Technique and complication of aortic surgery

Hyun-Chel Joo

Division of Cardiovascular Surgery,
Yonsei Cardiovascular Hospital,
Yonsei University College of Medicine, YUHS

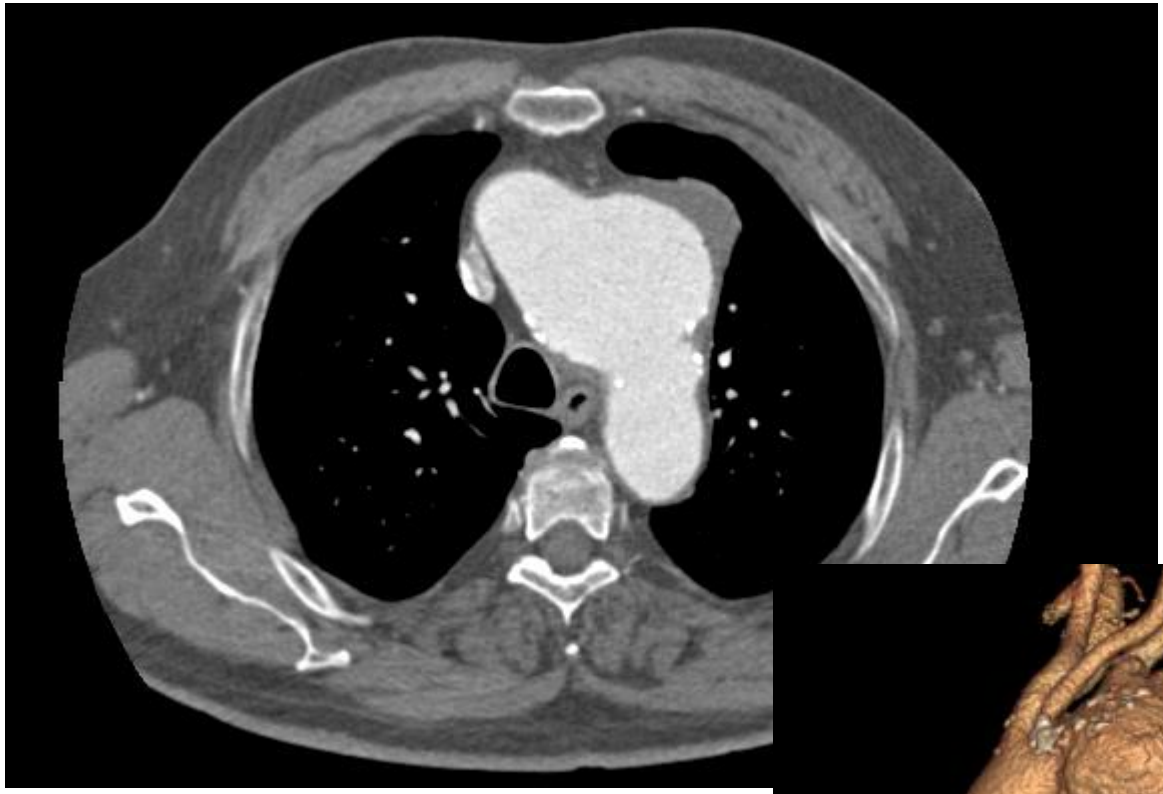
Type of aortic surgery

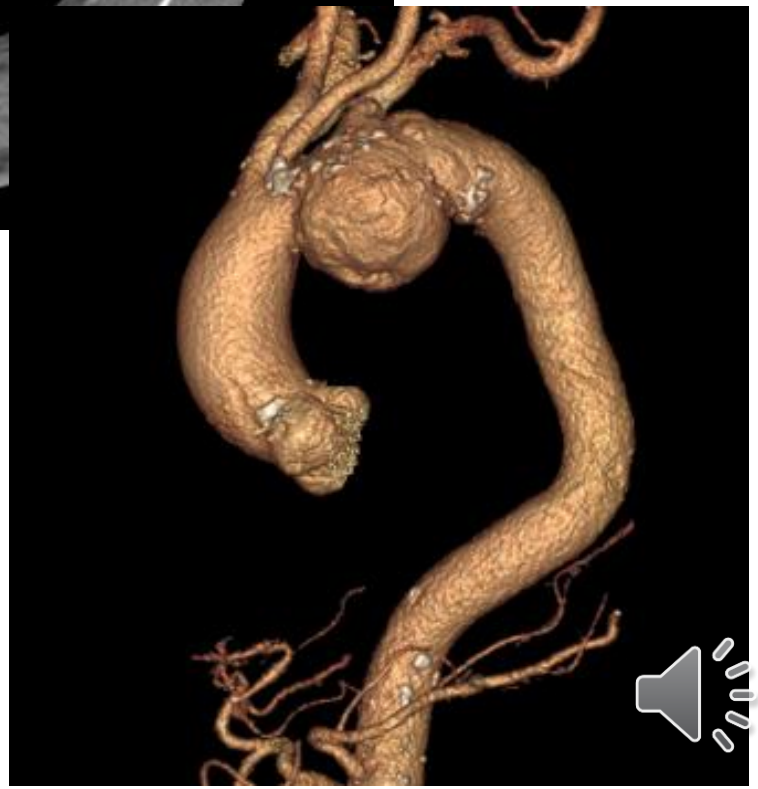
- Ascending aorta replacement
- Arch replacement
- Descending aorta replacement
- Thoraco-abdominal aorta replacement
- Abdominal aorta replacement

Aortic arch surgery

Case

- F/75
- hoarseness
- Arch aneurysm 75mm

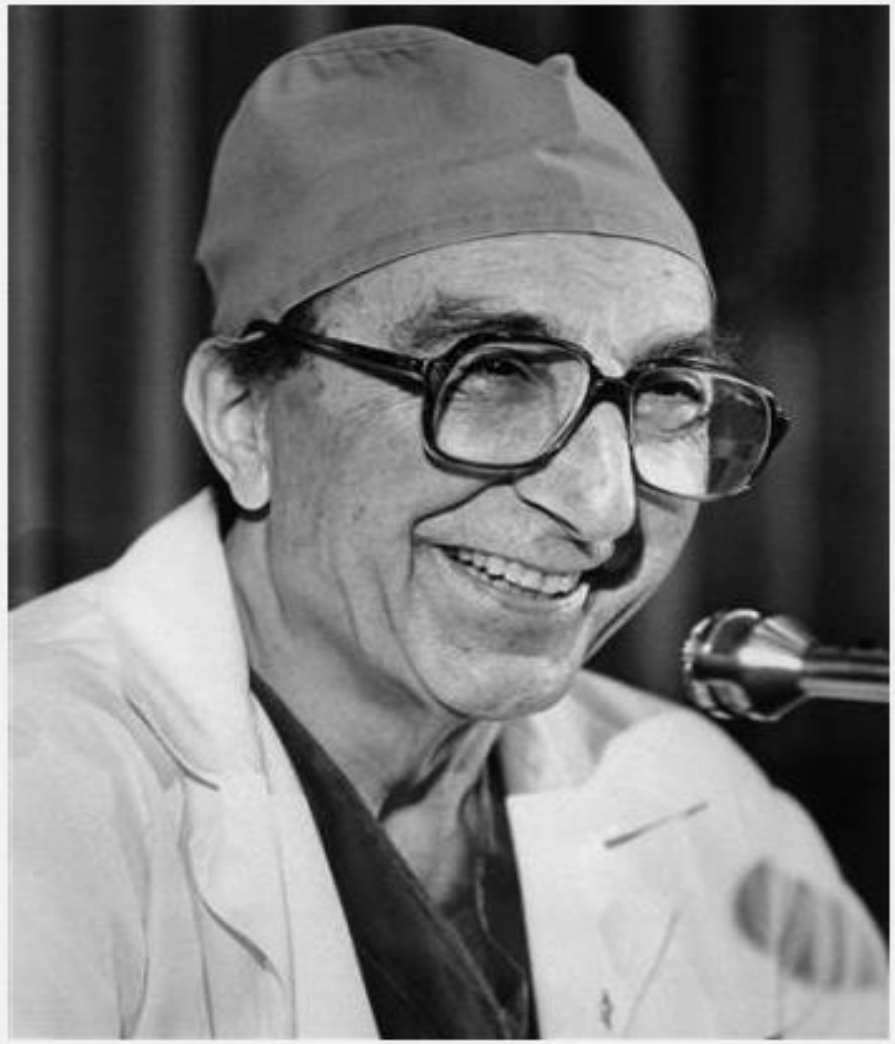




- plan ?

Heart Surgeon DeBakey Has Died at 99

Posted on July 12, 2008 by mrhoustonian



Dr. Michael E. Debakey

(1908 – 2008)

Pioneer, innovator, miracle maker, Samaritan

Houston heart surgeon Michael Ellis DeBakey, who pioneered the now-common bypass surgery and developed innovative pumps and other life saving devices, has died at 99. Dr. DeBakey died Friday night of natural causes at The Methodist Hospital in Houston, not far from the Baylor College of Medicine, a school that Dr. DeBakey helped transform into one of the world's great medical institutions.

In 1955, **Cooley and DeBakey**
repaired an aortic arch aneurysm using prosthetic graft replacement and an ascending-to-descending aortic shunt, which included side branches to the carotid arteries.

Extrait du *Bulletin de la Société Internationale de Chirurgie*.
T. XV, N° 3, mai 1956, pp. 206 à 215.

Hypothermia in the Surgical Treatment of Aortic Aneurysms (**)

Denton A. Cooley, M.D., and Michael E. De Bakey, M.D. (*).
(Houston)

During recent years the treatment of aortic aneurysms by surgical excision has been established as the method of choice wherever conditions permit its satisfactory application (1, 5, 10). However, a number of factors primarily concerned with the nature and location of the lesion determines the operative method to be employed. In general, two types of procedures may be used for this purpose depending upon whether the aneurysm is fusiform or sacciform in type. In the treatment of sacciform lesions, for example, the procedure consists in tangential excision with repair by lateral aortorrhaphy. This is accomplished by isolating and clamping the neck of the aneurysm with a large minimal trauma clamp, excising the sac and repairing the wall of the aorta with multiple mattress sutures. This method is particularly well suited to syphilitic aneurysms of the ascending thoracic aorta and aortic arch. In these cases the aortic wall adjacent to the neck of the aneurysm is usually of leathery consistency and holds sutures well. Furthermore tangential clamping of the aneurysm does not interrupt circulation through the aorta itself, a factor of considerable importance at this high level.

For fusiform aneurysms involving the entire aortic circumference temporary cross clamping of the aorta is necessary in order to excise the lesion and replace the diseased segment of aorta with an aortic homograft or plastic prosthesis. During the period of occlusion ischemic damage to tissues located distally may occur and prevent a success-

(*) From the Department of Surgery, Baylor University College of Medicine, and the Jefferson Davis, Methodist, and Veterans Administration Hospitals, Houston, Texas.
(**) Supported in part by a grant from the Houston Heart Association, and the Cora and Webb Mading Fund for Surgical Research.

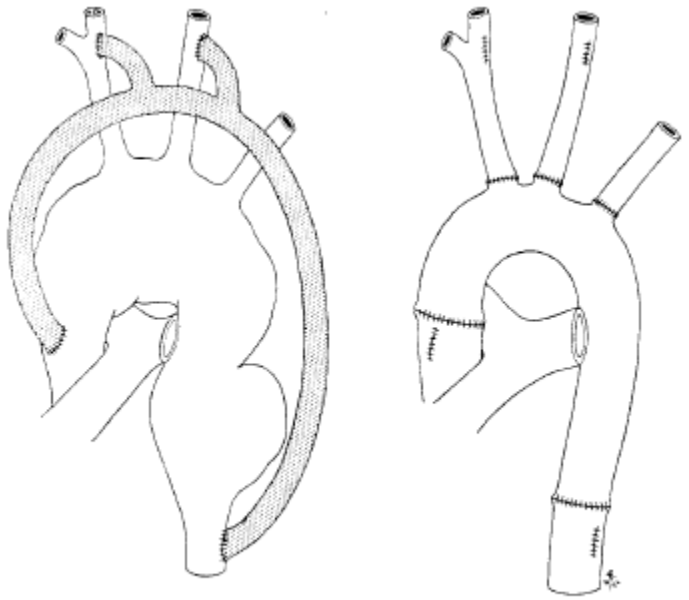


Fig. 1.
Drawing showing method of resection of entire aortic arch for aneurysm with the use of temporary by-pass shunts.

This shunting scheme did not prevent cerebral ischemia, and the patient died 6 days after the procedure.

Aortic surgery

- Preoperative setting ?
- Approach ?
- Perfusion (CPB strategy) – cannulation ?
- Cerebral protection ?
- Temperature ?
- Myocardial protection ?
- Anastomosis order & Suture technique ?
- Bleeding control ?

Preoperative setting

- Basic cardiac surgery Anesthesia
  - Rt radial artery monitoring
  - Femoral artery monitoring
  - swan-ganz
  - Mac central line
- Brain monitoring
  - rsO2
  - Bis

Near-infrared Spectroscopy

Preoperative setting . CT –re-check

- Approach route
- Aortic system – stenosis, occlusion, angulation
- Cannulation site status
- Suture site status (proximal , distal)
- Graft size measure
- Variation of Circle of Willis, vertebral artery origin

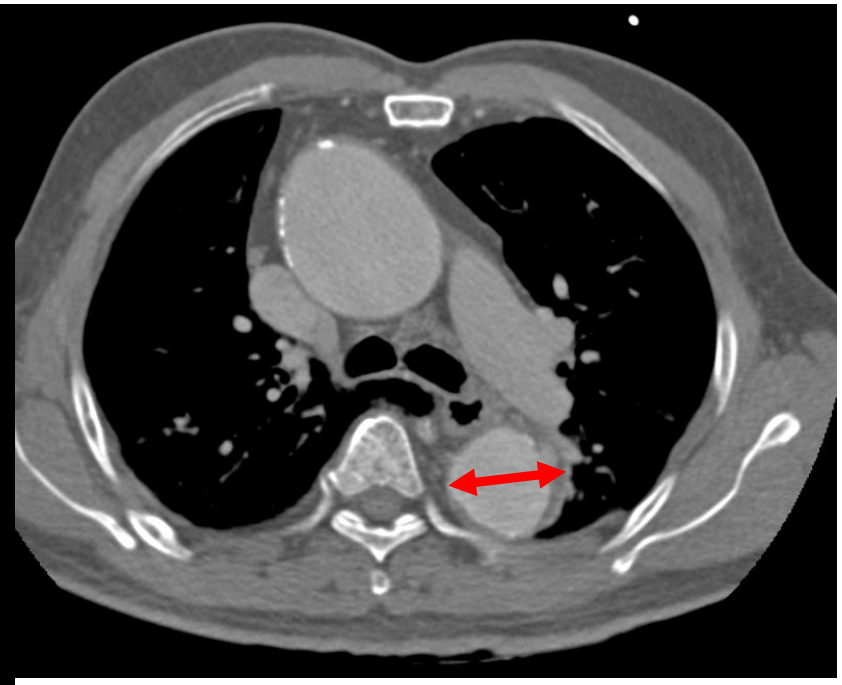
CT-check

- Aortic system

-stenosis, occlusion, angulation

CT-check

- Cannulation site status
- Suture site status
- Size measure

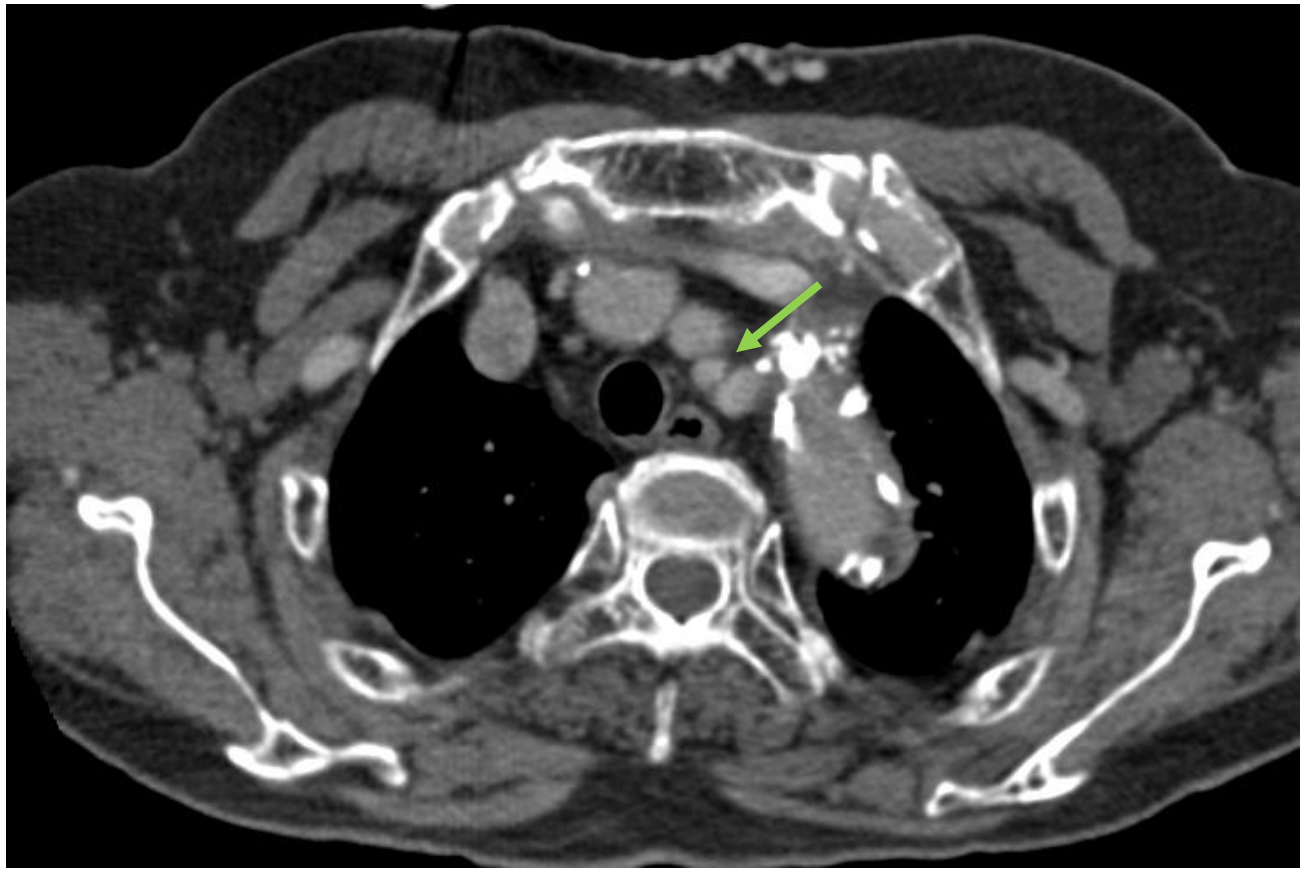


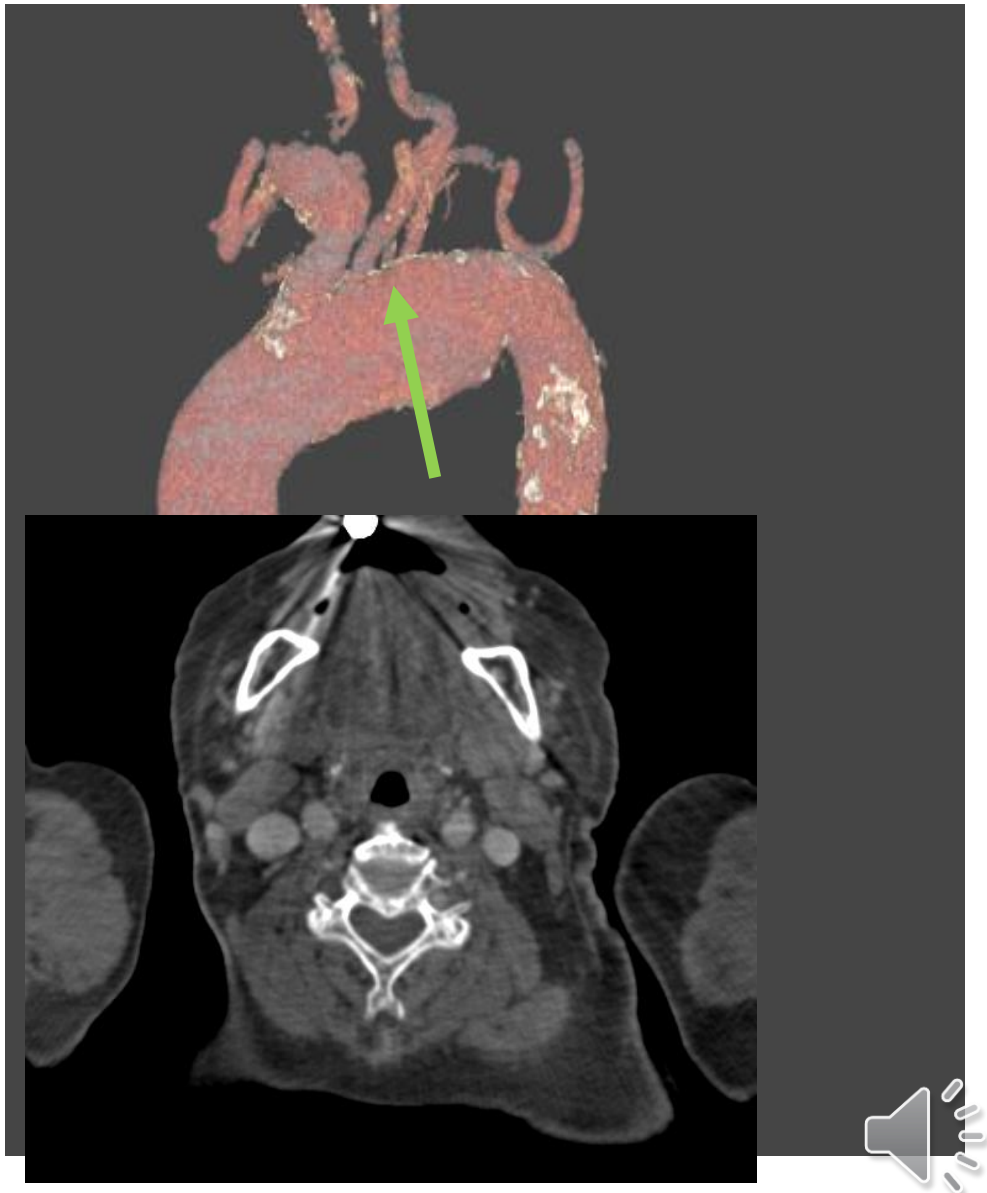
CT check

Vertebral artery communication and origin

CT check

- Lt Vertebral artery origin from aorta

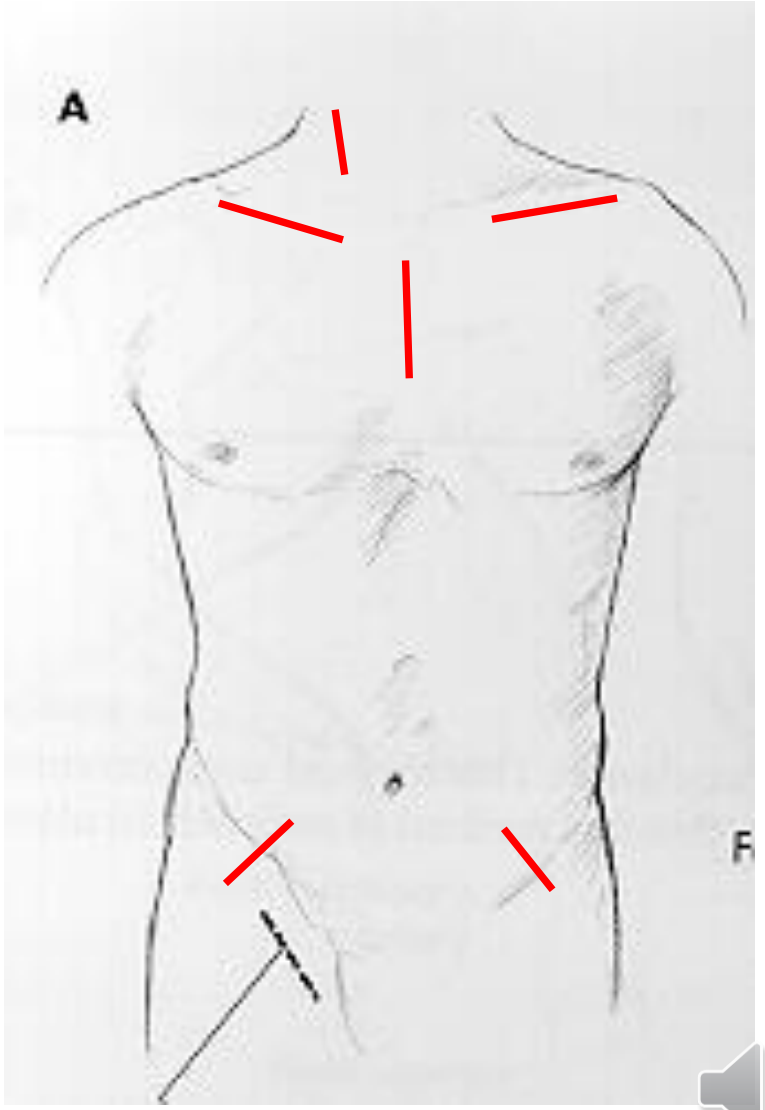




CPB-cannulation

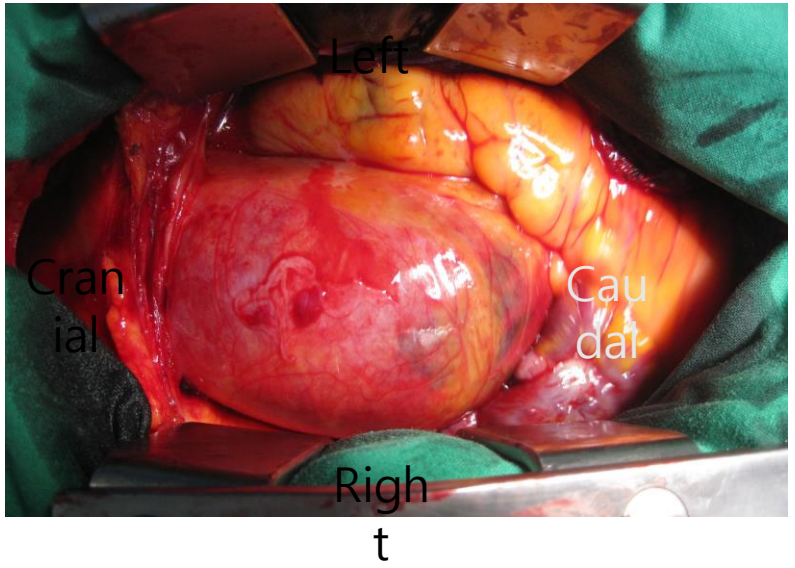
- Ascending aorta
- Femoral aorta
- Rt. subclavian aorta
- Innominate aorta

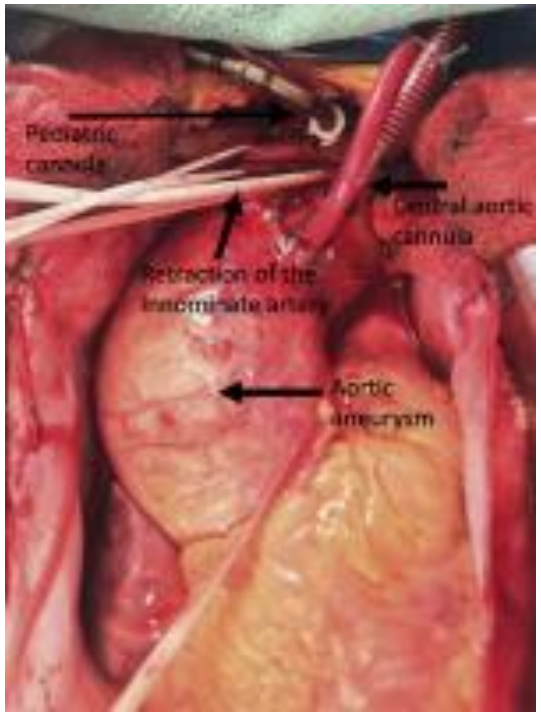
Purpose : perfusion + hypothermia

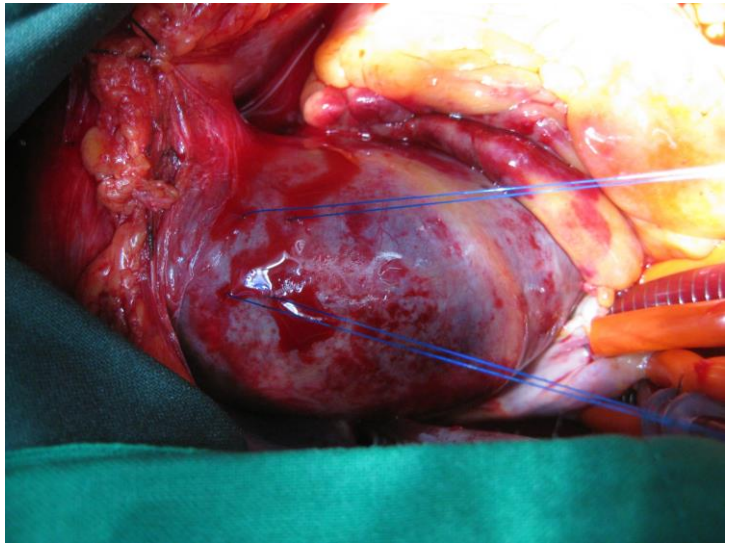


Ascending aorta

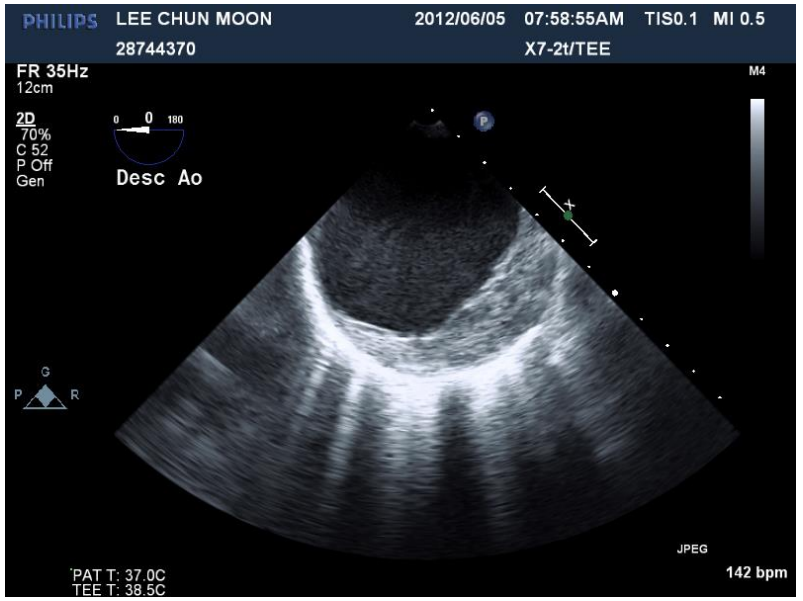
- Easy access
- Rupture risk (dissection, huge aneurysm)
- Antegrade embolic stroke
- Recently increase



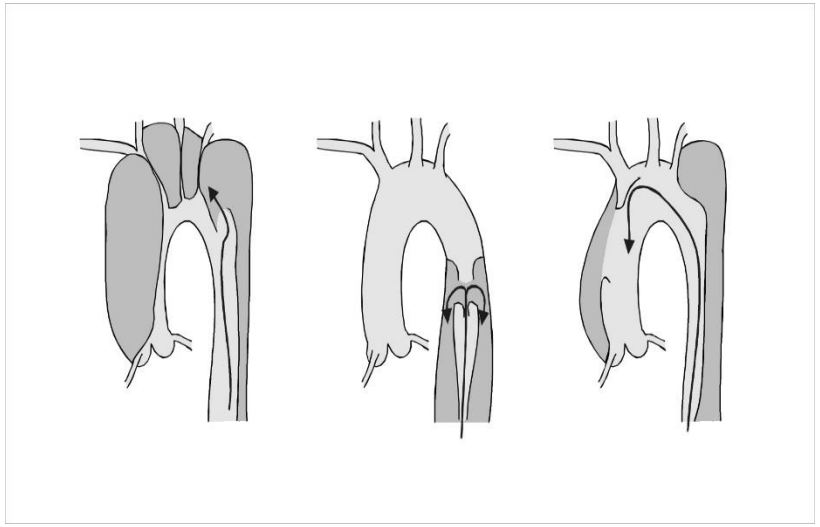




Femoral Artery Cannulation

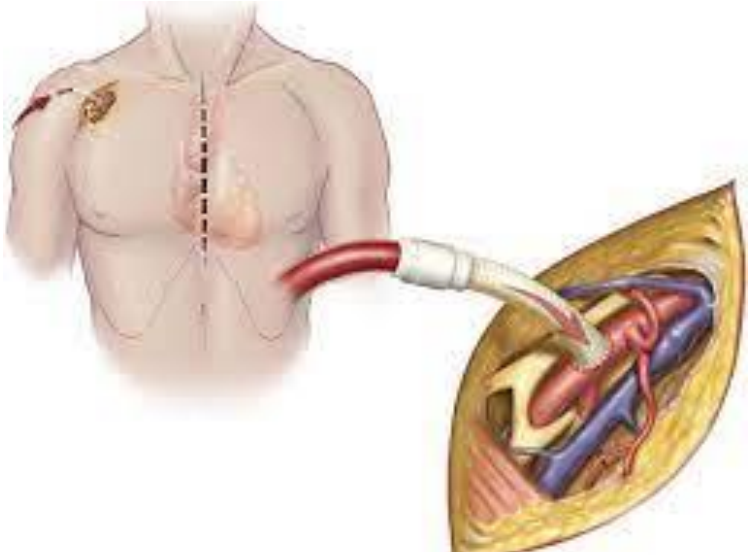


- 1950 ~
- Usually used for thoracic aortic surgery
- Advantages
  - Easy to access & repair
  - Emergency bypass
- Disadvantages
  - Retrograde perfusion of emboli
  - Malperfusion during Type A acute AD surgery
  - Ilio-femoral artery disease

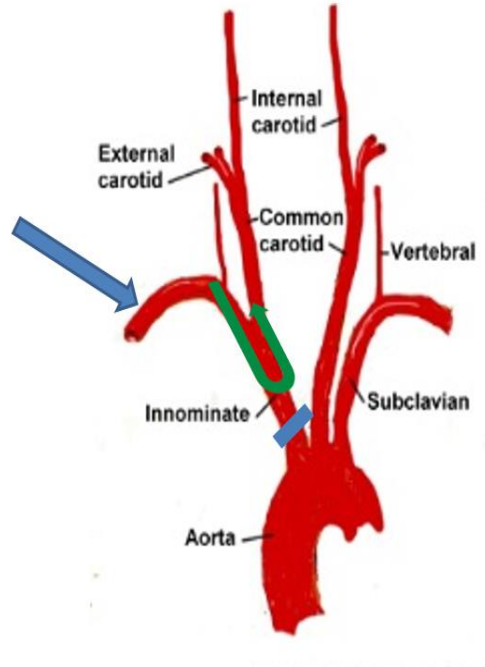


Axillary Artery Cannulation

- Advantages
  - Easily exposed
  - Less atherosclerosis
  - **Antegrade selective perfusion**
- Disadvantages
  - Time consuming
  - Axillary artery dissection
  - Small axillary artery



Cerebrovascular Anatomy

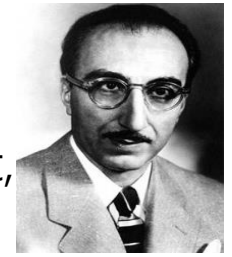


Brain protection

- Antegrade cerebral perfusion
  - Direct cerebral perfusion (selective cerebral perfusion)
  - Axillary cerebral perfusion

- Retrograde cerebral perfusion
  - by SVC

In 1955, **Cooley and DeBakey** repaired an aortic arch aneurysm using prosthetic graft replacement and an ascending-to-descending aortic shunt, which included side branches to the carotid arteries.



Extrait du *Bulletin de la Société Internationale de Chirurgie*.
T. XV, N° 3, mai 1956, pp. 206 à 215.

Hypothermia in the Surgical Treatment of Aortic Aneurysms (**)

Denton A. Cooley, M.D., and Michael E. De Bakey, M.D. (*).
(Houston)

During recent years the treatment of aortic aneurysms by surgical excision has been established as the method of choice wherever conditions permit its satisfactory application (1, 5, 10). However, a number of factors primarily concerned with the nature and location of the lesion determines the operative method to be employed. In general, two types of procedures may be used for this purpose depending upon whether the aneurysm is fusiform or sacciform in type. In the treatment of sacciform lesions, for example, the procedure consists in tangential excision with repair by lateral aortorrhaphy. This is accomplished by isolating and clamping the neck of the aneurysm with a large minimal trauma clamp, excising the sac and repairing the wall of the aorta with multiple mattress sutures. This method is particularly well suited to syphilitic aneurysms of the ascending thoracic aorta and aortic arch. In these cases the aortic wall adjacent to the neck of the aneurysm is usually of leathery consistency and holds sutures well. Furthermore tangential clamping of the aneurysm does not interrupt circulation through the aorta itself, a factor of considerable importance at this high level.

For fusiform aneurysms involving the entire aortic circumference temporary cross clamping of the aorta is necessary in order to excise the lesion and replace the diseased segment of aorta with an aortic homograft or plastic prosthesis. During the period of occlusion ischemic damage to tissues located distally may occur and prevent a success-

(*) From the Department of Surgery, Baylor University College of Medicine, and the Jefferson Davis, Methodist, and Veterans Administration Hospitals, Houston, Texas.

(**) Supported in part by a grant from the Houston Heart Association, and the Cora and Webb Mading Fund for Surgical Research.

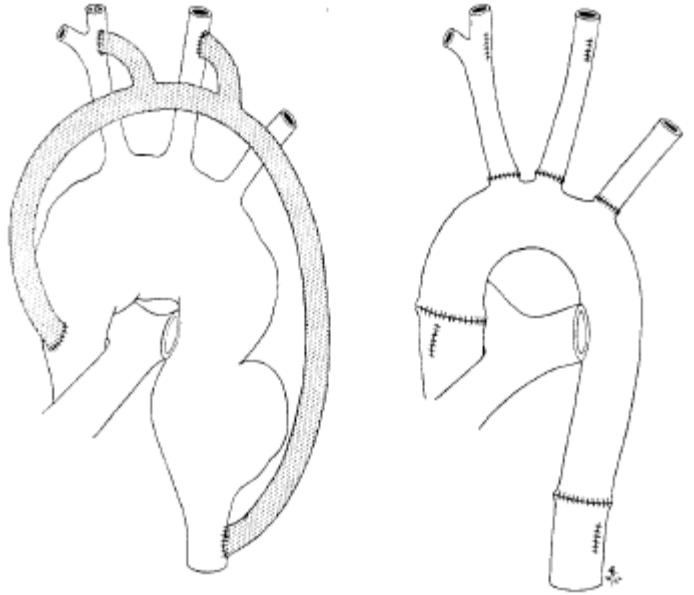


Fig. 1.
Drawing showing method of resection of entire aortic arch for aneurysm with the use of temporary by-pass shunts.

This shunting scheme did not prevent cerebral ischemia, and the patient died 6 days after the procedure.

Retrograde cerebral perfusion

1990 . ATS

Deep hypothermic systemic circulatory arrest and continuous retrograde cerebral perfusion for surgery of aortic arch aneurysm

Y. Ueda, S. Miki, K. Kusuhara, Y. Okita, T. Tahata, and K. Yamanaka

Department of Cardiovascular Surgery, Tenri Hospital, Tenri, Nara, Japan

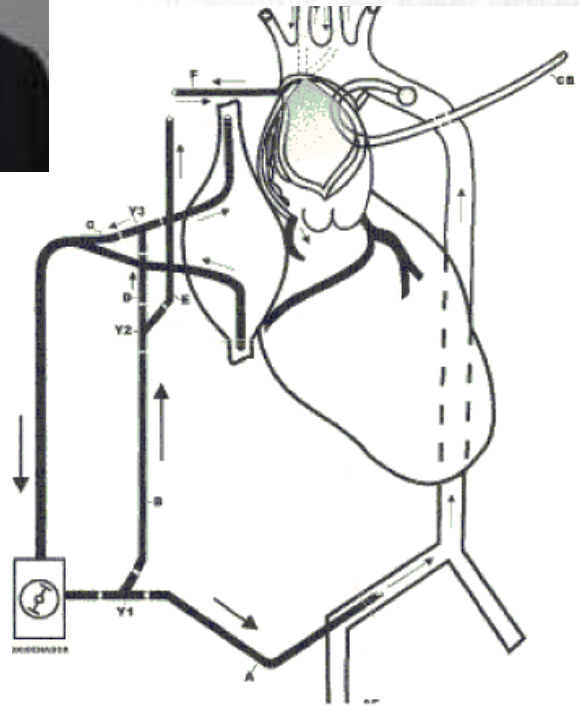
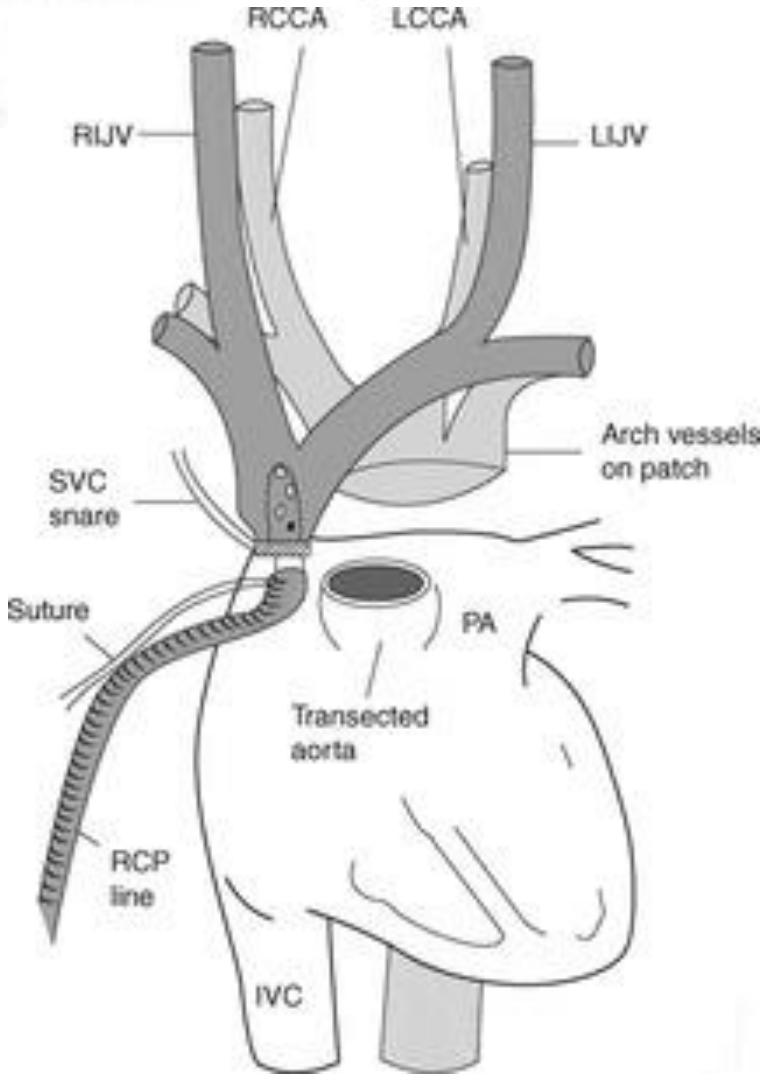


Fig. 1 – Schematic design of the cardiopulmonary bypass system used. Line A (femoral perfusion); Line B (retrograde D-perfusion, anterograde E-perfusion); Line C (normal venous drainage of the vena cavas); Line F (perfusion of the carotid arteries). CB - balloon catheter; Y1, Y2, Y3 – Y-shaped connectors; ACD - right carotid artery; ACE - left carotid artery; AF - femoral artery



Return to Antegrade cerebral perfusion

1992 . ATS
Selective cerebral perfusion for arch surgery

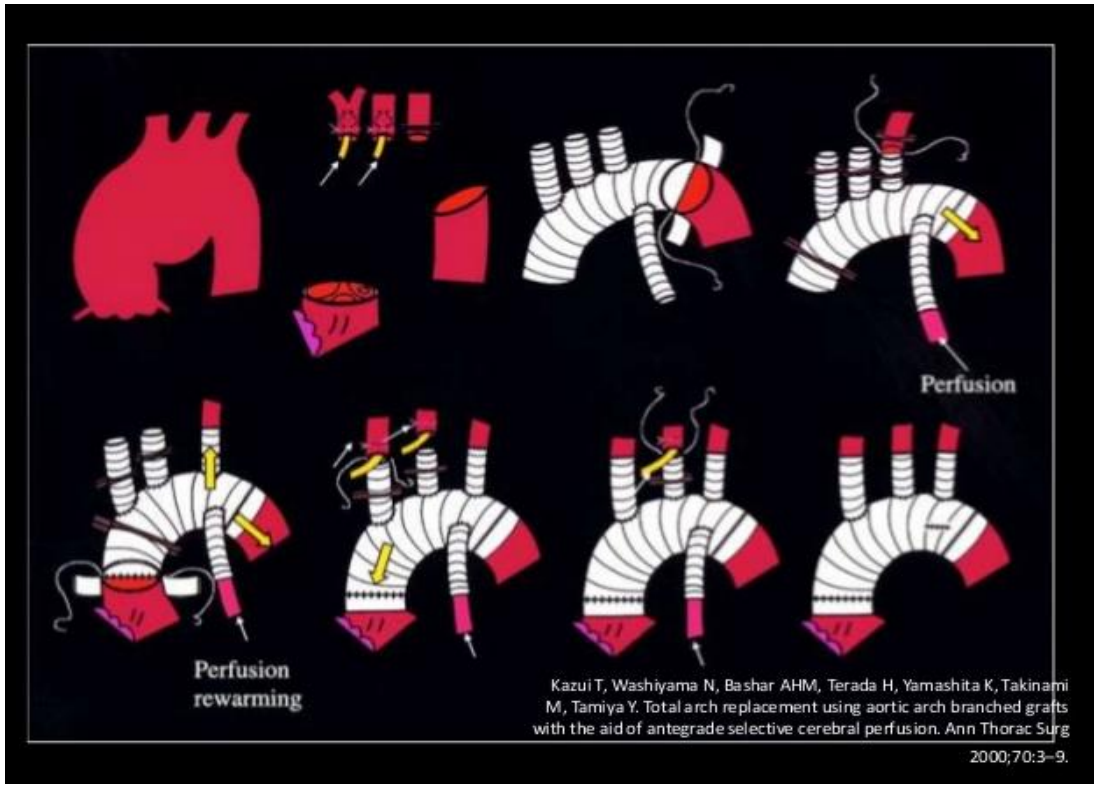
Selective Cerebral Perfusion During Operation for Aneurysms of the Aortic Arch: A Reassessment

Teruhisa Kazui, MD, Norio Inoue, MD, Osamu Yamada, MD, and Sakuzo Komatsu, MD

Department of Thoracic and Cardiovascular Surgery, Sapporo Medical College & Hospital, Sapporo, Japan

Thirty-two consecutive patients with thoracic aortic aneurysms who required aortic arch reconstruction were operated on with the aid of extracorporeal circulation and selective cerebral perfusion between January 1986 and August 1990. For selective cerebral perfusion, blood was infused into both the innominate and left common carotid arteries at a rate of 10 mL · kg^{-1} · min^{-1} using a single roller pump separately from the systemic circulation. In 9 patients treated before March 1987, the operations were performed without open aortic anastomosis (group 1), whereas in 23 patients treated from March 1987 onward we used open aortic anastomosis (group 2). The extracorporeal circulation and cardiac arrest times were significantly longer in group 2, but there was no significant difference in the cerebral perfusion time. Early death occurred in 1 patient in group 1 and 2 in group 2. No serious cerebrospinal neurological complications occurred in either group, and there were similar rates of postoperative hepatic and renal dysfunction in both groups. The present data suggest that selective cerebral perfusion and open aortic anastomosis are useful methods for thoracic aortic aneurysm operation requiring complex repair of the aortic arch.

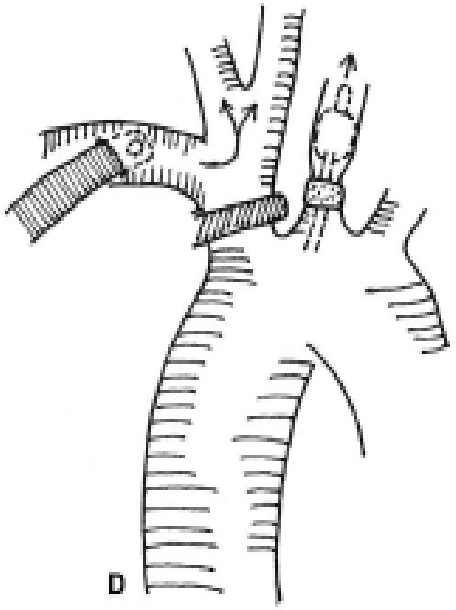
(Ann Thorac Surg 1992;53:109–14)



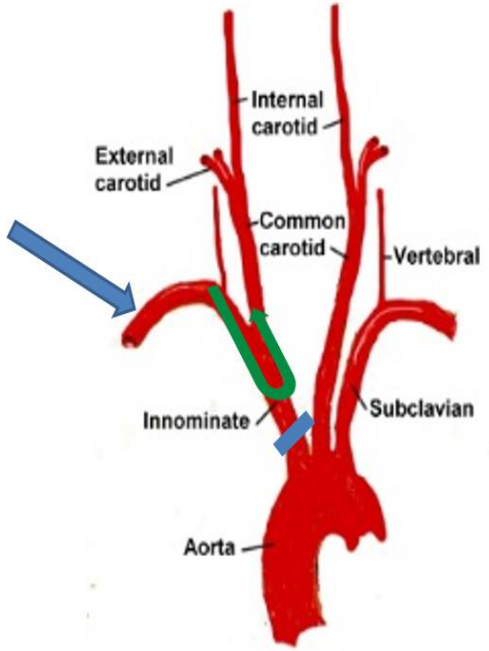
Kazui T, Washiyama N, Bashar AHM, Terada H, Yamashita K, Takinami M, Tamiya Y. Total arch replacement using aortic arch branched grafts with the aid of antegrade selective cerebral perfusion. Ann Thorac Surg 2000;70:3–9.

Axillary Artery Cannulation

- Sabik JF et al. (JTCS 1995;109:885-91)
- Advantages
  - Easily exposed
  - Less atherosclerosis
  - Antegrade selective perfusion



Cerebrovascular Anatomy



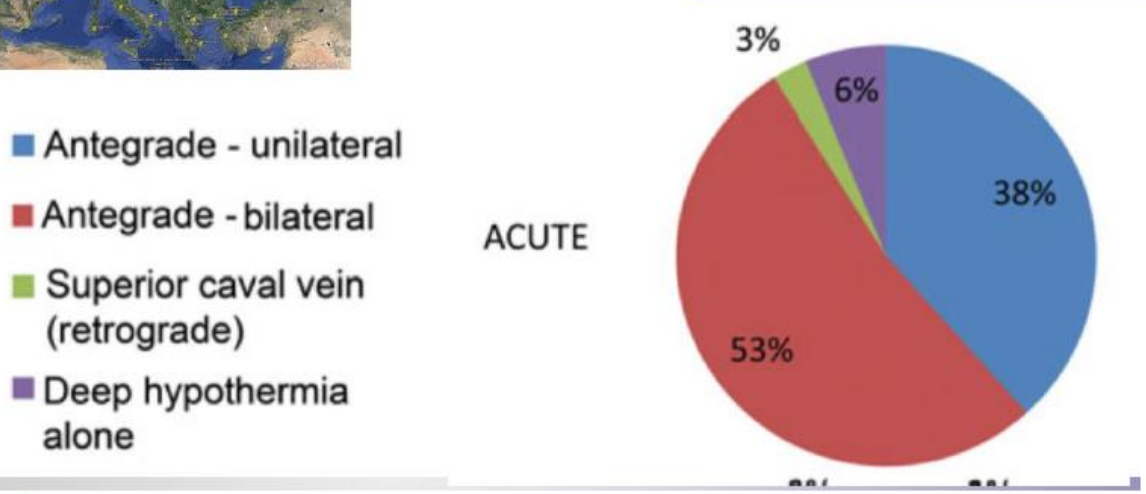
Aortic arch surgery – Type of cerebral perfusion

Current trends in cannulation and neuroprotection during surgery of the aortic arch in Europe[†‡]

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

Ruggero De Paulis[a,*], Martin Czerny[b], Luca Weltert[a], Joseph Bavaria[c], Michael A. Borger[d], Thierry P. Carrel[e], Christain D. Etz[d], Michael Grimm[f], Mahmoud Loubani[g], Davide Pacini[h], Timothy Resch[i], Paul P. Urbanski[j] and Ernst Weigang[k] (EACTS Vascular Domain Group)

> 90 % ASCP



Unilateral vs Bilateral ?

Heart, Lung and Circulation (2019) 28, 844–849
1443-9506/04/$36.00
https://doi.org/10.1016/j.hlc.2019.01.010

REVIEW

Unilateral Versus Bilateral Antegrade Cerebral Perfusion: A Meta-Analysis of Comparative Studies

David H. Tian, MD, PhD [a,b*], Ashley Wilson-Smith, BMed [a], Shanq Kuen Koo, BMed [a], Paul Forrest, MBChB [c,d], Hosen Kiat, MBBS [e], Tristan D. Yan, MD, PhD [a,f]

[a]The Collaborative Research (CORE) Group International, Macquarie University, Sydney, NSW, Australia
[b]Royal North Shore Hospital, Sydney, NSW, Australia
[c]Department of Anaesthetics, Royal Prince Alfred Hospital, Sydney, NSW, Australia
[d]Sydney University Medical School, Sydney, NSW, Australia
[e]Faculty of Medicine and Health Sciences, Macquarie University, Sydney, NSW, Australia
[f]Department of Cardiothoracic Surgery, Royal Prince Alfred Hospital, Sydney, NSW, Australia
[g]Faculty of Medicine, University of New South Wales, Sydney, NSW, Australia

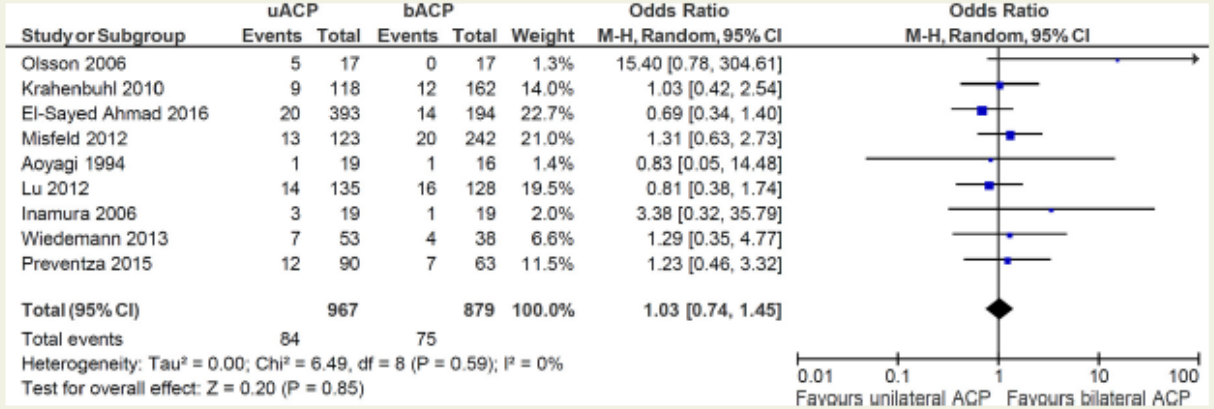
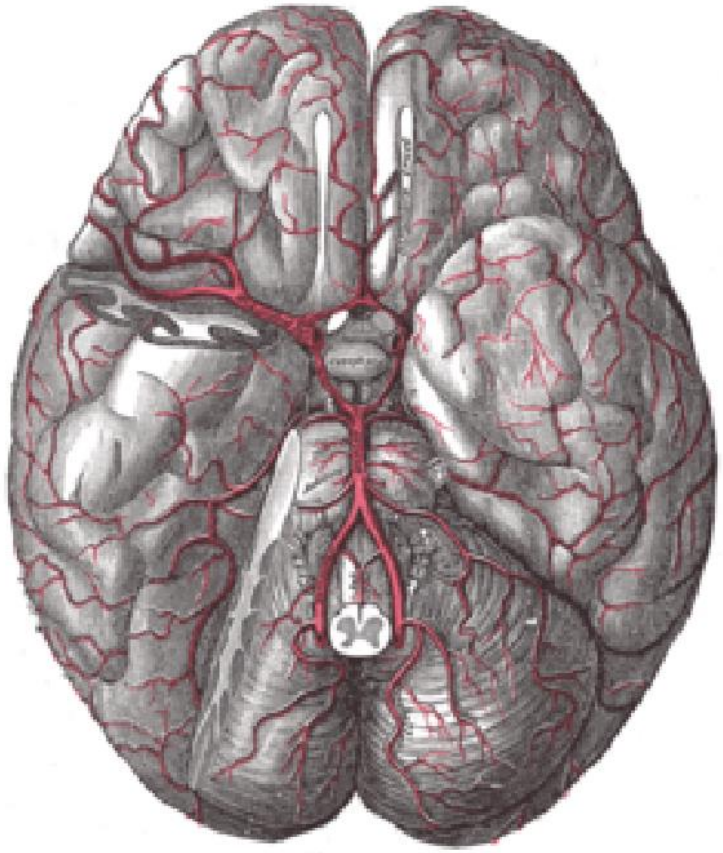
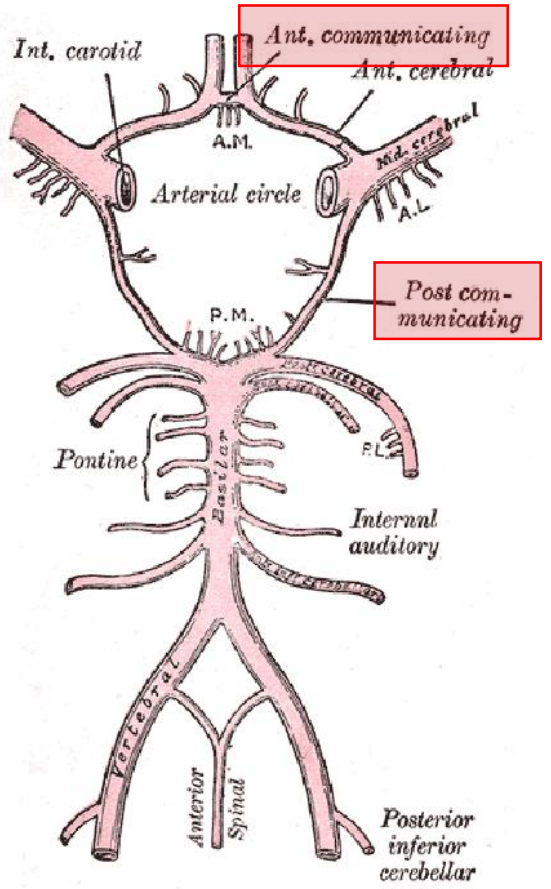


Figure 2 Forest plot of the odds ratio (OR) of permanent neurological deficit for comparative studies using unilateral antegrade cerebral perfusion (uACP) or bilateral antegrade cerebral perfusion (bACP). The estimate of the OR of each trial corresponds to the middle of the squares, and the horizontal line shows the 95% confidence interval (CI). On each line, the number of events as a fraction of the total number randomised is shown for both treatment groups. For each subgroup, the sum of the statistics, along with the summary OR, is represented by the middle of the solid diamonds. A test of heterogeneity between the trials within a subgroup is given below the summary statistics.
Abbreviation: M-H, Mantel-Haenszel

Circle of Willis

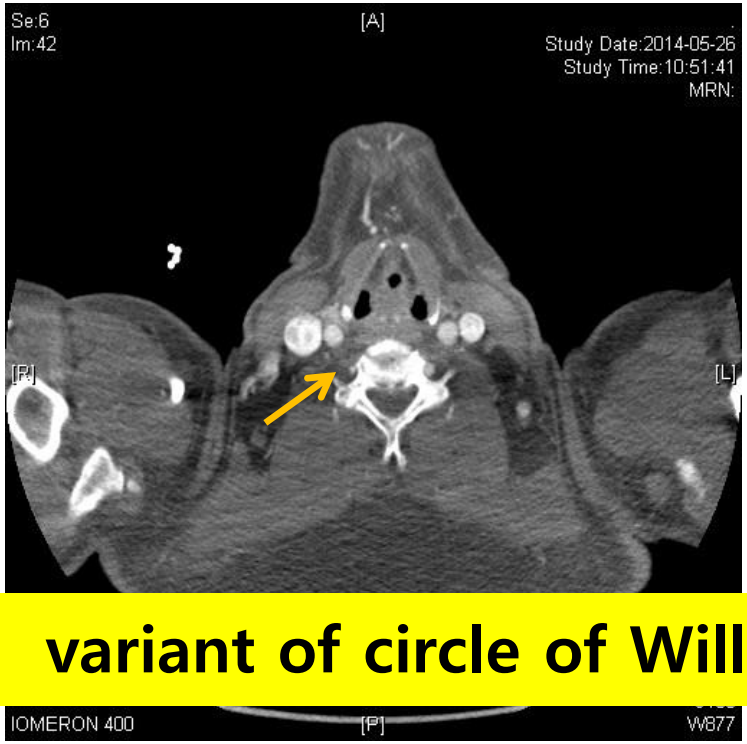
- Not intact: ~15%
- Cerebral oxymetery : usually frontal area

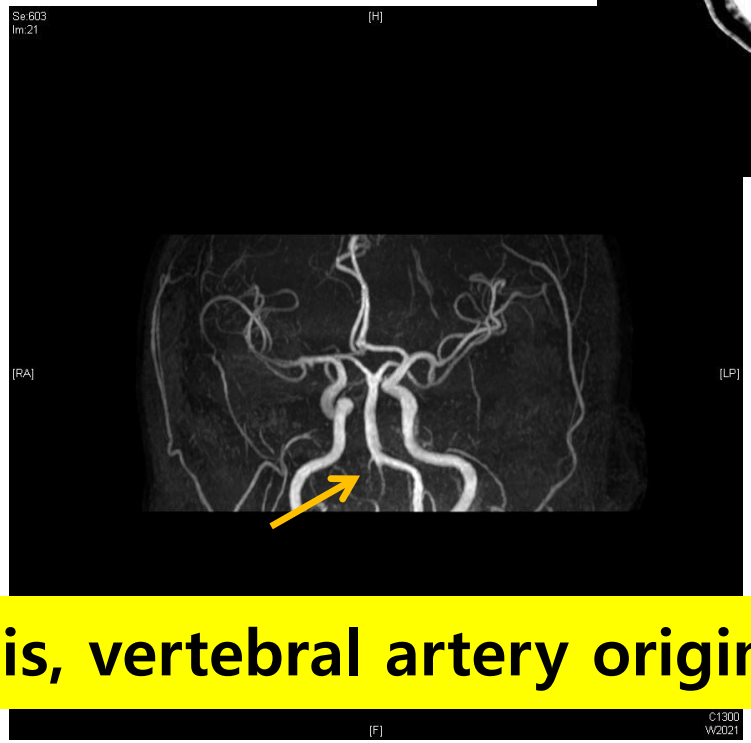




Variation of Circle of Willis

- Not uncommon
- Cerebral oxymetery: not helpful
- 3-vessel perfusion

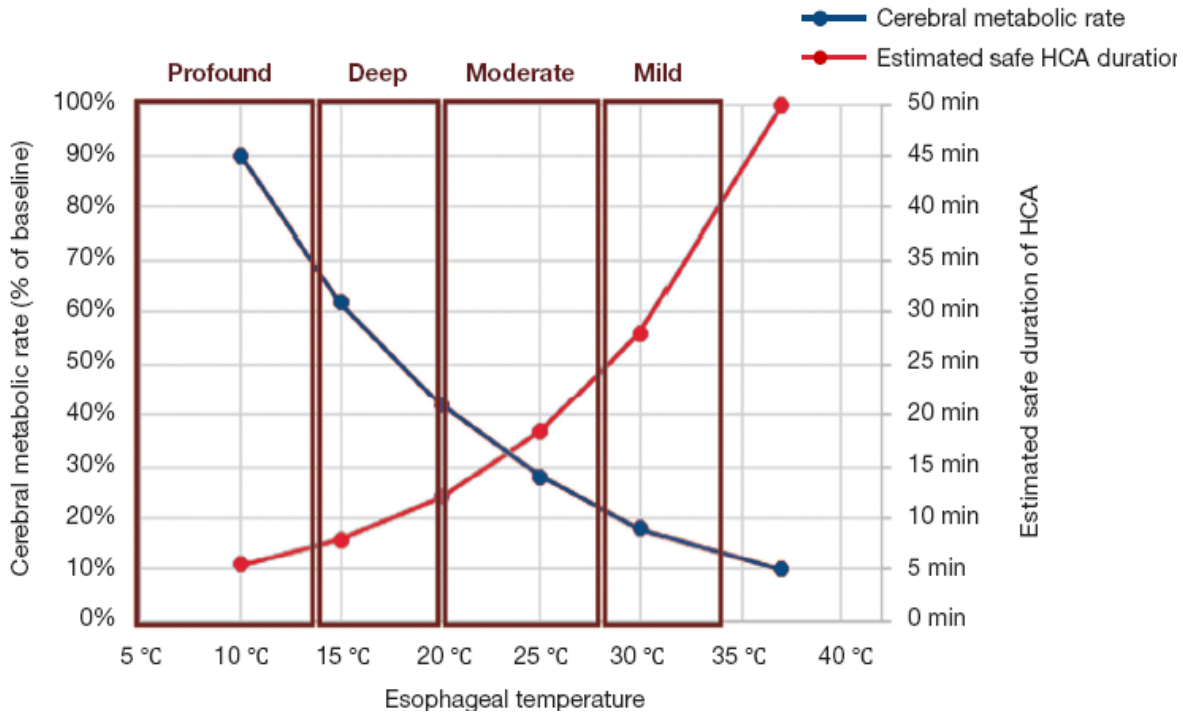




Preop CT : variant of circle of Willis, vertebral artery origin and communication

Hypothermia

- Decrease brain metabolism



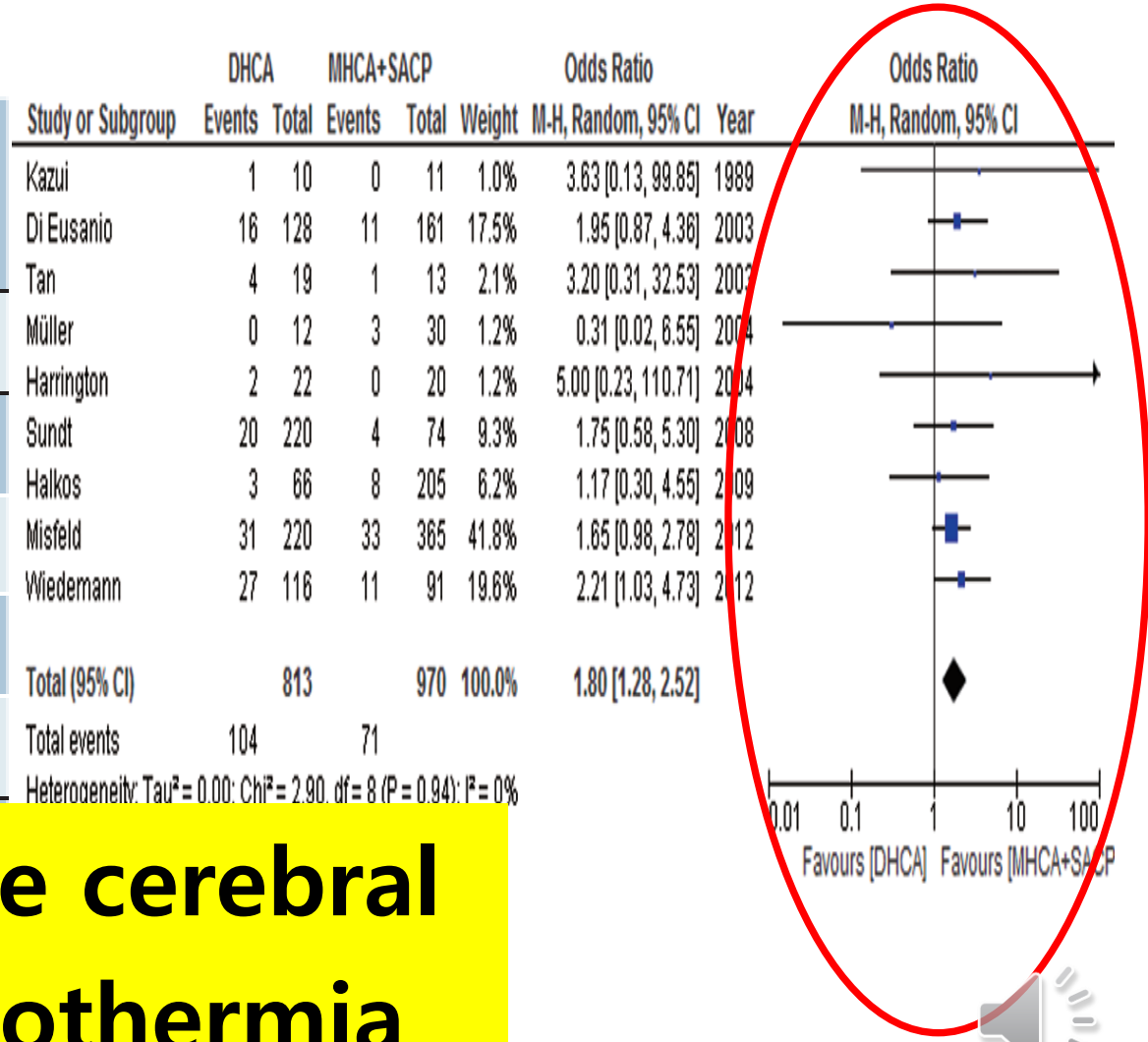
Hypothermia revisited
Benefit of profound hypothermic circulatory arrest for arch repair
4patients -> 3 surviors
Griepp et al
J Thoracic Cardiovasc surg 1975

Brain metabolism: 23% at 20°C, 17% at 15°C

Hypothermia

Table 1 Expert consensus on classifications of hypothermia in circulatory arrest during aortic arch surgery

Category	Nasopharyngeal temperature
Profound hypothermia	≤14 ℃
Deep hypothermia	14.1-20 ℃
Moderate hypothermia	20.1-28 ℃
Mild hypothermia	28.1-34 ℃
R	

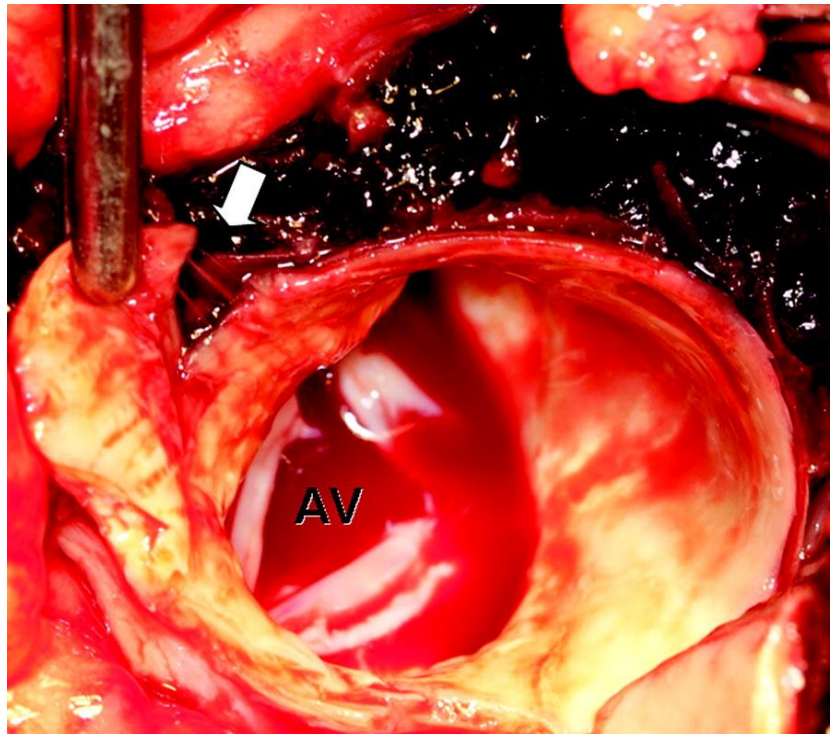


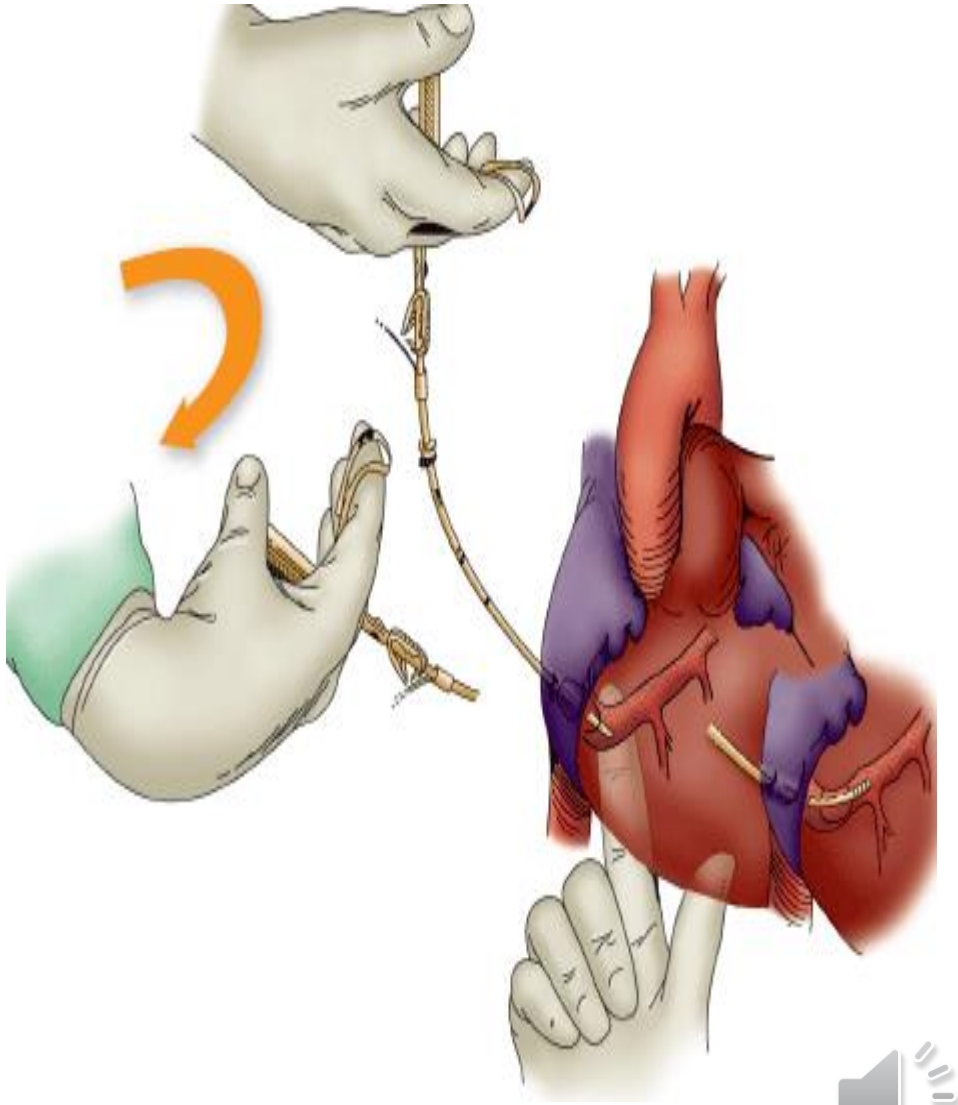
Current strategy: antegrade cerebral perfusion + mild(mod)hypothermia

Ann Cardiothorac Surg 2013;2(2):148-158

Myocardial protection

- Direct vs retrograde





Anastomosis strategy

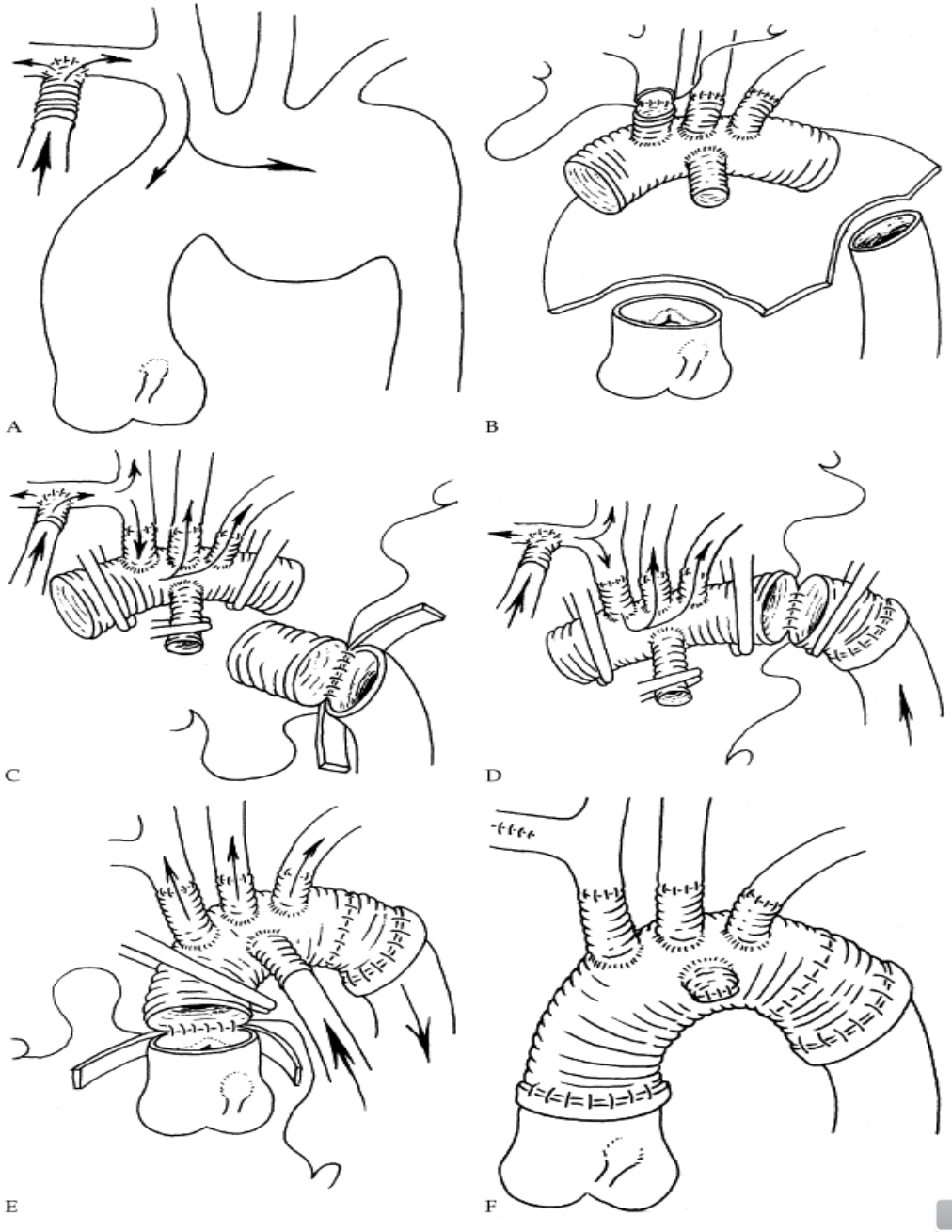
- Arch first vs Distal first

Arch first technique

Rokkas and Douchoukos 1999 JTCVS

Extensive arch aneurysm

* Problem
-distal anastomosis perfusion
-long operation time



Distal first technique

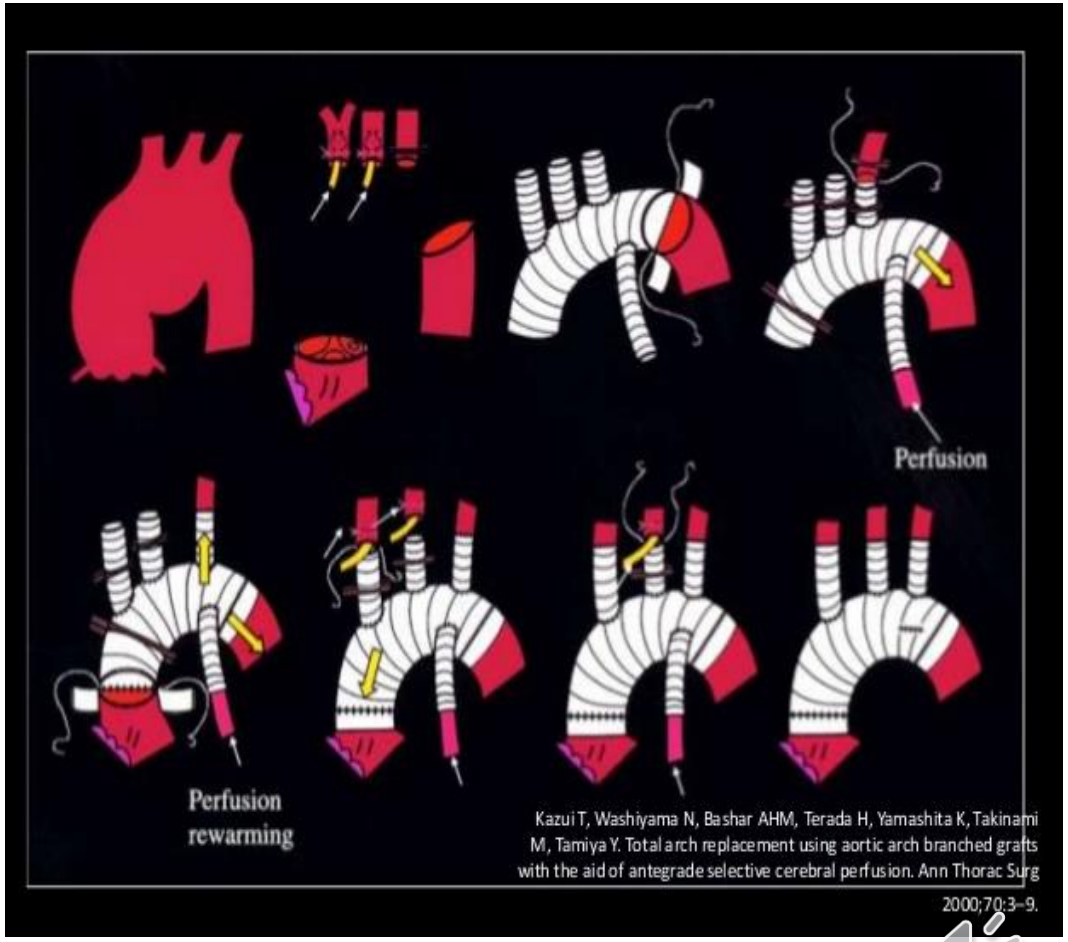
Separate graft technique

Kazui T et al (ATS 2007)

- N = 472
- In-hospital mortality: 9.3%
  - (4.1% in recent 266)
- Permanent neurologic dysfunction: 3.2%

Sasaki H et al (ATS 2007)

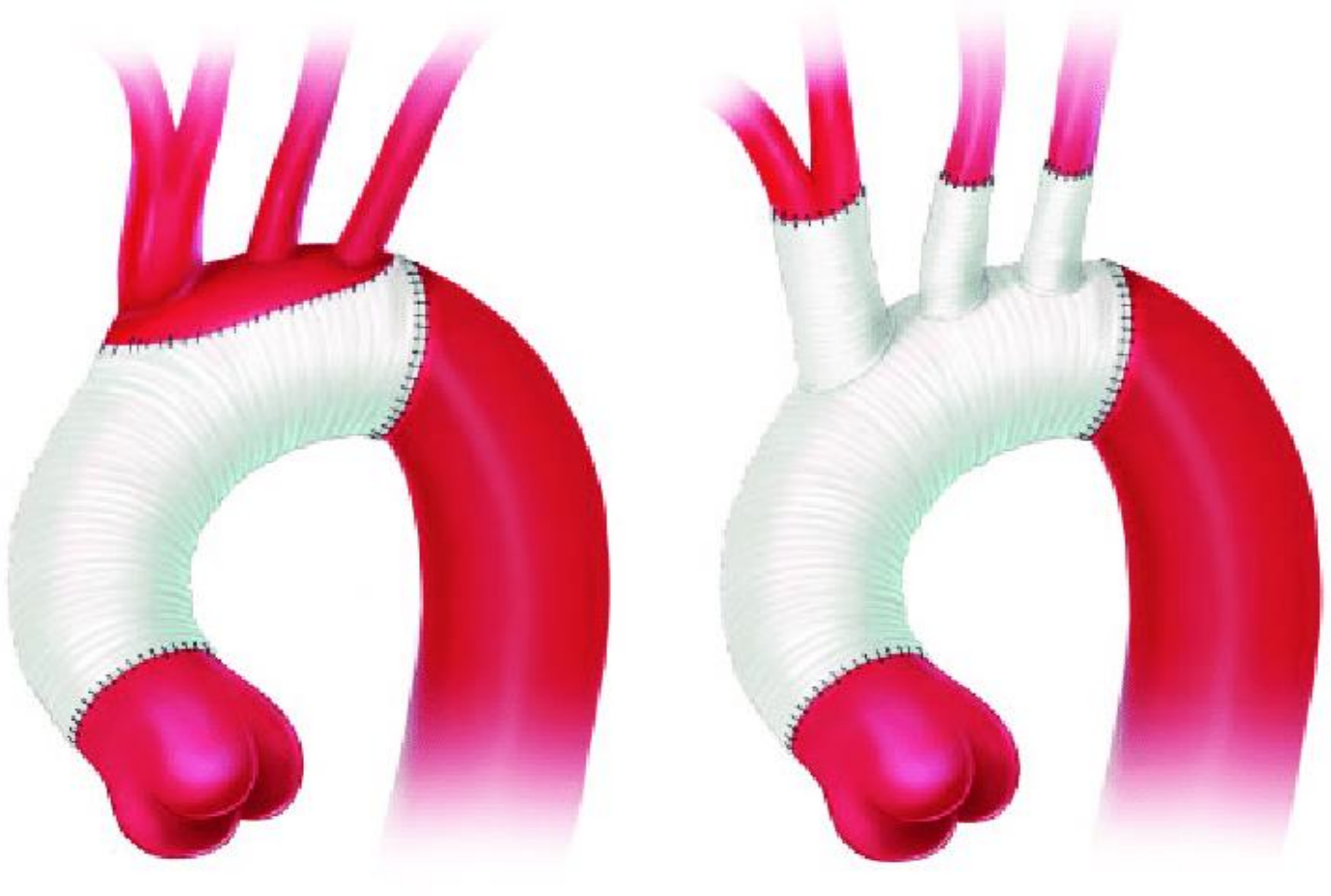
- N = 305 elective operation
- Early mortality: 2.3%
- Permanent neurologic dysfunction: 1.6%



Distal first technique

- Island type
- Separate type

- Bleeding
  (island >separate)

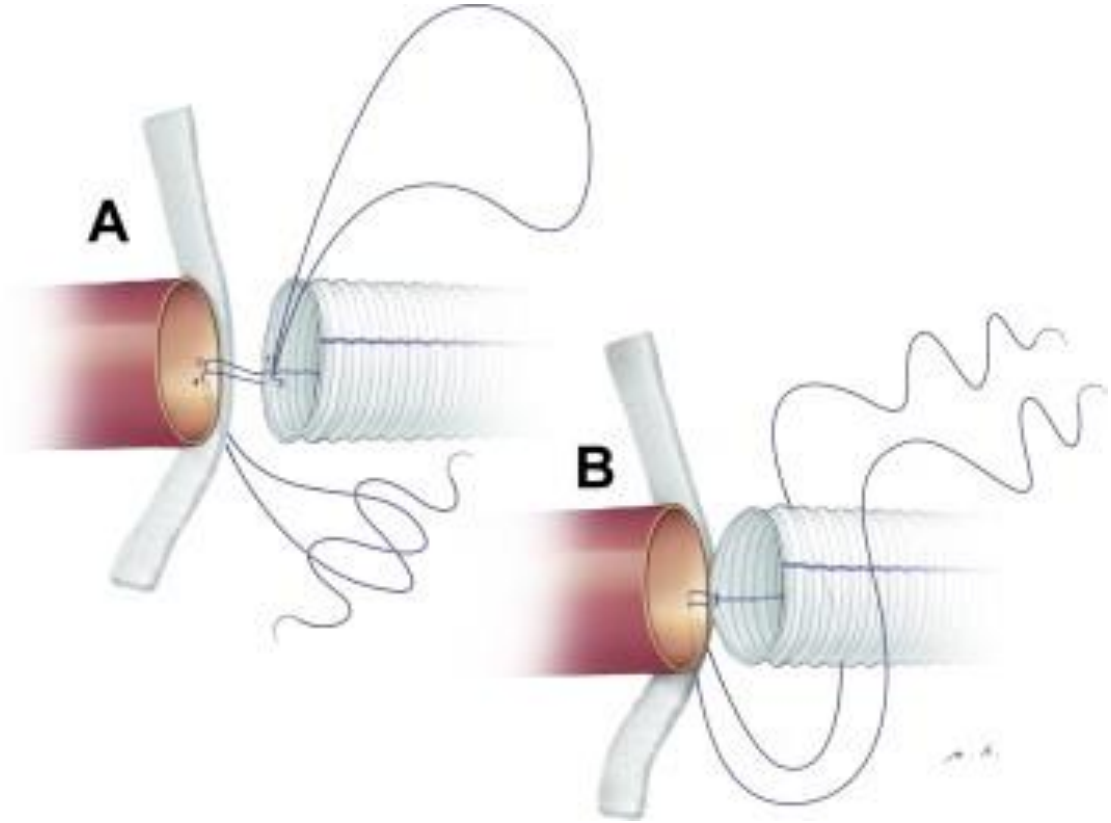


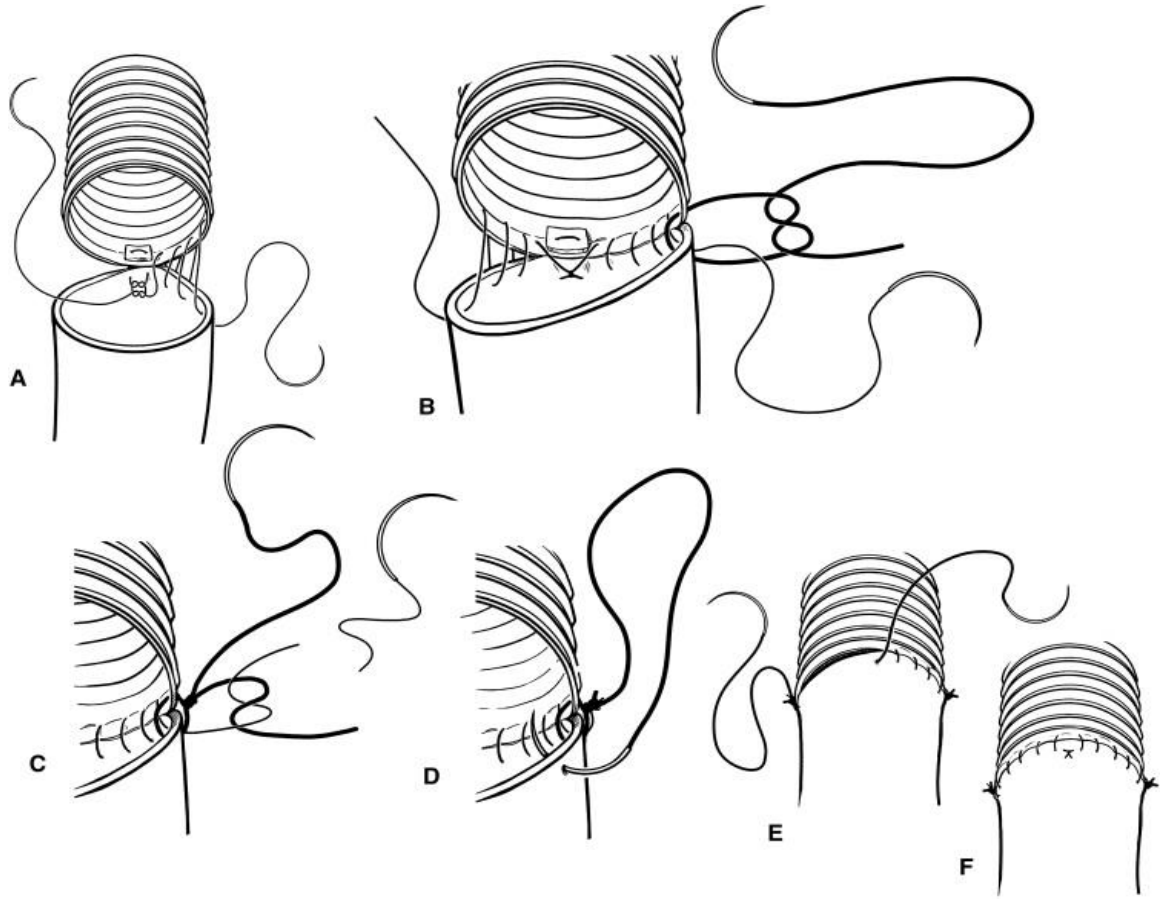
Distal first technique

- Benefit

  - Simple operation field
  - no waiting time for warming
  - short time of mal-perfusion of low body

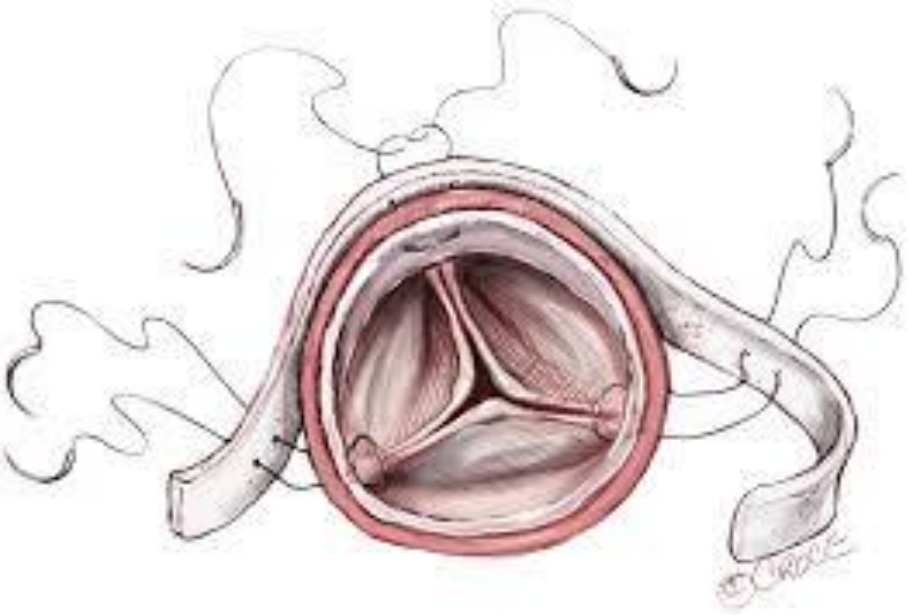
Suture technique

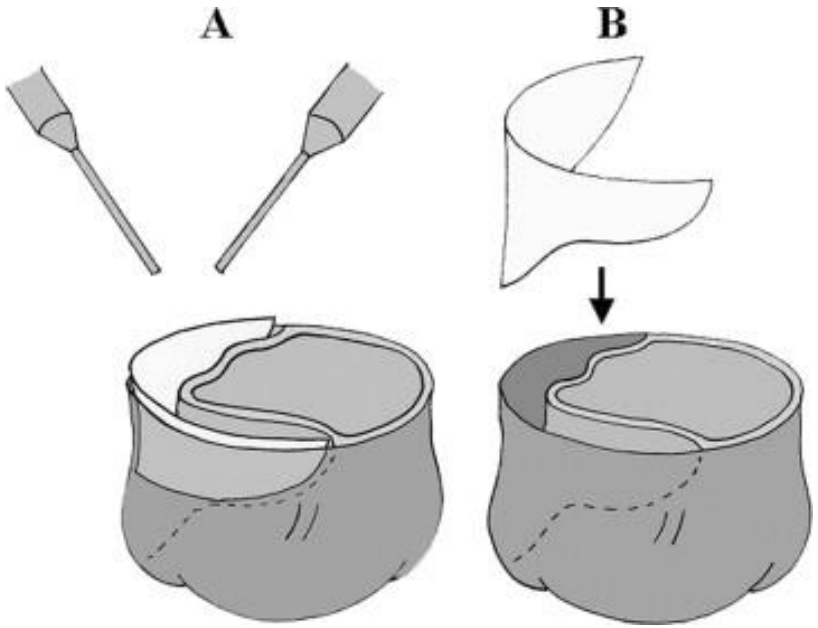


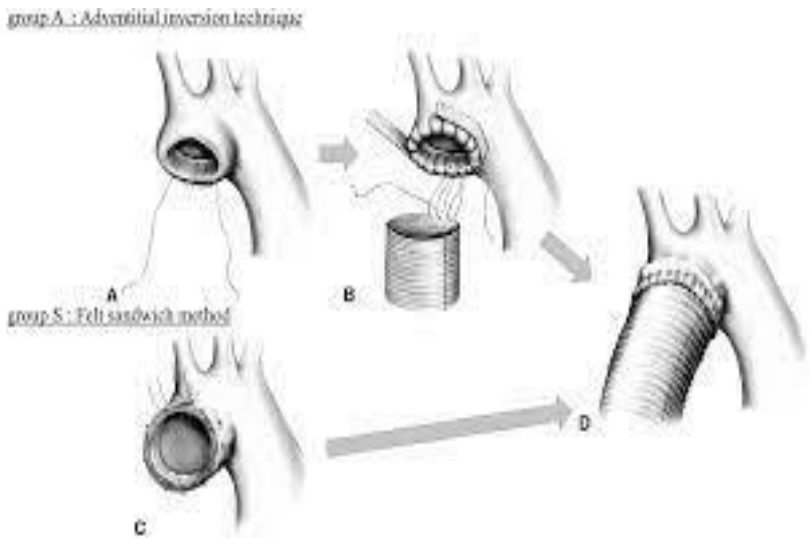


Suture technique

- Dissection







Severance strategy

- Simple sternotomy
- Rt. axillary cannulation (additional cannulation –ascending)
- Mild to moderate hypothermia (cooling to ≈ 28 ~ 30°C)
- Brain protection(via SCA, innominate clamp)
- Unilateral protection (rsO2 -> LCCA direct)
- Distal first anastomosis (LSCA-> LCCA-> RCCA->proximal)
- External eversion technique, sandwich (dissection)
- Rewarming during arch vessel anastomosis

Aortic surgery sequence

Simple sternotomy

Axillary cannulation

RA cannulation

Bypass on

Retrograde cardioplegia insertion

Head vessel dissection

Hypothermia (28oC)

Innominate clamp

Circulatory arrest . Cardioplegia infusion

LCCA,LSCA snaring

Distal anastomosis by prolene 3-0

Warming, distal perfusion by side branch

LSCA and LCCA anastomosis by 5-0

Innominate artery anastomosis by 4-0

Proximal anastomosis by 4-0

Weaning and bleeding control

Closure

Thank you for your attention!