Surgical Management of CTEPH: The Gold Standard

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Disclosures

• Consultant Fee
  – Bayer regarding medical treatment of CTEPH
Objectives

• Identify the indications for surgical management of CTEPH
Question 1

• In regards to surgical treatment of CTEPH, the best long-term outcome is achieved by:

  a) Combination of medical therapy and balloon angioplasty
  b) Pulmonary Embolectomy
  c) Pulmonary Endarterectomy
  d) Single/Double lung transplantation
  e) Heart & Lung Transplantation
Question 2

- Which CTEPH patients should not be referred for determination of operability:

- A - Patients with severe pulmonary hypertension (PVR > 1000 dynes/sec/cm-5)
- B - Patients with mild pulmonary hypertension
- C - Patients of advanced age
- D - Patients with clots only in the distal segmental branches (no proximal clots in the main and lobar arteries)
- E - None of the above
CTEPH – Key Points

• Underdiagnosed/Misdiagnosed
• Delay in referral
• Obstructive disease with poor Prognosis
• Surgical Treatment
  – curative if not delayed
  – Excellent Long-term results
• Medical Treatment (?)
  -- Only one approved drug
  -- ? effect on the obstructed vessels
  -- Long-term efficacy
• Role of BPA (?)
CTEPH – Key Points

• Clearly surgery is the best option
• But:
  – Surgery is technically challenging, and excellent outcomes requires access to an expert center
  – Operability determination challenges
  – Access to an expert center may be limited in certain areas of the world
• Need for other forms of treatment
Chronic Thrombotic Obstruction of Major Pulmonary Arteries

Report of a Case Successfully Treated by Thrombendarterectomy, and a Review of the Literature

Bethesda, Maryland

Cmdr. James E. McClanathan, mc, usn and Kenneth M. Moser, m.d.
Bethesda, Maryland

Washington, D. C.
Pulmonary Endarterectomy

Successful Surgical Intervention in Severe Chronic Thromboembolic Pulmonary Hypertension

Kenneth M. Moser and Nina S. Braunwald

*Chest* 1973:64:29-35
DOI 10.1378/chest.64.1.29
Surgical Principles

- Already well established\textsuperscript{1,2}
  - Median sternotomy
  - Cardiopulmonary bypass
  - Circulatory arrest
  - Bilateral endarterectomy
  - Identification of the plane
  - Complete endarterectomy

\textsuperscript{1}Jamieson et al. Cur Prog Surg 2000, 37:165-252
Pulmonary Endarterectomy
PEA Instruments
Double Action PEA Forceps

FL6034.2
FL6035.2
FL6025.2
FL6024.2
Old Surgical Classification

TYPE I

TYPE II

1 cm

TYPE III

TYPE IV
New UCSD Surgical Classification

• Based on the level of disease
• Fresh clot does not change the classification of the disease
• The level of disease corresponds to the degree of difficulty of the procedure
New UCSD Surgical Classification

• Identifying no evidence of CTEPH - as a separate entity
• Classifying a complete occlusion – as a separate entity as outcomes are somewhat unpredictable
New UCSD Surgical Classification

• **Level 0 (Old Type IV)**
  – No evidence of CTEPH in either lung

• **Level I (old Type I or II)**
  – Disease in the main pulmonary arteries
  – *Level IC*
    • Complete occlusion of one entire lung
New UCSD Surgical Classification

• **Level II (old Type I or II)**
  – Disease starting at the level of lobar arteries, or in the main descending PA’s

• **Level III (old Type III)**
  – Disease starting in the segmental levels

• **Level IV (old Type III)**
  – Disease starting at the level of subsegmental arteries
UCSD Classification

Level I

Level II

Level III

Level IV
Results

• Over 3100 cases at UCSD Medical Center
  – Mean age 53 (7 to 88)
  – Slight female predominance (50.3)
  – One third had at least one additional cardiac procedure (ASD/PFO, CABG, Valve, etc.)
  – Average operative time is about 7 hours
  – Mean CPB time 218 ± 41 min
  – Mean Cross clamp time 88 ± 25 min
  – Mean Circulatory arrest time 37 ± 12 min
Pre & Post-op Hemodynamics

PVR (dynes/sec/cm-5)

Pre-op: 897  
Post-op: 245

Mean PA (mm Hg)

Pre-op: 45.9  
Post-op: 26

Sys PA (mm Hg)

Pre-op: 79  
Post-op: 45

C.O. (Lit/min)

Pre-op: 3.6  
Post-op: 5.8

Pre-op  
Post-op
Overall Mortality By Era

Mortality

- Before 1990: 17%
- 1990-1998: 8%
- 1998-2006: 4.1%
- 2006-2010: 2.2%
- 2010-2014: 1%
Who is not a candidate?

• Operability
  – Hot Topic, but in reality difficult to determine
• Surgical Experience
• Center’s experience
• Patient factors:
  – Age, Comorbidities, Technical difficulties
• Hemodynamic vs Anatomical obstruction
Pulmonary Endarterectomy in Octogenarians

- Retrospective review of 1547 cases of PEA performed
- Time interval between 1994 and 2010 UCSD
- 28 (1.8%) cases of octogenarians.

Conclusion:
- Age over 80 was not a contraindication to surgery and these patients had significant benefit from surgery

Pretorius, GD et al. Should we offer Pulmonary Endarterectomy to Octogenarians? 5th WSPH, Nice 2013
Anatomic & Hemodynamic

• Is PVR of over 1000 in patients with segmental and subsegmental disease a contraindication to PEA?
PTE in Type III

• Patients Type III Disease achieve a significant reduction in mPAP and PVR, even in those with PVR >1000
• Similar perioperative mortality
• Higher incidence of PVR of >400 post-op
  • But, the clinical significance of this difference between the groups is likely small.

Auger, W. et al Pulmonary Hemodynamic Benefit is Achieved with Resection of Segmental-level (Jamieson Type III) Chronic Thromboembolic Disease, 5th WSPH, Nice 2013
Inoperable patients

- Technical Challenges
  - Varies between surgeons and centers
- Comorbidities
  - Some variability
- Lack of access to a surgical center
- Patient’s choice
Inoperable patients

• Options
  – Second opinion from an expert center
  – Medical Therapy
  – Transplantation
  – Role of balloon angioplasty (?)
    • When is it appropriate
Conclusion

• CTEPH is severely underdiagnosed and in many cases misdiagnosed
• Surgery is the best treatment option and should always be the first line of treatment
• Referral to an expert center should always be considered as a first option, and as a second opinion
• Surgery has proven excellent long-term outcomes, and operability should only be determined by an expert center
Question 1

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  b) Single lung transplantation
  c) Double lung Transplantation
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