 / 조 배정

	US-guided Vascular Procedure/ECMO Cannulation	ECMO Decannulation	ECMO Priming - EBS
08:00～08:30	1조	2조	3조
08:30～09:00	2조	1조	4조
09:00～09:10	Coffee Break		
09:10～09:40	5조	6조	1조
09:40～10:10	6조	5조	2조
10:10～10:30	Coffee Break 및 객실 Check Out <프론트에 객실키 반납>		
10:30～11:00	3조	4조	5조
11:00～11:30	4조	3조	6조

Hands-on & Simulation 시간 / 조 배정

	ECMO Priming - PLS	Echocardiography
08:00～08:30	4조	5조(임주영), 6조(김재범)
08:30～09:00	3조	
09:00～09:10	Coffee Break	
09:10～09:40	2조	3조(임주영), 4조(김재범)
09:40～10:10	1조	
10:10～10:30	Coffee Break 및 객실 Check Out <프론트에 객실키 반납>	
10:30～11:00	6조	1조(임주영), 2조(김재범)
11:00～11:30	5조	

12:00～13:00 **점심식사** **장소: 그랜드볼룸 안티구아 II (4층)**

13:00～14:00 **교육평가 및 종료** **장소: 세인트존스호텔 볼룸 바부다**

【일반흉부파트】

좌장: 이성수

Diagnosis and Management of Mediastinal Diseases

Pusan National University

Jeong Su Cho

Contents

- Anatomy
- Non invasive and invasive Investigations
- Mediastinal infection
- Primary mediastinal tumors and syndromes associated with mediastinal lesions
- Mediastinal cysts

Anatomy

- Traditional four-compartment subdivision
  - Sup / Ant / Middle / Post mediastinum

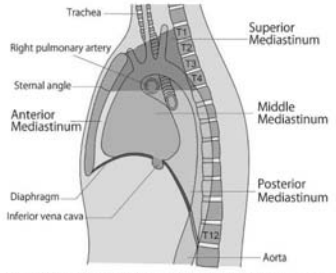


FIGURE 147.1 Schematic illustration of the traditional four-compartment subdivision of the mediastinum.

Anatomy

- Traditional three-compartment subdivision
  - Ant / Middle / Post mediastinum

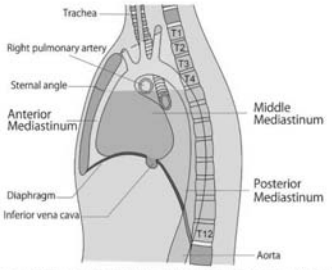


FIGURE 147.2 An example of the schematic illustration of the traditional three-compartment subdivision of the mediastinum.

Anatomy

- Felson's classification
  - Ant / Middle / Post mediastinum

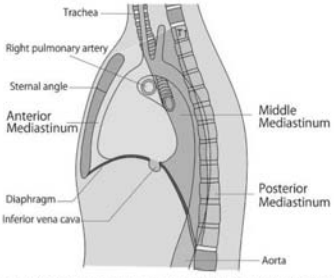


FIGURE 147.3 Schematic illustration of Felson's classification of the mediastinum compartment. Felson's classification is based on the chest roentgenology, therefore the boundary line could be vague.

Anatomy

- Shields' mediastinal subdivision.
  - Ant / Middle / Post mediastinum

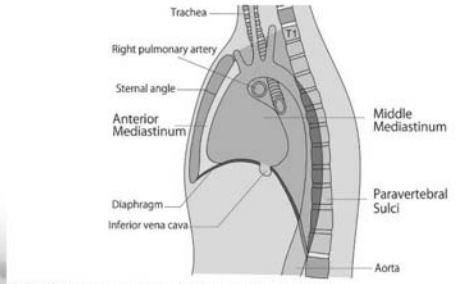
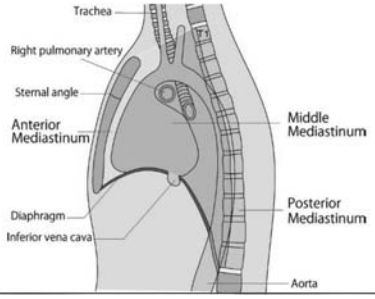


FIGURE 147.4 Schematic illustration of the Shields' mediastinal subdivision.

Anatomy

- International Thymic Malignancy Interest Group(ITMIG) Classification

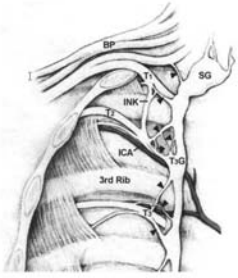


Anatomy(ITMIG)

- Ant mediastinum
  - **Thymus**
  - Connective tissue with fat
  - Left brachiocephalic vein

Anatomy(ITMIG)

- Middle compartment
  - Vascular category
    - heart, superior vena cava, ascen descending thoracic aorta, intrap thoracic ductof the azygos vein
  - The other category
    - trachea, carina, and esophagus, embryological origin

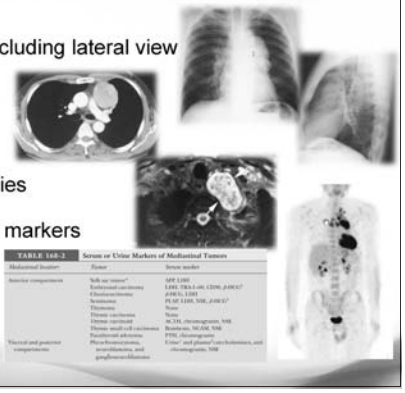


Anatomy(ITMIG)

- Post compartment
  - thoracic spine and paravertebral soft tissues.

Non invasive Investigations

- Chest plain film including lateral view
- Chest CT
- Chest MRI
- Radionuclide studies
- Mediastinal tumor markers



Invasive Investigations and surgical approaches

- Transcervical mediastinal LN sampling and Lymphadenectomy
  - Mediastinoscopy: extended, video-assisted
- Robotic or Video-assisted thoracic surgery
- Sternotomy and Thoracotomy
- Posterior Mediastinotomy

Mediastinal infections

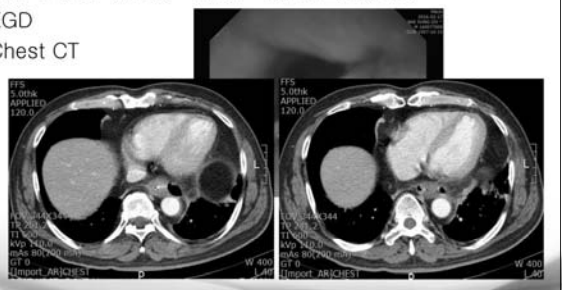
- **Acute and chronic mediastinitis**
  - **Perforation of the aero-digestive tract**
  - **Postoperative sternal infection and mediastinitis**
  - **Descending necrotizing mediastinitis**
  - **Sub-acute mediastinitis**
  - **Fibrosing mediastinitis**

Perforation of the aero-digestive tract

- ***Four principles*** of treatment
  1. **Eliminate source of soilage**
  2. **Provide thorough and wide mediastinal drainage**
  3. **Appropriate**
  4. **Maintain adequate nutrition.**

Case

- 56/M
- 내원 수일전 매운탕 먹다가 목에 이물감 발생
- EGD
- Chest CT



Postoperative sternal infection and mediastinitis

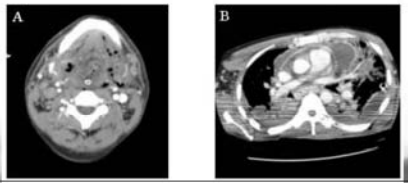
- Risk factor
  - Sternotomy: incomplete closure
  - Tracheostomy
  - CPB duration
  - Postoperative bleeding
  - Infection
  - Low cardiac output
  - Poor general condition
  - Steroid

Descending necrotizing mediastinitis

- Acute purulent mediastinitis due to oropharyngeal infection
- uncommon but still lethal form of mediastinitis
- 60 ~ 70%, secondary to odontogenic infections
- Peritonsillar abscess, Retropharyngeal and parapharyngeal abscess, Epiglottitis
- Other less common causes
  - trauma to the neck, including neck or mediastinal surgery
  - cervical lymphadenitis, endotracheal intubation

Case

- 43세 여자 환자가 고열과 전신무력감 호소
- Present illness : 최근 치통으로 충치치료를 지속적으로 받고 있었으나 잘 조절되지 않아 발치를 하였으며 이후 고열과 전신무력감이 심해짐
- V/S : BP 80/50, PR 120/min, BT 38.9°C
- P/Ex: 턱 아래쪽과 목 주위가 부어 있었으며 발적과 함께 열감과 동통
- Chest CT



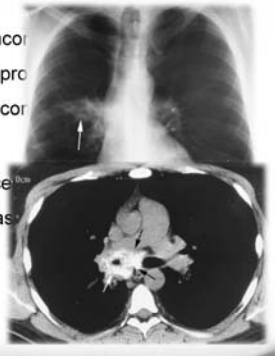
- 진단은?
- 치료는?
- 예후는?

Sub-acute mediastinitis

- The definition of subacute mediastinitis is unclear, but this term should embrace those inflammatory processes involving the mediastinum that produce minimal to mild and evanescent symptomatology (substernal pain, fever, night sweats) and an identifiable anterior or visceral mediastinal mass by radiographic or CT examination.
- These infections most often are the result of fungal, mycobacterial, or, rarely, actinomycotic organisms.
- Such subacute infections are observed only infrequently in previously normal, healthy persons but are becoming more common in immunocompromised patients, particularly those with AIDS.

Fibrosing mediastinitis

- Fibrosing mediastinitis is an unco
  resulting in the deposition and pro
  tissue through out the visceral cor
  mediastinum.
- This chronic inflammatory proce
  and compression of vital media



Primary mediastinal tumors and syndromes

- Thymic tumors
- Myasthenia Gravis
- Benign LN disease
- Germ cell tumor
- Neurogenic tumors

Thymic tumors

TABLE 166.1 WHO Histologic Subtypes of Thymic Epithelial Tumors

Thymoma	Thymic Carcinoma	Thymic Neuroendocrine Tumor
A	Squamous	Carcinoid tumor Typical Atypical
AB	Basaloid	Large cell neuroendocrine
B1	Mucoepidermoid	Small cell carcinoma
B2	Lymphoepithelioma-like	
B3	Clear cell	
Micronodular tumor with lymphoid stroma	Sarcomatoid	
Metaplastic thymoma	Adenocarcinoma	
	Undifferentiated carcinoma	

Sheild's Geneal Thoracic Surgery 8th edition

Thymic tumor

- Neoplasm of the thymus that originates in the gland's epithelial tissue.
- Incidence: thymoma(2.2 to 2.6/million/yr), thymic carcinomas (0.3 to 0.6/million/yr), thymic neuroendocrine tumors(even less common)
- Typically slow-growing tumors
- Spread by local extension
- Metastases are usually confined to the pleura, pericardium, or diaphragm, whereas extrathoracic metastases are uncommon.

Sheild's Geneal Thoracic Surgery 8th edition

Clinical presentation

- Thoracic symptoms
  - Related to the size of the tumor and its effects on adjacent organs
    : chest pain, shortness of breath, cough, phrenic nerve palsy, superior vena cava obstruction
  - Systemic ("B") symptoms
    : fever, weight loss, and/or night sweats

Sheild's Geneal Thoracic Surgery 8th edition

Paraneoplastic disorders

- Myasthenia gravis
- Pure red cell aplasia
- Immunodeficiency
- Thymoma-associated multiorgan autoimmunity

Sheild's Geneal Thoracic Surgery 8th edition

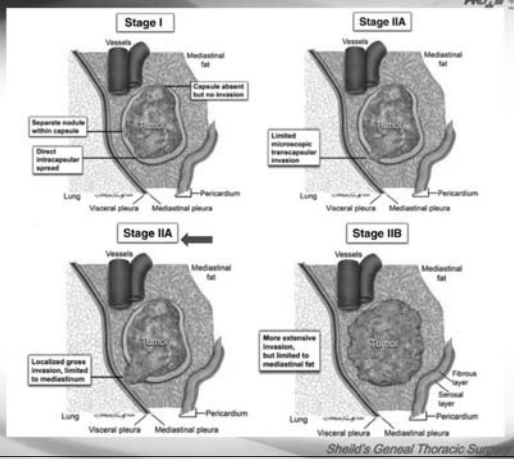
Staging system

TABLE 166.2 Description of Masaoka-Koga Staging System

Stage	Description
I	Grossly and microscopically encapsulated tumor
IIA	Microscopic invasion through the capsule
IIB	Gross/macroscopic invasion through the capsule into the surrounding fat but no invasion of pleura or pericardium
III	Direct invasion into adjacent structures (pleura, pericardium, lung parenchyma, vascular structures)
IVA	Pleural or pericardial metastasis/implants
IVB	Lymph node metastasis (no level specified). Hematogenous metastasis

Adapted from Koga K, Matsuno Y, Noguchi M, et al. A review of 79 thymomas: modification of staging system and reappraisal of conventional division into invasive and non-invasive thymoma. *Pathol Int* 1994;44:359–367. Copyright © 1994 by John Wiley Sons, Inc. Reprinted by permission of John Wiley & Sons, Inc.

Sheild's Geneal Thoracic Surgery 8th edition



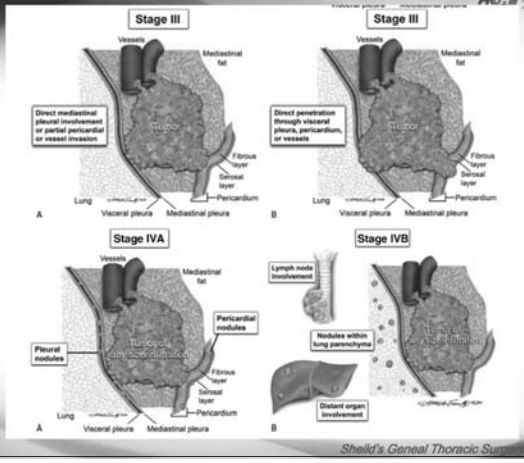
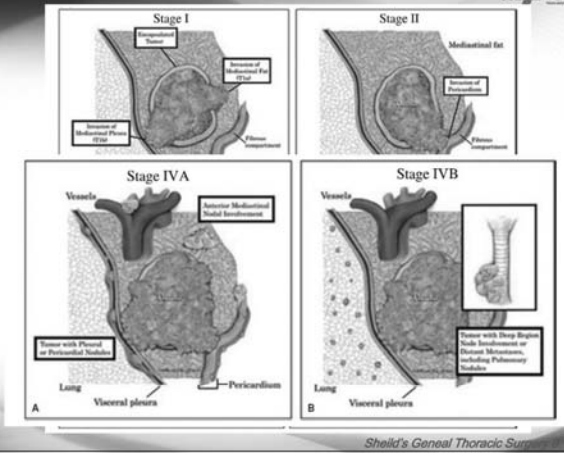


TABLE 166.3 The TNM Staging System Proposal by ITMIG/IASLC

	Description		
T1			
a	Tumor limited to capsule or mediastinal fat		
b	Extension into mediastinal pleura		
T2	Invasion of pericardium		
T3	Invasion of lung, chest wall, phrenic nerve, brachiocephalic vein, pulmonary vessels, hilum		
T4	Invasion of aorta, aortic arch vessels, main pulmonary artery, myocardium, trachea, esophagus		
N0	No nodal involvement		
N1	Anterior nodes (perithymic)		
N2	Deep intrathoracic or cervical nodes		
M0	No metastatic disease		
M1			
a	Pleural or pericardial nodules (separate from primary tumor)		
b	Pulmonary intraparenchymal metastasis, extrathoracic metastasis		
Stage	**T**	**N**	**M**
I	T1	N0	M0
II	T2	N0	M0
IIIA	T3	N0	M0
IIIB	T4	N0	M0
IVA	T any T any	N1 N0,1	M0 M1a
IVB	T any T any	N2 N any	M0, 1a M1b

Sheild's Geneal Thoracic Surgery 8th edition



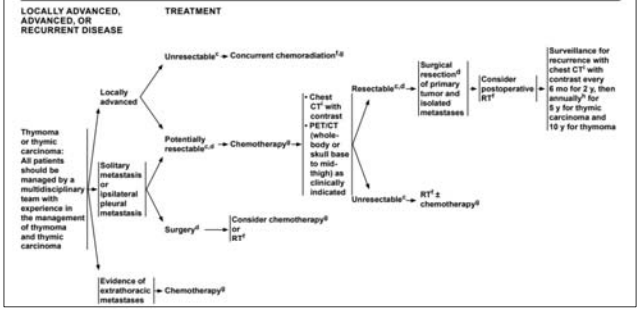
Sheild's Geneal Thoracic Surgery 8th edition

Treatment

National Comprehensive Cancer Network®

NCCN Guidelines Version 2.2019
Thymomas and Thymic Carcinomas

NCCN Guidelines Index
Table of Contents
Discussion



Early Stage Tumors

- **R0 resection** is the goal of treatment with care to avoid violating the tumor capsule.
  - **total thymectomy** with en-bloc resection of the tumor with the entire thymus gland and surrounding fat.
  - thymomectomy alone : not good
  - approaches
    - transsternal
    - thoracotomy or hemiclamshell,
    - minimally invasive thoracoscopic or robotic approach,
    - transcervical approach.

Locally Advanced Tumors

- Except for stage IVB tumors (LN or extrathoracic metastases) thymic tumors are generally considered a surgical disease, and **complete resection (R0) is the primary goal of treatment**.
- *Thymomas are typically chemosensitive and the goal of neoadjuvant chemotherapy is to improve the rate of R0 resection.*
- For advanced tumors with local invasion, especially if resection margins are close or positive, postoperative radiation treatment (PORT) is favored.

Locally Advanced Tumors

- Although thymic carcinomas are much less responsive to chemotherapy, recent evidence suggests that thymic carcinomas may benefit from PORT.
- Patients with thymic tumors are generally younger and healthier than those with lung or esophageal cancers and, thus, are able to tolerate **extended resections** quite well.
- It is recommended that surgical resection be performed within 6 to 8 weeks of completion of chemotherapy.

NEOADJUVANT TREATMENT FOR THYMIC TUMORS

- **Induction Chemotherapy**
  - Thymomas are considered to be chemosensitive tumors and a variety of combinations of chemotherapy regimens have been reported with varying response rates
  - There are no randomized trials examining different regimens
- **Induction Chemoradiation**
- **Induction Radiation Therapy**

ADJUVANT TREATMENT FOR THYMIC TUMORS

- **Adjuvant Chemotherapy**
- **Adjuvant Radiation Therapy**
  - ***Port in Thymoma***
  - ***Port in Thymic Carcinoma***

Prognosis

- Thymomas are indolent tumors that usually do not shorten life expectancy
- They can recur **and therefore, long-term follow-up is still required after resection.**
- **The majority of the recurrences are** intrathoracic and re-resection has been described and associated with long-term survival.
- Most authors have described treatment with **neoadjuvant chemotherapy or chemoradiation followed by local resection**, if there is no progression of disease. There are, however, significant biases in these studies and the decision to re-resect should be made on a case-by-case basis with multidisciplinary tumor board consensus.

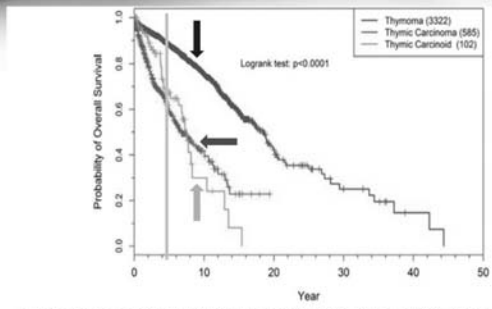


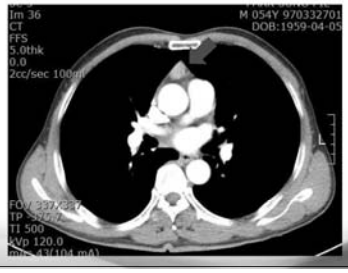
FIGURE 166.4 Overall survival of thymoma, thymic carcinoma, and neuroendocrine tumors in the ITMIG database. (Reprinted from Huang J, Ahmad U, Antonicelli A, et al. Development of the international thymic malignancy interest group international database: an unprecedented resource for the study of a rare group of tumors. *J Thorac Oncol* 2014;9(10):1573–1578. Copyright © 2014 International Association for the Study of Lung Cancer. With permission.)

Myasthenia Gravis

- Neuromuscular junction disorder
- caused by the autoimmune destruction of the acetylcholine receptors of voluntary muscle
- Sx: diplopia, ptosis, dysphagia, weakness, fatigue
- approximately 30% of patients with thymomas have myasthenia gravis
- rare in thymic carcinoma

Case

- 57세 남자 환자가 복시 현상 및 저녁이 되면 무기력함을 호소하여 응급실을 방문하였다. 시행한 흉부전산화단층촬영에서 아래와 같은 병변이 관찰되었다.



- 진단을 위한 검사는?
- 진단은?
- 적절한 그 다음 조치는?

DIAGNOSIS

- **Clinical Aspects**
- **Radiographic and Electrophysiologic Evaluation**
- **Antibodies to Acetycholine Receptor**

TABLE 164.1 Osserman and Genkins Classification of Myasthenia Gravis, Modified by the MGFA Task Force

Class	Clinical Form(s)	Symptoms
I[1]/MGFA I	Ocular form	Ptosis, diplopia
IIa[2]/MGFA II	Mild generalized form	Mild generalized weakness
IIb[2]/MGFA IIb	Faciopharyngeal form	IIa + bulbar weakness
III[2]	Severe acute generalized form	Acute severe general weakness + bulbar symptoms + respiratory insufficiency
MGFA III	Medium severity generalized form	Medium severity generalized weakness with:
MGFA IIIa		Involvement of the extremities/trunk musculature > faciopharyngeal musculature
MGFA IIIb		Faciopharyngeal/respiratory musculature > extremities/trunk musculature
IV[2]	Severe chronic generalized form	Severe, often progressive generalized weakness
MGFA IV	Severe generalized form	
MGFA IVa		Extremities/trunk musculature > faciopharyngeal musculature
MGFA IVb		Faciopharyngeal/respiratory musculature > extremities/trunk musculature
V[2]	Myasthenia with severe residual deficits	Severe chronic form with muscle atrophy
MGFA V	Severe MG requiring intubation	

[1]MGFA, Myasthenia Gravis Foundation Association; the entries marked.
[2]Refer to the Osserman and Genkins classification.
Adapted from Tsyka KV, Gold R. Treatment of Myasthenia Gravis. *Schweiz Arch Neurol Psychiatr* 2007;158:308. With permission from BMH Swiss Medical Publishers Ltd.

Sheild's Geneal Thoracic Surgery 8th edition

Treatment

- Medication
  - ACETYLCHOLINESTERASE INHIBITORS
  - CORTICOSTEROIDS
  - AZATHIOPRINE, CYCLOSPORINE
  - MYCOPHENOLATE MOFETIL
  - RITUXIMAB
- PLASMA EXCHANGE AND INTRAVENOUS IMMUNOGLOBULIN
- ***THYMECTOMY***

Thymectomy Classification

TABLE 165.1 Thymectomy Classification

T-1 Transcervical Thymectomy
  (a)-Basic
  (b)-Extended
T-2 Videoscopic Thymectomy
  (a)-"Classic"
  (b)-"VATET"
T-3 Transsternal Thymectomy
  (a)-Standard
  (b)-Extended
T-4 Transcervical & Transsternal Thymectomy

Regardless of the technique employed,
Complete removal of all thymic tissue is the goal

Minimally invasive maximal thymectomy.

Sheild's Geneal Thoracic Surgery 8th edition

MYASTHENIC CRISIS

- Approximately 16% of all patients experience a crisis, a figure that has not appreciably changed over time.
- Progressive weakness, oropharyngeal symptoms, refractoriness to anticholinesterase medication, and infection precede crisis in most of these patients.
- Crisis is a temporary exacerbation, regardless of the proximate cause.
- The goal is to keep the patient alive **until the transient morbidity of viral or bacterial infection, aspiration pneumonitis, surgery, or other complications subsides** and **responsiveness to anticholinesterase medication returns.**

Sheild's Geneal Thoracic Surgery 8th edition

Benign LN disease

TABLE 167.1 Benign Mediastinal Lymphadenopathies

I. Mediastinal granulomatous disease
- Tuberculosis
- Fungal infection
- Sarcoidosis
- Silicosis
- Wegener granulomatosis

II. Castleman disease

III. Others
- Systemic lupus erythematosus
- Infectious mononucleosis
- Reactive lymph node hyperplasia
- Amyloidosis
- HIV–associated *Pneumocystis carinii*

Sheild's Geneal Thoracic Surgery 8th edition

Germ cell tumor

TABLE 169.1 Classification of Mediastinal Germ Cell Tumors

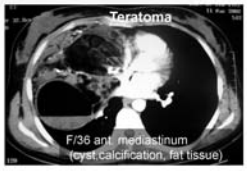
I. Teratomatous lesions
1. Mature teratoma (composed of well-differentiated, mature elements)
2. Immature teratoma (with the presence of immature mesenchymal or neuroepithelial tissue)
3. Teratoma with additional malignant component:
   - Type I: with an associated malignant GCT tumor (seminoma, embryonal carcinoma, yolk sac tumor, etc.)
   - Type II: with a non–germ cell epithelial component (squamous, adenocarcinoma, etc.)
   - Type III: with a malignant mesenchymal component (rhabdomyosarcoma, chondrosarcoma, etc.)
   - Type IV: a teratoma with any combination of the above

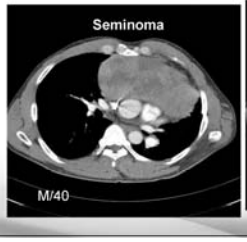
II. Nonteratomatous tumors
1. Seminoma
2. Yolk sac tumor, or endodermal sinus tumor
3. Embryonal carcinoma
4. Choriocarcinoma
5. Combined nonteratomatous tumors (a combination of any of the above)

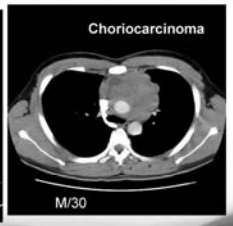
Sheild's Geneal Thoracic Surgery 8th edition

Mediastinal Tumor

- Anterior mediastinum
- Thymoma? Lymphoma? Teratoma? or other
- Biopsy?
- Operation?
  - When?
  - (VATS or sternotomy? thoracotomy?)
- Postop. ?







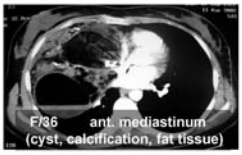
Incidence

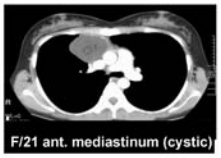
5-10% (extra-gonadal, mediastinum)	of Germ cell tumor
15% (85% benign) 25% (children, 대부분 benign)	of Anterior mediastinal tumors *Mullen & Richardson (1986)*
42 (10%) (50% benign)	400 mediastinal mass *Duke Univ. medical center (1930-1982)*

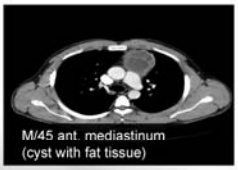
Benign GCT (Teratoma) *Shirodkar (1997)*
- 97-98% anterior mediastinum
- 3-8% posterior mediastinum)

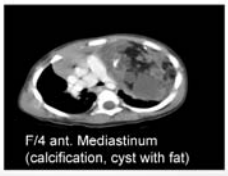
Malignant GCT
- 1-5% of all germ cell neoplasm
- 3-5% of mediastinal tumors
  - Seminoma 50% / Non-seminomatous GCT 50%

Benign Germ Cell Tumors





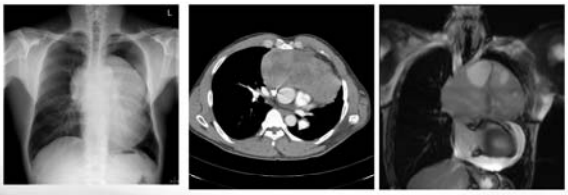




- **Three primodial layers**
  - Ectoderm; skin, hair
  - Mesoderm; bone, fat, muscle
  - Endoderm; respiratory epithelium, GIT
- Mature cells or tissues – **Mature teratoma**
- Less well-differentiated tissues – **Immature**
  - Infant; behave similarly to mature teratoma
  - Older patient; more aggressive (malignant teratoma)

Seminoma

- Second common mediastinal GCT / TMC malignant mediastinal GCT
- 3 rd ~ 5 th decade men, white men predominant
- Slow-growing tumors with lobular appearance including necrosis, hemorrhage
  - encapsulation – half of time, calcification – infrequently



40/M Seminoma

Seminoma

Young man with anterior mediastinal tumor

Serum Tumor markers
hCG AFP LDH

(+) hCG * (-) AFP → *Seminoma (pure)*

(++) hCG (+) AFP → *Mixed tumor or NSGCT*

NSGCT

Testicular exam. : bimanual exam. & U/S
Abdominal CT/ Bone scan/ Brain CT or MR

Biopsy Mediastinoscpy or Sternotomy VATS

Seminoma

Radiotherapy or adjuvant radiotherapy
Surgery

Chemotherapy

Poor Prognostic factor

Age greater than 35 years
Bulky mediastinal disease
SVC obstruction
Lymphadenopathy

Platinum-based complete remission 88 ~ 100 %
5 YSR 70 ~ 85 %

Courtesy by prof. Kim

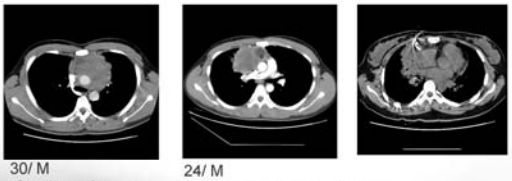
International Germ Cell Cancer Collaboration Group
J Clin Oncol 1977

Good Prognosis		
	Any Primary site	**90% of seminomas**
	No NPVM	**5 year PFS 82 %**
	Normal AFP, hCG, LDH	**5 YSR 86 %**
Intermediate Prognosis		
	Any Primary site	**10% of seminomas**
	NPVM (liver, bone, brain)	**5 year PFS 67 %**
	Normal AFP, hCG, LDH	**5 YSR 72 %**

NPVM non-pulmonary visceral metastasis
PFS progression free survival

Non-seminomatous GCT

- Potentially curable with surgery
- Exclusively in young adult, men (fewer than 30 cases reported in women)
- Rapid local growing tumors with early metastasis (85-90% at diagnosis)
- In-homogenous mass with multiple areas of necrosis & hemorrhage



30/ M
Choriocarcinoma

24/ M
Endodermal sinus tumor

NSGCT

Incidence	*Moran & Suster (1997) 229 cases*	*강창현 (2008) 29cases*
Teratocarcinoma	41 %	9.5 %
58% non-germ cell component (sarcoma, epithelial carcinoma)		
Endodermal sinus (Yolk sac) tumor	35 %	42.9 %
Choriocarcinama	7 %	4.8 %
Embryonal carcinoma	6 %	9.5 %
Mixed	11 %	9.5 %
Unknown		23.8 %

Differ from testis origin

Pure endodermal sinus tumor, extremely rare in testis
Embryonal carcinoma, much higher in testis
Non-germ call histologies is more common in mediastinum

NSGCT

Tumor markers	
hCG or AFP	90%
AFP with/without hCG	80%
hCG	30-35%
LDH	80-90%

APF 이 증가된 경우는 조직검사상 pure seminoma로 보인다고 해도 NSGCT와 같이 치료
hCG가 100 ng/ml 이상은 pure seminoma에서 uncommon

Differ from testis origin

Testicular NSGCT AFP & hCG equal frequency

NSGCT

Associated syndromes

Hematologic malignancies		
	Acute non-lymphocytic leukemia	Acute lymphocytic leukemia
	Erythroleukemia	Acute megakaryocytic leukemia
	Myelodysplastic syndrome	Malignant histiocytosis
	Hartmann(2000) 2% *(287 mediastinal NSGCT)*	*Median survival 5 months* *No patient more than 2 years*
Idiopathic thrombocytopenia		
Hemophagocytic syndrome	*single case of endodermal sinus tumor*	
Klinefelter's syndrome	*not associated with testicular GCT* *common underlying germ cell defect*	

NSGCT

Young man with anterior mediastinal tumor

Serum Tumor markers
hCG AFP LDH

(+) hCG * (-) AFP
Seminoma (pure)

(++) hCG (+) AFP
Mixed tumor or NSGCT

Biopsy, least invasive approach
Excess 500 ng/ml of hCG or AFP not delay chemotherapy due to biopsy

Platinum-based
Long-term survival 41 %

Chemotherapy

Surgery ? or not

Poor Prognostic factor
Bulky mediastinal disease – incomplete surgical resection
Histology – pure endodermal sinus tumor
Pre-chemotherapy hCG concentration

NSGCT

Initial Chemotherapy (3-4 cycles)

hCG, AFP (N)
CXR (N)

hCG, AFP (N)
CXR (residual tumor)

hCG, AFP

f/u for 24 months
during first 2 yrs
20% relapse

Surgical Resection

Salvage Chemotherapy

hCG AFP

Benign teratoma and/or Necrotic tumor

Viable GCT Resected

Viable GCT Incompletely Resected

Viable non-GCT Resected

f/u for 24 months

Chemotherapy add 2 cycles

Salvage Chemotherapy

Investigational treatment or Supportive care

Fig 187-7 Shield, General Thoracic Surgery

TABLE 169.2 Definitions of the Germ Cell Consensus Classification for Metastatic GCT

I. Good prognosis
- A. Nonseminoma. Testis/retroperitoneal primary and no nonpulmonary visceral metastases and good markers, including all of α-fetoprotein (α-FP) <1,000 ng/mL, and β-human chorionic gonadotropin (β-HCG) <5,000 IU/L (1,000 ng/mL) and serum lactate dehydrogenase (LDH) <1.5 times the upper limit of normal); 56% of nonseminomas show a progression-free survival (PFS) rate of 89% and a 5-year survival rate of 92%.
- B. Seminoma. At any primary site and no nonpulmonary visceral metastases and normal α-FP, any β-CG, any LDH; 90% seminomas, 5-year PFS rate of 82% and 5-year survival rate of 86%.

II. Intermediate prognosis
- A. Nonseminoma. Testis/retroperitoneal primary and no nonpulmonary visceral metastases and any of α-FP ≥1,000 ng/mL and ≤10,000 ng/mL or β-HCG ≥5,000 IU or ≤50,000 IU/L or LDH ≥1.5 times normal or ≤10 times normal; 28% of nonseminomas show a 5-year PFS rate of 75% and a 5-year survival rate of 80%.
- B. Seminoma. At any primary site and nonpulmonary visceral metastases and normal α-FP, any β-HCG, and any LDH; 10% of seminomas, 5-year PFS of 67% and 5-year survival of 72%.

III. Poor prognosis
- A. Nonseminoma. All patients with mediastinal primary, or nonpulmonary visceral metastases, or poor markers: α-FP >10,000 ng/ml or β-HCG >50,000 IU/L (1,000 ng/mL) or LDH >10 times × upper limit of normal; 16% of nonseminomas show a PFS of 41% and 5-year survival of 48%.
- B. Seminoma. No patients are classified as poor prognosis.

Sheild's Geneal Thoracic Surgery 8th edition

NSGCT

International Germ Cell Cancer Collaboration Group ***J Clin Oncol 1977***

	AFP	*hCG*	*LDH*	non-semonomas	
Good Prognosis					
Testis/retroperitoneal				56%	
No NPVM				5 year PFS	82 %
Good markers	< 1000	< 1000	< 1.5 x N	5 YSR	86 %
Intermediate Prognosis					
Testis/retroperitoneal				28%	
No NPVM				5 year PFS	75 %
Intermediate markers	1,000~ 10,000	1,000~ 10,000	1,5 x~ 10 x N	5 YSR	80 %
Poor Prognosis					
Mediastinal primary				16%	
NPVM (liver bone, brain)				5 year PFS	41 %
Poor markers	> 10,000	> 10,000	> 10 x N	5 YSR	48 %

NPVM non-pulmonary visceral metastasis
PFS progression free survival

Neurogenic tumors

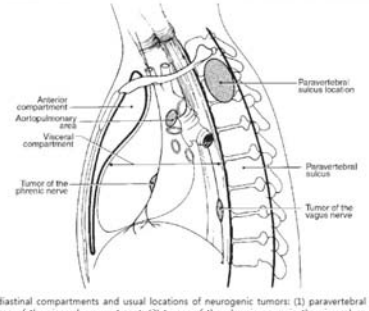


FIGURE 170.1 Mediastinal compartments and usual locations of neurogenic tumors: (1) paravertebral sulcus location; (2) aortopulmonary area of the visceral compartment; (3) tumor of the phrenic nerve in the visceral compartment; and (4) tumor of the vagus nerve in the visceral compartment. (Reprinted from Shields TW, Reynolds M. Neurogenic tumors of the thorax. *Surg Clin North Am* 1988;68:645. Copyright © 1988 Elsevier. With permission.)

Sheild's Geneal Thoracic Surgery 8th edition

TABLE 170.1 Neurogenic Tumors of the Thorax

Benign	Malignant	Age Group
Nerve sheath origin Neurilemoma	Malignant schwannoma; neurogenic sarcoma Neurogenic sarcoma	Adults
Neurofibroma Melanotic schwannoma		Adults Adults
Granular cell tumor		Adults
Autonomic ganglia Ganglioneuroma	Ganglioneuroblastoma Neuroblastoma Primary malignant melanotic tumor of the sympathetic ganglia	Children and young adults Children, rarely in adults Adults
Peripheral neuroectodermal tumor	Malignant small-cell tumor; Askin tumor	Children

TABLE 170.2 Mediastinal Neurogenic Tumors

Tumors of Autonomic Ganglia	Neuroblastoma	Ganglioneuroblastoma	Ganglioneuroma
Tumors of Nerve Sheath Origin	Schwannoma (Neurilemoma)	Neurofibroma	Malignant schwannoma (Neurogenic sarcoma)
Tumors of Neuroectodermal Origin	MNTI	Askin tumor	
Tumors of Paraganglia Origin	Paraganglioma		

Sheild's Geneal Thoracic Surgery 8th edition

Mesenchymal Tumors of the Mediastinum

TABLE 172.1 Primary Mesenchymal Tumors

Tissue	Benign	Malignant
Adipose	Lipoma Lipoblastoma Hibernoma	Liposarcoma
Lymphatic	Lymphangioma Lymphangioleiomyomatosis	
Blood Vessels	Hemangioma Hemangiopericytoma	Hemangioendothelioma Angiosarcoma
Fibroblasts	Fibromatosis	Fibrosarcoma Malignant Fibrous Histiocytoma Inflammatory Fibrosarcoma
Skeletal	Chondroma	Osteosarcoma Chondrosarcoma
Muscular		
Striated	Leiomyoma	Leiomyosarcoma
Smooth	Rhabdomyoma	Rhabdomyosarcoma

Sheild's Geneal Thoracic Surgery 8th edition

Diagnosis and Management of Pleural Diseases

분당서울대학교병원 흉부외과학교실

조 석 기

Contents

강의 내용

1. Pleural disease 내용이 상당히 많고, 평소에 잘 다루어지지 않는 부분도 포함되어 있어 따로 공부하기가 만만치 않습니다. 최대한 이 강의록을 바탕으로 공부하시고, 필요한 경우 교과서와 논문을 찾아보거나, 각 병원의 지도 전문의의 교육을 받기 바랍니다.
2. 전공의 역량강화 프로그램이라는 것을 수련심사위원회에서 현재 준비 중에 있어서 여기에 일부 적용하였습니다. 각 질환별로, 전공의 4년 동안 익혀야 할 지식과 술기 부분이 정리되어 있고 이 부분을 중심으로 강의록을 만들었습니다.
3. 이 모든 것을 강의시간에 다루지는 않으며, 그 중에서 꼭 필요하거나 강조하고 싶은 부분만 다루게 됩니다. 또한 강의슬라이드는 전반 부위는 강의시간에 다루게 되고 후반 부위는 강의록의 이해를 돕기 위해서 추가한 부분들로 참고하시기 바랍니다.

1. Pneumothorax

주제	공기가슴증 (Pneumothorax)	평가방법
수련목표	전공의로서 응급실에 내원한 공기 가슴증 환자에 대해서 정확히 진단하고 흉관을 삽입할 수 있으며, 수술이 필요한 경우 적절한 수술까지도 시행할 수 있어야 한다.	
	의학지식	
Basic (1, 2년차)	기흉의 정의를 설명할 수 있다. 기흉의 분류와 원인을 설명할 수 있다. 기흉의 진단 방법을 설명할 수 있다. 기흉의 치료 방법을 설명할 수 있다. 기흉의 수술 적응증을 설명할 수 있다. 기흉의 수술 후 재발의 원인을 설명할 수 있다	구두평가 (회진시)
Advanced (3, 4년차)	정상적인 가슴막의 생리를 설명할 수 있다. 기흉의 수술 방법에 대해서 설명할 수 있다. 기흉의 재발을 줄일 수 있는 수술방법에 대해서 설명할 수 있다 이차성, 외상성, 신생아, 월경성 기흉의 비수술적, 수술적 치료에 대한 비교평가 및 예후를 설명할 수 있다.	구두평가 (회진시)
Far advanced (전임의)	없음	구두평가 (회진시)
	술기와 수술	
Basic (1, 2년차)	다양한 크기의 흉관을 삽입을 할 수 있다. 다양한 위치에 흉관을 삽입할 수 있다. 흉관을 공기가 들어가지 않도록 제거 할 수 있다. 긴장성 공기가슴증에서 응급처치를 할 수 있다. 수술에 필요한 적절한 체위 조절을 할 수 있다. 흉관을 통한 chemical pleurodesis 를 할 수 있다	직접시행 (병동/ 응급실)
Advanced (3, 4년차)	수술 중 공기 유출에 대해서 정확히 평가할 수 있다. 공기가슴증에 대한 VATS wedge resection을 할 수 있다.	직접시행 (수술실)
Far advanced (전임의)	공기가슴증에 대한 복잡한 수술적 치료를 시행 할 수 있다. (Single port VATS-wedge resection, bullae ligation, pleurectomy등)	직접시행 (수술실)

1) Definition

- Accumulation of air in the pleural space
- Collapse of the lung

2) Classification

① Spontaneous

- Primary: no immediate apparent lung disease, bulla or bleb rupture
- Secondary: a complication of clinically apparent lung disease

② Traumatic

- Blunt trauma; rib fracture
- Penetration trauma; gun shot, knife

③ Iatrogenic

- Transthoracic or transbronchial lung biopsy
- Placement of central venous catheter
- Thoracentesis or pleural biopsy
- Barotrauma; mechanical ventilation

④ Catamenial

- Female (20–30 yr), recurrent, menstrual cycle (48–72 hr),
- Right dominant (90%), No pneumothorax if not ovulation
- Surgery (diaphragm resection), ovulatory suppressive drug

Differences Between Primary and Secondary Pneumothorax

		Primary	*Secondary*
Presentation	Age Chest pain Dyspnea	Usually <35 years Usual, may be severe Usually mild/moderate	Usually > 45 years Occasional Often severe
Chest radiograph	Degree of collapse Pleural reaction Other findings	Any size, often small Common, may suggest diagnosis Often mediastinal shift in complete collapse	Usually small or moderate Occasional Changes of underlying disease
Resolution on medical management	Observation alone Preferred initial intervention Persistent air leak	Often possiible, outpatient Simple aspiration or CASP Occasional, surgery indicated	Usually inappropriate, requires admission Simple aspiration or CASP
	Medical pleurodesis Surgical approach[a]	Not appropriate VATS is best option	Common, but 20% eventually resolve If high surgical risk VATS, but mini-thoracotomy may be needed

CASP, catheter aspiration of pneumothorax.
[a]Surgical approach includes a combination of bleb excision, apical pleurectomy, pleural abrasion, talc or doxycycline pleurodesis

3) Diagnosis

① Chest PA

- Amount of pneumothorax
- If small amount, check expiration CXR
- If necessary to ddx from large bulla, check decubitus CXR

② Chest CT

- Bleb; subpleural collection of air within layers of visceral pleura as a result of ruptured pleura. Air from ruptured alveolus dissects through the thin, fibrous layer of visceral pleura to form the bleb
- Bulla; air–filled space within the lung parenchyma as result of deterioration of alveolar tissue
- Cyst; congenital or acquired, check valve obstruction of small bronchioles
- LAM; lymphangiomyotosis

4) Treatment

① Flow chart (slide)

② Tube thoracostomy

- Small bore (10 Fr); + portable bag
- Large bore (>20 Fr); for chemical pleurodesis
- Skin incision; considering port site of VATS

- Subcutaneous tunnel
- Rib upper margin
- Removal on Valsalva maneuver

③ Chemical pleurodesis
- Aseptic inflammation with symphysis of pleura
- Doxycyclin, Talc, Fibrin glue, Betadine, Autologous blood….

④ Surgical indications
- Recurrent ipsilateral pneumothorax (PNX)
- Contralateral PNX
- Bilateral PNX
- Persistent air leak >2–5 days
- Hemopneumothorax
- Professional at risk (pilot, diver)
- Large bulla visible on chest x-ray

⑤ Surgery
- VATS wedge resection; mc, single or multi-port
- Mini thoracotomy; secondary PNX

⑥ Additional procedure to prevent recurrence
- Mechanical pleurodesis
- Visceral pleural coverage (bioglue + bio sheet <surgicel, neoveil>)
- Pleural symphysis with chemical agents

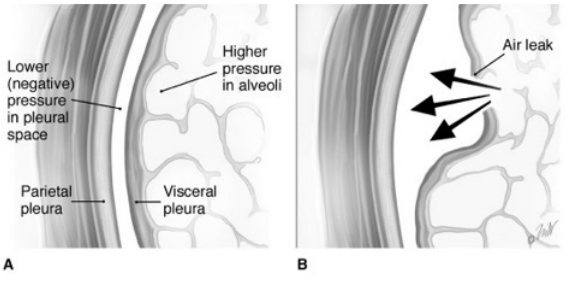
⑦ Reason of postoperative recurrence
- Regrowth of bulla at stapled margin
- Missed bulla at first operation
- Regrowth of bulla at other sites

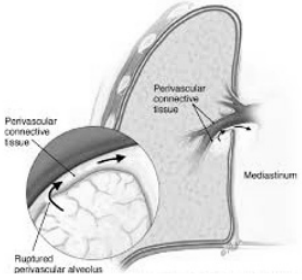
2. Pneumomediastinum (supplement slide)

1) Definition: air in the mediastinum, generally benign, self-limited

2) Pathophysiology

- Caused by air from pharynx, tracheobronchial tree, esophagus
- Excessive intra-alveolar pressure → rupture of perivascular alveoli





3) Diagnosis

- To ensure that a serious underlying cause is not missed
- CT, Esophagogram, Bronchoscopy

4) Treatment

- Close observation
- Subxiphoid incision along the entire length of sternum
- Transverse suprasternal incision

3. Pleural effusion

주제	가슴막 삼출(pleural effusion)	평가방법
수련목표	흉막 삼출 유무를 정확히 진단 할 수 있고 감별 진단할 수 있으며, 각 진단에 따른 비수술적, 수술적 방법을 이해하고 다양한 위치에 안전하게 흉관을 삽입할 수 있으며 필요에 따라서는 응급 개흉술을 시행하여 출혈을 해결할 수 있어야 한다.	
	술기와 수술	
Basic (1, 2년차)	진단 목적의 가슴강 천자를 할 수 있다. 치료 목적의 흉관 삽입술을 할 수 있다.	직접시행 (병동 /응급실)
Advanced (3, 4년차)	진단목적의 가슴막 생검술을 감독 하에 시행할 수 있다. 응급 개흉술을 감독 하에 시행할 수 있다. 흉관 (thoracic duct) 박리, 결찰을 감독하에 시행할 수 있다. 늑간혈관 결찰을 정확히 시행할 수 있다.	직접시행 (수술실)
Far advanced (전임의)	응급으로 혼자 혈흉을 해결할 수 있다. 초음파를 이용하여 흉막삼출 정도를 파악하고 정확히 배액할 수 있다.	직접시행 (수술실)

주제	가슴막삼출(pleural effusion)	평가방법
수련목표	흉막 삼출 유무를 정확히 진단 할 수 있고 감별 진단할 수 있으며, 각 진단에 따른 비수술적, 수술적 방법을 이해하고 다양한 위치에 안전하게 흉관을 삽입할 수 있으며 필요에 따라서는 응급 개흉술을 시행하여 출혈을 해결할 수 있어야 한다.	
	의학지식	
Basic (1, 2년차)	가슴막 삼출의 종류에 대해서 설명할 수 있다. 가슴막 삼출의 진단 방법을 설명 할 수 있다. 가슴막 삼출의 감별 방법을 설명 할 수 있다. 가슴막 삼출의 치료 방법을 설명 할 수 있다. 가슴막 삼출에서 흉관 삽입술의 적응증을 설명할 수 있다. 혈흉에서 개흉술의 적응증을 설명할 수 있다.	구두평가 (회진시)
Advanced (3, 4년차)	흉관 (thoracic duct)의 주행경로를 설명할 수 있다. 유미흉의 비수술적 방법에 대해서 설명할 수 있다. 유미흉의 수술 시기와 다양한 수술 방법에 대해서 설명할 수 있다.	구두평가 (회진시)
Far advanced (전임의)		구두평가 (회진시)

1) Pleural effusion

- 4 types
  - Hydrothorax; serous fluid
  - Hemothorax; blood
  - Chylothorax; lipid
  - Empyema; pus

① Diagnosis

- CXR, decubitus; blunting (>300 cc), shifting (r/o loculation)
- CT; location, guide to PCD or chest tube
- Pleural tapping (USG-guided); color, amount, lab.

② Differential diagnosis

- Exudate; fluid/s-protein >0.5, fluid/s-LDH>0.6, LDH >200 (Light criteria)

Transudate from systemic disease	Exudate from local pleural process		
	Infectious	Inflammatory	Lymphatic abnormality
Congestive heart disease	Pneumonia	Pancreatitis	Yellow nail synd.
Albuminemia	(bacterial and mycobacterial)	Radiation	Lymphangioleiomyomatosis
Cirrhosis	Subphrenic abscess	Hemothorax	Malignant obstruction
Urinothorax	Malignancy	ARDS	
SVC obstruction		Immunologic ds	
Atelectasis		Lupus pleuritis	
Trapped lung		Rheumatoid pleuritic	
Malignancy		Wegner granulomatosis	
Pneumonia		Sarcoidosis	

- Volume; large - malignancy
- Color; bloody and recurrent - malignant pleural mesothelioma
  Milky - chylothorax
- High amylase - esophageal perforation, acute pancreatitis
- Low glucose - Tuberculosis, empyema

③ Treatment

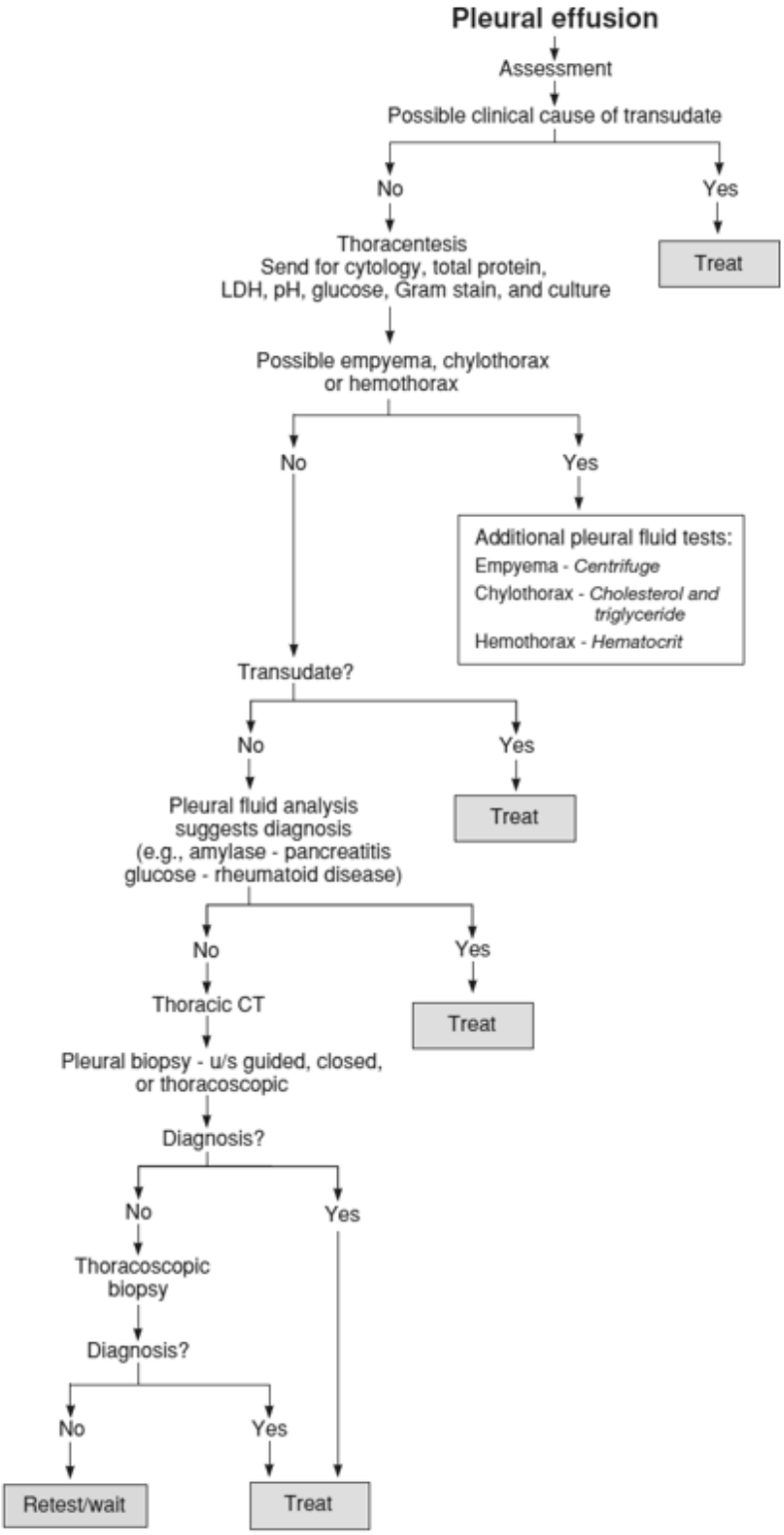
- Thoracentesis
- Tube thoracostomy
- Chemical pleurodesis; malignant pleural effusion
- Pleuro-peritoneal shunt

④ Indications of tube thoracostomy (or VATS drainage)

- Parapneumonic effusion, complex type
  - Pus
  - Positive Gram stain or culture
  - Glucose<60 mg/dl
  - pH <7.20
  - LDH >3x upper serum level

– Loculation

⑤ Flow diagram for workup of pleural effusion



2) Hemothorax

① Embolization

② Indications for thoracotomy after tube thoracostomy

- Massive hemothorax, >1,000 to 1,500 mL of initial drainage
- Continued bleeding, >300 mL in the first hour, >200 mL/hr for 3 or more hour
- Increasing size of hemothorax or clotted hemothorax
- Combined with persistent or large air leak

3) Chylothorax

① Thoracic duct course (slide)

② Composition of chyle

- Fat in thoracic duct lymph
  - Neutral fat, Free fatty acids, Sphingomyelin, phospholipids
  - Cholesterol, Cholesterol esters
- Fatty acids of <10 carbon atoms
  - Absorbed directly into the portal system
  - Largely bypass the lymphatic circulation
  - Medium-chain Triglycerides (MCTs) has been used
- Cellular elements: predominantly T lymphocytes
- Fat-soluble vitamins, antibodies, enzymes, urea nitrogens
- Bateriostatic due to high fatty acid content
- Very little pleural reaction

③ Causes - injury site (after surgery)

- Below the T6 level: tend to present on the right
- Above the T6 level: tend to present on the left
  - Radical neck dissection
  - PDA, CoA - left subclavian artery
  - Esophagectomy - direct trauma (0.5%-3.4%)
  - MLND in lung cancer - paratracheal or subcarinal

④ Diagnosis

- Milky or turbid (ddx, empyema-pus went down over time)
- TG >110 mg/dl
- Cholesterol/TG ratio <1
- Lymphangiography (slide)
- Intraoperatively; subcutaneous injection of 1% of Evans blue dye in the thigh

⑤ Treatment

- Conservative treatment for 2 weeks
- NPO, parenteral (MCFA, middle chain fat acid)
- Radiation therapy especially in chylothorax associated with lymphoma or metastasis to mediastinum
- Pleuroperitoneal shunting

- Thoracic duct embolization
  - Lymphangiogram
  - Cisterna chyli cannulation
  - Catheter threaded up the thoracic duct under fluoroscopic guidance
  - Coil or glue injection to leak point
  - Success rate: 45–71%
  - Sometimes accompanied with MRI to localized cisterna chyli
  - Contraindication: previous abdominal surgery hx.
- Surgical management
  - Direct ligation of thoracic duct; preop. Ice cream or high fat milk (slide)
    - ◆ If the leak can be identified
  - Mass ligation of thoracic duct
    - ◆ If the leak cannot be identified, extensive dissection should be avoided
    - ◆ all tissue between aorta, spine, esophagus, azygos vein, pericardium
    - ◆ Above the diaphragmatic hiatus via the right pleural space
    - ◆ Particular care following esophagectomy
  - Indications
    - ◆ loss of >1,500mL/d in adults or >100 mL/d in child over 5-day
    - ◆ Persistent leak for >2 weeks despite conservative management
    - ◆ Nutritional or metabolic complications
    - ◆ If the lung is entrapped or pleural symphysis cannot be achieved
  - Early attempt is better
  - Right-side mass ligation ≫ direct repair of the leak
  - Thoracic duct between aorta and azygos vein

4. Empyema

- Collection of pus in the pleural space

주제	가슴고름집 (empyema)	평가방법
학습목표	농흉의 원인을 설명할 수 있으며 비수술적으로 배농할 수 있으며, 수술의 적응증과 시기를 설명할 수 있으며 흉막 박피술, Eloesser 수술을 감독하에 시행 할 수 있으며 수술 후 배액관의 관리, 세척술을 독립적으로 시행하여 농흉을 해결할 수 있어야 한다	
	의학지식	
Basic (1, 2년차)	가슴고름집의 원인을 설명할 수 있다. 가슴고름집의 진단 방법을 설명할 수 있다. 가슴고름집의 진행과정 (급성, 아급성, 만성)을 설명할 수 있다. 가슴고름집의 진행과정에 따른 치료를 설명할 수 있다.	구두평가 (회진시)
Advanced (3, 4년차)	가슴막 고름집의 수술방법에 대해서 설명할 수 있다. 가슴막 고름집의 수술 후 합병증에 대해 설명 할 수 있다. 수술 후 발생한 가슴막 고름집의 확진 방법에 대해서 설명할 수 있다. 흉곽 내 빈 공간을 채울 수 있는 방법에 대해서 설명할 수 있다.	구두평가 (회진시)
Far advanced (전임의)		구두평가 (회진시)

주제	가슴고름집 (empyema)	평가방법
학습목표	가슴고름집의 원인, 분류, 치료에 대해 설명할 수 있다.	
	가슴막 중양의 병태생리 및 치료에 대해 이해한다.	
	술기와 수술	
Basic (1, 2년차)	진단목적의 가슴강 천자를 할 수 있다. 배농목적의 흉관 삽입을 시행할 수 있다. 피부 절개 및 배농을 적절히 시행할 수 있다. Eloesser식 배농술 환자의 드레싱을 시행할 수 있다.	직접시행 (병실/ 응급실)
Advanced (3,4년차)	가슴고름집 수술을 감독하에 보조, 시행할 수 있다. 수술 후 공기 유출을 막기 위한 폐봉합을 시행할 수 있다. 수술 후 적절한 흉관을 포함한 배액관을 위치시킬 수 있다. Eloesser식 배농술 후 흉경경을 이용한 세척술을 시행할 수 있다.	직접시행 (수술실)
Far advanced (fellow)	가슴 고름집 배액술 및 박피술을 시행할 수 있다. Eloesser식 배농술을 시행할 수 있다. 이동식 초음파를 이용하여 가슴 고름집을 정확히 배액할 수 있다. 가슴 고름집의 원인을 해결할 수 있다.	직접시행 (수술실)

1) 3-steps dynamic process of empyema

① Exudative (0–2 weeks); nonviscous, freely flowing

② Fibrinopurulent (1–6 weeks); increasing viscosity, thickening of pleura, loculation

③ Organizing (>5 weeks); pleural peel

2) Decision making of surgery in empyema treatment

① At least 50% compression of the lung (esp, with apical involvement)

② Unsuccessful attempts at aspiration

③ Lack of improvement after 6 weeks of conservative management

3) Contraindications for decortication

① Malignant pleural disease

② Endobronchial disease preventing lung expansion

③ Extensive ipsilateral parenchymal disease

④ Significant operative risk

⑤ Chronic debilitation

⑥ Fibrothorax with limited subjective or objective impairment

4) Surgical technique

① Open

- Posterolateral thoracotomy
- 6th intercostal space to provide better exposure of lower lobe and diaphragm
- Rib resection (prn)
- Extrapleural dissection, sometimes
- Lung inflation at dissecting visceral peel

- Better to leave some layers of the peel behind than to create a severe lung injury, instead relaxing incision allowing some re-expansion of lung
- 3-chest tube (2 straight and 1 curved)

② VATS

- For early-stage

5) Postoperative care

① Suction of all chest tubes

② Elective positive-pressure ventilation

③ CT check to identify the presence of any undrained collection

5. Pleural tumor

주제	가슴막 종양(pleural tumor)	평가방법
학습목표	가슴막 종양의 종류를 이해하고 각각의 종양의 증상, 진단방법, 수술 원칙, 수술 방법, 수술 후 합병증에 대해서 이해한다. 수술은 고난이도에 해당되기 때문에 전공의 수준에서는 시행하지 않는다	
	의학지식	
Basic (1, 2년차)	가슴막 종양의 종류와 각각의 영상검사상 특징을 설명 할 수 있다. 악성 중피종의 수술 종류에 대해서 설명할 수 있다.	구두평가 (회진시)
Advanced (3, 4년차)	Solitary fibrous tumor 의 증상, 소견, 수술 원칙에 대해서 설명할 수 있다. 악성 중피종의 수술 방법마다의 합병증, 예후에 대해서 설명할 수 있다.	구두평가 (회진시)
Far advanced (전임의)	Solitary fibrous tumor의 악성을 시사하는 소견을 설명할 수 있다. MPM의 병리학적 소견과 예후 인자에 대해서 설명할 수 있다.	구두평가 (회진시)

주제	가슴막 종양(pleural tumor)	평가방법
학습목표	가슴막 종양의 종류를 이해하고 각각의 종양의 증상, 진단방법, 수술 원칙, 수술 방법, 수술 후 합병증에 대해서 이해한다. 수술은 고난이도에 해당되기 때문에 전공의 수준에서는 시행하지 않는다	
	술기와 수술	
Basic (1, 2년차)	없음	직접시행 (병실/ 응급실)
Advanced (3,4년차)	수술 소견으로 SFT의 폐절제 범위를 설명할 수 있다. EPP 수술 중 심장 외막, 횡격막 재건을 시행할 수 있다.	직접시행 (수술실)
Far advanced (fellow)	흉막 박피술을 시행할 수 있다.	직접시행 (수술실)

1) Benign

① Solitary fibrous tumor (slide)

- Visceral pl >parietal pl
- Pedunculated
- Hypervascular pedicle

- Malignancy 12%, especially if size >10 cm, heterogenous feature on CT
- Complete resection (+wedge or lobectomy)

② Lipoma, lipoblastoma

③ Adenomatoid tumor

④ Calcifying fibrous tumor

2) Malignant pleural mesothelioma (MPM)

① Type

- Epithelioid (50–70%), bad prognosis (Px)
- Mixed or biphasic (30%), worse Px
- Sarcomatoid (10–20%); worst Px

② Stage

- T

T1	Tumor involves ipsilateral parietal or visceral pleura only
T2	T1 + Invasion of diaphragmatic muscle, lung parenchyma
T3	T1 + Invasion of endothoracic fascia, mediastinal fat, solitary focus of chest wall
T4	T1 + chest wall, peritoneum, contralateral pleura, mediastinal organs, vertebra

- N

N1	Metastases to ipsilateral intrathoracic lymph nodes
N2	Metastases to contralateral intrathoracic lymph nodes, ipsilateral or contralateral

③ Surgical treatment

- Indications
  - ✓ Good performance status
  - ✓ Epithelioid or mixed histology
  - ✓ N0 status
- Methods
  - ✓ Partial pleurectomy
  - ✓ Pleurectomy and decortication (P/D)
  - ✓ Extrapleural pneumonectomy (EPP)

6. Diaphragm

주제	가로막 질환(Disease of the diaphragm)	평가방법
학습목표	가로막의 해부학적 구조 및 생리를 이해한다.	
	선천성, 외상성 가로막 탈장의 병태 생리 및 치료를 이해 한다.	
	가로막성 내장전위의 임상양상 및 치료를 이해한다	
	가로막 종양에 대해 이해한다.	
	의학지식	
Basic (1, 2년차)	가로막의 정상적인 구조, 혈관분포, 신경지배에 대해 설명 할 수 있다. 가로막 탈장시 좌/우측에 따라 영상검사상 특징 소견을 설명 할 수 있다. 가로막 질환 진단을 위한 검사방법을 나열하고 임상증상을 설명할 수 있다. 외상성 가로막 탈장의 병태 생리를 이해한다. 가로막성 내장전위의 탈장을 구별하고 치료법을 설명한다.	구두평가 (회진시)
Advanced (3, 4년차)	선천성 가로막 탈장의 종류, 해부학적 이상소견, 병태생리에 대해 이해한다. 선천성 가로막 탈장의 치료 및 수술적 방법을 나열한다. 선천성 가로막 탈장의 수술 후 관리 및 합병증에 대해 설명한다. 가로막성 내장전위의 수술 적응증 및 수술방법을 설명한다. 가로막 종양의 발생빈도, 임상양상, 예후에 관해 설명한다.	구두평가 (회진시)
Far advanced (전임의)	가로막 봉합, 주름술, 패치 성형술 등 수술 방법을 숙지하고 장,단점, 예후 등의 근거를 들어 설명할 수 있다.	구두평가 (회진시)

주제	가로막 질환(Disease of the diaphragm)	평가방법
학습목표	가로막의 해부학적 구조 및 생리를 이해한다	
	선천성, 외상성 가로막 탈장의 병태 생리 및 치료를 이해 한다	
	가로막성 내장전위의 임상양상 및 치료를 이해한다	
	가로막 종양에 대해 이해한다.	
	술기와 수술	
Basic (1, 2년차)	수술 접근 방법에 대해 이해한다. 수술 체위에 대해서 이해한다.	직접시행 (수술실)
Advanced (3, 4년차)	가로막 손상의 봉합을 시행할 수 있다.	직접시행 (수술실)
Far advanced (전임의)	탈장 복원 및 가로막 주름성형술 시행할 수 있다. (VATS or Open Diaphragmatic plication)	직접시행 (수술실)

1) Structure and function

① Three natural openings

- aortic opening; most posterior, aorta, azygos vein, thoracic duct
- esophageal hiatus; middle
- IVC opening; anterior, within the confluence of the tendons

② Central tendon

③ Peripheral muscle

2) Phrenic nerve

① Anterior trunk → anteromedial & sternal branch

② Posterior trunk → posteromedial & crural branches

③ Anteromedial and posteromedial branches are main

3) Phrenic vessels

① Superior phrenic artery from lower thoracic aorta

② Inferior phrenic artery from abdominal aorta above the celiac artery

4) Diaphragmatic incision

① Circumferential

- At least 5 cm lateral to the edge of central tendon
- Difficult to correctly realign

② Central tendon

- Centrally
- Excellent visualization
- Always extend toward the posterolateral portion

③ Radial

- For thoracoabdominal incision or resection of GE junction

5) Diaphragmatic resection and reconstruction

① Resection; lung cancer with diaphragmatic invasion, mesothelioma, thymoma with pleural and diaphragm implantation

② Reconstruction

- Suture anchoring the patch to the anterior spinal ligament
- A tongue of extrapatch material folded inferiorly along the lumbar spine in simulation of the diaphragmatic crus
- A composite of two patches of 2mm Gore-tex stapled together in the middle with TA stapler

6) Congenital diaphragmatic hernia

① Definition; Muscle defect between abdomen and thoracic cavity + Pulmonary hypoplasia

② Type

- According to the site: Bochdalek hernia (90%), Morgagni hernia (2%), Esophageal hiatal hernia

- According to the laterality: Left-sided (84%), Right-sided (14%), bilateral (2%)
- Often associated with cardiac, GI, GU, skeletal, neural anomalies, or trisomies

③ Pathophysiology

- Long-term compression of fetal lungs by the herniation of the viscera into the thoracic cavity
- Pulmonary underdevelopment and lung hypoplasia, both side
- Decrease of the total arteriolar cross-sectional area, increase of adventitial and medial thickness of all size pulmonary arteries

- Persistent pulmonary hypertension (PPHT) > Respiratory failure, R>L extrapulmonary shunting, progressive acidosis and heart failure

④ Diagnosis

- Prenatal US: Presence of fluid-filled loops of bowel in the thorax
- Prenatal MRI: distinguish a CDH from CCAM, pulmonary sequestration, bronchogenic cyst, enteric cysts or mediastinal teratoma.

⑤ Management: No consensus

- Prenatal management: Fetal Tracheal Occlusion (FETO)
- Postnatal treatment
  - ➢ After birth, all efforts should be made to stabilize the cardiopulmonary system during resuscitation
  - ➢ Intubate to relieve respiratory distress, and insert gastric tube to decompress the stomach
  - ➢ Ventilation by mask is contraindicated as it may cause a distention of the stomach situated in the thoracic cavity
  - ➢ Must be sedated but muscle paralysis is not encouraged because of its untoward consequences on ventilatory mechanics
  - ➢ Systemic hypotension must be reversed with fluid administration
- Conventional ventilation: Controlling the peak inflation pressure (18 to 22 cmH2O) by limiting the pressure of ventilation while tolerating an oxygen saturation of 85% and a rise of the arterial pressure of CO2 (permissive hypercapnia), and stimulating spontaneous ventilation
- High-frequency oscillation (HFO): can used as the first choice of ventilation or when conventional ventilatory strategies fail
- Surfactant: Standard treatment in the fight against PPHT in children with CDH
- Other drugs: Guanylate cyclase and cGMP-specific phosphodiesterase, Calcium channel blockers, NO
- ECMO
  - ➢ Criteria: vary widely from center to center, and the final decision is often reached when an infant shows a clinical deterioration
  - ➢ Type: Both venovenous and venoarterial techniques have been reported with equally effective results
- CDH repair
  - ➢ Optimal timing? Timing of surgery makes no difference in the outcome of early and late repair groups
  - ➢ Must first take into account the stability of the child and its capacity to tolerate “gentle” ventilation with low peak pressure, a FiO2 lower than 50%, a minimum of inhaled NO, and good blood gas values
  - ➢ Cautions: Repair often worsen pulmonary compliance by reducing elasticity of chest wall and increasing intra-abdominal pressure
- OP Technique
  - ➢ Subcostal incision > Reduce herniated viscera > Repair diaphragm w/non absorbable interrupted mattress or pledgetted suture
  - ➢ Transthoracic approach: especially for a CDH on the right side, affords a nice view for a liver reduction.
  - ➢ Prosthetic implant may be needed, but no optimal patch material (too rigid for adapting to the growth of thoracic cavity)

⑥ Prognosis

- Mortality rate? 20%
- Major determinant of survival? Degree of associated pulmonary hypoplasia + Severity of pulmonary hypertension
- Two factors influence postnatal mortality? Timing of termination of gestation + Presence of additional anomalies.

7. Post-resectional pleural space

흉벽질환, 다한증, 흉곽출구증후군

강남세브란스병원 흉부외과학교실

이 성 수

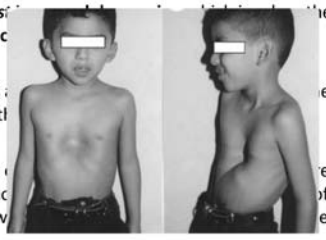
Chest Wall Deformity

Deformities of the anterior chest wall are widely recognized,
poorly understood and
generally neglected.

- Charles W. Lester

Pectus Excavatum

- ***Funnel ches*** ...**sternum** as well as the c...
- Usually it is ... ...es more marked as th...
- The degree ... ...ession on the sterno-xipho... ...of the anterior chest wall w... ...ebral column.



- Pectus excavatum is a relatively common anomaly
  - occurs in about one in 300–400 live births
  - three times more frequent in males
  - often associated with connective tissue disorders, such as Marfan's disease or Ehlers-Danlos syndrome
- Symptoms
  - palpitation, exertional dyspnea, fatigue and dull precordial pain, paradoxical breathing, exercise intolerance
- The deformity is also often emotionally disturbing, especially in adolescents, who often avoid active sports and become shy and retiring.

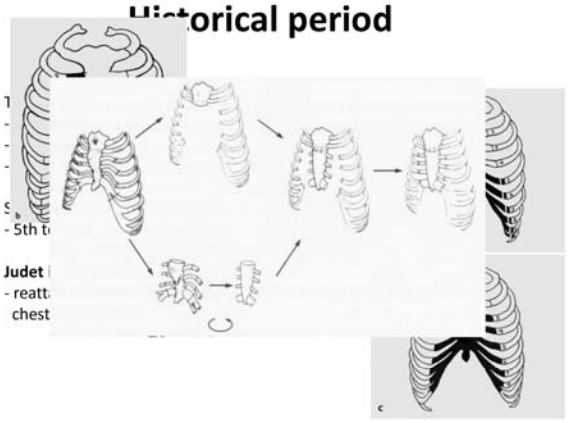
Etiology

- heredity :about 20 to 50% of patients have a family history of pectus deformities - Williams 1872
- an overgrowth of the costal cartilages – Flesch 1873
- arrested growth of the sternum - Ebstein 1882
- various intrauterine compressive forces such as pressure by the chin, knee or elbow
- latent mediastinitis – Raubitsch
- undue traction exerted upon the sternum by the diaphragmatico-sternal ligament - Lincoln Brown 1939(1596)

Repair of PE

- Initially surgical intervention
  - only for patients with severe sternal depression
  - aimed primarily at relieving cardiac compression
  - cosmesis played a secondary role
- Deformed chest
  - a potential source of embarrassment
  - especially during adolescence and in young adulthood
  - operative correction is now recommended by most practitioners even in the absence of other symptoms
- Earlier operations - easy to perform, better results
  - at a later age :chest is less pliable and less accommodating

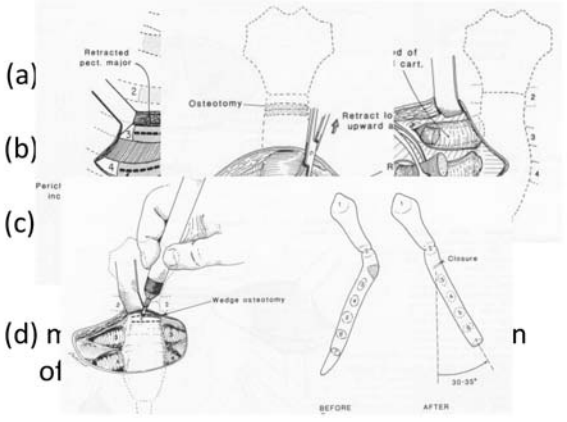
Historical period



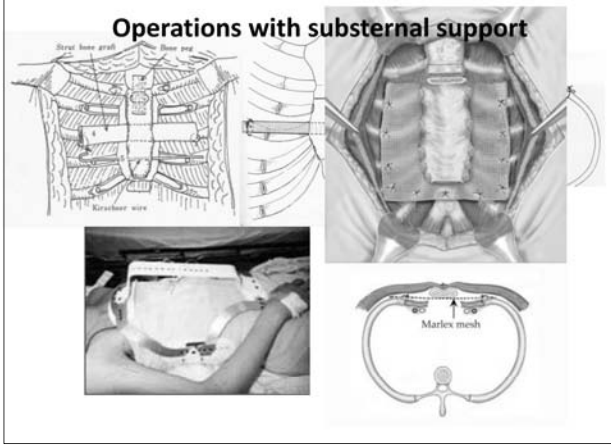
The modern era

- less than satisfactory late outcomes
- corrected position of the sternum using substernal support
- The principles of modern pectus excavatum surgery
  - Ravitch in 1949.

  (a) the removal of deformed cartilages,
  (b) division of the xiphisternal articulation,
  (c) transverse cuneiform osteotomy of the sternum at the upper level of the deformity
  (d) maintenance of the corrected position of the sternum



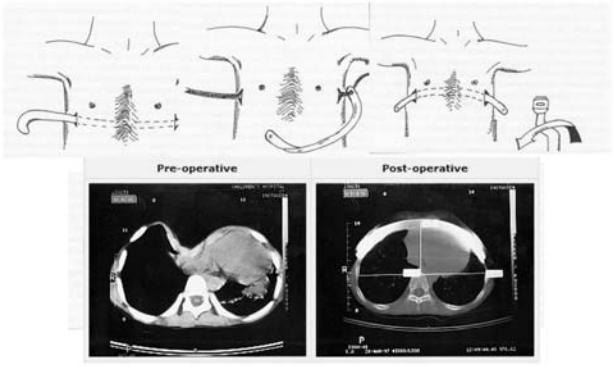
Operations with substernal support



New Pectus Excavatum Surgery

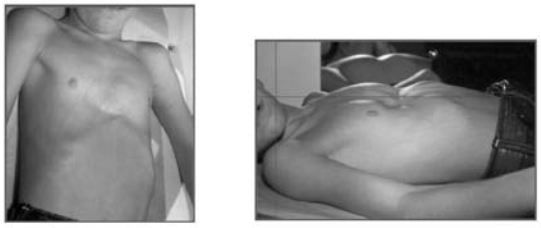
- "minimally invasive repair of pectus excavatum" by Donald Nuss in 1998
- the number of patients operated for pectus excavatum has more than tripled in the last few years

Nuss procedure

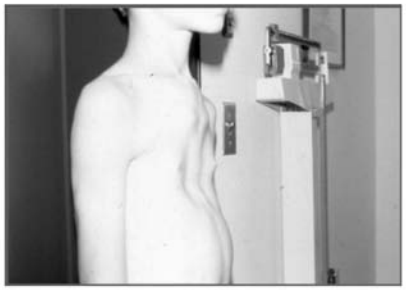


Why a new approach?

NORFOLK 1977
POST RAVITCH REPAIR
Failed rib regeneration, subcutaneous cardiac impulse



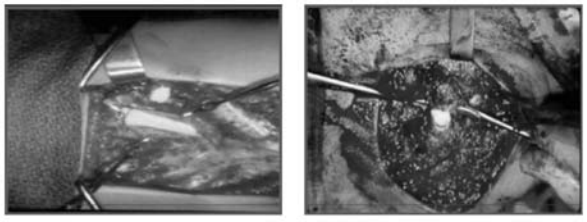
Acquired Asphyxiating Chondrodystrophy



Rigid and corrugated anterior chest wall.

Second opinion post Ravitch recurrence,
Procedure done elsewhere.

When removing the rib cartilage it bent to a 90* angle

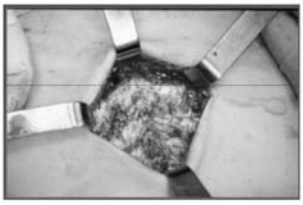


"Why are you removing it?
Can you not see how flexible it is?"

A New Idea

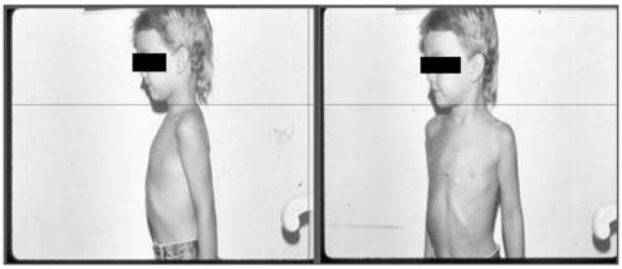
1987

First Minimally Invasive Pectus Procedure

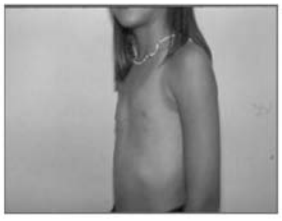


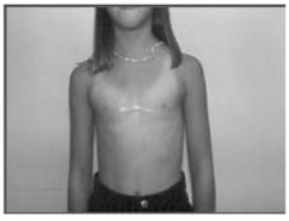
Kelly clamp tunneled under the sternum

1st Patient – One month Post 1987



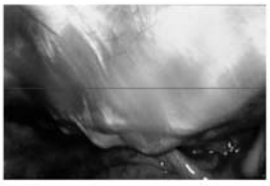
A.C age ten, 6 years post repair
Keloid formation

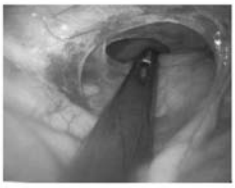




Conclusion: Move the incision away from the anterior chest.

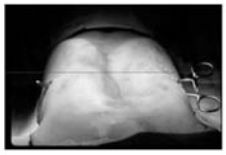
Thoracoscopy With Co2 Insufflation (1998)

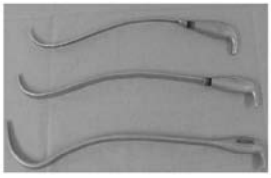


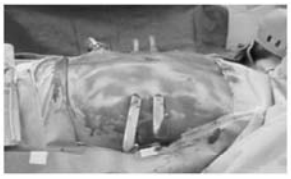


Helps with selecting bar position and makes the procedure safer.
May be inserted on the right, left or both sides.
Always keep the Tip of the Introducer in view

New Instruments

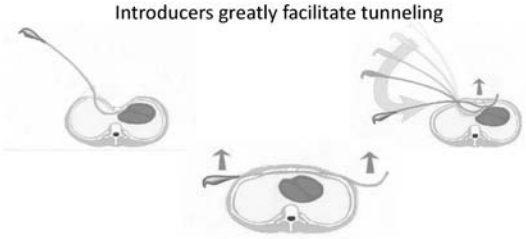






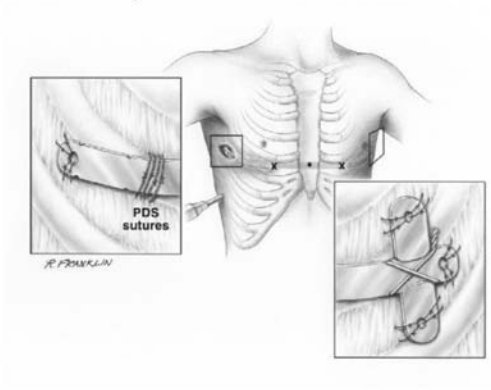
"New introducers" permit sternal elevation

Introducers greatly facilitate tunneling

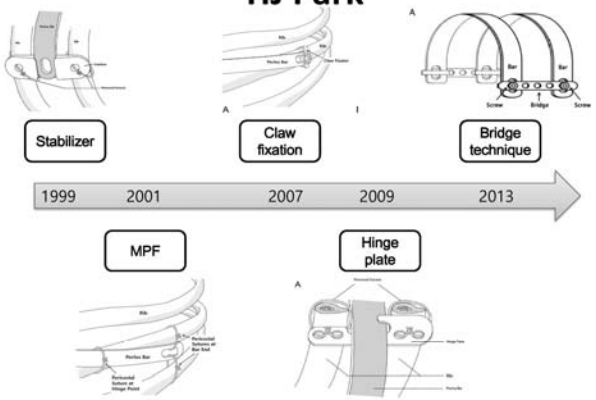


Sternal elevation corrects the deformity before bar insertion and decreases the amount of pressure on the bar.

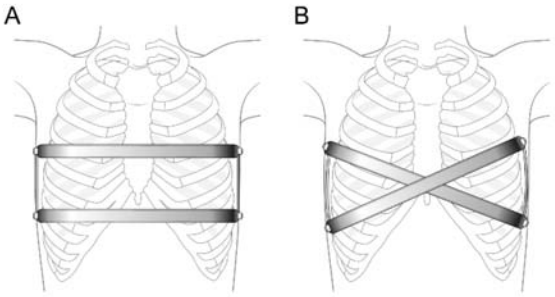
PDS pericostal sutures 2002



HJ Park



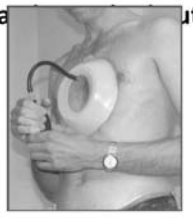
Parallel vs Cross

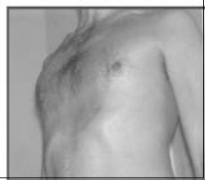


Vaccum Bell

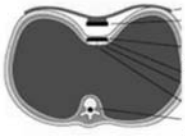
on cup for pectus excavatum:

ca ut, can it be



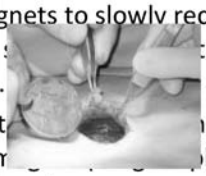


Magnetic Mini Mover Procedure (3MP)

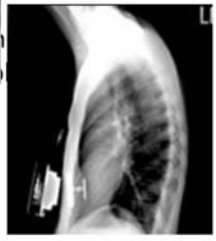


gnets to slowly reconfigure the

t to

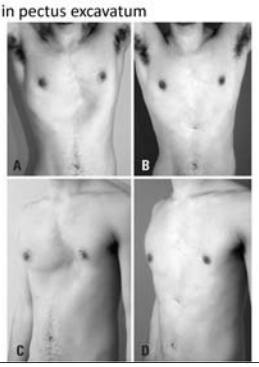


- By adjusting t
  the internal m
  reconfigure the chest



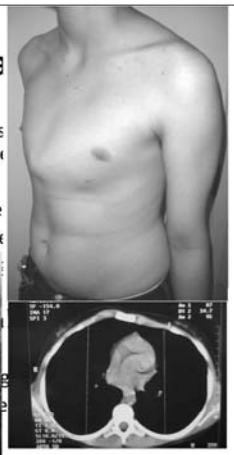
Silastic molds

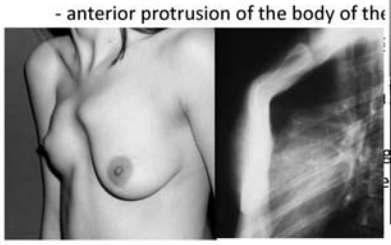
- Allen and Douglas implanted Silastic molds into the subcutaneous space to fill the depression in pectus excavatum



Pectus Carina

- Pectus carinatum is 16.7% of all ches
  Boston children's hospital experienc
- Chondrogladiolar type : most freque
  - anterior protrusion of the body of the



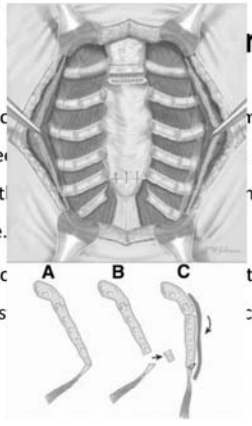


Pectus Carinatum

- Etiology : not clear
  - an overgrowth of the costal catilages with forward buckling of the cartilages and anterior displacement of the sternum
  - genetic basis : 26% had a family history of chest wall deformity and 12% of scoliosis.
  - more frequent in boys than in girls - 3:1
- PC is rarely present at birth
  - deformity was not identified until after the eleventh birthday
  - deformity often progresses during early childhood particularly in the period of rapid growth at puberty.

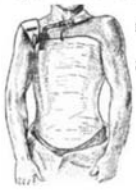
r

- The current c n is surgical, often involving rese sternal osteotomy and recently t modifications using thoracoscope.
- The majority c tions of the procedure firs ch.



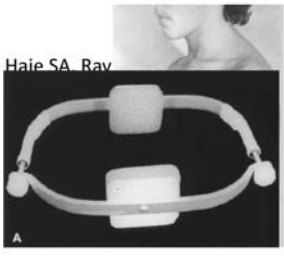
1960s and 1970s

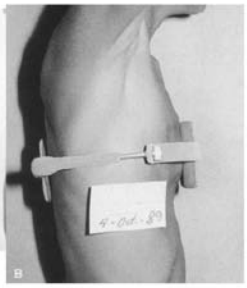
- Some authors reported corrective effe an



Dynamic Chest Compressor

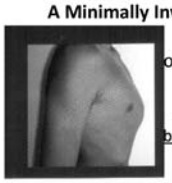
Haje SA, Ray





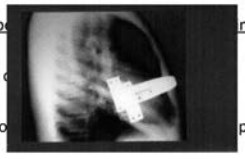
A Minimally Invasive Technique to Repair Pectus Carinatum. Preliminary Report

on, Arch Bronconeumol 2005; 41: 349 - 351



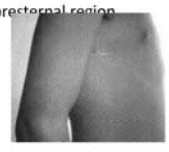
natum

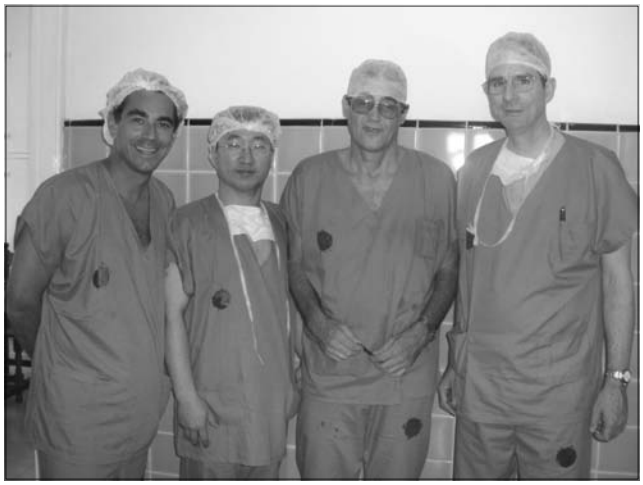
- chest wall was

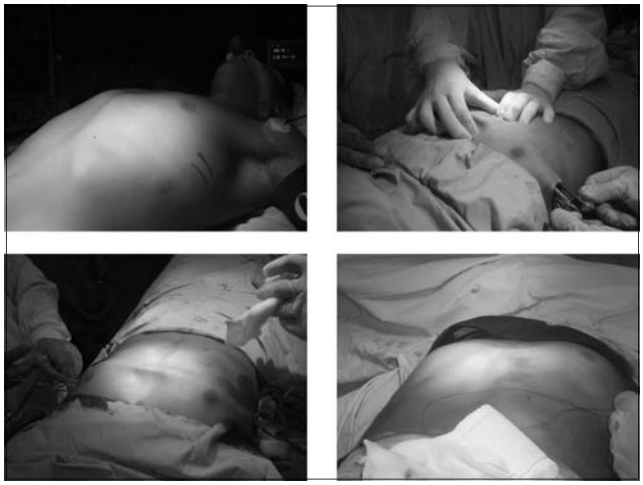


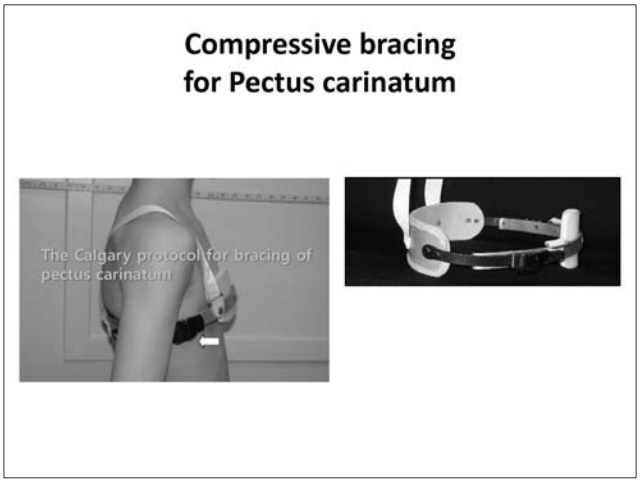
- intrathoracic co presternal region

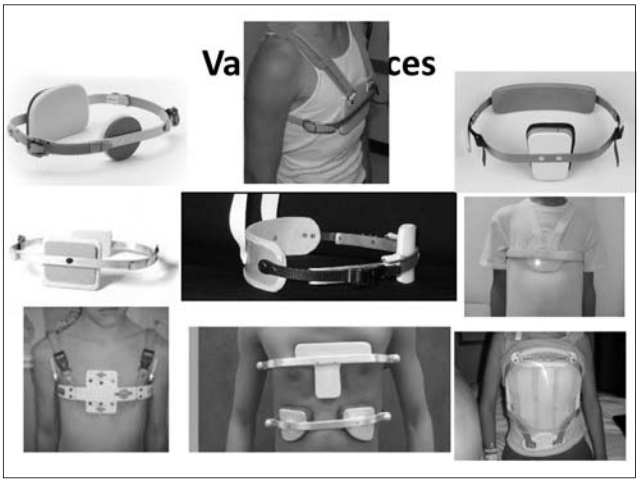
- the strut was removed after 1 year

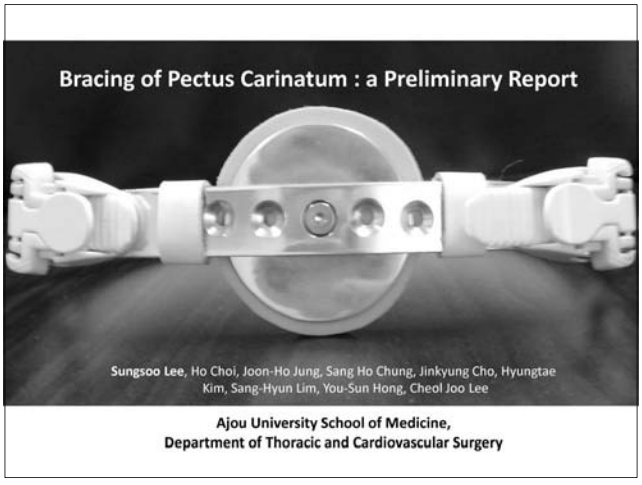


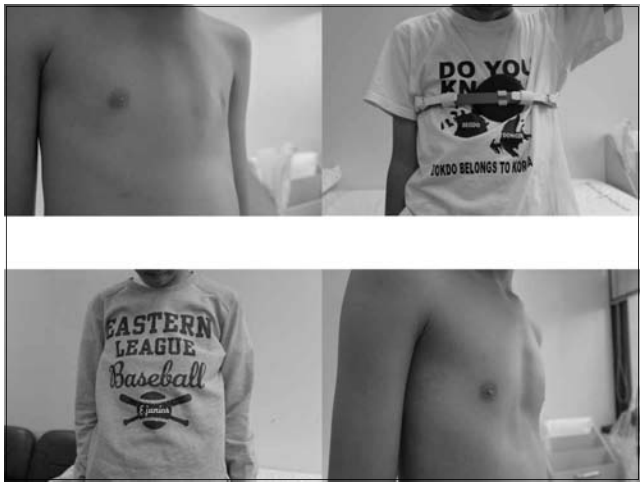





Compressive bracing
for Pectus carinatum
The Calgary protocol for bracing of pectus carinatum

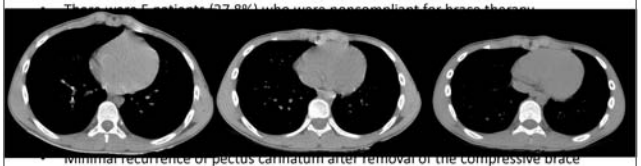

Va ces


Bracing of Pectus Carinatum : a Preliminary Report
Sungsoo Lee, Ho Choi, Joon-Ho Jung, Sang Ho Chung, Jinkyung Cho, Hyungtae Kim, Sang-Hyun Lim, You-Sun Hong, Cheol Joo Lee
Ajou University School of Medicine,
Department of Thoracic and Cardiovascular Surgery


EASTERN
LEAGUE
Baseball

Results

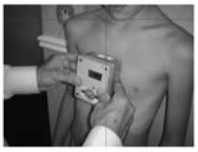
- 13 (72.2%) patients have completed treatment (mean bracing time, 4.9 ± 1.4 months).
- [illegible] patients (27.8%) who were noncompliant for brace therapy.

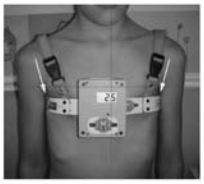


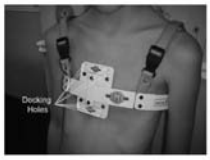
- Minimal recurrence of pectus carinatum after removal of the compressive brace occurred in 5 (38.5%) of 13 patients.
- All these patients stopped wearing the compressive brace in 4 months against our advice.

9th Annual International Nuss Pectus Excavatum and Carinatum Lecture Series
June 23-24, 2011

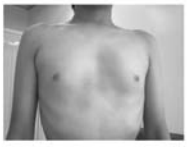
New brace

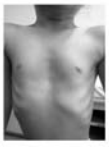


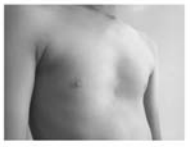




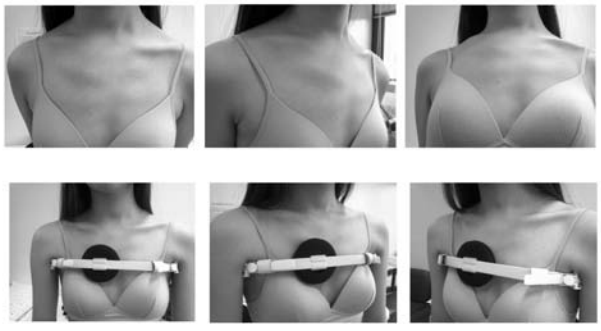
Overcorrection



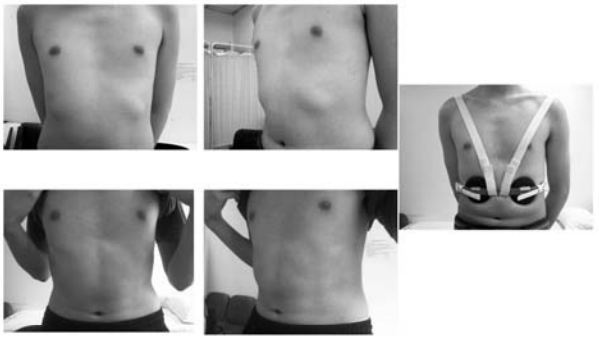




Atypical lesion



Flared rib

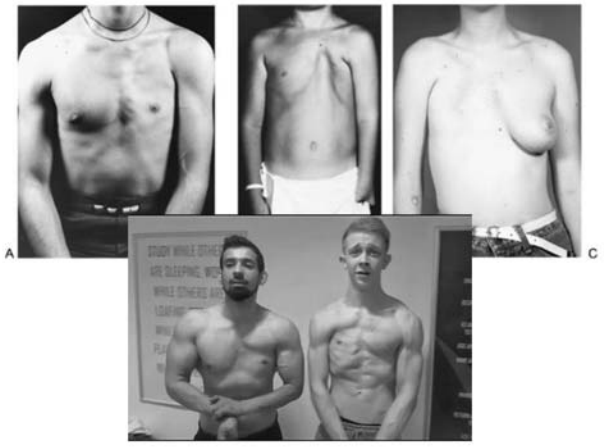


Brace with Excercise

Sydney A Haje, MD – Dynamic Remodeling

Poland's syndrome

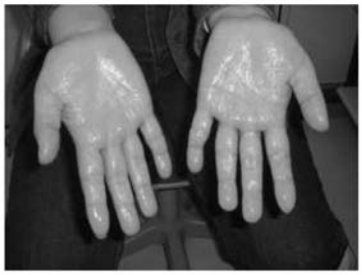
- In 1841, while Poland was a medical student, he described congenital absence of the pectoralis major and minor muscles associated with syndactyly
- Incidence of 1 in 30,000 to 32,000
- Associated with
  - Unilateral palsy of the abducens oculi muscle and facial muscles
  - Abnormalities of the hand
    - Syndactyly
    - Hypoplasia of the thumb
    - Hypoplasia or aplasia of the middle phalanges
    - Rarely, complete absence or hypoplasia of the hand and forearm



Hyperhidrosis

Hyperhidrosis

- Pathologic condition of *excessive sweating* in amounts *greater than physiologically needed for thermoregulation*

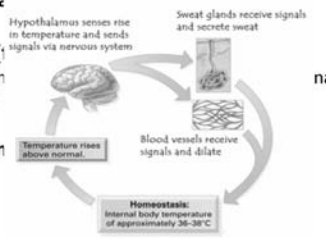


Pathogenesis

- **Eccrine sweat glands are responsible for hyperhidrosis**
  - mixture of the two [apo/eccrine] glands may play a role in axillary hyperhidrosis
- **A sympathetic signal is carried to sweat glands by cholinergic a**
- **Idiopathic (**
  - Sweat glan
  - Abnormal

nally normal.

- **Genetic com**



Types of hyperhidrosis

- **Focal or primary hyperhidrosis**
  - face, palms, soles, or axillae
- **Generalized sweating(secondary)**
  - Excessive heat and obesity
  - Infections, endocrine disorders, neuroendocrine tumors, malignancy, neurologic disorders, toxins, and previous spinal cord injuries
  - Present as adults and have excessive sweating that occurs both while awake and asleep

Treatment

- **Nonsurgical Treatment**

Table 2. Comparison of Therapies for Primary Hyperhidrosis

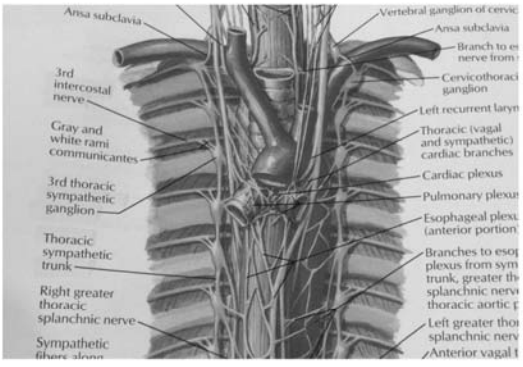
Treatment	Cost*	Side Effects
Topical, 20% to 35% aluminum chloride	$288+/year	Skin irritation, localized burning, stinging, desquamation, poor efficacy, temporary (lasts about 48 hours per application)
Iontophoresis (usually 20 mA 3 to 4 treatments a week for 30 to 40 minutes each)	$500/device	Irritation, dryness or peeling of skin, burning or stinging during therapy, temporary (one treatment lasts 1 to 4 weeks). Not recommended for women who are pregnant or for persons with pacemakers or substantial implants (eg, joint replacements)
Oral therapy (glycopyrrolate, atropine, acetylcholine inhibitors)	$240+/year	Dry mouth, dry eyes, constipation, mydriasis, difficulty urinating, blurry vision
Botulinum toxin (Botox A or B)	$2,250/session	Pain from injections, muscle weakness, headache, hematoma, swelling, need for repeat procedures
Liposuction/VASER	$3,000/session	Hematoma, superficial skin erosion, alopecia, paresthesia
Endoscopic thoracic sympathotomy	$15,000	Compensatory hyperhidrosis, bradycardia, pneumothorax, postoperative pain, Horner's syndrome

* Approximate cost in US dollars.

Nomenclature for Sympathetic Surgery

- **Rib- oriented nomenclature**
  - Too many patients having mediastinal fat that can obscure clear identification of the specific ganglia
  - Many anatomical variations in the ganglion anatomy
- **Type of interruption**
  - Clipped, cut, or cauterized, or a segment removed
- For example
  - Clipped R5, top
  - cauterized, top R4, bottom R4

Nomenclature for Sympathetic Surgery



Patient Selection

- Surgical consultation should include
  - Secure diagnosis of **primary focal** hyperhidrosis
  - **Anatomic locations** involved
  - **Amount** of hyperhidrosis
  - Full discussion of the options to surgery and potential complications
- The patients should be made aware that the most satisfied patients are those with palmar or palmar-axillary hyperhidrosis, or both.

Location of Interruption of Sympathetic Chain

- **Palmar hyperhidrosis**
  - R4 alone interruption(*Yang and colleagues,2007*)
    - Limits the degree of CH
    - May lead to moister hands
  - R3, R4 interruption
    - Completely dry hands
    - Higher risk of CH

AXILLARY HYPERHIDROSIS

- ETS for axillary hyperhidrosis
  - often less successful and has higher "regret rates" than ETS for palmar hyperhidrosis.
- **R4 and R5 transection is suggested**
  - Palmar-axillary, palmar-axillary-plantar, or pure axillary hyperhidrosis
- A qualitative review shows a trend of lower incidence of CH with fewer interruptions
  - Incidence of CH *(Munia and colleagues, 2008)*
    - R3/R4 ETS 100% and higher severity
    - R4 ETS alone (42%)
  - Patients who underwent R5 clipping alone experienced no CH, and none regretted having the surgery *(Chou and associates)*

CRANIOFACIAL HYPERHIDROSIS

- R2 vs R3
  - R3: 9% regretted the procedure, and 27% reported CH
  - R2: 16.7% regretted and more than 40% experienced CH
- R2 vs R2+R3
  - significantly higher CH rate in the group that underwent the R2 and R3 transection (95%), as compared with the R2 group (83%)
- **R3-alone interruption is suggested?**
  - It reduces the risk of CH and the risk of Horner's when compared with R2 or an R2 and R3 transection

Type of Interruption

- Transection? Resection? Ablatation with a cautery? Division with a harmonic scalpel? or Clipping?
  - No clear differences(but clipping shows recurrence)
    - If the correct level division was achieved
  - Enough separation between the ends of the chain
    - Regrowth is impossible

Complications and Treatment

- Primary side effects of hyperhidrosis surgery
  - **CH, bradycardia, and Horner's syndrome**
    - The higher the level of blockade on the chain, the higher is the expected regret rate

Compensatory Hyperhidrosis

- **The most common side effect**
  - which occurs in the literature from 3% to 98%
- **The most common risk factor**
  - T2 ganglion interruption(R2, R3)
  - The number of levels interrupted has been inconclusive as a risk factor
- **Preoperative testing? controversial**
  - Injecting bupivicaine
    - reversibly achieve sympathetic nerve blockade observe for CH
- **Treatment**
  - Ditropan or other anticholinergic medications in escalating doses

Compensatory Hyperhidrosis

Reversal surgery

- Nerve reconstruction
- R5,6,7,8?

Gustatory Hyperhidrosis

Postop. Craniofacial hyperhidrosis d/t food

- Variable degree even smell, vision
- 15 - 50%
- Informed consent : necessary

Thoracic Outlet Syndrome

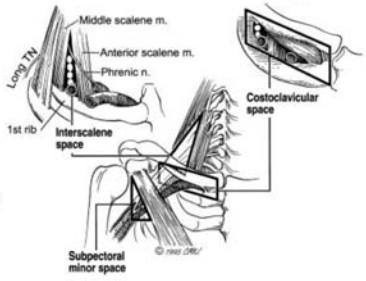
What is TOS

- TOS is a group of anatomically related, conditions caused by compression of neurovascular structures that serve the upper extremity.

Scalene triangle

Costoclavicular space

Pectoralis minor space



Classification

Type	Characteristics
Neurogenic TOS **85 – 90%**	Caused from **brachial plexus compression** Symptoms include **pain, dysesthesia, numbness, weakness – not localized** in specific peripheral nerve distribution
Venous TOS	Caused from **subclavian vein compression** Symptoms include **swelling, paresthesias** in the fingers
Arterial TOS	Caused from **subclavian artery compression** Almost always associated with a **cervical rib** or **anomalous rib** Symptoms include **hand ischemia** with **pain, pallor, paresthesia, coldness**

Cause

- Congenital abnormality
  - Cervical rib
  - Prolonged transverse process
  - Muscular abnormality(ant. scalene m., sickle-shaped scalene m.)
  - Fibrous connective tissue anomalies.
- **Trauma**
  - **Whiplash injury**
- **Repetitive strain**
- Etc.
  - Tumor
  - Hyperostosis
  - Osteomyelitis

Evolution of TOS surgery

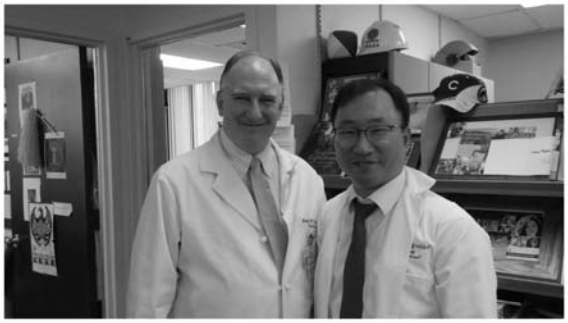
Table 1 Evolution of thoracic outlet syndrome surgery

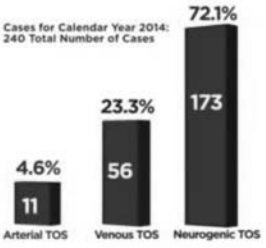
Name of operation	Year first performed	Surgeon who introduced it
Cervical rib resection	1861	Coote
First rib resection	1908	Murphy
Scalenotomy	1927	Adson/Coffey
First rib resection – posterior approach	1961	Clagett
First rib resection – supra- and infraclavicular approach	1960s	Various surgeons
First rib resection – transaxillary approach	1966	Roos
Scalenectomy	1938	Adson
Refined scalenectomy	1979	Sanders
Combined approach (transaxillary first rib resection followed immediately by transcervical anterior and middle scalenectomy)	1989	Atasoy

(Adson and Coffey 1927; Atasoy 1996, 2004b)

Barnes-Jewish Hospital
Washington Univ, St. Louis

Prof. Robert Thompson





Multidisciplinary TOS Clinical Care Team

TOS Surgery Cases

- Barnes-Jewish Hospital : 285 cases/2014
- USA : about 2000 cases annually
- More than 100 cases : 5 institutes in USA
- In KOREA — **Neglected 333 cases ?**
- Thoracic Surgery data registry
- 4.2 cases annually for 5 years

Message

TOS surgery is one of thoracic surgeon's area.

Thank you for your attention!

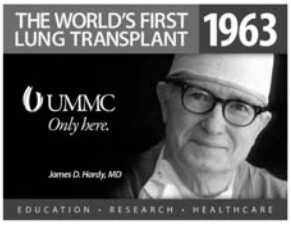
Lung Transplantation

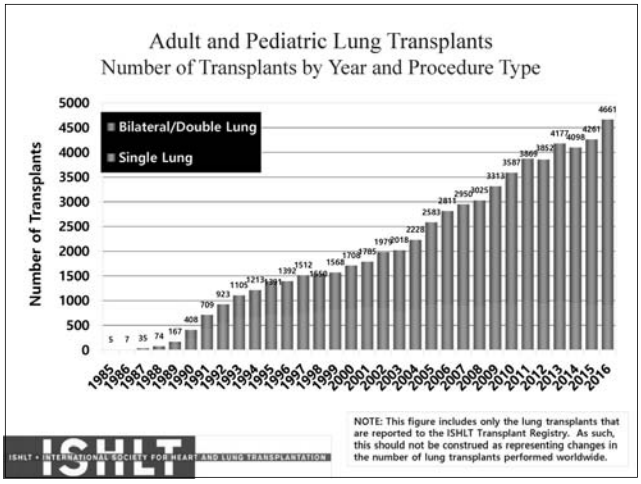
아주대학교 의과대학 흉부외과학교실

함 석 진

History of LTx

- •1963: James Hardy
  - •1st human LTx: 18 days
- •1983: Joel Cooper
  - •1st successful single LTx
- •1986: Joel Cooper
  - •1st successful double LTx





1st LTx in Korea

- The first operation
  - 1996
  - Right single LTx
- Recipient
  - M/53
  - IPF
- Donor
  - M/18
  - Traffic accident
- Survival : 82 days
  - Cause of death : aspergillosis

Number of Solid Organ Transplants from the Brain Death Donors

(단위: 건)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
신장	99	99	68	123	164	171	263	278	479	488	491	680	768	750	808	901	1,059	903
간장	34	37	28	50	64	66	118	128	233	236	242	313	363	367	404	456	508	450
췌장	11	5	8	12	10	12	29	18	22	22	25	43	34	57	55	57	74	62
심장	12	21	11	15	23	26	29	50	84	65	73	98	107	127	118	145	156	184
폐장	1	0	2	2	3	7	3	9	7	8	18	35	37	46	55	64	89	93
계	157	162	117	202	264	282	442	483	825	819	849	1,169	1,309	1,347	1,440	1,623	1,886	1,692

Indication

Recipient considerations

I. High (>50%) risk of death due to lung disease within 2 years if lung transplantation is not performed;

II. High (>80%) likelihood of surviving at least 90 days after lung transplantation;

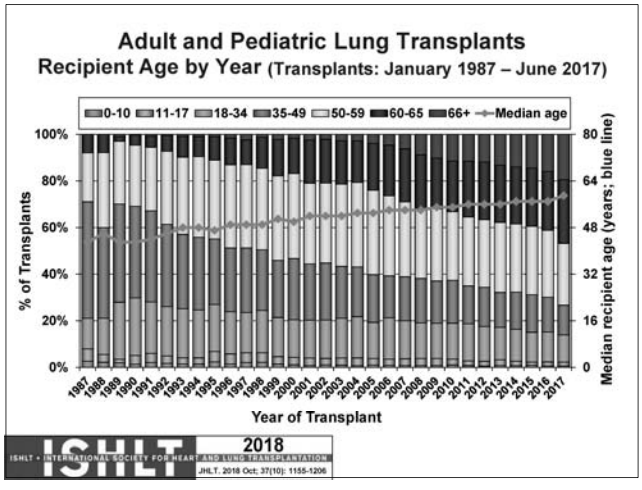
III. High (>80%) likelihood of 5-year post-transplant survival from a general medical perspective provided there is adequate graft function.

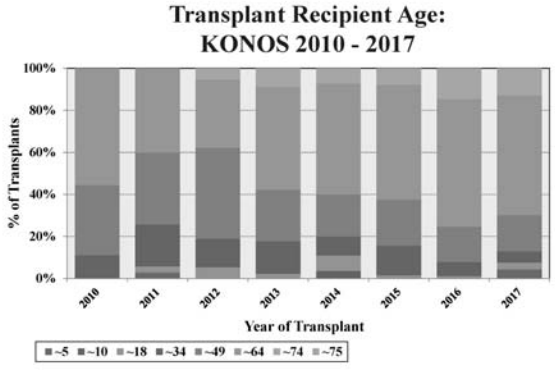
Absolute contraindications

- Recent history of malignancy
  - A 2-year disease-free interval combined with a low predicted risk of recurrence after lung transplantation, for instance in skin cancers other than melanoma
  - A 5-year disease-free interval should be demonstrated in most cases, particularly hematologic malignancy, sarcoma, melanoma, or cancers of the breast, bladder, or kidney
- Poorly controlled significant dysfunction of another major organ system
  - Heart, liver, kidney or brain disease unless a multi-organ transplant is being considered
- Uncorrected coronary artery disease with end-organ ischemia or dysfunction and/or coronary artery disease not amenable to revascularization
- An unstable medical condition (acute sepsis, myocardial infarction, and liver failure)
- Uncorrectable bleeding disorder
- Poorly controlled infection with a virulent and/or resistant microbes;
- Evidence of active *Mycobacterium tuberculosis* infection
- A chest wall or spinal deformity expected to cause severe restriction after transplantation
- Class II or III obesity (BMI≥35.0 kg/m^2)
- Current non-adherence to medical therapy
- Psychiatric or psychological issues
- Inadequate social support system
- Functionally limited with inability to participate in a rehabilitation program
- A history of illicit substance abuse or dependence (e.g., alcohol, tobacco, marijuana, or other illicit substances)

Relative contraindications

- Age
  - 65 years in association with low physiological reserve and/or other relative contraindications
  - Although no limitation, >75 years of age are less likely to be candidates for lung transplantation
- Class I obesity (BMI 30.0 to 34.9 kg/m2), particularly central obesity
- Significant malnutrition
- Significant osteoporosis
- Extensive prior chest surgery with lung resection
- Mechanical ventilation and/or extracorporeal life support (ECLS)
  - Carefully selected candidates without other acute or chronic organ dysfunction may be successfully transplanted
- Colonization with resistant or highly virulent pathogens;
- Candidates infected with hepatitis B and/or C
  - Without significant clinical, radiological, or biochemical signs of cirrhosis or portal hypertension and who are stable on appropriate therapy
- Patients infected with HIV
  - Controlled disease with undetectable HIV-RNA, and adherent with anti-retroviral therapy (cART)
- Extrapulmonary conditions that have not resulted in significant organ damage
- Diabetes mellitus, systemic hypertension, epilepsy, central venous obstruction, peptic ulcer disease, or gastroesophageal reflux





Indication for lung transplantation

- Obstructive
  - Emphysema
  - α-1 antitrypsin deficiency
  - Obliterative bronchiolitis
- Suppurative
  - Cystic fibrosis
  - Bronchiectasis
- Interstitial
  - Idiopathic pulmonary fibrosis
  - Sarcoidosis
  - Connective tissue disease
  - Eosinophillic granulomatosis
  - Occupational lung disease
  - Hypersensitivity pneumonitis
  - Drug intoxicity
  - Lymphangioleiomyomatosis (LAM)

Indication for lung transplantation

- Obstructive
  - FEV1< 25% predicted and/or
  - PaCO2>55 mmHg and/or
  - Cor pulmonale
  - Preference to patients on oxygen therapy
- Suppurative
  - FEV1< 30% predicted or
  - FEV1> 30% with
    - Increased number of hospitalization
    - Rapid fall in FEV1
    - Massive hemoptysis
    - Increased cachexia
  - PaCO2> 50 mmHg
- Pulmonary fibrosis
  - Symptomatic and progressive disease
  - Abnormal pulmonary function without symptoms
  - Vital capacity < 60~70% predicted
  - DLCO corrected < 50~60% predicted

Indication for lung transplantation

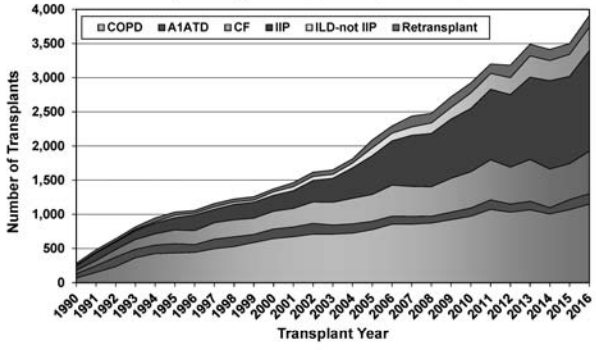
- Pulmonary hypertension
  - NYHA III or IV
  - Cardiac index < 2L/min/m^2
  - Right atrial pressure> 15 mmHg
  - Mean pulmonary arterial pressure> 55 mmHg
- Eisenmenger syndrome
  - NYHA III or IV
  - Progressive symptom

Adult Lung Transplants
Diagnoses (Transplants: January 1995 – June 2017)

Diagnosis	SLT (N=19,112)	BLT (N=39,813)	TOTAL (N=58,925)
COPD	7,525 (39.4%)	10,505 (26.4%)	18,030 (30.6%)
IIP	7,100 (37.1%)	8,064 (20.3%)	15,164 (25.7%)
CF	225 (1.2%)	8,871 (22.3%)	9,096 (15.4%)
ILD-not IIP	1,067 (5.6%)	2,209 (5.5%)	3,276 (5.6%)
A1ATD	806 (4.2%)	2,056 (5.2%)	2,862 (4.9%)
Retransplant	966 (5.1%)	1,410 (3.5%)	2,376 (4.0%)
IPAH	93 (0.5%)	1,609 (4.0%)	1,702 (2.9%)
Non CF-bronchiectasis	73 (0.4%)	1,526 (3.8%)	1,599 (2.7%)
Sarcoidosis	328 (1.7%)	1,126 (2.8%)	1,454 (2.5%)
PH-not IPAH	136 (0.7%)	767 (1.9%)	903 (1.5%)
LAM/tuberous sclerosis	155 (0.8%)	400 (1.0%)	555 (0.9%)
OB	76 (0.4%)	431 (1.1%)	507 (0.9%)
CTD	154 (0.8%)	349 (0.9%)	503 (0.9%)
Cancer	7 (0.0%)	30 (0.1%)	37 (0.1%)
Other	401 (2.1%)	460 (1.2%)	861 (1.5%)

ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION

Adult Lung Transplants
Major Diagnoses by Year (Number)



ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION 2018
JHLT. 2018 Oct; 37(10): 1155-1206

Indications of LTx in Korea: KONOS Data 2010 - 2014

	2010	2011	2012	2013	2014
Asbestosis					1
Bronchiectasis	1	5	6	1	2
Cystic fibrosis			1		
Eisenmenger SD	1				
COPD/Emphysema	1				
IPF	7	9	12	22	25
LAM	1	5	2	1	2
PPH		1	1	3	
BO after Tx		1	3	5	5
Unknown	1	2			
기타	6	12	12	14	20
Total	18	35	37	46	55

Complication

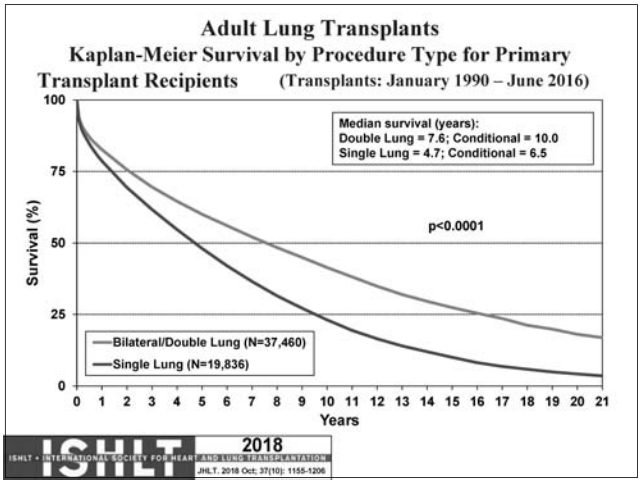
- **Ischemia-reperfusion injury**
  - the most worrisome complication in early postoperative course
  - Characteristics
    - progressive lung injury over the first few postoperative hours
    - noncardiogenic pulmonary edema
    - mild and transient edema in most cases
  - Causes
    - poor preservation of the graft
    - Prolonged ischemic time
    - Aspiration in the donor lung
  - Treatment
    - Mechanical ventilatory support: minimizing inhaled tidal volume
    - Diuresis
    - NO inhalation
    - ECMO

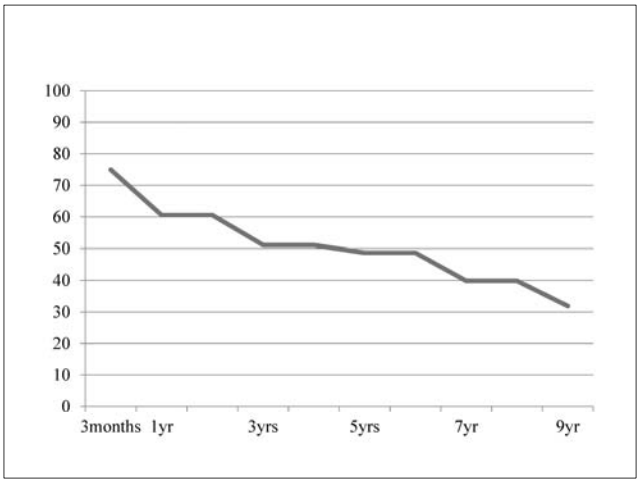
- **Anastomotic complications**
  - Bronchial dehiscence and necrosis
  - the early use of sirolimus

- **Acute rejection**
  - Lung : susceptible to acute rejection among all solid organ transplants
  - up to 50% of patients within the first month
  - present with cough, desaturation, low grade fever
  - pulmonary edema pattern or normal in X-ray
  - Diagnosis
    - transbronchial biopsy via bronchoscopy
  - Treatment
    - IV pulse dose steroids
    - optimization of the cyclosporine and azathioprine doses

- **Infectious complications**
  - leading cause of early postoperative deaths
  - predispose to acute allograft rejection
  - *Bacterial infections*
    - the most common in the early posttransplant period
    - use of broad spectrum antimicrobial prophylaxis
    - → antibiotic regimen based on the recipient and donor sputum culture
  - *Viral infections*
    - particularly CMV infection
      - highest risk: R(-) + D(+)
      - 12-week regimen of IV ganciclovir in high-risk mismatch
  - Fungal infections
    - *Aspergillus*
      - Mortality: ~ 60% in aspergillus pneumonia
      - Treatment: combination of systemic and inhaled antifungal agents
      - Preventention
        - » oral voriconazole or inhaled abelcet
        - » Systemic antifungals
    - *Candida*

Survival





Adult Lung Transplants
Cause of Death (Deaths: January 1990 – June 2017)

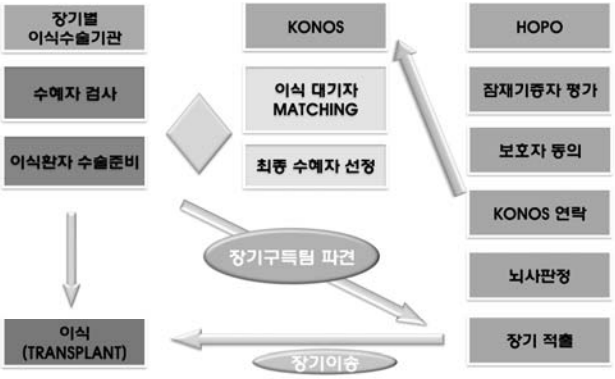
Cause of Death	0-30 Days (N=3,707)	31 Days - 1 Year (N=6,724)	>1 Year - 3 Years (N=6,619)	>3 Years - 5 Years (N=3,941)	>5 Years - 10 Years (N=4,992)	>10 Years (N=2,097)
OB/BOS	11 (0.3%)	309 (4.6%)	1,729 (26.1%)	1,176 (29.8%)	1,234 (24.7%)	464 (22.1%)
Acute Rejection	118 (3.2%)	119 (1.8%)	102 (1.5%)	24 (0.6%)	23 (0.5%)	4 (0.2%)
Lymphoma	1 (0.0%)	141 (2.1%)	112 (1.7%)	55 (1.4%)	93 (1.9%)	60 (2.9%)
Malignancy, Non-Lymphoma	5 (0.1%)	201 (3.0%)	554 (8.4%)	478 (12.1%)	761 (15.2%)	301 (14.4%)
CMV	3 (0.1%)	132 (2.0%)	58 (0.9%)	10 (0.3%)	6 (0.1%)	1 (0.0%)
Infection, Non-CMV	693 (18.7%)	2,313 (34.4%)	1,374 (20.8%)	694 (17.6%)	835 (16.7%)	344 (16.4%)
Graft Failure	888 (24.0%)	1,102 (16.4%)	1,252 (18.9%)	704 (17.9%)	804 (16.1%)	312 (14.9%)
Cardiovascular	445 (12.0%)	369 (5.5%)	292 (4.4%)	184 (4.7%)	293 (5.9%)	142 (6.8%)
Technical	439 (11.8%)	237 (3.5%)	61 (0.9%)	18 (0.5%)	36 (0.7%)	14 (0.7%)
Multiple Organ Failure	471 (12.7%)	817 (12.2%)	338 (5.1%)	158 (4.0%)	233 (4.7%)	109 (5.2%)
Other	633 (17.1%)	984 (14.6%)	747 (11.3%)	440 (11.2%)	674 (13.5%)	346 (16.5%)

ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION 2018
JHLT. 2018 Oct; 37(10): 1155-1206

Percentages represent % of deaths in the respective time period.

Waiting List

뇌사 장기기증 절차



Lung Allocation Score (LAS) of UNOS

Table 1. Parameter estimates for waiting list model

CHARACTERISTIC (X)	β and conditions
Age at effect	0.0064*Age
Bilirubin (mg/dL)	0.0433*(bilirubin – 1), if bilirubin ≥ 1
Bilirubin, increase of at least 50%	0.3174, if diagnosis group B
Body mass index (BMI) (kg/m²)	0.1282*(30 – BMI), if BMI < 30 kg/m²
Cardiac index prior to any exercise (L/min/m²)	0.1610, if cardiac index < 1 L/min/m²
Central venous pressure (CVP) (mmHg) at rest, prior to any exercise	0.0176*(CVP – 7), if CVP > 7 mmHg and diagnosis group B
Continuous mechanical ventilation, if candidate is hospitalized	0.6694
Creatinine (serum) (mg/dL)	0.1810*creatinine, if candidate at least 18 years old at time of offer
Diabetes (regardless of insulin dependency)	0.3092
Diagnosis* — Group A	0
Diagnosis* — Group B	1.3976
Diagnosis* — Group C	1.5214
Diagnosis* — Group D	0.6260
Diagnosis detailed — Bronchiectasis (in Group A)	0.6484
Diagnosis detailed — Eisenmenger's syndrome (in Group B)	-0.8279
Diagnosis detailed — Lymphangioleiomyomatosis (in Group A)	-0.7203
Diagnosis detailed — Obliterative bronchiolitis (not retransplant) (in Group D)	0.4433
Diagnosis detailed — Pulmonary fibrosis, not idiopathic (in Group D)	-0.2692
Diagnosis detailed — Sarcoidosis with PA mean pressure < 30 mmHg (in group A)	-0.4178
Diagnosis detailed — Sarcoidosis with PA mean pressure ≥ 30 mmHg (in group A)	0.9531
Forced vital capacity (FVC) (%predicted	0.1829*(68-FVC)/10, if FVC < 68% of diagnosis group D
Functional status	0.1789, if no assistance needed with activities of daily living
Oxygen need to maintain adequate oxygen saturation (SO²) or greater) at rest (L/min)	0.0821*SO², if diagnosis group B, C or D
pCO²	0.1189*(SO²-55), if pCO² < 40
pCO² increase of at least 15%*	0.3321
Pulmonary artery (PA) systolic pressure at rest, prior to any exercise (mmHg)	0.0175*(PA systolic – 40)/10, if PA systolic > 40 mmHg and group A 0.0902*PA systolic/10, if diagnosis groups B, C or D
Six-minute walk distance (feet) obtained while the candidate was receiving supplemental oxygen required to maintain an oxygen saturation of 88% or greater at rest	-0.0045*six-minute walk distance/100

Table 2. Parameter estimates for post-transplant model

CHARACTERISTIC (X)	α and conditions
Age at transplant (years)	0.0247*(age – 43.9972402), if candidate age ≥ 46 years
Cardiac index prior to any exercise (L/min/m²)	0.3496, if cardiac index < 2 L/min/m²
Continuous mechanical ventilation, if candidate is hospitalized	0.6094
Creatinine at transplant (mg/dl)	0.0896*creatinine, if candidate age ≥ 18 years
Creatinine increase ≥ 150%*	0.7709
Diagnosis* — Group A	0
Diagnosis* — Group B	0.6116
Diagnosis* — Group C	0.3627
Diagnosis* — Group D	0.4641
Diagnosis detailed — Bronchiectasis (in Group A)	0.1889
Diagnosis detailed — Eisenmenger's syndrome (in Group B)	0.9147
Diagnosis detailed — Lymphangioleiomyomatosis (in Group A)	-1.5194
Diagnosis detailed — Obliterative bronchiolitis (not retransplant) (in Group D)	-1.2051
Diagnosis detailed — Pulmonary fibrosis, not idiopathic (in Group D)	-0.0724
Diagnosis detailed — Sarcoidosis with PA mean pressure < 30 mmHg (in group A)	-0.0438
Diagnosis detailed — Sarcoidosis with PA mean pressure ≥ 30 mmHg (in group A)	-0.1389
Functional status: If no assistance needed to perform activities of daily living	-0.1906
Oxygen need to maintain adequate oxygen saturation (SO²) or greater) at rest (L/min)	0.0748*SO², if diagnosis group A; 0.0164*SO², if diagnosis groups B, C or D
Six-minute walk distance (feet) obtained while the candidate was receiving supplemental oxygen required to maintain an oxygen saturation of 88% or greater at rest.	0.0005*(1200 – six-minute walk distance)

폐이식 응급도

□ 응급도 0	- 다음 한 가지 이상 해당하는 경우 □ 호흡부전증으로 인공호흡기를 부착중인 환자 □ 체외막형 심폐기를 가동중인 환자
□ 응급도 1	- 다음 한 가지 이상 해당하는 경우 □ NYHA IV 이면서 산소 투여 없이 측정한 동맥혈 가스 검사상 PaO2 < 55mmHg □ NYHA IV 이면서 평균 폐동맥압(> 60mmHg 또는 평균 우심방 압력 > 15mmHg □ Cardiac index < 2L/min/m2인 경우
□ 응급도 2	- 다음 한 가지 이상 해당하는 경우 □ 폐기능검사에서 1초 강제호기량(FEV1) < 25% □ 산소 없이 측정한 동맥혈 가스 검사상 PaO_2 < 60mmHg □ 평균 우심방혈압이 10-15 mmHg인 경우 □ 평균 폐동맥압력이 55-65 mmHg인 경우 □ Cardiac index < 2-2.5 L/min/m2인 경우 □ 과거에 폐이식을 시행한 경우로 다시 폐이식이 필요한 경우 □ 과거에 폐혈전 감소술을 시행한 경우로 상태가 악화된 경우 □ 폐암에서 폐이식이 적응된 경우

※ 유의사항
- 응급도 0과 1,2의 등록은 장기이식정보시스템(K-net) 등록후 24시간 내에 폐 응급도 서식을 KONOS로 통보함
- 해당 응급도로 연장할 경우 8일 이내에 재등록토록 하여야 하고 등 내용은 마감일 24시간 이전에 서면으로 통보하여야 하며, 변경된 응급도로 등록할 경우에도 장기이식정보시스템에 등록후 24시간 내에 응급도 서식을 KONOS로 통보함
- 그 외는 응급도 3으로 떨어지오니 항상 유의하셔야 함

표 4-1-24. 이식자의 평균 대기시간 (퍼) - 성별

(단위 : 일)

구분	2013	2014	2015	2016	2017
평균	91	96	118	116	116
남자	82	60	77	108	115
여자	106	149	178	131	119

표 4-1-26. 이식자의 평균 대기시간 (퍼) - 혈액형별

(단위 : 일)

구분	2013	2014	2015	2016	2017
평균	91	96	118	116	116
A	106	68	80	86	118
B	80	89	176	76	128
O	99	154	155	244	106
AB	48	81	62	92	112

표 4-1-28. 이식자의 평균 대기시간 (퍼) - 응급도별

(단위 : 일)

구분	2013	2014	2015	2016	2017
평균	91	96	118	116	116
Status0	79	34	55	84	64
Status1	102	153	172	138	173
Status2	6		83	278	
Status3	190	207	205	97	83

The Fate of Patients on the Waiting List for Lung Transplantation in Korea

H.C. Park, S.J. Haam, D.Y. Lee, G.J. Yi, S.W. Song, Y.T. Kim, C.H. Kang, K.M. Kim, S.J. Park, and S.H. Jheon

ABSTRACT

Lung transplantation for end-stage lung disease results in prolonged actuarial survival and improved pulmonary function. However, the shortage of donor lungs has been a major limiting factor in transplantation. The purpose of this study was to analyze the waiting time and mortality rate for each disease entity. The medical records of all patients listed in The Korean Network for Organ Sharing (KONOS) from May 1996 to May 2011 were analyzed to identify waiting times and causes of death. During the study period, 146 patients (86 males and 60 females) of mean age of 46.6 years (range, 5 to 73 years) showed idiopathic pulmonary fibrosis (IPF; n = 61), chronic obstructive pulmonary disease (COPD; n = 35) or bronchiectasis (n = 15). Sixty-five patients (44.5%) underwent lung or heart-lung transplantation. Sixty-two patients (42.5%) expired during the waiting period, and 19 patients are still on the waiting list. The mortality rate while waiting was highest among patients with primary pulmonary hypertension (62.5%) followed by IPF (57.4%), and acute respiratory distress syndrome (ARDS) (57.6%). The mean time from diagnosis to registration in KONOS was 15.1 months among the expired and 13.2 months in the transplanted group ($P = .457$). The mean time on waiting list was 8.2 months in the expired group and 1.7 months in the transplanted group ($P = .012$). In the expired group, the mean survival time was significantly shorter among patients with ARDS (2.2 months, $P = .004$) compared to IPF (7.9 months), COPD (10.7 months), and primary pulmonary hypertension (PPH) (30.0 months). The high mortality rate (42.5%) during the waiting period in Korea may result from the lack of donors and the delay in registration.

Lung transplantation (LTx) is a life-saving treatment for patients with end-stage lung disease. However, donor organ availability is a serious problem because only 15% to 20% of multiorgan donors are considered to be suitable for LTx.[1] Approximately 3000 LTx per year have been performed worldwide[2] since the first successful procedure in 1983.[3] The LTx program in Korea started in July 1996.[4] Until May 2011, five institutions have performed LTx. The purpose of this study was to review the characteristics waiting times, and mortality rates for each disease entity among patients awaiting LTx.

METHODS

We retrospectively reviewed the medical records of all patients awaiting LTx in five institutions and listed in The Korean Network for Organ Sharing (KONOS) from May 1996 to May 2011. The five institutions

From the Department of Thoracic and Cardiovascular Surgery (H.C.P., S.J.H., D.Y.L., G.J.Y., S.W.S.), Gangnam Severance Hospital, Yonsei University College of Medicine; Department of Thoracic and Cardiovascular Surgery (Y.T.K., C.H.K.), Seoul National University Hospital, Seoul National University School of Medicine, Seoul, Korea; Department of Thoracic and Cardiovascular Surgery (K.M.K.), Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea; Department of Thoracic and Cardiovascular Surgery (S.J.P.), Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea; and the Department of Thoracic and Cardiovascular Surgery (S.H.J.), Seoul National University Bundang Hospital, Seoul National University College of Medicine, Syeongi, Korea.

Address reprint requests to Hyo Chae Park, Department of Thoracic and Cardiovascular Surgery, Gangnam Severance Hospital, 211, Eonju-Ro, Gangnam-Gu, Seoul, Korea. E-mail: hcpark@yuhs.ac

0041-1345/- see front matter
doi:10.1016/j.transproceed.2011.12.059

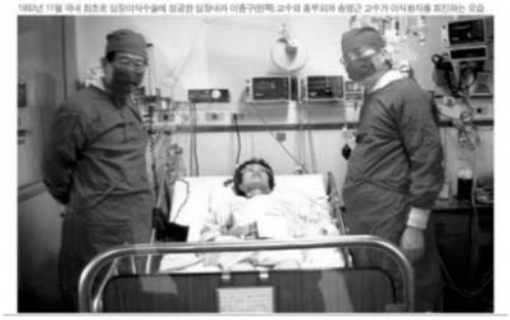
Transplantation Proceedings, 44, 860-864 (2012)

Heart transplantation

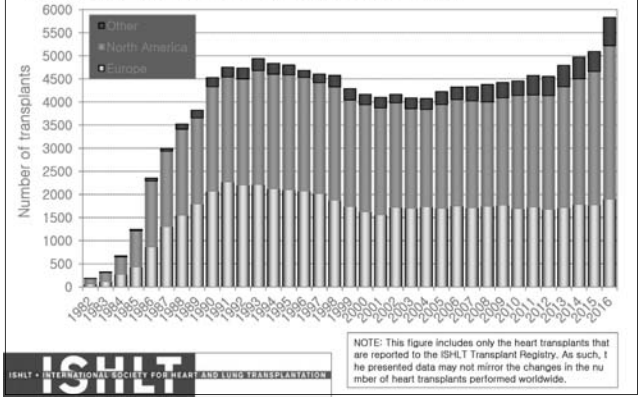
History of HTx

- •1964: James Hardy
  - •1st Animal HTx
- •1967: Christiaan Bernard
  - •1st Human HTx: Survival for 18 days
- •1968: Norman Schumway
  - •1st HTx in USA
  - •< 3months, less than 1/3 patients
- •1983: Cyclosporine

First case of HTx in Korea



Adult and Pediatric Heart Transplants
Number of Transplants by Year and Location

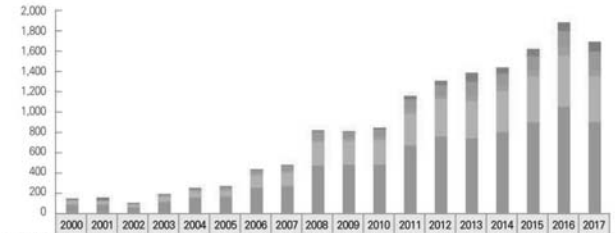


ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION

NOTE: This figure includes only the heart transplants that are reported to the ISHLT Transplant Registry. As such, t he presented data may not mirror the changes in the nu mber of heart transplants performed worldwide.

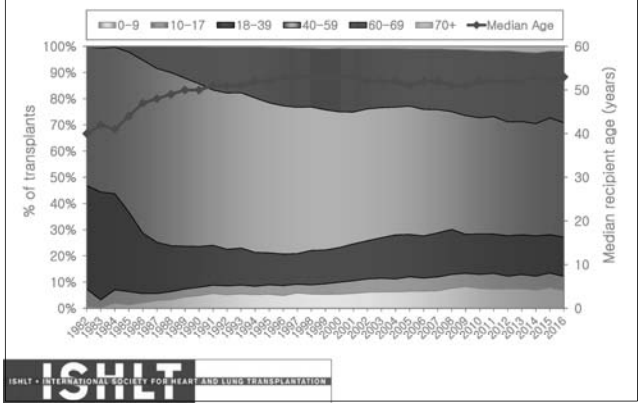
Number of Solid Organ Transplants from the Brain Death Donors

(단위: 건)

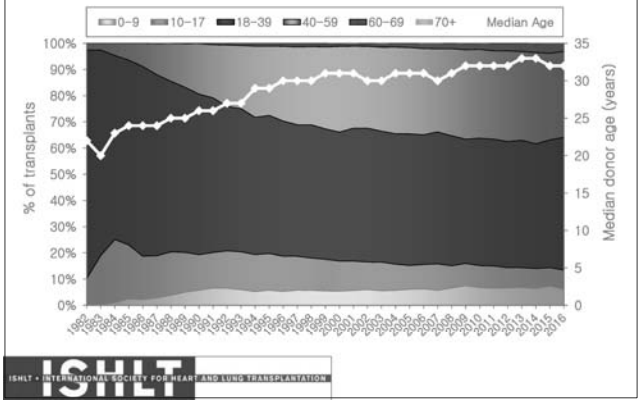


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
신장	99	99	68	123	164	171	263	278	479	488	491	680	768	750	808	901	1,059	903
간장	34	37	28	50	64	66	118	128	233	236	242	313	363	367	404	456	508	450
췌장	11	5	8	12	10	12	29	18	22	22	25	43	34	57	55	57	74	62
심장	12	21	11	15	23	26	29	50	84	65	73	98	107	127	118	145	156	184
폐장	1	0	2	2	3	7	3	9	7	8	18	35	37	46	55	64	89	93
계	157	162	117	202	264	282	442	483	825	819	849	1,169	1,309	1,347	1,440	1,623	1,886	1,692

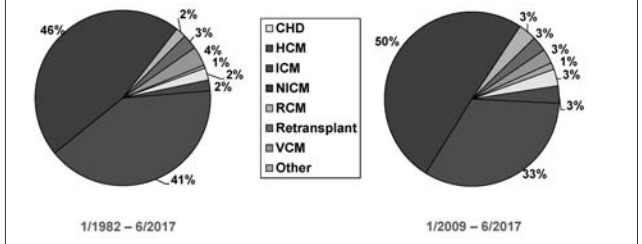
Adult and Pediatric Heart Transplants
Recipient Age by Year of Transplant



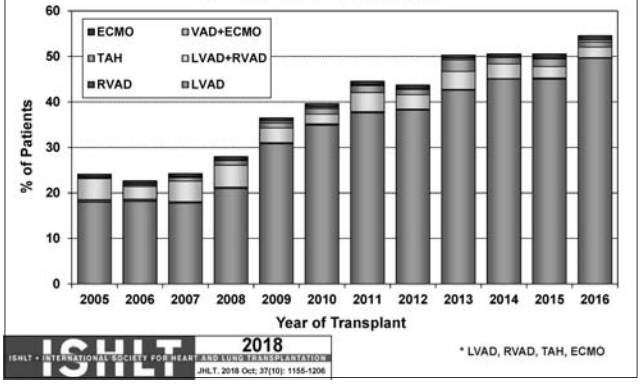
Adult and Pediatric Heart Transplants
Donor Age by Year of Transplant



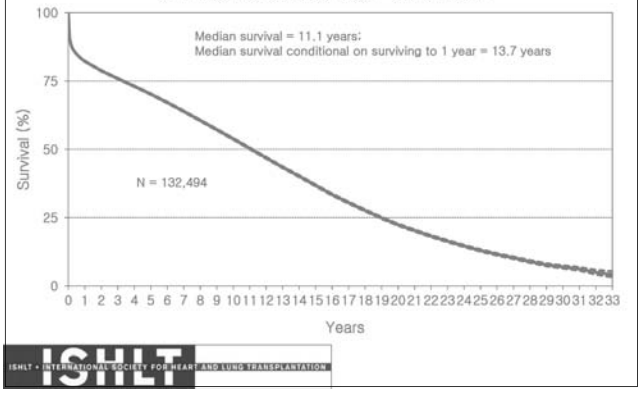
Adult Heart Transplants
Diagnosis



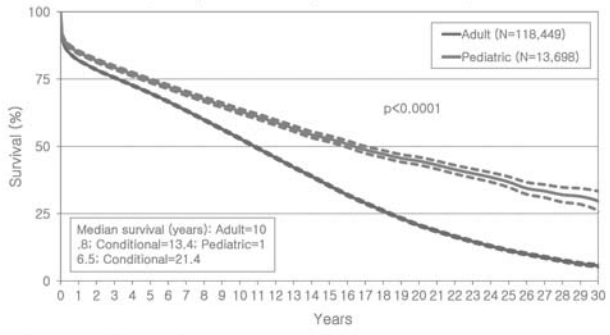
Adult Heart Transplants
% of Patients Bridged with Mechanical Circulatory Support* by Year and Device Type



Adult and Pediatric Heart Transplants
Kaplan–Meier Survival
(Transplants: January 1982 – June 2016)



Adult and Pediatric Heart Transplants
Kaplan–Meier Survival by Age Group
(Transplants: January 1982 – June 2016)



ISHLT • INTERNATIONAL SOCIETY FOR HEART AND LUNG TRANSPLANTATION

Adult Heart Transplants
Cause of Death (Deaths: January 1994 – June 2017)

Cause of Death	0-30 Days (N=7,048)	31 Days - 1 Year (N=6,076)	>1-3 Years (N=4,298)	>3-5 Years (N=3,693)	>5-10 Years (N=9,428)	>10-15 Years (N=6,759)	>15 Years (N=5,176)
Cardiac Allograft Vasculopathy	90 (1.3%)	212 (3.5%)	494 (11.5%)	483 (13.1%)	1,201 (12.7%)	834 (12.3%)	560 (10.8%)
Acute Rejection	294 (4.2%)	516 (8.5%)	413 (9.6%)	172 (4.7%)	177 (1.9%)	62 (0.9%)	28 (0.5%)
Lymphoma	2 (0.0%)	64 (1.1%)	104 (2.4%)	115 (3.1%)	312 (3.3%)	183 (2.7%)	109 (2.1%)
Malignancy, Other	4 (0.1%)	151 (2.5%)	529 (12.3%)	720 (19.5%)	2,036 (21.6%)	1,438 (21.3%)	985 (19.0%)
CMV	3 (0.0%)	58 (1.0%)	21 (0.5%)	6 (0.2%)	8 (0.1%)	4 (0.1%)	2 (0.0%)
Infection, Non-CMV	981 (13.9%)	1,928 (31.7%)	574 (13.4%)	389 (10.5%)	1,006 (10.7%)	736 (10.9%)	638 (12.3%)
Graft Failure	2,858 (40.6%)	1,074 (17.7%)	1,137 (26.5%)	888 (24.0%)	1,835 (19.5%)	1,176 (17.4%)	862 (16.7%)
Technical	500 (7.1%)	93 (1.5%)	31 (0.7%)	28 (0.8%)	94 (1.0%)	81 (1.2%)	68 (1.3%)
Other	312 (4.4%)	401 (6.6%)	338 (7.9%)	281 (7.6%)	719 (7.6%)	449 (6.6%)	381 (7.4%)
Multiple Organ Failure	1,243 (17.6%)	964 (15.9%)	261 (6.1%)	209 (5.7%)	650 (6.9%)	571 (8.4%)	486 (9.4%)
Renal Failure	30 (0.4%)	53 (0.9%)	57 (1.3%)	114 (3.1%)	516 (5.5%)	538 (8.0%)	509 (9.8%)
Pulmonary	189 (2.7%)	230 (3.8%)	175 (4.1%)	164 (4.4%)	429 (4.6%)	318 (4.7%)	252 (4.9%)
Cerebrovascular	542 (7.7%)	332 (5.5%)	164 (3.8%)	124 (3.4%)	445 (4.7%)	369 (5.5%)	296 (5.7%)
Total Deaths (N)	8,121	6,979	5,276	4,647	12,489	9,763	7,735

ISHLT 2018 JHLT. 2018 Oct; 37(10): 1155-1206

Percentages represent % of deaths in the respective time period. Total number of deaths includes deaths with unknown causes.

Adult Heart Transplants
Cumulative Morbidity Rates in Survivors within 1, 5 and 10 Years Post Transplant (Transplants: January 1994 – June 2016)

Outcome	Within 1 Year	Total N with known response	Within 5 Years	Total N with known response	Within 10 Years	Total N with known response
Severe Renal Dysfunction[1]	6.9%	(N=38,588)	16.1%	(N=22,131)	23.1%	(N=9,000)
Creatinine > 2.5 mg/dl	*5.4%*		*12.7%*		*15.1%*	
Chronic Dialysis	*1.4%*		*2.9%*		*6.0%*	
Renal Transplant	*0.1%*		*0.6%*		*2.0%*	
Diabetes[2]	21.0%	(N=38,844)	34.5%	(N=22,396)	-	
Cardiac Allograft Vasculopathy	7.6%	(N=35,766)	29.2%	(N=16,921)	47.2%	(N=5,787)

ISHLT 2018 JHLT. 2018 Oct; 37(10): 1155-1206

[1] Severe renal dysfunction = Creatinine > 2.5 mg/dl (221 µmol/L), dialysis or renal transplant
[2] Data are not available 10 years post-transplant.

Adult Heart Transplants
Post Transplant Malignancy (Transplants: January 1994 – June 2016)
Cumulative Morbidity Rates in Survivors

Malignancy/Type		1-Year Survivors	5-Year Survivors	10-Year Survivors
No Malignancy		37,928 (94.8%)	20,922 (84.0%)	8,451 (72.1%)
Malignancy (all types combined)		2,062 (5.2%)	3,981 (16.0%)	3,277 (27.9%)
*Malignancy Type**	*Skin*	*677 (1.7%)*	*2,378 (9.5%)*	*2,189 (18.7%)*
	Lymphoma	*203 (0.5%)*	*279 (1.1%)*	*211 (1.8%)*
	Other	*1,141 (2.9%)*	*1,545 (6.2%)*	*1,190 (10.1%)*
	Type Not Reported	*41 (0.1%)*	*38 (0.2%)*	*21 (0.2%)*

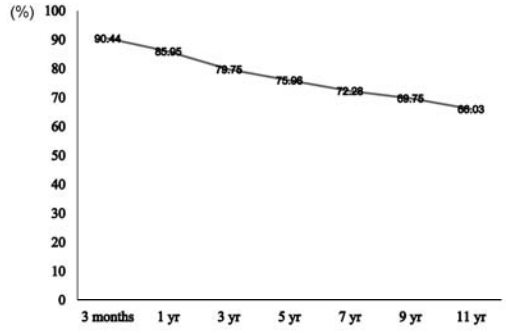
"Other" includes: prostate (11, 31, 19), adenocarcinoma (7, 2, 1), lung (6, 5, 1), bladder (2, 3, 0), Kaposi's sarcoma (0, 2, 0), breast (1, 4, 2), cervical (2, 3, 2), colon (2, 4, 3), and renal (2, 6, 1). Numbers in parentheses are those reported within 1 year, 5 years and 10 years, respectively.

* Recipients may have experienced more than one type of malignancy so the sum of individual malignancy types may be greater than the total number with malignancy.

ISHLT 2018 JHLT. 2018 Oct; 37(10): 1155-1206

Skin malignancy includes melanoma and non-melanoma skin cancers.

Survival after HTx in Korea



Immunosuppression in organ transplantation

Introduction

- Alloimmune response
  - Hyperacute rejection
    - Onset: Immediate after perfusion
    - ABO mismatch
    - Tx: Removal of graft
  - Acute rejection (Most common rejection)
    - Onset: 2 weeks ~ several years after transplantation
    - Infiltration of lymphocyte and interstitial edema
    - Tx: Steroid pulse therapy, anti-thymocyte globulin
  - Chronic rejection
    - Onset: 6 months ~ several years after transplantation
    - Bronchiolitis obliterans syndrome: fibrous obstruction of bronchiole
    - Humoral immune reaction, IR injury, CMV infection, HTN, hyperlipidemia
    - Tx: no medical treatment

- Types of immune suppression
  - Induction therapy
  - Maintenance therapy
  - Treatment of rejection

- Principles of immune suppression
  - Combinations of agents
    - Different mechanism
    - Synergic effect
    - Reduced toxicity

Immunosuppressants

- Biologic agents
  - Induction therapy
  - Monoclonal antibody: Muromonab-CD3 (OKT3)
  - Polyclonal antibody: Antithymocyte globulin/antilymphocyte globulin

- Non-biological agents
  - Maintenance therapy
  - Calcineurin inhibitor: Cyclosporin/tacrolimus
  - DNA synthesis inhibitor: Azathioprine/ Mycophemolate mofetil
  - Steroid
  - Mammarian Target of rapamicin(mTOR) inhibitor: Sirolimus/everolimus

Calcineurin inhibitor (CNI)

- Mechanism
  - inhibition of phosphatase activity of calcineurin in T-cell cytoplasm
  - → inhibition of IL-2 production
  - Monitoring of blood level: food intake
  - Adverse effect
    - Nephrotoxicity: most common
    - Lymphoproliferative disorder: cardiomyopathy in pediatric heart transplantation (Tac)
    - Hypertension, hyperlipidemia (Cs>Tac): with steroid
    - hepatotoxicity, hyperkalemia, hyperuricemia

Calcineurin inhibitor (CNI)

- Cyclosporine (Sandimmun®, Neoral®, Cipol®)
  - No suppression of BM
  - TGF-β↑→ fibrosis → BOS?
  - Adverse effect: hirsutism, GI trouble, gingival hypertrophy

- Tacrolimus (Prograf®, Tacrobell®)
  - up to 10~100 times more potent than cyclosporine
  - Adverse effect: tremor (more severe than Cs), post-transplant DM, neurotoxicity, alopecia

Calcineurin inhibitor (CNI)

- Drug interaction
  - Increasing CNI level (cytochrome P-450 inhibitors)
    - Calcium channer blocker: diltiazem, nicardipine, nifedipine
    - Antifungal agents: voriconazole, fluconazole, itraconazole
    - Macrolide antibiotics: clarithromycin, erythromycin
    - Prokinetic agents: cisapride, metoclopramide
    - Others: benzodiazepine, cimetidine, methylprednisolone, allopurinol
    - Food: Grapefruit juice
  - Decreasing CNI level (cytochrome P-450 inducers)
    - Anti-convulsants: phenobarbital, phenytoin
    - TB medication: Rifampicin, Isoniazid

Corticosteroid

- Mechanism
  - Prevention of cytokines production by B cell
  - Inhibition of T-cell growth factor
  - Anti-inflammatory effect
- Type
  - Methylprednisolone (IV): solumedrol
  - Prednisolone:Solondo
  - Deflazacort: Calcort, Prandin- reduced DM and moon face
- Tendency to use low dose ←dose and time dependent
- Acute rejection: Treatment of choice
- Adverse effect
  - wound dehiscence, infection, gastric ulcer, moon face, osteoporosis, AVN, hypertension, hyperglycemia, wt. gain

DNA synthesis inhibitor

- Mechanism
  - Block of purine synthesis
  - → inhibition of differentiation and proliferation of lymphocytes
- Azathioprine (Imuran®)
  - Adverse effects
    - BM suppression (WBC>platelet>RBC), hepatotoxicity, nausea, skin cancer (?)
- Mycophenolate mofetil (Cellcept®)
  - Better effective than Aza
  - Inhibition of smooth muscle proliferation→BOS↓
  - Acute rejection and recurrent rejection
  - Adverse effects
    - < Aza: hepatotoxicity, BM suppression
    - > Aza: GI trouble (Myfortic®), infection (strong suppression)

mTOR inhibitor

- Mechanism
  - mTOR inhibition→ cell cycle arrest in the late G_1 phase of T-cell
- No nephrotoxicity: Substitute for CNI
- Anticarcinogenic
- Antifibroproliferative effect
  - Treatment and prevention of BOS
- Sirolimus (Rapamune®)/ Everolimus (Certican®)
- Adverse effect
  - Hyperlipidemia, gingivitis, arthritis, BM suppression, diarrhea, wound dehiscence, elevation of nephrotoxicity of CNI

Anti-T cell agents

- Abs to antigenic determinant on T cell surface
- Polyclonal Ab: Anti-thymocyte globulin (Thymoglobulin®)
  - T-cell depletion
  - Adverse effect
    - Cytokine release syndrome → fever, chill, headache, hypotension: acetaminophen, antihistamin, steroid
    - CMV infection, post-transplant lymphoproliferative disease
- Monoclonal Ab
  - Murononab-CD3 (OKT3)
    - Treatment of steroid-non-response rejection
  - IL-2R antibody:Basiliximab(Simulect®)/Daclizumab(Zenapax®)
    - reduce modestly the incidence of acute cellular rejection
    - no cytokine release syndrome, no increase in infection

Induction therapy

- Biologic agents

Advantage	Disadvantage
• Intensified immunosuppression early after Tx • Reduced incidence of acute rejection • Delay of rejection until stable graft function • Ability to delay introduction of nephrotoxic drugs such as Cs • Reduced incidence of BOS	• First dose side effect • Increased incidence and severity of infection (CMV) • Increased of PTLD • Increased cost • Need for antimicrovial pophylaxis

감사합니다.

Imaging in Thoracic Disease

Department of Thoracic and Cardiovascular Surgery, Yonsei University College of Medicine, Seoul, Korea

Seong Yong Park, MD, PhD

JAMA Network Open.

Original Investigation | Imaging

Development and Validation of a Deep Learning-Based Automated Detection Algorithm for Major Thoracic Diseases on Chest Radiographs

Abstract

IMPORTANCE Interpretation of chest radiographs is a challenging task prone to errors, requiring expert readers. An automated system that can accurately classify chest radiographs may help streamline the clinical workflow.

OBJECTIVES To develop a deep learning–based algorithm that can classify normal and abnormal results from chest radiographs with major thoracic diseases including pulmonary malignant neoplasm, active tuberculosis, pneumonia, and pneumothorax and to validate the algorithm's performance using independent data sets.

DESIGN, SETTING, AND PARTICIPANTS This diagnostic study developed a deep learning–based algorithm using single-center data collected between November 1, 2016, and January 31, 2017. The algorithm was externally validated with multicenter data collected between May 1 and July 31, 2018. A total of 54 221 chest radiographs with normal findings from 47 917 individuals (27 556 men and 26 361 women; mean [SD] age, 51 [16] years) and 35 613 chest radiographs with abnormal findings from 14 102 individuals (8373 men and 5729 women; mean [SD] age, 62 [15] years) were used to develop the algorithm. A total of 486 chest radiographs with normal results and 529 with abnormal results (1 from each participant; 628 men and 387 women; mean [SD] age, 53 [18] years) from 5 institutions were used for external validation. Fifteen physicians, including nonradiology physicians, board-certified radiologists, and thoracic radiologists, participated in observer performance testing. Data were analyzed in August 2018.

EXPOSURES Deep learning–based algorithm.

MAIN OUTCOMES AND MEASURES Image-wise classification performances measured by area under the receiver operating characteristic curve; lesion-wise localization performances measured by area under the alternative free-response receiver operating characteristic curve.

RESULTS The algorithm demonstrated a median (range) area under the curve of 0.979 (0.973-1.000) for image-wise classification and 0.972 (0.923-0.985) for lesion-wise localization; the algorithm demonstrated significantly higher performance than all 3 physician groups in both image-wise classification (0.983 vs 0.814-0.932; all $P < .005$) and lesion-wise localization (0.985 vs 0.781-0.907; all $P < .005$). Significant improvements in both image-wise classification (0.814-0.932 to 0.904-0.958; all $P < .005$) and lesion-wise localization (0.781-0.907 to 0.873-0.938; all $P = .005$) were observed in all 3 physician groups with assistance of the algorithm.

CONCLUSIONS AND RELEVANCE The algorithm consistently outperformed physicians, including thoracic radiologists, in the discrimination of chest radiographs with major thoracic diseases.

Key Points

Question Can a deep learning–based algorithm accurately discriminate abnormal chest radiograph results showing major thoracic diseases from normal chest radiograph results?

Findings In this diagnostic study of 54 221 chest radiographs with normal findings and 35 613 with abnormal findings, the deep learning–based algorithm for discrimination of chest radiographs with pulmonary malignant neoplasms, active tuberculosis, pneumonia, or pneumothorax demonstrated excellent and consistent performance throughout 5 independent data sets. The algorithm outperformed physicians, including radiologists, and enhanced physician performance when used as a second reader.

Meaning A deep learning–based algorithm may help improve diagnostic accuracy in reading chest radiographs and assist in prioritizing chest radiographs, thereby increasing workflow efficacy.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

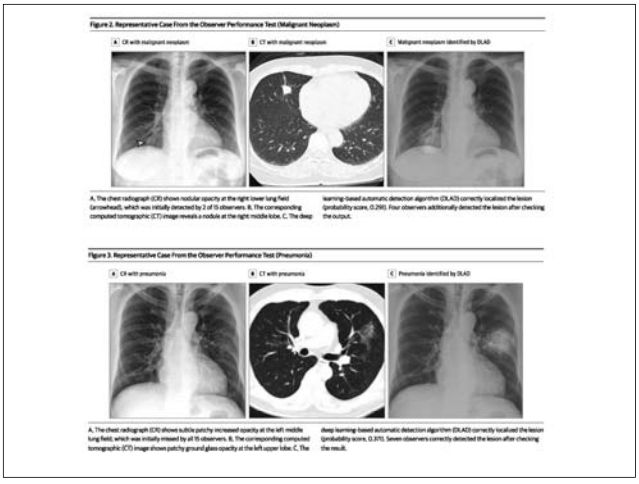


Figure 2. Representative Case From the Observer Performance Test (Malignant Neoplasm)

A. The chest radiograph (CR) shows nodular opacity at the right lower lung field (arrowhead), which was initially detected by 2 of 15 observers. B. The corresponding computed tomographic (CT) image reveals a nodule at the right middle lobe. C. The deep learning–based automatic detection algorithm (DLAD) correctly localized the lesion (probability score, 0.290). Four observers additionally detected the lesion after checking the output.

Figure 3. Representative Case From the Observer Performance Test (Pneumonia)

A. The chest radiograph (CR) shows subtle patchy increased opacity at the left middle lung field, which was initially missed by all 15 observers. B. The corresponding computed tomographic (CT) image shows patchy ground-glass opacity at the left upper lobe. C. The deep learning–based automatic detection algorithm (DLAD) correctly localized the lesion (probability score, 0.371). Seven observers correctly detected the lesion after checking the result.

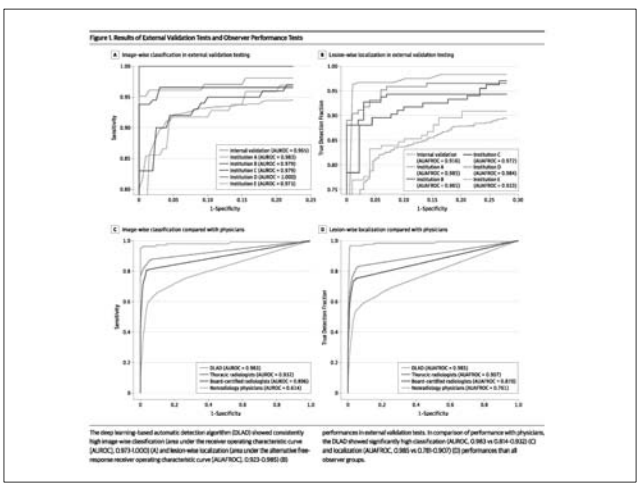


Figure 1. Results of External Validation Tests and Observer Performance Tests

The deep learning–based automatic detection algorithm (DLAD) showed consistently high image-wise classification (area under the receiver operating characteristic curve [AUROC], 0.973-1.000) (A) and lesion-wise localization (area under the alternative free-response receiver operating characteristic curve [AUAFROC], 0.923-0.985) (B) performances in external validation tests. In comparison of performance with physicians, the DLAD showed significantly high classification (AUROC, 0.983 vs 0.814-0.932) (C) and localization (AUAFROC, 0.985 vs 0.781-0.907) (D) performances than all observer groups.

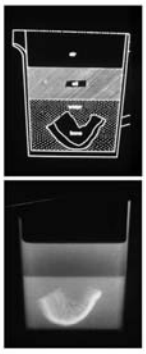
많이 사용하는 영상

- Chest X-ray
- Chest CT, abdomen CT
- PET
- MRI
- Esophagography

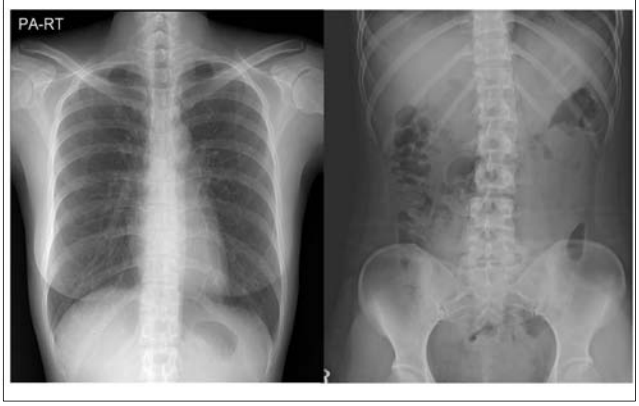
- Bed-side ultrasound

Radiologic Density Contrast

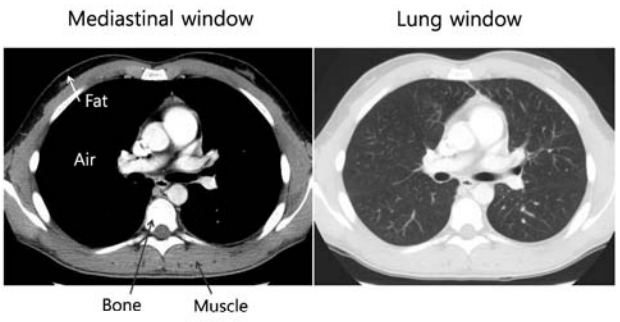
- X-ray absorption coefficient
  - Metal density ; bone, calcified LN
  - Water density ; almost all solid organs
  - Fat density ; subcutaneous, mesenteric retroperitonal fat
  - Air density ; lung, hollow viscus
- Hounsfield Unit
  - X선이 몸을 투과할대 부위별 밀도에 의해 흡수되는 정도를 상대적으로 표현
  - Water 0, Bone 1000, air -1000



Radiologic Density Contrast

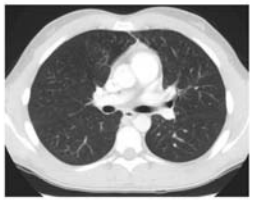


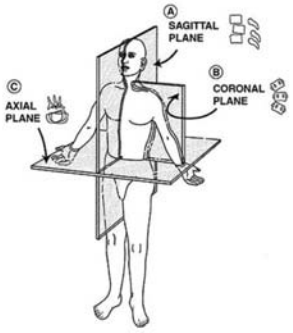
Radiologic Density Contrast



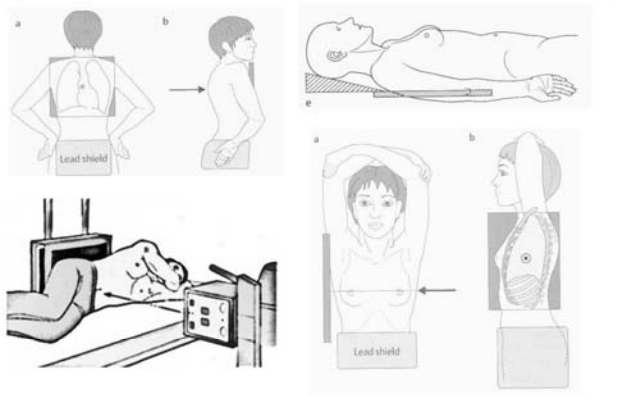
Plane

- Axial; 위에서 아래로 촬영
- Coronal; 정면에서 촬영
- Sagittal; 측면에서 촬영



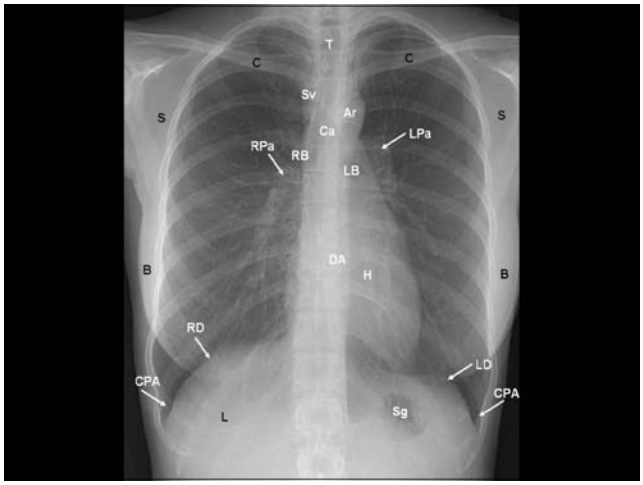


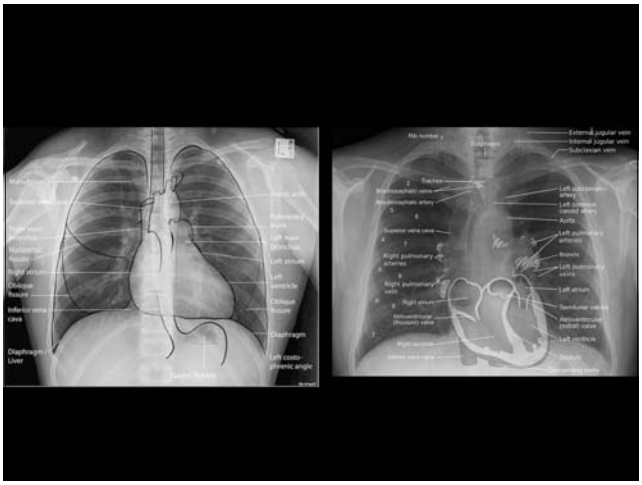
X-ray 촬영 방법

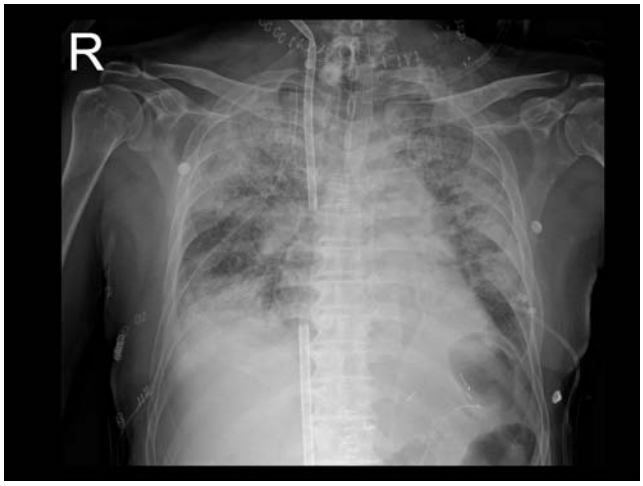


Chest X-ray

- Pneumothorax, pleural effusion
- Atelectasis
- Infiltration
- Mass lesion
- Rib fracture
- Central line, chest tube 및 기타 삽관들의 위치 확인, 위치의 변화
  - Tracheostomy, L-tube, drain....
- 항상 이전 X-ray와 비교해야 한다
- Density를 잘 조정해야 한다







Chest CT

- Most important imaging modality in thoracic disease (backbone of thoracic imaging)
- Contrast
  - Iodine dye
  - Can cause the renal failure
- 종류
  - Chest CT contrast vs. noncontrast
  - Chest HR CT
  - Pulmonary CT
  - Aorta CT

Chest CT

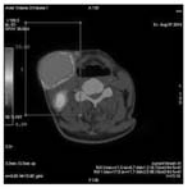
- Axial, coronal, sagittal view를 모두 확인
- Lung setting, mediastinal setting
- Mediastinal setting으로 먼저 본 후, lung setting으로 바꾸어서 본다
- Setting을 바꿔가면서 병변의 변화가 있는지 살펴본다
- 양측 폐를 동시에 보지 말고, 한쪽을 먼저 보고 반대쪽을 다시 보도록
- 조직의 Hounsfield Unit, contrast enhancement 여부도 중요한 단서가 된다

Chest CT

- CT 이미지의 thickness를 확인할 것
- Chest X-ray 가 애매하면 항상 CT를 찍어본다 (noncon이라도)
- Leak이 의심되는 경우는 barium등을 먹이고 CT를 촬영해볼 수 있다
- Nodule과 vessel이 헷갈릴 경우는 위 아래로 이어지는 병변인지 확인한다

PET

- Glucose uptake of cells
- Physiologic uptake, inflammation
- Tracer; FDG, other tracers (ex. 11C-MET for parathyroid)
- Parameters
  - SUV (standardized uptake value)max, SUVmean
  - MTV (metabolic tumor volume)
  - TLG (Total lesion glycolysis) = SUVmean x MTV

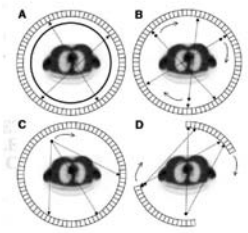


Biography

Dr. Zang Hee Cho graduated Seoul National University and did Ph.D in Applied physics at Uppsala University, Sweden.

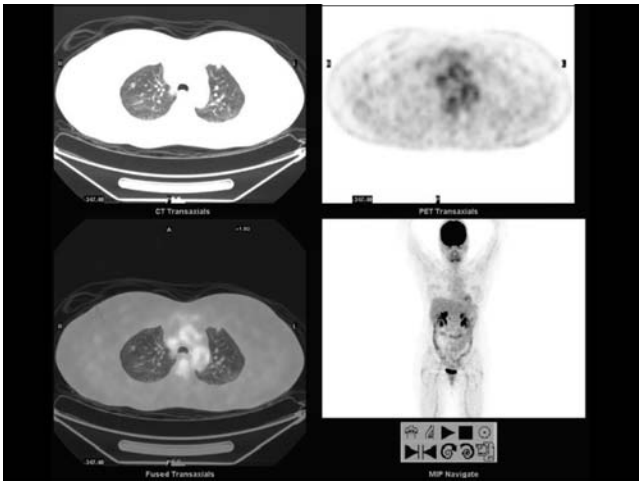
Professor Cho has been faculty of University of California, Los Angeles, Columbia University, and University of California, Irvine. Professor Cho is currently Distinguished Research Fellow at the AICT, Seoul National University.

Professor Cho in the pioneer of CT, PET, and MRI and developed world's first PET scanner in 1975 while he was at UCLA. Among many awards and honors, Professor Cho elected as a member of US National Academy of Medicine in 1977.



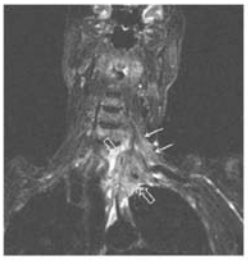
PET

- Brain 병변은 확실히 알 수 없다
- 크기가 작은 병변은 FDG uptake이 높아도 PET에서는 잘 보이지 않을 수 있다; 7mm ~ 1cm 이상은 되어야 확인 가능
- PET/CT 상에서 두 이미지가 완벽하게 일치하지 않을 수 있다; breathing, normal GI motility
- 감염성 질환은 암과 오인될 수 있다
- 그래도 현재로서 preoperative staging에 가장 정확한 imaging tool 이다

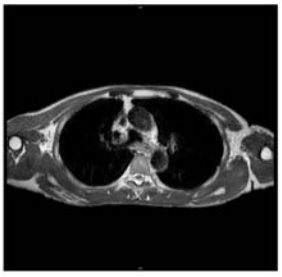


MRI

- Useful situation
  - Brachial plexus invasion
  - Spinal cord invasion
  - Brain metastasis
  - Pancoast tumor, thoracic outlet syndrome, mesothelioma, adrenal mass
- Not useful situation
  - Invasion of aorta or trachea
- 어떤 MRI를 촬영해야 하는지는 영상의학과 전문의와 반드시 상의

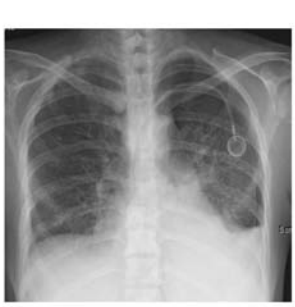


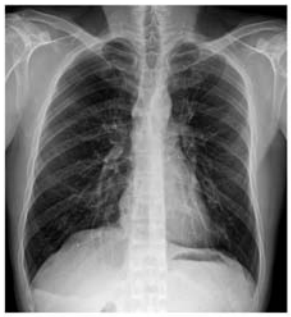
MRI in esophageal cancer



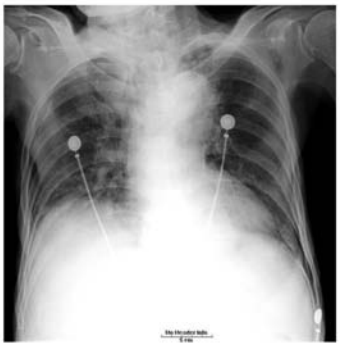
- Chest MR with cine, dynamic, T2-SSH, b-FFE, THRIVE, DWI, T2-STIR
- Asymmetric enhancing wall thickening of upper esophagus, suggestive of esophageal cancer.
- Ill-defined margin between posterior tracheal membrane and esophageal mass, suspicious of invasion.
- Suspicious of azygos vein invasion.
- No definite aortic invasion.
- r/o metastatic LN in the Lt. highest mediastinum.
- Fibrosis with granulomas in both upper lobes, probably Tbc sequelae.

Pneumothorax



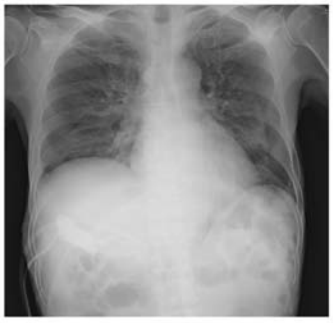


Pneumothorax in chest AP



- 앙아위에서는 약 500cc 정도의 공기가 있어야 진단이 가능
- 공기는 주로 내전방부, 폐하부, 늑골횡경막각에 존재
- 늑골횡경막각, 심장횡경막각의 방사선 투과성 증가
- 심장 윤곽이 분명해짐

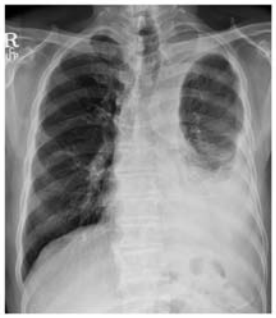
Skinfold



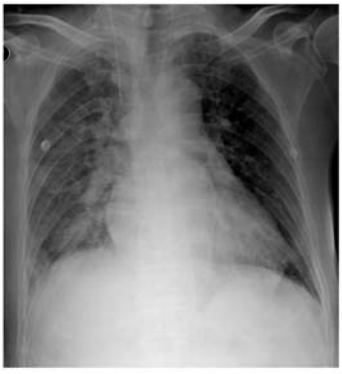
- 기흉으로 오인될 가능성 있음
- Line 바깥에 존재하는 혈관음영
- Line이 흉벽까지 연장

Pleural effusion

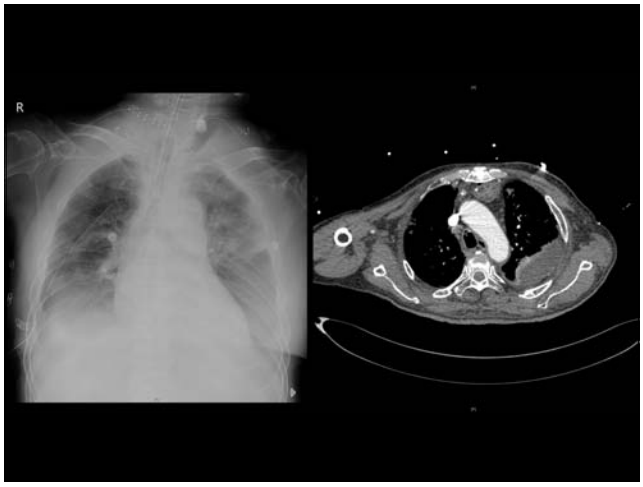
- Meniscus sign: 위로 오목한 fluid level
- CPA의 blunting
- 75ml → posterior CPA blunting → lateral view
- 150ml → Lateral CPA blunting → chest PA
- 50ml → Lateral decubitus view (fluid shift)
- Meniscus가 4번째 늑골의 전방부에 도달하면 약 1,000ml

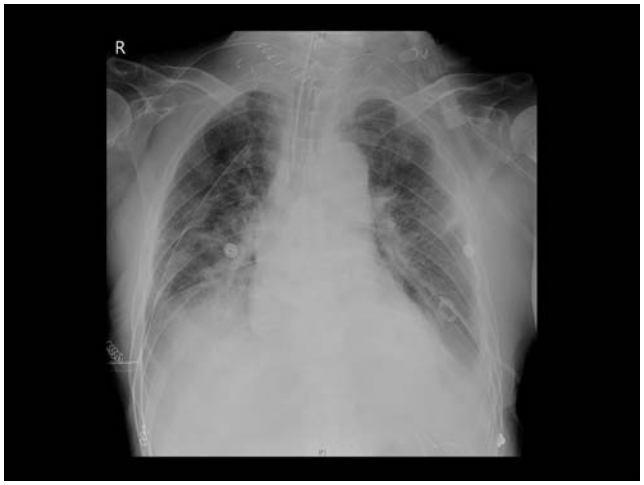


Pleural effusion at chest AP

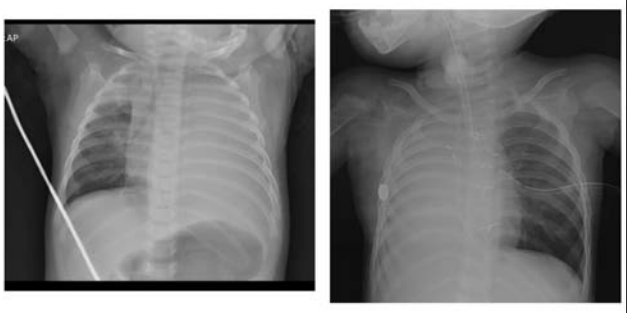


- 흉수가 폐 뒤쪽에 고임
- 소견
  - 폐음영의 전반적인 증가
  - 횡격막 윤곽의 둔화
  - 두꺼워진 폐첨

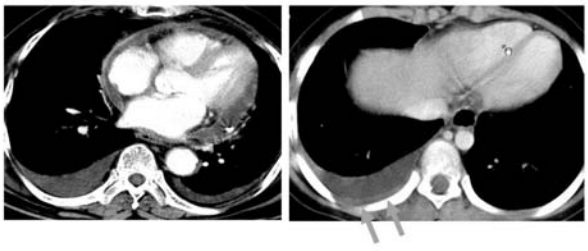




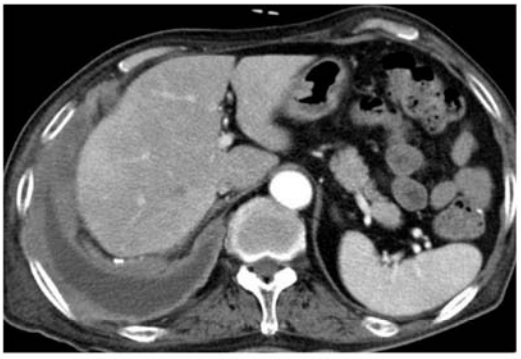
Effusion vs. atelectasis



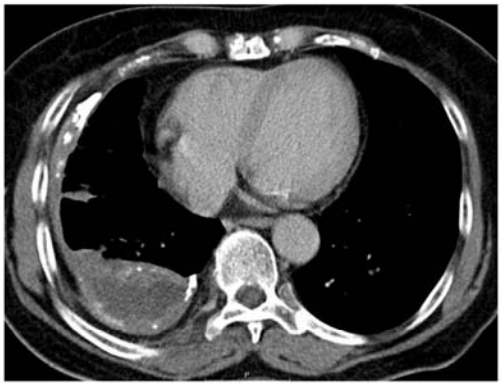
Pleural effusion at chest CT



Empyema sac



Empyema sac

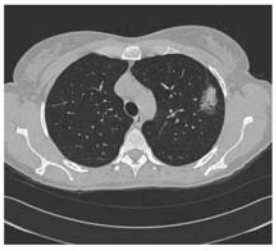


Solitary pulmonary nodule

Table 3-2
DIFFERENTIAL DIAGNOSIS FOR SOLITARY PULMONARY NODULES

NODULE ETIOLOGY	DISTINGUISHING CHARACTERISTICS
Granuloma	Smooth margins Solid or lamellated calcifications
Carcinoid	Lobulated margins Dystrophic, eccentric calcifications
Hamartoma	Lobulated margins Calcifications appear in rings or arcs Fat
AVM	Lobulated margins Infrequent calcification (vascular) Feeding/draining vessels
Lung cancer	Spiculated, lobulated, or smooth margins Dystrophic calcifications Large lesions with necrosis Cavitation in squamous cell carcinoma and adenocarcinoma
AIS/MIA	≤5 mm of atypical adenomatous hyperplasia Ground-glass opacity Well-demarcated margins Part-solid nodule Cystic spaces Focal extensions to pleura Very slow growth
Solid pulmonary metastasis	Nonspecific, although may have appearance characteristic of primary tumor

AVM, arteriovenous malformation; AIS/MIA, adenocarcinoma in situ/minimally invasive carcinoma.



Mediastinal mass

Table 3-3
DIFFERENTIAL DIAGNOSIS OF MEDIASTINAL MASSES

MASS	DIFFERENTIAL DIAGNOSIS	LOCATION	FEATURES
Anterior mediastinal mass	Thyroid mass	Contiguous with thyroid gland	Deviation of trachea
	Thymoma or thymic cyst	Thymic bed	Smoothly marginated
	Lymphoma and small cell lung cancer	All lymph node stations in superior mediastinum, thymic bed, prevascular space, aorticopulmonic window	May be lobulated Mass may involve multiple lymph node groups
		Extramediastinal location hilar lymph nodes	Hilar lymph node enlargement may be asymmetric Hodgkin disease spreads from thymic bed to middle mediastinum to hilar lymph nodes
	Germ cell tumor	Variable, including prevascular space and thymic bed	Fat, hair, and teeth are diagnostic
			May be homogeneous with smooth margins
Middle mediastinal mass	Duplication cyst (includes bronchogenic cyst)	Most often located at bifurcation of trachea and central airways May be paraesophageal or intrapericardial	Smoothly marginated High-attenuation fluid
	Lymphadenopathy	All lymph node stations, including subcarinal space	May appear as separate enlarged nodes or as a multiple lymph node mass May be homogeneous or heterogeneous Low attenuation indicates tuberculosis Single site with enhancement indicates Castleman disease
	Pericardial cyst	Adjacent to heart, especially in cardiophrenic sulcus	Smoothly marginated Water attenuation Can also represent pericardial diverticulum if history of mediastinoscopy
	Thyroid mass (intrathoracic goiter)	Thyroid, extending into thorax 15% of these masses extend behind the trachea	Appearance of thyroid tissue is heterogeneous, can include calcifications and focal fluid
	Tracheal tumor	Within or surrounding trachea	Narrowing of trachea Adenoid cystic carcinoma has more tumor outside the trachea than within it, so-called toothpaste lesion
	Vascular variants and abnormalities	Posterior to trachea Anterior or posterior to esophagus	Diverticulum of Kommerell with aberrant subclavian artery Vascular rings and slings
Posterior mediastinal mass	Esophageal abnormalities and masses	Large esophageal mass can occupy middle and posterior mediastinal compartments	Esophageal cancer Foregut duplication cyst
	Neurogenic tumor	Connected to neural foramen	Smoothly marginated or lobulated May have low attenuation
	Extramedullary hematopoiesis	Paraspinal masses	May contain fat Masses are often paired Smoothly marginated

Note: Radiographic division of middle mediastinum may include esophagus, thyroid, and lymph nodes, leaving neurogenic tumors and extramedullary hematopoiesis as primary considerations in posterior mediastinum.

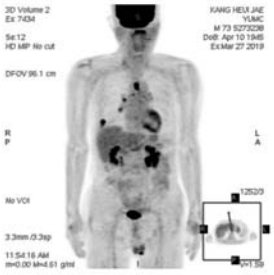
조언

- 사진은 가능성일 뿐이며, 판독은 가능성일 뿐이다
- 사진보다 중요한 것은 증상이다; 사진은 증상보다 뒤늦게 움직인다
- 영상의학과의 판독을 믿지 말아라, 하지만 영상의학과 전문의의 조언은 항상 귀담아 들어야 한다
- 특히 수술 받은 환자의 경우 수술을 이해해야만 정확히 판독이 가능하다
- 수술 후 anatomy는 외과의사만이 제대로 이해가 가능하다

조언

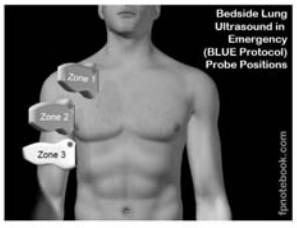
- 영상은 병에 대한 사전 지식이 있어야 해석이 가능하며, 지식을 바탕으로 확률을 계산하는 것이다
- 사진은 항상 이전 사진과 비교해야 한다
- 수술 시 최근 한 달 이내의 사진을 확인해야 한다
- 수술전 항암 방사선 치료를 받은 이후에는 치료 이전과 반드시 비교해야 한다
- 수술 후에는 반드시 수술 전 이미지와 수술 소견을 맞추어 보는 연습을 해야 한다
- 병변은 여러분이 생각하는 곳과 다른 곳에 위치할 수 있다 (특히 폐)

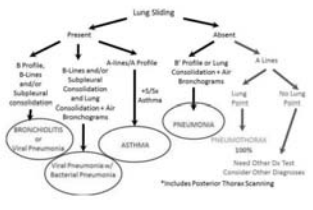
Disease pattern



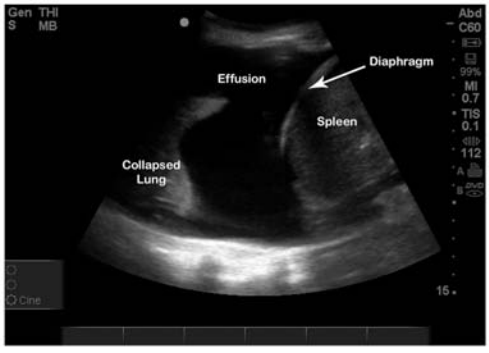
- Intense FDG uptake in the known RLL subpleural nodule, suspicious for primary malignancy.
- Enlarged LNs with intense FDG uptake in the Rt. interlobar, Rt. hilar and Rt. lower paratracheal spaces, suggesting LN metastases.
- Intense FDG uptake in the upper to middle esophagus, suspicious for double primary esophageal cancer. D/Dx> paraesophageal metastatic LNs, less likely; Rec) Enhanced CT and EGD.
- No other remarkable findings.

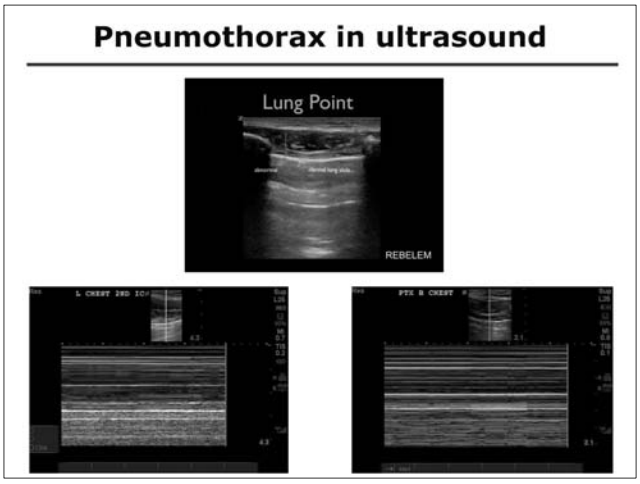
Bedside Ultrasound





Effusion in ultrasound



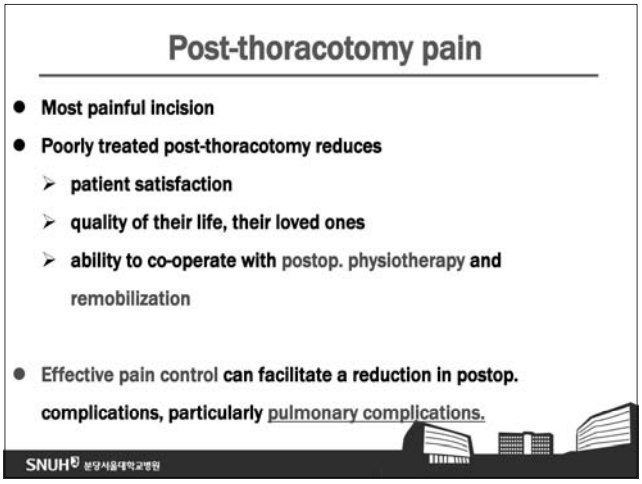

Pneumothorax in ultrasound
Lung Point
REBELEM

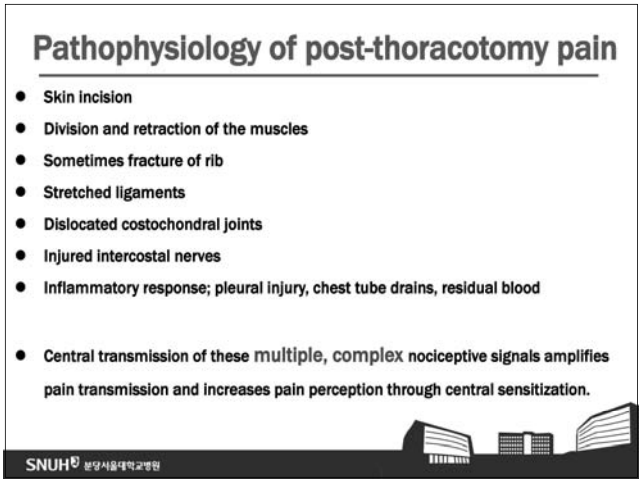

Thank you for attention!!!

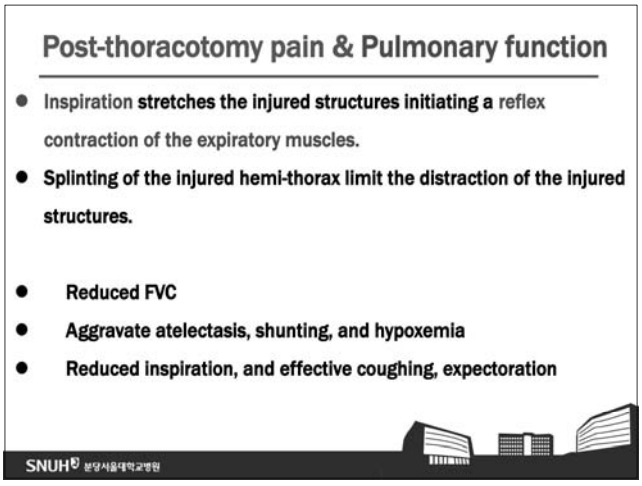
Pain Control After Thoracic Surgery

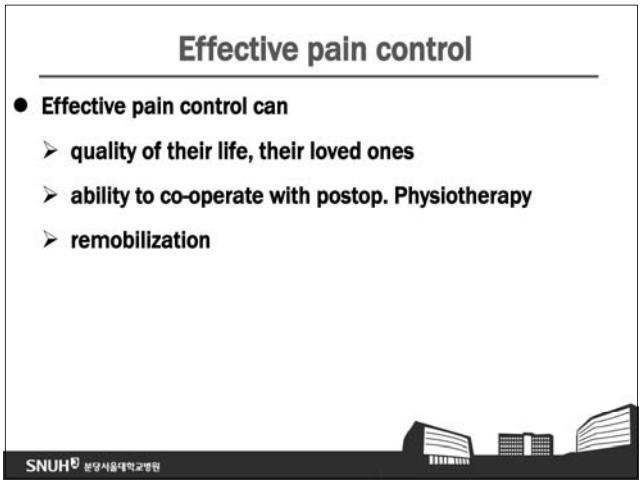
Department of Thoracic and Cardiovascular Surgery, Seoul National University Bundang Hospital

Jae Hyun Jeon





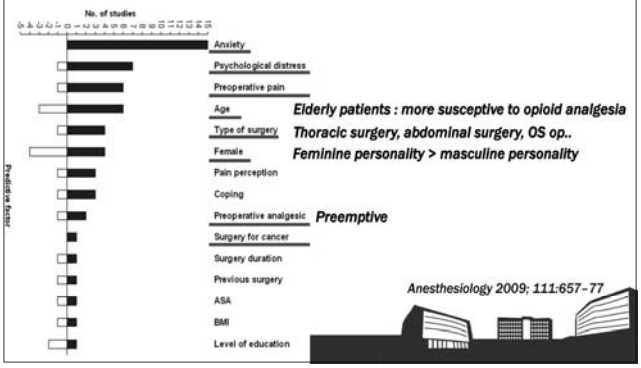




Predictors of Postoperative Pain and Analgesic Consumption

A Qualitative Systematic Review

Hui Yun Vivian Ip, M.B.Ch.B., M.R.C.P., F.R.C.A.,* Amir Abrishami, M.D.,† Philip W. H. Peng, M.B.B.S., F.R.C.P.C.,‡ Jean Wong, M.D., F.R.C.P.C.,§ Frances Chung, M.D., F.R.C.P.C.‖



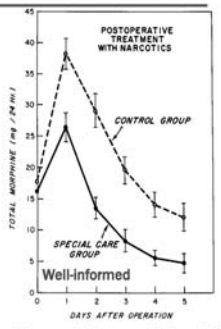
Anesthesiology 2009; 111:657-77

Pre-operative Preparedness

- Pre-operative Preparedness

; Well-informed patients may experience less pain

; Patients should receive a full explanation of the analgesic protocol, its limitations, and potential side effects

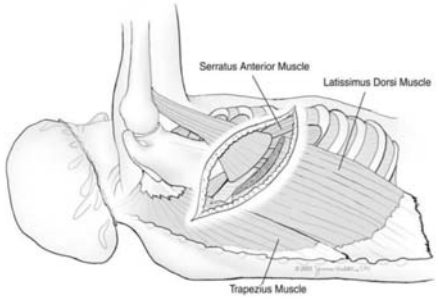


NEJM 1964;270:825-7

FIGURE 1. *Postoperative Treatment with Narcotics (Means for Each Day ± Standard Error of the Mean).*

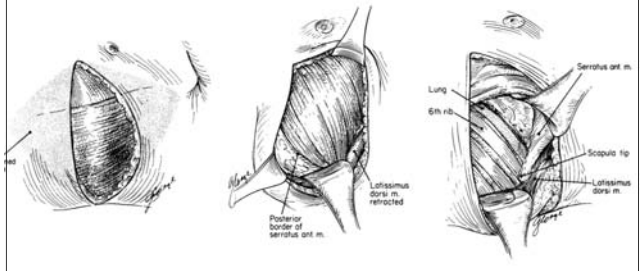
SNUH 분당서울대학교병원

Posterolateral thoracotomy



SNUH 분당서울대학교병원

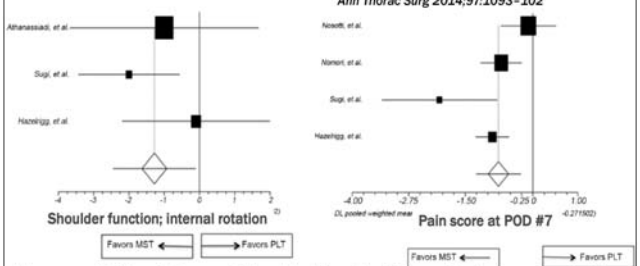
Muscle-sparing thoracotomy



SNUH 분당서울대학교병원

A Meta-Analysis Comparing Muscle-Sparing and Posterolateral Thoracotomy

Ann Thorac Surg 2014;97:1093-102

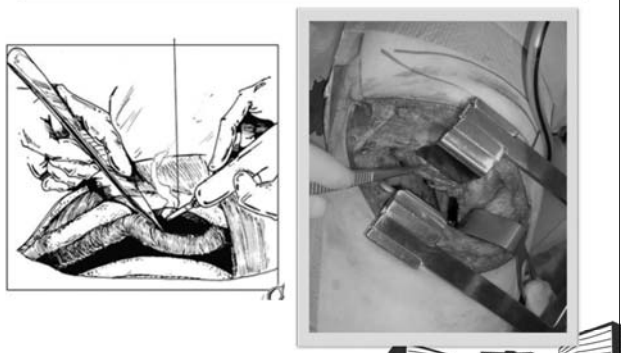


There was significantly improved shoulder internal rotation, **and** pain scores on day 7.

Higher incidence of seroma, similar postop pulmonary function, and complications.

SNUH 분당서울대학교병원

Non-divided intercostal muscle flap



SNUH 분당서울대학교병원

Non-divided intercostal muscle flap

A Nondivided Intercostal Muscle Flap Further Reduces Pain of Thoracotomy: A Prospective Randomized Trial

Robert James Cerfolio, MD, Ayesha S. Bryant, MSPH, MD, and Lee M. Maniscalco, BS
Division of Cardiothoracic Surgery, Departments of Surgery and Cardiothoracic Surgery, University of Alabama at Birmingham, Birmingham, and University of South Alabama, Mobile, Alabama

Ann Thorac Surg 2008;85:1901–7

Intercostal Muscle Flap for Decreasing Pain After Thoracotomy: A Prospective Randomized Trial

Amr Mohammad Allama, MD
Cardiothoracic Surgery Department, Faculty of Medicine, Menoufia University, Menoufia, Egypt

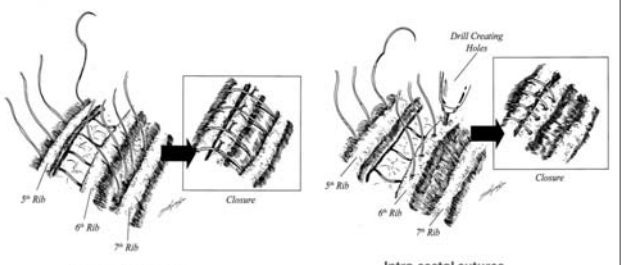
Ann Thorac Surg 2010;89:195–9

Non-divided intercostal muscle flap

Variable	IMF Group (n = 60)	PCS Group (n = 60)	*p* Value
Postoperative FEV_1 (% predicted)	63.28 ± 8.84	62.83 ± 10.2	0.797
Time to ambulation (hours)	15.31 ± 3	17.43 ± 4.61	0.003*
Pain score (0–10)			
Day 1	5.17 ± 0.99	5.6 ± 1.15	0.029*
Day 2	4.18 ± 0.96	4.62 ± 1.11	0.024*
Day 3	3.28 ± 0.96	3.72 ± 0.97	0.016*
Day 4	2.63 ± 0.86	3 ± 0.97	0.019*
Day 5	1.92 ± 0.81	2.27 ± 0.94	0.034*
Day 6	1.5 ± 0.62	1.78 ± 0.76	0.04*
Day 7	1.15 ± 0.48	1.4 ± 0.56	0.012*
Number of analgesic dose injected in the epidural catheter	3 ± 0.9	3.6 ± 1.1	0.002*
Complications			0.959
Air leak	6 (10%)	5 (8.3%)	
Empyema	1 (1.7%)	1 (1.7%)	
Bleeding	1 (1.7%)	2 (3.3%)	
Wound infection	3 (5%)	2 (3.3%)	
Chest tube drainage (mL)	480.8 ± 184.1	458.3 ± 173.5	0.506
Hospital stay (days)	4.6 ± 2.7	4.7 ± 2.3	0.429
Return to normal daily activities (days)	13.25 ± 4	14.8 ± 3.3	0.024*

Intercostals muscle flap **and** intracostal sutures **are rapid, safe, and effective procedures in** decreasing early pain **after thoracotomy.**

Intra-costal sutures



Peri-costal sutures

Intra-costal sutures

Intracostal Sutures Decrease the Pain of Thoracotomy

Robert J. Cerfolio, MD, FACS, Theolynn N. Price, MD, Ayesha S. Bryant, MSPH, Cynthia Sale Bass, RN, MSN, and Alfred A. Bartolucci, PhD
Departments of Cardiothoracic Surgery and Biostatistics, University of Alabama at Birmingham, Birmingham, Alabama

Ann Thorac Surg 2003;76:407–12

Table 4. Mean Pain Scores With Standard Deviations at 2 Weeks, and 1, 2, and 3 Months After Thoracotomy for the Two Groups

	Pericostal Group	Intracostal Group	*p* Value
2 weeks	5.5 ± 1.4	3.3 ± 1.9	0.004
1 month	3.8 ± 1.3	1.7 ± 1.4	0.001
2 months	2.3 ± 1.0	1.1 ± 0.9	< 0.001
3 months	1.6 ± 0.8	0.6 ± 0.7	< 0.001

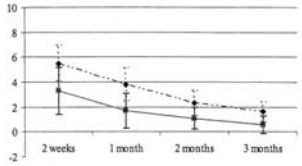
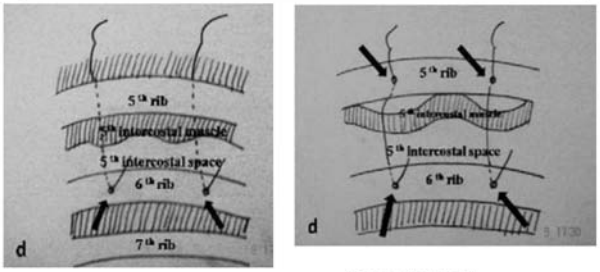


Fig 3. Mean pain scores with standard deviations. (♦ = P group; ▫ = I group.)

Intercostal nerve compression



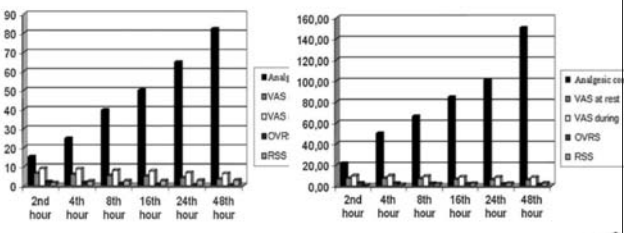
Intracostal sutures only

Intracostal sutures + intercostal nerve dissection

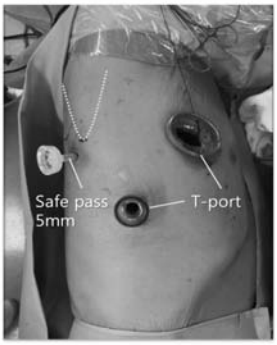
Rib approximation without intercostal nerve compression reduces post-thoracotomy pain: a prospective randomized study

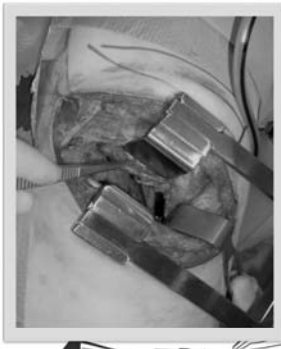
Ahmet Sami Bayram [a,*], Metin Ozcan [a], Fatma Nur Kaya [b], Cengiz Gebitekin [a]

Eur J Cardiothorac Surg. 2011;39:570-4



Video-assisted thoracic surgery (VATS)





SNUH 분당서울대학교병원

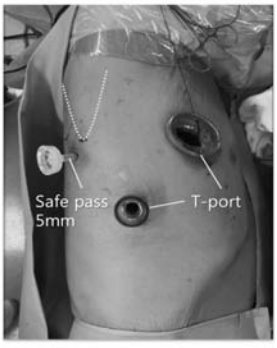
VATS VS Thoracotomy

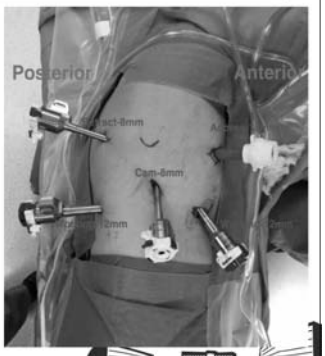
- Fewer complications — Paul[1]
- Less pain — Nagahiro[2]
- Better quality of life — Handy[3]
- Better PFTs — Nakata[4]
- Less pneumonia — Whitson[5]
- Earlier recovery — Flores[6]
- Easier for octogenarians — Port[7]
- Better compliance with adjuvant chemotherapy — Petersen[8]

1. *J Thorac Cardiovasc Surg. 2010;139:366-78*
2. *Ann Thorac Surg 2001;72:362-5*
3. *Eur J Cardiothorac Surg 2010 ;37:451-5*
4. *Ann Thorac Surg. 2000;70:938-41*
5. *Ann Thorac Surg. 2007;83:1965-70*
6. *J Thorac Cardiovasc Surg 2009;138:11-8*
7. *Ann Thorac Surg 2011;92:1951-7*
8. *Ann Thorac Surg. 2007;83:1245-9*

SNUH 분당서울대학교병원

VATS VS Robotic

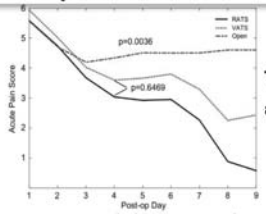




SNUH 분당서울대학교병원

Evaluation of acute and chronic pain outcomes after robotic, video-assisted thoracoscopic surgery, or open anatomic pulmonary resection

J Thorac Cardiovasc Surg 2017;154:652-9



The benefits of RATS lobectomy in terms of acute and chronic pain outcomes is unclear.

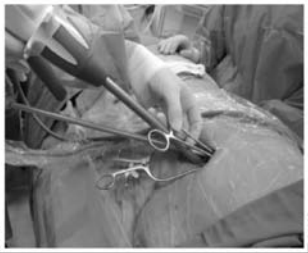
	Acute pain score difference between RATS vs VATS		Acute pain score difference between MIS vs open	
	Confidence interval	*P*	Confidence interval	*P*
POD1	−1.0491 to 0.3522	.3294	−0.7768 to 0.2096	.2596
POD2	−0.8575 to 0.3002	.3452	−0.6298 to 0.1624	.2474
POD3	−0.9258 to 0.2341	.2423	−0.1411 to 0.6508	.2070
POD4	−1.3696 to 0.2447	.1719	0.3810 to 1.3176	**.0004**
POD5	−1.6257 to 0.1500	.1033	0.5030 to 1.4892	**<.0001**
POD6	−2.1261 to 0.4178	.1950	0.1855 to 1.5872	**.0132**
POD7	−2.4716 to 0.4178	.1634	0.6688 to 2.2302	**.0003**
POD8	−4.0033 to 1.2640	.3078	1.3177 to 3.9896	**.0001**
POD9	−5.3282 to 1.6299	.2959	0.8405 to 4.2324	**.0034**

Single-incision thoracoscopic surgery (SITS)

Uniportal video-assisted thoracoscopic lobectomy versus other video-assisted thoracoscopic lobectomy techniques: a randomized study

Valerio Perna*, Angel Francisco Carvajal, Juan Antonio Torrecilla and Orlando Gigirey

Eur J Cardiothorac Surg. 2016;50:411-5



SNUH 분당서울대학교병원

Table 3: Primary outcomes: Group A and Group B

	Group A	Group B	*P*-value
Patients, *n*	51	55	
Median VAS in the first 24 h	3	3	0.58
Median VAS on the second day	2	2	0.64
Median VAS on the third day	1	1	0.85
Median morphine use in the first 24 h (mg)	14	11	0.72
Median morphine use on the second day (mg)	8	7	0.81
Median morphine use on the third day (mg)	2	2	0.64

Table 4: Secondary outcomes with interquartile and confidence interval: Group A and Group B

	Group A	Group B	*P*-value
Patients, *n*	51	55	
Median duration of PVC	1 (1, 1)	1 (1, 2)	0.82
Median duration of chest drain (days)	2 (2, 3)	2 (1, 4)	0.65
Median in-hospital stay (days)	3 (2, 5)	3 (2, 5)	0.62
Reoperation	0	1	0.24
Operative or 30-day mortality	0	0	1

SITS lobectomy does not present better postoperative outcomes than VATS lobectomy.

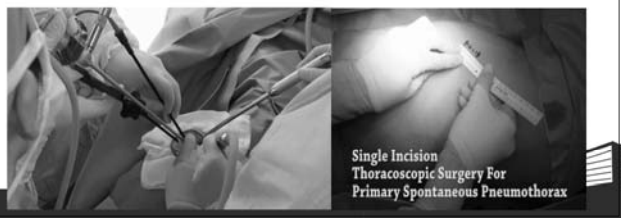
Single-incision thoracoscopic surgery (SITS)

Single-incision thoracoscopic surgery for primary spontaneous pneumothorax using the SILS port compared with conventional three-port surgery

Hee Chul Yang · Sukki Cho · Sanghoon Jheon

Surg Endosc. 2013;27:139-45

SITS (n=27) VS conventional 3-port procedures (n=13)



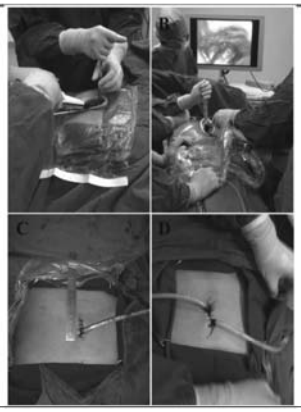
Single-incision thoracoscopic surgery (SITS)

Table 3 Efficacy of the uniport group compared with the three-port group

Variable	Uniport ($n = 27$)	Three-port ($n = 13$)	p value
Pain score			
Day 0	4.1 ± 1.7	4.8 ± 2.2	0.26
Day 1	3.2 ± 1.4	2.8 ± 1.4	0.33
Day 2	2.7 ± 1.0	2.6 ± 1.1	0.61
IV analgesics	2.8 ± 1.0	3.5 ± 2.5	0.23
Paresthesia: n (%)			
Yes	9 (33.3) <	10 (76.9)	0.01
No	18 (66.7)	3 (23.1)	
Cosmesis: n (%)			
Satisfied	19 (70.4) >	4 (30.7)	0.03
Fair	7 (25.9)	5 (38.6)	
Dissatisfied	1 (3.7)	4 (30.7)	
Total surgical material cost (US$)	1,810 ± 320[a]	1,741 ± 329[a]	0.58

SNUH 분당서울대학교병원

Subxiphoid approach



Original research

Subxiphoid vs intercostal single-incision video-assisted thoracoscopic surgery for spontaneous pneumothorax: A randomised controlled trial

Lin Li, Hui Tian*, Weiming Yue, Shuhai Li, Cun Gao, Libo Si

Department of Thoracic Surgery, Qilu Hospital, Shandong University, Jinan, China

Int J Surg. 2016;30:99-103

Table 3
VAS scores of unilateral postoperative pain.

	SUV (n = 16)	IUV (n = 15)	p-value
VAS scores			
POD 0	2.0 ± 0.81	4.20 ± 0.86	<0.001
POD 1	1.37 ± 0.50 <	3.0 ± 0.84	<0.001
POD 2	0.56 ± 0.51	1.20 ± 0.67	<0.001
POD 3	0.12 ± 0.34	0.66 ± 0.48	0.001

SUV: Subxiphoid uniport VATS, IUV: Intercostal uniport VATS.

Table 4
VAS scores of bilateral postoperative pain.

	SUV (n = 6)	IUV (n = 6)	p-value
VAS scores			
POD 0	3. 0 ± 0.89	4.66 ± 0.51	0.003
POD 1	1.66 ± 0.51 <	3.0 ± 0.63	0.003
POD 2	0.66 ± 0.52	1.50 ± 0.54	0.023
POD 3	0.33 ± 0.51	1.16 ± 0.40	0.011

SUV: Subxiphoid uniport VATS, IUV: Intercostal uniport VATS.

Single-incision subxiphoid approach seemed to be associated with lower postoperative pain.

Chest tube removal

The impact of chest tube removal on pain and pulmonary function after pulmonary resection†

Majed Refai*, Alessandro Brunelli, Michele Salati, Francesco Xiumè, Cecilia Pompili and Armando Sabbatini

Eur J Cardiothorac Surg. 201;41:820-2

Table 2: Comparison of the pre- and post-removal pain and FEV1

Variables	Pre-removal	Post-removal	*P*-value
Static pain	2.6 (2)	1.5 (1.5)	<0.0001
Dynamic pain	4.1 (2.1)	2.4 (1.9)	<0.0001
FEV1 (l/s)	1.5 (0.8)	1.7 (0.9)	0.0004
FEV1%	53 (24.7)	60.2 (30.8)	0.0004

SNUH 분당서울대학교병원

ERAS protocol

Pain Management in an Enhanced Recovery Pathway After Thoracic Surgical Procedures

Reza J. Mehran, MD, Linda W. Martin, MD, MPH, Carla M. Baker, MS, Gabriel E. Mena, MD, and David C. Rice, MD

Departments of Thoracic and Cardiovascular Surgery, and Anesthesia, The University of Texas MD Anderson Cancer Center, Houston, Texas; and Division of Thoracic and Cardiovascular Surgery, University of Virginia School of Medicine, Charlottesville, Virginia

Ann Thorac Surg 2016;102:e595–6

Review Article

Pain management within an enhanced recovery program after thoracic surgery

J Thorac Dis. 2018;10:S3773-S3780

SNUH 분당서울대학교병원

ERAS protocol

ERAS guidelines **recommend** multimodal pain management strategies.

(I) The use of a variety of analgesic medications to target different mechanisms of action in the peripheral and/or central nervous system;

(II) The use of regional anesthesia;

(III) Avoidance of opioids whenever possible;

(IV) Transitioning to oral medications as soon as possible.

SNUH 분당서울대학교병원

ERAS protocol

Pre-, intra-operative

- Detailed written information about operation and perioperative care
- Gabapentin 300 mg and tramadol 300 mg orally within 45 min of the induction
- Thoracotomy : multilevel posterior intercostal nerve block, before & after incision
- Minimally invasive procedures : preemptive injection into intercostal space

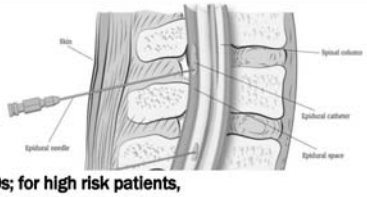
Post-operative

- Remove chest tube as quickly as possible
- Gabapentin 300mg po tid, 30 days
- AAP 1000mg qid IVS -> oral AAP
- Tramadol 50mg po qid
- Prn) Hydromorphone

Ann Thorac Surg 2016;102:e595-6

SNUH 분당서울대학교병원

Thoracic epidural analgesia (TEA)

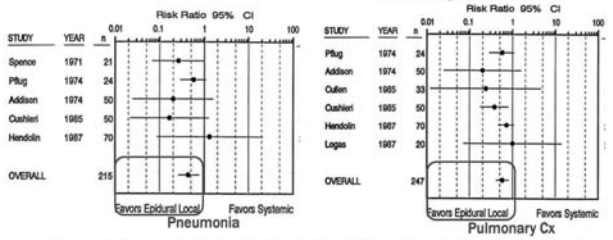


- mid-1970s; for high risk patients, 1990s; mainstay of post-thoracotomy analgesia
- "Gold standard" for post-thoracotomy analgesia, traditionally
- Provide effective, and reliable post-thoracotomy analgesia
- Reduce pulmonary complications, and improve the outcome after thoracic surgery.

SNUH 분당서울대학교병원

The Comparative Effects of Postoperative Analgesic Therapies on Pulmonary Outcome: Cumulative Meta-Analyses of Randomized, Controlled Trials

Anesth Analg 1998;86:598-612



- Postoperative TEA **can significantly decrease the incidence of pulmonary morbidity c/w** other local anesthetic methods, and systemic opioid.

SNUH 분당서울대학교병원

Pre-emptive analgesia

- Pre-emptive analgesia

; anti-nociceptive treatment started before the noxious stimulus

; to prevent the establishment of altered central processing of sensory input that amplifies postoperative pain

; decrease acute post-operative pain

; inhibit the development of chronic post-operative pain

pre-incisional thoracic epidurals, paravertebral blocks, NMDA antagonists, gabapentin and systemic opioids.

SNUH 분당서울대학교병원

Pre-emptive thoracic epidural analgesia (TEA)

Clinical Study

The Effectiveness of Preemptive Thoracic Epidural Analgesia in Thoracic Surgery

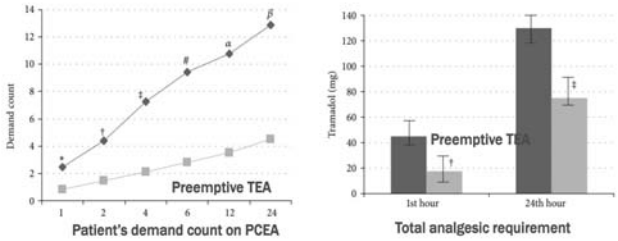
Engin Erturk,[1] Ferdane Aydogdu Kaya,[1] Dilek Kutanis,[1] Ahmet Besir,[1] Ali Akdogan,[1] Sükran Geze,[1] and Ersagun Tugcugil[2]

- RCT, Patients who underwent thoracotomy
- Preemptive TEA (n = 22) vs. Postop. TEA only (n = 22)

Biomed Res Int. 2014;673682

SNUH 분당서울대학교병원

Pre-emptive thoracic epidural analgesia (TEA)



Biomed Res Int. 2014;673682

SNUH 분당서울대학교병원

Pre-emptive thoracic epidural analgesia (TEA)

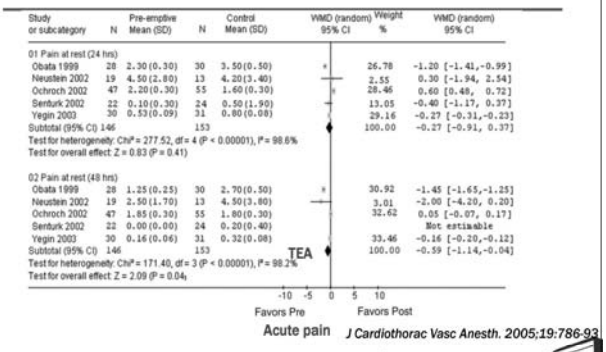
Postop pain score (VAS)

	Group C		Group P	*P* value
Postoperative 1st hour	4.05 ± 2.18	>	1.90 ± 1.21	**0.002**
Postoperative 2nd hour	3.45 ± 2.23		1.40 ± 0.94	**0.001**
Postoperative 4th hour	2.60 ± 1.93		1.20 ± 0.83	**0.009**
Postoperative 6th hour	1.45 ± 1.27		1.05 ± 1.63	0.134
Postoperative 12th hour	1.10 ± 1.37		0.50 ± 0.82	0.134
Postoperative 24th hour	0.75 ± 1.02		0.35 ± 0.81	0.192

Biomed Res Int. 2014;673682

SNUH 분당서울대학교병원

Pre-emptive thoracic epidural analgesia (TEA)

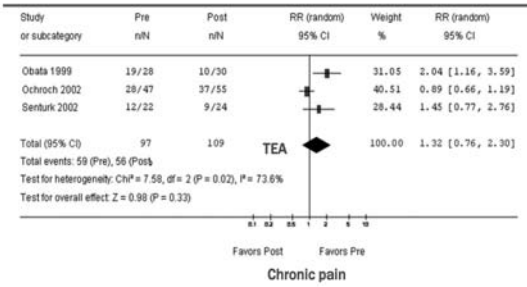


Acute pain

J Cardiothorac Vasc Anesth. 2005;19:786-93

SNUH 분당서울대학교병원

Pre-emptive thoracic epidural analgesia (TEA)



Chronic pain

Preemptive TEA **appeared to** reduce the severity of acute pain **but had no effect on the incidence of chronic pain.**

J Cardiothorac Vasc Anesth. 2005;19:786-93

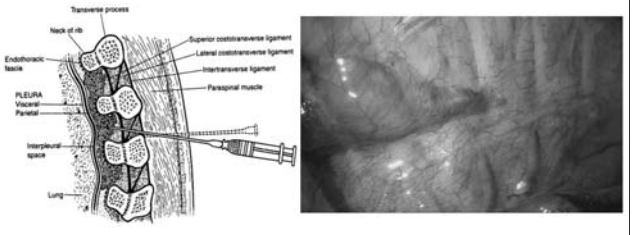
SNUH 분당서울대학교병원

TEA: Limitations

- **Failure rate ~ 15%**
- **Major complication ~0.02%**
  - **Respiratory depression**
  - **Epidural hematoma; anticoagulants – contralx.**
  - **Epidural abscess**
  - **Urinary retention: m/c complication**

SNUH 분당서울대학교병원

Paravertebral blocks



Percutaneous

Intraoperative

SNUH 분당서울대학교병원

Paravertebral blocks

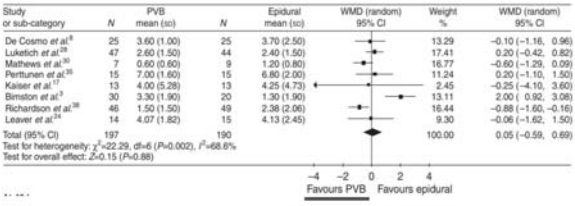
- Continuous thoracic paravertebral blocks > single bolus
- Rates of failed block were lower
- Provide comparable pain relief
- Better side-effect profile (hypotension, urinary retention, nausea, vomiting)
- Reduction in pulmonary complications
- Cost ?

SNUH 분당서울대학교병원

REVIEW ARTICLE

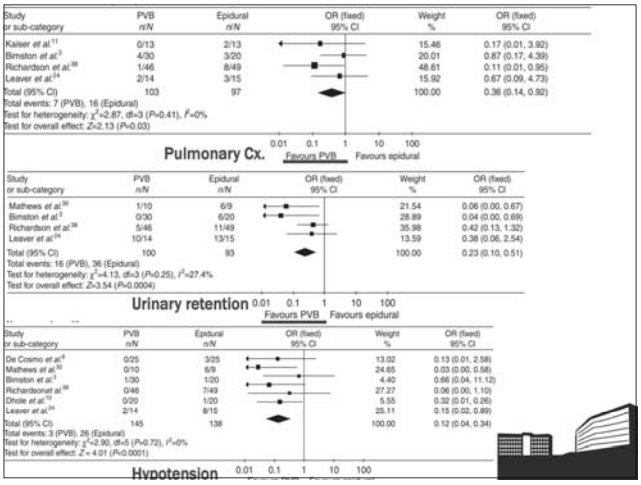
A comparison of the analgesic efficacy and side-effects of paravertebral *vs* epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials

Br J Anaesth 2006;96: 418–26

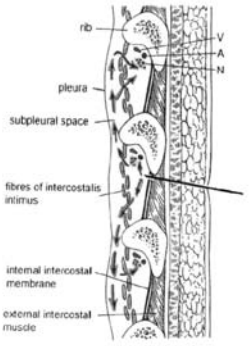


Comparable pain profile

SNUH 분당서울대학교병원



Intercostal nerve blocks



- Pre-emptive > Postop injection
- Short half-life
- Repeated percutaneous blocks are usually required.

SNUH 분당서울대학교병원

Take home message

- Thoracotomy induces severe postoperative pain, which can cause respiratory complications, such as hypoxia, atelectasis, and pulmonary infections
- Appropriate analgesia is important both for humanitarian reasons and to allow early mobilization and pulmonary rehabilitation.
- Pain after thoracic surgery is generated from multiple structures and is transmitted via a number of afferent pathways.
- Various procedures has been introduced to reduce postop pain.

SNUH 분당서울대학교병원

Take home message

- Pre-emptive analgesia to prevent the establishment of altered central processing of sensory input that amplifies postoperative pain
- Less invasive surgery should be considered to reduce postop pain.
- Most patients are best managed by a combination of regional analgesia and opioids, sometimes supplemented with non-opioid analgesics.

SNUH 분당서울대학교병원

【흉부외과 추천 도서 소개】

흉부외과 추천 도서 소개

분당서울대학교병원 흉부외과학교실

조 석 기

【특 강】

의사와 환자의 소통

교육위원장

박 계 현

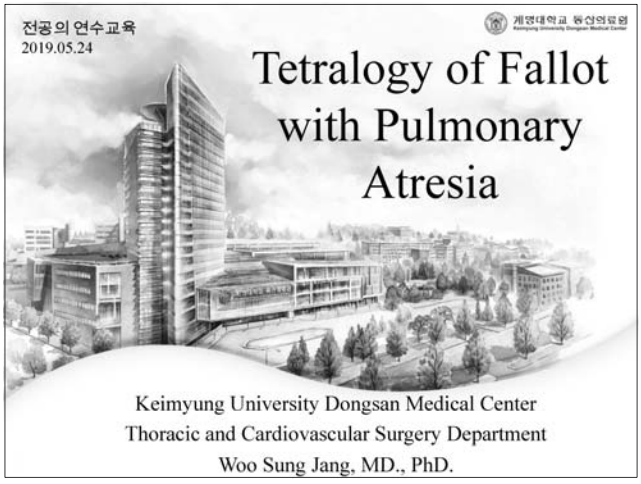
【소아심장파트】

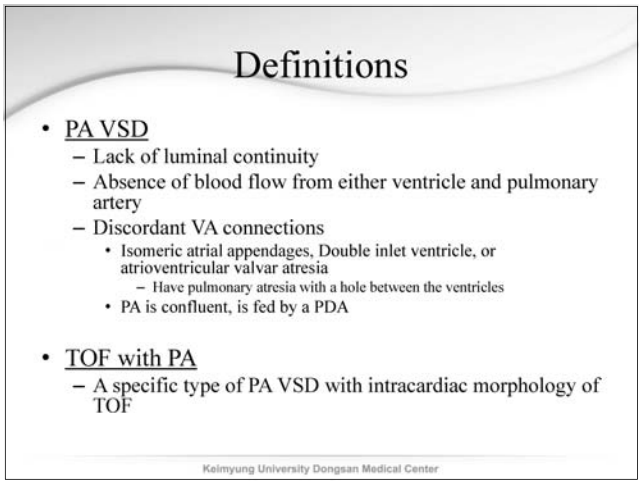
좌장: 이 철

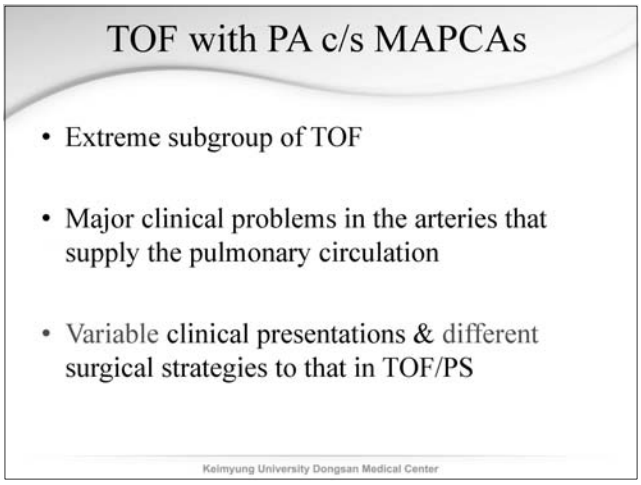
PA with VSD c/s MAPCA

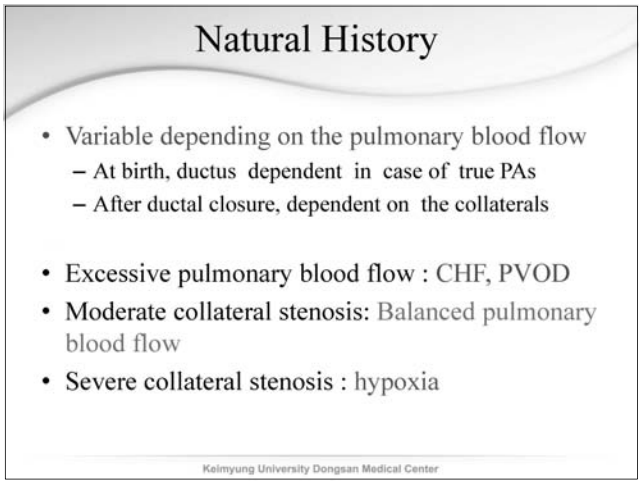
Department of Thoracic and Cardiovascular Surgery, Keimyung University Dongsan Medical Center

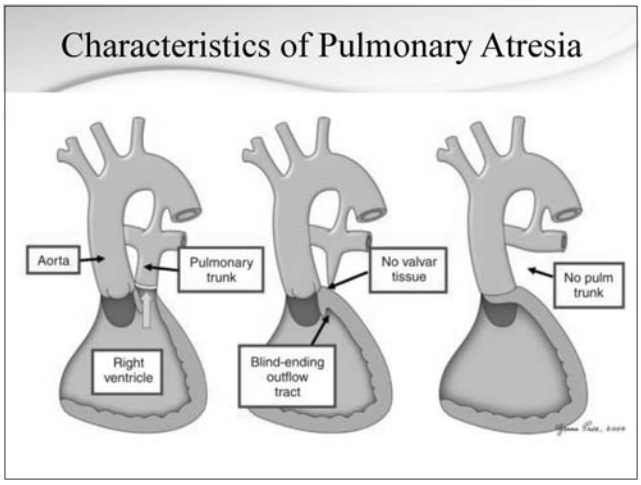
Woo Sung Jang, MD, PhD

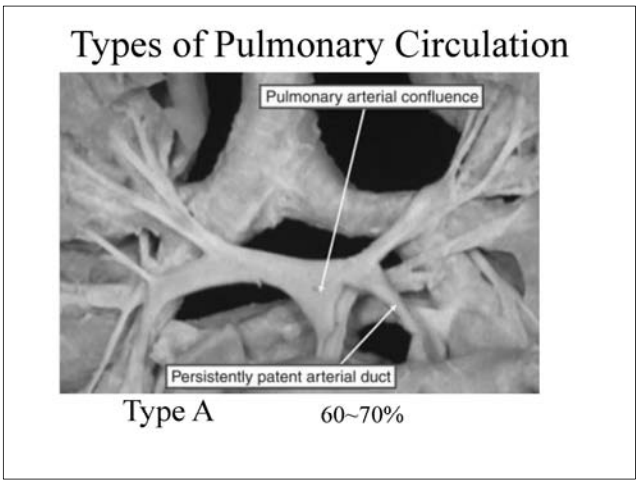


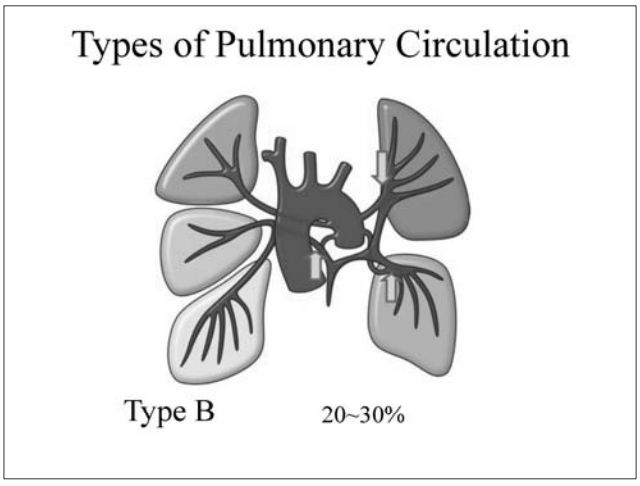


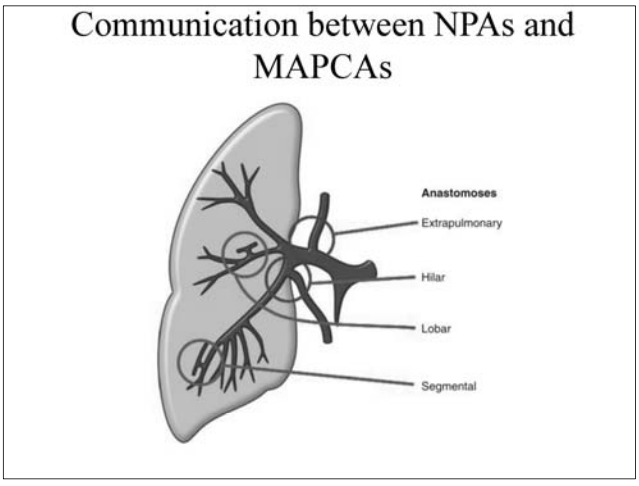


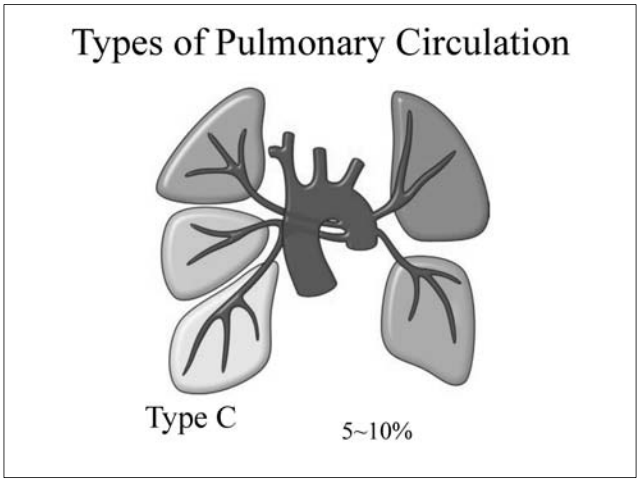


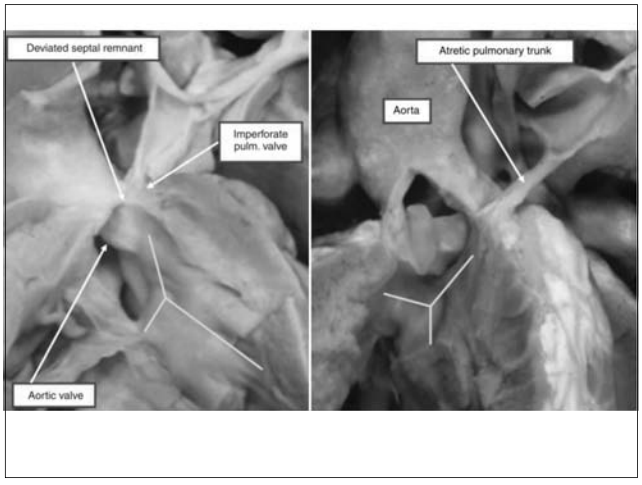

Characteristics of Pulmonary Atresia
Aorta
Pulmonary trunk
Right ventricle
No valvar tissue
Blind-ending outflow tract
No pulm trunk

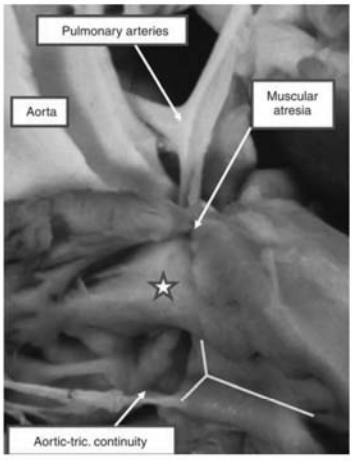

Types of Pulmonary Circulation
Pulmonary arterial confluence
Persistently patent arterial duct
Type A
60~70%


Types of Pulmonary Circulation
Type B
20~30%


Communication between NPAs and MAPCAs
Anastomoses
Extrapulmonary
Hilar
Lobar
Segmental


Types of Pulmonary Circulation
Type C
5~10%


Deviated septal remnant
Imperforate pulm. valve
Aortic valve
Atretic pulmonary trunk
Aorta

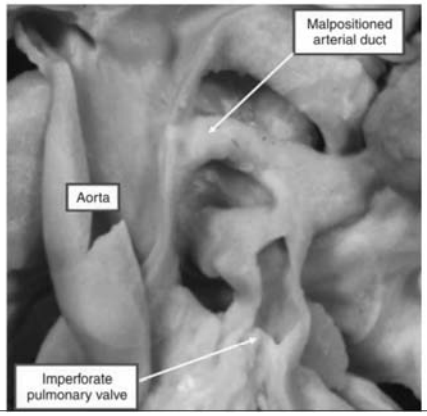


Sources of Pulmonary Blood Flow

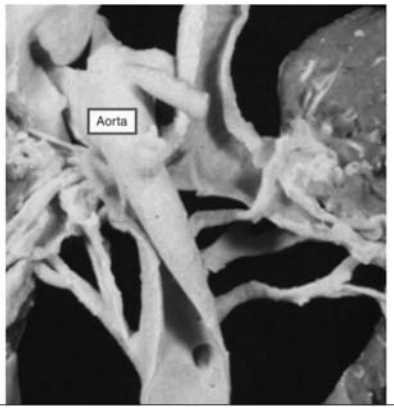
- Unifocal pulmonary blood supply
  - Patent ductus arteriosus (PDA)
- Multifocal pulmonary blood supply
  - Major aortopulmonary collateral arteries (MAPCA)

Keimyung University Dongsan Medical Center

Supply from PDA



Supply from MAPCAs



Supply from MAPCAs

- Usually co-exist with intrapericardial PAs
- Number between 2~6
- Usually arise from descending thoracic aorta
  - May originate from the aortic arch, subcalvian a, carotid a. or even the coronary arteries
- Frequently develop stenosis
- PHT and progressive PVOD
- MAPCAs connect with branches of central PAs, or constitute the only blood supply

Keimyung University Dongsan Medical Center

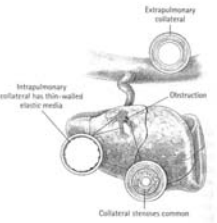
Influence of MAPCA

- Chronic shunt & LV volume overload
  - Decreased LV function
  - Aortic annular dilatation
  - AR
- Segmental loss of lung parenchyme
  - In case of collateral stenosis
    - Hypoxia
  - In Unobstructed cases
    - CHF, PVOD

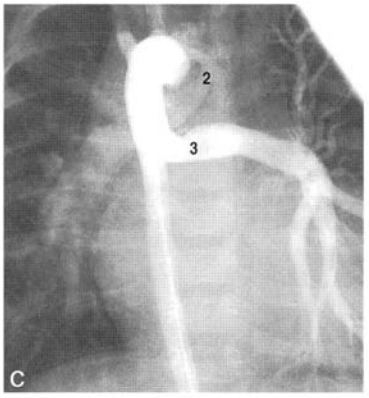
Keimyung University Dongsan Medical Center

Histologic Characteristics of MAPCAs

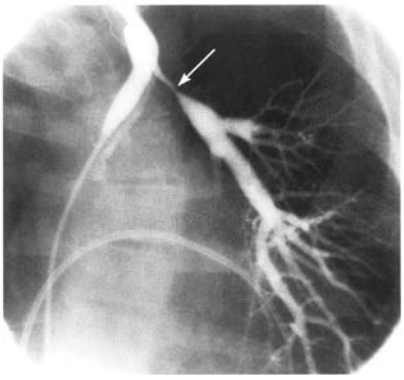
- **Extrapulmonary**
  - muscular artery with well developed muscular media & adventitia
- **Intrapulmonary**
  - medial muscle is gradually replaced by a thin elastic lamina resembling true PAs
- **Unobstructed MAPCAs**
  - PVOD
- Muscular segments of collaterals
  - prone to the development of severe stenosis, often progressive



Keimyung University Dongsan Medical Center



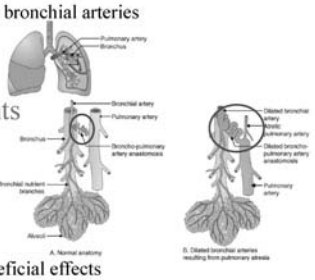
Unobstructed MAPCA



Long stenotic segment

MAPCA = Dilated Bronchial Arteries

- RCH, 2006
- All MAPCAs : anatomy similar to bronchial arteries

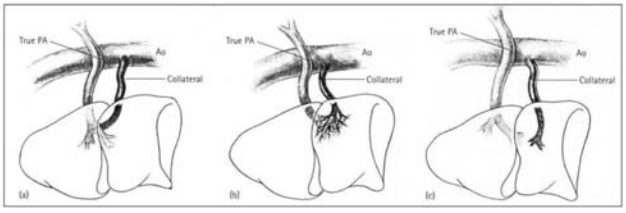


Bronchopulmonary shunts

BAs: limited growth potential and vasoreactivity
→ might preclude long-term beneficial effects of unifocalization

Keimyung University Dongsan Medical Center

Connection between MAPCA and true PA



Characteristics of MAPCAs

- Highly variable pulmonary arterial morphology, but some predictable pattern
  - The PDA connected to a central PA
    - **Peripheral PA distribution is normal** (no sytemic collateral arteries in that hemithorax, ductus arteriosus dose not coexist with MAPCAs in the same lung)
  - RUL and LLL segments often are supplied by single, noncommunicating MAPCAs (from subclavian artery and descending aorta)

Keimyung University Dongsan Medical Center

Definitive Repair of PA with VSD

Ultimate goal

: Completely separated pulmonary & systemic circulation

1. Closure of ventricular septal defect
2. Establish continuity between RV & PA
3. Occlusion of redundant collaterals & shunts / Unifocalization

Keimyung University Dongsan Medical Center

Surgery for **Type A** PA VSD

- **Initial palliation**
  - Shunt
  - Complete repair around 6~10 months of age
- **Primary neonatal repair**
  - Using RV-PA conduit or transannular patch
  - Foramen ovale is narrowed to 3~4mm
- Options for RVOT reconstruction
  - Conduit ± Pulmonary valve
  - Transannular patch ± pulmonary valve

Keimyung University Dongsan Medical Center

Surgery for **Type A** PA VSD

- **Initial palliation**
  - Shunt related complication
    - High inter-stage mortality
    - PA distortion
- **Early primary repair**
  - Early RV volume loading
  - LPA stenosis
    - Required multiple intervention

Keimyung University Dongsan Medical Center

Surgery for **Type B&C** PA VSD

- **Unifocalize** the greatest number of segmental arteries together
  - Native PA and/or MPACAs
  - **Single stage vs multi-stage**
- Remove aortic sources of blood flow to segments that are dual supplied.
- Closed VSD (if possible) and create RV to PA communication achieving a RV/LV ratio of < 0.7

Keimyung University Dongsan Medical Center

Surgery for **Type B&C** PA VSD

- Maximize the pulmonary artery
  - The size & distribution
- Maintain the adequate PBF
- Avoid the excessive PBF

Keimyung University Dongsan Medical Center

Early Palliative Procedures

Goals 1) Create a balanced PBF
2) Incorporation & growth of PAs

Excessive blood flow	Inadequate blood flow
-Ligation	- Systemic-pulmonary shunt
- Embolization	- RV-PA connection
- Creating stenosis	: conduit or outflow patch
	- Unifocalization

Keimyung University Dongsan Medical Center

Evolution of Surgical Approach

- Pre 1980's inoperable (palliation only)
- 1980's The concept of unifocalization suggested
  - Multi-stage unifocalization and repair
- 1990's Melbourne shunt described
  Single-stage complete repair described
- 2000's Selective single vs multi-stage repair

Keimyung University Dongsan Medical Center

Surgical strategy in PA, VSD, MAPCA

- **Single stage repair**
  - complete unifocalization with RV to PA conduit and VSD closure at age of 4~8 months
  - High RV pressure > 80% of RV/LV
    - VSD fenestration
- **Staged repair**
  - Including growth of the central PAs with central shunt or RV-PA conduit
  - Staged thoracotomy-based unifocalization of MAPCAs
  - RV-PA conduit with VSD closure

Keimyung University Dongsan Medical Center

Rationale for early single stage unifocalization

- One can incorporate all segments of blood supply to the lung **before stenosis develop** in the MAPCAs and **before potential changes of PH** occur
- Preferred age for single stage repairs
  - **4 to 8 months of age**
    - Improved tolerance of long operations as compared to young infancy
    - Prior to the development of risks of PVOD
    - Prior to the development of MAPCA stenosis

Keimyung University Dongsan Medical Center

Advantages of One-stage Complete Repair

- Eliminate the need for multiple operations
- Eliminate the use of prosthetic materials
- Establish the normal physiology early in life
  - Growth of respiratory & PA system
  - Avoid cyanosis & volume overload
  - Prevent the PVOD

Keimyung University Dongsan Medical Center

Disadvantages of Earlier Repair

- Increased pulmonary morbidity
  - Contusion & congestion
  - Bronchospasm
  - Phrenic nerve injury
- Magnitude of operation
- Technically more demanding
- Unknown ideal age

Keimyung University Dongsan Medical Center

Rationale for staged unifocalization

- **Small central PAs** needs to be "rehabilitated" to normal size with shunt or RV to PA conduit
- To gain exposure to the distal MAPCA, hilar and intraparenchymal dissection is facilitated through unilateral or staged bilateral thoracotomies
- Identification and mobilization of MAPCAs is much easier through posterolateral thoracotomy than a sternotomy approach
- Single stage unifocalization is a long and tedious procedure (very stressful to a child)

Keimyung University Dongsan Medical Center

Disadvantages of Multistage Approach

- The final repair is achieved on an old age
- Mediastinum & hilar regions are significantly scarred, increasing surgical risks
- Prolonged cyanosis & previous operation cause secondary collaterals, risks of bleeding
- The risk of drop-off before the final repair

Unifocalization

- Definition
  - Procedures that **join the multifocal sources** of pulmonary blood flow, be they intrapericardial native pulmonary arteries or one or more collateral arteries (MAPCAs), **into a single source**

Ideal Unifocalization Procedure

- Incorporation of all the nonredundant collaterals & True PAs
  - Healthy microvasculature of lung
  - Use conduit that is growing, large & minimizing the risk of thrombosis
  - Easily accessible from the mediastinum at the time of definitive repair

Timing of Unifocalization

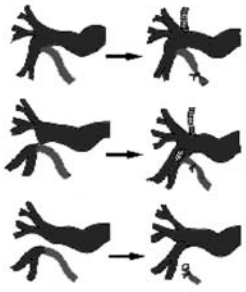
- At any age, when collaterals are large to allow technical ease without risk of thrombosis
- Variable depending on collateral size, usually older than 2~3 months
- Staged procedures may be required for the bilateral aortopulmonary collaterals

Techniques of Unifocalization

- Procedures for collaterals
  - Ligation
  - Patch enlargement
  - Direct anastomosis
- Interposition grafts
  - Synthetic graft
  - Homograft
  - Xenograft
  - Autologous tissue including pericardium, azygos vein

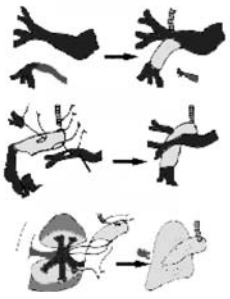
Unifocalization procedure

- Ligation
- Angioplasty
- Anastomosis



Unifocalization procedure

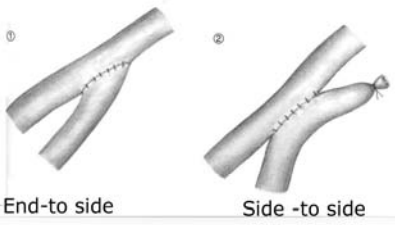
- Interposition
- Additional PA creation
- Central PA creation



Keimyung University Dongsan Medical Center

Unifocalization procedure

- Offbypass during dissection
- Maximal use of native tissue
- Avoid circumferential use of non-viable conduits for growth potential



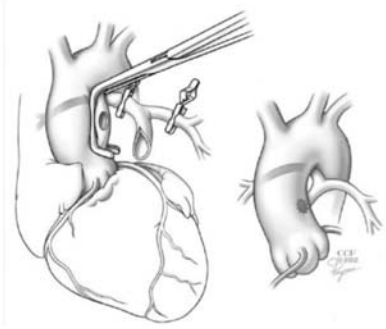
Keimyung University Dongsan Medical Center

Repair without Unifocalization

- RCH, 2009
- **Unifocalization brings no long-term benefits**
  . Unifocalization: sufficient to allow a safe repair
  but, **failed to achieve adequate growth**
  . **Dilated BAs**: limited growth potential & unstable
  → Growth of the native PA rather than recruitment of MAPCAs
- **Multi-stage approach**
  . 4~6wks: **Modified central shunt**
  . 4~6months: **RV-PA conduit**
  . 3rd : complete repair or 2nd conduit
- 18 pts enrolled in this protocol (No Unifocalization)
  . 7 : complete repair, RVP 59% of systemic
  . 8 : awaiting repair
  . 4 MAPCAs in 17 pts: ligated

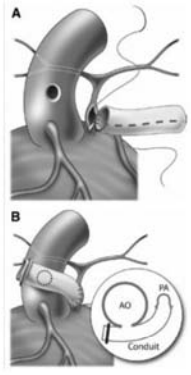
Keimyung University Dongsan Medical Center

Melbourne Shunt

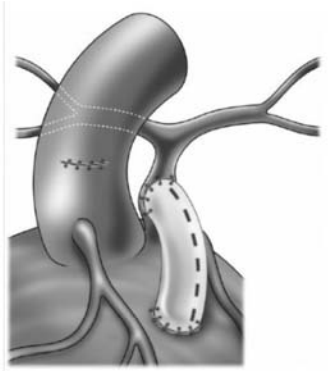


- Central end-to-side Aortopulmonary shunt
- Diminutive central pulmonary arteries

Modified Central shunt



RV-PA conduit



Advantages of RV - PA Connection

- Reduction of LV volume overload
- **Pulsatile blood flow** to enhance PA growth
- Facilitating the **catheter access** for the later evaluation & intervention

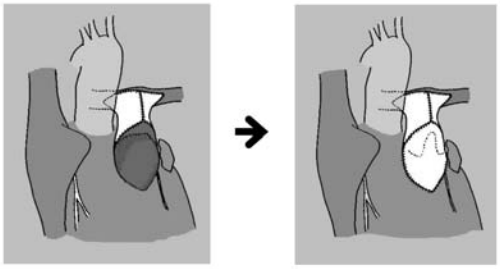
- Complications
  - aneurysm and pseudoaneurysm
  - **pulmonary flow and pressure is completely uncontrolled**

Keimyung University Dongsan Medical Center

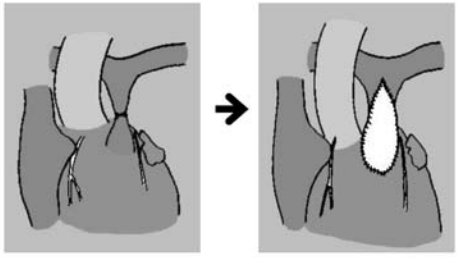
RV-PA Reconstruction

Keimyung University Dongsan Medical Center

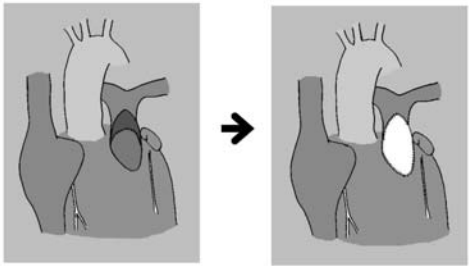
RVOT Reconstruction with Valved Conduit



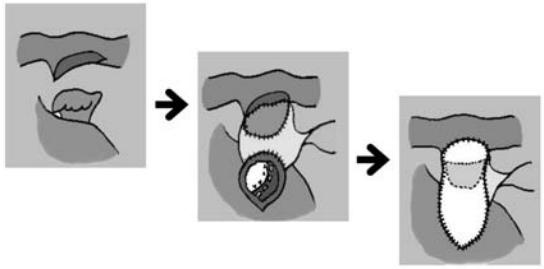
RVOT Reconstruction with Outflow Patch



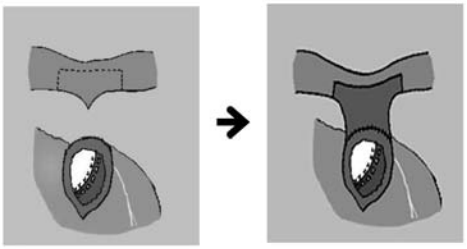
RVOT Reconstruction with PA Reimplantation



RVOT Reconstruction with LA Appendage



RVOT Reconstruction with PA Flap



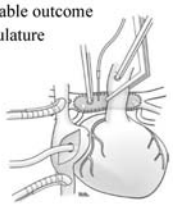
VSD closure

Keimyung University Dongsan Medical Center

Functional Intraoperative PBF Study

* Post-repair RVSP: most reliable predictor of favorable outcome
* Data of functionality of the entire pulmonary vasculature

Hanley
- **m PAP < 25mmHg at a full flow** (2.5L/min/m²) predicts RV/LV pressure ratio < 0.5



Toronto, 2009
- Close the VSD for a **mPAP of <30mmHg**
- Predict postop. physiology better than standard anatomic measures

Keimyung University Dongsan Medical Center

Anatomic Predictors of successful VSD closure

- Central PA area ≥ 50% of predicted normal
  - Puga et al JTCS 1989;98(6):1028-9
- Predicted pRV/pLV≤0.7, no MAPCA remain
  - More than 2/3 lung segments are centralized
    - Iyer and Mee, ATS 1991; 51:65-72
- Nakata index > 150 ㎟/㎡ BSA
  - Metras, EJCTS 2001;20:590-6
- TNPAI ≥200 ㎟/㎡
  - Hanley, JTCS 1997;113(5):858-66
- More than 15 of lung segments connected to native PA
  - Baker, 2002

Keimyung University Dongsan Medical Center

Functional predictors of successful VSD closure

- Net **left to right shunt**
- SpO2 is typically in the **high 80s or low 90s**
- At a cardiac index of 2.5L/min/㎡ and PA pressure of less than 30mmHg after unifocalization

Keimyung University Dongsan Medical Center

Long-Term Surgical Outcome

- Depends on
  - Number of lung segments incorporated into final repair
  - Status of pulmonary microvasculature
  - Absence of obstruction in RV-PA conduit and branch PAs.

Keimyung University Dongsan Medical Center

Surgical Results

Table 22-1. Summary of surgical outcomes in patients with pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries

Authors (year)	Time period of operation	No. of patients	Strategy of unifocalization	Age at first operation	Early death	Follow-up duration	Late death	Outcomes at last follow-up
Reddy (2000)[77]	1992-1998	85	Single-stage	5m (10d – 37y)	9 (10.6%)	22m (1 – 69m)	7	84% 1YSR 74% 4YSR 93% total repair
Carotti (2003)[57]	1994-2002	37	Integrated approach	39m (22d – 13y)		43m (1 – 85m)		81% 7YSR 85% total repair
Gupta (2003)[60]	1983-2000	104	Staged	7d (3d – 22y)	11.5%	10.2y	5%	
Duncan (2003)[59]	1993-2001	46	Staged	7.2m (17d – 23y)	0	44m (1 – 79m)	1 (2.2%)	61% total repair
d'Udekem (2005)[69]	1975-1995	82	Staged	1.4y (7d – 34y)	4% + 8%	14.2y (3m – 25y)	9	51% 12YSR (total repair) 65% total repair
Ishibashi (2007)[78]	1982-2004	113	Staged	6.3y (1.1m – 34y)		8.8y (0.8 – 23.3y)		80.9% 5YSR 73.8% 10YSR 80.5% total repair
Davies (2009)[79]	1989-2008	216	Staged/ Single	2y	6%	2.3y	6%	89% 3YSR 73% total repair
Horjo (2009)[61]	2003-2008	20	Single-stage	7.7m (2-197m)	0	31m (8-66m)	5%	94% 1YSR 95% total repair
Malhotra (2009)[80]	1992-2007	462	Single-stage	7.7m (10d – 39y)	5.9%	NR	NR	86% 5YSR 90% total repair

* d: days, m: months, y: years, YSR: year survival rate

Table 1. Review of Literature on Single-Stage Complete Repair, Ultimate Complete Repair, and Postoperative Hemodynamics of Patients With Pulmonary Atresia With Ventricular Septal Defect and Major Aortopulmonary Collaterals

First Author	Year Published	Single-Stage Repair	Ultimate Repair	Postoperative RV/LV Ratio
Carrillo	Current study	80%	91%	0.33
d'Udekem	2005	0%	65%	0.62
Ishibashi	2007	0%	81%	0.70
Carotti	2010	48%	77%	0.48
Liava'a	2012	0%	48%	0.64
Griselli	2004	23%	72%	0.60
Song	2009	0%	43%	0.57
Amark	2006	33%	60%	…
Mumtaz	2008	0%	62%	…
Davies	2009	56%	85%	…
De Campli	2010	24%	68%	…
Hibino	2014	0%	76%	…

LV = left ventricle; RV = right ventricle.

Conclusions

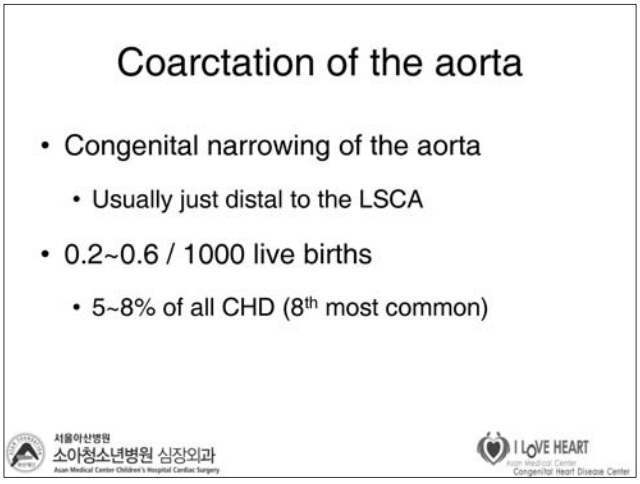
- MAPCAs
  - Wide spectrum of pulmonary vascular morphology and physiology, ranging
- Management
  - complex and must be individualized according to their anatomy and clinical situations

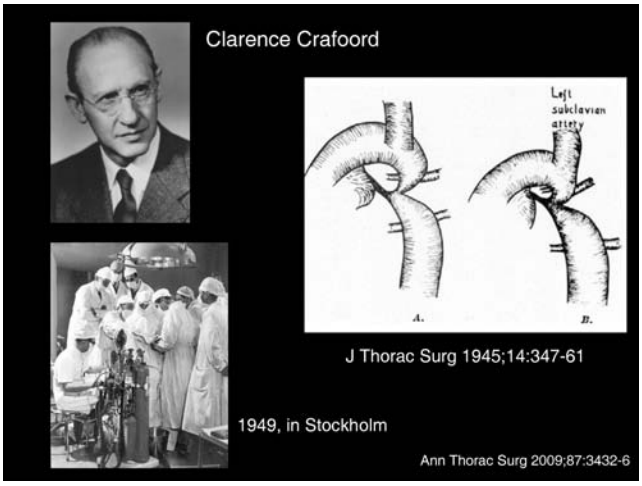
Keimyung University Dongsan Medical Center

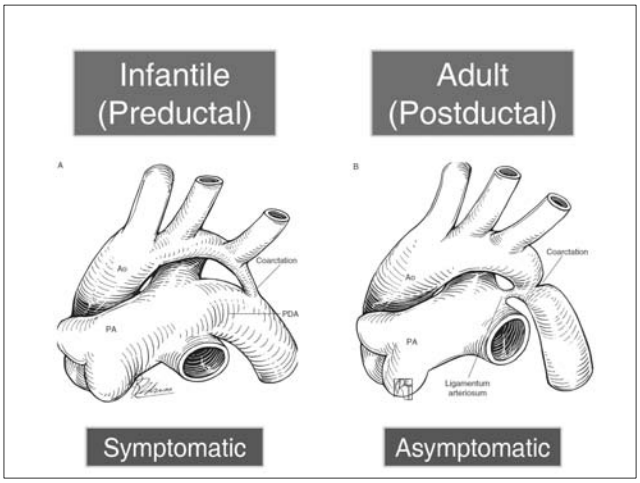
Coarctation of the Aorta

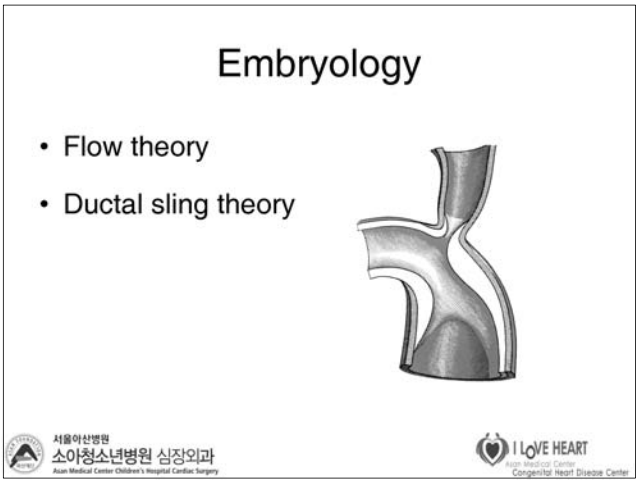
서울아산병원 소아심장외과

최 은 석



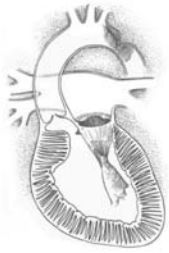






Associated anomalies

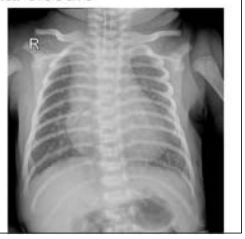
- 75%
- VSD
  - post. malalignment
- Bicuspid aortic valve
- Mitral valve anomalies
  - Shone's syndrome



Am J Cardiol 1963;11:714

Symptoms and Signs

- Bimodal
  - Symptomatic (infants)
    - Circulatory collapse after ductal closure
    - Congestive heart failure
    - Marked cardiomegaly
  - Asymptomatic
    - HTN



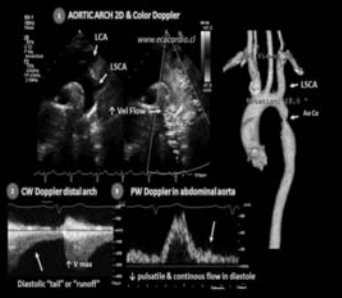
Diagnosis

- Echocardiography
  - Anatomy: posterior shelf
  - CoA pressure gradient
  - Diastolic tail in DTAo
  - Tricky if large PDA (+)
- CT angiography

서울아산병원 소아청소년병원 심장외과
Asan Medical Center Children's Hospital Cardiac Surgery

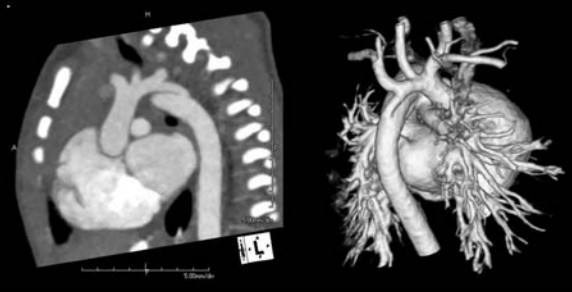
I LOVE HEART
Asan Medical Center Congenital Heart Disease Center

Echocardiography

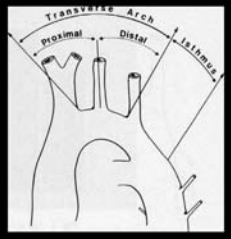


J Thorac Cardiovasc Surg 3(2):1-7

CT angiography



Hypoplastic aortic arch



- Proximal / Distal / Isthmus : < 60 / 50 / 40 % of Ascending Aorta
- Transverse arch < weight + 1 mm

Semin Thorac Cardiovasc Surg Pediatr Card Surg Ann 2009;12;66-69

Pseudocoarctation

- Elongation of the aortic arch - kinking
- No actual obstruction

Medical management

- Prostaglandin E1 (PGE1)
  - Alprostadil, Eglandin®
  - Maintaining PDA

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

Balloon angioplasty

- For native coarctation
  - Controversial
  - Concern
    - Rupture of the aorta, femoral vessel injury
    - Aneurysmal formation, re-coarctation

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

Surgical approach

Thoracotomy | Sternotomy

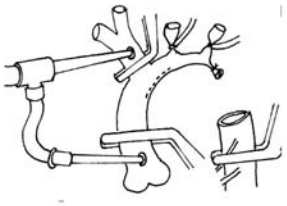
- Arch hypoplasia
- Associated cardiac defects
- One stage vs. staged

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

CPB strategy

- No CPB or Partial CPB
- Deep hypothermic circulatory arrest (DHCA)
- Selective cerebral perfusion
- Selective cerebral and myocardial perfusion



Eur J Cardiothorac Surg 2003;23:149-155

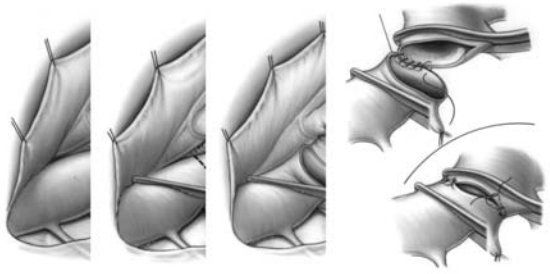
Surgical techniques

- Excision of ductal tissue + direct anastomosis → End-to-end, Extended E to E, End to side
- Subclavian flap
- Patch aortoplasty
- Graft interposition → Anatomic, Extra-anatomic

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

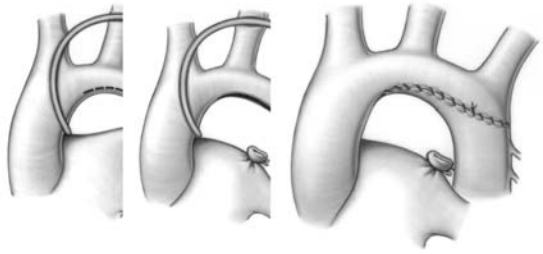
Resection and end-to-end anastomosis



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

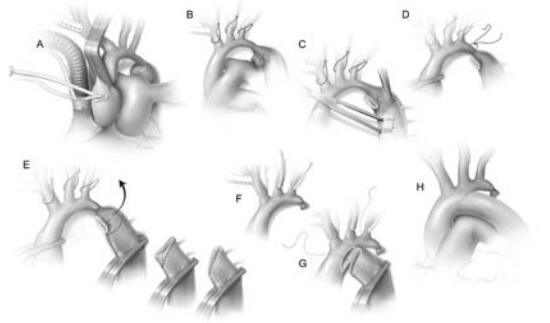
Extended end-to-end anastomosis



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

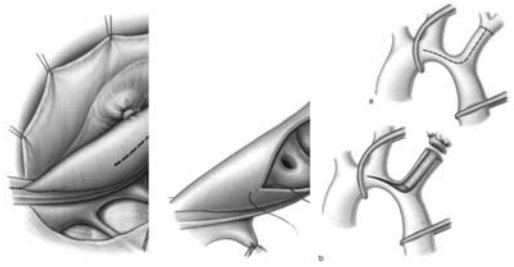
End-to-side anatomosis



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

Ann Thorac Surg 2014;98:625-33

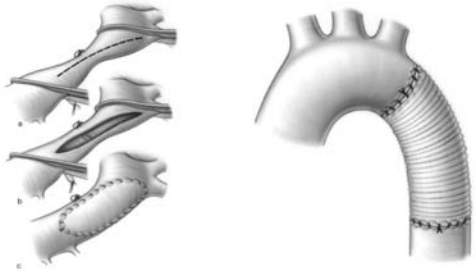
Subclavian flap technique



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

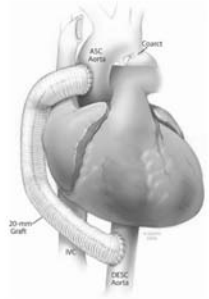
Patch or Graft



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

Extra-anatomic bypass



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

J Thorac Cardiovasc Surg 2007;133:1504-9

Early complications

- Renal failure
- Paraplegia

- Vocal cord paralysis
- Chylothorax

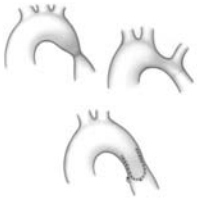
- Paradoxical HTN
- Abdominal pain

Outcomes

- Mortality — Associated lesions
- Re-coarctation
- Hypertension — Age at repair, Endothelial response
- Aneurysm — Patch

Re-coarctation

- Causes
  - Technically inadequate repair
    - Ductal tissue
    - Circumferential suture line
    - Hypoplasia of the arch
  - Tension on the anastomosis



서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

Re-coarctation

- Indication for intervention
  - Significant narrowing on imaging
  - Pressure gradient of 20-30 mmHg
- Treatment
  - Balloon dilatation
  - Surgery

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

CASE

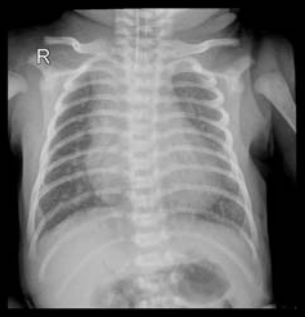
Brief Hx

- Fetal diagnosis: COA with VSD
- GA 38+1 wks
- 3030 gm, male
- PGE1 infusion in NICU
- Intubation at 6 days

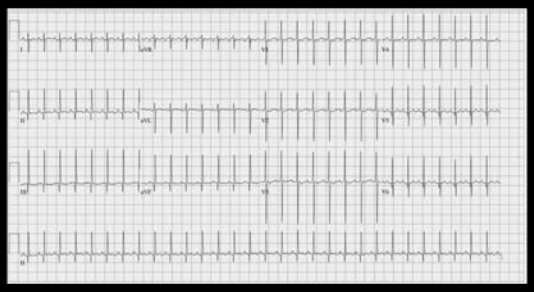
서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center

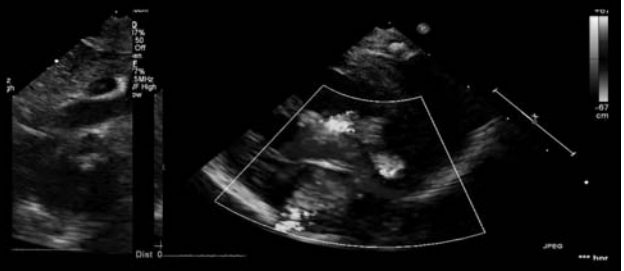
Preop. CXR



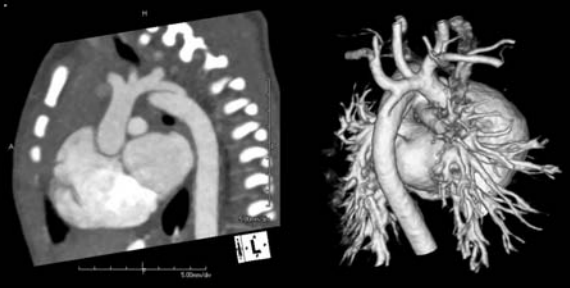
Preop. ECG



Preop. EchoCG



Preop. CT angio



Operation

- M/9d, 3.1kg
- Op name
  - COA repair (end-to-side)
  - VSD patch closure
  - ASD closure, PDA division
- CPB/ACC/SCMP time: 132/48/29 min

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

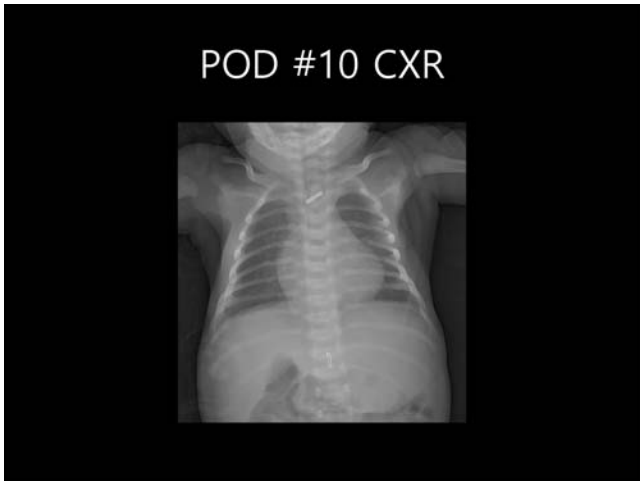
I LOVE HEART Asan Medical Center Congenital Heart Disease Center

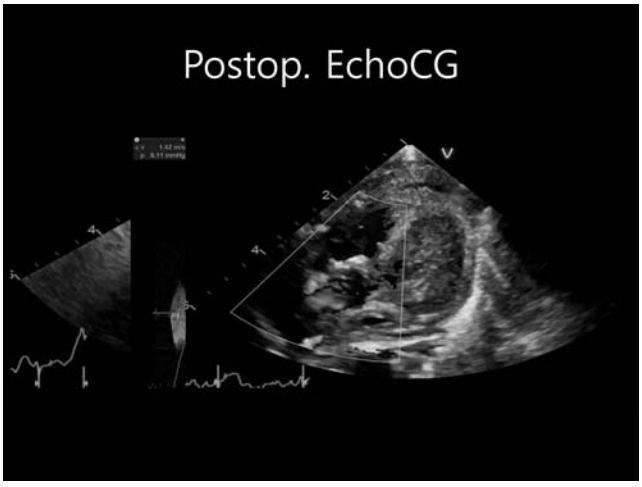
Postop. course

- POD #5 extubation
- POD #6 Transfer to general ward
- POD #10 discharge

서울아산병원 소아청소년병원 심장외과 Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART Asan Medical Center Congenital Heart Disease Center





Reference

- Stark JF. (2007). *Surgery for Congenital Heart Defects* (3rd ed.)
- Mavroudis C, Backer CL. (2013). *Pediatric Cardiac Surgery* (4th ed.)

서울아산병원 소아청소년병원 심장외과
Asan Medical Center Children's Hospital Cardiac Surgery

I LOVE HEART
Asan Medical Center Congenital Heart Disease Center

Single Ventricle

Pediatric and Congenital Heart Surgery, Seoul St. Mary's Hospital,
College of Medicine, The Catholic University of Korea

Cheul Lee, MD

Single Ventricle

- Broad category of hearts that lack two well-developed ventricles
- Functionally univentricular heart
- One of the most challenging congenital heart diseases

Congenital Heart Surgery Nomenclature and Database Project: Single Ventricle

Marshall L. Jacobs, MD, and John E. Mayer, Jr, MD

Section of Cardiothoracic Surgery, St. Christopher's Hospital for Children, Philadelphia, Pennsylvania, and Department of Cardiac Surgery, Children's Hospital, Boston, Massachusetts

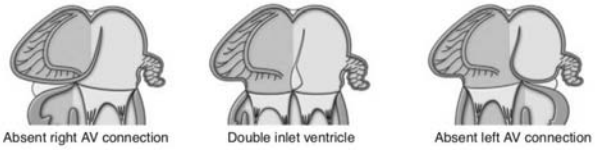
The extant nomenclature for single ventricle (SV) hearts is reviewed for the purpose of establishing a unified reporting system. The subject was debated and reviewed by members of the STS-Congenital Heart Surgery Database Committee and representatives from the European Association for Cardiothoracic Surgery. Efforts were made to include all relevant nomenclature categories using synonyms where appropriate. Although many issues regarding single ventricle or univentricular hearts remain unresolved among anatomists and pathologists, a classification is proposed that is relevant to surgical therapy. A comprehensive database set is presented, which is based on a hierarchical scheme. Data are entered at various levels of complexity and detail, which can be determined by the clinician. These data can lay the foundation for comprehensive risk stratification analyses. A minimum data set is also presented that will allow for data sharing and would lend itself to basic interpretation of trends. Outcome tables relating diagnoses, procedures, and various risk factors are presented.

(Ann Thorac Surg 2000;69:S197–204)

Classification of Single Ventricle

- Double inlet left ventricle
- Double inlet right ventricle
- Mitral atresia
- Tricuspid atresia
- Unbalanced atrioventricular canal defect
- Heterotaxia syndrome
- Other

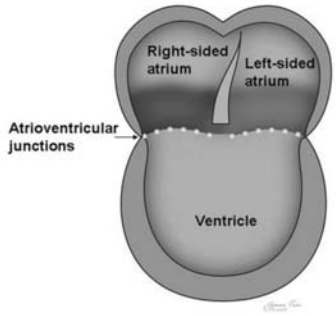
Univentricular Atrioventricular Connections



Absent right AV connection | Double inlet ventricle | Absent left AV connection

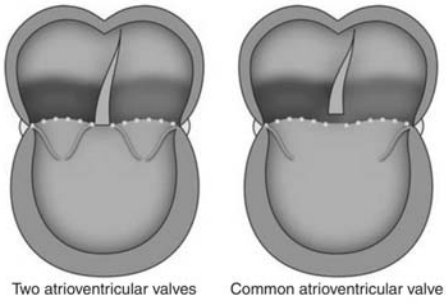
Anderson RH, et al. Paediatric Cardiology. 3rd ed.

Double Inlet Ventricle



Cardiol Young 2006;16 Suppl 1:22-6

Double Inlet Ventricle



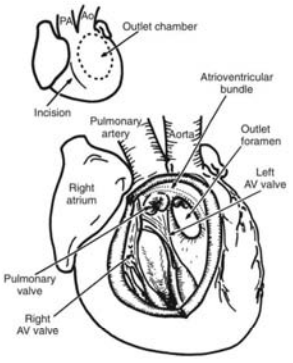
Cardiol Young 2006;16 Suppl 1:22-6

Double Inlet Left Ventricle (DILV)

- DILV, {S,L,L}
- DILV, {S,D,D}
- DILV, {S,D,N} (Holmes heart)
- DILV, DOLV
- DILV, DORV

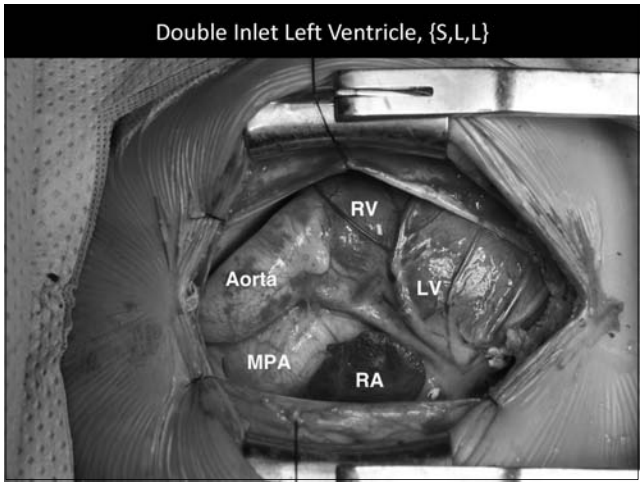
- Atrial situs is usually solitus.
- Ventriculo-arterial connection is usually discordant.

Double Inlet Left Ventricle, {S,L,L}

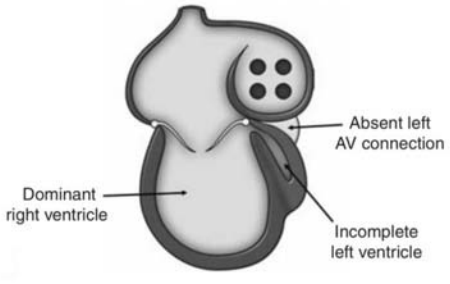


Mavroudis C, et al. Pediatric Cardiac Surgery. 4th ed.

Double Inlet Left Ventricle, {S,L,L}

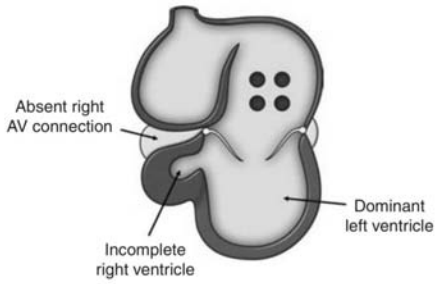


Mitral Atresia



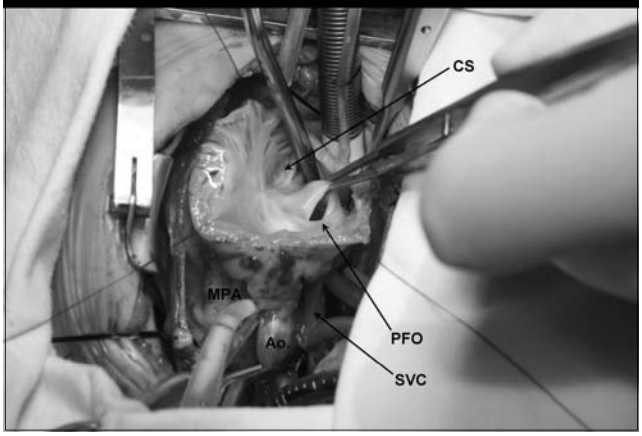
Cardiol Young 2006;16 Suppl 1:27-34

Tricuspid Atresia



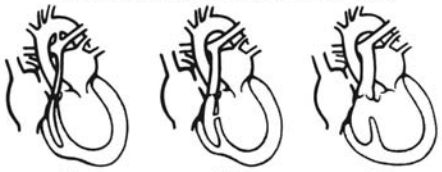
Cardiol Young 2006;16 Suppl 1:27-34

Tricuspid Atresia



Classification of Tricuspid Atresia

Tricuspid atresia with no transposition (69% - 83%)



I(a)
Pulmonary atresia

I(b)
Pulmonary hypoplasia, small ventricular septal defect

I(c)
No pulmonary hypoplasia, large ventricular septal defect

Mavroudis C, et al. Pediatric Cardiac Surgery. 4th ed.

Classification of Tricuspid Atresia

Tricuspid atresia with D-transposition (17% - 27%)

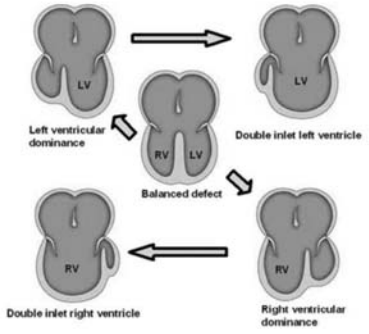
II(a)
Pulmonary atresia

II(b)
Pulmonary or subpulmonary stenosis

II(c)
Large pulmonary artery

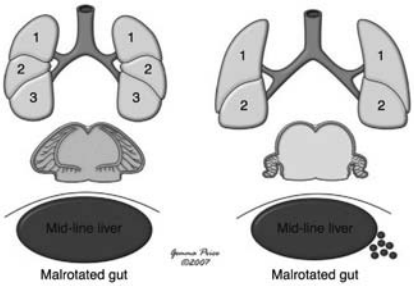
Mavroudis C, et al. Pediatric Cardiac Surgery. 4th ed.

Unbalanced Atrioventricular Canal Defect



Cardiol Young 2006;16 Suppl 3:43-51

Heterotaxia Syndrome (Isomerism of the Atrial Appendages)



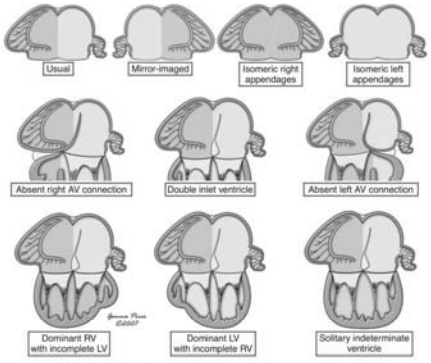
Anderson RH, et al. Paediatric Cardiology. 3rd ed.

Congenital Heart Surgery Nomenclature and Database Project: Single Ventricle

Single ventricle, Heterotaxia syndrome, **DORV, CAVC, Asplenia**
Single ventricle, Heterotaxia syndrome, **DORV, CAVC, Polysplenia**
Single ventricle, Heterotaxia syndrome, **Single LV**
Single ventricle, Heterotaxia syndrome, **Other**

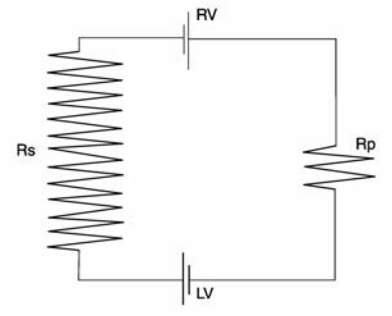
Ann Thorac Surg 2000;69:S197-204

Segmental Combinations Producing a Univentricular Atrioventricular Connection



Anderson RH, et al. Paediatric Cardiology. 3rd ed.

Normal Heart
A Serial Circuit



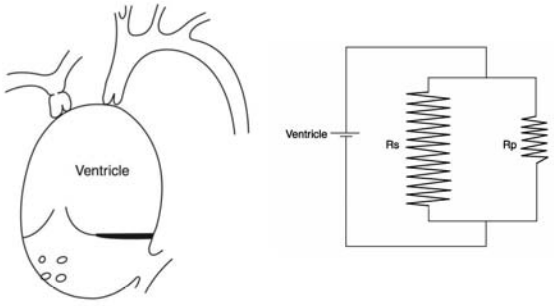
Cardiol Young 2003;13:316-22

Normal Heart

- Serial systemic and pulmonary circulations
- Different BP and O_2 saturation in each part
- Cardiac output = Qp = Qs (Qp/Qs = 1)

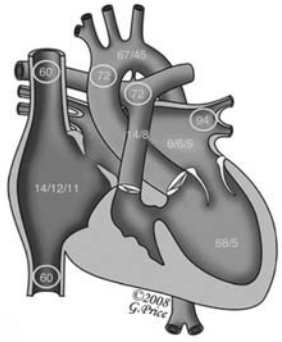
BP: blood pressure
Qp: pulmonary blood flow
Qs: systemic blood flow

Single Ventricle
Parallel Circuits



Cardiol Young 2003;13:316-22

Hemodynamics of Tricuspid Atresia



Anderson RH, et al. Paediatric Cardiology. 3rd ed.

Hemodynamics of Single Ventricle (1)

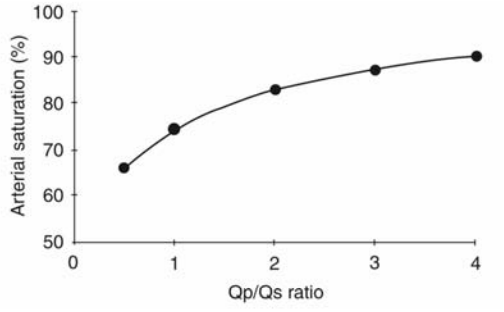
- Parallel systemic and pulmonary circulations
- BP in each part of the circulation is the same, if there is no obstruction to systemic and pulmonary outflow.
- O_2 saturation is the same in the aorta and the pulmonary arteries, if complete mixing of desaturated and saturated blood occurs within the single ventricle.

Hemodynamics of Single Ventricle (2)

- Cardiac output = Qp + Qs
- Qp/Qs = (BP/Rp)/(BP/Rs) = Rs/Rp
- Arterial O_2 saturation is determined by the ratio between the pulmonary blood flow and the systemic blood flow (Qp/Qs).

Rp: pulmonary vascular resistance
Rs: systemic vascular resistance

O_2 Saturation in Single Ventricle



Cardiol Young 2003;13:316-22

"Balanced" Single Ventricle

- Qp = Qs
- Needs natural obstruction to pulmonary blood flow
- Arterial O_2 saturation of approximately 80%
- Volume overloaded (2 × normal cardiac output)

Clinical Presentaion

- Determined by Qp/Qs and associated cardiac lesions
- Cyanosis (inadequate Qp)
- Congestive heart failure (excessive Qp)
- Asymptomatic with mild cyanosis (Qp = Qs)

Goal of Surgery for Single Ventricle

- Separation of systemic and pulmonary circulations, with the single ventricle connected to the systemic circulation (creation of serial systemic and pulmonary circulations)
- Best achieved by optimizing compliance of the single ventricle as well as by minimizing the total resistance between the systemic veins and the ventricular chamber

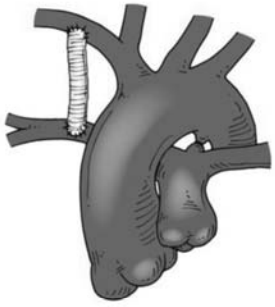
Three-Stage Surgical Management of Single Ventricle

1. First-stage palliation
2. Bidirectional cavopulmonary anastomosis
3. Fontan operation

First-Stage Palliation

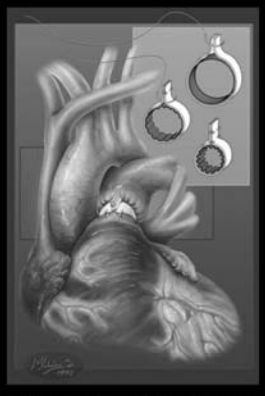
- Goals
  - ✓ Balanced systemic and pulmonary blood flow (Qp/Qs = 1)
  - ✓ Unobstructed mixing at the atrial level
  - ✓ Unobstructed systemic cardiac output
- Performed during neonatal or early infantile period
- The choice of procedure is determined to achieve the above-mentioned goals.

Modified Blalock-Taussig Shunt



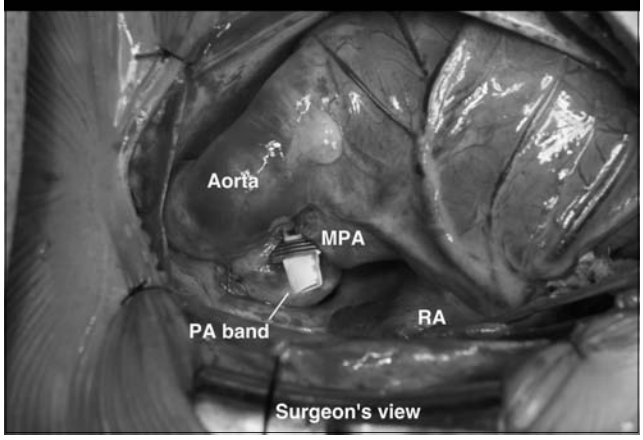
Ungerleider RM, et al. Critical Heart Disease in Infants and Children. 3rd ed.

Pulmonary Artery Banding



Mavroudis C, et al. Atlas of Pediatric Cardiac Surgery.

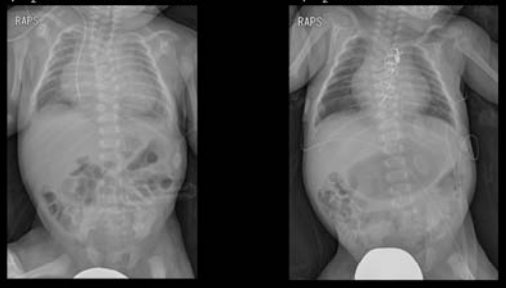
Pulmonary Artery Banding for {S,L,L} DILV



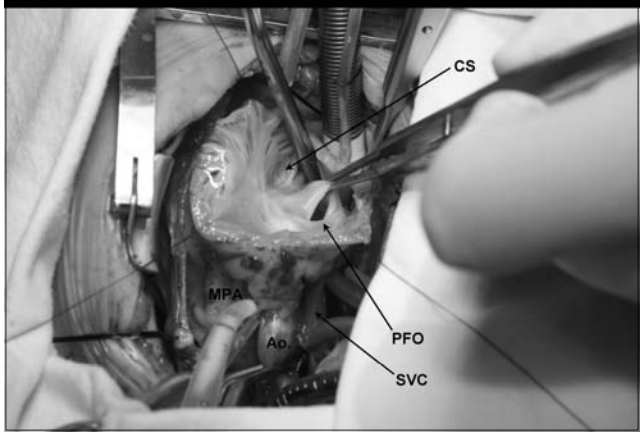
A Neonate with Mitral Atresia and DORV

Pre-PA banding
SpO_2 around 95% at room air

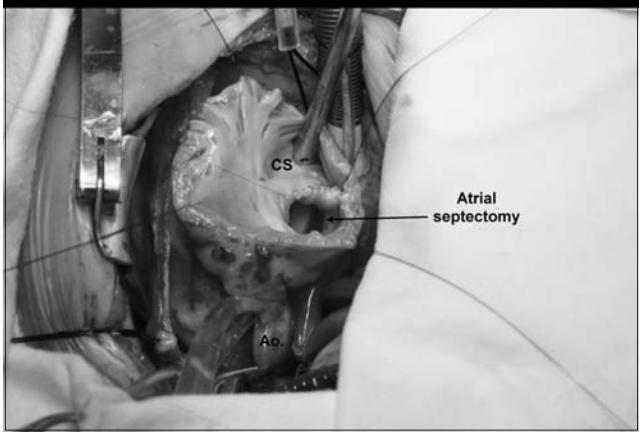
Post-PA banding
SpO_2 around 75% at room air



Tricuspid Atresia with a Restrictive ASD



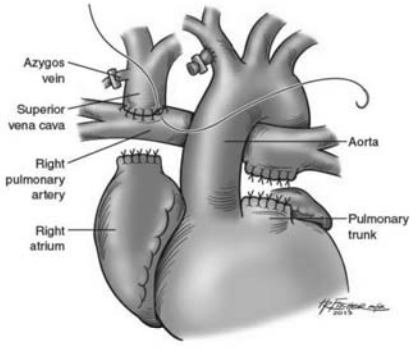
Atrial Septectomy for Tricuspid Atresia with a Restrictive ASD



Bidirectional Cavopulmonary Anastomosis

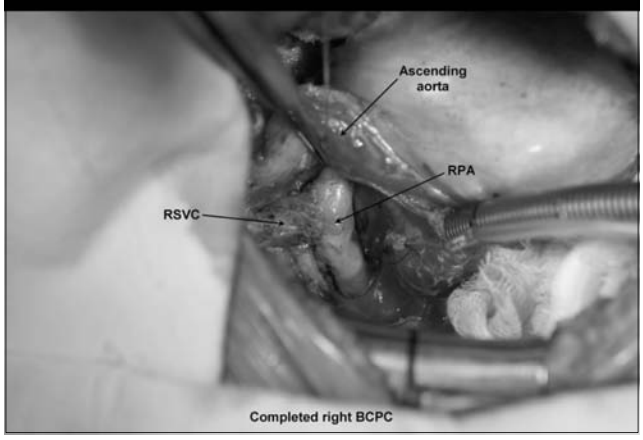
- Goals (Benefits)
  - ✓ Improvement in efficiency of gas exchange
  - ✓ Reduction in volume overload of the single ventricle
- Diversion of SVC blood into the pulmonary arteries
- Usually performed at 3-6 months of age

Bidirectional Cavopulmonary Anastomosis



Kaiser LR, et al. Mastery of Cardiothoracic Surgery. 3rd ed.

Bidirectional Cavopulmonary Anastomosis



Fontan Operation

- Total cavopulmonary connection
- Separation of systemic and pulmonary circulations
- Usually performed at 2-3 years of age

Thorax (1971), **26**, 240.

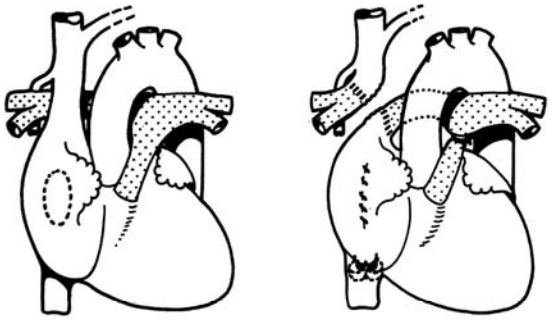
Surgical repair of tricuspid atresia

F. FONTAN and E. BAUDET

Centre de Cardiologie, Université de Bordeaux II, Hôpital du Tondu, Bordeaux, France

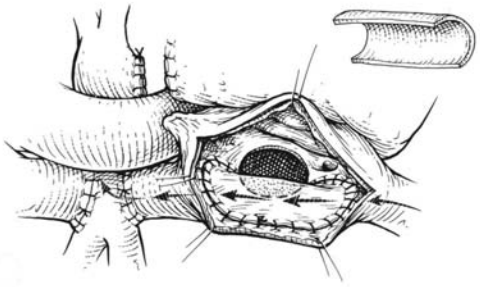
Surgical repair of tricuspid atresia has been carried out in three patients ; two of these operations have been successful. A new surgical procedure has been used which transmits the whole vena caval blood to the lungs, while only oxygenated blood returns to the left heart. The right atrium is, in this way, 'ventriclized', to direct the inferior vena caval blood to the left lung, the right pulmonary artery receiving the superior vena caval blood through a cava-pulmonary anastomosis. This technique depends on the size of the pulmonary arteries, which must be large enough and at sufficiently low pressure to allow a cava-pulmonary anastomosis. The indications for this procedure apply only to children sufficiently well developed. Younger children or those whose pulmonary arteries are too small should be treated by palliative surgical procedures.

Original Fontan Operation



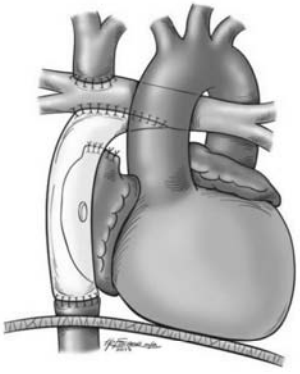
Thorax 1971;26:240-8

Lateral Tunnel Fontan Operation



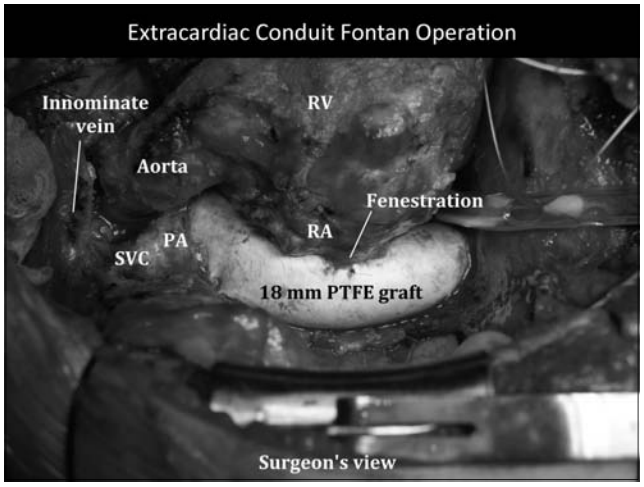
Kouchoukos NT, et al. Kirklin/Barratt-Boyes Cardiac Surgery. 4th ed.

Extracardiac Conduit Fontan Operation



Kaiser LR, et al. Mastery of Cardiothoracic Surgery. 3rd ed.

Extracardiac Conduit Fontan Operation



BOX 129-1 **The "Ten Commandments" for Selection of Patients with Tricuspid Atresia for the Fontan Procedure**

1. Minimum age 4 years
2. Sinus rhythm
3. Normal caval drainage
4. Right atrium of normal volume
5. Mean pulmonary artery pressure ≤15 mm Hg
6. Pulmonary arterial resistance <4 U/m^2
7. Pulmonary artery to aorta diameter ratio ≥0.75
8. Normal ventricular functions (ejection fraction >0.6)
9. Competent left atrioventricular valve
10. No impairing effects of previous shunts

Selke FW, et al. Sabiston & Spencer Surgery of the Chest. 9th ed.

Selection Criteria for Fontan Operation

- The pulmonary vasculature and ventricular function remains the most important selection criteria for successful outcome after the Fontan operation.

- Pulmonary vascular resistance < 4 WU·m^2
- Mean pulmonary artery pressure < 15-20 mmHg
- Ventricular end-diastolic pressure < 12-15 mmHg

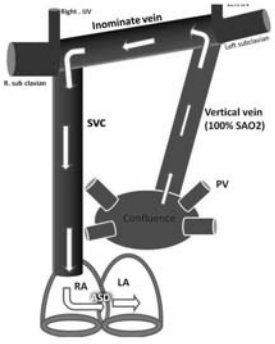
Pulmonary Venous Anomalies

서울대학교병원 흉부외과학교실

조 성 규

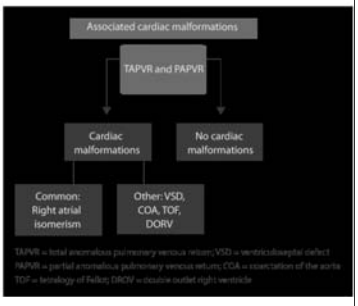
Total anomalous pulmonary venous returns (TAPVR)

- All pulmonary venous blood flow returns anomalously to the systemic veins or directly to the right atrium
- Prevalence estimated at 1 in 10,000
- Acutely cyanotic infant in shock
- One of the true surgical emergencies across the entire spectrum of congenital heart surgery.

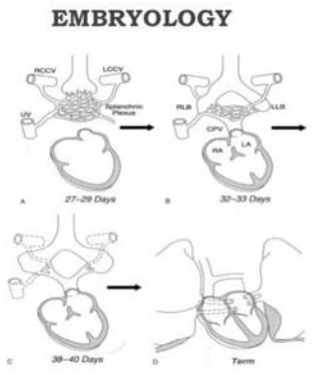


TAPVR

- Biventriclular heart
- Single ventricle
- Heterotaxy syndrome

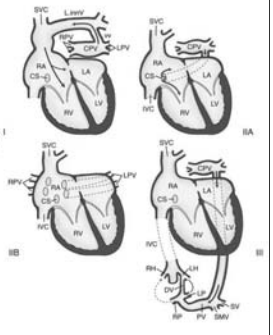


Embryology



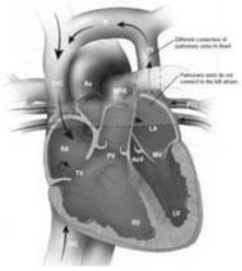
Anatomic subtype

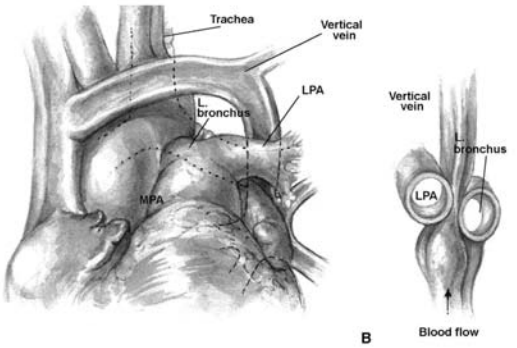
- Type 1 : supracardiac (43-50%)
- Type 2 : Cardiac (18-20%)
- Type 3 : Infracardiac type (20-27%)
- Type 4 : Mixed (10-12%)
- Non-opstructed vs. Obstructed



Type 1 : Supracardiac type

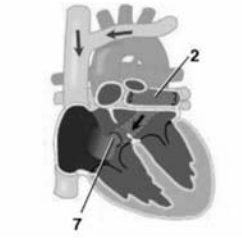
- Vertical vein most often drains to LIV
- Course between LPA and left main bronch
- May present obstructed (around 50%)





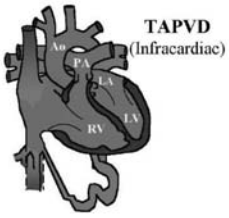
Type 2 : Cardiac type

- Typically to the coronary sinus
- Less likely to be obstructed
- Can present later

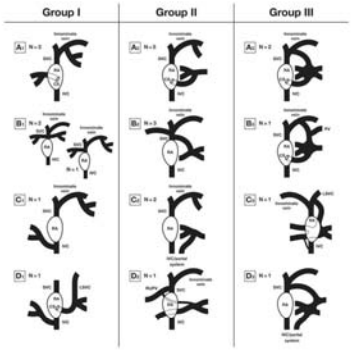


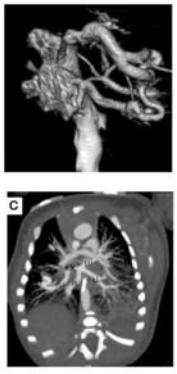
Type 3: Infracardiac type

- Descending vein to portal vein, IVC, hepatic vein, or ductus venosus
- Nearly all obstructed → present at birth



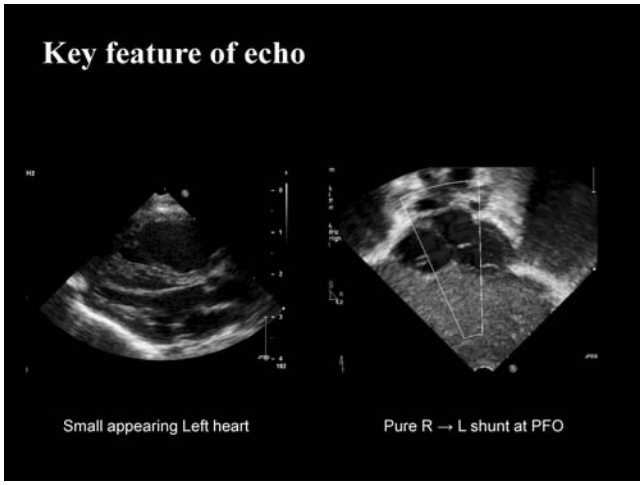
Type 4 : mixed type



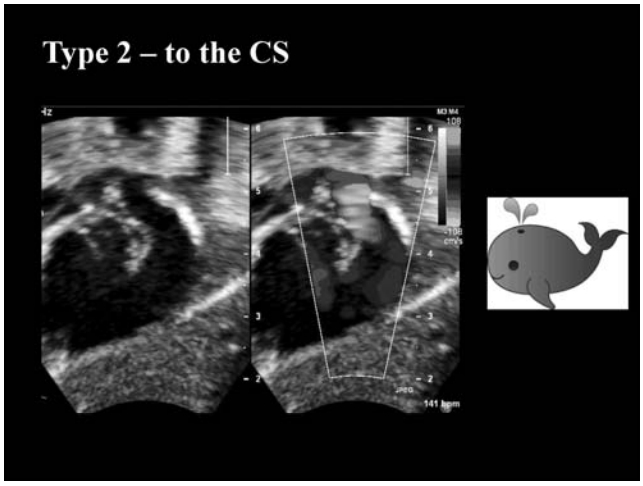


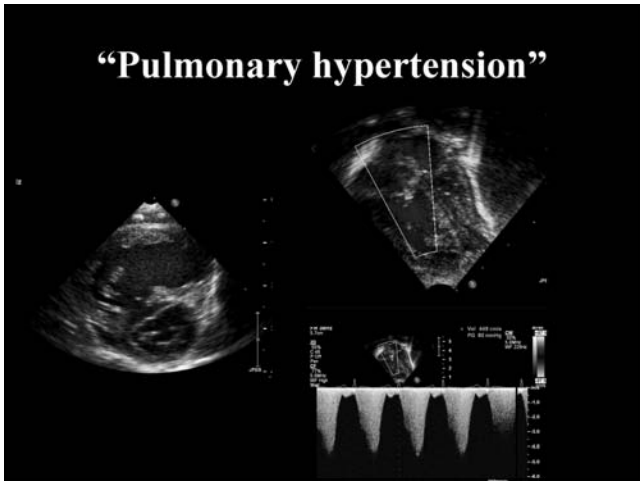
Diagnosis

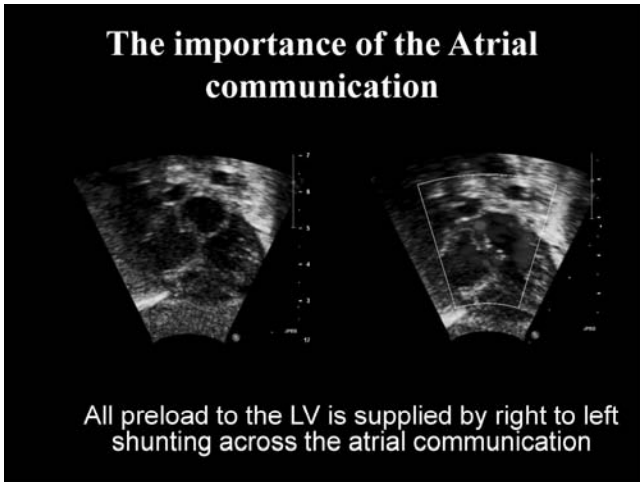
- Echocardiography
- Cardiac angiography
- CT
- Cardiac MRI

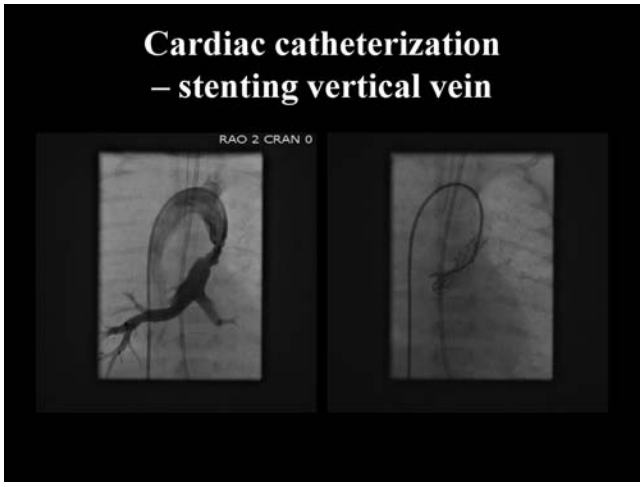

Key feature of echo
Small appearing Left heart
Pure R → L shunt at PFO

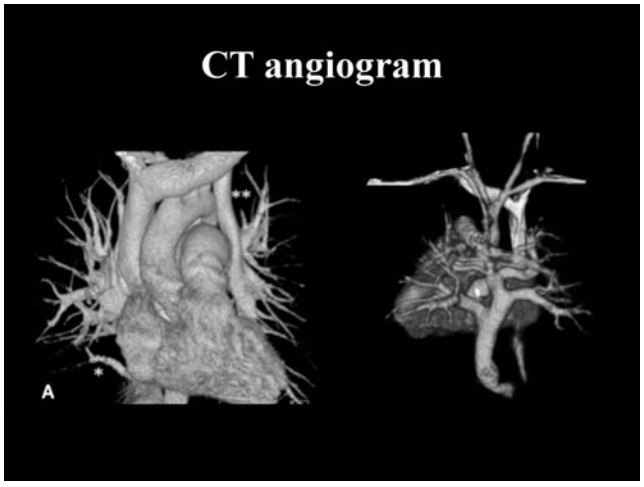

Key feature of ech.o
PV veins to confluence


Type 2 – to the CS


"Pulmonary hypertension"


The importance of the Atrial communication
All preload to the LV is supplied by right to left shunting across the atrial communication

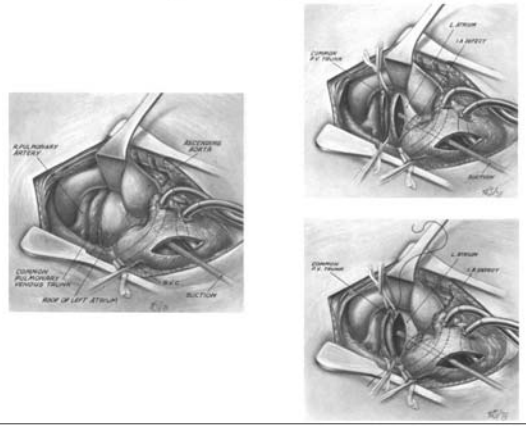

Cardiac catheterization – stenting vertical vein
RAO 2 CRAN 0



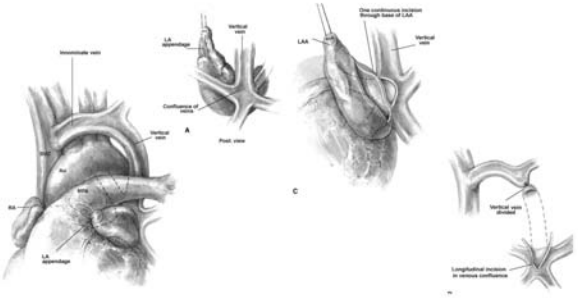
Surgery

- The superior approach
- Lateral technique
- "In situ" technique
- Sutureless repair
- Primary sutureless Repair
- Lateral approach
- Surgery for pulmonary venous obstruction after repair of TAPVC

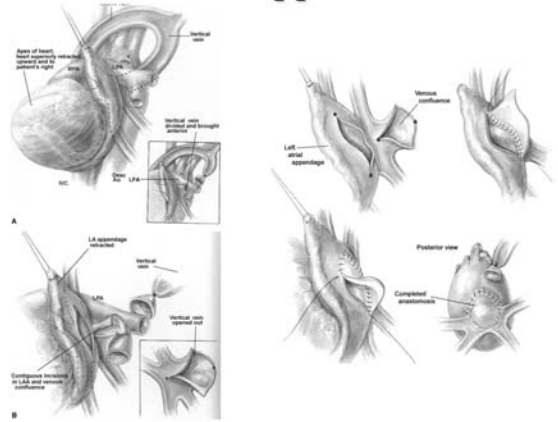
Superior approach



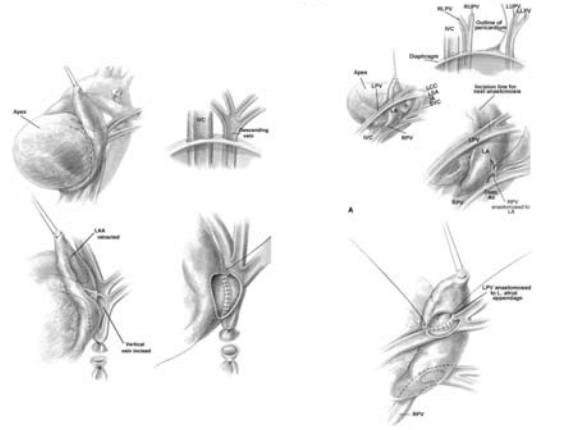
Lateral approach



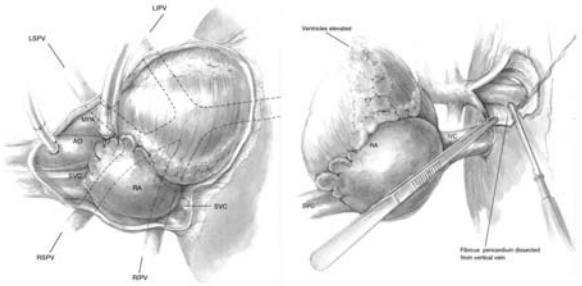
Lateral approach



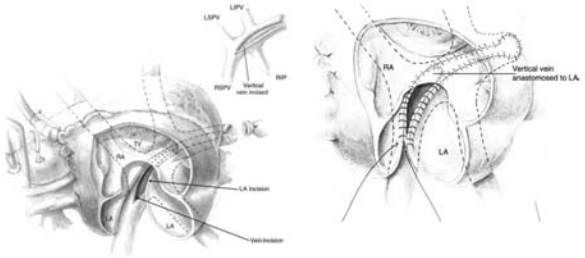
Lateral approach



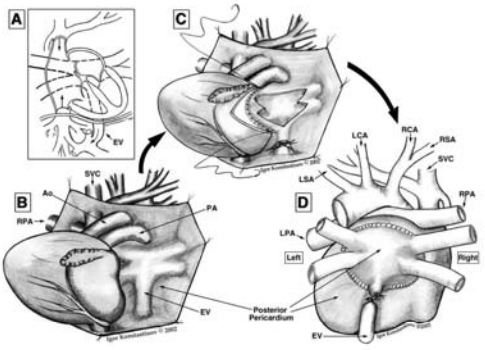
"In situ" technique



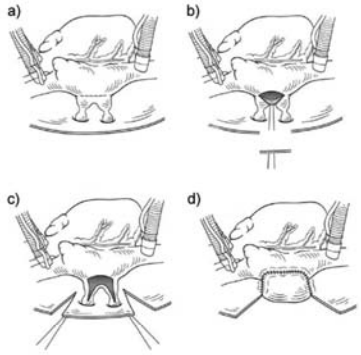
"In situ" technique



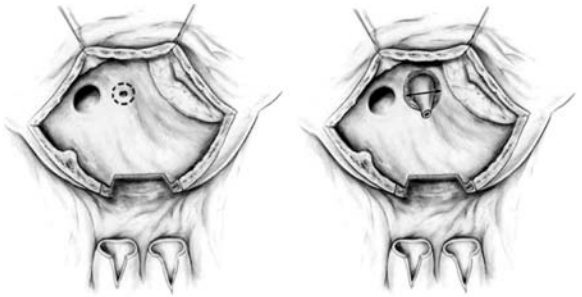
Sutureless repair



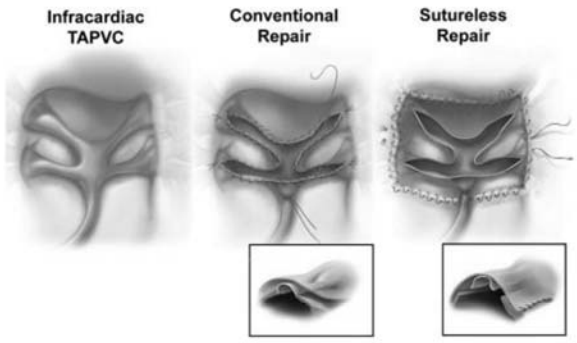
Surgery for post-repair pulmonary vein stenosis



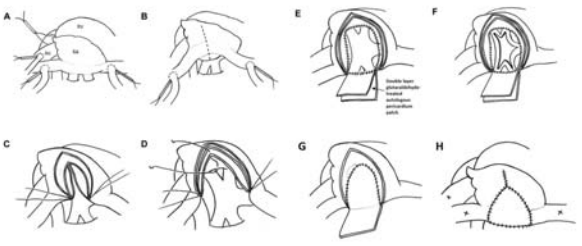
Surgery for post-repair pulmonary vein stenosis



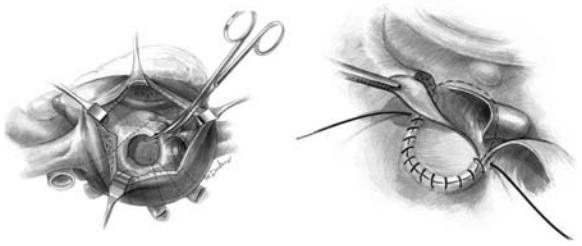
Primary sutureless repair



Primary sutureless repair



Cardiac type repair



Postop. management

- Consideration of muscularized pulmonary arteries (obstructive TAPVC)
- Minimization of pulmonary resistance
  - Appropriate ventilator care (PCO2 level)
  - Oxygen, NO gas
  - Low dose isoproterenol (pulmonary vasodilatory effect)
  - Sedation
- Careful observation for pulmonary hypertensive crisis

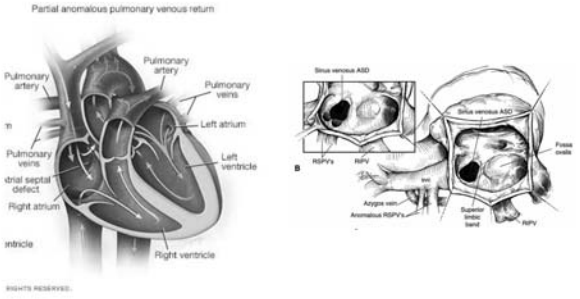
Prognosis

- Early mortality : 8-20%
- Risk factors for early mortality
  - Preoperative pulmonary venous obstruction
  - Single ventricle anatomy
  - Chromosomal anomaly
  - Small pulmonary confluence
  - Diffuse pulmonary vein
- Pulmonary vein stenosis : 10-20%
  - Presence of preoperative obstruction
  - Endocardial sclerosis (recurrent obstruction)

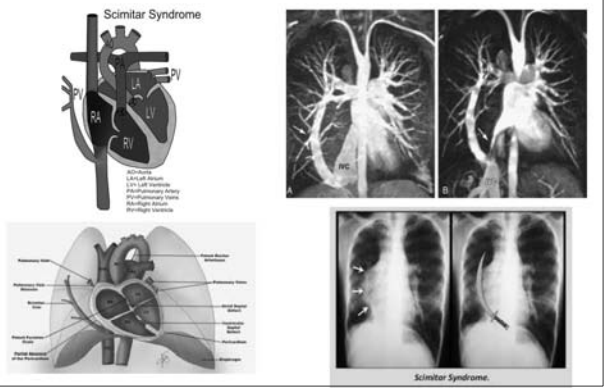
Partial anomalous pulmonary venous return

- M/C associated with sinus venosus ASD
- Usually, RUL draining to SVC
- Rare anomaly in right pulmonary veins
  - Single vertical trunk descends in a curve to enter the IVC (Scimitar syndrome)
- No symptoms and signs when Qp/Qs is less than 1.5

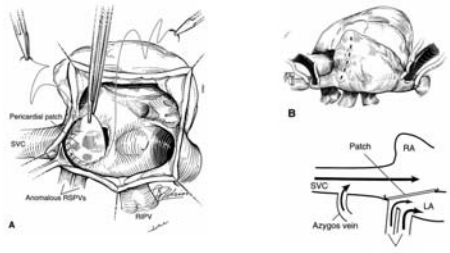
PAPVR



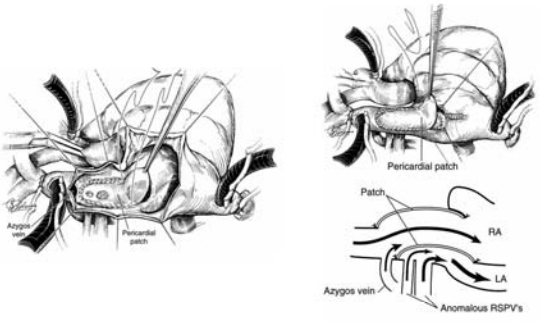
Scimitar syndrome



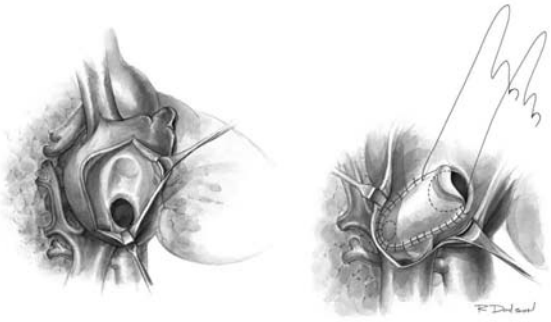
PAPVR repair



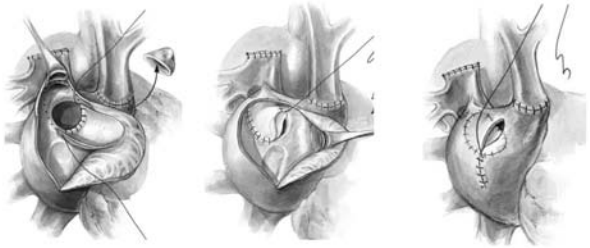
PAPVR repair



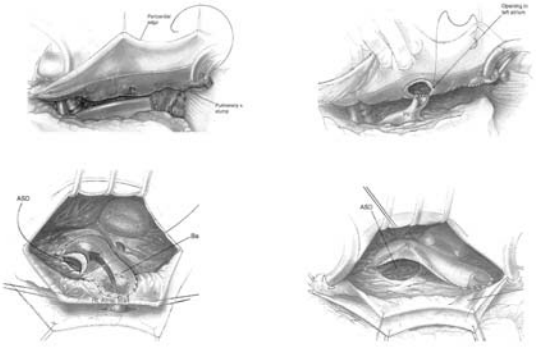
PAPVR repair



Warden procedure



Repair of scimitar syndrome



Possible complications

- SVC obstruction
- Pulmonary venous stenosis
- Sinus node dysfunction
- Sick sinus syndrome

【혈관파트】

좌장: 공준혁

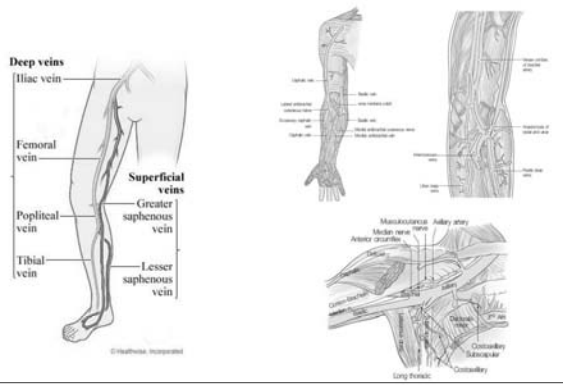
Deep Vein Thrombosis & Pulmonary Embolism: Overview & Treatment

Department of Thoracic and Cardiovascular Surgery, Kangbuk Samsung Medical Center, Sungkyunkwan University, School of Medicine

Joon Hyuk Kong

Anatomy

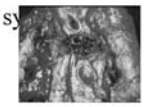
Venous System



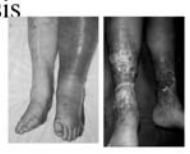
Pathophysiology

Venous Thromboembolic Disorder

- **Deep Vein thrombosis / Pulmonary embolism**
  - Traveler's thrombosis (Economy class s
  - Chronic venous insufficiency



- Other forms of venous thrombosis
  - Superficial thrombophlebitis
  - Axillary-Subclavian thrombosis
  - Mesenteric venous thrombosis

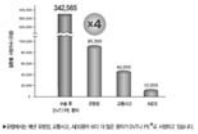


Superficial Thrombophlebitis

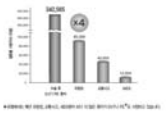
- Cause ; Spontaneous, Trauma, Varicose vein, Buerger's disease, Malignancy, Hypercoagulability
- Not related with bacterial infection, except caused by recent iv catheterization
- Symptoms ; localized pain, erythema, warmth, tenderness, swelling, palpable cord
- **Asymptomatic Synchronous DVT(+) in 35%** => Check venous duplex study!
- Indication for treatment
  - Isolated superficial thrombophlebitis with encroachment on the S-F junction
  - Purulent infection
  - >5cm involvement: 45 days LMWH

Venous Thromboembolic Disorder

- Deep Vein thrombosis / Pulmonary embolism
  - Possible cause of mortality
    - First year mortality of acute DVT ; 19-21%
    - PE death; 15% hospital death, 150,000-200,000 death/year in USA
  - Significant morbidity due to progression to chronic venous insufficiency



Venous Thromboembolic Disorder



- Incidence of acute DVT
  - Autopsy cases ; 35-52%
  - Community-based, venography, symptomatic ; 1.6 /1000 residents, yearly
  - Postoperative DVT; GS(19%), NS(24%), hip fracture(48%), hip arthroplasty(51%), knee arthroplasty(61%)
  - Trauma; autopsied casualties(62%), venography(58%) -- duplex(4-20%)

Epidemiology and Natural history

- The incidence of **recurrent, fatal, and non fatal VTE** has been estimated to exceed 900,000 cases annually in the united state alone.
- In the United States of America, 200,000 new cases of **pulmonary embolism(PE)** occur each year, and 50,000 of these result in death.
- **VTE** kills four to five more people annually than dose breast cancer or acquired Immunodeficiency syndrome.
- **PE** is the third most common fatal vascular disorder following coronary artery disease (CAD) and cerebrovascular accident (CVA).
- The in-hospital mortality rate is 12%, and it is thus the number one preventable death in hospitalized patients.

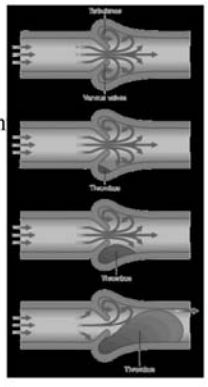
*(*Rutherford's Vascular Surgery 7th edition, section 7 venous disease, chapter 48, p 736, chapter 50 , p 770, Saunders 2010)*

Isolated calf vein thrombosis

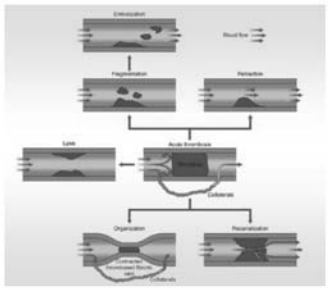
- Differences in
  - Rates of PE / post-thrombotic complications
- **Recanalize more rapidly**
- Lower reflux in involved calf vein segments
- Lower long term complication
  - PE : 10%, 33% by V/Q scan
  - PTS: 23% at 1yr (vs 54% in proximal DVT)
- Proximal propagation : 15% to 23%
  - in the absence of treatment
    - 1/4 - 1/3 by Kearon
- **However, Need anticoagulation !!!**

Pathophysiology

- Virchow's triad
  - Endothelial abnormality
  - Stasis of blood flow (predominan
  - Hypercoagulability of blood



Pathophysiological consequences



Clinical spectrum of acute DVT

1. Asymtomatic calf vein thrombosis
2. Symptomatic calf vein thrombosis
3. Femoropopliteal DVT
4. Phlegmasia Alba Dolens
5. Phlegmasia Cerulea Dolens
6. Venous gangrene

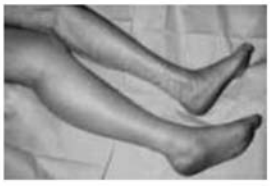
Clinical Course

- Acute (<2wks)
  - Flow void, low echogenic thrombus, venous distension, loss of compression
- Subacute (2-4wks)
  - Increased echogenecity, decreased venous size, resumption of flow
- Chronic (>4wks)
  - Echogenic thrombus, wall irregularity, valve abnormality, collateral veins

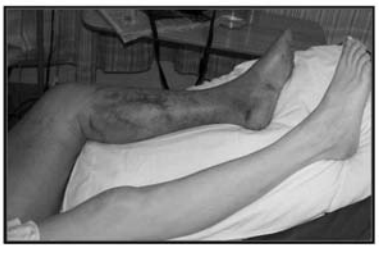
Clincal Course

- Acute DVT
  - Symptomless, warmness, redness, pain, swelling
- Phlegmasia alba dolens (=milk leg, white leg)
  - Increased tissue pressure exceeds the capillary perfusion pressure, causing pallor
- Phlegmasia cerulea dolens(=blue leg)
  - Deoxyhemoglobin in stagnnat vein imparts a cyanotic hue to the limb

Phlegmasia alba dolens (=white leg)



Phlegmasia cerulea dolens(=blue leg)



Risk Factors

Risk factors- hypercoagulable status

Inherited	Acquired
Common	Age
Factor V Leiden	Surgery and trauma
Prothrombin gene mutation (G20110A)	Immobilization
Homozygous C677T mutation in methylene	Malignant disease
Tetrahydrofolate reductase gene	Previous venous thromboembolism
	Pregnancy and puerperium
	Oral contraceptive
	Hormone replacement therapy
	Antiphospholipid antibodies
Rare	**Unknown (probably multifactorial)**
Antithrombin deficiency	Elevated levels of factor VIII, IX, and XI and fibrinogen
Protein S deficiency	
Protein C deficiency	
Dysfibrinogenemia	
Homozygous homocystinuria	

Acquired Risk Factors - Surgery

	Calf DVT	Proximal DVT	Fatal PE
High risk	**40-80%**	**10-30%**	**>1%**
• Surgical patients with history of venous thromboembolism			
• Major pelvic or abdominal surgery for malignancy			
• Major trauma			
• Major lower limb orthopedic surgery			
Moderate risk	**10-40%**	**1-10%**	**0.1-1%**
• Geberak surgery in patients >40 years			
• Patients on oral contraception			
• Neurosurgical patients			
Low risk	**<10%**	**<1%**	**<0.1%**
• Uncomplicated surgery in patients <40 years without any other risk factors			
• Minor surgery in patients >40 years without any other risk factors			

Acquired Risk Factors

- **Old age**
  - a major risk factor of VTE
- **Prior venous thromboembolism**
  - independent risk factor for future VTE / adequate prophylaxis
- **Immobilization**
  - 60% of the paralyzed limb / 7% contralateral normal control leg
  - air travel
- **Malignancy**
  - resulting rom activation of the cogulation cascade?
- **Superficial thrombophlebitis**
  - an independent risk factor for VTE
- **Antiphospholipid antibody syndrome**
  - anticardiolipin antibody / lupus anticoagulant antibody
  - 2% of population / 30-50% of patients with SLE
  - 50% frequency of DVT/ half having PE

Inherited Thrombophilia

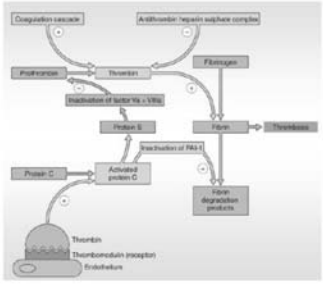
- Epidemiology

Thrombophilia	General population (%)	Patients with VTE (%)
Factor V Leiden*	5	20
Prothrombin G20210A	3	7
Elevated factor VIII**	6-8	10-15
Protein C deficiency	0.2-0.5	3
Protein S deficiency	0.2-0.5	3
Antithrombin deficiency	0.02	1
Hyperhomocysteinemia**	5	10
*Rare in the Asian and African populations		
**Likely to be multifactorial		

- Diagnosis of inherited thrombophilia
  - Should be considered in **any patient with VTE**

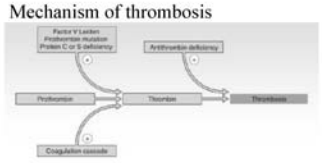
Inherited Thrombophilia

- Regulation of coagulation pathway



Inherited Thrombophilia

- Mechanism of thrombosis

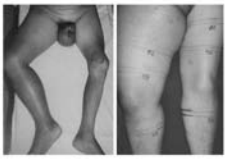


- Investigation for suspected inherited thrombophilia
  - age less than 45 years
  - recurrent episodes of VTE
  - Family history of VTE
  - thrombosis at unusual venous sites such as dural sinuses
  - recurrent miscarriages

Clinical Features

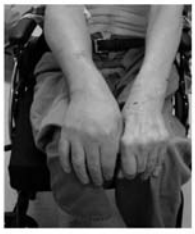
Clinical Features – L/E DVT

- Mostly asymptomatic
- Pain, Edema
  - due to vein obstruction, inflammation of perivascular tissue, lymphatic obstruction
- Distention of superficial veins
- Cutaneous erythema
- Homan's sign
  - pain in calf with forced dorsiflexion of foot



Clinical Features – U/E DVT

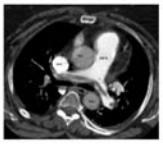
- **Less common (2-5% of population)**
- Indwelling mechanical devices
  - pacer lead, central venous catheters
  - 30-40% of cases
- Conditions of venous compression
  - lymphadenopathy, tumors
- Paget-Schroetter sndrome
- 10-30% risk for **PE** (**similar to leg DVT**)

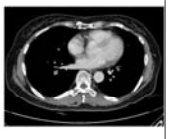


Clinical Features – PE

- Classification of PE

Pulmonary embolism	History	Pathophysiology	Therapy
Acute massive	Acute	Circulatory collapse	Thrombolysis, thrombectomy
Acute submassive	Acute	Stable, echocardio-graphic signs of RV overload	Thrombolysis?, heparin
Acute nonmassive	Acute	Stable	Heparin
CTEPH (Chronic thromboembolic pulmonary Hypertension)	Chronic	RV overload	Medical or elective thromboendartectomy



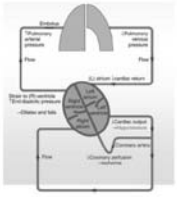


- **Acute massive**: >50% PA occlusion
  - sudden death in 10%, within 1 hr,
  - severe acute dyspnea, syncope
- **Acute submassive**
- **Acute nonmassive:** <50% PA occlusion
  - asymptomatic or tachypnea, dyspnea, pleuritic pain

Complication

Complications (I)

- **Pulmonary Embolism**
  - most devastating complication
    - obstruction of blood flow distal to the clot
    - rapid increase in pulmonary arterial and right heart pressure



Complications (II)

- **Pulmonary Embolism**
  - Inadequate tx. of proximal venous thrombosis
    - 20% to 50% risk of significant recurrent VTE
    - 90% of thromboemboli arising from L/Ex veins
  - Sx PE: 7% to 17% of proximal U/Ex thrombi
  - Lung scan: + in 25- 51% of Asx patients
  - Autopsy : [DVT + PE] = [1.8 X DVT alone]
  - PE contributes to **approx. 15% of hospital deaths**
  - 1-week survival rate after a PE : 71%
  - 25% of PE manifest as sudden death
  - Mortality in adequate Dx. and Tx.: 8% to 9%

Complications (III)

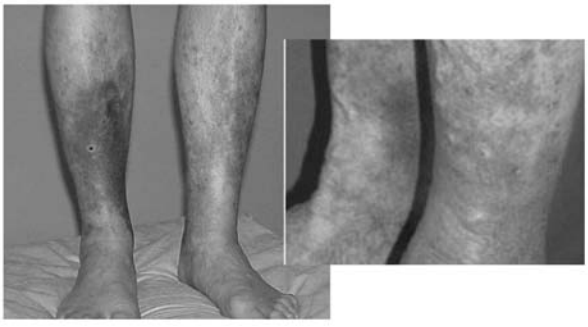
- **Post-thrombotic Syndrome**
  - less dramatic than PE
  - greater degree of chronic socioeconomic morbidity
  - 29% to 79% of patients
    - pain, edema, hyperpigmentation, or ulceration
  - Severe manifestations
  - ambulatory venous hypertension
    - valvular reflux / persistent venous obstruction / anatomic distribution of these abnormalities
  - X6 risk of post-thrombotic syndrome with recurrent DVT

Post-Thrombotic Syndrome (PTS)

- Painfula heavy leg
- Cramps
- Paresthesia
- Prutitus
- Formation of varicosities
- Edema
- Hyperpigmentation of the skin

=> **Reduced quality of life (QoL)**

PTS



Diagnosis

Diagnosis of DVT

- **D-dimer** ; cross-linked degradation product of fibrin.
  - Sensitivity 44-72%, specificity 44-70%
  - High negative predictive value; 97-99%
- **Duplex USG** ; test of choice (Accuracy >95%)
- **CT venography** ; pelvic vein evaluation, PE study

- Impedence phlethysmography
- Ascending venography
- MR Venography
- Lung ventilation & perfusion scan

DVT ; Diagnosis

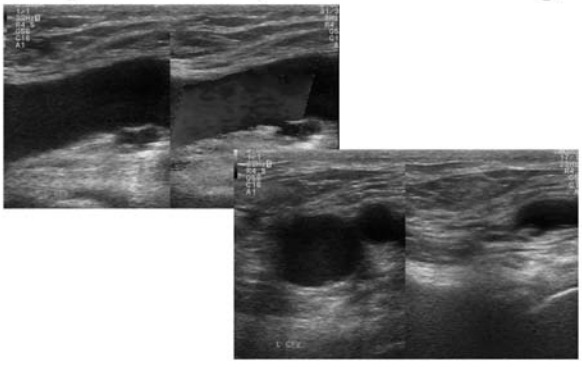
- **Before anticoagulation,** Check coagulation profiles !
  - CBC ; Hb, Hct, platelet
  - BT / PT / aPTT
  - AT-III, protein C, protein S
  - Coagulation factors VIII, IX, XI
  - Fibrinogen, FDP, D-dimer, homocysteine
  - Lupus anticoagulant, anticardiolipin Ab, antiphospholipid Ab
- **Family study in hereditary or familiar tendency**
  - Factor V Leiden, Prothrombin gene mutation ; rare in KOREA

Duplex criteria for DVT

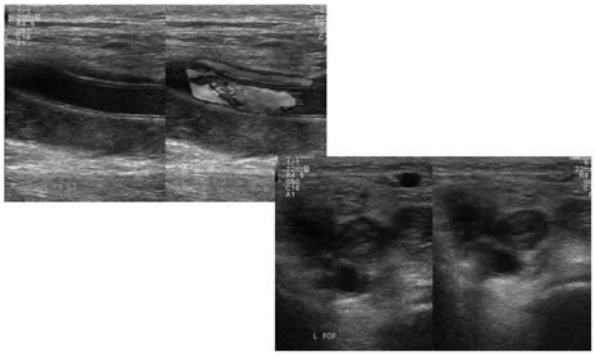
- Negative for DVT
  - Complete approximation of the vein wall during compression
  - Complete color filling of the lumen without any defect
- **Positive** for DVT
  - Partially compressible or noncompressible vein
  - **Echogenic material** within the vein
  - **Filling defect** on color imaging
  - Absence of doppler signal

Mansour & Labropoulos: Vascular DIagnosis(2005)

Duplex USG ; normal finding



Duplex USG ; abnormal finding



Conditions that may mimic acute DVT

Muscle strain or blunt trauma
Ruptured muscle with subfascial hematoma
Spontaneous hemorrhage or hematoma
Ruptured synovial cysts (Baker's cysts)
Arthritis, synovitis, or myositis
Cellulitis, lymphangitis, or inflammatory lymphedema
Superficial thrombophlebitis
Arterial insufficiency
Pregnancy or oral contraceptive use
Lymphedema
Lipedema
Chronic venous insufficiency or venous reflux syndromes
Extrinsic venous compression: lymphadenopathy, tumors, lymphomas, hematomas, abscesses, right iliac artery
Systemic edema: congestive heart failure, metabolic, nephrotic syndrome, post–arterial reconstruction
Dependency or leg immobilization (casts)
Arteriovenous fistula

Diagnostic strategies for DVT

- Assessment of risk of venous thrombosis; Modified Wells Criteria

Criteria	Score
Active cancer (receiving treatment within previous 6 months or receiving palliative treatment)	1
Paralysis, paresis, or recent immobilization of lower extremity	1
Recently bedridden for ≥ 3 days, or major surgery within 12 weeks requiring any type anesthesia	1
Localized tenderness along distribution of deep venous system	1
Entire leg swollen	1
Calf swelling ≥ 3cm increased compared to asymptomatic leg (measured 10cm below tibial tuberosity)	1
Pitting edema confined to symptomatic leg	1
Collateral superficial veins (nonvaricose)	1
Previously documented DVT	1
Alternative diagnosis at least as likely as DVT	-2

Risk Assessment	Score
Low risk	≤ 0
Intermediate risk	1-2
Likely	>2

Diagnostic strategies for DVT

Annal Int Med 2003

Summary of Pathophysiology

- Deep vein thrombosis (DVT) and pulmonary embolism (PE) are a single clinicopathological entity
  - > venous thromboembolic disease, VTE
- The incidence: 1 (DVT) and 0.5 (PE) cases per **1000 population per year** in the **Western world**
- In a hospital setting, 15% of medical and 30-50% of surgical patients develop VTE if no prophylaxis is initiated
- Clinical feature: nonspecific and inaccurate
- Serious complications; ***30-40% mortality*** in **untreated PE**, ***~50% PTS*** in DVT
- Clinical risk assessment and plasma D-dimer testing with duplex study and pulmonary CT angiography

Treatment

Concerns in a patients with DVT

- Pulmonary embolism
- Symptoms
- Extension of thrombosis
- Recurrence
- Post-thrombotic syndrome

=> Aim of DVT treatment

Goals of DVT Therapy

- **Diminish the severity and duration of lower extremity symptoms**
- **Prevent Pulmonary embolism**
- **Minimize the risk of recurrent venous thrombosis**
- **Prevent the postthrombotic syndrome (PTS)**

Overview of Treatment

1. **Systemic Anticoagulation**
2. **Systemic Thrombolysis**
3. Surgical Thrombectomy
4. **IVC filter**
5. **Catheter Directed Thrombolysis (CDT)**
6. **Percuataneous Mechanical Thrombectomy (PMT?)**
7. **PharmacoMechanical Thrombolysis (PMT)**
8. **Adjuvant Venous Angioplasty and Stenting**

DVT: Treatment options

- Anticoagulants
- Thrombolytic therapy

- Pharmacomechanical thrombectomy
- Surgical thrombectomy

- Vena cava filter
- Conservative treatment

DVT: Treatment options

Goal	Caval filter	Anti-Coagulation	Thrombolytic Therapy	Venous Thrombectomy
reduce PE	+	+	+	+
prevent thrombus extension		+	+	+/-
reduce DVT recurrence		+	+	+/-
restore venous patency			+	+
restore venous valve			+	+
reduce chronic venous insufficiency		+/-	+	+

Treatment

- **Conservative Treatment**

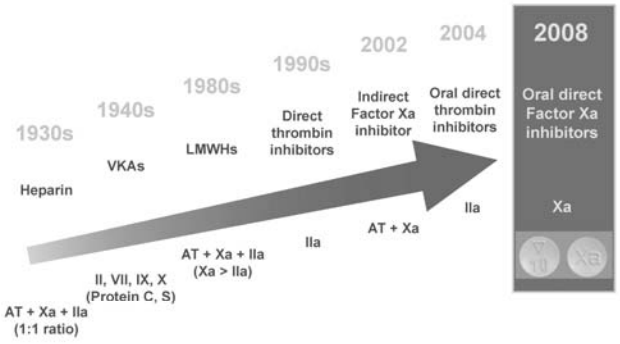
Conservative Treatment

- **Bed rest** and **leg elevation**
  - 1289 prospective cohort study
  - Bed rest does not prevent PE
  - LMWH + early ambulation + compression bandage or ES, faster improvement of pain and swelling w/o increasing risk of PE, decreased PTS
    - Partsch H, JVS 2002
- Graduated **compression stocking**
  - Graduated compression stocking for 24 months post-5 yr cumulative data of incidence of PTS 26% vs. 49%
    - Prandoni P et al, Ann Int Med 2004
- Below-the-knee stocking is equivalent to the thigh one

Treatment

- **Anticoagulation**

The evolution of anticoagulant drugs



Outpatient Anticoagulation Therapy: Relative CIx

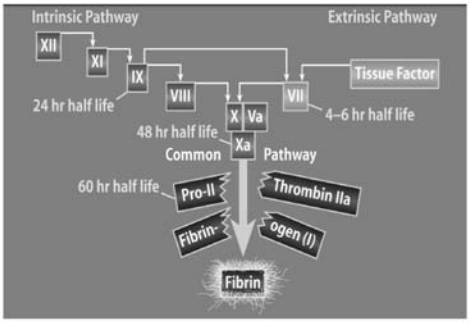
- PE with hemodynamic or respiratory instability
- Extensive iliofemoral thrombus
- Known potential for non-compliance
- Active bleeding
- Severe hypertension (HTN)
- Renal clearance <30 mL/min or SCr >2.5 mg/dL
- Thrombocytopenia <100,000
- History of heparin-induced thrombocytopenia

Michigan Quality Improvement Consortium (MQIC) guidelines 2011

Anticoagulants

- UFH (Unfractionated heparin)
- LMWH (low molecular weight heparin)
- Fondaparinux
- Vitamin K antagonist
- Direct thrombin inhibitor
- Factor Xa inhibitor

Clotting Cascade



Heparin (UFH)

- **Heterogenous mixture** of polysaccharide fragments w/ molecular weight 12,000~15,000
- **Bind to** the antithrombin, results **conformational change of AT**, thereby enhance AT's inhibitory effect on thrombin and other coagulation factors esp., Xa
- Drawbacks of unfractionated heparin (UFH)
  - Need to administer heparin by continuous IV infusion
  - Unpredictable activity, requiring laboratory monitoring
  - Heparin induced thrombocytopenia (HIT)

Low Molecular Weight Heparin (LMWH)

- Obtained by various fractionation or depolymerisation of polymeric heparin
- Molecular weight < 8000
- Various activity to the **AT and Xa**
- Constant release → predictable effect, do not need monitoring

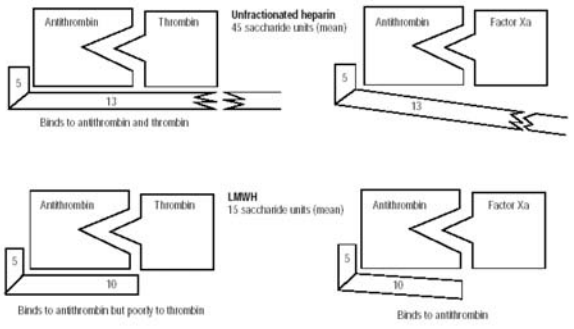
Low Molecular Weight Heparin (LMWH)

Agent	Trade Name	Mean MW	Anti-Xa:Anti-Iia Ratio
UFH	-	12,000~15,000	1
Ardeparin	Normiflo	6,000	1.9
Dalteparin	Fragmin	6,000	2.7
Enoxaparin	Clexane	4,200	3.8
Nadroparin	Fraxiparin	4,500	3.6
Reviparin	Clivarine	4,000	3.5
Tinzaparin	Innohep	4,500	1.9

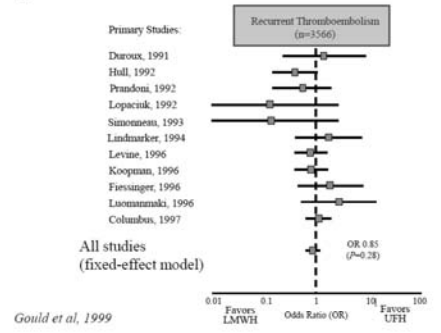
Advantages of LMWH

Pharmacokinetic Characteristic	Clinical advantage
Reduced protein binding	Good bioavailability
	Predictable dose response
	Resistance not encountered
Predictable dose response	Fixed or wt-based dosing possible
	Monitoring not required
Longer plasma half-life	Once- or twice-daily dose possible
Smaller molecule	Improved subcutaneous absorption
Less effect on platelets and endothelium	Reduced incidence of HIT and, possibly, bleeding

Heparin vs. LMWH



Meta-Analysis LMWH vs Heparin for Treatment of DVT



Gould et al, 1999

Fondaparinux

- Synthetic pentasaccharide
- Factor Xa inhibitor
- For injection
- Fondaparinux vs enoxaparin in hip/knee surgery
  - More effective at preventing VTE
  - No difference in major bleeding
- no report of HIT

UFH vs LMWH vs Fondaparinux

	UFH	LMWH	Fondaparinux
Mechanism	Enhances AT effects on Xa & thrombin	Enhances AT effects more selectively on Xa than on thrombin	Enhances anti-Xa activity of AT
Half-life	1-2 hr	4.5-7hr	17-21 hr
Dosing	Continuous drip	BID or once daily	Once daily
Reversal agents	Protamin sulfate 1mg neutralizes 100u of heparin	Protamin sulfate neutralizes 60% of activity	Not reversible by protamin
Monitoring	aPTT, heparin assays	none	none
Clearance	Hepatic & RES, No renal adjustments	Renal Adjust for CrCl<30mL/min	Renal contraindicated in CrCL<30mL/min
Cause HIT	yes	yes	no

LMWH vs. UF Heparin

Recurrences rate	Enoxaparin	UF Heparin	RR (>0.75)
Vein thrombosis event	4.5 %	5.7 %	0.81
DVT	3.1 %	4.4 %	0.79
PE	0.95 %	1.8 %	0.63

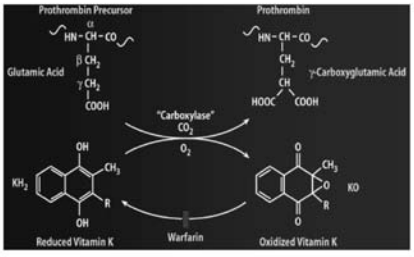
인천사랑병원 심혈관센터

LMWH vs. UF Heparin

Complication (%)		Enoxaparin	UF Heparin	RR (> 0.75)
Major bleeding	10days	2.2 %	2.0 %	NS
	30days	2.9 %	4.3 %	0.74 (28%)
Death		3.3 %	5.8 %	NS
Mortality				0.69 (31%)

인천사랑병원 심혈관센터

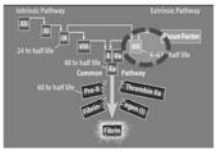
Warfarin : Mechanism of Action



- Inhibit carboxylation of coagulation factor II, VII, IX, X in the liver
- Also inhibits natural anticoagulant protein C/S

VKA should be given with heparin at the begining

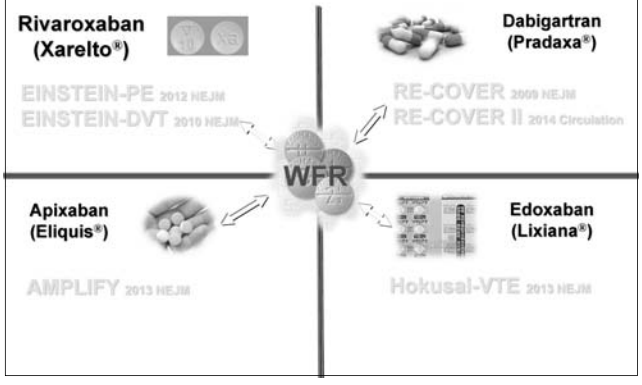
- Slow action of VKA
- Relatively hypercoagulable state due to short half life of natural anticoagulants (protein C/S)
- Very short half life of factor VII → initial INR may not reflect effect of VKA



New Oral Anticoagulants (NOACs)

- Factor Xa inhibitors
  - Rivaroxaban
  - Apixaban
  - Edoxaban
- Direct thrombin inhibitors
  - Dabigatran

New ERA of NOAC in VTE treatment



Pharmacokinetics of NOACs

	Dabigatran	Rivaroxaban	Apixaban
Administration	bid	QD	bid
Bioavailability	6.50%	80%	66%
Tmax	1.25-3 h	2-4 h	1-3 h
Half life	12.14 h	5-13 h	8-15 h
Renal excretion	80%	66%	25%
Plasma protein binding	35%	>90%	87%
Dialysability	Yes	Not expected	Unlikely

Anticoagulant therapy: Contraindication

- Active bleeding
- Recent CNS surgery : 2 mo
- Recent major surgery : 2 wk
- Recent hemorrhagic stroke 2 mo
- Severe uncontrolled hypertension
- Severe renal and/or hepatic dysfunction

Optimal Duration of Anticoagulant Therapy for Symptomatic Venous Thrombosis

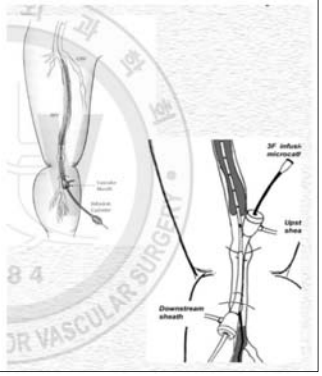
Indication	Duration
DVT with provocative events	3 months
DVT without proviocative cause	6 months to > 1 year
DVT with malignancy	until resolution of malignancy
Hypercoagulable state	life long
Recurrent DVT	life long

Treatment

- **Catheter Directed Thrombolysis (CDT)**

Catheter directed thrombolytic therapy (CDT)

- **Access**
  - Ipsilateral Popliteal vein
  - Contralateral Femoral vein
  - Internal Jugular vein
- **6-F sheath : Heparin**
- **5F multi-sideportcatheter : UK**
  - Heparin 500 unit/hr
  - Urokinase30~100 x 103IU/hr



Catheter directed thrombolytic therapy (CDT)

- Delivery of thrombolytics into the thrombus
- Popliteal approach
- Urokinase>>streptokinase, rtPA – more bleeding
- Pulsed spray catheter

National Multicenter Registry
Radiology 1999

- 287 patients
  - Acute 188, 45 chronic, 54 acute on chronic
- Results
  - Complete lysis 31%, significant(50-99%) 52%, incomplete(<50%) 17%
  - 7.8 million U of UK during 53.4 hrs
  - Higher complete lysis rate in patients with symptoms of less than 10days
  - Major non-fatal bleeding complication 11%
  - Pulmonary embolism in 6 patients, 1 death
  - Overall mortality 0.4%
  - Improved 1 yr patency in treated w/ stent(74%) than w/o stent(53%)

Limitations of CDT

- Time to lysis
- Need to hospitalization and intensive monitoring
- Risk of hemorrhage
- Cost

Treatment

- **PharmacoMechanical Thrombolysis (PMT)**

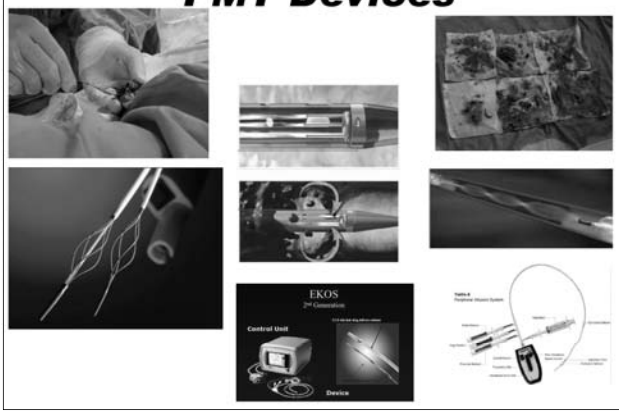
Pharmacomechanical thrombectomy(PMT)

- Reduce dosage of thrombolytic Tx
- Reduce treatment time
- Increase safety
  - narrows contraindications
  - decrease complications
- Reduced cost

PMT Devices

- Aspiration thrombectomy device
- Rotational device
  - Arrow PTD
- Rheolytic thrombectomy
  - angiojet, oasis, hydrolyser
- Isolated PMT
  - trellis
- Ultrasound accelerated thrombolysis
  - Ekos

PMT Devices



CDT vs. PMT

	complete thrombus remove	partial thrombus remove	angioplasty & stenting
CDT	70 %	30 %	78 %
PMT	75 %	25 %	82 %

Lin PH et al. Am J Surg 2006

❖ Compared to CDT, it provided similar treatment success, with reduced ICU, total hospital length of stay, and hospital costs

인천사랑병원 심혈관센터

Treatment

- **Adjuvant Venous Angioplasty and Stenting**

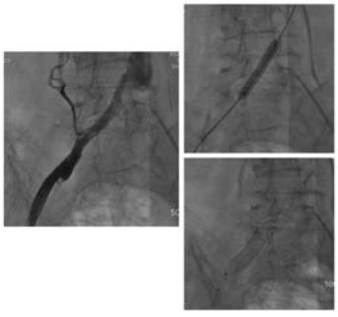
May-Thurner Syndrome

- Iliac vein compression syndrome
  - Compression of the left common iliac vein by the overlying right common iliac artery

• 김창원, 부산대

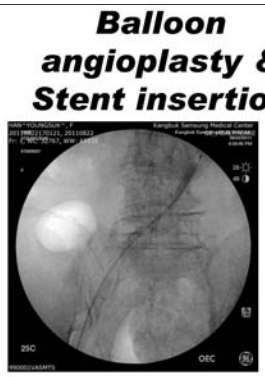
Adjuvant Venoplasty & Stenting

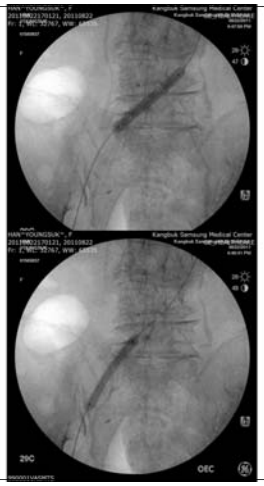
- **Technique**
  - Popliteal vein approach
  - Venoplasty balloon (8~10 mm)
  - Self-expanding stents (10~16 mm)
  - After the procedure, oral warfarin for 6 months



인천사랑병원 심혈관센터

Balloon angioplasty & Stent insertion





Balloon angioplasty & Stent insertion

Author (year)	N	Success rate	Primary patency				Sx resolution	Complication
			6 mths	1 yr	2 yrs	4 yrs		
O'Sullivan GJ (2000)	39	87%		92% (A) 94% (C)			85%	17%
Hurst DR (2001)	18		89%	79%				
Kwak HS (2005)	22	96%		95%	95%			9%
Husmann MJ (2007)	11	100%		90%	82%		90%	
Oguzkurt L (2008)	36	94%		85%		80%	85% (A) 25% (C)	3%

Treatment

- **Surgical Thrombecotmy**

Venous Thrombectomy

- Revival of thrombectomy in the management of acute iliofemoral venous thrombosis.
  - 230 thrombectomy
  - No fatal PE
  - 1 operative mortality
  - Early & long-term patency 80% vs 30% of anticoagulated pts
    - Eklof B, Contemp Surg 1992

Venous Thrombectomy

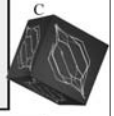
- AVF treatment guidelines for acute DVT
  - Accurate definition preoperatively of the extent of thrombosis, including routine contralateral iliocavography
  - Completion phlebography after thrombectomy to insure the adequacy of thrombectomy & examine residual venous lumen
  - Construction of a small arteriovenous fistula to increase velocity through a thrombogenic iliofemoral venous segment which assists in maintaining patency
  - Immediate & prolonged anticoagulation

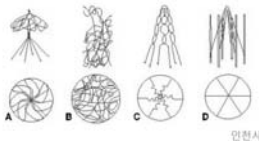
Treatment

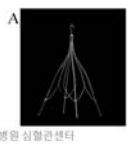
- **IVC filter**

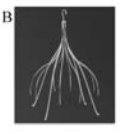
Inferior Vena Cava Filters

Permanent filter	Optional retrievable filter
Simon Nitinol (A) Bird's Nest (B) Greenfield (C) VenaTech (D) TrapEase	Gunther Tulip (A) Cook Celect Filter (B) OptEase (C) Recovery Filter









인천사랑병원 심혈관센터

Permanent IVC filter Indication

- Contraindication to anticoagulation
- Patients who experience a complication to anticoagulation treatment
- Recurrent PE
- DVT pts who have cancer, burns
- DVT during Pregnant
- High-risk surgical and trauma patients with a contraindication for anticoagulation

인천사랑병원 심혈관센터

Inferior Vena Cava Filter

- **Absolute** Indication
  - Contraindications to anticoagulation
  - Recurrent thromboembolism despite adequate anticoagulation
  - Complications of anticoagulations that have to be forced the therapy to be discontinued
  - Immediately after pulmonary embolectomy
  - Failure of another form of caval interruption, demonstrated by recurrent thromboembolism

Inferior Vena Cava Filter

- **Relative** indications
  - A large free-floating iliofemoral thrombus demonstrated on venography in a high-risk patient
  - Propagating ilio-femoral thrombus despite adequate anticoagulation
  - Chronic pulmonary embolism in a patient with pulmonary hypertension and cor pulmonale
  - Occlusion of more than 50% of pulmonary bed and would not be tolerate any additional thrombus
  - Recurrent septic embolism

Summary

- **IVC filters**
  - are *not considered* indicated for thrombolysis,
  - **strongly considered**
    - in case of loose (free-floating) thrombi or patients with poor cardiopulmonary reserve, **filter placement before thrombolysis or mechanical thrombectomy** should be strongly considered.

* Optimal or retrievable filters should be considered for this purpose.

Summary (cont'd)

- **CDT** for lower extremity DVT
  - are ***not esblished***,
  - **seriously considered**
    - patients with iliac and proximal femoral vein thrombosis, especially who are younger,
    - patients with thrombosis of short duration (less than 10 – 14 days)

Summary (cont'd)

- **Mechanical thrombectomy**
  - may turn out to shorten the treatment time
  - possibly decrease the risk of complications, but this remains to be proved
- **Endovascular stents**
  - are used almost only in the iliac veins

Highlights in Thrombolytic Management of DVT

- WHAT'S IN?
  - **Cather-directed thrombolysis**: **good effect** and **low rate of bleeding** complications
- WHATS'S OUT?
  - **Systemic thrombolysis**: because of **a high rate of bleeding complications**

Highlights in Thrombolytic Management of DVT

- WHAT'S NEW?
  - Pharmacomechanical thrombolysis:
    - is associated with **reduced thrombolysis time**
    - allows **aggressive treatment of underlying pathology**
- WHATS'S CONTROVERSIAL?
  - Aggressive thrombolysis combined with immediate treatment of underlying obstructions or other causes

Acute DVT

Studies
- Thrombolysis registry 1999
- **Cavent study 2012, 2016**
- PEARL registry 2015
- **Attract study 2013, 2017**
- VIDIO trial 2016

Guidelines
- SIR 2006
- SIR 2009
- SVS 2012
- AHA 2011
- ACCP 2012 9th
- **ACCP 2016 9th update**
- **ESC 2017**

CaVenT trial (2016)

- **Additional CDT resulted in a persistent and increased clinical benefit during follow-up for up to 5 years, supporting the use of additional CDT in patients with extensive proximal DVT**
- **However, allocation to this therapy did not lead to better quality of life**

ATTRACT trial (2017)


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Pharmacomechanical Catheter-Directed Thrombolysis for Deep-Vein Thrombosis

S. Vedantham, S.Z. Goldhaber, J.A. Julian, S.R. Kahn, M.R. Jaff, D.J. Cohen, E. Magnuson, M.K. Razavi, A.J. Comerota, H.L. Gornik, T.P. Murphy, L. Lewis, J.R. Duncan, P. Nieters, M.C. Derfler, M. Filion, C.-S. Gu, S. Kee, J. Schneider, N. Saad, M. Blinder, S. Moll, D. Sacks, J. Lin, J. Rundback, M. Garcia, R. Razdan, E. VanderWoude, V. Marques, and C. Kearon, for the ATTRACT Trial Investigators*

N Engl J Med 2017;377:2240-52.

ATTRACT Trial

- **recombinant tissue plasminogen activator (rt-PA) (Activase, Genentech, South San Francisco, CA)**
- **Good flow to popliteal vein**
  - **Isolated thrombolysis using Trellis**
  - **PowerPulse Thrombolysis using the AngioJet**
- **Pootr inflow to popliteal vein**
  - **Infusion-First Thrombolysis using a multisidehole catheter**
- **PTS, defined as a score of ≥5 on the Villalta PTS Scale**

Assessment	Baseline	Initial Tx	10 d	30 d	6 m	12 m	18 m	24 m
Leg pain (Likert)	X		X	X				
Leg circumference	X		X	X				
Venous QOL (VEINES)	X			X	X	X	X	X
General QOL (SF-36 version 2)	X			X	X	X	X	X
Duplex ultrasonography	X			X		X*		
Venogram (PCDT arm only)		X†						
Cost diary review			X	X	X	X	X	X
Villalta Scale to assess PTS	X		X	X	X	X	X	X
VCSS					X	X	X	X
CEAP classification					X	X	X	X

Abbreviations: VEINES, Venous insufficiency epidemiological and economic study; SF-36, short-form 36; VCSS, venous clinical severity score; CEAP, clinical-etiologic-pathophysiologic-anatomic classification.
* Performed in a subgroup of patients.

ATTRACT trial (2017)

- **Leg pain and swelling significantly improved** in PCDT vs no-PCDT out to **30 days** (p=0.019 and p=0.05)
  - In IFDVT mod-severe PTS
    18.4% vs 28.2% in PCDT vs no-PCDT
  - In FPDVT mod-severe PTS
    17.1% vs 18.1% in PCDT vs no-PCDT

ATTRACT trial

- **PTS** : 46.7% for PCDT vs 48.2% for no-PTCD (p=0.56)
- **Recurrent VTE** : 12.5% for PCDT vs 8.5% for no-PCDT (p=0.09)
- **Major** and ***any*** **bleeding** rates statistically higher in PCDT arm (**1.7% vs 0.3%** ; p=0.49 and ***4.5% vs 1.7%***; p=0.034)

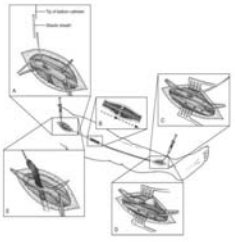
ATTRACT trial

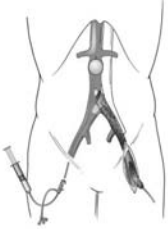
PCDT (pharmacomechanical catheter directed thrombolysis)

- Helpful for **acute symptoms**
- More benefit in **IFDVT**
- **Did not** result in a **lower risk of the PTS**
- Higher risk of **major bleeding**

Hybrid is non-inferior (2016)

- **novel single-incision approach that combines operative and endovascular techniques to maximize thrombus resolution.**





Hybrid is non-inferior (2016)

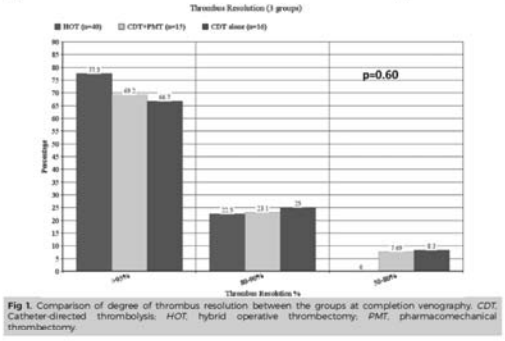


Fig 1. Comparison of degree of thrombus resolution between the groups at completion venography. *CDT*, Catheter-directed thrombolysis; *HOT*, hybrid operative thrombectomy; *PMT*, pharmacomechanical thrombectomy.

HOT thrombectomy established complete (≥ 95%) thrombus resolution more frequently than PT did (78% vs 67%; P = .11

Calf Vein Thrombosis (CVT)

Calf Vein Thrombosis (CVT)

- CVT usually do not cause major sequelae & high risk of PE
- But CVT can embolize, propagation to large veins substantially increases the risk of PE & post-thrombotic syndrome
- Propagation rate : 6-30%
- If not treated, recurrent VTE occurred in 30% of pts.
- 29% recurrent VTE in pts treated w/ 5 days IV heparin vs. no recurrence in pts receiving 3 mo of anticoagulation

Lagerstedt CI, Lancet 1985

Guideline

Acute DVT

Studies
- Thrombolysis registry 1999
- **Cavent study 2012, 2016**
- PEARL registry 2015
- **Attract study 2013, 2017**
- VIDIO trial 2016

Guidelines
- SIR 2006
- SIR 2009
- SVS 2012
- AHA 2011
- ACCP 2012 9th
- **ACCP 2016 9th update**
- **ESC 2017**

ACCP 9th update 2016

Outcomes	No. of Participants (Studies) Follow-up	Quality of the Evidence (GRADE)	Relative Effect (95% CI)	Anticipated Absolute Effects: Risk with Anticoagulation Alone	Anticipated Absolute Effects: Risk Difference with Catheter-Assisted Thrombus Removal (95% CI)
All-cause mortality	209 (1 study) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 0.43 (0.08-2.16)	46 per 1,000[c]	26 fewer per 1,000 (from 43 fewer to 54 more)
Recurrent VTE	189 (1 study) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 0.61 (0.3-1.23)[d]		Moderate-Risk Population[e]
				48 per 1,000	19 fewer per 1,000 (from 34 fewer to 12 more)
Major bleeding	224 (2 studies) 3 mo	⊕⊕⊖⊖ **Low**[a,b] because of imprecision	RR 7.69 (0.4-146.9)[d]		Moderate-Risk Population[e,f]
				29 per 1,000	194 more per 1,000 (from 17 fewer to 1000 more)
PTS	189 (1 study) 2 y	⊕⊕⊕⊖ **Moderate**[a] because of imprecision	RR 0.74 (0.55-1)[d]		Moderate-Risk Population[e]
				588 per 1,000	153 fewer per 1,000 (from 265 fewer to 0 more)[f]
Patency	189 (1 study) 6 mo	⊕⊕⊕⊖ **Moderate**[a] because of imprecision	RR 1.42 (1.09-1.85)	455 per 1,000[c]	191 more per 1,000 (from 41 more to 386 more)
QoL	189 (1 study) 24 mo	⊕⊕⊕⊖ **Moderate**[a] because of risk of bias			The mean quality of life in the intervention groups was 0.2 higher (2.8 lower to 3 higher)[g,h]

This new evidence has not led to a change in our recommendation for the use of CDT in patients with DVT since ACCP 2012

The CAVENT Study has reported that CDT reduced PTS, did not alter quality of life, and appears to be cost-effective

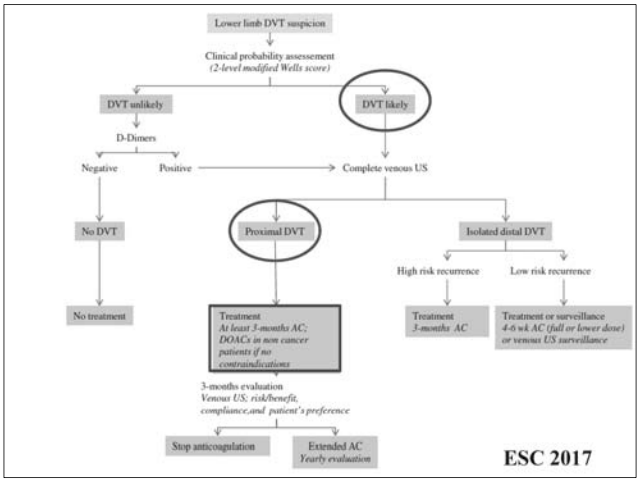
A retrospective analysis of CDT (3649 patients) was associated with increase in transfusion(2X), intracranial bleeding (3X), PE(1.5X), and vena caval filter insertion(2X)

CHEST 2016; 149(2):315-352

ACCP Guideline 2016

- **Catheter-Directed Thrombolysis** for **Acute DVT** of the Leg
  - In patients with **acute proximal DVT of the leg**, we suggest anticoagulant therapy alone over CDT (Grade 2C)
  - We propose that the patients who are most likely to benefit from CDT have
    - **Iliofemoral DVT**
    - **Symptoms for <14 days**
    - **Good functional status**
    - **Life expectancy of >1 year**
    - **Low risk of bleeding**

CHEST 2016; 149(2):315-352



Pregnancy

DVT in pregnancy

- Increased risk of VTE in pregnancy
- Warfarin – teratogenic
- LMWH until delivery

Malignancy

Anticoagulant therapy in pts with malignancy

- Risk of VTE : 11%, 2nd leading cause of death in pt w/ overt malignancy
- Recurrence rate is higher in pts w/ malignancy than without malignancy
- Bleeding complication is higher in pts c malignancy than without malignancy

- Anticoagulant therapy LMWH>VKA
- NOAC – no data availble
- Extended anticoagulation

Anticoagulant therapy in pts with brain tumors

- High risk of VTE : 7.5~25%
  - esp., age≥60 years, glioblastoma, large tumor size, subtotal resection, use of chemotherapy, neurosurgery ≤ 2 mo, leg paresis
- Risk of bleeding: 2~4% in pts w/ glioma,
  - esp., pituitary adenoma, metastatic tumor from melanoma, choriocarcinoma, thyroid ca., renal cell ca.
- Anticoagulant therapy LMWH>VKA

Prophylaxis

DVT: Prophylaxis

	Calf DVT	Proximal DVT	Fatal PE
High risk	**40-80%**	**10-30%**	**>1%**
• Surgical patients with history of venous thromboembolism			
• Major pelvic or abdominal surgery for malignancy			
• Major trauma			
• Major lower limb orthopedic surgery			
Moderate risk	**10-40%**	**1-10%**	**0.1-1%**
• Geberak surgery in patients >40 years			
• Patients on oral contraception			
• Neurosurgical patients			
Low risk	**<10%**	**<1%**	**<0.1%**
• Uncomplicated surgery in patients <40 years without any other risk factors			
• Minor surgery in patients >40 years without any other risk factors			

DVT: Prophylaxis

- **Pharmacologic**
  - UFH
  - LMWH
  - Fondaparinux
  - Oral direct thrombin inhibitor
  - Factor Xa inhibitor
  - VKA
  - Aspirin
- **Mechanical**
  - Intermittent pneumatic compression

Summary

Therapeutic Goals of DVT Treatment

- **Relieve the patient's symptoms**
- **Prevent further thrombus propagation**
- **Prevent pulmonary embolism & CTEPH**
- **Prevent DVT recurrence**
- **Prevent postthrombotic syndrome**

Varicose Vein

제주 수 흉부외과의원

이 길 수

Hemodialysis and Vascular Access

Incheon St. Mary's Hospital, The Catholic University of Korea

김 도 연

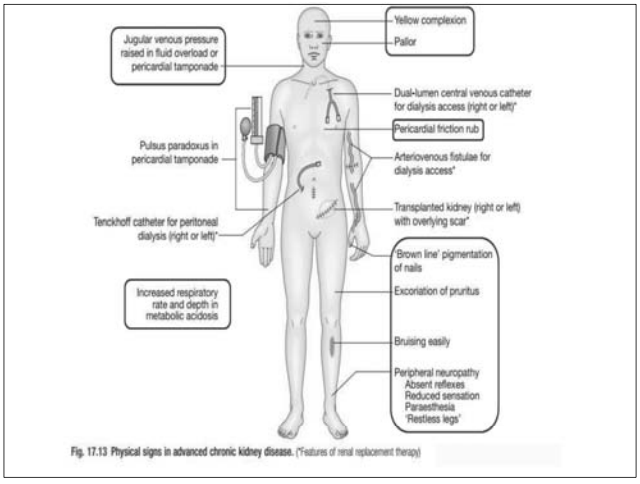
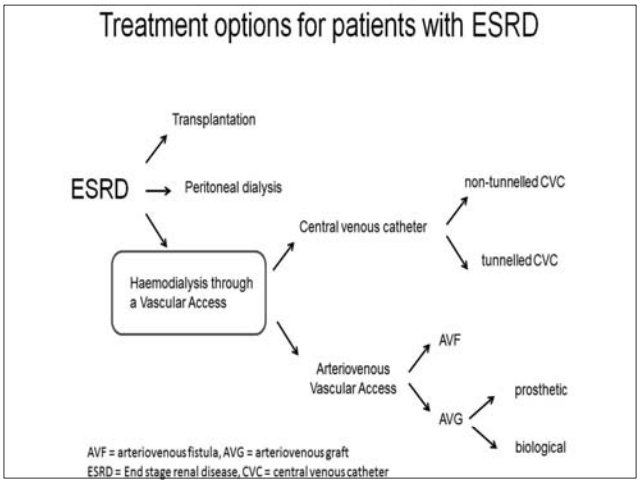
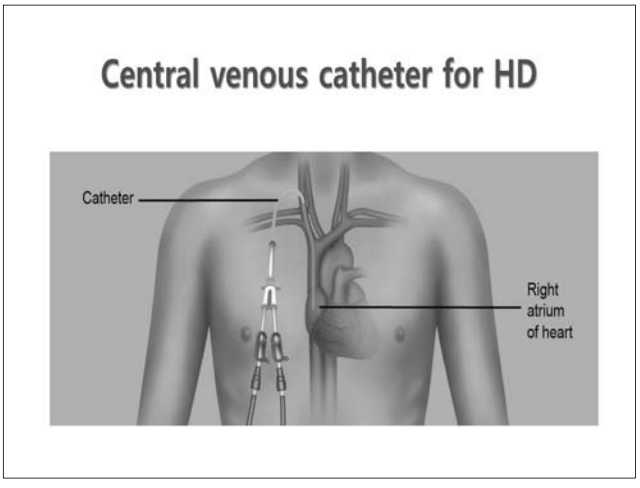


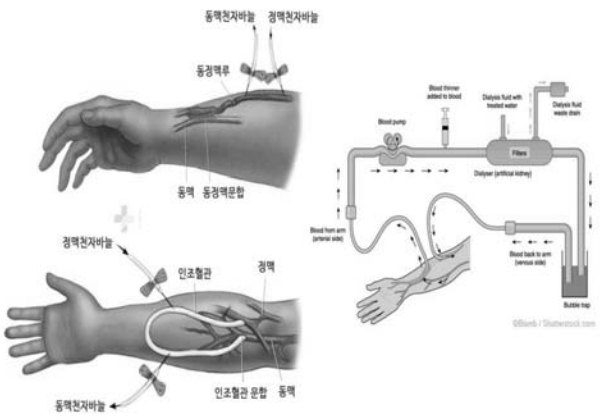
Fig. 17.13 Physical signs in advanced chronic kidney disease. (*Features of renal replacement therapy)

Table 3. Classification of chronic kidney disease based on glomerular filtration rate (GFR).[8–11]

	Stage	Description	GFR mL/min/1.73 m^2
	Stage 1	Kidney damage with normal or elevated GFR	90+
	Stage 2	Kidney damage with mildly decreased GFR	60–89
	Stage 3	Moderately decreased GFR	30–59
투석준비단계 ➡	Stage 4	Severely decreased GFR	15–29
투석시작단계 ➡	Stage 5	End stage renal disease (ESRD)	<15 or on dialysis







Vascular access(VA, 혈관접근)

- **For hemodialysis**
  ; Blood flow at least 300ml/min, preferably 500ml/min.
- **Central venous catheters (CVC)**
  ; Acute HD, or as bridging VA
- **Arterialization of a vein(AVF, arterio-venous fistula)**
  ; Autogenous anastomosis between artery and vein
- **Interposition of a graft between an artery and a vein(AVGs, arteriovenous grafts)**
  ; VA using a prosthetic graft

Advantages and Disadvantages of CVC for HD

Advantages	Disadvantages
• Universally applicable • Variety sites for placement • Immediately available for use • Low cost	• Thrombosis • Infection • Central venous stenosis or occlusion • Low patient satisfaction • Lower blood flow rate, long dialysis time → Risk of morbidity & mortality

투석혈관접근 과정

신장내과 협진 → 문진 및 초음파검사를 통한 혈관 및 수술방법 결정 (수술 부위, 자가 or 인조혈관, 손목 or 상완..., AVF or AVG, basilic vein transposition...) → 수술시행(국소 or 부위마취...) (Flow check, thrill, bruit...) → 투석가능여부 확인 후 투석시작 (Maturation, 협착부위, 상처 확인)

Choice of type of vascular access

- **Ideal VA**
  ; Resistant to infection and thrombosis, minimum adverse events

- **First option** : *Distal autogenous AVF* in the non dominant arm.
  - Lower incidence of postoperative complications and fewer endovascular and surgical revision for AVF failure

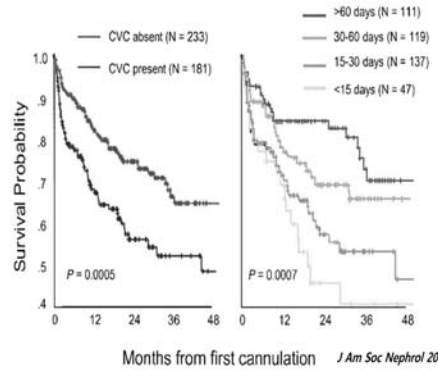
- **Next options** : *Prosthetic AVG* and *CVC(central venous catheter)*
  - Higher morbidity and mortality in CVCs(infection...)

Time of referral for VA surgery

- Importance for the outcome of the VA.
- Early referral → More well functional autogenous AVFs
- Late referral → Non-maturation and need for a CVC
- **Risk factors of AVF failure**
  - HD initiation with CVC, long AVF maturation time
  - Cardiovascular disease
  - Early cannulation

- The knowledge and experience of the VA surgeon is of importance in creating predominantly AVFs and has a major impact on the outcome of surgery.

Kaplan-Meier curves of time to AVF failure

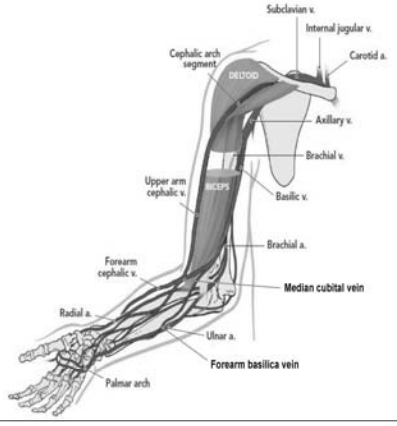


J Am Soc Nephrol 2004;15:204 e9. Ravani et al.

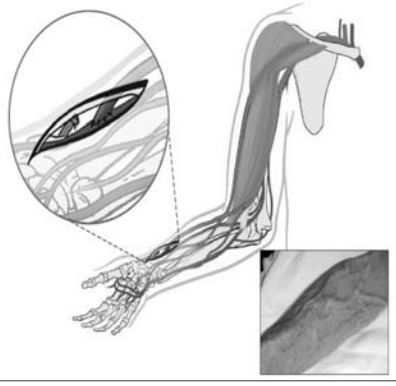
Primary option for vascular access (1)

- Autogenous arteriovenous fistula.
- **The first choice for VA creation** : ***Radiocephalic AVF (RCAVF)***
- **Advantages**
  - Minimum of complications, revisions and hospital admissions
- **Non-dominant arm**
- **A minimum internal vessel diameter**
  - ***Radial artery and cephalic vein*** : *2.0mm* using tourniquet
    → Successful fistula creation and maturation
  (Brachiobasilic (BBAVF) AVFs ; 3.0mm in artery and vein)

Anatomy of Upper Extremity Vessels



Radiocephalic AVF (RCAVF)



Disadvantages of AVF

- **Risk of early thrombosis and non-maturation**
  → Access failure
  (17% mean early failure rate, up to 45%)
  → One year patency from 52% to 83%
- **Old age** : Maturation failure

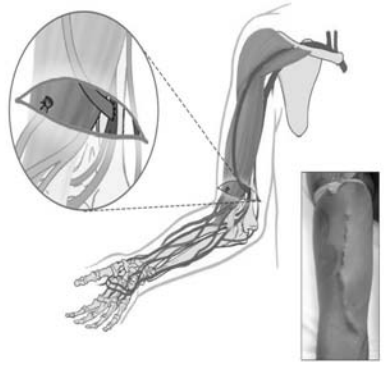
Table 5. Early failure and one year secondary patency rate of the radiocephalic AVF.

Reference	No. RCAVF	Early failure (%)	Secondary patency (%)
Silva et al.[59]	108	26	83
Golledge et al.[60]	107	18	69
Wolowczyk et al.[61]	208	20	65
Gibson et al.[62]	130	23	56
Allon et al.[63]	139	46	42
Dixon et al.[64]	205	30	53
Ravani et al.[65]	197	5	71
Rooijens et al.[66]	86	41	52
Biuckians et al.[67]	80	37	63
Huijbregts et al.[26]	649	30	70

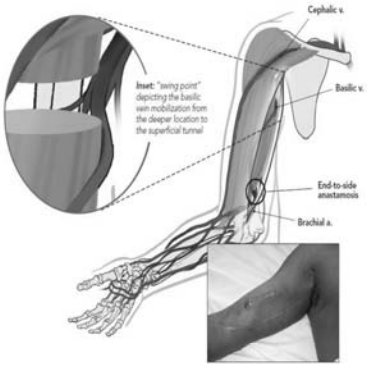
Primary option for vascular access (2)

- **Brachial artery based AVFs**
  ; BCAVF(brachiocephalic AVF) and BBAVF(Brachiobasilic AVF)
- **High access flow**
- **Good one year patency**
- **Low incidence of thrombosis** (0.2 events per patient/year) and **infection** (2%)
- **Reduced distal arterial perfusion and cardiac overload**
  → Risk of Steal syndrome ↑
- **Basilic vein transposition (BVT)** (upper or forearm)

Brachiocephalic AVF(BCAVF)



Transposed Basilic Vein AVF(BBAVF)



Variables and outcome of AVF

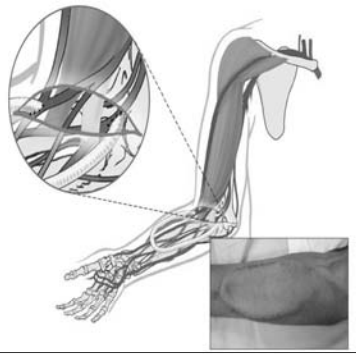
- **Age**(>65 years old)
- **DM**
- **Female**(smaller vessels, poor maturation and low long-term patency, more revision and AVG)
- **PAOD**
- **Obesity**
- **CCB, aspirin, ACEi** ; Better AVF, AVG patency
- **Anastomosis length** : Donor artery size↓→ failure ↑

Secondary options for vascular access

- **AVG VA with**
  - 4-6mm tapered or 6mm PTFE(polytetrafluoroethylene) graft
  - Biological material (ovine graft/Omniflow)
- **AVG**
  - Primary patency ; 1yr (40~50%), 2yr(20~30%)
  - Secondary patency : 1yr (70~90%), 2yr(50~70%)
  - Neointimal proliperation
  - Multiple intervention (outcome ↑)
  - Elderly patients may benefit
- **Minimum outflow vein diameter** : 4mm

Forearm Loop AVG

- **Anastomosis site**
  : Brachial artery
  to antecubital vein
  to cephalic vein
  to basilica vein
  to brachial vein



Pre-operative assessment

- **History and physical examination**
- **Duplex ultrasound(DUS)**
- **Digital subtraction angiography (DSA)**

History and physical examination

- **Hand dominance**
- **Previous vascular access**
  ; Central venous catheters, peripherally inserted central catheter, pacemaker, defibrillator)
- **Upper and lower extremity venous thrombosis, hand ischemia**
- **Pulmonary hypertension or heart disease**

- **Skin conditions** : Dryness, redness and infection.
- **Upper arm swelling** (Central vein stenosis)
- **Hemiplegia** (Create VA on the paralytic side).
- **Contracture of the elbow joint**

Duplex ultrasound sonography

- **Venous mapping** (depth and VA site)
  ; Measure artery and vein diameters and stenotic lesions

- **Evaluation of maturation**(flow and diameter check)

- **The first line imaging method in suspected VA dysfunction after VA creation**
  (eg. Stenosis or thrombosis)

Digital subtraction angiography

- Previous CVCs additional preoperative imaging of the central veins should be performed.

- Significant peripheral vascular disease and suspected proximal arterial stenosis

Creation of Vascular Access
- Technical aspects

- Venous preservation
- Arm exercise : Improve artery and vein diameters
- Pre or peri operative hydration
- Prophylactic antibiotics
  ; Cephalosporin, amoxycillin/clavulanic acid or a glycopeptide
- Anesthesia : Local or regional anesthesia
- Peri-operative anticoagulation : heparin ?
- Arteriovenous fistula configuration
  ; End to side (vein to artery) anastomosis

Summary of surgical techniques (1)

- **AVF** ; *Most distal site possible*

- **Proximal AVFs** : Lower initial failure & better patency
  → Steal syndrome ↑, less comfortable

- **Arterial & venous diameters** : More than 2 mm

- **Non-dominant arm**

- **Pacemaker or CVC** : Contralateral side

Summary of surgical techniques (2)

- **1st choice** : *RCAVF*
- **2nd choice**
  : Young patients
  → BCAVF(any vein is ok~) or basilica vein transposition, AVG
  : Old patients
  → BCAVF or AVG
- **The number of re-interventions** : Significantly higher in AVGs
- **Choice of graft** : 4-6mm tapered ePTFE or 6mm ePTFE
  → Can be use after 1~2 week(4 weeks)

Peri-operative assessment

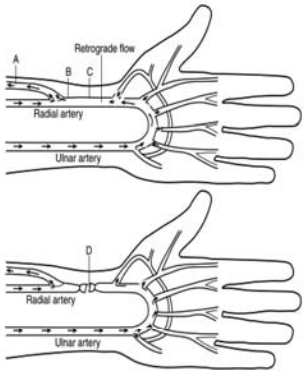
- Should be a *palpable thrill* or, at least an *audible bruit*
- ***The absence of a bruit*** ; Something wrong
  → A good predictor of early AVF thrombosis or occlusion
- ***Flow meter check***
  ; Radio-cephalic fistula : about 300mL/min
  ; AVG on brachial or BCAVF : 700~1000mL/min

Peri-operative complications

- **Hemorrhage**
- **Post-operative infection**
- **Non-infected fluid collections**
- **Vascular access induced limb ischemia :** 4~9% (Stage 3, 4)
- **Early thrombosis**

AVF and Steal syndrome

	VA induced ischemia
Stage 1	Slight coldness, numbness, pale skin, no pain
Stage 2	Loss of sensation, pain during HD or exercise
Stage 3	Rest pain
Stage 4	Tissue loss affecting the distal parts of the limb, usually the digits



Access maturation and care

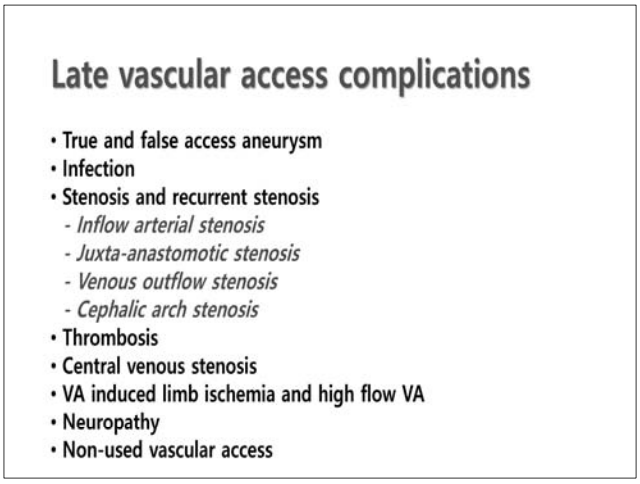
- **AVF** : Preferably *4~6 weeks*
- **AVG** creation : *2~4 weeks*
- Check points, "*Rule of 6s* "
  (1) Bruit and thrill
  (2) Adequate venous diameter ; > 6mm
  (3) Adequate length and depth ; < 6mm
  (4) Adequate volume flow ; > 600 ml/min

Management of maturation failure

- **The most common causes**
  ; Venous, arterial or anastomotic stenosis
  → Intervention(balloon angioplasty), surgical revision
  ; Competing veins or large patent branches
  → Branch ligation
  ; Excessive depth from the skin
  → Superficialisation
- **Hand-arm exercise**

Anticoagulation therapy

- **Reduce thrombosis but no long term benefits.**
- **Case by case....**
  ; Aspirin, clopidogrel, cilostazol, warfarin, berasil
- **Omega-3 fatty acids** (fish oil) in improving VA function or maturation


Late vascular access complications
• True and false access aneurysm
• Infection
• Stenosis and recurrent stenosis
- Inflow arterial stenosis
- Juxta-anastomotic stenosis
- Venous outflow stenosis
- Cephalic arch stenosis
• Thrombosis
• Central venous stenosis
• VA induced limb ischemia and high flow VA
• Neuropathy
• Non-used vascular access

【특 강】

흉부외과 의사의 사회 / 해외 봉사

서울대학교병원 흉부외과학교실

김 응 한

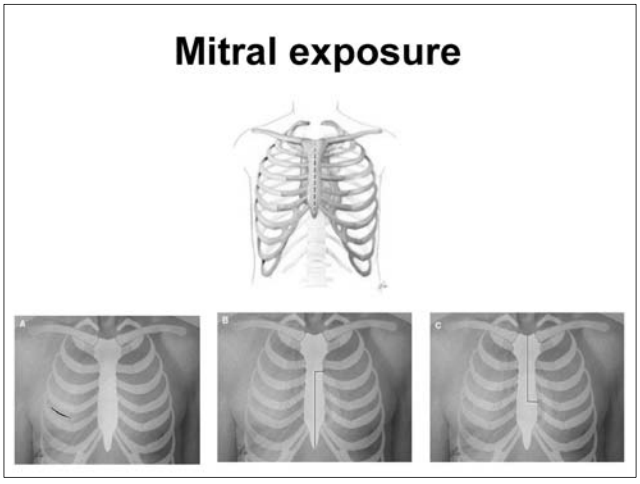
【성인심장파트】

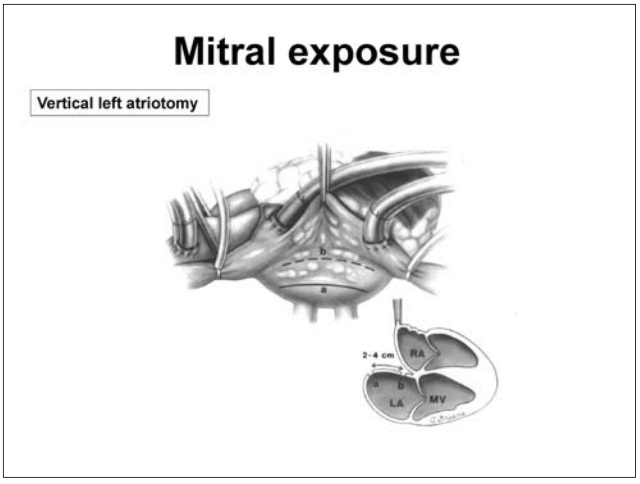
좌장: 조민섭

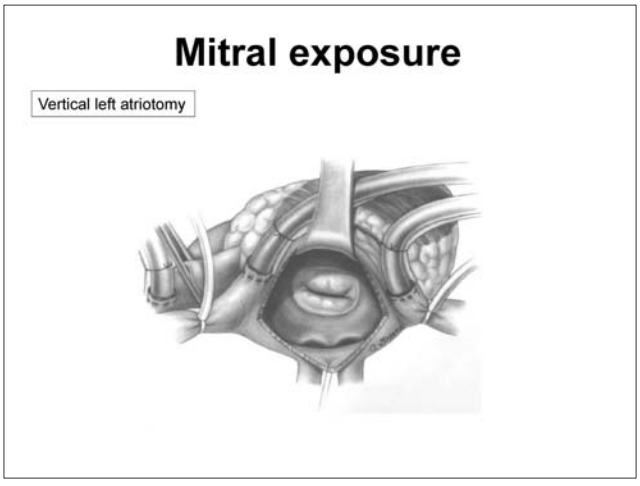
Indication and Techniques of Mitral Valve Surgery

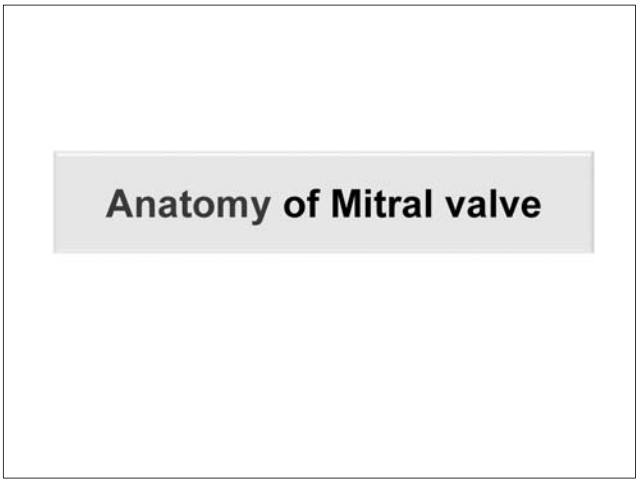
경북대학교병원 흉부외과학교실

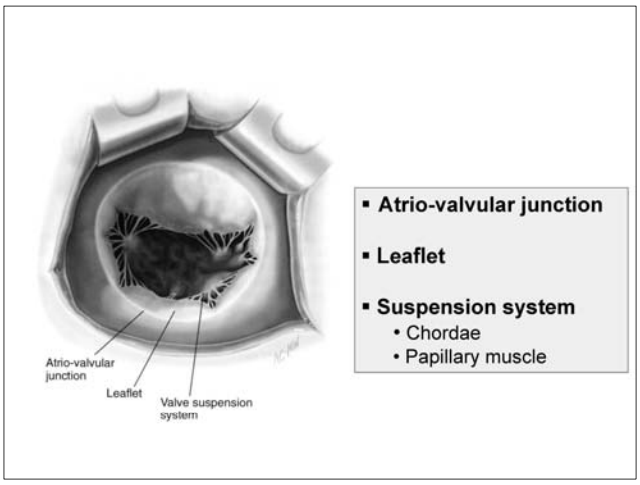
김 근 직

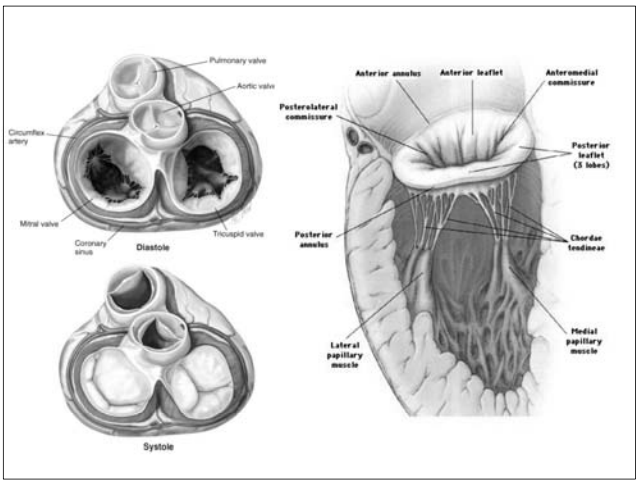


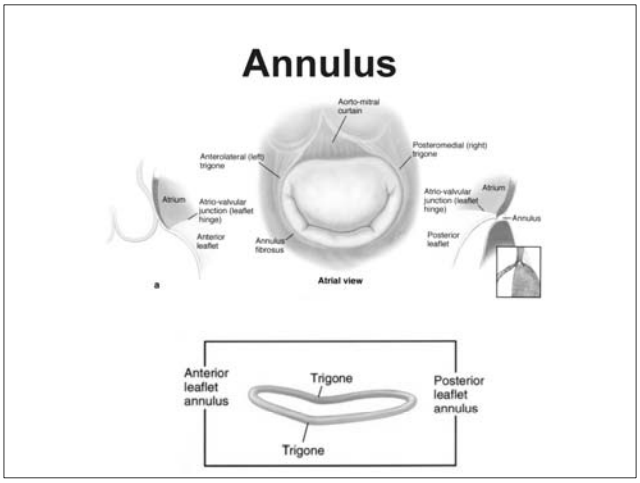


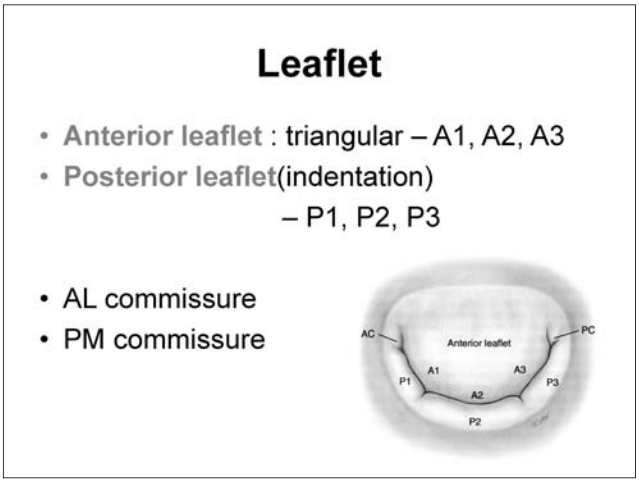


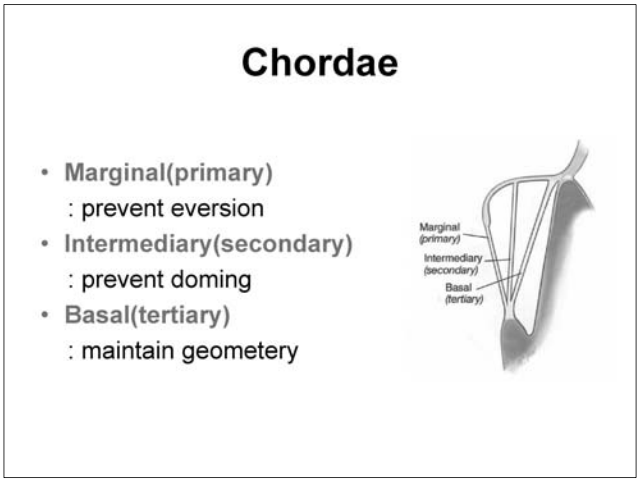


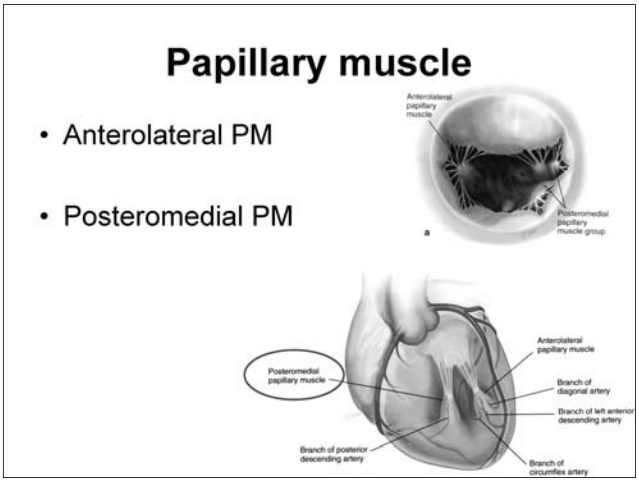

Atrio-valvular junction
Leaflet
Valve suspension system
▪ Atrio-valvular junction
▪ Leaflet
▪ Suspension system
• Chordae
• Papillary muscle


Pulmonary valve
Aortic valve
Circumflex artery
Mitral valve
Coronary sinus
Tricuspid valve
Diastole
Systole
Anterior annulus
Anterior leaflet
Anteromedial commissure
Posterolateral commissure
Posterior leaflet (3 lobes)
Posterior annulus
Chordae tendineae
Lateral papillary muscle
Medial papillary muscle


Annulus
Aorto-mitral curtain
Anterolateral (left) trigone
Posteromedial (right) trigone
Atrium
Atrio-valvular junction (leaflet hinge)
Anterior leaflet
Annulus fibrosus
Posterior leaflet
Annulus
Atrial view
Anterior leaflet annulus
Trigone
Posterior leaflet annulus
Trigone


Leaflet
• Anterior leaflet : triangular – A1, A2, A3
• Posterior leaflet(indentation)
– P1, P2, P3
• AL commissure
• PM commissure
AC
PC
Anterior leaflet
A1
A3
P1
P3
A2
P2


Chordae
• Marginal(primary)
: prevent eversion
• Intermediary(secondary)
: prevent doming
• Basal(tertiary)
: maintain geometery
Marginal (primary)
Intermediary (secondary)
Basal (tertiary)

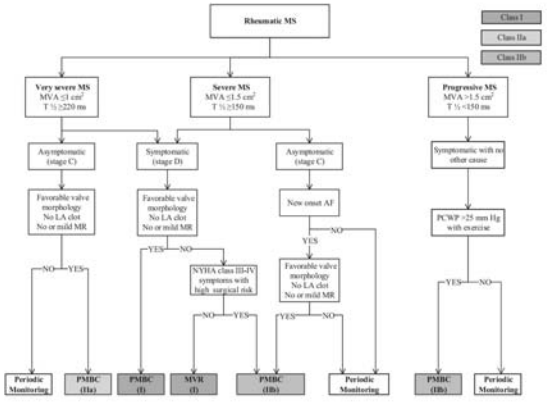

Papillary muscle
• Anterolateral PM
• Posteromedial PM
Anterolateral papillary muscle
Posteromedial papillary muscle group
Posteromedial papillary muscle
Anterolateral papillary muscle
Branch of diagonal artery
Branch of left anterior descending artery
Branch of posterior descending artery
Branch of circumflex artery

Mitral valve replacement

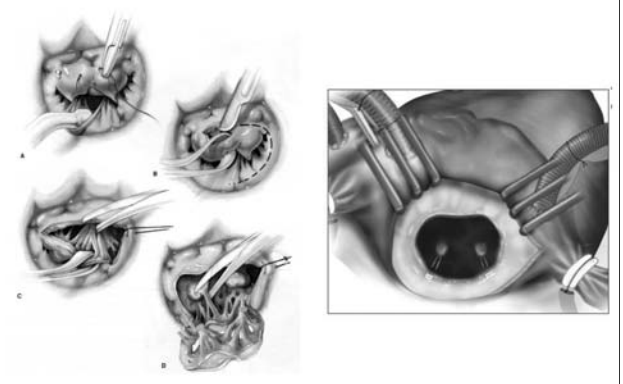
- ✓ **Mitral stenosis**
- ✓ **Mitral regurgitation**

Mitral stenosis

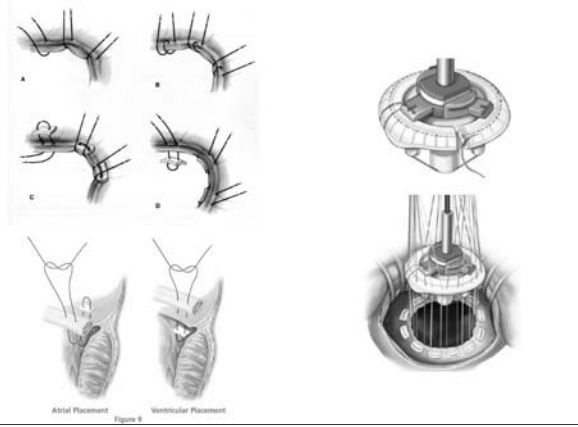
ACC/AHA 2014 guideline



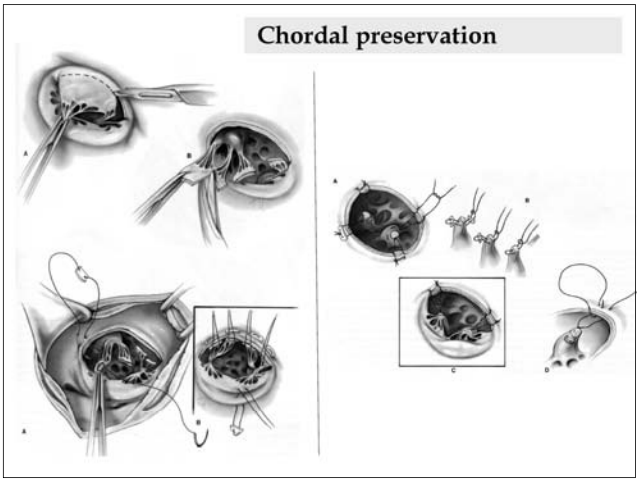
Mitral valve excision



Valve suture insertion



Chordal preservation

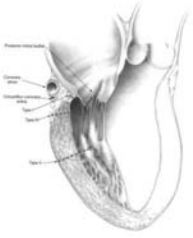


Complications after MV Replacement

- Thromboembolism
- Hemorrhage
- Endocarditis
- Arrhythmias
- Prosthesis malfunction
- Late cardiac failure
- LV rupture: untethered loop theory

Left Ventricular Rupture

- Cause
  - High profile tissue valve
  - Lesser subvalvular apparatus
  - Injuries during operation



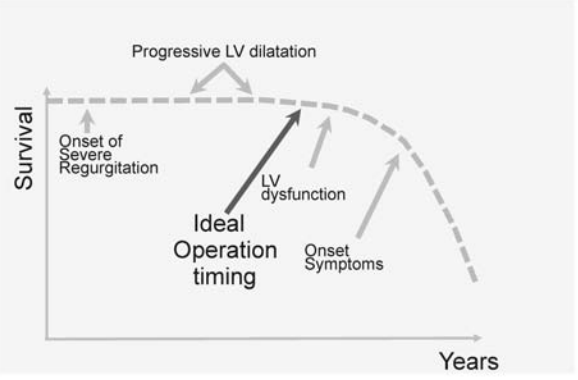
→ Should maintain **annulopapillary continuity**

Mitral valve repair

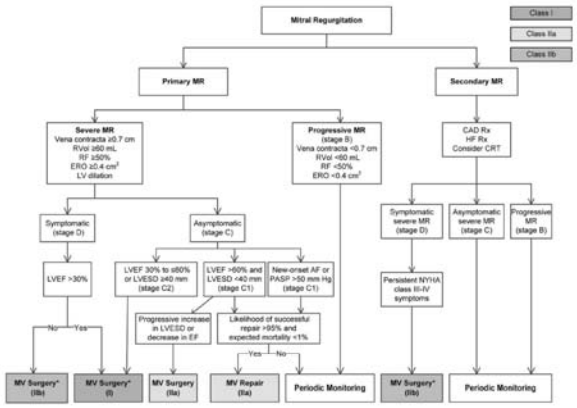
✓ **Mitral regurgitation**
✓ **Mitral stenosis**

Mitral regurgitation

Natural History



ACC/AHA 2019 guideline

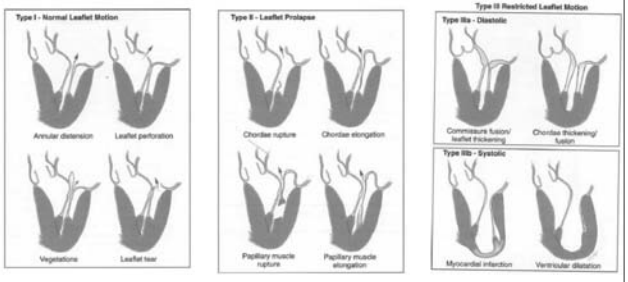


Reconstructive Valve Surgery
Three Fundamental Principles

1. Preserve or restore full leaflet motion
2. Create large surface of coaptation
3. Remodel the annulus

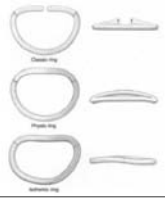
A. Carpentier. JTCS 1983;86(3):323-37

Carpentier's Classification



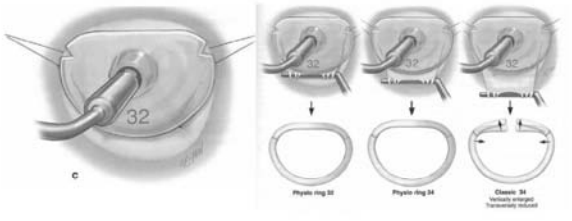
Annuloplasty ring

- Complete vs incomplete
  - Incomplete
    - Usually posterior annular dilatation
    - Leaflet repair itself reduce annular circumference
    - Difficult visualization of anterior annulus
  - Complete
    - Functional MR(to reduce annular circumference)
- Rigid, Semi-rigid, Flexible
  - Flexible ring
    - Physiologic movement of MV annulus
    - Valve distorsion or orifice narrowing
  - Rigid ring : more prone to produce SAM
- Adjustable vs fixed



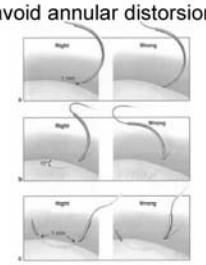
Ring sizing

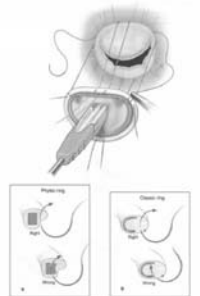
- Measurement of anterior leaflet
- Commissure to commissure
- Height of anterior leaflet : partial ring?



Annuloplasty suture

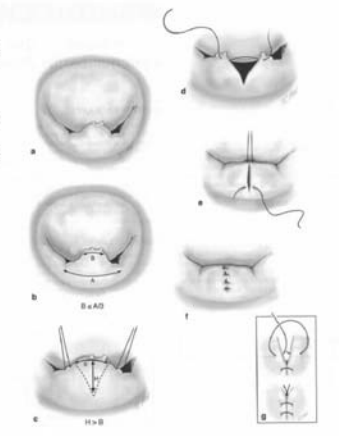
- Suture within the annulus fibrosus
  - to avoid ring dehiscence
- Not to suture metallic core of ring
  - to avoid annular distorsion





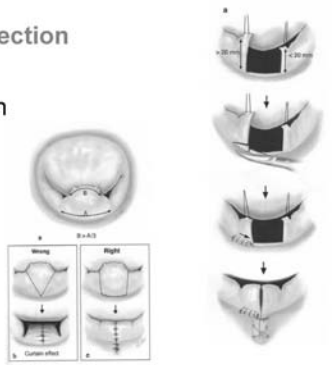
Pos

- Triangular re
  : <1/3 of segme



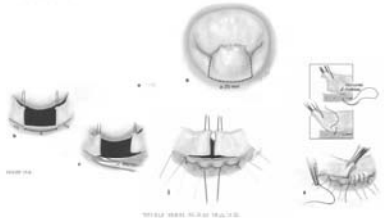
Posterior prolapse

- Quadrangular resection
  : >1/3 of segment
  Annular plication



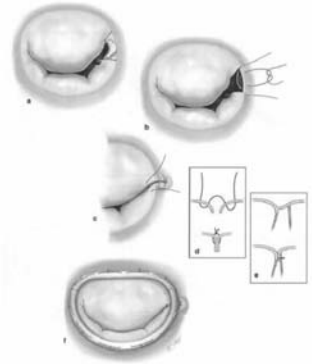
Posterior prolapse

- Quadrangular resection+sliding annuloplasty
  : >30mm
  Prevent SAM
  Compression suture



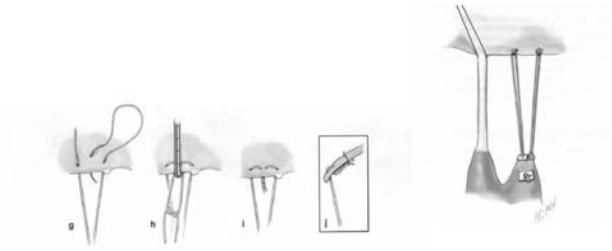
Commissural prolapse

- Commissural plication
- Triangular resection



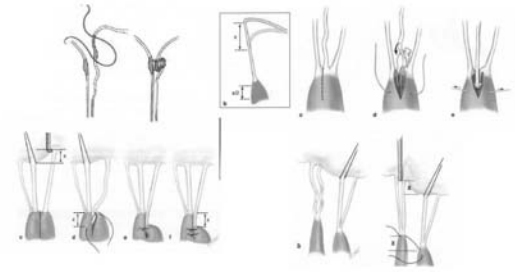
Anterior prolapse

- Long-term results : posterior>>anterior
- Artificial chordae implantation



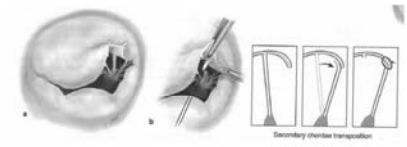
Anterior prolapse

- Chordae shortening
- Papillary muscle sliding plasty



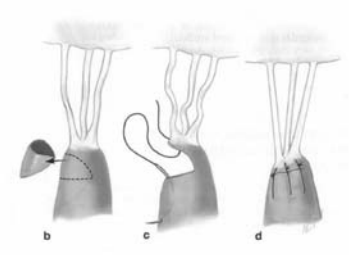
Anterior prolapse

- Chordae transfer
  - 2ndary chordae
  - Posterior chordae



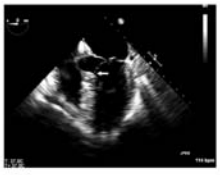
Anterior prolapse

- Papillary muscle shortening



SAM(Systolic Ant Motion)

- depend on hemodynamic status
- Risk factors
  - **Excess valvular tissue**
  - **Undersized annuloplasty**
  - Narrow aorto-mitral angle
  - Hyperkinetic small ventricle
  - Septum bulging
  - Abn. Configuration of Ant. leaflet

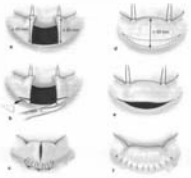


SAM-Medical Therapy

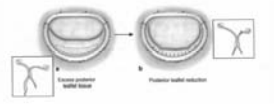
- Usually associated with
  - Hypotension
  - Hypovolemia
  - Small ventricular cavity
  - Ventricular hypertrophy
  - Hyperdynamic state(eg, catecholamine)
- Treatment
  - Withdrawal of inotrops
  - Volume loading
  - Slowing heart rate
  - Increased afterload

SAM-Repair Technique

- Larger annuloplasty ring
  Band >> complete ring
  Flexible >> rigid ring

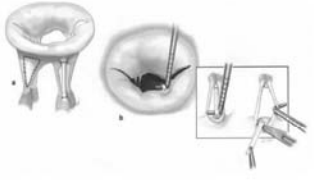


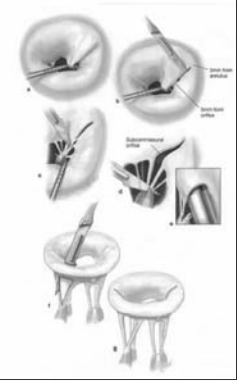
- Sliding annuloplasty:
  : posterior leaflet height ↓
- Pomeroy procedure: ant. leaflet resection
- Transaortic septal myectomy



Rheumatic MV disease

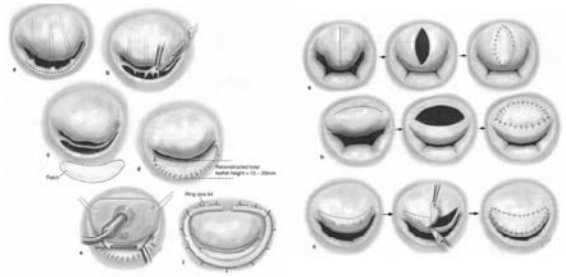
- Commissurotomy
- 2ndary chordae resection
- Not good result
  in severe deformity valve





Rheumatic MV disease

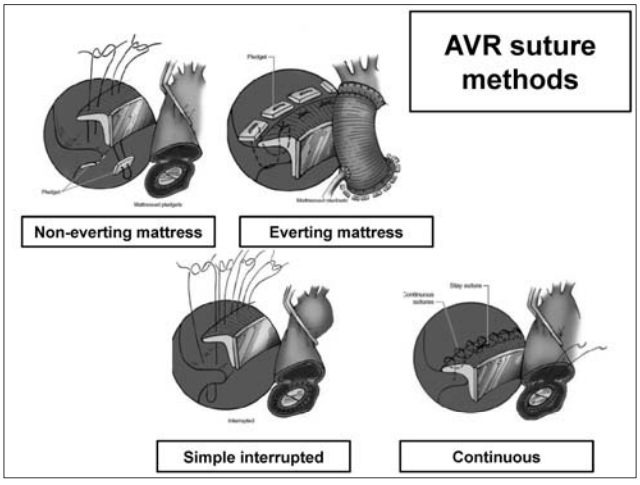
- Leaflet extension : pericardium

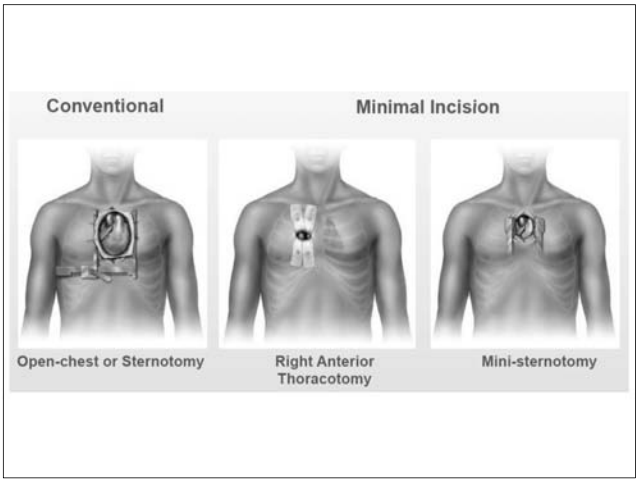


Indication and Techniques of Aortic Valve Surgery

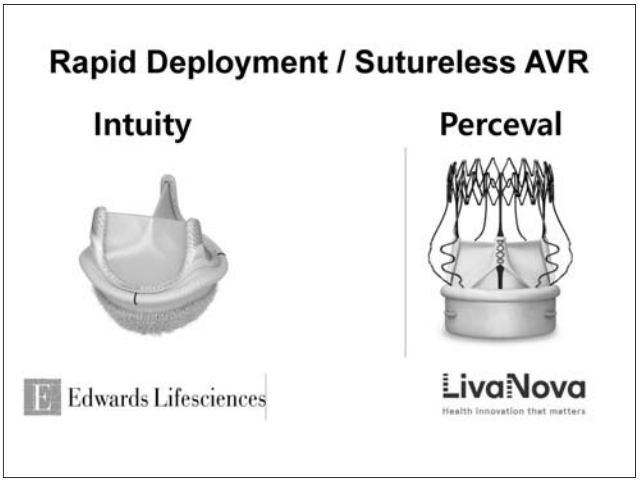
Department of Thoracic and Cardiovascular Surgery,
Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

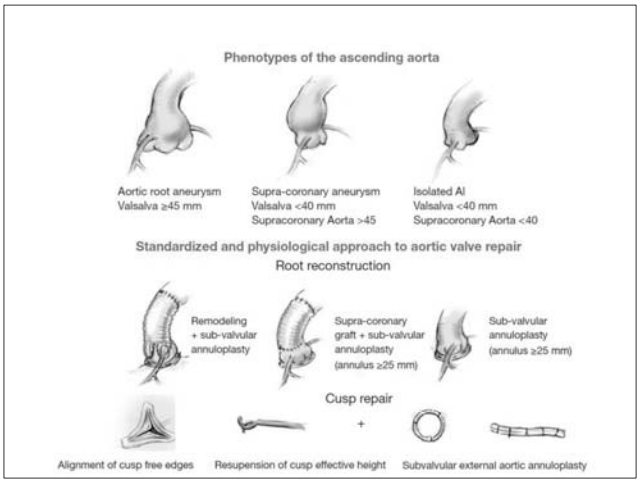
Joon Bum Kim, MD, PhD

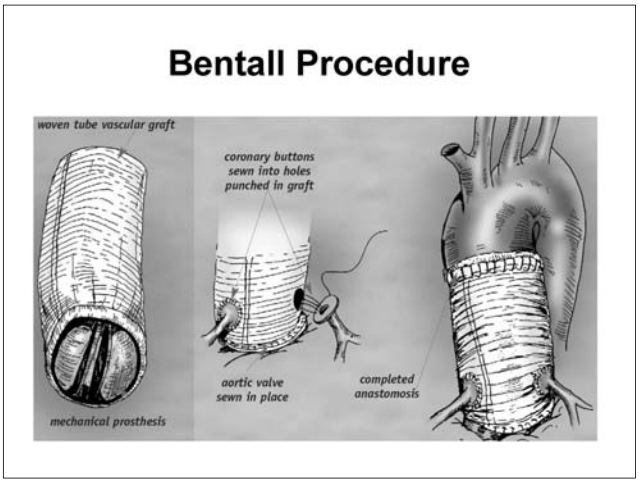


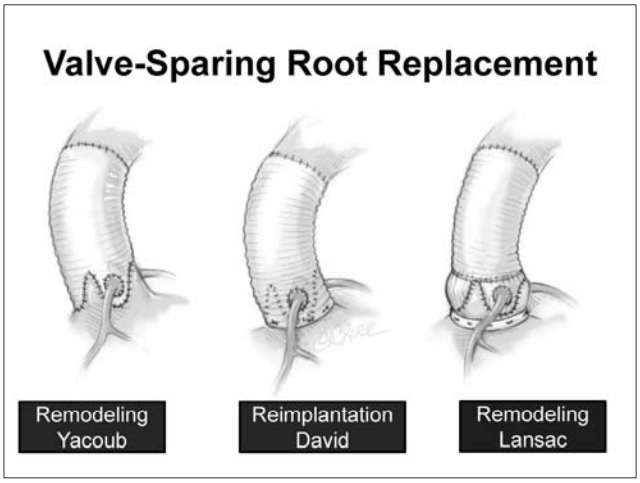


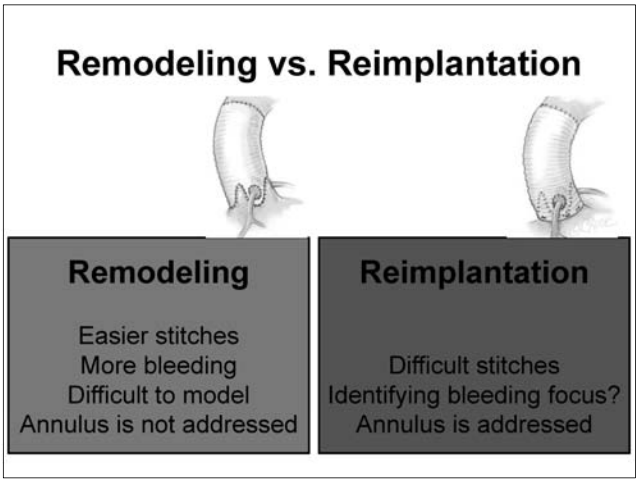
Rapid Deployment / Sutureless AVR

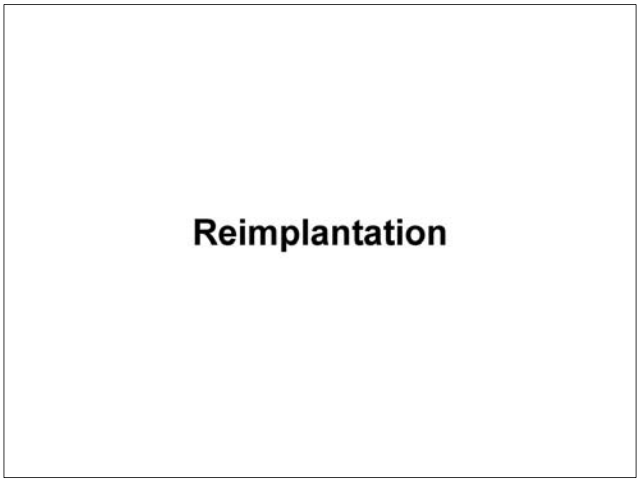


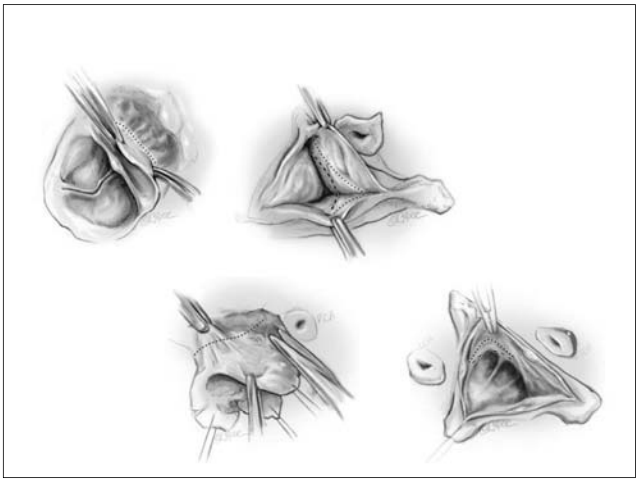

Phenotypes of the ascending aorta
Aortic root aneurysm
Valsalva ≥45 mm
Supra-coronary aneurysm
Valsalva <40 mm
Supracoronary Aorta >45
Isolated AI
Valsalva <40 mm
Supracoronary Aorta <40
Standardized and physiological approach to aortic valve repair
Root reconstruction
Remodeling
+ sub-valvular
annuloplasty
Supra-coronary
graft + sub-valvular
annuloplasty
(annulus ≥25 mm)
Sub-valvular
annuloplasty
(annulus ≥25 mm)
Cusp repair
+
Alignment of cusp free edges
Resuspension of cusp effective height
Subvalvular external aortic annuloplasty

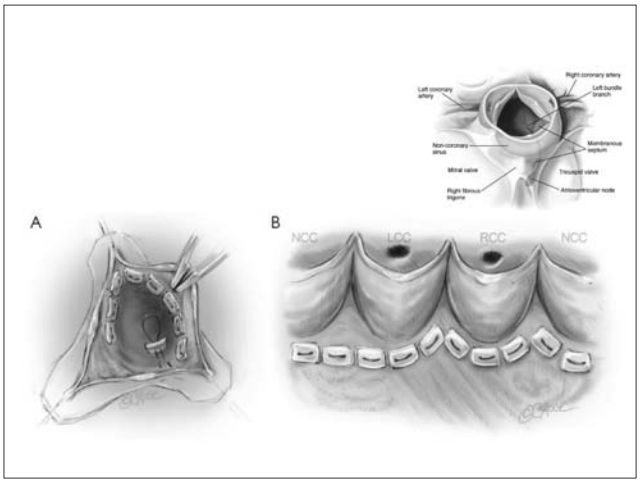

Bentall Procedure
woven tube vascular graft
coronary buttons
sewn into holes
punched in graft
aortic valve
sewn in place
completed
anastomosis
mechanical prosthesis

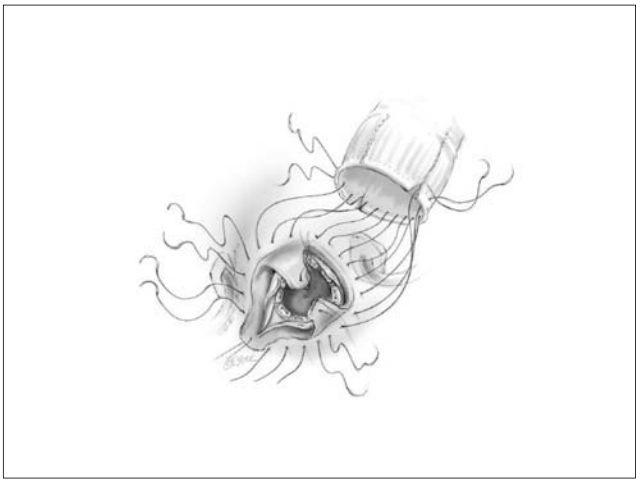

Valve-Sparing Root Replacement
Remodeling
Yacoub
Reimplantation
David
Remodeling
Lansac

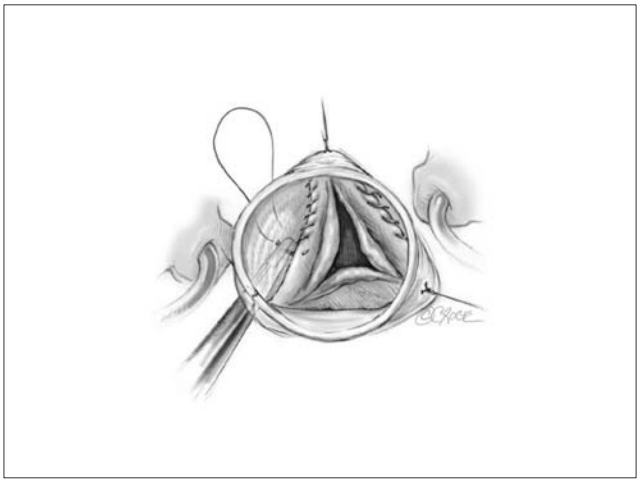

Remodeling vs. Reimplantation
Remodeling
Easier stitches
More bleeding
Difficult to model
Annulus is not addressed
Reimplantation
Difficult stitches
Identifying bleeding focus?
Annulus is addressed

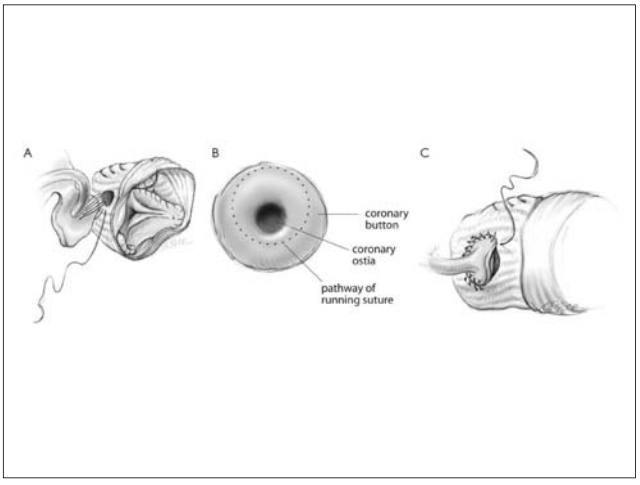

Reimplantation











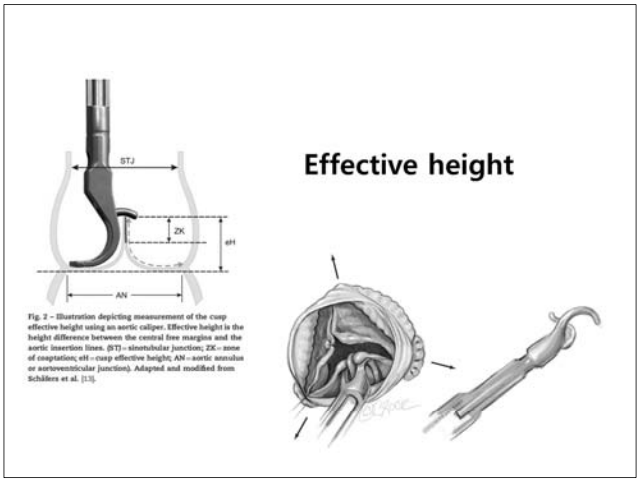
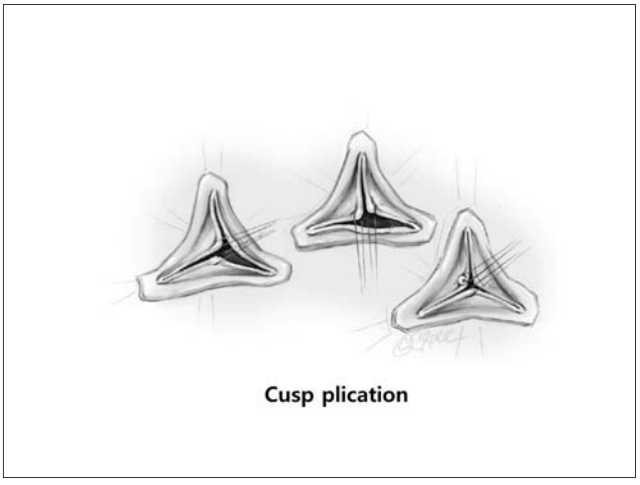
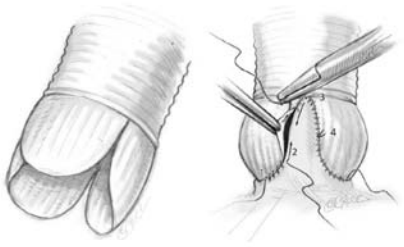


Fig. 2 – Illustration depicting measurement of the cusp effective height using an aortic caliper. Effective height is the height difference between the central free margins and the aortic insertion lines. (ST) – sinotubular junction; ZK – zone of coaptation; eH – cusp effective height; AN – aortic annulus or aortoventricular junction). Adapted and modified from Schäfers et al. [13].



Remodeling



Surgical Indication: AS

Severe AS AND

HF
Angina
Syncope / presyncope
Symptom (+)

OR

LVEF < 50%

AVA ≤1.0cm²
Ao Vmax ≥ 4m/s
Mean PG ≥ 40mmHg

Surgical Indication: AS

Severe AS BUT

Symptom (-)

AND

LVEF ≥ 50%

Maybe considered
if low surgical risk + rapid progression
(Class IIb)

Surgical Indication: AS

Severe AS BUT

Symptom (-)

AND

LVEF ≥ 50%

Reasonable
if (+) Exercise test results
(Class IIa)

Surgical Indication: AR

Severe AR AND

HF
Angina
Symptom (+)

OR

LVEF < 50%

- Jet width ≥ 65% of LVOT
- Vena contracta>0.6cm
- ERO ≥ 0.3cm²
- Holo-diastolic flow reversal in proximal abdominal aorta

Surgical Indication: AR

Severe AS BUT

Symptom (-)

AND

LVEF ≥ 50%

Reasonable
if (+) LVESD > 50mm
(Class IIa)

Selection of Valve Prostheses

가톨릭대학교 성빈센트병원 흉부외과학교실

조 민 섭

Tricuspid Valve Disease / Infective Endocarditis

Department of Thoracic & Cardiovascular Surgery, Seoul National Univ. Bundang Hospital

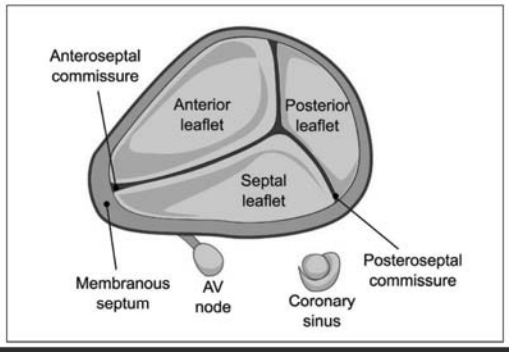
Jae Hang Lee, MD, PhD

SNUH 분당서울대학교병원

Tricuspid valve disease

SNUH 분당서울대학교병원

Anatomy



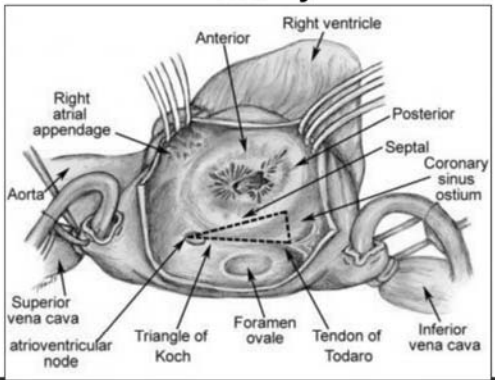
SNUH 분당서울대학교병원

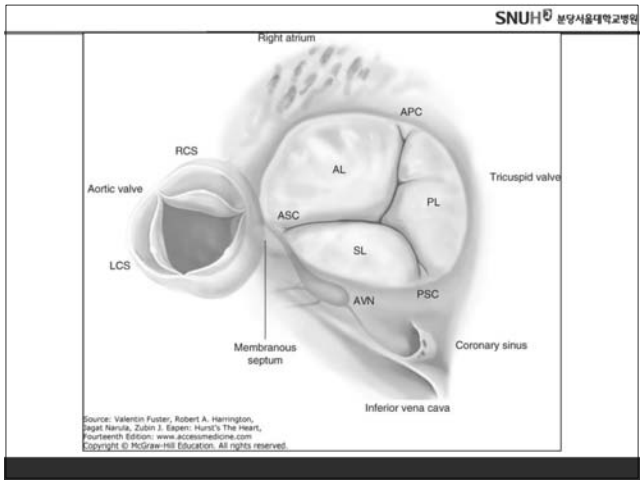
Anatomy

- Most apically placed
- Largest orifice among the 4 valves
- TV annulus is 20% larger than MV annulus
- Septal and anterior leaflets are larger than posterior leaflet
- Septal leaflet
  - Basis for spontaneous closure of the PM-VSD

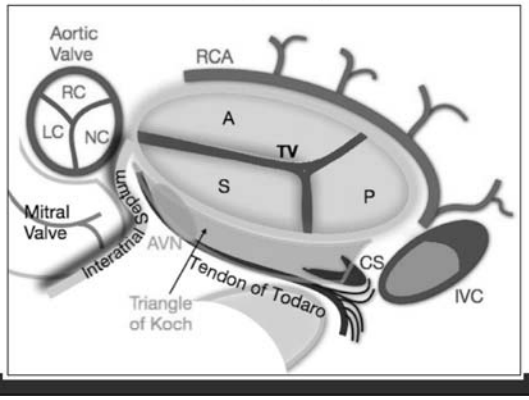
SNUH 분당서울대학교병원

Anatomy





Anatomy



Tricuspid regurgitation

Pathophysiology

- *Most TR is secondary to tricuspid annular dilatation : functional TR..!! – 80%*
  - RV failure
  - Pulmonary vascular disease (mitral valve disease)
  - RV infarction
  - Congenital : pulmonary stenosis, primary pulmonary HTN, Marfan (annular dilatation)

→ May diminish or disappear if RV decrease in size with HF treatment..!!

Pathophysiology

- Primary TR
  - Congenital disease
    - Ebstein anomaly, AV canal defect, corrected TGA
  - Rheumatic
  - Carcinoid syndrome
  - Prolapse caused by myxomatous change
  - Others
    - Tumor (ex. myxoma), PM leads, endomyocardial fibrosis, trauma, endocarditis..

Symptoms

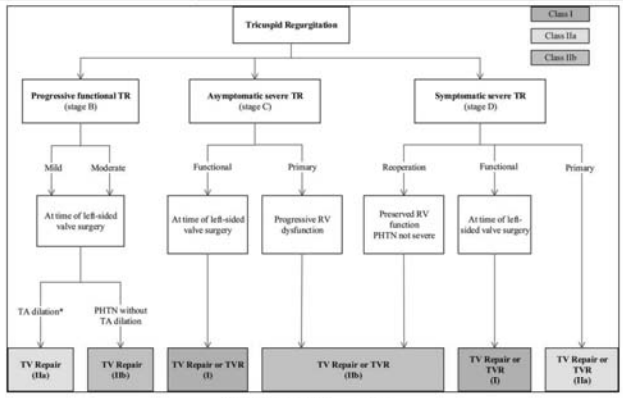
- *TR is generally well tolerated in absence of pulmonary HTN..!!*
- Rt. Side HF with pul HTN + TR
  - Ascites, hepatomegaly, edema
- Wt.loss, cachexia, cyanosis, jaundice
- Jugular distension, venous thrill & murmur
- Pulsations of an enlarged liver

SNUH 분당서울대학교병원

Treatment

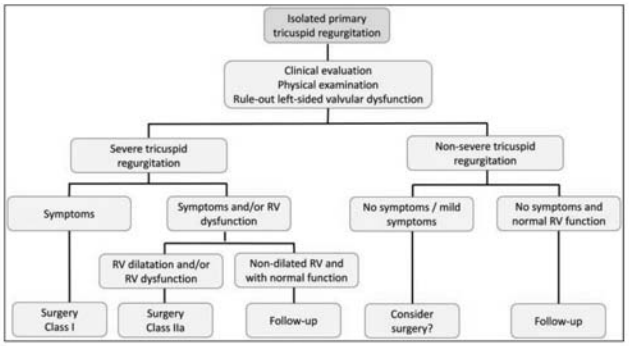
- Medical
  - Diuretics if Rt.side heart failure
  - Reduce PAP and PVR
- Surgical
  - Absence of pul.HTN → no surgery!
  - Mostly annuloplasty
  - If, TVR
    → Bioprosthesis >> Mechanical
    : risk of thrombosis, d/t lower flow rate

SNUH 분당서울대학교병원



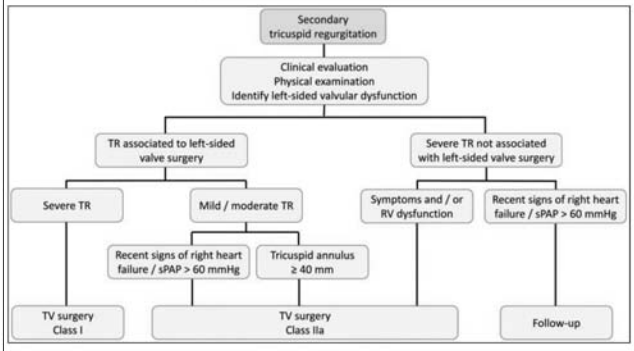
2014 ACC/AHA guideline

SNUH 분당서울대학교병원



Management of primary tricuspid regurgitation
Eur J Cardiothorac Surg 2017;52:1022-30.

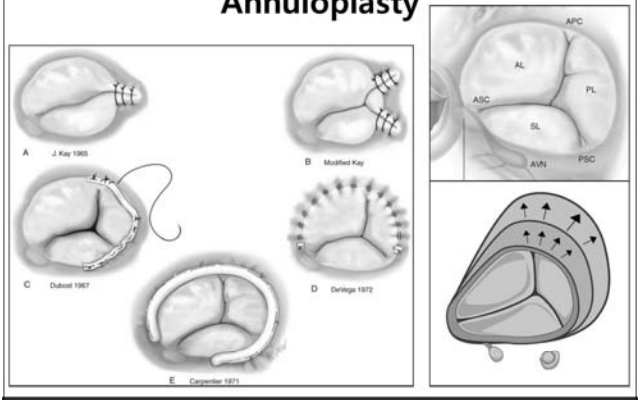
SNUH 분당서울대학교병원



Management of secondary TR
Eur J Cardiothorac Surg 2017;52:1022-30.

SNUH 분당서울대학교병원

Annuloplasty



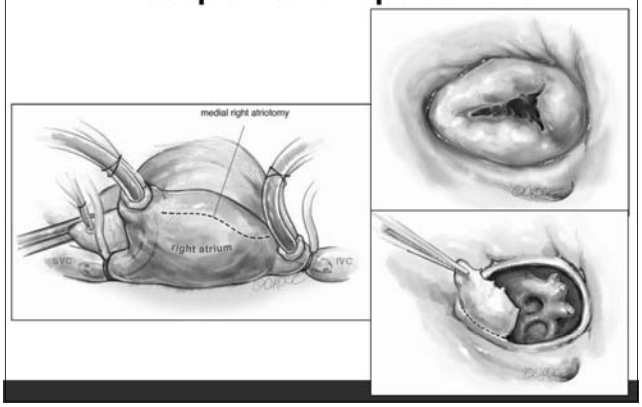
SNUH 분당서울대학교병원

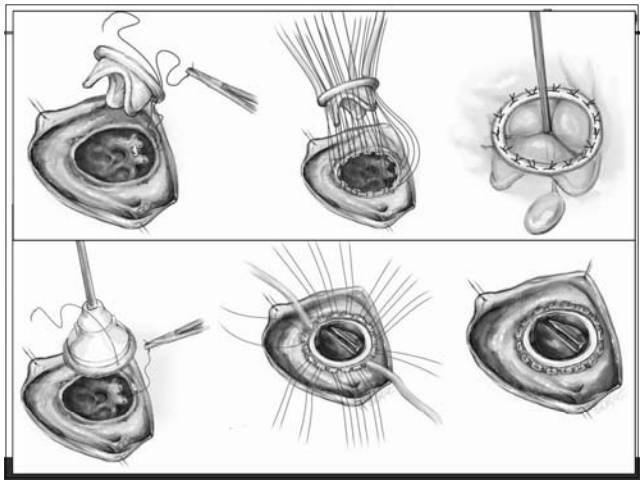
Tricuspid stenosis

Pathophysiology & symptoms

- Mostly rheumatic, rare isolated TS
- Symptoms : similar to TR
  - Fatigue
  - Distension of neck veins
  - Hepatomegaly, ascites, peripheral edema

Tricuspid valve replacement





Infective endocarditis

Definition

- Infection of the endocardial surface of the heart, which may include one or more heart valves, the mural endocardium, or a septal defect

Epidemiology

- IE is rare in healthy individuals despite common bacteremia (ex. dental procedures)
- Increasing incidence of nosocomial endocarditis - both native and prosthetic valve
- Increasing risk
  - Infecting drug user
  - long-term HD
  - Patients with IV cath
  - Diabetes
  - HIV-infected patients

SNUH 분당서울대학교병원

Native valve endocarditis (NVE)

- Rheumatic valvular disease
  - Usually mitral valve followed by the aortic valve
- Congenital heart disease
  - PDA, VSD, ToF, *any native or surgical high-flow lesion*
- Mitral valve prolapse
- Degenerative heart disease
  - Aortic stenosis in elderly ,bicuspid valve, Marfan syndrome, rarely syphilitic disease
  - Mitral regurgitation

SNUH 분당서울대학교병원

Prosthetic valve endocarditis (PVE)

- Early PVE
  - within 1 year (60 days)
  - usually aggressive nosocomial infection of se wing material
- Late PVE
  - 1 year after surgery / implantation

SNUH 분당서울대학교병원

Organisms

- Dental procedures, poor dental hygiene : viridans streptococci, nutritionally variant streptococci, HACEK (Haemophilus, Actinobacill us, Cardiobacterium, Eikenella, Kingella)
- Prosthetic valves
  - Early: coagulase negative staphylococci, S. aureus
  - Late: coagulase negative staphylococci, viridans streptococci
- Gastrointestinal or genitourinary procedures : enterococci or S. bovis (colon carcinoma)

SNUH 분당서울대학교병원

Organisms

- Nosocomial : S. aureus (including MRSA), Gram negatives, Candida species
- HIV : S. aureus
- Animal or farm exposure: Coxiella, Chlamydia, Brucella
- History of homelessness, alcoholism (body lice): Bartonella

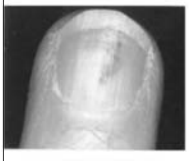
SNUH 분당서울대학교병원

Clinical presentation

- Fever (95%), signs of systemic disease (naus ea, weight loss....)
- Heart murmur (85%)
- Septic embolization (20-50%)
  - brain, kidneys, spleen
  - pulmonary
- Peripheral microembolization less common

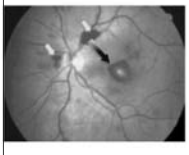
SNUH 분당서울대학교병원

Clinical presentation



Splinter hemorrhage

Osler node



Roth's spot

Janeway lesion

SNUH 분당서울대학교병원

Diagnosis

- Blood cultures
  - 3 sets (aero + anaerobe)
  - At different times + from diff. sites
  - 85-90% - streptococci, staphylococci, enterococci
  - 10% culture negative
    - usually due to previous antibiotics Tx.
    - less commonly HACEK
    - Fungi – Candida, Aspergillus
    - Intracellular pathogens: Coxiella, Bartonella, Chlamydia, Mycoplasma, Legionella, Trephonema

SNUH 분당서울대학교병원

Echocardiogrpahy

- TTE - low sensitivity (40-60%)
- TEE – high sensitivity (90-100%)

- Definite finding
  - Vegetations
  - Abscess
  - new prosthetic valve dehiscence

SNUH 분당서울대학교병원

Duke criteria

Major Criteria
- Positive echocardiography
- Positive blood culture

Minor Criteria
- Predisposing conditions
- Fever > 37⁰ C
- Vascular phenomenon
- Immunologic phenomenon
- Suggestive echocardiogram
- Ambiguous blood culture

Diagnosis of infective endocarditis requires two major, or one major and three minor or five minor criteria.

SNUH 분당서울대학교병원

Modified Duke criteria

Definite IE
- Pathologic criteria
  1. Microorganisms demonstrated by culture or histologic examination of a vegetation, a vegetation that has embolized, or an intracardiac abscess specimen; or
  2. Pathologic lesions; vegetation or intracardiac abscess confirmed by histologic examination showing active endocarditis
- Clinical criteria (see Table 34.3)
  1. Two major criteria
  2. One major criterion and three minor criteria
  3. Five minor criteria

Possible IE (see Table 34.3)
1. One major criterion and one minor criterion
2. Three minor criteria

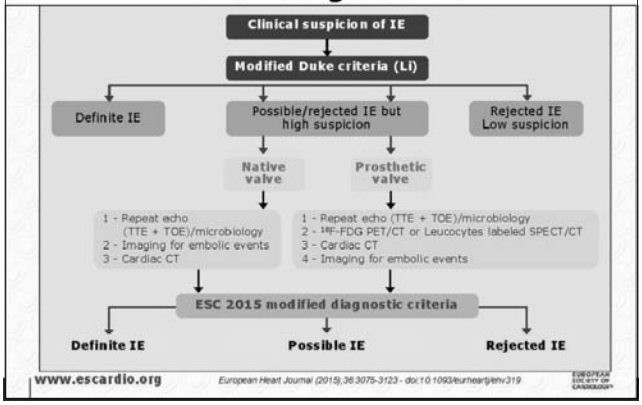
Rejected
1. Firm alternate diagnosis explaining evidence of IE
2. Resolution of infection endocarditis syndrome with antibiotic therapy for ≤4 days
3. No pathologic evidence of IE at surgery or autopsy, with antibiotic therapy for ≤4 days
4. Does not meet criteria for possible IE, as described previously

Major Criteria
- Blood culture positive for IE
  - Typical microorganisms consistent with IE from two separate blood cultures
    - Viridans streptococci; *Streptococcus bovis*, HACEK group, *Staphylococcus aureus*; or
    - Community-acquired enterococci, in the absence of a primary focus
  - Microorganisms consistent with IE from persistently positive blood cultures, defined as follows:
    - At least two positive blood cultures of blood samples drawn >12 h apart; or
    - All of three or a majority of ≥4 separate cultures of blood (with first and last sample drawn at least 1 h apart)
  - Single positive blood culture for *Coxiella burnetii* or antiphase I IgG antibody titer >1:800
- Evidence of endocardial involvement
- Echocardiogram positive for IE (TEE recommended in patients with prosthetic valves, rated at least "possible IE" by clinical criteria, or complicated IE [paravalvular abscess]; TTE as first test in other patients), defined as follows:
  - Oscillating intracardiac mass on valve or supporting structures, in the path of regurgitant jets, or on implanted material in the absence of an alternative anatomic explanation; or
  - Abscess; or
  - New partial dehiscence of prosthetic valve
- New valvular regurgitation (worsening or changing or preexisting murmur not sufficient)

Minor Criteria
- Predisposition, predisposing heart condition or injection drug use
- Fever, temperature >38°C
- Vascular phenomena, major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, and Janeway lesions
- Immunologic phenomena: Glomerulonephritis, Osler nodes, Roth's spots, and rheumatoid factor
- Microbiological evidence: Positive blood culture but does not meet a major criterion as noted previously (excluding single positive cultures for coagulase-negative staphylococci and organisms that do not cause endocarditis) or serologic evidence of active infection with organisms consistent with IE
- Echocardiographic minor criteria eliminated

SNUH 분당서울대학교병원

2015 ESC guideline



ESC 2015 modified criteria for diagnosis of IE:

Major criteria

1. Blood cultures positive for IE
a. Typical microorganisms consistent with IE from 2 separate blood cultures:
   - *Viridans streptococci, Streptococcus gallolyticus (Streptococcus bovis), HACEK group, Staphylococcus aureus*; or
   - Community-acquired enterococci, in the absence of a primary focus; or
b. Microorganisms consistent with IE from persistently positive blood cultures:
   - ≥2 positive blood cultures of blood samples drawn >12 h apart; or
   - All of 3 or a majority of ≥4 separate cultures of blood (with first and last samples drawn ≥1 h apart); or
c. Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titre >1:800

2. Imaging positive for IE
a. Echocardiogram positive for IE:
   - Vegetation
   - Abscess, pseudoaneurysm, intracardiac fistula
   - Valvular perforation or aneurysm
   - New partial dehiscence of prosthetic valve
b. Abnormal activity around the site of prosthetic valve implantation detected by ^{18}F-FDG PET/CT (only if the prosthesis was implanted for >3 months) or radiolabelled leukocytes SPECT/CT.
c. Definite paravalvular lesions by cardiac CT.

www.escardio.org European Heart Journal (2015) 36 3075-3123 - doi:10.1093/eurheartj/ehv319

ESC 2015 modified criteria for diagnosis of IE:

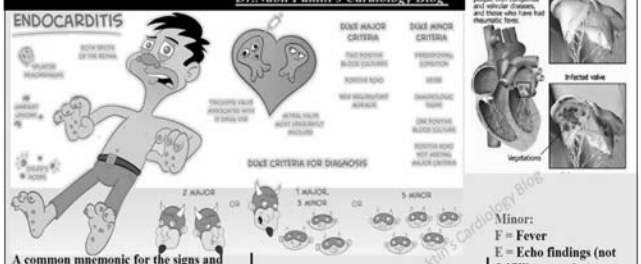
Minor criteria

1. Predisposition such as predisposing heart condition, or injection drug use.
2. Fever defined as temperature >38°C.
3. Vascular phenomena **(including those detected only by imaging)**: major arterial emboli, septic pulmonary infarcts, infectious (mycotic) aneurysm, intracranial haemorrhage, conjunctival haemorrhages, and Janeway's lesions.
4. Immunological phenomena: glomerulonephritis, Osler's nodes, Roth's spots, and rheumatoid factor.
5. Microbiological evidence: positive blood culture but does not meet a major criterion as noted above or serological evidence of active infection with organism consistent with IE.

www.escardio.org European Heart Journal (2015) 36 3075-3123 - doi:10.1093/eurheartj/ehv319

Infective Endocarditis
How to Remember Dukes Criteria

www.afghanheart.wordpress.com
Dr.Nabil Paktin's Cardiology Blog



A common mnemonic for the signs and symptoms of endocarditis is FROM JANE:
Fever
Roth's spots
Osler's nodes
Murmur
Janeway lesions
Anemia
Nail hemorrhage (splinter hemorrhages)
Emboli

DUKES CRITERIA
BE FEVEER
(*BE - Bacterial Endocarditis)
Major:
B = blood culture +ve >2 times 12 hr part
E = Endocardial involvement from Echo

Minor:
F = Fever
E = Echo findings (not fulfilling a major)
V = Vascular findings
EE = Evidences from microbiological/immunology (2 evidences)
R = Risk - factors/prediposing factors -drug abuse , valvular disease

SNUH 분당서울대학교병원

Treatment

- Antibiotic therapy
- Surgery - performed in high-risk patients
  - Age/comorbidities/PVE/DM
  - Complicated IE (heart failure, shock…)
  - High-risk agents (S.aureus, fungi…), ATB failure
  - TTE/TEE high-risk morphology parameters – risk of embolisation

SNUH 분당서울대학교병원

Antibiotics

- beta-lactam (penicillin, cefalosporin)
- Glykopeptide (vancomycine)
- Aminoglykosides (gentamicin)
- Rifampicin in PVE

- Streptococci: PEN/CEF + GENTA, (VANCO)
- Enterococci: like streptococci, PEN resist. comm on
- Staphylococci: MET/OXA + GENTA
- Empirical therapy - should focus on S. aureus

SNUH 분당서울대학교병원

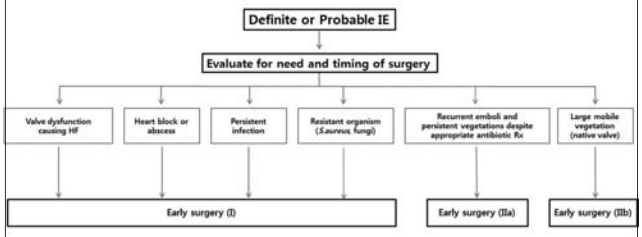
Surgery

- Indications
  - Progressive heart failure
  - Significant heart failure: fail to improve
  - Major embolism, large vegetation
  - Persistent bacteremia despite antibiotics Tx.
  - Fungal endocarditis
  - Patients with intravascular devices
  - Heart block
  - Prosthetic valve dehiscence or obstruction
  - Relapse

Indications and timing of surgery

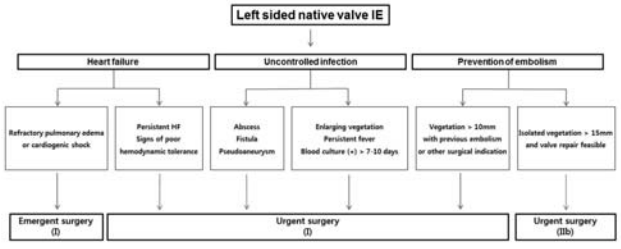
Indications for surgery	Timing	Class	Level
1. Heart Failure			
Aortic or mitral NVE or PVE with severe acute regurgitation, obstruction or fistula causing refractory pulmonary oedema or cardiogenic shock.	Emergency	I	B
Aortic or mitral NVE or PVE with severe regurgitation or obstruction causing symptoms of HF or echocardiographic signs of poor haemodynamic tolerance.	Urgent	I	B
2. Uncontrolled infection			
Locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation).	Urgent	I	B
Infection caused by fungi or multiresistant organisms.	Urgent/elective	I	C
Persisting positive blood cultures despite appropriate antibiotic therapy and adequate control of septic metastatic foci.	Urgent	IIa	B
PVE caused by staphylococci or non-HACEK Gram negative bacteria.	Urgent/elective	IIa	C
3. Prevention of embolism			
Aortic or mitral NVE or PVE with persistent vegetations >10 mm after one or more embolic episode despite appropriate antibiotic therapy.	Urgent	I	B
Aortic or mitral NVE with vegetations >10 mm, associated with severe valve stenosis or regurgitation, and low operative risk.	Urgent	IIa	B
Aortic or mitral NVE or PVE with isolated very large vegetations (>30 mm).	Urgent	IIa	B
Aortic or mitral NVE or PVE with isolated large vegetations (>15 mm) and no other indication for surgery.	Urgent	IIb	C

Indication for early surgery



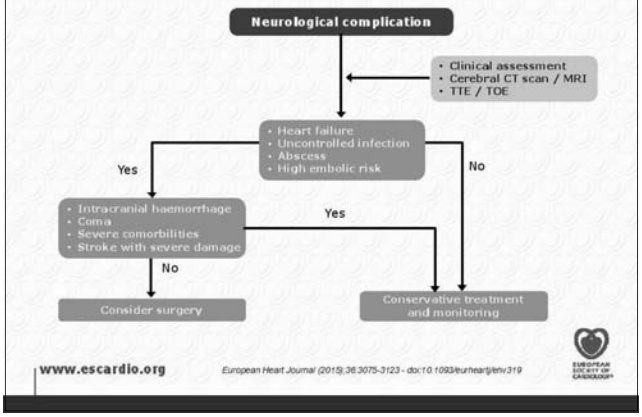
2014 AHA/ACC guidelines.

Indications for early surgery



2009 ESC guidelines

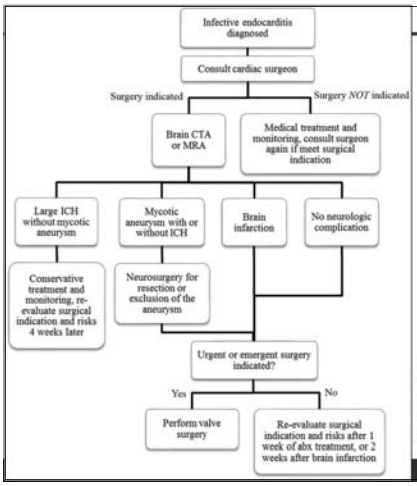
Management of neurological complications



Management of neurological complications

Recommendations	Class	Level
After a silent embolism or transient ischaemic attack, cardiac surgery, if indicated, is recommended without delay.	I	B
Neurosurgery or endovascular therapy is indicated for very large, enlarging or ruptured intracranial infectious aneurysms.	I	C
Following intracranial haemorrhage, surgery should generally be postponed for ≥1 month.	IIa	B
After a stroke, surgery indicated for HF, uncontrolled infection, abscess, or persistent high embolic risk should be considered without any delay as long as coma is absent and the presence of cerebral haemorrhage has been excluded by cranial CT or MRI.	IIa	B
Intracranial infectious aneurysms should be looked for in patients with IE and neurological symptoms. CT or MR angiography should be considered for diagnosis. If non-invasive techniques are negative and the suspicion of intracranial aneurysm remains, conventional angiography should be considered.	IIa	B

www.escardio.org European Heart Journal (2015);36:3075-3123 - doi:10.1093/eurheartj/ehv319



Lee H-A, et al. Surgical interventions of isolated active mitral valve endocarditis. *Medicine*. 2018;97:11.

Right-sided infective endocarditis

Recommendations	Class	Level
Surgical treatment should be considered in the following scenarios: • Microorganisms difficult to eradicate (e.g. persistent *fungi*) or bacteraemia for >7 days (e.g. *Staphylococcus aureus, P. aeruginosa*) despite adequate antimicrobial therapy or • Persistent tricuspid valve vegetations >20 mm after recurrent pulmonary emboli with or without concomitant right heart failure or • Right HF secondary to severe tricuspid regurgitation with poor response to diuretic therapy.	IIa	C

www.escardio.org

European Heart Journal (2015);36:3075-3123 - doi:10.1093/eurheartj/ehv319

SNUH 분당서울대학교병원

Prevention

Recommendations	Class	Level
Antibiotic prophylaxis should only be considered for patients at highest risk of IE: 1. Patients with any prosthetic valve, including a transcatheter valve, or those in whom any prosthetic material was used for cardiac valve repair. 2. Patients with previous IE. 3. Patients with congenital heart disease. a. Any cyanotic congenital heart disease. b. Any type of congenital heart disease repaired with a prosthetic material whether placed surgically or by percutaneous techniques, up to 6 months after the procedure or lifelong if residual shunt or valvular regurgitation remains.	IIa	C
Antibiotic prophylaxis is not recommended in other forms of valvular or congenital heart disease.	III	C

www.escardio.org

European Heart Journal (2015);36:3075-3123 - doi:10.1093/eurheartj/ehv319

Procedures at highest-risk of IE

Recommendations	Class	Level
A. Dental procedures • Antibiotic prophylaxis should only be considered for dental procedures requiring manipulation of the gingival or periapical region of the teeth or perforation of the oral mucosa.	IIa	C
• Antibiotic prophylaxis is not recommended for local anaesthetic injections in non-infected tissues, treatment of superficial caries, removal of sutures, dental X-rays, placement or adjustment of removable prosthodontic or orthodontic appliances or braces, or following the shedding of deciduous teeth or trauma to the lips and oral mucosa.	III	C
B. Respiratory tract procedures • Antibiotic prophylaxis is not recommended for respiratory tract procedures, including bronchoscopy or laryngoscopy, transnasal or endotracheal intubation.	III	C
C. Gastrointestinal or urogenital procedures or TOE • Antibiotic prophylaxis is not recommended for gastroscopy, colonoscopy, cystoscopy, vaginal or caesarean delivery or TOE.	III	C
D. Skin and soft tissues procedures • Antibiotic prophylaxis is not recommended for any procedure.	III	C

www.escardio.org

European Heart Journal (2015);36:3075-3123 - doi:10.1093/eurheartj/ehv319

Prophylaxis for dental procedures at risk

Situation	Antibiotic	Single-dose 30–60 minutes before procedure	
		Adults	Children
No allergy to penicillin or ampicillin	Amoxicillin or Ampicillin[a]	2 g orally or i.v.	50 mg/kg orally or i.v.
Allergy to penicillin or ampicillin	Clindamycin	600 mg orally or i.v.	20 mg/kg orally or i.v.

[a]Alternatively, cephalexin 2 g i.v. for adults or 50 mg/kg i.v. for children, cefazolin or ceftriaxone 1 g i.v. for adults or 50 mg/kg i.v. for children.

"Cephalosporins should not be used in patients with anaphylaxis, angio-oedema, or urticaria after intake of penicillin or ampicillin due to cross-sensitivity".

www.escardio.org

European Heart Journal (2015);36:3075-3123 - doi:10.1093/eurheartj/ehv319

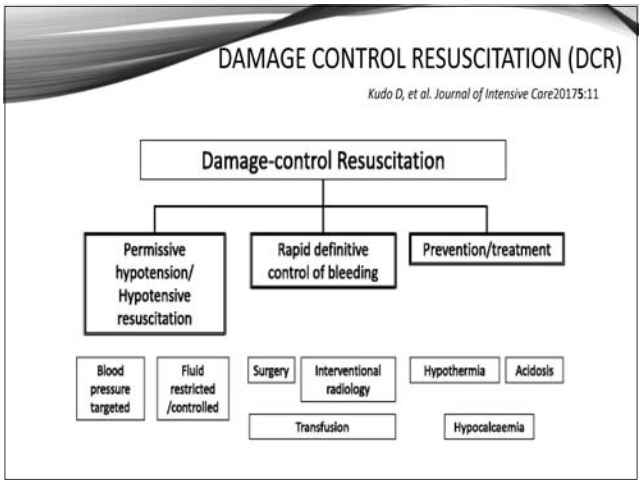
【외상 및 ECMO】

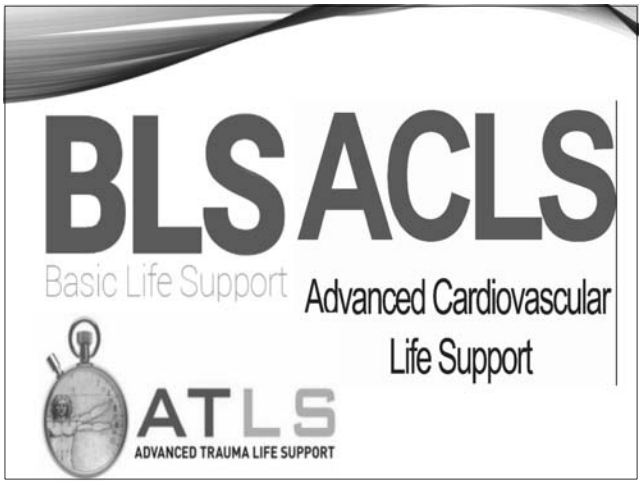
좌장: 최창휴

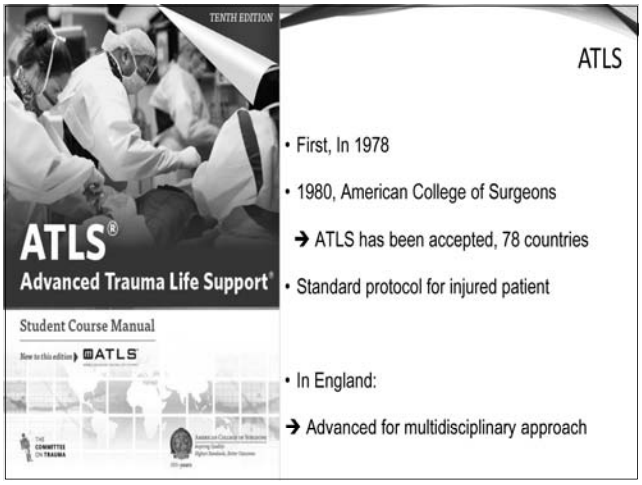
Primary and Secondary Survey for Trauma Patients

Department of Thoracic and Cardiovascular Surgery, Trauma Center, Dankook University Hospital

Sung Wook Chang

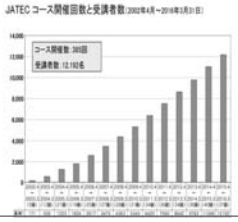






JATEC

- 일본 구급의학회 및 외상학회
- First course, in 2002, Now, over 14000 doctors
- Residents: associated with trauma care



IN SOUTH KOREA

- BLS, ACLS → 병원 인증평가
- KTAT (Korean Trauma Assessment and Treatment)

  → 대한응급의학회, 대한외상학회 + 대한외상소생협회
- First, 2011, Total 22 times (2018)
- Obligation for only trauma surgeon, not residents
- Previously, emergency medicine resident
- Management for trauma patient → Primary and secondary survey

Primary survey

DKU DANKOOK UNIVERSITY HOSPITAL TRAUMA CENTER

WHEN TREATING INJURED PATIENTS

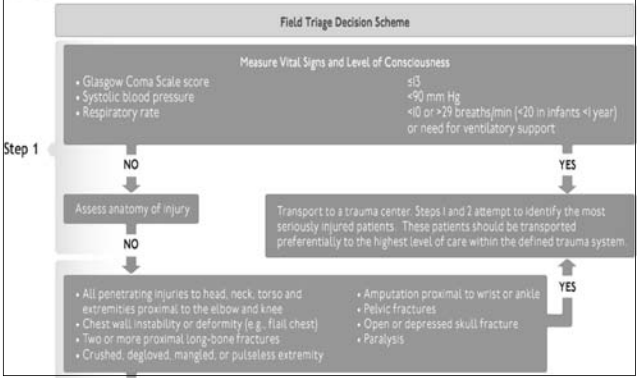
- Preparation
- Triage
- Primary survey (ABCDEs) with immediate resuscitation of patients with life-threatening injuries
- Adjuncts to the primary survey and resuscitation
- Consideration of the need for patient transfer
- Secondary survey (head-to-toe evaluation and patient history)
- Adjuncts to the secondary survey
- Continued postresuscitation monitoring and reevaluation
- Definitive care

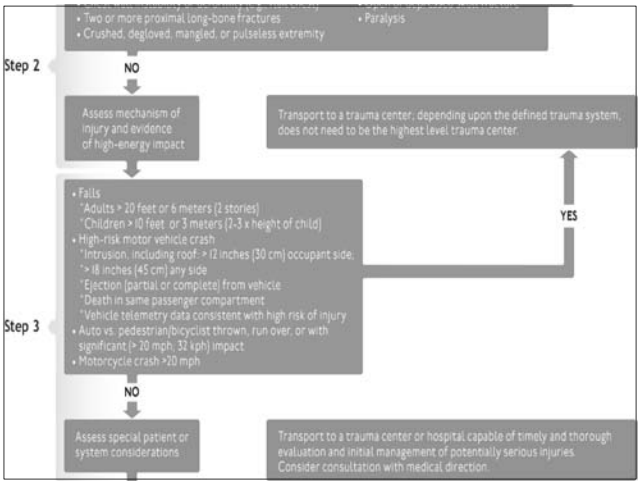
PREPARATION

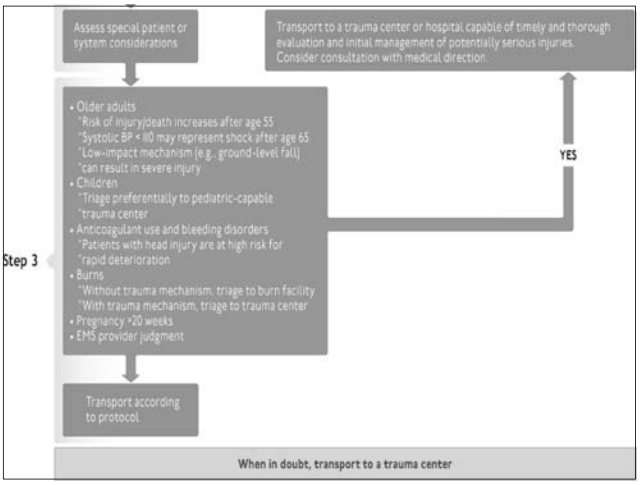
■ FIGURE 1-1 Prehospital Phase. During the prehospital phase, personnel emphasize airway maintenance, control of external bleeding and shock, immobilization of the patient, and immediate transport to the closest appropriate facility, preferably a verified trauma center.

■ FIGURE 1-3 Trauma team members are trained to use standard precautions, including face mask, eye protection, water-impervious gown, and gloves, when coming into contact with body fluids.

TRIAGE







INITIAL ASSESSMENT AND MANAGEMENT

THE PRIMARY AND SECONDARY SURVEYS ARE REPEATED FREQUENTLY TO IDENTIFY ANY CHANGE IN THE PATIENT'S STATUS THAT INDICATES THE NEED FOR ADDITIONAL INTERVENTION.

PRINCIPLE

THE PATIENT'S VITAL FUNCTIONS MUST BE ASSESSED QUICKLY AND EFFICIENTLY. MANAGEMENT CONSISTS OF A RAPID PRIMARY SURVEY WITH SIMULTANEOUS RESUSCITATION OF VITAL FUNCTIONS, A MORE DETAILED SECONDARY SURVEY, AND THE INITIATION OF DEFINITIVE CARE

QUESTION 1, ON TRAUMA BAY

- 50/M, Driver TA
- On Scene: SOL (+), Upon arrival: SOL (-)
- CPR time: (7) minutes
- Next step ??? What should you do for patient on trauma bay?

- Signs of Life
  - Respiratory or Motor effort
  - Electrical activity
  - Pupillary activity

JUST 10 SECONDS (ABCD)

Clinicians can quickly assess A, B, C, and D in a trauma patient by identifying themselves, asking the patient for his or her name, and asking what happened.

- Airway maintenance with restriction of cervical spine motion
- Breathing and ventilation
- Circulation with hemorrhage control
- Disability(assessment of neurologic status)
- Exposure/Environmental control

AIRWAY AND CERVICAL IMMOBILIZATION

- Airway maintenance
  - suctioning to clear accumulated blood or secretions
  - GCS ≤ 8 : placement of a definitive airway
  - → Establish a definitive airway if there is any doubt
- While assessing and managing a patient's airway,
  - → take great care to prevent excessive movement of the cervical spine
  - if intubation cannot be accomplished→ Establish an airway surgically

AIRWAY AND CERVICAL IMMOBILIZATION

- Airway maintenance
  - suctioning to clear acc
  - GCS ≤ 8 : placement c
  - → Establish a definitive
- While assessing and ma
  - → take great care to
  - if intubation cannot be

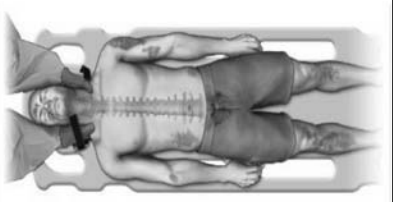
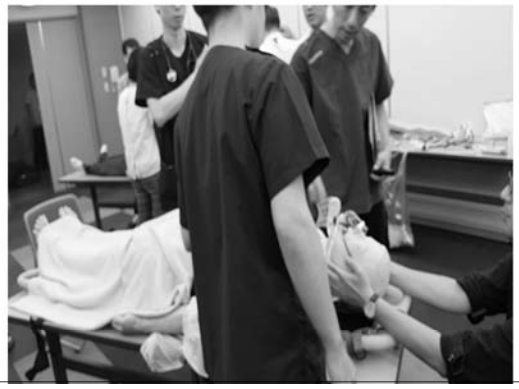


FIGURE 1-4 Cervical spine motion restriction technique. When the cervical collar is removed, a member of the trauma team manually stabilizes the patient's head and neck.

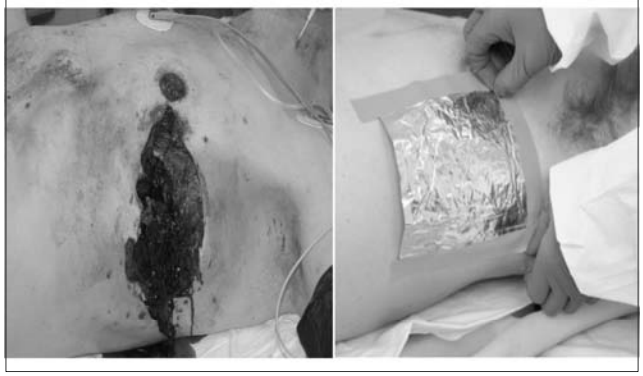
TEMPORARILY RELEASING THE CERVICAL COLLAR



BREATHING AND VENTILATION

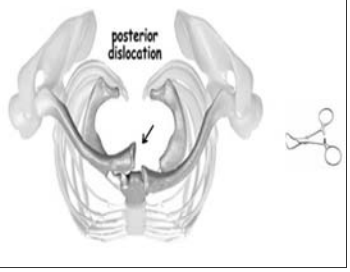
- Auscultation/ Visual inspection/ Palpation/ Percussion
- To adequately assess jugular venous distention, position of the trachea, and chest wall excursion, expose the patient's neck and chest.
- Detect injuries: Tension pneumothorax/ Massive hemothorax/ Open pneumothorax/ Trachea injury/ Flail chest c severe lung contusion/ Tamponade
- A simple pneumothorax can be converted to a tension pneumothorax when a patient is intubated and positive pressure ventilation is provided before decompressing the pneumothorax with a chest tube.

OPEN PNEUMOTHORAX

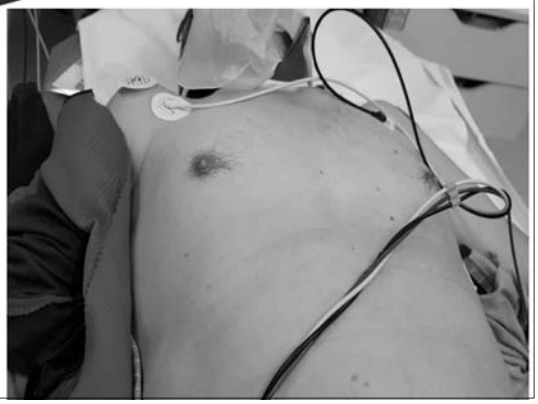


STRIDOR, MARKED CHANGE OF VOICE

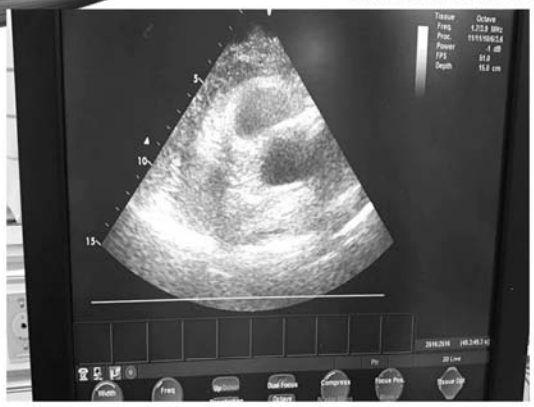
- Driver TA



LT. FLAIL CHEST C PARADOXICAL MOVEMENT



CARDIAC TAMPONADE



CIRCULATION WITH HEMORRHAGIC CONTROL

- Once tension pneumothorax has been excluded as a cause of shock,

→ consider that hypotension is due to blood loss until proven otherwise

- Blood Volume and Cardiac Output: Level of consciousness, skin, pulse etc
- Bleeding: Direct manual pressure, Tourniquets for extremity for selected patient, Application of a pelvic stabilizing device, large-bore peripheral venous catheters, tranexamic acid(within 3 hours of ibnjury), definitive control of hemorrhage etc.
- All IV solutions should be warmed, a bolus of 1 L of an isotonic solution

→ unresponsive to initial crystalloid therapy, a blood transfusion

DISABILITY (NEUROLOGIC EVALUATION)

- Patient's level of consciousness and pupillary size and reaction
- GCS
- Drug or alcohol intoxication can accompany traumatic brain injury
- Prevention of secondary brain injury by maintaining adequate oxygenation and perfusion
- Patients with evidence of brain injury

→ Neurosurgeon contact, not available -> transfer

EXPOSURE AND ENVIRONMENTAL CONTROL

- Completely undress the patient, usually by cutting off
- After completing the assessment, cover the patient with warm blankets
- Hypothermia is a potentially lethal complication in injured patients
- A high-flow fluid warmer to heat crystalloid fluids to 39°C is recommended.
- A microwave can be used to warm crystalloid fluids, but it should never be used to warm blood products.

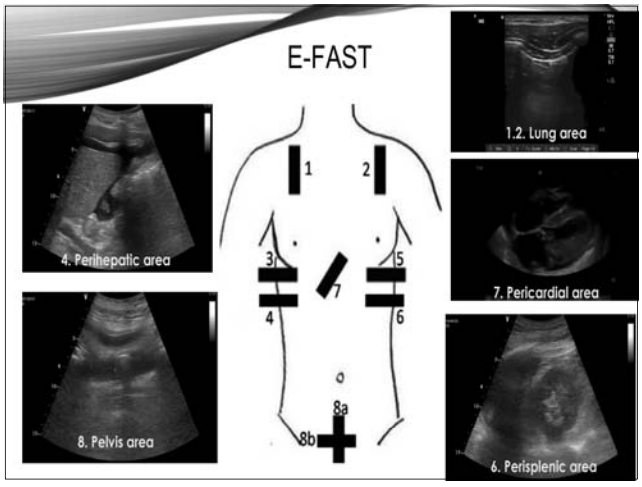
DURING THE PRIMARY SURVEY

- ECG monitoring
- Pulse oximetry
- Ventilatory Rate, Capnography, and Arterial Blood Gases
- Urinary and gastric catheters
- Trauma series (X-ray; Chest AP, Pelvis AP, C-spine lateral)
- FAST (focused assessment with sonography for trauma). Extended FAST
- Surgical consultation/ Patient transfer (not to delay transfer)

FAST (FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA)

- A rapid bedside ultrasound examination
- Screening test for blood around
  - Heart (Pericardial effusion)
  - Abdominal organs (Hemoperitoneum)
    - Morison's pouch, splenorenal recess, pelvic cavity
- Extended FAST (E-FAST)
  - Examination of both lungs (pneumothorax, hemothorax)

E-FAST



QUESTION 1, ON TRAUMA BAY

- 50/M, Driver TA
- On Scene: SOL (+), Upon arrival: SOL (-)
- CPR time: (7) minutes
- Next step ??? What should you do for patient on trauma bay?

- Signs of Life
  - Respiratory or Motor effort
  - Electrical activity
  - Pupillary activity

During the primary survey, life-threatening conditions are identified and treated in a prioritized sequence

QUESTION 1, ON TRAUMA BAY

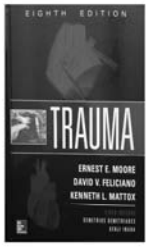
- 50/M, Driver TA
- On Scene: SOL (+), Upon arrival: SOL (-)
- CPR time: (7) minutes
- FAST: Hemopericardium (+)

  Hemoperitoneum (-)
- V/S: Not checkable
- Next step ??? What should you do for patient on trauma bay

- Signs of Life
  - Respiratory or Motor effort
  - Electrical activity
  - Pupillary activity

RESUSCITATIVE THORACOTOMY

- Indication



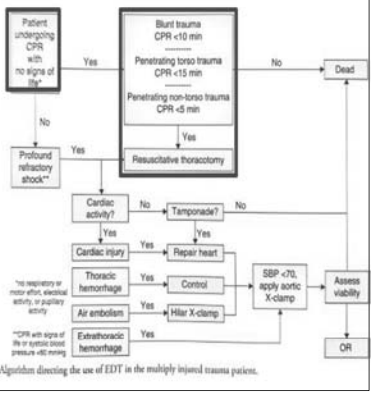
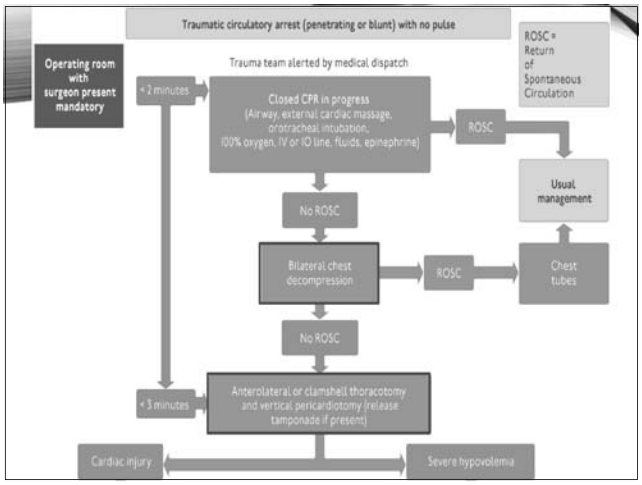
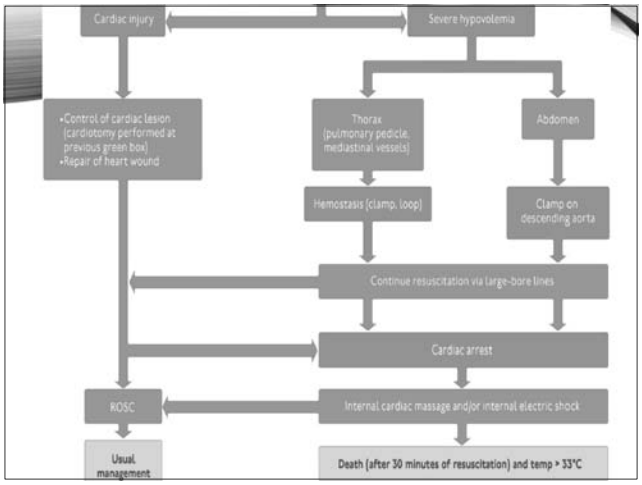


FIGURE 14-1 Algorithm directing the use of EDT in the multiply injured trauma patient.





BILATERAL CHEST DECOMPRESSION

- In TRAUMA patient, What is the critical point during CPR?
- CHEST DECOMPRESSION

IS THE MOST IMPORTANT PROCEDURE DURING CHEST COMPRESSION

BILATERAL CHEST DECOMPRESSION

- Field thoracostomy

Resuscitation (2007) 75, 276–285

Outcome in 757 severely injured patients with traumatic cardiorespiratory arrest☆

Stefan Huber-Wagner[a,*], Rolf Lefering[b], Mike Qvick[a], Michael V. Kay[a], Thomas Paffrath[b], Wolf Mutschler[a], Karl-Georg Kanz[a],

Working Group on Polytrauma of the German Trauma Society (DGU)[1]

Conclusions: Prehospital chest tube insertion was found to be a strong predictor for survival. On-scene chest decompression of TCRA patients is recommended in case of the decision to start with ECC. Based on our data, resuscitation after severe trauma seems to be more justified than the current guidelines state.

Field resuscitative thoracotomy

LONDON'S AIR AMBULANCE

Traumatic Cardiac Arrest: Who Are the Survivors?

David Lockey, FRCA, FIMC, RCS(Ed)
Kate Crewdson, MB, BS, BSc
Gareth Davies, FFAEM, FRCP

From the London Helicopter Emergency Medical Service, Royal London Hospital, London, United Kingdom.

Study objective: Survival from traumatic cardiac arrest is poor, and some consider resuscitation of this patient group futile. This study identified survival rates and characteristics of the survivors in a physician-led out-of-hospital trauma service. The results are discussed in relation to recent resuscitation guidelines.

Methods: A 10-year retrospective database review was conducted to identify trauma patients receiving out-of-hospital cardiopulmonary resuscitation. The primary outcome measure was survival to hospital discharge.

Results: Nine hundred nine patients had out-of-hospital cardiopulmonary resuscitation. Sixty-eight (7.5% [95% confidence interval 5.8% to 9.2%]) patients survived to hospital discharge. Six patients had isolated head injuries and 6 had cervical spine trauma. Eight underwent on-scene thoracotomy for penetrating chest trauma. Six patients recovered after decompression of tension pneumothorax. Thirty patients sustained asphyxial or hypoxic insults. Eleven patients appeared to have had "medical" cardiac arrests that occurred before and was usually the cause of their trauma. One patient survived hypovolemic cardiac arrest. Thirteen survivors breached recently published guidelines.

Conclusion: The survival rates described are poor but comparable with (or better than) published survival rates for out-of-hospital cardiac arrest of any cause. Patients who arrest after hypoxic insults and those who undergo out-of-hospital thoracotomy after penetrating trauma have a higher chance of survival. Patients with hypovolemia as the primary cause of arrest rarely survive. Adherence to recently published guidelines may result in withholding resuscitation in a small number of patients who have a chance of survival. [Ann Emerg Med. 2006;48:240-244.]

Resuscitative Thoracotomy

Trauma Center
ankook University Hospit
Sung Wook, Chang

Secondary survey

DKU DANKOOK UNIVERSITY HOSPITAL TRAUMA CENTER

SECONDARY SURVEY

- Head-to-toe evaluation
- Complete history
- Physical examination
- Each region of the body
- The potential for missing an injury or failing

TABLE I-I MECHANISMS OF INJURY AND SUSPECTED INJURY PATTERNS

MECHANISM OF INJURY	SUSPECTED INJURY PATTERNS	MECHANISM OF INJURY	SUSPECTED INJURY PATTERNS
BLUNT INJURY			
Frontal impact, automobile collision • Bent steering wheel • Knee imprint, dashboard • Bull's-eye fracture, windscreen	• Cervical spine fracture • Anterior flail chest • Myocardial contusion • Pneumothorax • Traumatic aortic disruption • Fractured spleen or liver • Posterior fracture/dislocation of hip and/or knee • Head injury • Facial fractures	**Rear impact, automobile collision**	• Cervical spine injury • Head injury • Soft tissue injury to neck
		Ejection from vehicle	• Ejection from the vehicle precludes meaningful prediction of injury patterns, but places patient at greater risk for virtually all injury mechanisms
Side impact, automobile collision	• Contralateral neck sprain • Head injury • Cervical spine fracture • Lateral flail chest • Pneumothorax • Traumatic aortic disruption • Diaphragmatic rupture • Fractured spleen/liver and/or kidney, depending on side of impact • Fractured pelvis or acetabulum	**Motor vehicle impact with pedestrian**	• Head injury • Traumatic aortic disruption • Abdominal visceral injuries • Fractured lower extremities/pelvis
		Fall from height	• Head injury • Axial spine injury • Abdominal visceral injuries • Fractured pelvis or acetabulum • Bilateral lower extremity fractures (including calcaneal fractures)

HISTORY

- History of the mechanism of injury (MOI)

TABLE I-I MECHANISMS OF INJURY AND SUSPECTED INJURY PATTERNS

MECHANISM OF INJURY	SUSPECTED INJURY PATTERNS	MECHANISM OF INJURY	SUSPECTED INJURY PATTERNS
PENETRATING INJURY		**THERMAL INJURY**	
Stab wounds • Anterior chest	• Cardiac tamponade if within "box" • Hemothorax • Pneumothorax • Hemopneumothorax	**Thermal burns**	• Circumferential eschar on extremity or chest • Occult trauma (mechanism of burn/means of escape)
• Left thoraco-abdominal	• Left diaphragm injury/spleen injury/hemopneumothorax	**Electrical burns**	• Cardiac arrhythmias • Myonecrosis/compartment syndrome
• Abdomen	• Abdominal visceral injury possible if peritoneal penetration	**Inhalational burns**	• Carbon monoxide poisoning • Upper airway swelling • Pulmonary edema
Gunshot wounds (GSW) • Truncal	• High likelihood of injury • Trajectory from GSW/retained projectiles help predict injury		
• Extremity	• Neurovascular injury • Fractures • Compartment syndrome		

HISTORY

- History of the mechanism of injury (MOI)

AMPLE HISTORY

- Include a history of the mechanism of injury (MOI)
- Allergies
- Medications currently used
- Past illnesses/Pregnancy
- Last meal
- Events/Environment related to the injury

HEAD

- Visual acuity, Ocular entrapment
- Pupillary size
- Hemorrhage of the conjunctiva and/or fundi
- Penetrating injury
- Contact lenses (remove before edema occurs), Dislocation of the lens
- Maxillofacial structures

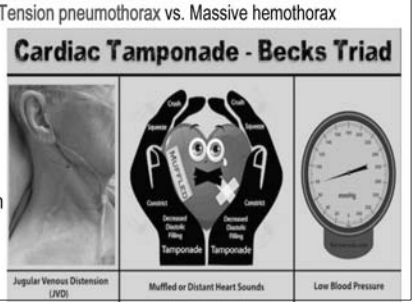
CERVICAL SPINE AND NECK

- Patients with maxillofacial or head trauma should be presumed to have a cervical spine injury, and cervical spine motion must be restricted.
- The absence of neurologic deficit does not exclude injury to the cervical spine
- Active arterial bleeding, an expanding hematoma, arterial bruit, or airway compromise usually requires operative evaluation.
- Protective helmet → protection of a potentially unstable cervical spine
- Unexplained paralysis of an upper extremity → a cervical nerve root injury

CHEST

- Inspection, palpation, auscultation and percussion of the chest
- Cardiac tamponade vs. Tension pneumothorax vs. Massive hemothorax
- Hypovolemia

→ No neck vein distention



CHEST

- Inspection, palpation, auscultation and percussion of the chest
- Cardiac tamponade vs. Tension pneumothorax vs. Massive hemothorax

TABLE 4-1 DIFFERENTIATING TENSION PNEUMOTHORAX AND MASSIVE HEMOTHORAX

CONDITION	PHYSICAL SIGNS				
	BREATH SOUNDS	PERCUSSION	TRACHEAL POSITION	NECK VEINS	CHEST MOVEMENT
Tension pneumothorax	Decreased or absent	Hyperresonant	Deviated away	Distended	Expanded immobile
Massive hemothorax	Decreased	Dull	Midline	Collapsed	Mobile

ABDOMEN, PELVIS, PERINEUM, RECTUM, AND VAGINA

- Early involvement of a surgeon is essential
- Pelvic fractures: ecchymosis over the iliac wings, pubis, labia, or scrotum.
- Pain on palpation of the pelvic ring is an important finding.
- Perineum and pelvis → Urethral injury
- A rectal examination

→ integrity of the rectal wall, and quality of sphincter tone

- Vaginal examination in patients with a risk of vaginal injury.

ABDOMEN, PELVIS, PERINEUM, RECTUM, AND VAGINA

- Early involvement of a surgeon is essential
- Pelvic fractures: ecchymosis over the iliac wings, pubis, labia, or scrotum.
- Pain on palpation of the pelvic ring is an important finding.
- Perineum and pelvis → Urethral injury
- A rectal examination

→ integrity of the rectal wall, and quality c

- Vaginal examination in patients with a ris

PITFALL	PREVENTION
Pelvic fractures can produce large blood loss.	• Placement of a pelvic binder or sheet can limit blood loss from pelvic fractures. • Do not repeatedly or vigorously manipulate the pelvis in patients with fractures, as clots can become dislodged and increase blood loss.

MUSKULOSKELETAL AND NEUROLOGICAL SYSTEM

PITFALL	PREVENTION
Compartment syndrome can develop.	• Maintain a high level of suspicion and recognize injuries with a high risk of development of compartment syndrome (e.g., long bone fractures, crush injuries, prolonged ischemia, and circumferential thermal injuries).

ADJUNCTS TO THE SECONDARY SURVEY

- Additional x-ray examinations of the spine and extremities
- CT scans of the head, chest, abdomen, and spine
- Contrast urography and angiography
- Transesophageal ultrasound
- Bronchoscopy
- Esophagoscopy
- Other diagnostic procedures

REEVALUATION

TRAUMA PATIENTS MUST BE REEVALUATED CONSTANTLY TO ENSURE THAT NEW FINDINGS ARE NOT OVERLOOKED AND TO DISCOVER ANY DETERIORATION IN PREVIOUSLY NOTED FINDINGS

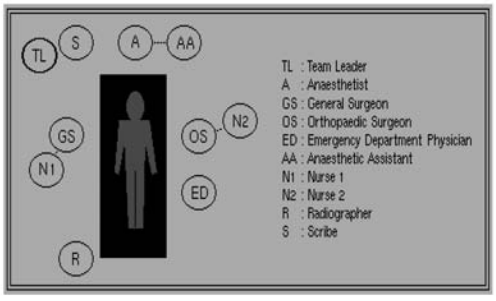
AS INITIAL LIFE-THREATENING INJURIES ARE MANAGED, BUT OTHER LIFE-THREATENING PROBLEMS MAY....

DAMAGE CONTROL RESUSCITATION

- Why ??? Traumatology ???
- Highly preventable death rate on trauma in South Korea?
- It is not my business.
- I am not a trauma surgeon.
- I am not interested in traumatology.
- I am just thoracic surgeon/ cardiac surgeon/ vascular surgeon .....
- In trainee course, I don't have a chance to meet and treat the injured patient.

TRAUMA TEAMWORK

http://www.trauma.org/archive/resus/traumateam.html



Trauma Team Tasks.

TRAUMA TEAMWORK

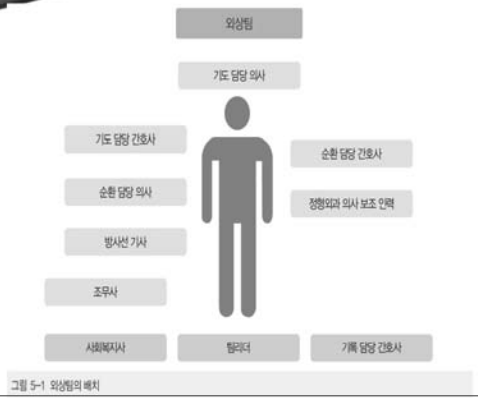


그림 5-1 외상팀의 배치

QUESTION 2, ON TRAUMA BAY

- 50/M, After Penetrating injury, Torso
- On Scene: SOL (+), Upon arrival: SOL (-)
- CPR time: (12) minutes
- FAST: Hemopericardium (+)

  Hemoperitoneum (-)
- V/S: Not checkable
- Next step ??? What should you do for patient on trauma bay?

- Signs of Life
  - Respiratory or Motor effort
  - Electrical activity
  - Pupillary activity

General Introduction of ECMO (1)

가천대학교 길병원 흉부외과학교실

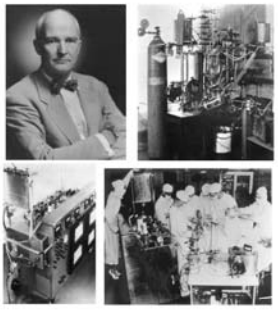
최 창 휴

History

- 1953 Gibbon — Heart lung machine
- 1960s — Development of membrane oxygenators
- 1969 Dorson et al. — 1st neonate case
- 1971 Hill et al. — 1st successful adult case
- 1975 Bartlett et al. — 1st successful neonate case
- 1989 — ELSO was founded

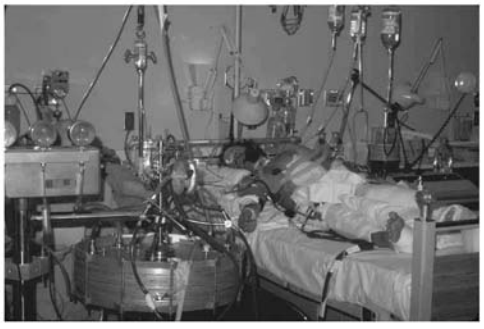
Heart Lung Machine

- The first heart – lung machine
  - John Gibbon (1937)
  - first successful heart operation (1953: Cecelia Bavolek)
- Limitation
  - minimize hemolysis, prevent air bubbles & infection
  - direct air– blood interface
  - duration of use limited to a few hours



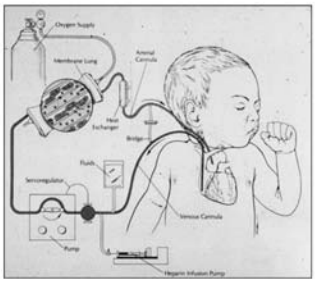
1st successful ECLS 1971

N Engl J Med 286:629-634,1972



J Donald Hill MD and Maury Bramson BME, Santa Barbara, Ca, 1971: Courtesy Dr. R. Bartlett

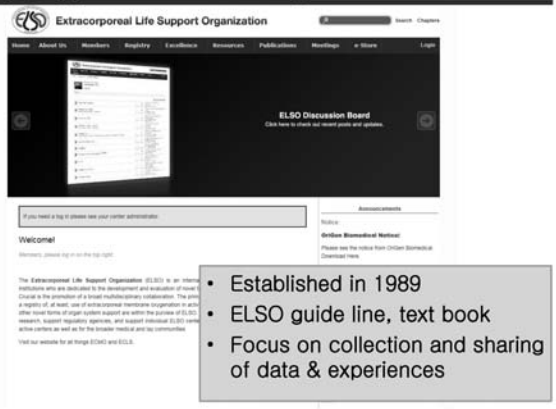
1st successful neonate case



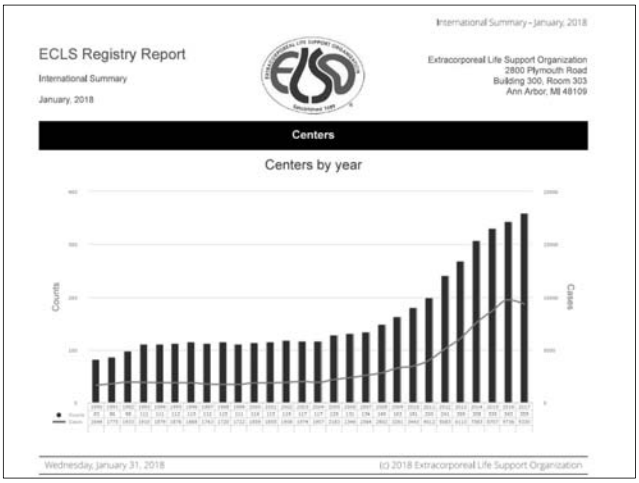
1975, Dr. Robert Bartlett, the father of modern extracorporeal support

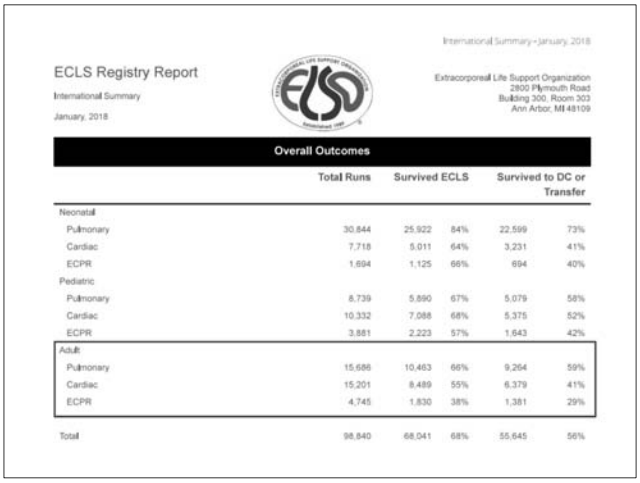
The 1st use of in a child (Esperanza), meconium aspiration

https://www.elso.org



- Established in 1989
- ELSO guide line, text book
- Focus on collection and sharing of data & experiences





	Total Runs	Survived ECLS		Survived to DC or Transfer	
Neonatal					
Pulmonary	30,844	25,922	84%	22,599	73%
Cardiac	7,718	5,011	64%	3,231	41%
ECPR	1,694	1,125	66%	694	40%
Pediatric					
Pulmonary	8,739	5,890	67%	5,079	58%
Cardiac	10,332	7,088	68%	5,375	52%
ECPR	3,881	2,223	57%	1,643	42%
Adult					
Pulmonary	15,686	10,463	66%	9,264	59%
Cardiac	15,201	8,489	55%	6,379	41%
ECPR	4,745	1,830	38%	1,381	29%
Total	98,840	68,041	68%	55,645	56%

Extracorporeal Life Support (ECLS) System

	Extracorporeal Life Support (ECLS)				
SYSTEM	Extracorporeal Membrane Oxygenation (ECMO)			Extracorporeal Carbon Dioxide Removal ($ECCO_2R$)	
SUPPORT MODE	VA ECMO	VVA ECMO	VV ECMO	VV $ECCO_2R$	AV $ECCO_2R$
CONDITION	Cardiac failure	Cardiorespiratory failure	Respiratory failure	CO_2 retention	
APPLICATION	• Cardiac ECMO • ECPR • EISOR	Cardiac and respiratory ECMO	Respiratory ECMO	Lung protection	

AV = arteriovenous; ECPR = extracorporeal cardiopulmonary resuscitation; EISOR = extracorporeal interval support for organ retrieval; VA = venoarterial; VV = venovenous; VVA = venovenoarterial

Am J Respir Crit Care Med 2018:198:447

Level 1: Cannula Hierarchy

- All cannulas contributing to the primary (major) draining and return circuit flow are written in upper case letters, such as "V-V"
- All cannulas with minor flow for secondary drainage are written in lower case letters after the major flow cannula to which side it belongs, such as "V-Aa"
- The use of a dual-lumen cannula for venovenous support would be indicated with a preceding "(dl)" abbreviation such as"(dl)V-V"

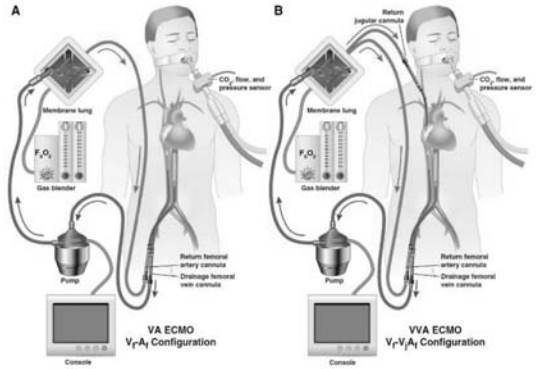
Level 2: Cannulation Site

- The next level of descriptors includes the vessel that is cannulated through the use of subscripted lowercase letters indexing the relevant drainage or return cannulation descriptor.
- Bifemoral cannulation for venoarterial support would be indicated as "V_f-A_f."
- The traditional two-cannula venovenous configuration with drainage from the femoral and return to the internal jugular would be indicated as "V_f-V_j."

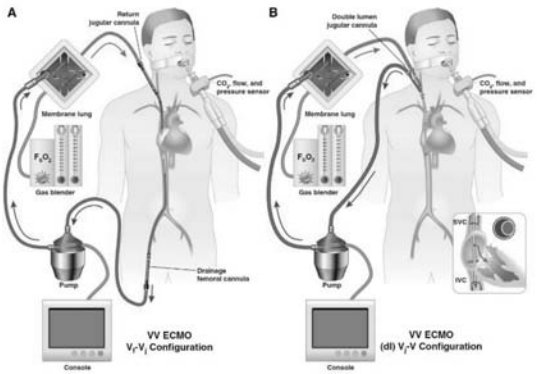
Abbreviations for Cannulation

Level	Abbreviation	Definition
Primary or secondary access	A or a	Systemic artery
	V	Systemic vein
	P	Pulmonary artery
Cannulation site	c	Carotid artery
	f	Femoral vessel
	j	Jugular vein
	s	Subclavian vessel
Central cannulation sites	RA	Right atrium
	LA	Left atrium
	LV	Left ventricle
	AO	Aorta
	PA	Pulmonary artery
	v_a	Left atrial vent

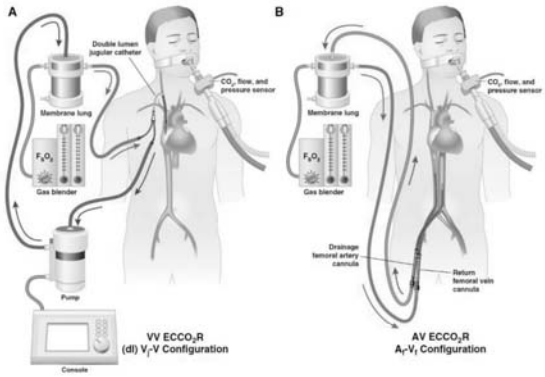
Schematic of VA & VVA ECMO



Schematic of VV ECMO

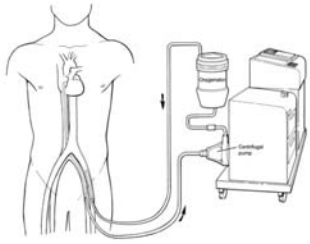


Schematic of $ECCO_2R$



Basic Physiology of ECMO

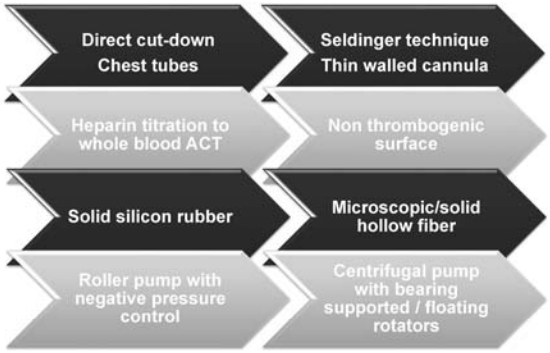
- Hollow-fiber membrane oxygenator
- Centrifugal pump: totally nonocclusive and afterload-dependent
- Circuitry interfaced between the patient and the system



Closed circuit → No Venous Reservoir

Drain amount = Reinfusion amount → Constant total volume

ECMO Equipment

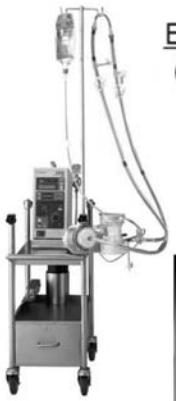


EBS; 66.7%
Emergency Bypass?

PLS: 18.2%
Permanent life support ?

- Capiox EBS (Terumo com.)
  - Quick, Compact and Simple (have the minimum number of necessary functions).

- Quadrox PLS® oxygenator
  - durability silicon membrane
  - approval for 14 days
  - Rota flow RF 32 pump
  - minimal priming volume
  - minimal hemolysis

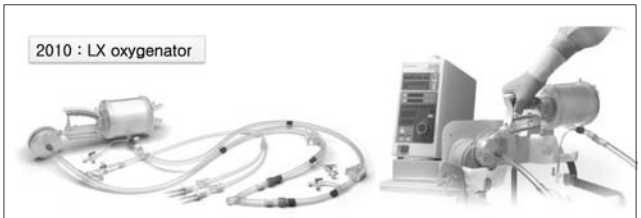


Emergency Bypass System (EBS®,Terumo, Japan)

- Quick / Compact / Simple / Safe

- 일본 1995년 개발
- 우리나라 2003년도 도입, 현재 국내 101대 사용

2010 : LX oxygenator



2015 : SP-200

専用カートでのシステム例

コントローラー

流量/気泡センサー
（チューブ取付け時）

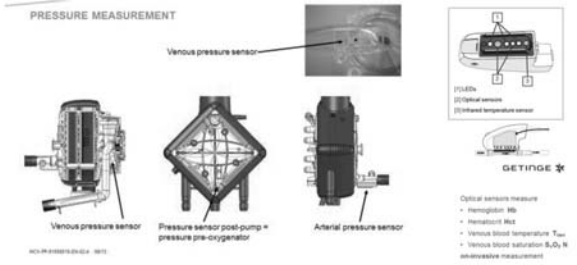
QUADROX PLS 2007
- Permanent Life Support -

MAQUET

Centrifugal pumpe Rotaflow RF 32

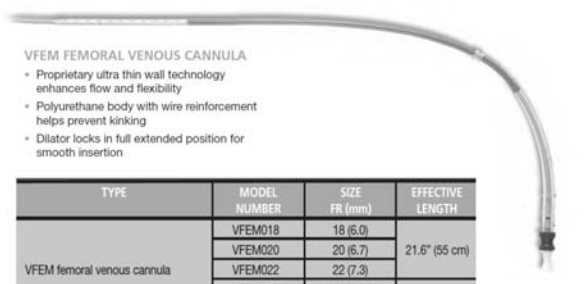
Cardiohelp (MAQUET)

HLS set advance(Cardiohelp-i)



12월중 치료재료 결정신청 접수예정, 6개월 심평원 검토기간 소요

VFEM®
Femoral Venous Cannula

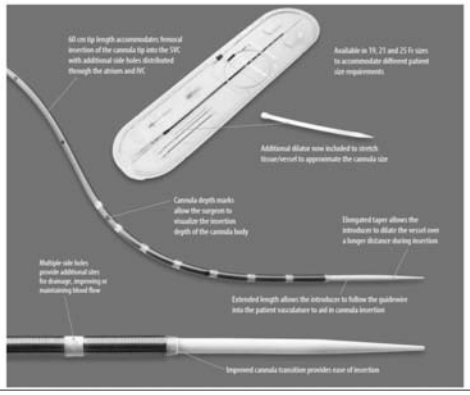


VFEM FEMORAL VENOUS CANNULA

- Proprietary ultra thin wall technology enhances flow and flexibility
- Polyurethane body with wire reinforcement helps prevent kinking
- Dilator locks in full extended position for smooth insertion

TYPE	MODEL NUMBER	SIZE FR (mm)	EFFECTIVE LENGTH
VFEM femoral venous cannula	VFEM018	18 (6.0)	21.6" (55 cm)
	VFEM020	20 (6.7)	
	VFEM022	22 (7.3)	
	VFEM024	24 (8.0)	26.8" (68 cm)
	VFEM028	28 (9.3)	

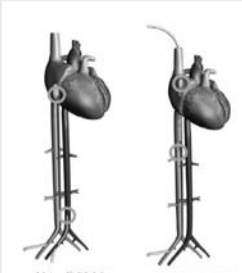
Medtronic
Bio-Medicus® Multi-Stage Femoral Venous Cannula



HLS CANNULAE

- Features & Benefits
- **Four different insertion lengths**
- Arterial short: 15 cm
- Arterial long: 23 cm
- Venous short: 38 cm
- Venous long: 55 cm

► Covering of all applications (V-A / V-V)



VA- ECMO VV- ECMO

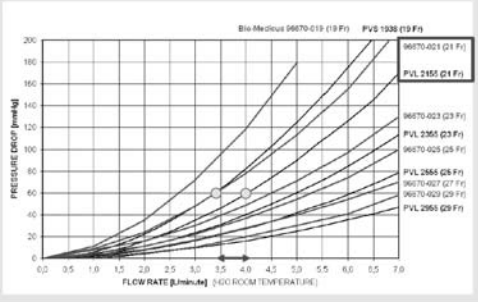
HLS cannula: 12월 1일 보험 고시, 선별급여 50%, 836,000원, 30 일 guarantee

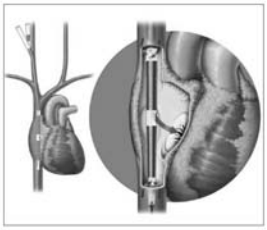
- Features & Benefits
- **Side holes on arterial and venous**
- **cannulae tip**
- ► Excellent flow/ drainage characteristics
- ► Reduced risk of plaque embolism due to reduced infusion jet, efficient drainage characteri

- **One-piece design**
- ► Reduced risk of hemolysis and thromboembolic events
- ► Excellent flow/ drainage characteristics with minimized risk for flow turbulences

COMPETITOR COMPARISON - FLOWCHARTS

- Comparison: Venous HLS Cannula vs. Bio-Medicus/Medtronic

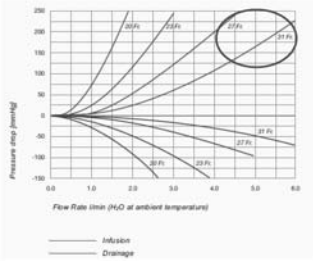




Avalon Elite Bi-Caval Dual Lumen Catheters

Article No.	Size
10013	13 Fr. (4.3 mm)
10016	16 Fr. (5.3 mm)
10019	19 Fr. (6.4 mm)
10020	20 Fr. (6.7 mm)
10023	23 Fr. (7.7 mm)
10027	27 Fr. (9.0 mm)
10031	31 Fr. (10.3 mm)

Pressure drop vs. flow 20, 23, 27, 31 Fr.



Avalone Elite DLC, 식약청 접수 6 개월, 심평원 검토 6 개월

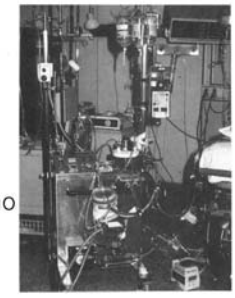
1st ECMO Cases in Korea

- 1st case report (4cases 1990.7~1991.12)

Prolonged Extracorporeal Lung and Heart Assist
(Extracorporeal Membrane Oxygenation)
– 4 cases report –

Hyun Choi, M.D., Wang Gyu Lee, M.D., Sang Min Lee, M.D.*, Hyun Soo Moon, M.D.*
Young Kyun Chung, M.D.**, Kook Hyun Lee, M.D.†, Byung Moon Ham, M.D.† and Kwang Woo Kim, M.D.†
Department of Anesthesiology, College of Medicine, Hallym University
*Department of Anesthesiology, Seiong General Hospital
**Department of Anesthesiology, College of Medicine, Kyung Sung University
†Department of Anesthesiology, College of Medicine, Seoul National University

– korean J Anesthesiol 1992;025(02):424–32



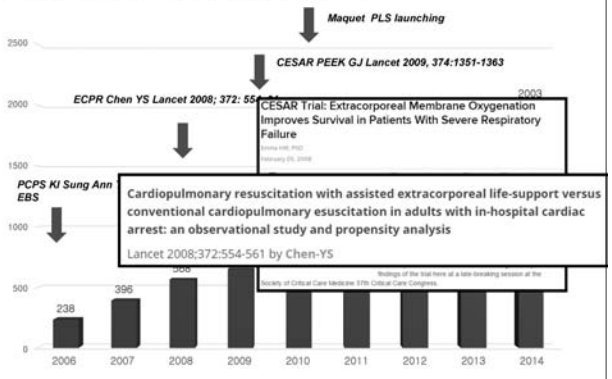
- 1st Respiratory support
  – KP Hong KJTC Surg 1994;27:60–2
- 1st Extracorporeal Cardiopulmo Resuscitation (E-CPR)
  – JH JUN KJTC Surg 1999;32:53–7

1st APESLO. in Beijing , 2013 Oct

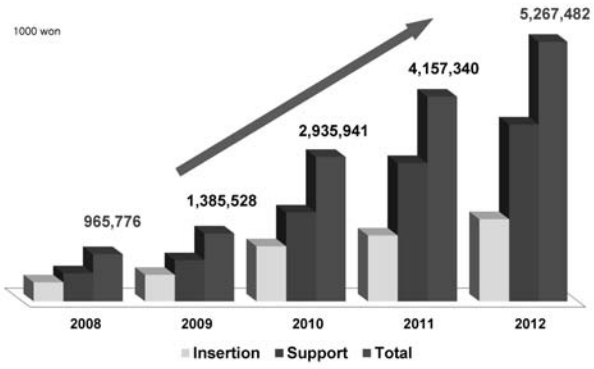
Current ECMO in Korea from 15 Center Data

Total: 2668 (based on HIRA, 2011: 1174, 2012: 1494)
N=1087 (based on 15 Center data)
- M:F = 685:401
- mean age: 52.8±21.9yrs

● 국내 에크모 현황
(2006~2014 건강심사평가원 자료) http://www.hira.or.kr



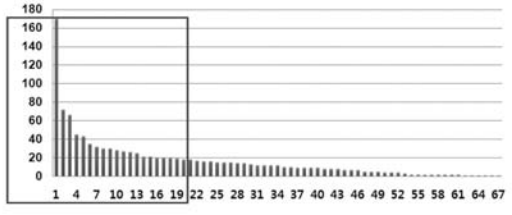
ECMO in KOREA



Korean Health Insurance Review, HIRA-NPS-2009-0051 & http://www.hira.or.kr

ECMO in KOREA

- ECMO center (2011) 71(1122 cases)
- More than 20 cases 19 center
- Planed to open 15 hospital

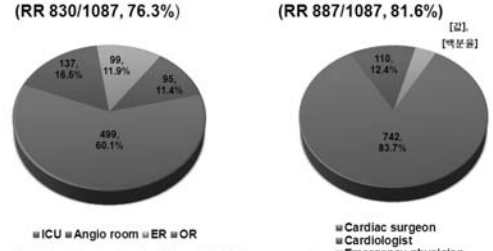


Telephone Survey(2011)

ECMO in KOREA

ECMO Insertion I

- Where? (RR 830/1087, 76.3%)
- Who? (RR 887/1087, 81.6%)

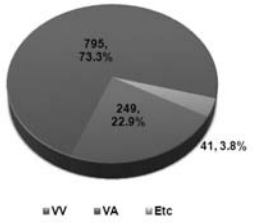


- Patients status before ECMO support
  - Arrest = 304/833(36.5%) (RR 833/108, 76.6%)

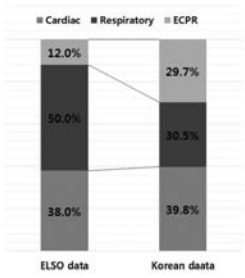
ECMO in KOREA

ECMO Management I

● Support Type of ECMO (RR1087/1085,99.8%)



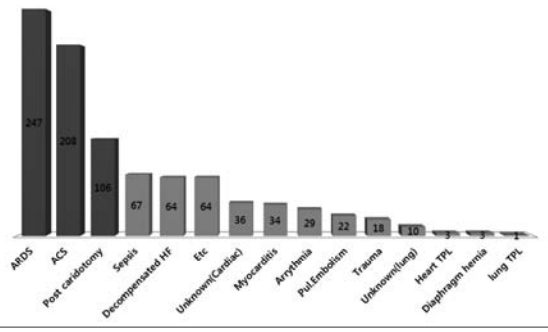
● Target of ECMO (RR 1087/1087, 100.0%)



ECMO in KOREA

ECMO Management II

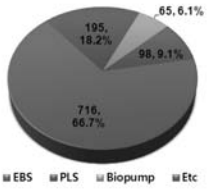
● Indication (Response Rate(RR), 912/1087, 84.2%)



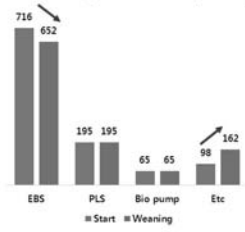
ECMO in KOREA

ECMO Management IV

● ECMO Equipment (RR 1074/1087, 98.8%)

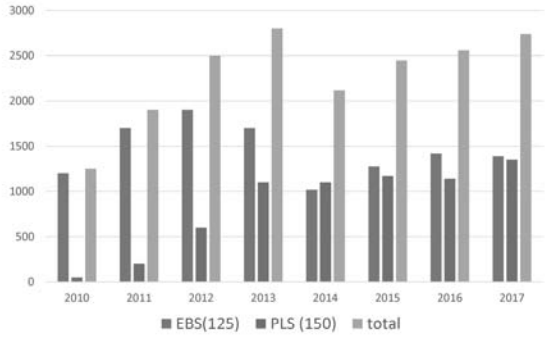


● Equipment change 'from start to wean' (RR 1074/1087, 98.8%)



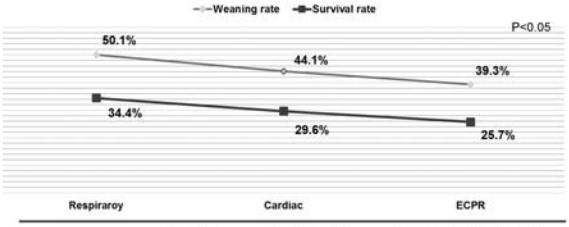
● Anticoagulation(RR 427/1087, 38.8%)
- Heparin 233/425(54.6%), Futhan102/422(23.9%), None 82/422(19.4%)

ECMO in KOREA



ECMO in KOREA

Results of ECMO

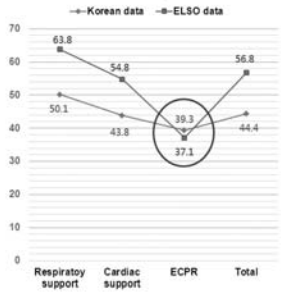


	Cases	Weaning	Survival discharge
Respiratory	331	166(50.1%)	114(34.4%)
Cardiac	433	191(44.1%)	128(29.6%)
ECPR	323	128(39.6%)	83 (25.7%)
Total	1087	483(44.4%)	325(29.9%)

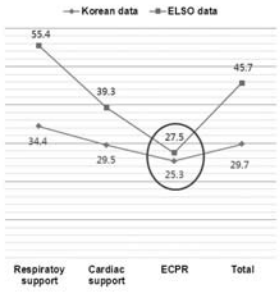
ECMO in KOREA

Summary of ECMO Results

● ECMO Weaning Rate



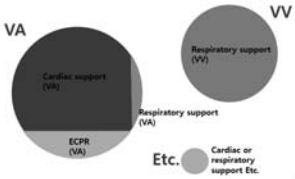
● Survival Rate



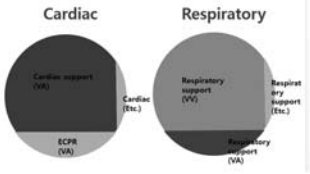
ECMO Type

- Cardiac ECMO (VA)
  - Support for both heart & lungs
  - Severe cardiopulmonary failure
  - As a bridge to heart transplantation
- Respiratory ECMO (VV)
  - Support for lungs only
  - Potentially reversible respiratory failure

ECMO Support Type

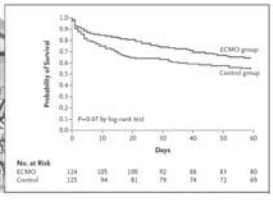


ECMO Support Target



VA ≒ Cardiac support
VV ≒ Venous support

ECMO to Rescue Lung Injury in Severe ARDS (EOLIA) trial



Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

△11% (p = 0.09)

After 6.5 ± 9.7 days, 35 (28%) patients in control arm crossover to ECMO

Combes et al. N Engl J Med 2018; 378:1965-1975. DOI: 10.1056/NEJMoa1800385

ECMO in ARDS

- 1950s Development of membrane oxygenator in lab
- 1972 First adult ECMO successful case
- 1975 First neonatal case
- 1979 Trial in ARDS, 10% survival **(1st RCT by Zapol)**
- 1986 48.8% survival rate by $ECCO_2R$ (Gattinoni et al)
- 1989 ELSO registry
- 1994 42% vs 33% survival rate **(2nd RCT by Morris)**
- 2009 CESAR trial **(3rd RCT by Peek)**
- 2009 ECMO during H1N1 influenza pandemic

Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Marianna M Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration

Summary

Background Severe acute respiratory failure in adults causes high mortality despite improvements in ventilation techniques and other treatments (eg, steroids, prone positioning, bronchoscopy, and inhaled nitric oxide). We aimed to delineate the safety, clinical efficacy, and cost-effectiveness of extracorporeal membrane oxygenation (ECMO) compared with conventional ventilation support.

Methods In this UK-based multicentre trial, we used an independent central randomisation service to randomly assign 180 adults in a 1:1 ratio to receive continued conventional management or referral to consideration for treatment by ECMO. Eligible patients were aged 18–65 years and had severe (Murray score >3·0 or pH <7·20) but potentially reversible respiratory failure. Exclusion criteria were: high pressure (>30 cm H_2O of peak inspiratory pressure) or high FiO_2 (>0·8) ventilation for more than 7 days; intracranial bleeding; any other contraindication to limited heparinisation; or any con… was death or severe disability at 6 months aft… was by intention to treat. Only researchers wh… Data about resource use and economic outcor… ost generating events were undertaken, and we… odelled lifetime cost-utility. This study is regist…

ECMO vs Conventional
→ 63% vs 47% (p=.03)

Findings 766 patients were screened; 180 were enrolled and randomly allocated to consideration for treatment by ECMO (n=90 patients) or to receive conventional management (n=90). 68 (75%) patients actually received ECMO; 63% (57/90) of patients allocated to consideration for treatment by ECMO survived to 6 months without disability compared with 47% (41/87) of those allocated to conventional management (relative risk 0·69; 95% CI 0·05–0·97, p=0·03). Referral to consideration for treatment by ECMO treatment led to a gain of 0·03 quality-adjusted life-years (QALYs) at 6-month follow-up. A lifetime model predicted the cost per QALY of ECMO to be £19 252 (95% CI 7622–59 200) at a discount rate of 3·5%.

Lancet 2009; 374: 1351–63
Published Online September 15, 2009
DOI:10.1016/S0140-6736(09)61069-2

See Comment page 1307
See Department of Error page 1310

Department of Cardiothoracic Surgery (G J Peek MD, R K Firmin MBBS) and Department of Extracorporeal Membrane Oxygenation (G J Peek, R Tiruvoipati FRCSEd, R K Firmin), Glenfield Hospital, Leicester, UK; School of Medicine, Health Policy and Practice, University of East Anglia, Norwich, UK (Prof M Mugford DPhil, M M Thalanany MSc); Department of Health Sciences, University of Leicester, Leicester, UK (Prof A Wilson MD, N Cooper PhD); Medical Statistics Unit, London School of Hygiene and Tropical Medicine, London, UK (E Allen PhD, A Truesdale BSc,

체외순환막형산화요법(ECMO)의 인정기준 (~2017)

가. 적응증

(1) 기존의 치료법에 의해 교정되지 않는 **중증 심부전**

(2) 기존의 기계적 인공호흡기 치료로 생명유지가 불가능한 **중증 급성 호흡부전**

나. 금기증

(1) 이미 진행된 **다발성 장기부전**으로 **회복 가능성이 없는** 경우

(2) **불가역적 중추신경 장애**

(3) 지혈이 곤란한 출혈부위가 있어서 **항응고요법의 절대적 금기증**에 해당하는 경우

(4) **말기암환자** 등 동 시술이 의의가 없다고 판단되는 경우

가. 적응증

2018 현재

1) 기존의 치료법에 의해 교정되지 않으나 회복 가능성이 있는 중증 급성 심부전

가) 급성심근경색증, 급성심근염, 주산기심근증(Peripartum Cardiomyopathy), 대상부전의 만성 심부전(Decompensated chronic heart failure), 수술 후 심기능부전, 불응성 심실성 빈맥(Refractory ventricular tarchycardia) 등

나) 충전(volume replacement), 약물치료(drug intervention), 대동맥내풍선 등 기존의 심부전 치료에 반응하지 않는 급성 쇼크

2) 목격된 심정지(witnessed arrest)이거나 심정지 시점이 비교적 정확히 유추 가능한 경우로 심폐소생술이 시행되어 회생가능성이 있는 경우 또는 가역적 심정지(accidental hypothermia, drug intoxication)

3) 기존의 기계적 인공호흡기 치료로는 생명유지가 불가능하지만 ECMO 시술로 회복 가능성이 있는 중증 급성 호흡부전

가) 급성호흡곤란증후군, 중증폐렴, 폐이식 후 원발성 이식실패

나) 일시적인 air way유지를 위해 실시하는 경우(기도 이물질, 기도 시술(수술) 등)

다) 심한 폐공기누출증후군(Severe air leak syndromes)

라) 폐이식 전 기관내삽관이 필요한 급성호흡곤란증후군

마) 급박한 심장 또는 폐의 허탈(최선의 치료에 반응하지 않는 폐색전증, 기도폐쇄)

4) 심장 또는 폐 이식대상환자의 교량치료 (Bridge to transplantation)로써 이식등록과정이 사전.사후에 확인된 경우

나. 금기증

2018 현재

1) 회복이 불가능한 심장질환으로, 이식 또는 심실보조장치를 시행 할 수 없는 경우

2) 충분한 조직관류(adequate tissue perfusion)없이 60분을 초과하여 심폐소생술을 시행하는 경우

3) 심폐소생술을 거부한 경우

4) 의학적으로 심폐소생술이 필요한 심정지가 목격되지 아니하여, 심정지 시간과 심폐소생술이 적시에 시행되었음을 확인할 수 없는 경우

5) 호흡부전환자에서 FiO2>90% 이거나 Pplat>30cmH2O의 높은 설정의 인공호흡기를 7일 이상 유지하는 경우

6) 지혈이 불가능한 출혈부위가 있어서 항응고요법의 절대적 금기증에 해당하는 경우

7) **최근(recent) 뇌출혈이 있거나 출혈이 증가하는 경우**

8) 이미 진행된 다발성장기부전 등으로 회복가능성이 없는 경우

9) **진행성 혈액암, 골수이식 실패, 무과립구증, 절대호중구수(ANC)<400/mm3 등 심한 면역기능저하상태인 경우**

10) 회복 불가능한 뇌손상, 비가역적 중추신경계 장애가 있는 경우

11) 말기암, 회복가능성이 없는 폐, 간, 신장 등의 만성중증장기부전

12) **동 시술이 의의가 없는 고령 환자의 경우**

사전 · 사후관리를 위한 요건

가. 시술 동의서 작성

시술 환자 또는 가족의 동의서를 작성 및 비치하여야 함

(시술의 성공가능성, 합병증, 예후 등에 대해 설명하고 소정 양식의 동의서를 작성 · 비치).

다만, 동의서 작성이 불가능한 경우에는 의사소견서(사유서) 등을 참조할 수 있음

나. 시술 후 정기적 재평가

동 시술 적용 중 정기적인 반응 평가를 통해 지속여부를 결정해야 하며, 진료기록부에 평가결과를 기재하여야 함

(반응평가: 심장 · 폐기능, 뇌손상 평가 등 **최소 3일** 마다 실시)

「건강보험 행위 급여 · 비급여 목록표 및 급여 상대가치점수」

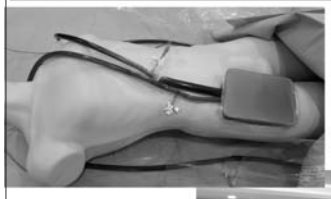
('18.1.1. 점수당 단가 병원 73.5원 기준)

분류번호	코 드	분 류	점 수	금액(원)
		제9장 처치 및 수술료 등		
		제1절 처치 및 수술료		
		[순환기]		
자-190	O1903	부분체외순환-ECMO 사용	9,079.03	667,310
		Partial Extracorporeal Circulation		
	O1904	부분체외순환10시간 초과 익일부터[1일당] -ECMO사용	4,766.98	350,370

* 3차병원 가산(30%), 흉부외과 가산(100%)

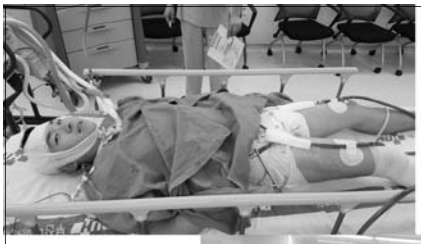
환자 부담	
HF, OHS = 5%	I1903 -> 1.735.620 x 0.05 = 86.750
	I1904 -> 910.962 x 0.05 = 45.548
그 외 (ARDS 포함) = 20%	I1903 -> 1.735.620 x 0.2 = 347.001
	I1904 -> 910.962 x 0.2 = 182.192

Traning & Simulation



2016 Basic course of ECMO
: Hand on simulation

부산대병원
외상 시뮬레이션센터



Take Home Massage

- 국내 에크모 현황은 심장보조, ECPR이 많은 특징을 가지고 있으나 최근 폐이식 수술의 증가와 더불어 폐 보조를 의한 에크모도 크게 증가하고 있다. 현재 에크모의 성적은 ELSO의 결과에 비교해 전체적으로 약간 낮은 수준을 보여주나,향후 적응증 조절 및 관리 기술의 등의 발달로 향상 될 것을 기대한다.

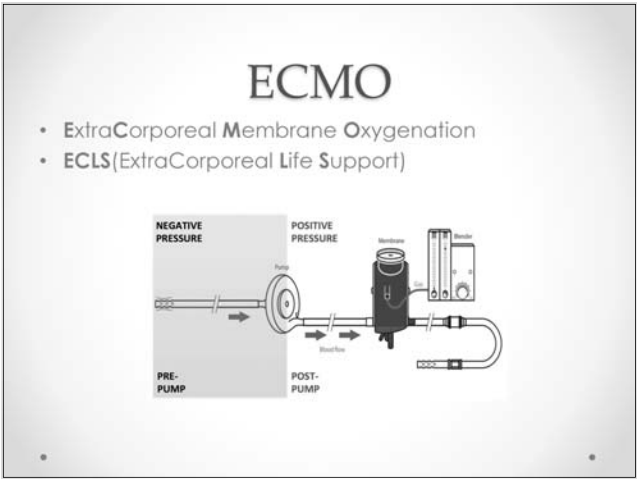
- 국내 에크모 건수는 빠르게 증가하여 연간 2000례를 넘고 있으며 심평원의 **적응증** 조절과 함께, 자체적인 **레지스트리** 구축이 필요할 것으로 여겨진다.

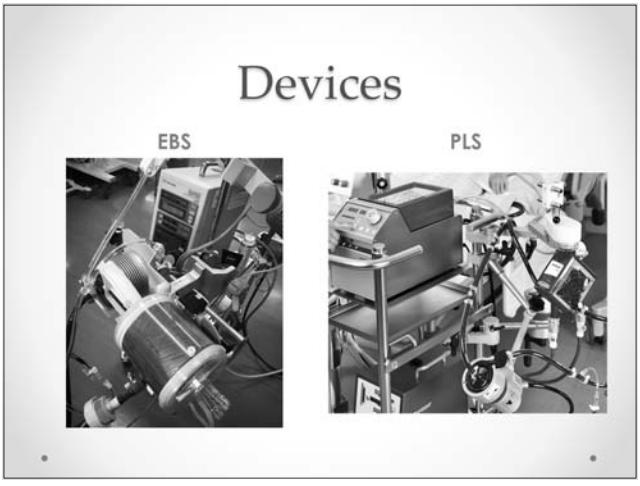
- 향후 에크모는 장비 발달, 시스템의 표준화 등으로 좀더 확대 될 것으로 보이며, **새로운 장비**들이 개발 되 현재의 한계 등을 극복하게 될 것으로 판단되므로 이에 대한 준비로 다양한 **연구와 교육**이 필요할 것으로 생각된다.

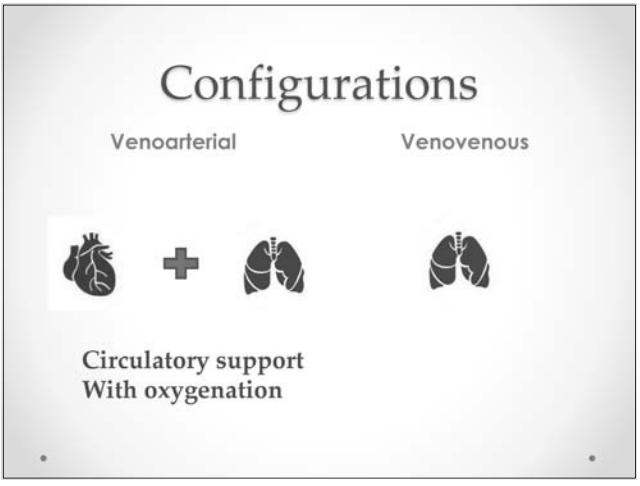
Management of ECMO

부산대학교병원 흉부외과학교실

송 승 환







Role of ECMO

Management of ECMO

ECMO flow

- 적절한 flow ?
  1. Normal CI = CO / BSA = 2.4 – 4.0 L/min/m^2
  2. Adequate RPM

Flow 를 결정하는 인자

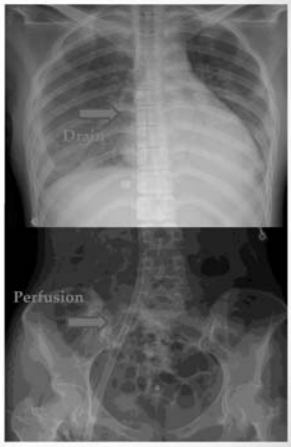
1. Pump speed
2. Size of cannula
3. Position of cannula
4. Patient blood volume

Line Chattering

- High negative pressure
- Squeeze blood cells – hemolysis
- Cannula position
- Patient's **low** blood volume

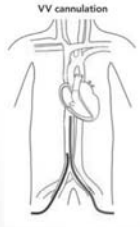
VA ECMO

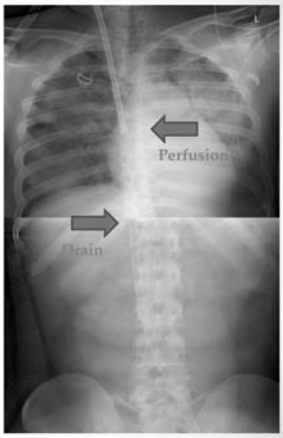
- Drain - **FV**, IJV, RA
- Perfusion - **FA**, axillary artery, aorta



VV ECMO

- Drain **FV**
- Perfusion **FV, IJV**





Veno-venous ECMO

physiologic

"simply **elevate the oxygen** in central venous blood"

Hemodynamic

- Normal blood pressure
- Usually result in **decreasing vasopressor** and inotropic requirements
- **lung rest** -> reduction of intrathoracic pressure
- **Improved myocardial** oxygen delivery
- Maintaining **adequate preload** without concern of worsening lung function

Respiratory support

- **VILI**(ventilator induced lung injury)
- "**Lung protective**" parameters
  - Tidal volume ≤ 6ml/kg
  - Plateau airway pressures ≤ 30 cmH2O
  - PEEP(positive end expiratory pressure) 10 cmH2O
  - Respiratory rate 10~12 breaths per minute
  - FiO2 30 %, accepting PaO2 ≥ 45 mmHg
- Peripheral sat%: 85-92%

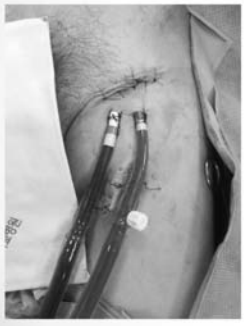
ECMO gas exchange

- Ventilator 와 유사
  - **Sweep gas flow** = minute volume

  CO2 clearance 관련
  - ECMO flow : sweep flow = 1:1
  - **FiO2** = ventilator FiO2

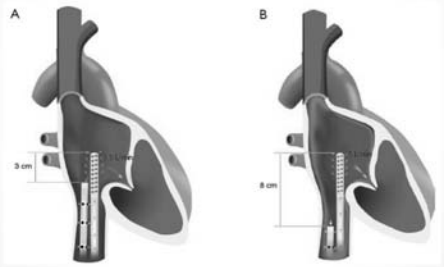
  O2 level과 관련

Gas exchange Monitoring



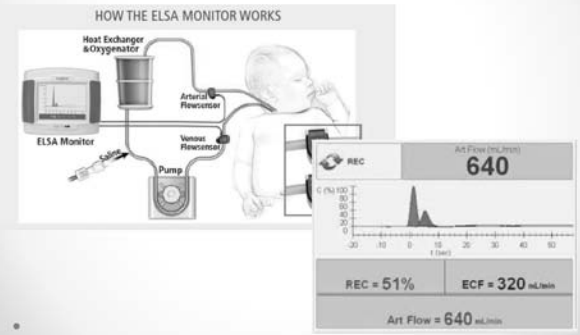
- **ECMO ABGA** = Oxygenator function 을 반영
- 항상 drain line vs perfusion line의 color 차이를 확인

Re-circulation

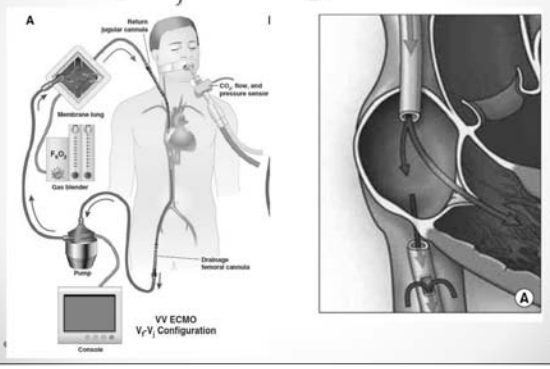


ELSA

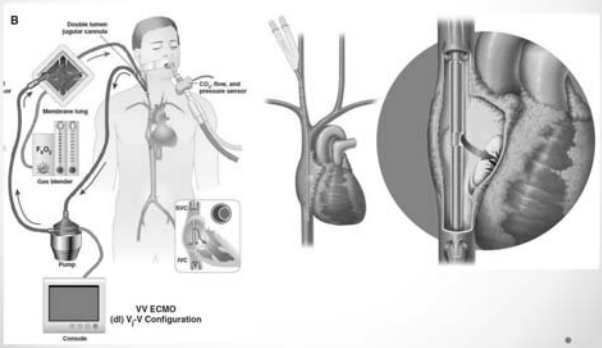
(assurance)



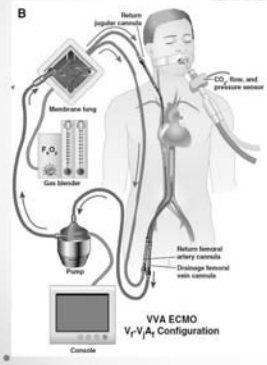
V_f-V_j configuration



Dual Lumen (dl) V_j-V configuration



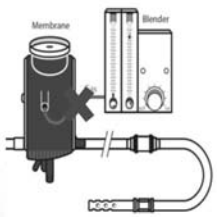
VV ECMO with RV failure



- V_f-V_jA_f configuration
- Both, partial support
- Sternotomy, **oxyRVAD**
  - RA-PA

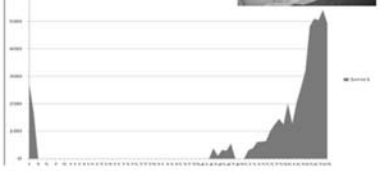
Weaning of VV ECMO

- Capping the gas inlet
- After12-24 hrs observation, decannulate



Lung recovery

Tidal volumes long run ECMO



40 yo, viral ARDS, Awake alert on ECMO, total consolidation for 50 days

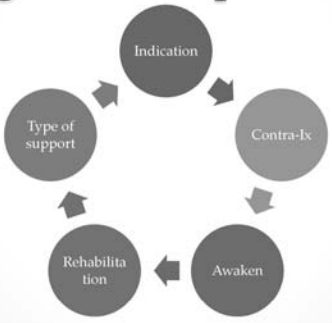
courtesy of Paile Palmer, Karolinska

Change

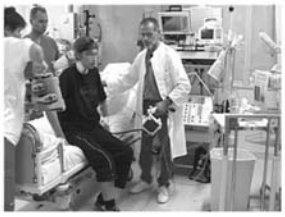
Change of concept of ECMO

ECMO I	ECMO II
Sedation, Paralysis	Awake, Spontaneous breathing
Intubated	Tracheostomy
Rest vent settings	CPAP, extubate?
Specialist 24/7	ICU Nurse, ECMO Team role
Lung recruitment?	Watch and wait
Bleeding: major	Bleeding: minor

Bridge to transplantation



Ambulatory, BTT



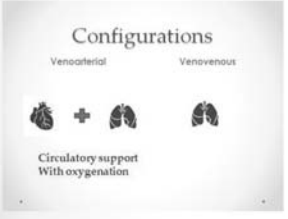
Ambulatory Lung Assist
PA-LA implantation, 5 weeks, bridging to transplant
Regensberg, 2007

Veno-arterial ECMO

• • •

More complicated

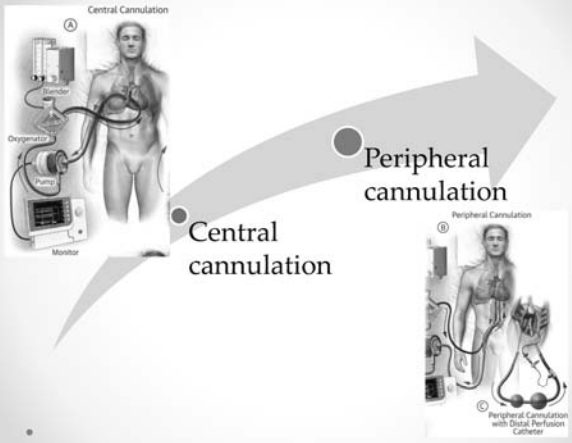
Hemodynamic



1. Mean arterial blood pressure ≒ **60 mmHg**
2. Discontinue vasoactive agents
3. **Avoid hypertension**
   1. Afterload 증가로 myocardial recovery를 방해
   2. Centrifugal pump의 경우 venous return을 방해하여 flow 감소를 야기

Monitoring

- Monitoring for adequate tissue perfusion
  1. Serum **lactate** level
  2. acidosis
  3. Adequate urine output
  4. Mixed venous saturation (**SVO2**) **> 70%**

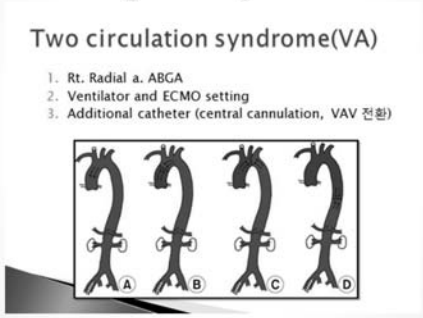


Central vs peripheral

- Open
- Good ECMO flow
- On-site Left vent
- Bleeding

- **Percutaneous**
- Limited flow
- Additional vent procedure
- Harlequin syndrome
- Limb ischemia

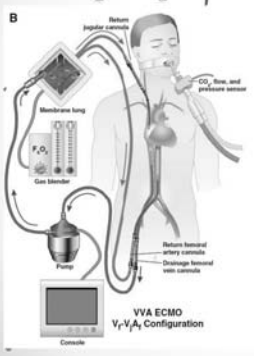
Harlequin syndrome



Peripheral Saturation

- SpO2 target
  1. **95**% for VA ECMO
- **Lung rest**
  - Avoid high tidal volume and pressure < 25 cmH2O
- Avoid hyperoxia
- Avoid respiratory acidosis

V_f-$A_f$$V_j$ configuration



- Peripheral VA ECMO with lung failure
- **V-VA ECMO**

-> VV ECMO

-> weaning

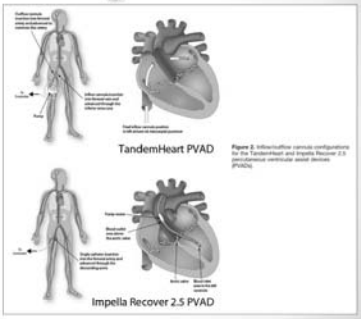
Vent the LV

- Pulmonary edema despite of diuresis and inotropes

Prevent lung injury → Avoid stasis within the LV → Promote myocardial recovery

Venting

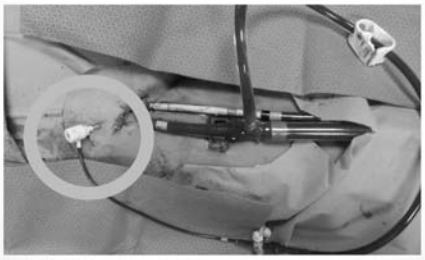
- **Septostomy**, trans-aortic venting
- Open **surgical** venting



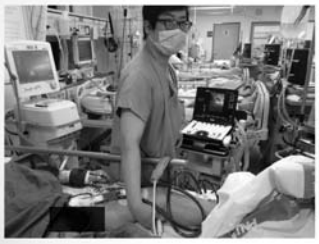
Limb ischemia

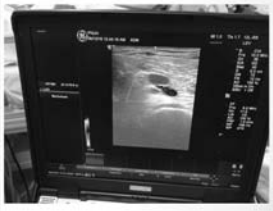
- Most fetal vascular complication
- Golden time, doppler check every 2 hrs.
- Reperfusion injury
- Acidosis
- ARF

Distal perfusion

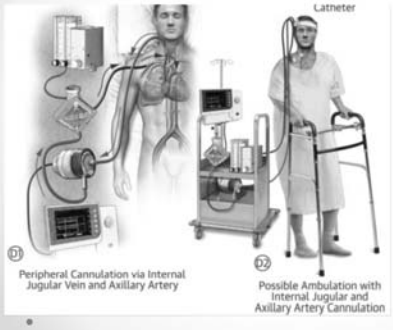


Reassurance



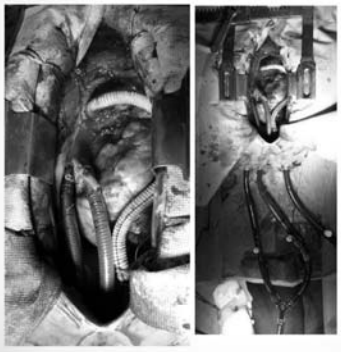


Peripheral, but upper extremities



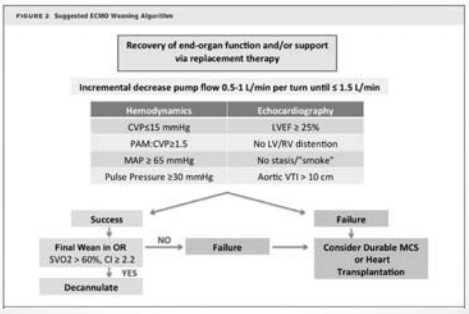
- Jugular v. – subclavian a.
- Need open technique
- Arm swelling

Central ECMO



RAv_a-Ao configuration

Wean ECMO



VTI=Velocity-time integral

Short-term mechanical circulatory support as a bridge to durable left ventricular assist device implantation in refractory cardiogenic shock: a systematic review and meta-analysis

European Journal of Cardio-Thoracic Surgery 52 (2017) 14-25

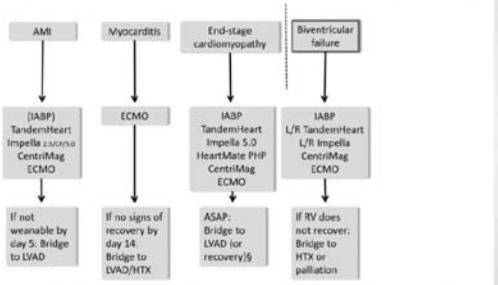


Figure 2: Current application of short-term mechanical circulatory support and possible timing towards durable left ventricular assist device in patients with refractory cardiogenic shock. § Bridge to recovery is only realistic in case of *de novo* heart failure or in acute on chronic heart failure when a clear cause for exacerbation exists.

Common management

Anticoagulation (Heparin)

- Target ACT (activated clotting time) : 180-220 sec
- aPTT, factor Xa assay
- Futhan, argatroban

Blood product administration

- Platelet count > 10 만/mm^3
- Hematocrit > 35-40 %
- Fibrinogen > 150 mg/dl (50-100 mg in 1 pack of cryoprecipitate)
- FFP
  - Hypovolemia, 응고인자부족, **AT III** 부족
  - Vit. K 같이 보충하는 것이 좋다
- Albumin > 2.5 mg/dl
- Electrolyte imbalance (potassium...)

Practice

Table 7-3. Laboratory Schedule.

Anticoagulation Lab	Guideline
ACT	Q1h – Q2h
aPTT	Q6h – Q12
Anti- factor Xa Assay	Q6h
Platelets	Q6h - Q12h
INR	Q6h - Q12h
Fibrinogen	Q12h - Q24h
CBC	Q6h - Q12h
Antithrombin Level	Daily - PRN
Thromboelastography	Daily – PRN for bleeding or clotting complications

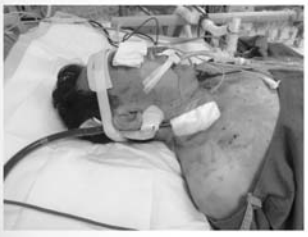
Table 7-4. Blood Product and Factor Replacement.

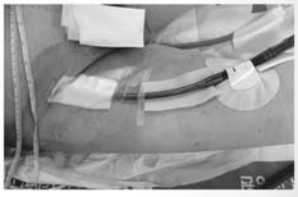
Anticoagulation Lab	Guidelines
Platelets	Platelet transfusion to maintain counts >80,000 μL to 100,000 μL
INR	FFP transfusion to maintain INR <2.0
Fibrinogen	Cryoprecipitate to maintain fibrinogen >100 mg/dL OR >150 mg/dL if bleeding or prior surgical intervention
Hematocrit	PRBCs to maintain hematocrit >30% (consider higher goal for neonates and children with cyanotic congenital heart disease or lower goal for stable, adult patients)
Antithrombin	>50%-80% (>0.5-0.8 u/mL), consider AT replacement if on maximum dose of UNFH and unable to obtain therapeutic anti-factor Xa assay

Cannula site Bleeding

- Compression
- Purse-string suture
- Coagulopathy 교정
- Revision

Fixation





ECMO emergencies

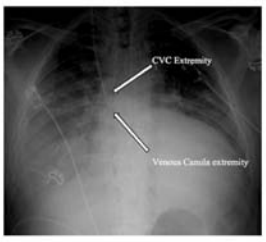
Pump failure

- Acute thrombosis
- Circuit change

Air embolism

Massive air embolism from central venous catheter during veno-arterial ECMO therapy

Anaesth Crit Care Pain Med 37 (2018) 271–272



Rupture of circuit

Accidental de-cannulation

- Clamp
- Compress
- Stop pump

- Call for help
- Resuscitate the patient

Shut down

- Re-booting
- Another machine

- Hand crank

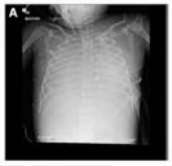
ASAIO Journal 2019 Case Report

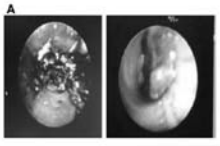
Recovery from Total Acute Lung Failure After 20 Months of Extracorporeal Life Support

Kristen Nelson-McMillan,*†‡ Luca A. Vricella,*¶ Dylan Stewart,*¶‖ John Young,** Ashish S. Shah,†† Narutoshi Hibino,*¶ # and John D. Colvson*‖§

Table1. Organ Support by Phase

	ECMO (Phase 1)	ECMO (Phase 2)	ECMO (Phase 3)	ECMO (Phase 4)	ECMO (Phase 5)
ECLS Day #	1–7	7–61	61–420	420–552	553–605
Type of extracorporeal support	VA-ECMO	VV-ECMO	RVAD-oxygenator "CentriMag with Quadrox"	Peds RVAD-oxygenator "PediMag with Ped-Quadrox"	ECCOR
Supports oxygenation	X	X	X	X	
Supports carbon dioxide removal	X	X	X	X	X
Supports left ventricle	X				
Supports right ventricle	X		X	X	





Take home massage

Viable exit strategy

Management goal

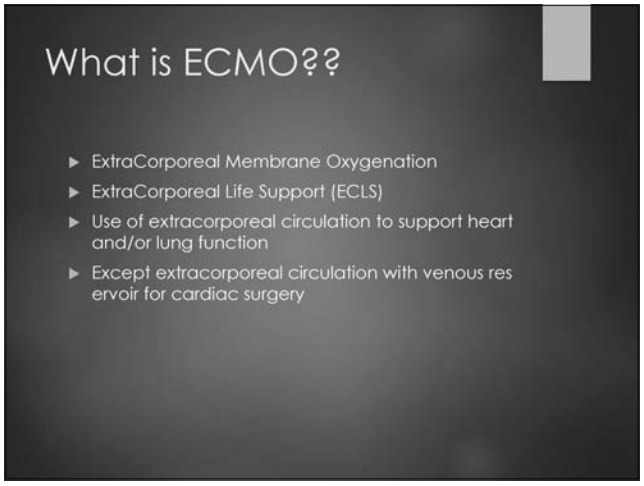
Timely change of type of support

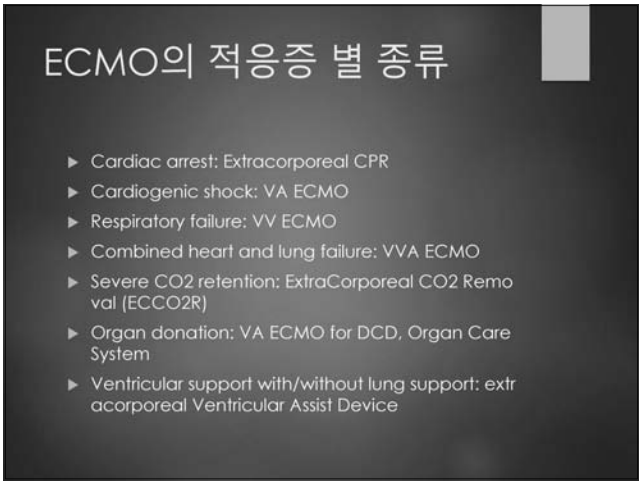
Thank you for your attention

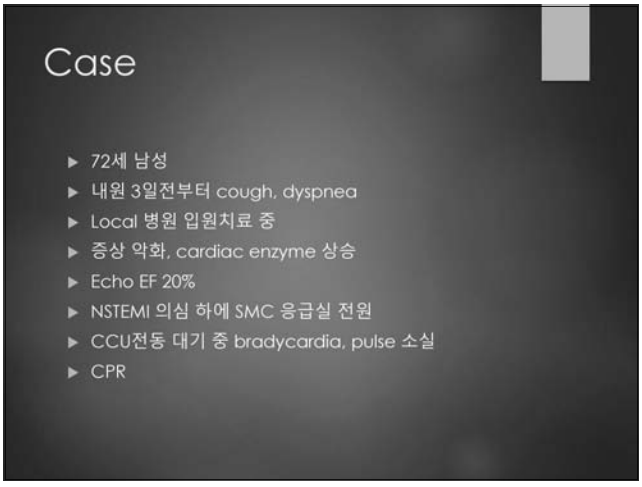
에크모 적용의 실제

Director of Adult ECMO Service, Surgical Director of Heart Transplantation and MCS Service,
Director of Adult Cardiac Surgical ICU, Samsung Medical Center

Yang Hyun Cho, MD







Non Cardiac cause Cardiac Arrest in Cancer patients?

- Circulatory collapse or shock → cardiac arrest (heart stops beating)
- Direct causes of cardiac arrest
  - Pure cardiac etiologies: ischemic, nonischemic
  - Secondary cardiac
    - Thrombotic process, stress & spasm (ischemic)
    - Immunocompromise, stress, Apical balloon syndrome, lung failure, brain failure (non-ischemic)

ECMO 시술기록

■ 기본정보
시술일 : 2019-03-15
시술의 : 조양현, 김영수, 김신, 김명환, 이주형
삽입장소 : ER
응급도 : On CPR

■ 진단명
r/o AMI

■ 시술명
ECMO insertion

■ 시술경위 (Brief history)
시술사유 : ECPR or Post CPR hemodynamic instability
시술목적 : Bridge to recovery

■ 시술중 발견사항
Lt.femoral vein guide wire 진입이 되지 않아 3차례 시도 후 Rt.femoral vein으로 insertion 시행함

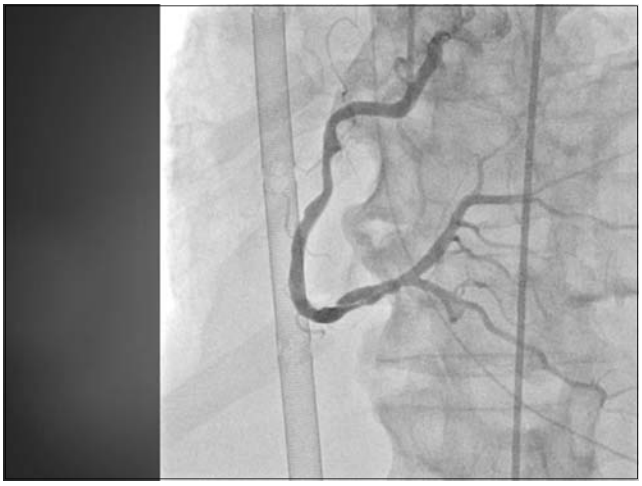
■ 시술과정
ECMO support mode : VA
Pump : SP Pump (Terumo)
Oxygenator : EBS Long-term

	Size	Type	Insertion site	Insertion technique	Cannula tip 위치
Drain 1	21Fr.	가(E)	Rt.Femoral	Seldinger	IVC
Perfusion 1	15Fr.	가(E)	Rt.Femoral	Seldinger	

Distal perfusion : No (Dorsalis pedis artery pulse check)

ECPR, Essentials

- Indications: high probability of primary cardiac and favorable neurologic outcome
  - Witnessed arrest, bystander CPR
  - Shockable rhythm (bit RCA occlusion), Echo, EKG, symptom, past history
- Contraindications
  - Asystole, no ROSC for prolonged time (>30min), airway cause
- Cannulation
  - Use ROSC! Feel pulse! Use vascular sono and Echo! See color of blood!
  - Small cannulae (15 for A, 19~21 for V)
  - Never stop CPR until proper cannulation is confirmed.
  - Heparin after vessel puncture
- 모든 invasive line을 잡을 때 ECMO cannulation을 하는 기분으로!

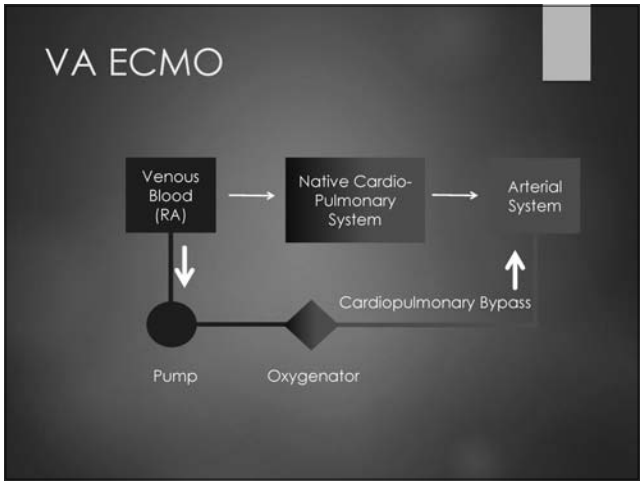


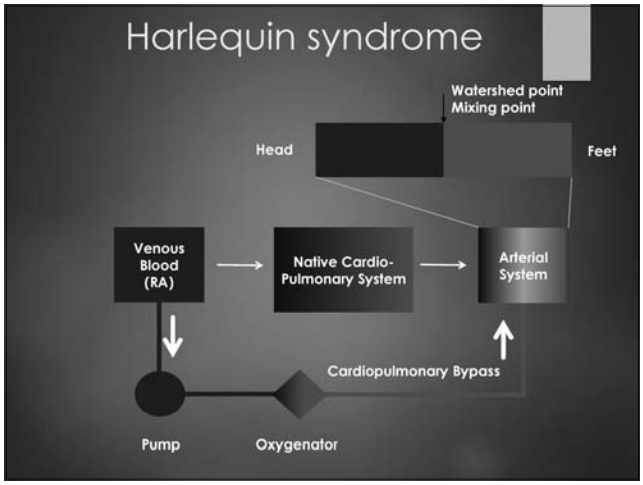
VA ECMO

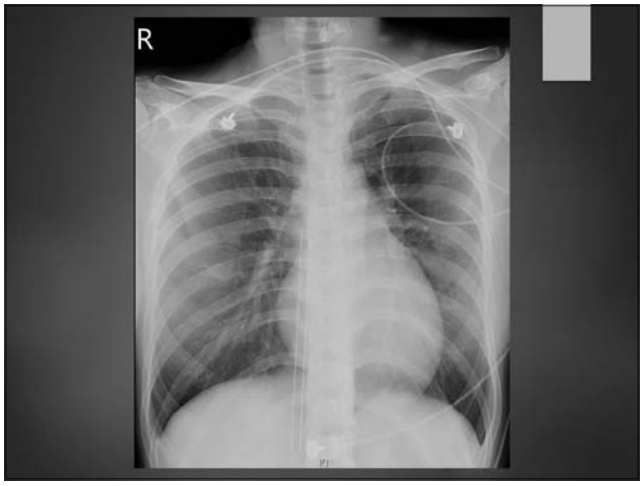
ACUTE CARDIAC FAILURE

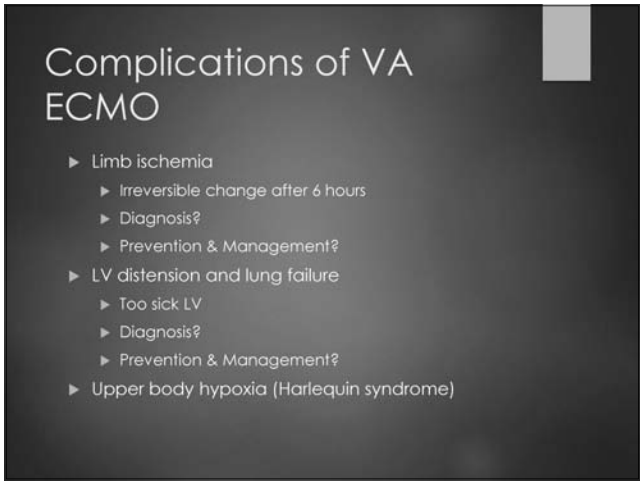
Case

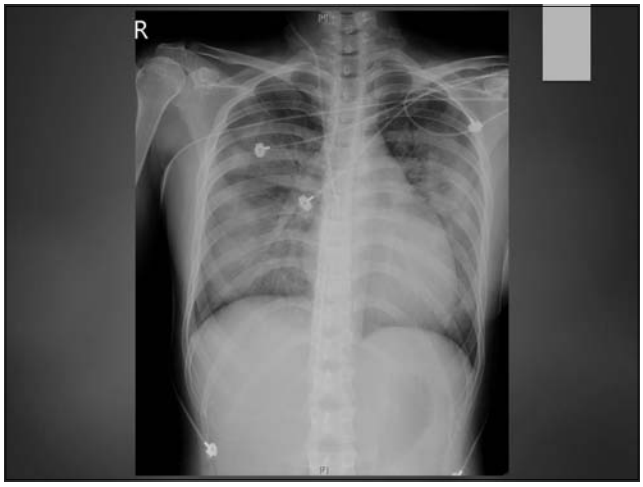
- 22세 여대생
- Chest pain and chest discomfort for 3 days
- Local clinic for nausea, vomiting, headache
- After local medication, vomiting 지속, SMC ER 방문
- Hypotension, ST change, Coronary CT (normal)
- Complete AV block, Ventricular rhythm

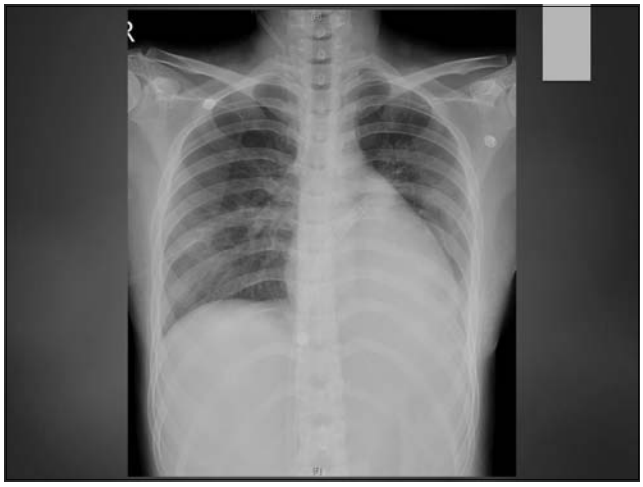

VA ECMO
Venous Blood (RA)
Native Cardio-Pulmonary System
Arterial System
Cardiopulmonary Bypass
Pump
Oxygenator


Harlequin syndrome
Watershed point
Mixing point
Head
Feet
Venous Blood (RA)
Native Cardio-Pulmonary System
Arterial System
Cardiopulmonary Bypass
Pump
Oxygenator


R


Complications of VA ECMO
Limb ischemia
Irreversible change after 6 hours
Diagnosis?
Prevention & Management?
LV distension and lung failure
Too sick LV
Diagnosis?
Prevention & Management?
Upper body hypoxia (Harlequin syndrome)


R


R

VA ECMO, Essentials

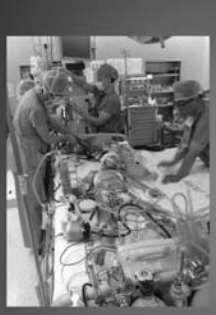
- Cardiac arrest를 피해라. 불안하면 넣어버리거나 삽입할 준비를 해 둔다 (A, V sheath 삽입).
- 역시 삽입하기 어려운 큰 cannula는 꼭 필요치 않다.
- 일단 삽입한 후에는 합병증에 대비하라.
  - 예방, 진단, 치료
- Organ perfusion을 모니터 한다.
  - Mentality, skin, urine output
  - SVO2, Lactate clearance
  - MAP

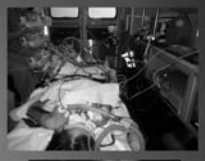
VV ECMO

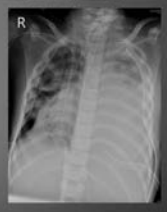
Male 10 years old

■ 현병력
상기 10세 남아, 이전 병력없는 환아로

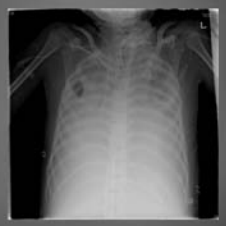
2013.07.18 아파트 단지내에서 승용차에 치인후 바닥에 쓰러진뒤 승용차가 밟고 지나가며 상긴 TA 로 고대 안산병원 응급실 내원함. 내원후 기도삽관중에도 hemoptysis 다량 보임. 이후 TS 에서 bilateral closed thoracostomy 및 ventilator care 시행함.
이후 ventilator care 하며 weaning try 하였으나 FiO2 0.6 에서 SaO2 70# 대로 유지되지 않아
2013.07.29 V-V ECMO apply (Rt.jugular vein: 14fr, Rt.femoral vein: 15fr, Lt. femoral vein, 14fr), ecmo flow 3liter 유지함
2013.07.30 thracoscopic Lt.lung repair
2013.08.01 thoracoscopic Lt.lung bleeding control 시행함
2013.08.05 환아 ECMO 시행 8일째 further management 위해 본원 전원옴



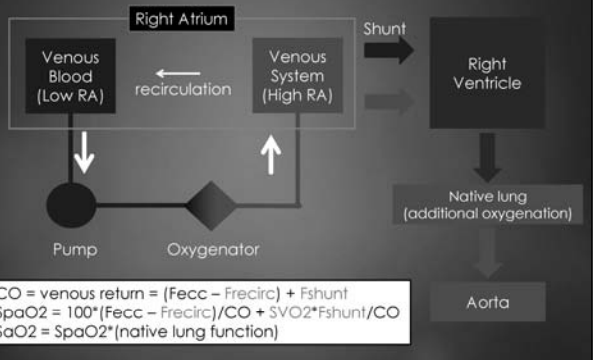




About a week later…

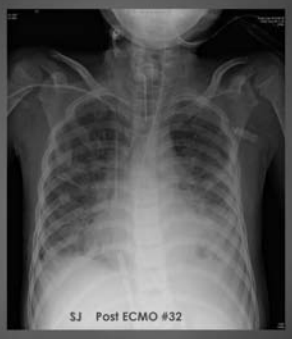


VV ECMO



Determinants of Oxygenation During VV ECMO

- Extracorporeal flow fraction
  - Fraction of cardiac output captured by circuit
  - Shunt
- Mixed venous oxygen saturation
  - Oxygen extraction
  - Hemoglobin
  - Cardiac output
- Native lung function: Ventilator setting
- Cardiac output > 60% associated with Sao2 > 90% (Schmidt M, et al. Intensive Care Med. 2013;39:838-846.)



2014.04.05
■ 주관적 소견
doing well
달리기 포함한 운동 잘함.
URI hx : 2/month (1일만에 호전)

Summary

- ECMO의 정의, 의미, 구분
  - 산소 공급장치
- ECPR
  - Selection criteria
- VA ECMO
  - Timing of insertion
  - Complication management
- VV ECMO
  - Determinants of SaO2
  - Lung protection!

Hands-on & Simulation

[1]고려대학교 안암병원, [2]계명대학교 동산의료원, [3]분당서울대학교병원, [4]전남대학교병원, [5]부산대학교병원

임주영[1], 김재범[2], 김동중[3], 정인석[4], 송승환[5]

1. Echocardiography (담당: 임주영, 김재범)
2. US-guided Vascular Procedure/ECMO Cannulation (담당: 김동중)
3. ECMO Decannulation (Device Closure) (담당: 정인석)
4. ECMO Priming - EBS & PLS (담당: 송승환)

조양현 (성균관대학교 삼성서울병원), 강민형 (부산대학교병원 체외순환사),
이광일 (전남대학교병원 체외순환사), 황현주 (부산대학교병원 간호사)

Hands-on & Simulation 시간 / 조 배정

	US-guided Vascular Procedure/ECMO Cannulation	ECMO Decannulation	ECMO Priming - EBS
08:00～08:30	1조	2조	3조
08:30～09:00	2조	1조	4조
09:00～09:10	Coffee Break		
09:10～09:40	5조	6조	1조
09:40～10:10	6조	5조	2조
10:10～10:30	Coffee Break 및 객실 Check Out <프론트에 객실키 반납>		
10:30～11:00	3조	4조	5조
11:00～11:30	4조	3조	6조

Hands-on & Simulation 시간 / 조 배정

	ECMO Priming - PLS	Echocardiography
08:00～08:30	4조	5조(임주영), 6조(김재범)
08:30～09:00	3조	
09:00～09:10	Coffee Break	
09:10～09:40	2조	3조(임주영), 4조(김재범)
09:40～10:10	1조	
10:10～10:30	Coffee Break 및 객실 Check Out <프론트에 객실키 반납>	
10:30～11:00	6조	1조(임주영), 2조(김재범)
11:00～11:30	5조	

2019년 대한흉부심장혈관외과학회
제12차 전공의 연수교육

인　　쇄 : 2019년 5월 17일

발　　행 : 2019년 5월 23일

발 행 인 : 권　오　춘

발 행 처 : 대한흉부심장혈관외과학회

[04501] 서울시 중구 만리재로33길 21
LIG서울역리가 101동 401호
Tel: 02-3482-7869, Fax: 02-3482-7868
E-mail: society@ktcs.or.kr

편집제작 : (주)더 위드인

[04038] 서울시 마포구 양화로 100-20
(서교동 372-10) 삼경빌딩 5층
Tel: 02-6959-5333, Fax: 070-8677-6333
E-mail: with@thewithin.co.kr