Pulmonary Endarterectomy

Lessons learned in 30 years of experience and 4,000 cases
Operation

Rationale:
Restores perfusion of functional tissue (bronchial circulation)

Trendelenberg 1908
Operation

Aim is threefold:

**Hemodynamic** — relief of right heart failure

**Alveo-respiratory** — restoration of ventilation

**Palliative** — Prevention of progressive RV failure, small vessel disease
Operation

Tends to be underestimated

Significant learning curve

Mandatory

Bilateral

Circulatory arrest
The Surgery

Median sternotomy

Cardiopulmonary bypass

Deep hypothermic circulatory arrest (DHCA)

Both pulmonary arteries are treated

Complete endarterectomy

ASD repair or other procedures
The Surgery
important points

The head
The plane
The disease
The PVR
Distal disease
The Surgery
important points

The head
The plane
The disease
The PVR
Distal disease
The head is wrapped in a circulating cold water cooling blanket in preparation for Deep Hypothermic Circulatory Arrest (DHCA)
Assessment of the cooling jacket in 55 patients -

Rectal temperature 20.8 $\pm$ 1.5 $^\circ$C

Bladder temperature 19.8 $\pm$ 1.1 $^\circ$C

Tympanic temperature 15.1 $\pm$ 1.1 $^\circ$C $^{**}$

$^{**}$ $p < 0.0001$
The Surgery

On bypass, cool to 20° C

PA and LA vents (bronchial circulation)

The right PA is exposed between the aorta and SVC

Right side, then left under circulatory arrest
The Surgery

Deep hypothermic circulatory arrest (DHCA)

20 minute periods interspersed with 10 minutes reperfusion
The Surgery
important points

The head

The plane

The disease

The PVR

Distal disease
Endarterectomy instruments
The plane is raised posteriorly.

- SVC
- RPA
- Aorta
Endarterectomized area

Normal thickness PA
The Plane

1. Should strip easily
2. Pearly white
3. Corrugations or pink – too deep
The Surgery
important points

The head

The plane

The disease

The PVR

Distal disease
Classification of Operative Specimens:

– **TYPE I:**
  • 15 - 20% of cases, major vessel clot is present and readily visible upon opening of PA

– **TYPE II:**
  • 40% of cases, no major vessel thrombus, thickened intima with webs

– **TYPE III:**
  • 35 - 40%, very distal disease, confined to segmental and sub-segmental branches

– **TYPE IV:**
  • No thromboembolic pulmonary hypertension, inoperable, intrinsic small vessel disease.
Segmental disease – Type 3
The Surgery

important points

The head

The plane

The disease

The PVR

Distal disease
Mortality Rate

Effect of High PVR?
It has long been said that a high PVR is a significant risk factor.
Mortality Rate


- Pre-op PVR < 1,000 = 1.3%
- Pre-op PVR > 1,000 = 10.1%
  \[ p = <.0001 \]
Mortality Rate


Regardless of preop PVR, if

- Post-op PVR < 500 = 0.9%
- Post-op PVR > 500 = 30.6%

p = <.0001
PTE
The Key to Success

Complete resolution of obstruction

Mortality NOT related to ischemic time, but post-op PVR
The Surgery
important points

The head

The plane

The disease

The PVR

Distal disease (Type III)
PTE in Type III

Retrospective review of 449 patients who underwent PTE at UCSD from January 2009 to July 2012.

Patients were classified into either Jamieson Type III disease or non-Type III disease.

Only patients with bilateral Type III disease were included in this group for analysis.

Auger, W. et al Pulmonary Hemodynamic Benefit is Achieved with Resection of Segmental-level (Jamieson Type III) Chronic Thromboembolic Disease, 5th WSPH, Nice 2013
Patients with Pre-Operative PVR > 1000

- Type III Disease: 22.0%
- non Type III Disease: 18.5%
Hemodynamic Outcomes

Mean PA Pressure

- Preop: 45.1 mmHg
- Postop: 45.2 mmHg

Cardiac Output

- Type III
  - Preop: 4.3 L/min
  - Postop: 5.3 L/min

- non Type III
  - Preop: 4.5 L/min
  - Postop: 5.8 L/min
Hemodynamic Outcomes

Pulmonary Vascular Resistance

Preop: Type III = 719.6, non Type III = 693.8
Postop: Type III = 287.2, non Type III = 230.7
Patients with Type III Disease achieve a significant reduction in mPAP and PVR, even in those with PVR >1000.

Similar perioperative mortality (1.7% vs. 1.2% p = 0.672).
“Inoperable”

- Depends on surgeon and center experience (1-2% mortality at UCSD)
- No degree of right heart failure or PVR Inoperable
  - Generally if etiology is thromboembolic it’s operable
Thirty Years ago –
Only UCSD was doing the operation

Now the entity of Chronic Thromboembolic Disease is widely recognized

Many other groups internationally are doing this difficult procedure with excellent results