

state of the art in

**ADVANCED HEART FAILURE**  
CLINICAL PRACTICE AND ORGANIZATIONAL MODELS

Venue · University Hospital A Coruña



Papworth Hospital

NHS Foundation Trust

**NHS**

# Pulmonary Endarterectomy



**Steven Tsui**  
Papworth Hospital,  
Cambridge, UK.



# Papworth Hospital

- Cambridge University Teaching Hospital
- Surgical Activities:
  - > 2,200 cardiac cases
  - > 150 PTEs
  - > 70 transplants
  - LVAD
  - ECMO
  - TAVI



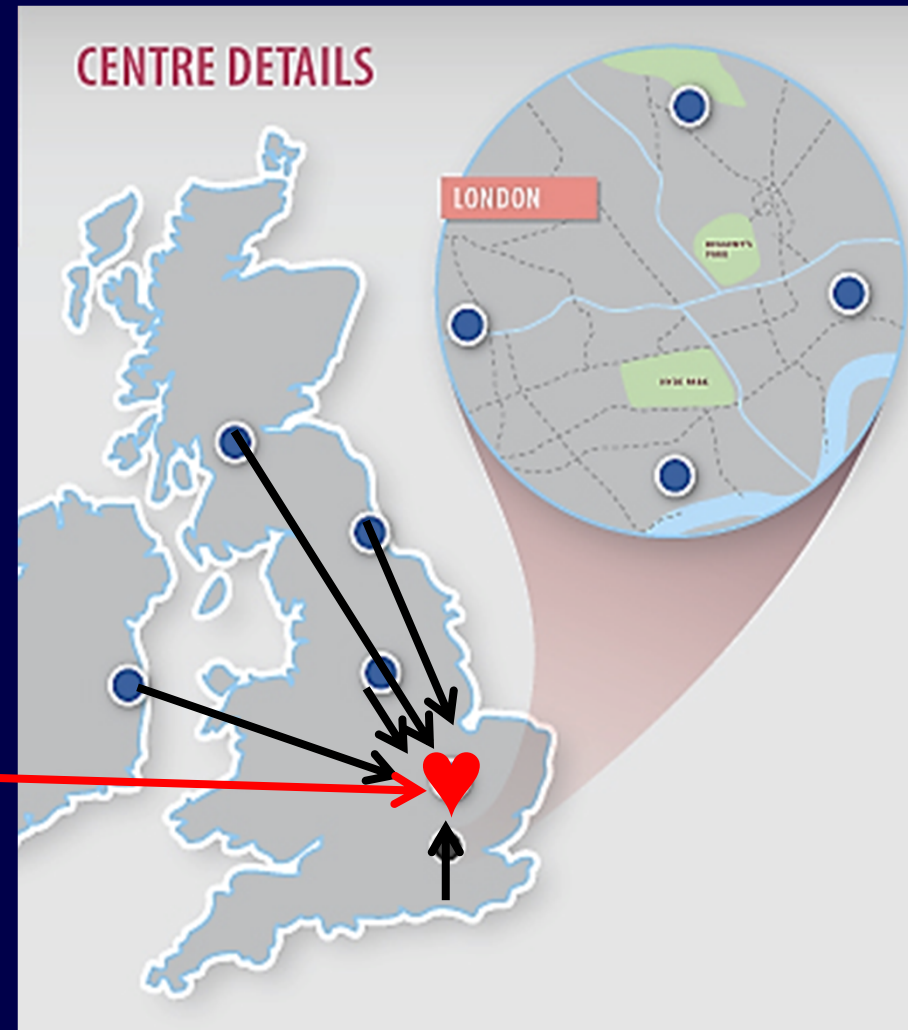
# UK & Ireland CTEPH Service

## National Pulm. Hypertension Centres

1. Dublin
2. Glasgow
3. Newcastle
4. Sheffield
5. Hammersmith, London
6. Brompton, London
7. Royal Free, London
8. Great Ormond Street Hospital

## Pulmonary Endarterectomy Centre

- Papworth Hospital, Cambridge

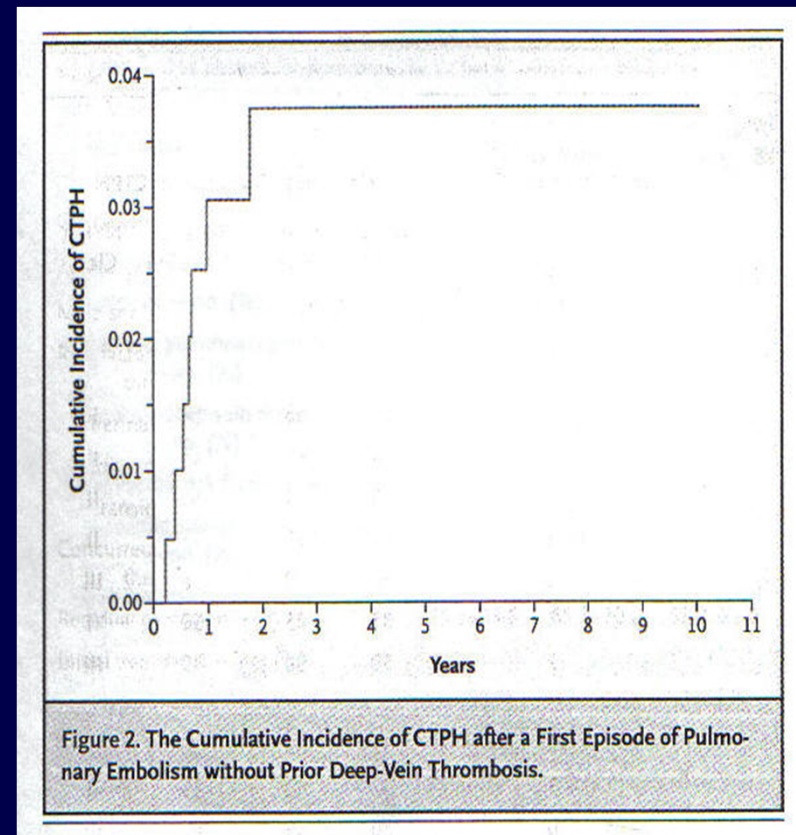


NATIONAL PULMONARY HYPERTENSION CENTRES  
OF UNITED KINGDOM AND IRELAND  
PHYSICIANS' COMMITTEE

# How common is CTEPH?

Prospective study of acute PE survivors:

- N=305
- Clot lysis is the norm
- Incidence of symptomatic CTEPH
  - 3.1% at 1 year
  - 3.8% at 2 years

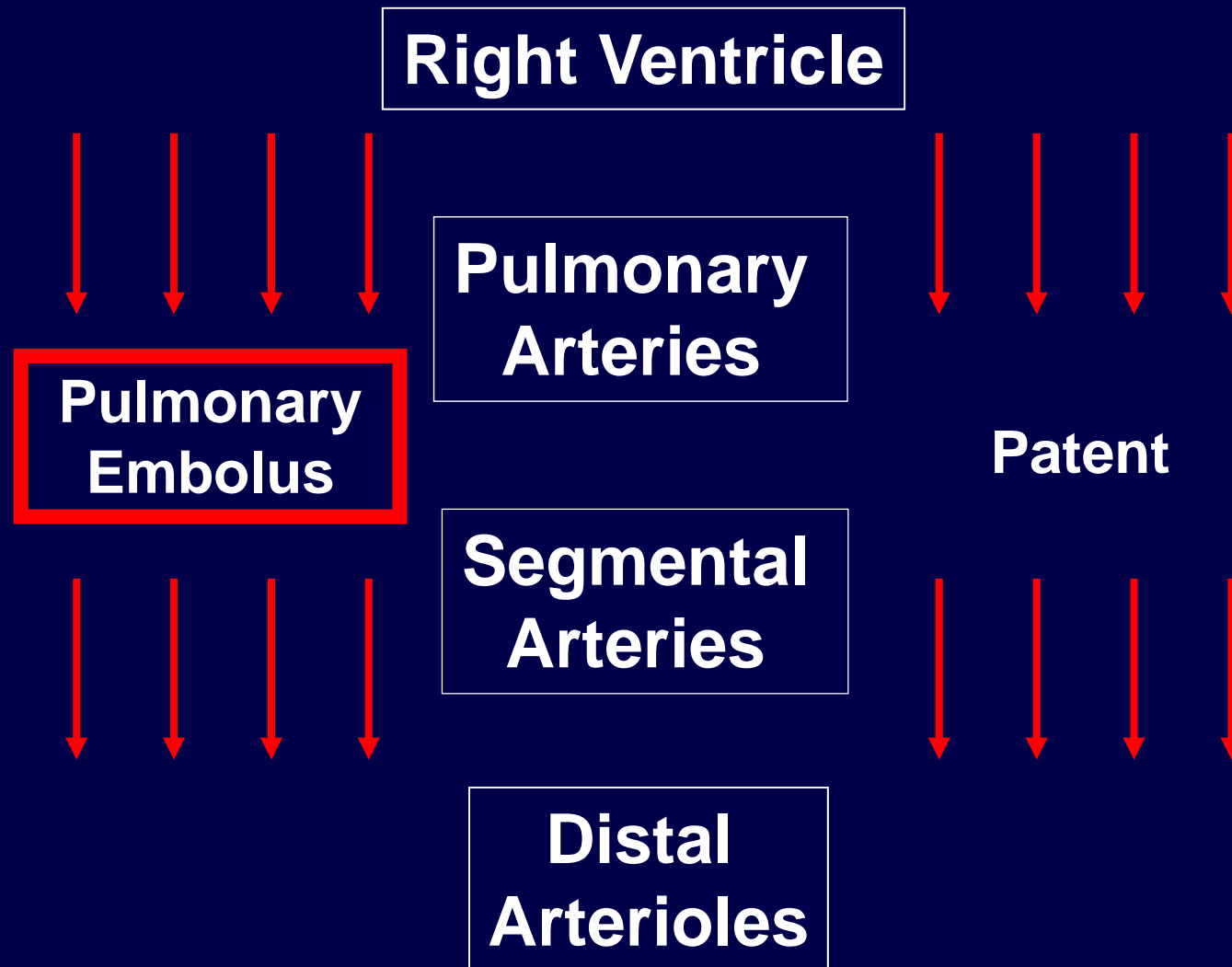


Pengo et al. NEJM. 2004;350:2257-2264

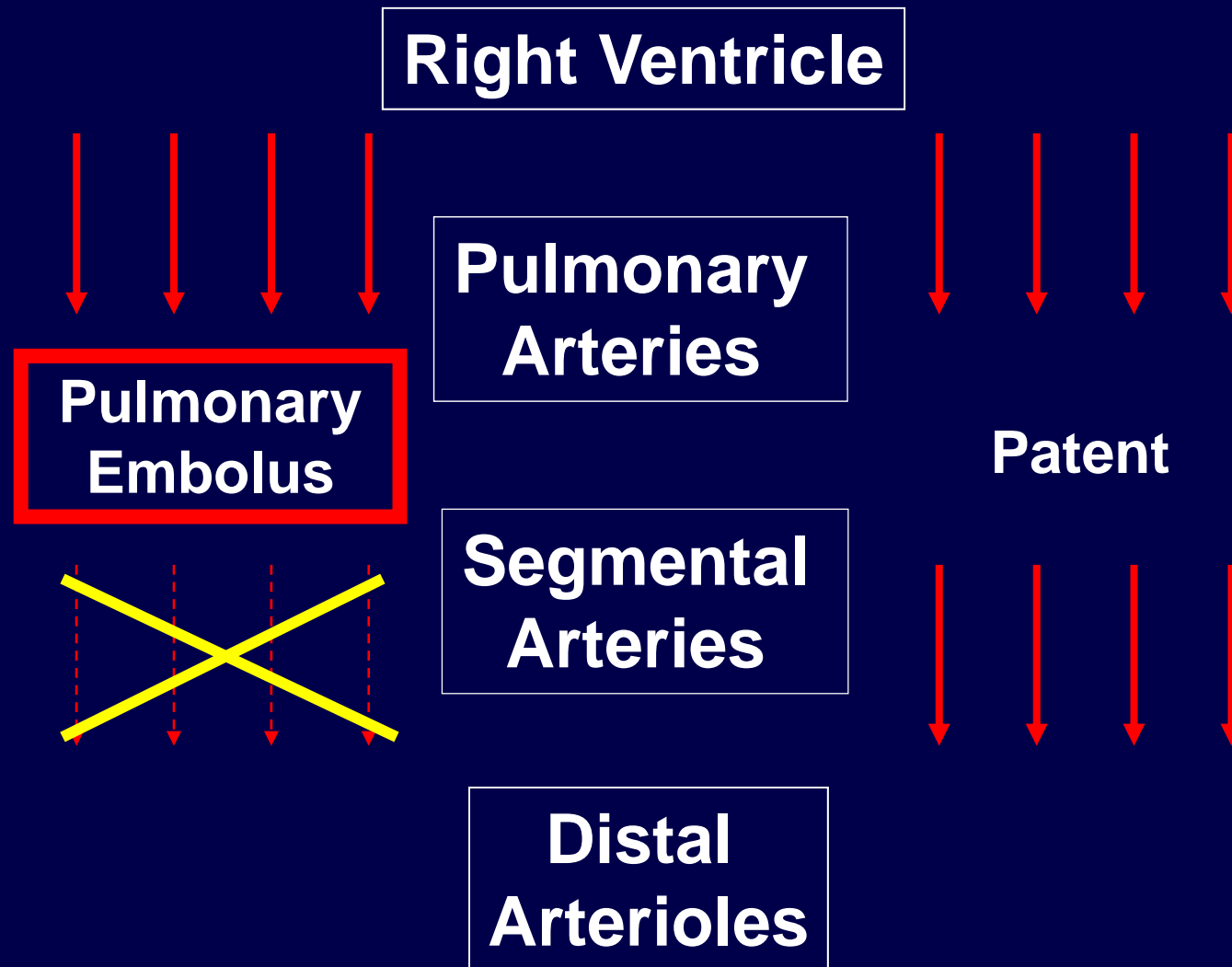
# Delayed Diagnosis

- Slow symptom onset to diagnosis:
  - Gradual onset of SOB/OE
  - Subtle clinical signs in early phase
  - Low CTEPH awareness amongst doctors  
( δ▲ “asthma”, “LVF” .....)
  - Av. 2-3 YEAR delay in diagnosis common

# Patho-Physiology of CTEPH

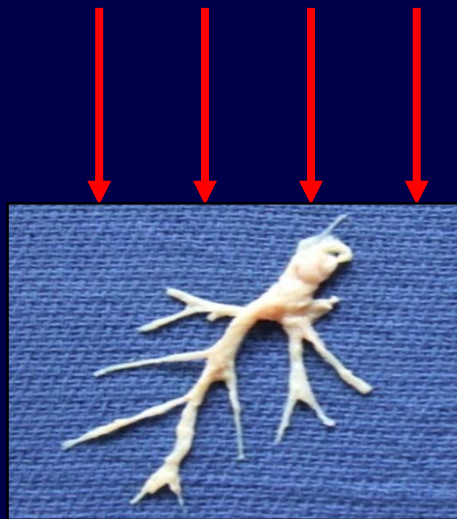


# Patho-Physiology of CTEPH



# Patho-Physiology of CTEPH

Right Ventricle

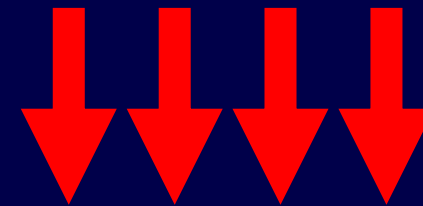


Protected  
i.e. normal

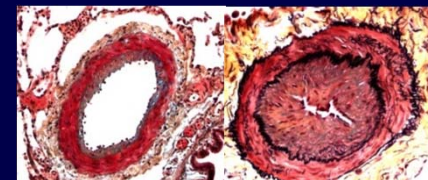
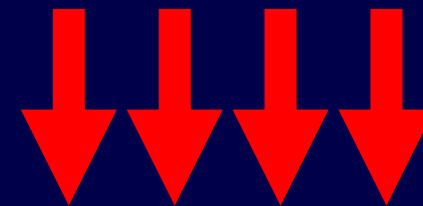
Pulmonary  
Arteries

Segmental  
Arteries

Distal  
Arterioles

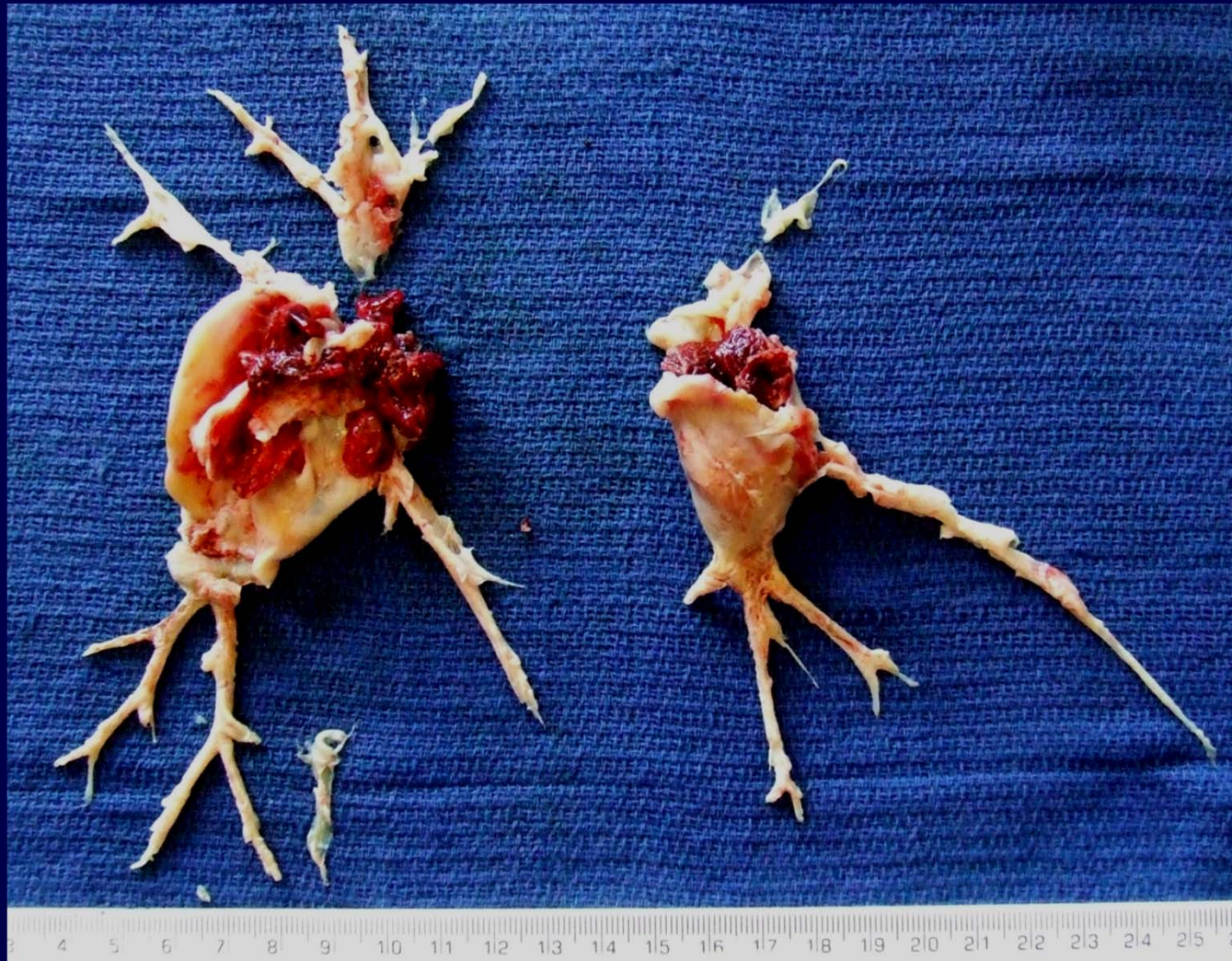


Patent





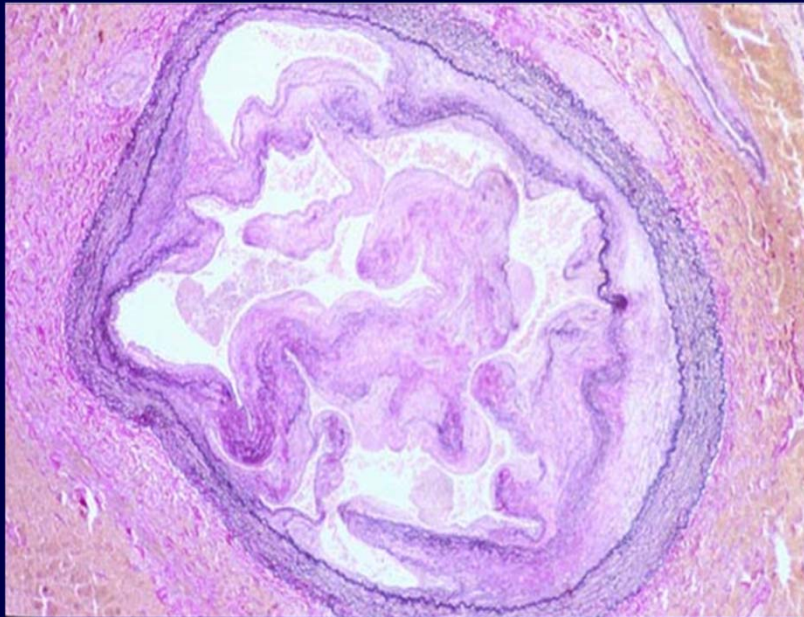
# Macroscopic Lesions



# Histology

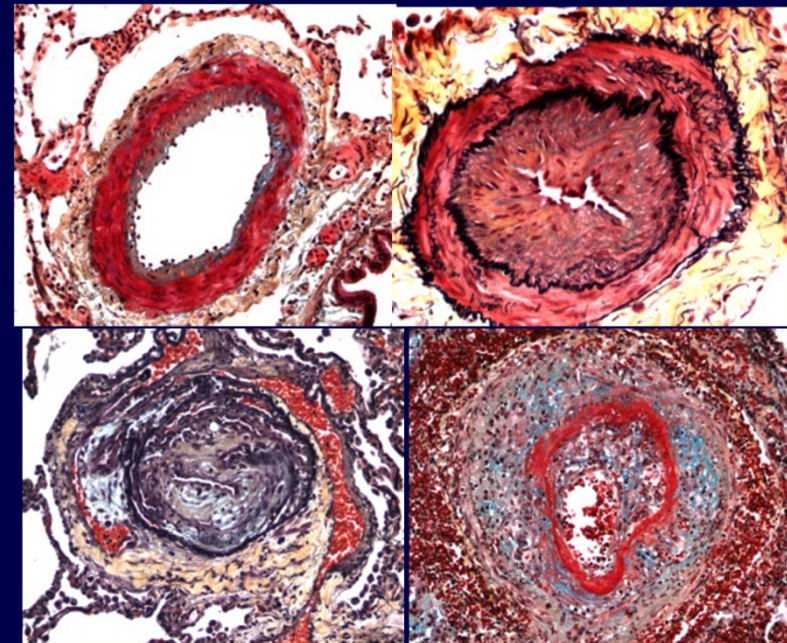
## Segmental arteries:

Fibrous organisation  
incorporated in vessel  
wall



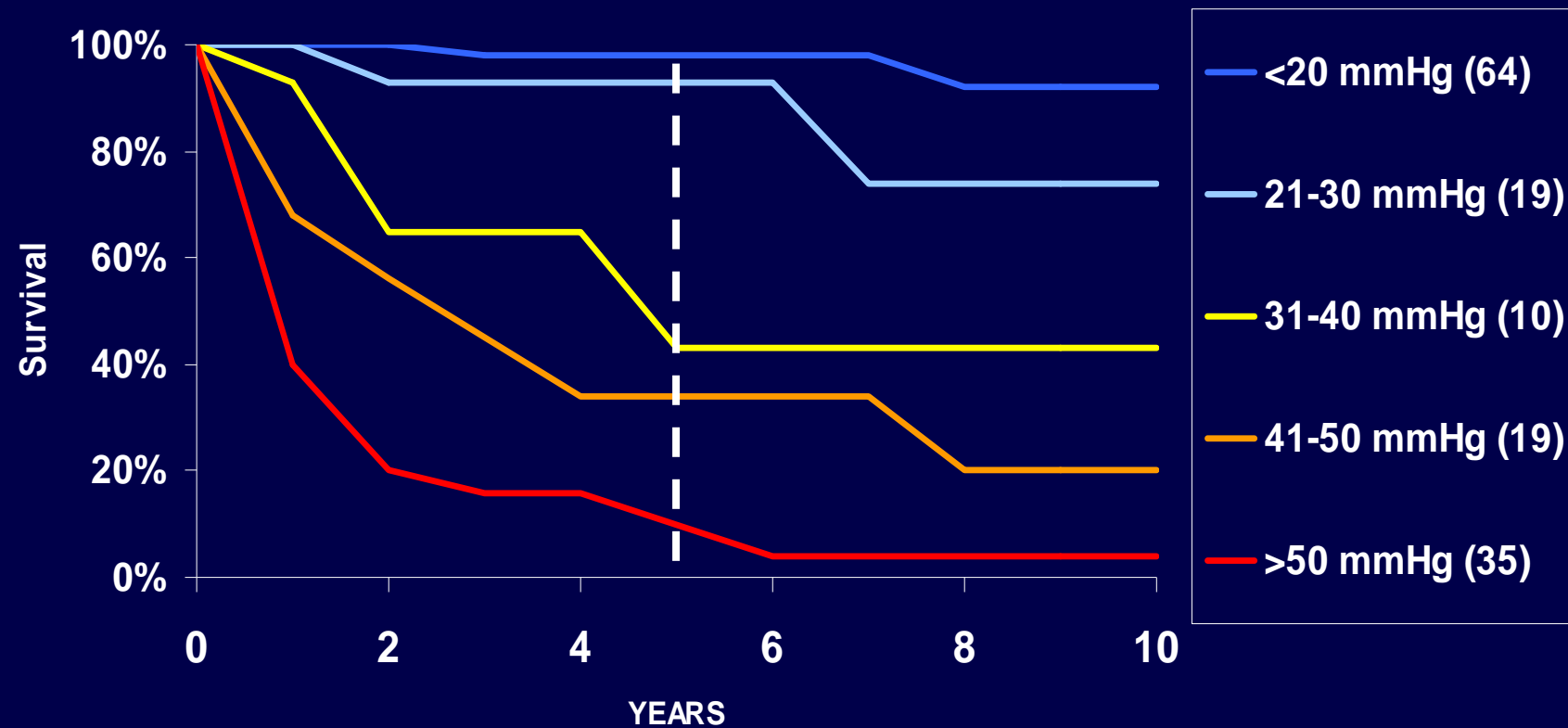
## Arterioles:

Vasculopathy with  
remodelling of small  
vessels



# Prognosis of CTEPH

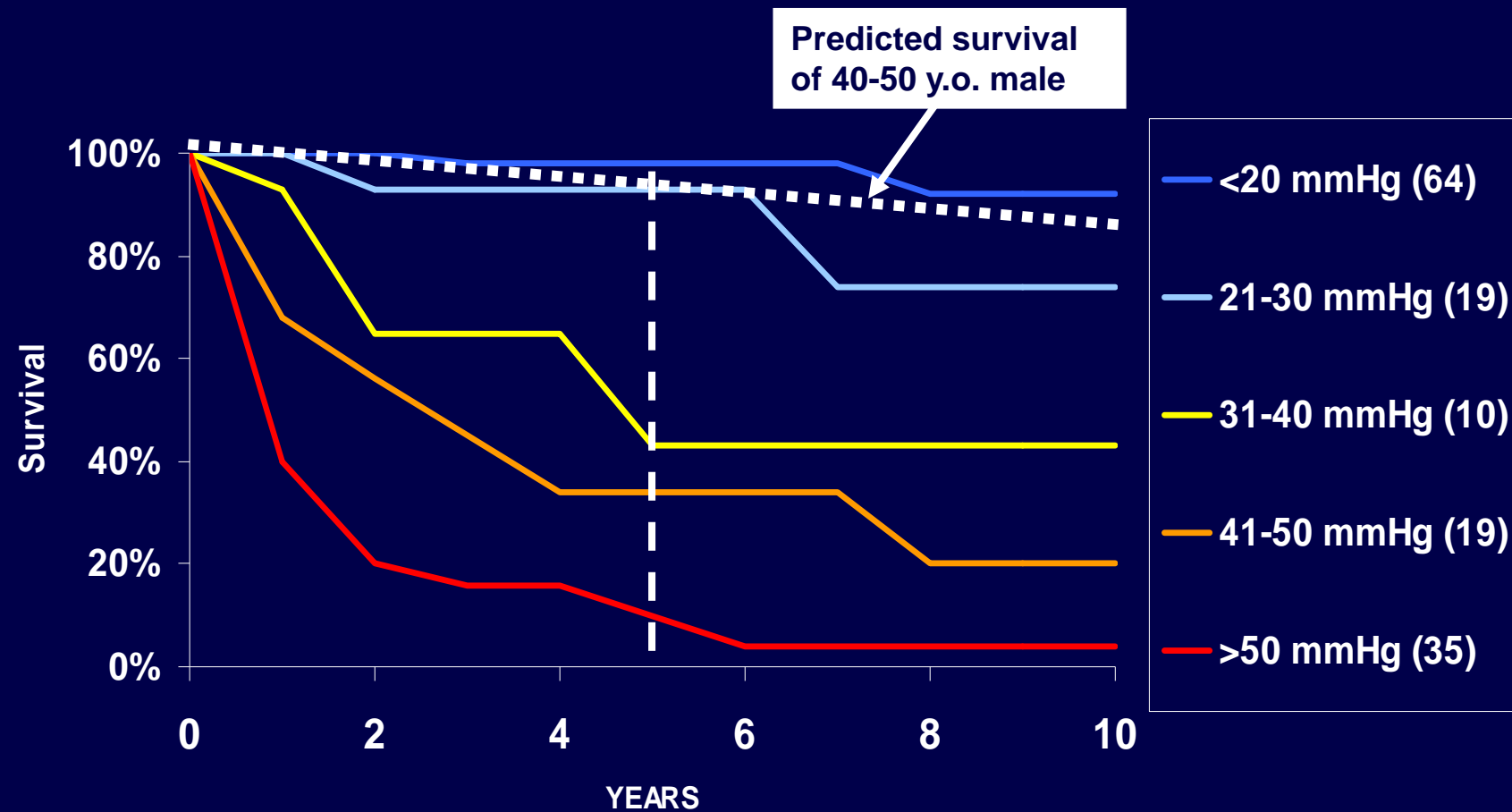
*Stratified by mean PAP (n=147)*



Reidel et al. Chest. 1982;81:151-158

# Prognosis of CTEPH

*Stratified by mean PAP (n=147)*

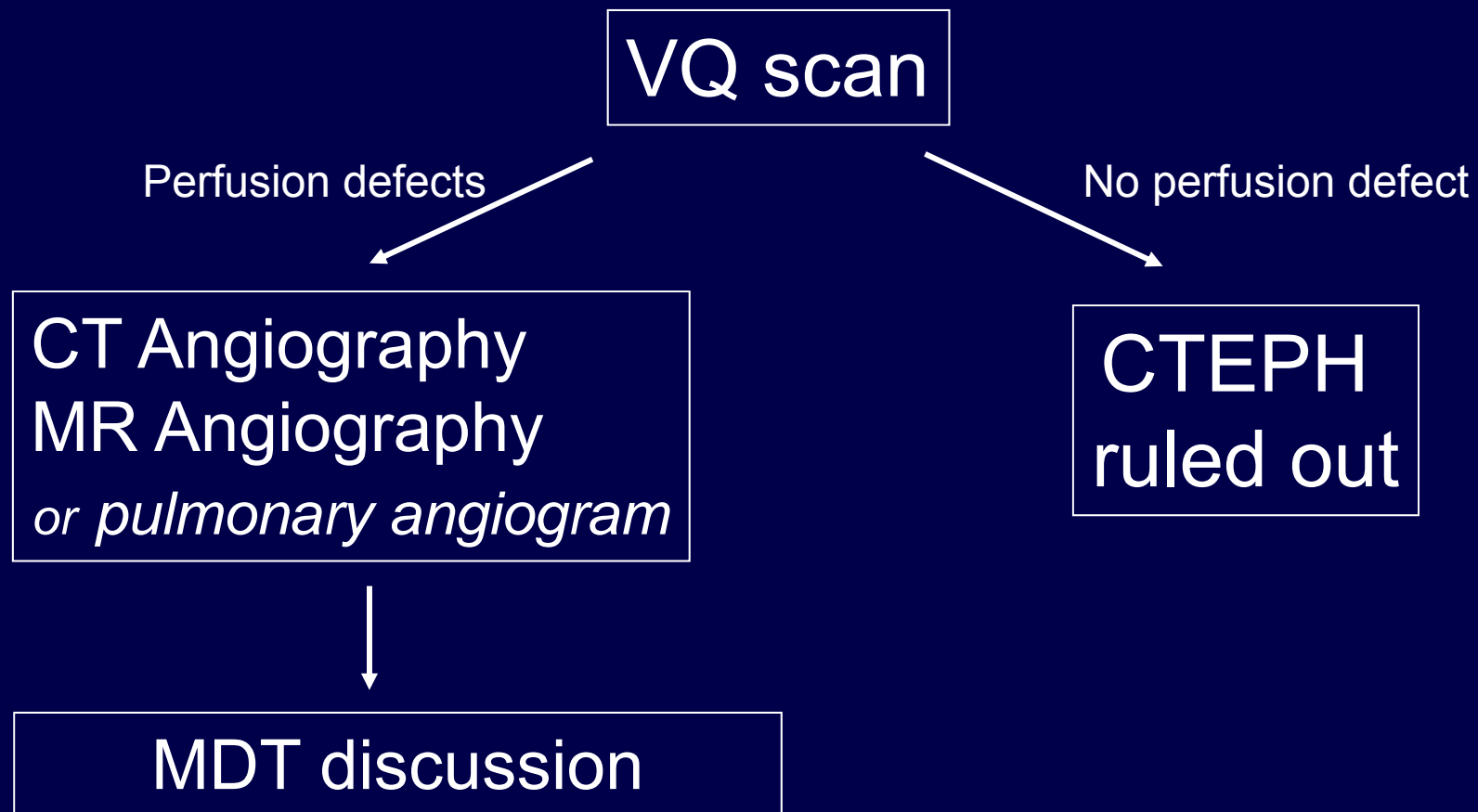


# Investigations

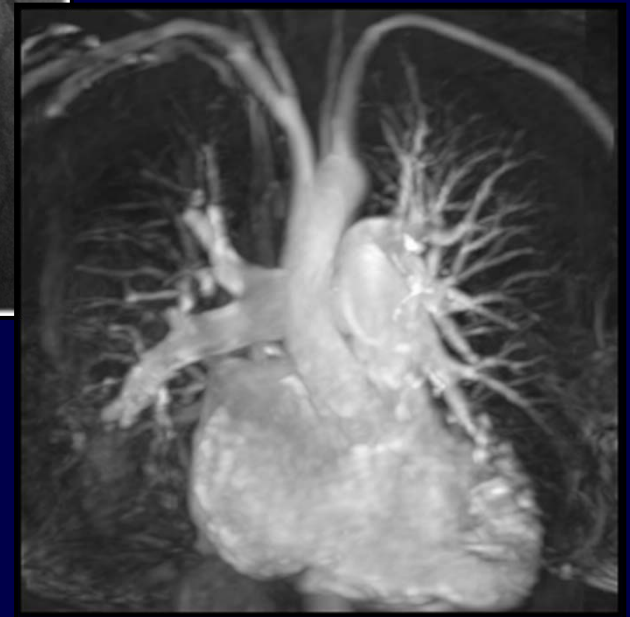
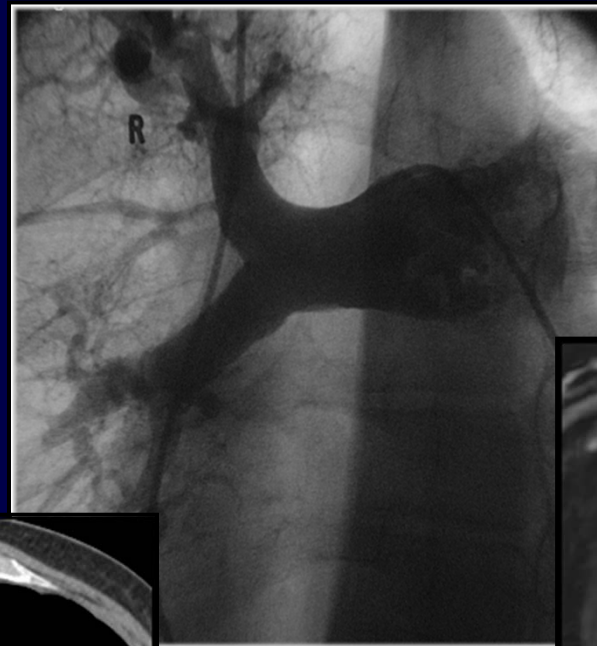
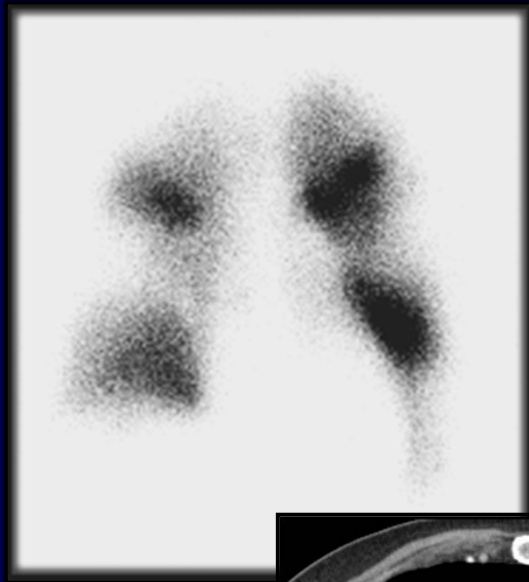
Referral via National Pulm. Hypertension Centres:

- Exercise testing (6-min. walk)
- Echocardiogram
- Pulmonary function tests
- V/Q scan
- Right heart catheterisation
  
- Phase II coronary angio, carotid dopplers

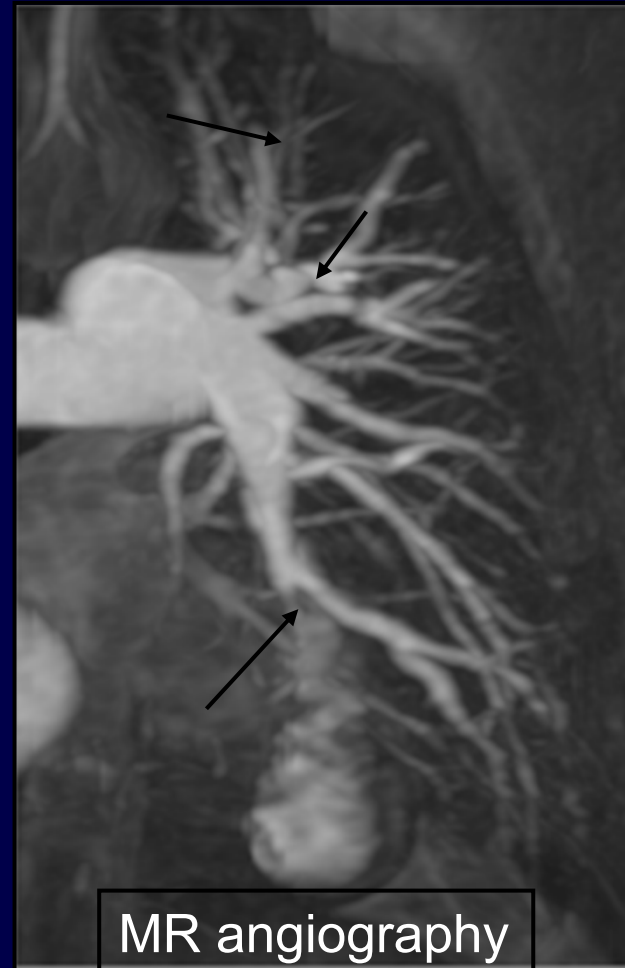
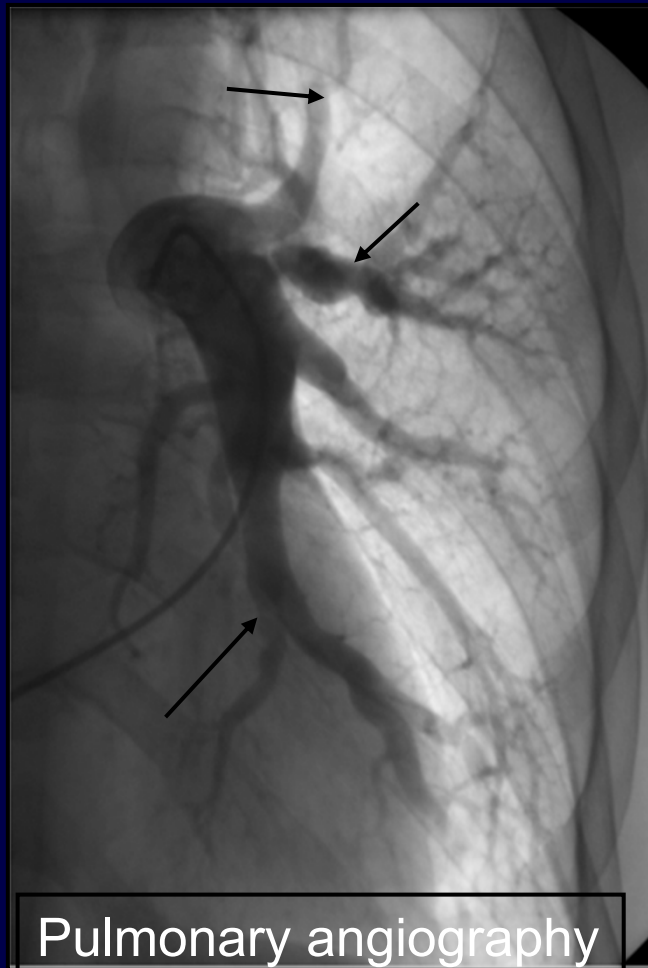
# Diagnostic Imaging



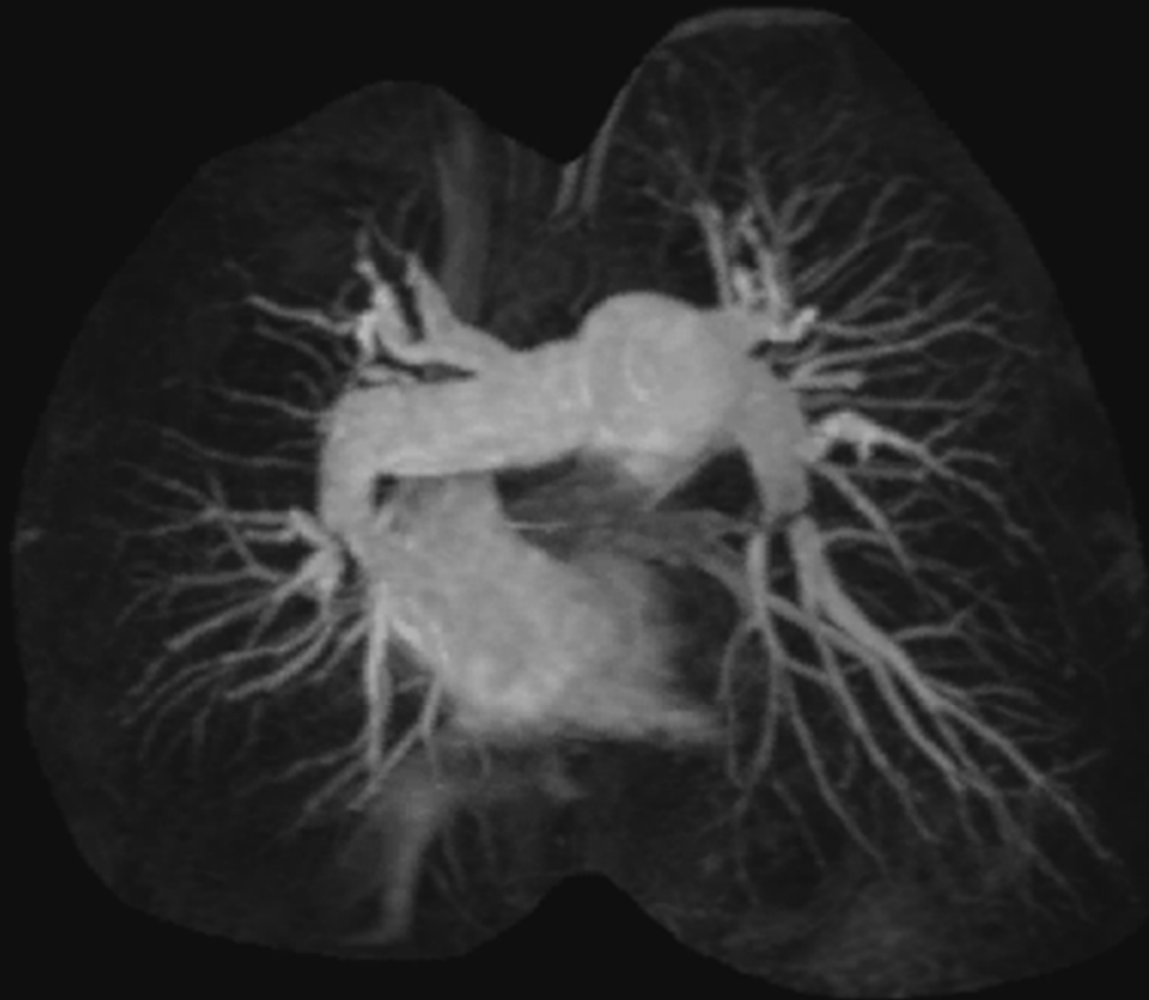
# Imaging



# Imaging







# Proximal versus Distal



# Investigations

Referral via National Pulm. Hypertension Centres:

- Exercise testing (6-min. walk)
- Echocardiogram
- Pulmonary function tests
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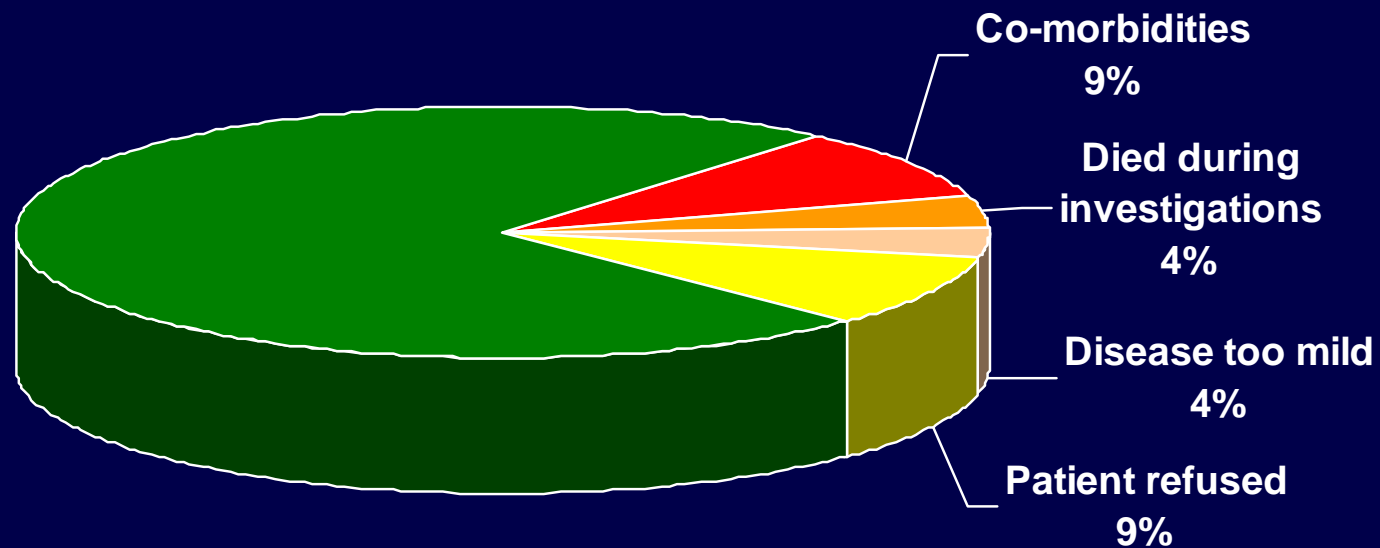
# Selection of patients for PTE

- NYHA class III-IV symptoms, ? **Class II**
- Significant pulmonary hypertension at rest or on exercise (mPAP>25 mmHg)
- Raised PVR
- Thromboembolic disease on **imaging**
- Co-morbidities
- Age?

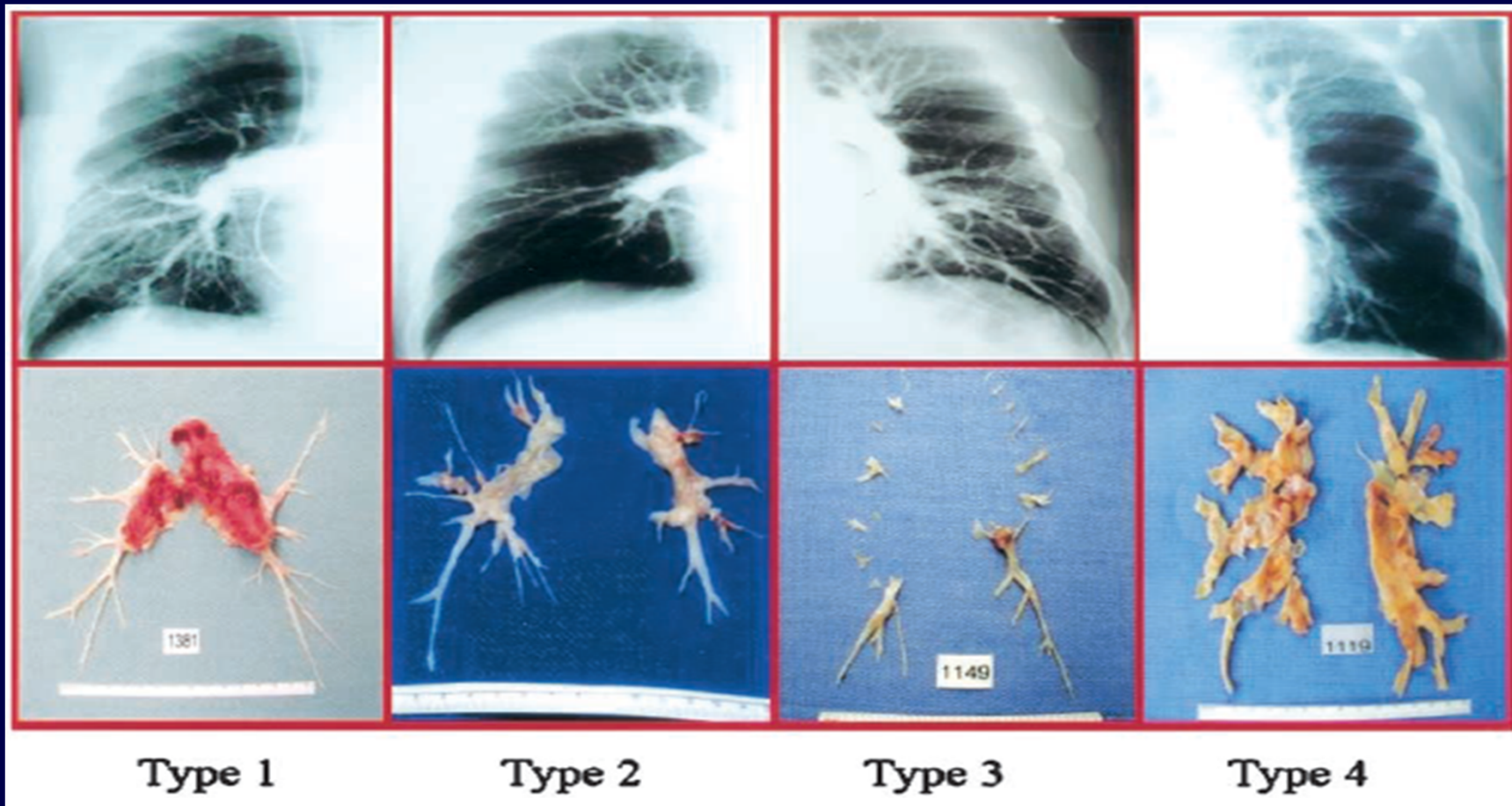
# Outcome of Patients Referred with Surgical Disease, n=321

PTE performed 74%

PTE not performed 26%

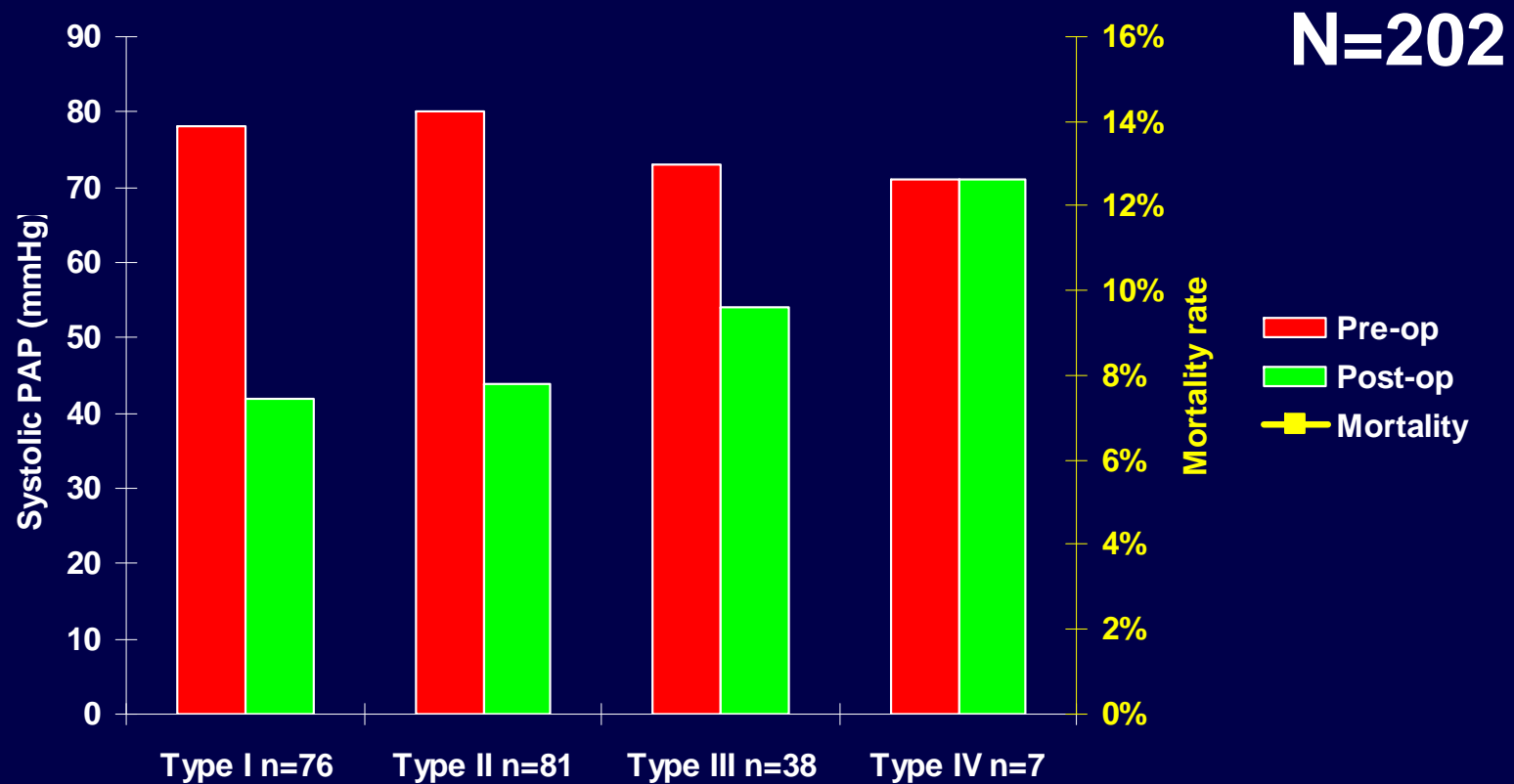


# Surgical Classification of CTEPH



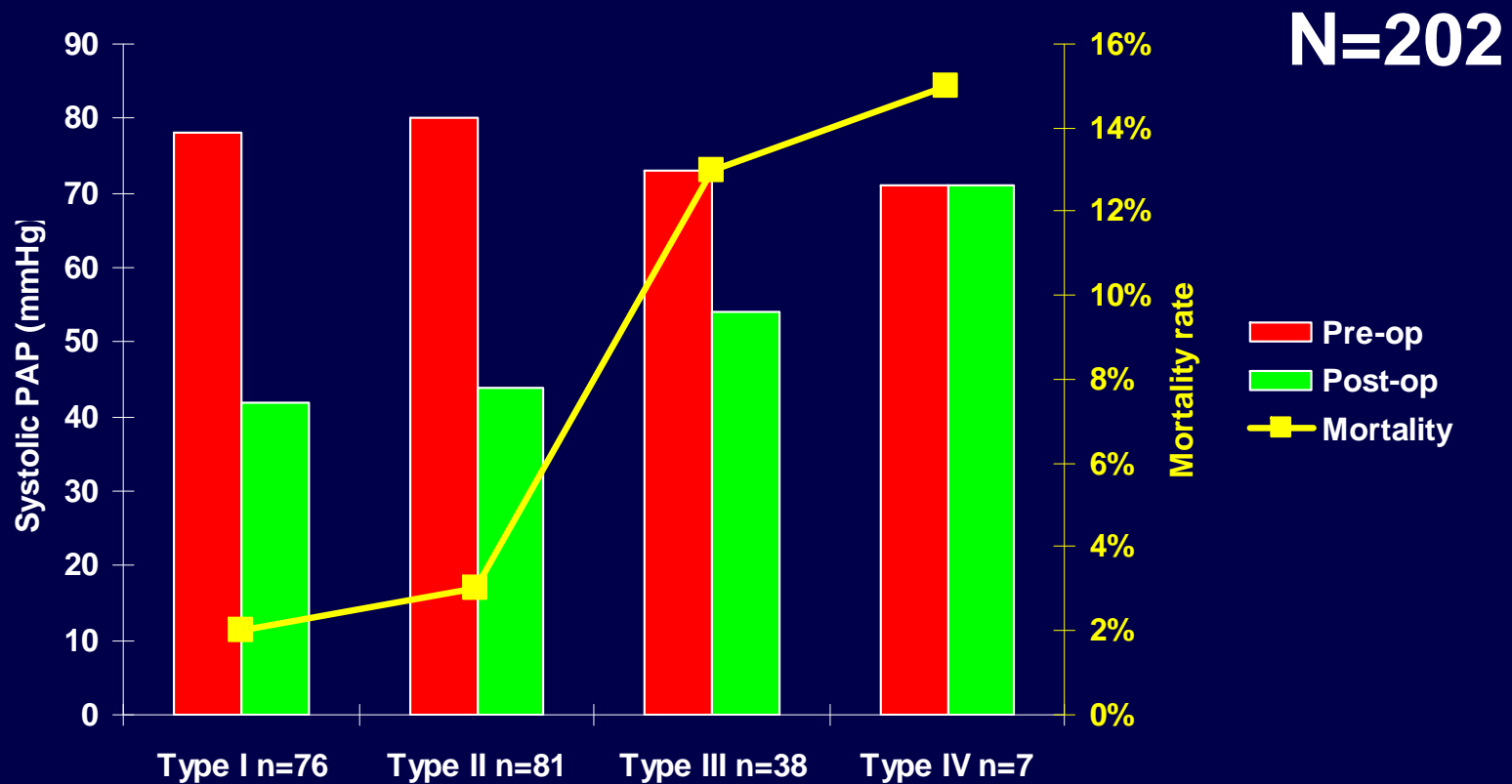
Thistlethwaite et al JTCVS 2002;124:1203-1211

# Disease Type Affects Outcome



Thistlethwaite et al JTCVS 2002;124:1203-1211

# Disease Type Affects Outcome



Thistlethwaite et al JTCVS 2002;124:1203-1211



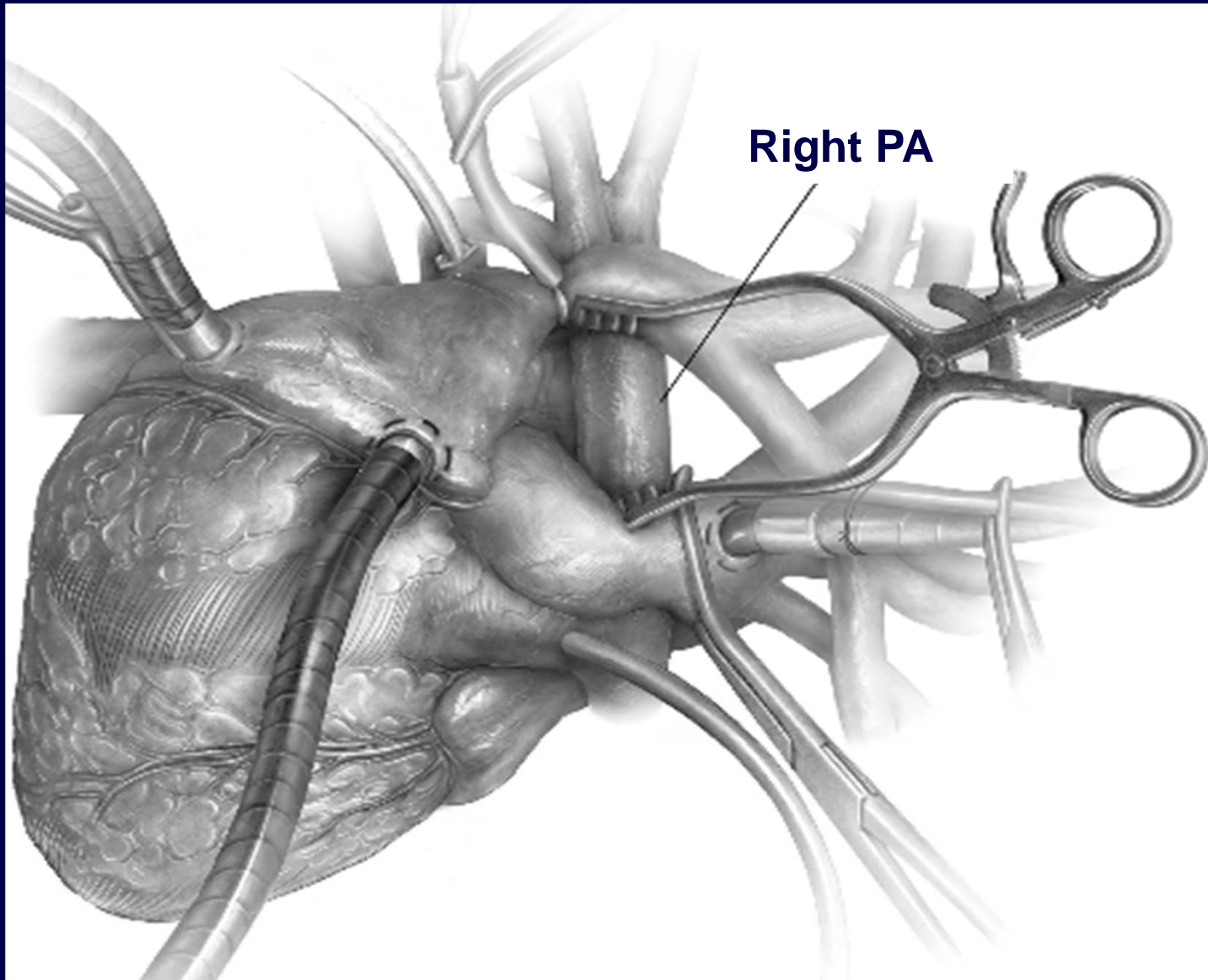
# History of surgical attempts

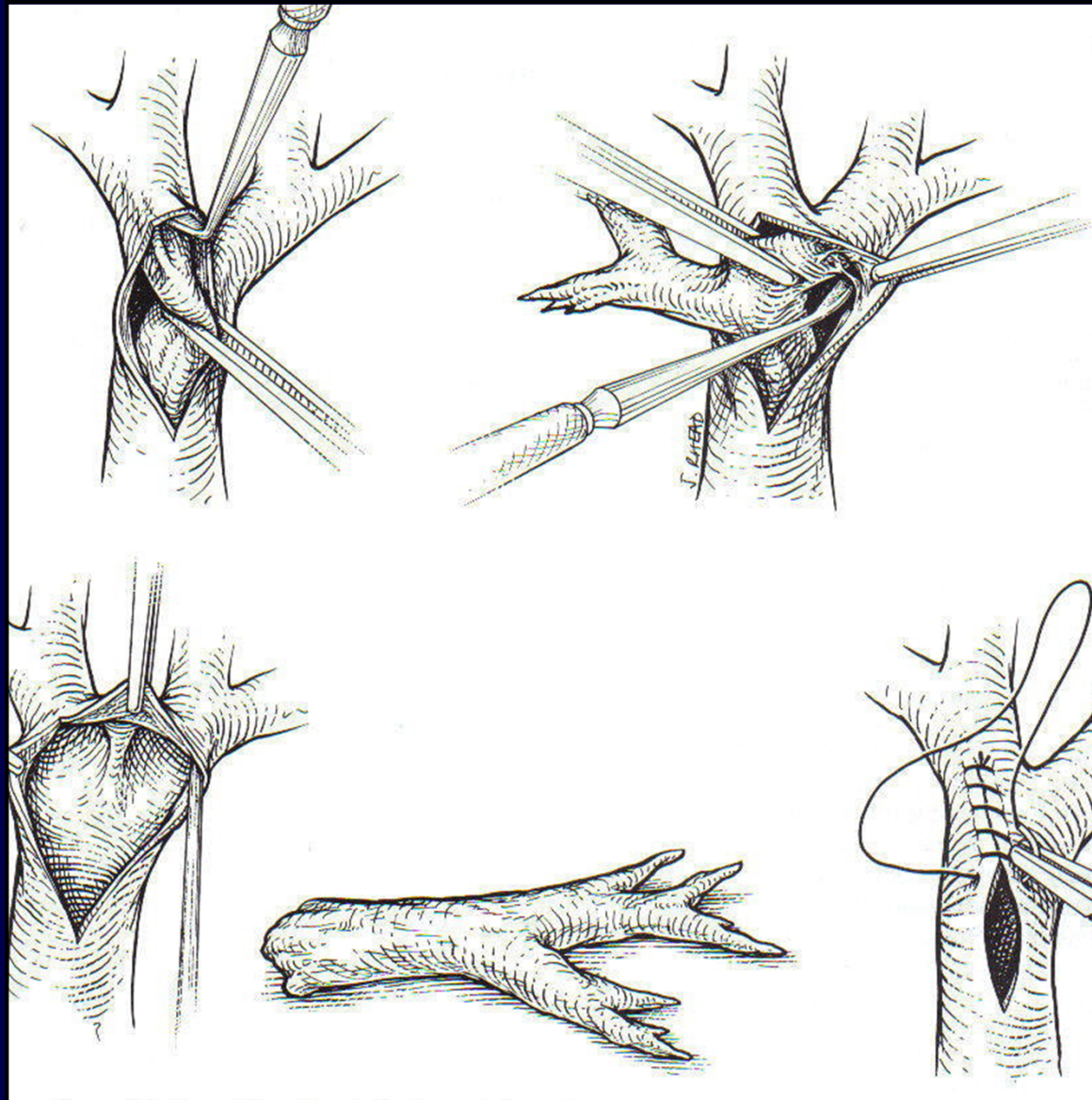
- 1908 **Trendelenburg** 1<sup>st</sup> operation for PE
- 1948 **Blalock** 1<sup>st</sup> operation for CTEPH
- 1961 **Cooley** Operation for CTEPH using CPB
- 1962 **Hufnagel** 1<sup>st</sup> successful op. for CTEPH
- 1970 **Braunwald** 1<sup>st</sup> operation at UCSD
  
- 1984 Review of world experience, only 85 cases, with 22% reported mortality
  
- 1990 **Jamieson** Start of modern era, large series commenced at UCSD, >3000 cases.

# Surgical technique

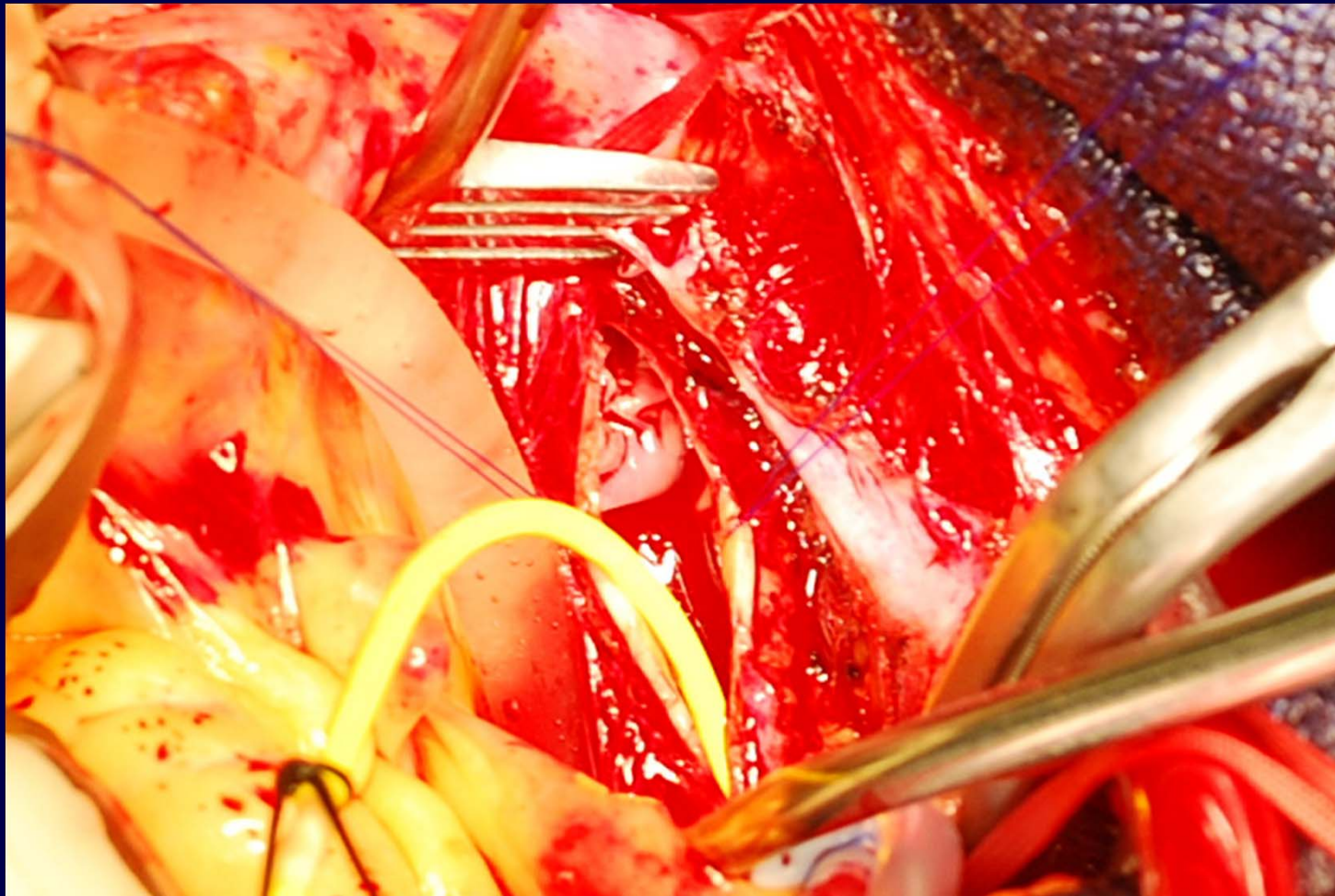
## *After San Diego*

- Median sternotomy incision
- Eliminate collateral blood flow:
  - CPB with cooling to 20°C +/- DHCA
  - Cardioplegic arrest
- Intra-pericardial pulmonary arteries incisions
- True endarterectomy in plane of vessel media and full distal dissection

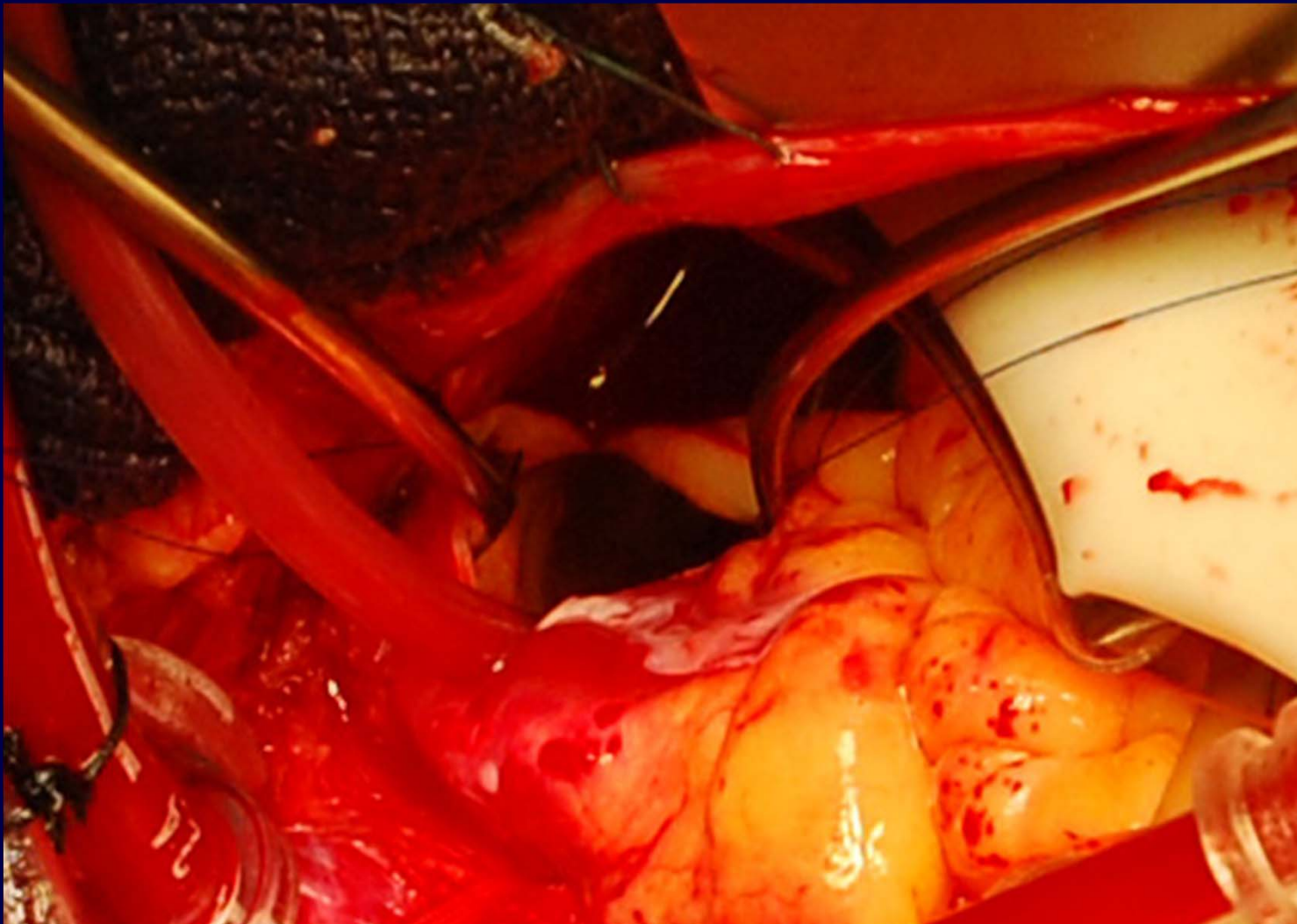




# Right Pulmonary Artery



# Left Pulmonary Artery



**“ PEA is like.....”**



**“.....fixing a car engine  
thru’ the exhaust!”**



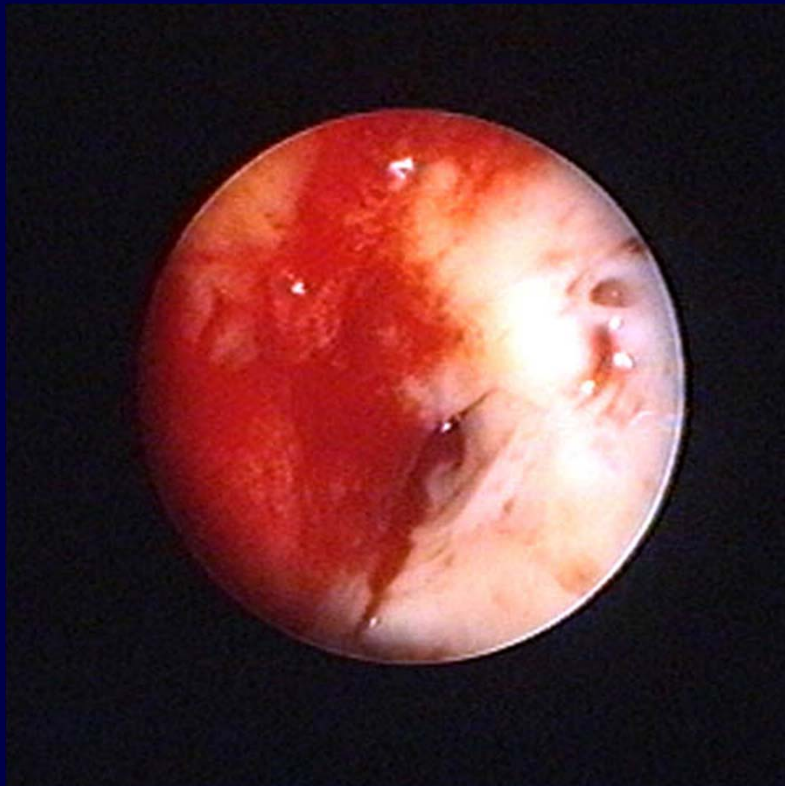


# PEA Operative Video

## Pulmonary Endarterectomy

PAPWORTH HOSPITAL, UK

# Views inside pulmonary artery

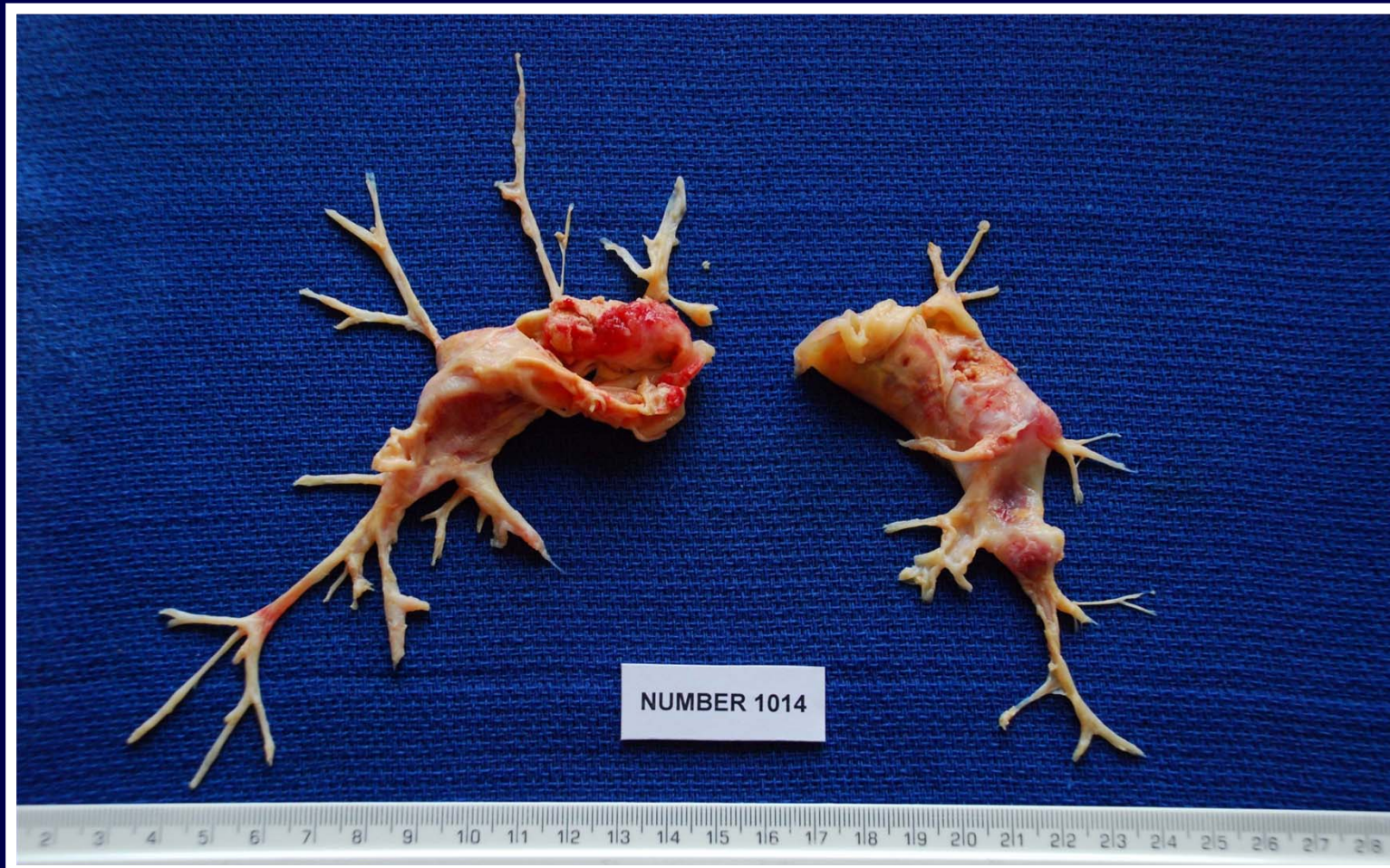


**Before**



**After**

# Pulmonary Endarterectomy Specimen: *Type I disease*



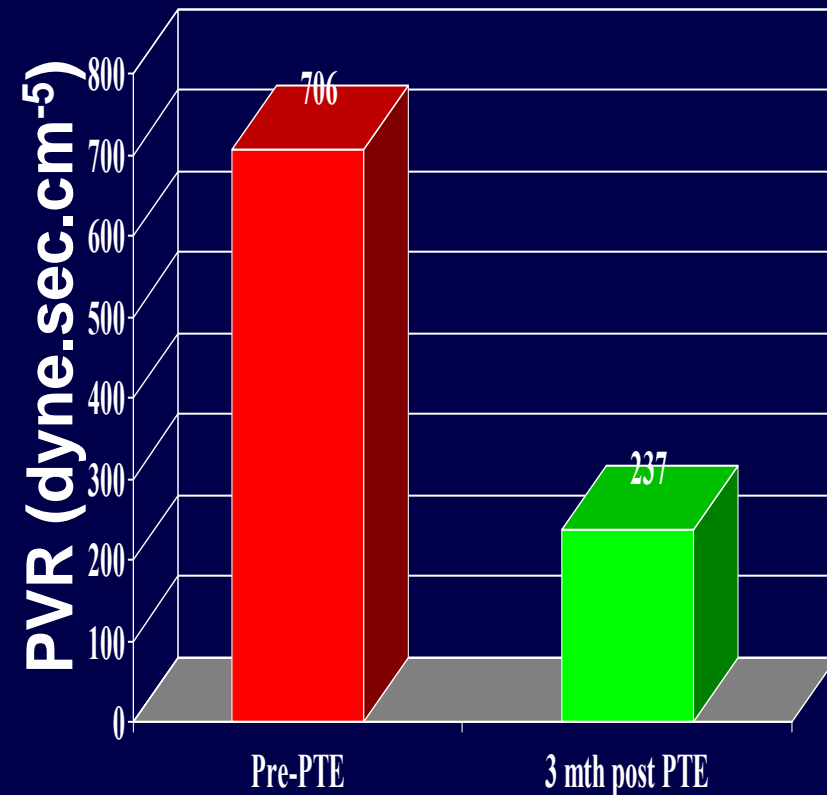
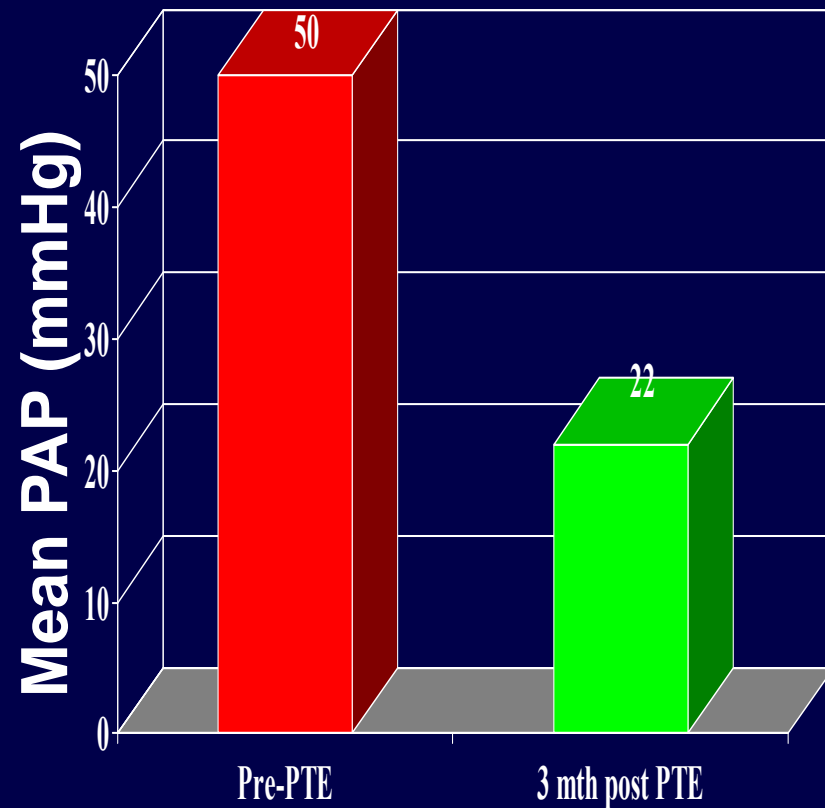
# Papworth Experience

## *Last 500 PEA*

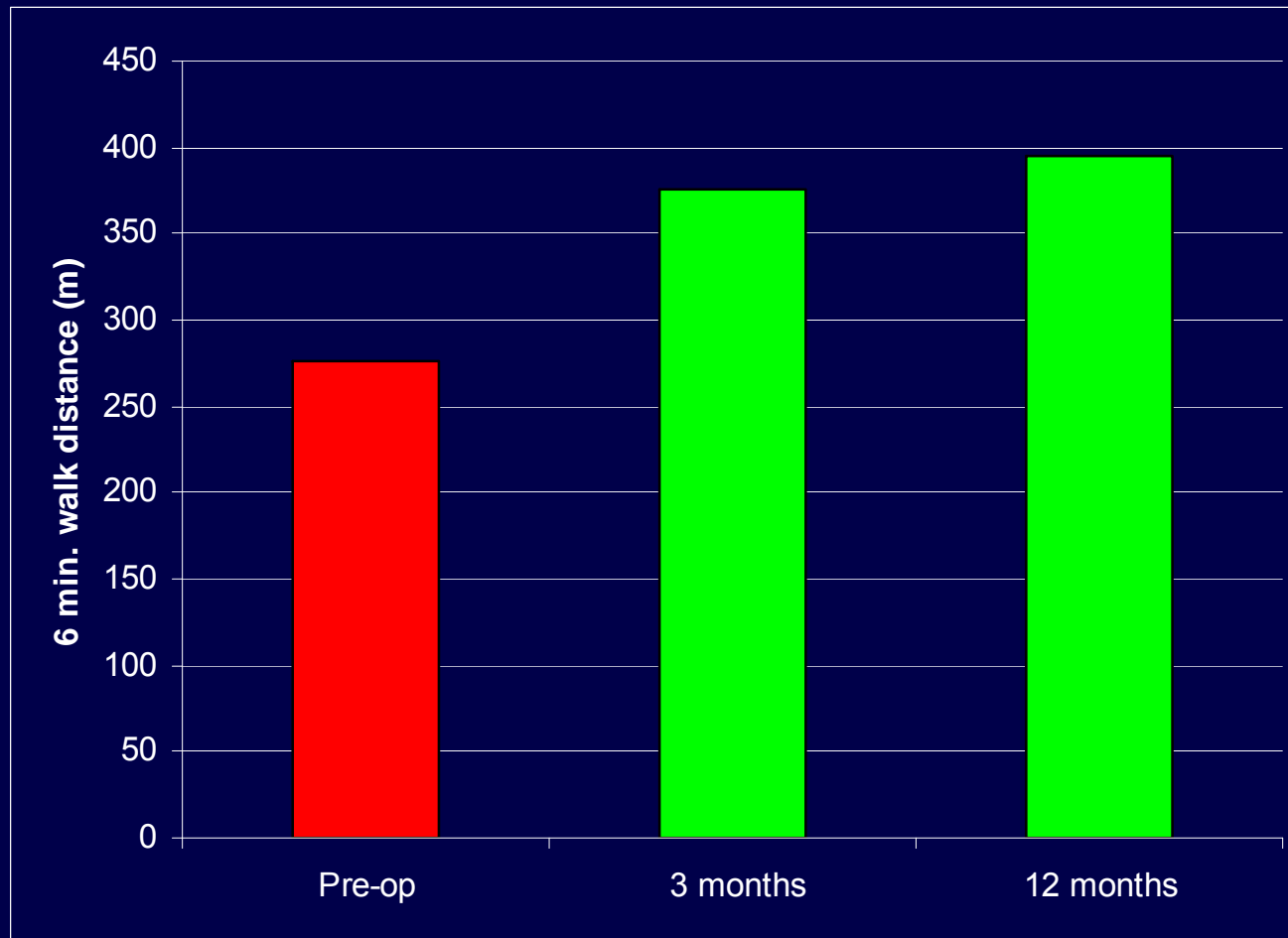
- Median age, yrs (range) 60 (24-84)
- Concomitant surgery: 10%
- Redo PTE, n= 6
- CPB time (min): 329 +/- 57
- X clamp time (total min.): 62 +/- 28
- DHCA times (total min.): 34
- **In-hospital mortality in 2014: 4/151 (2.6%)**

# Mean PAP & PVR

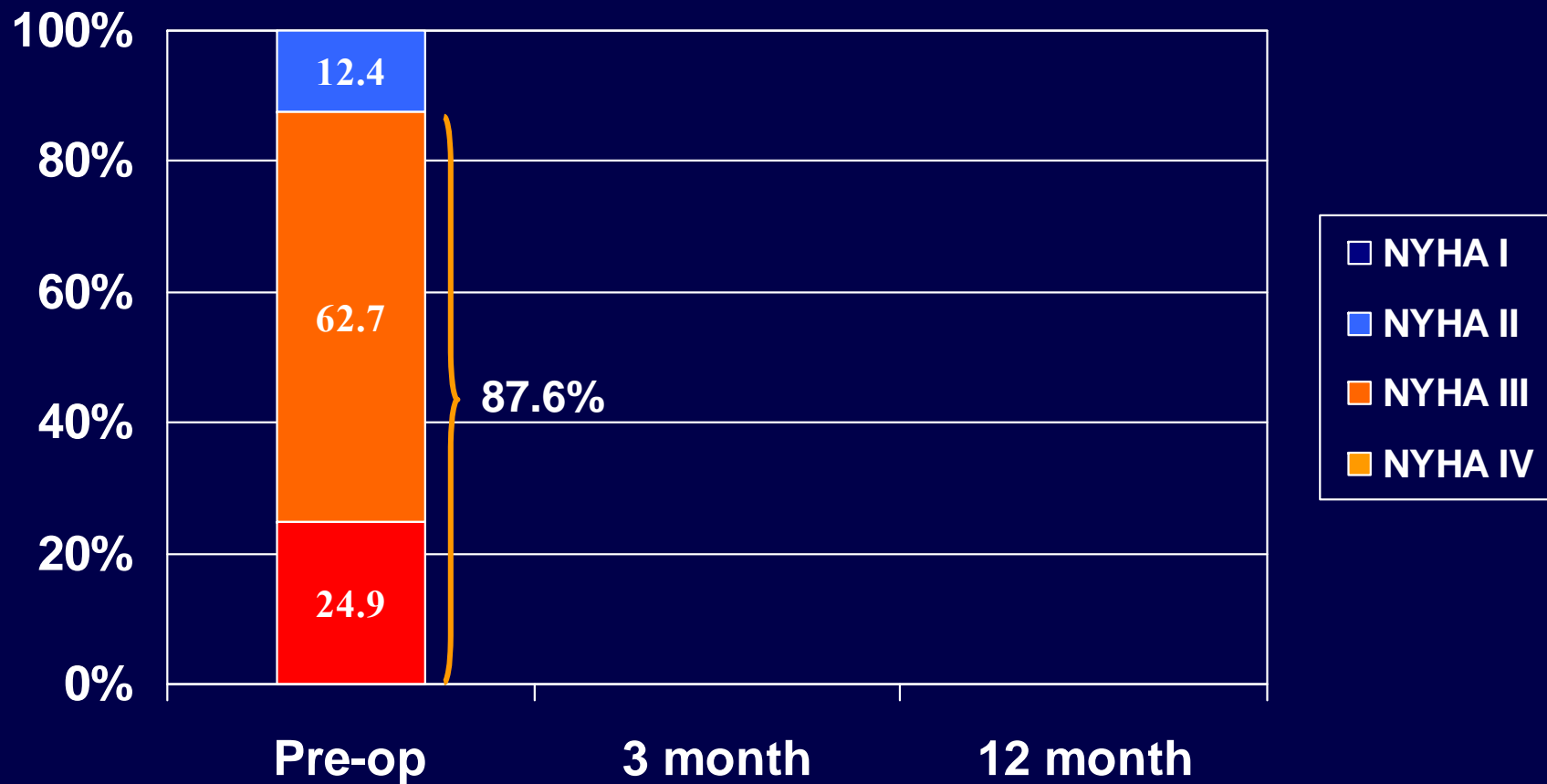
## Pre- and Post-PTE



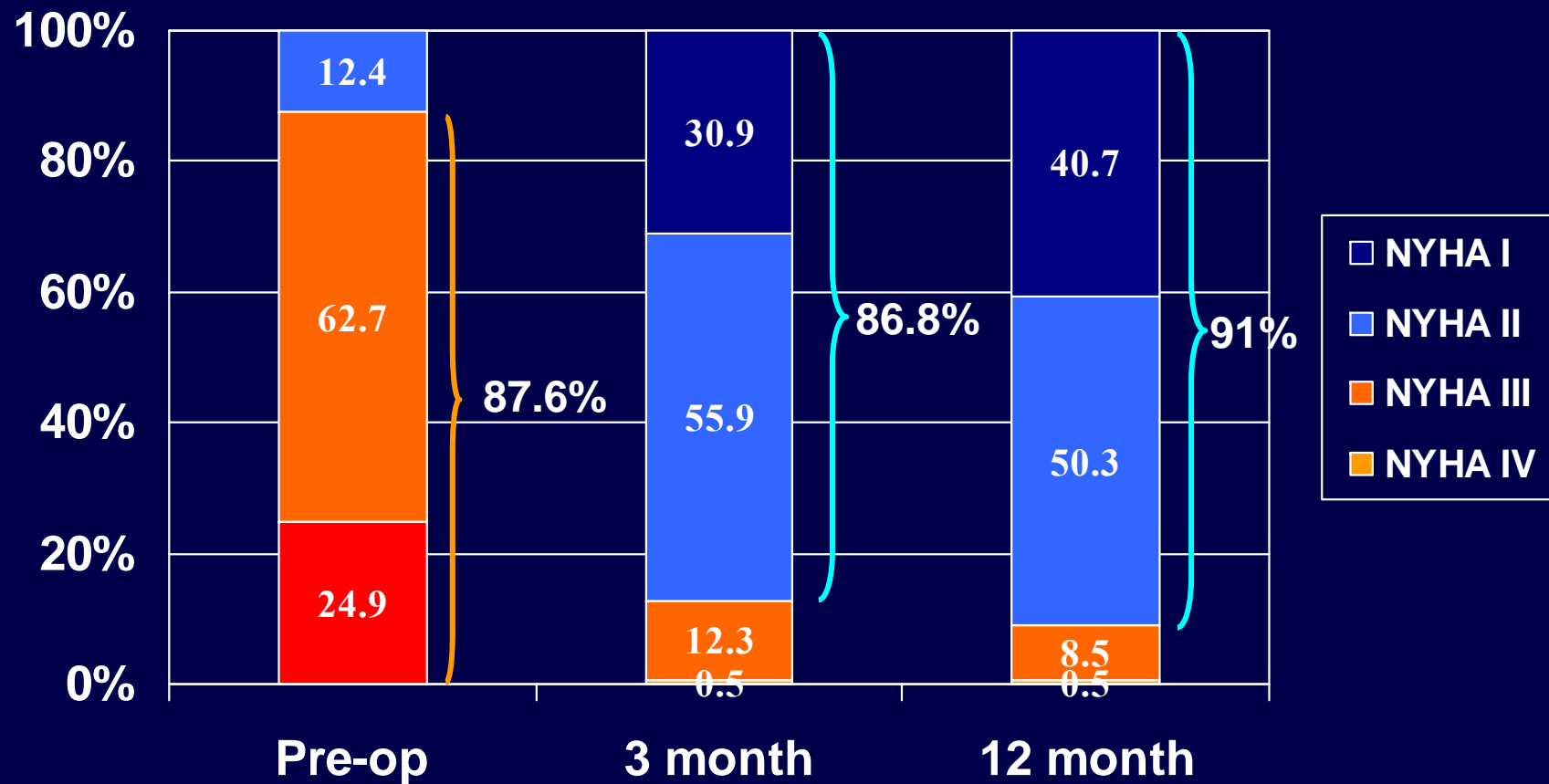
# 6-min Walk Distance



# NYHA Class post-PTE

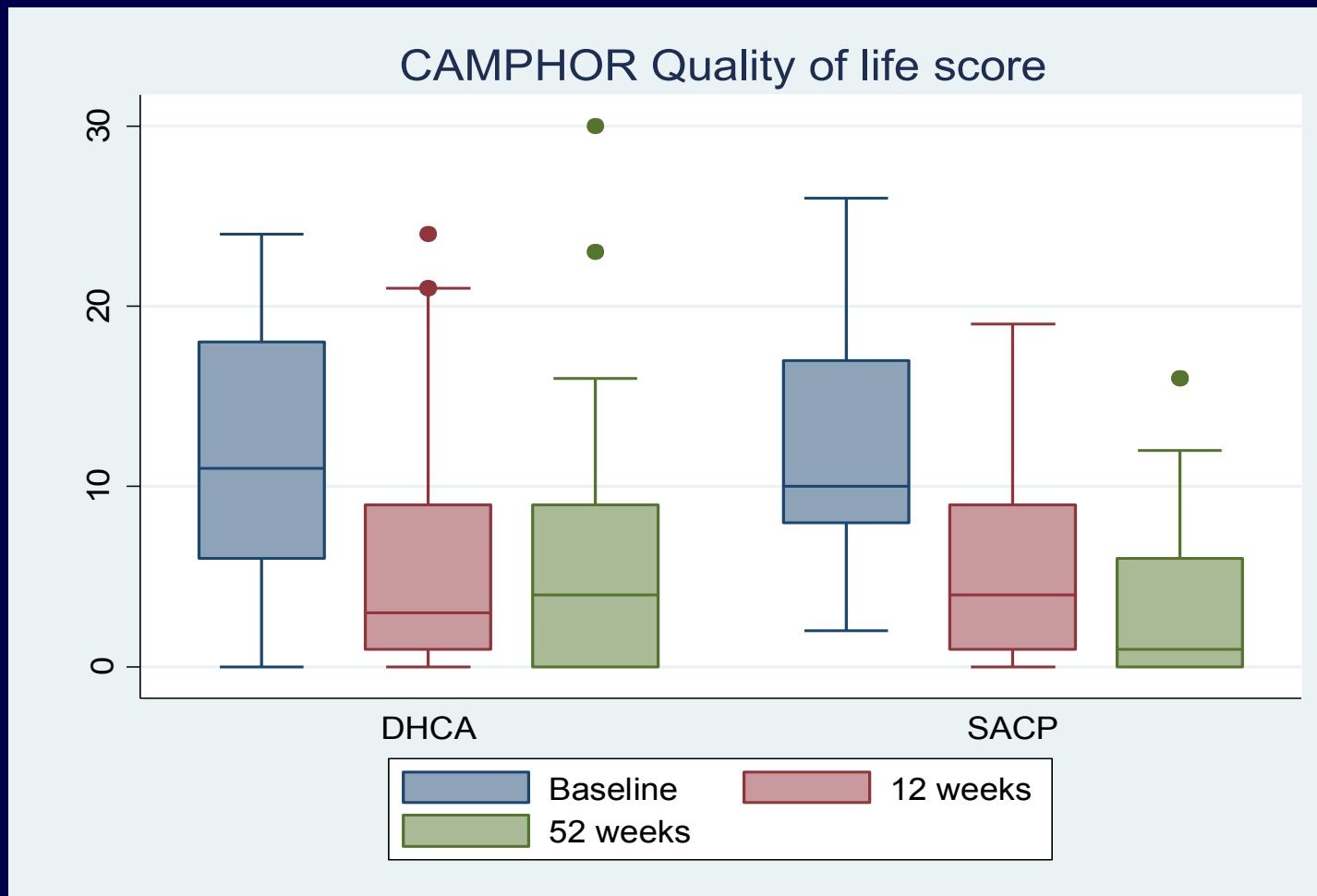


# NYHA Class post-PTE

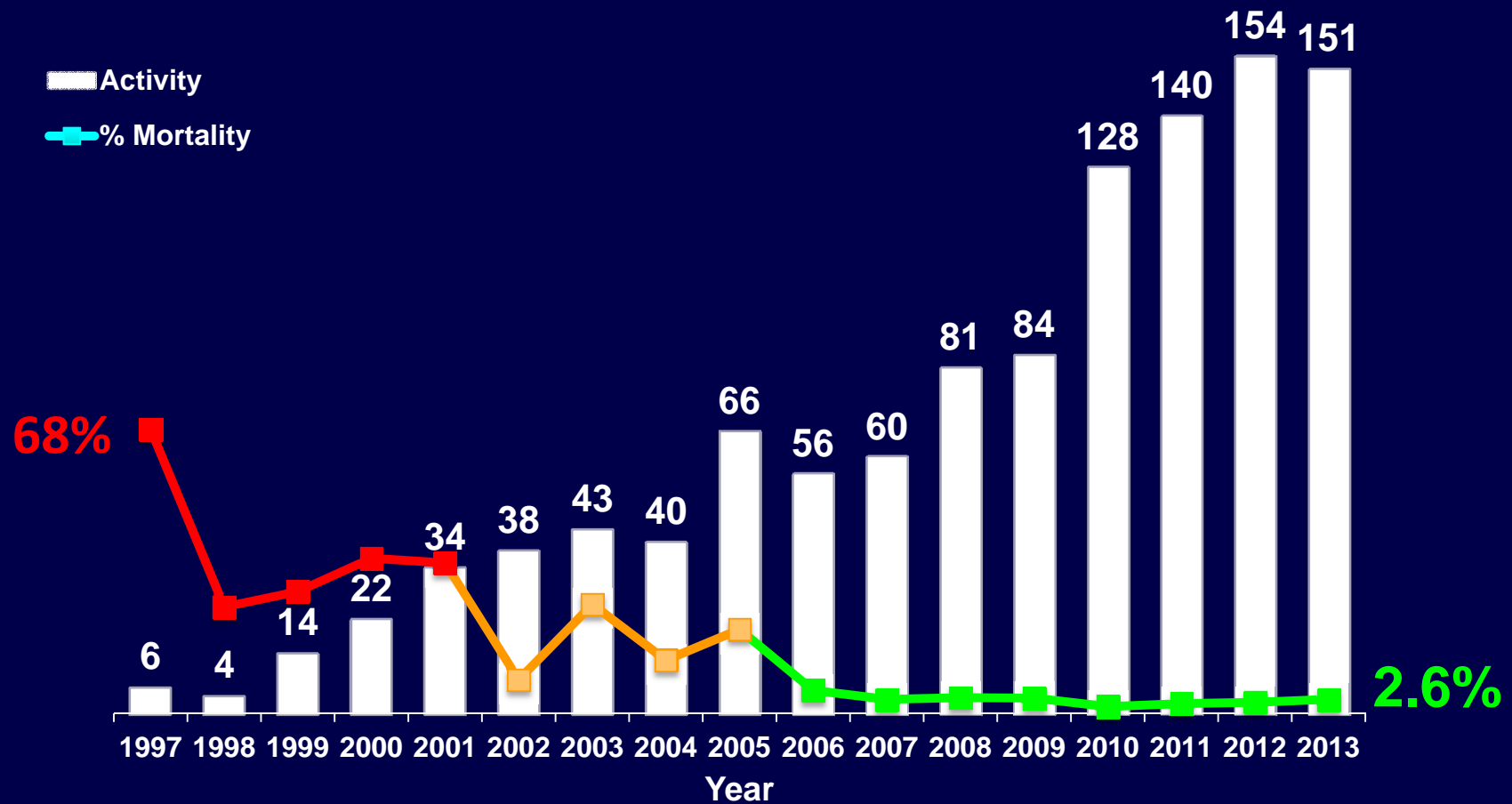




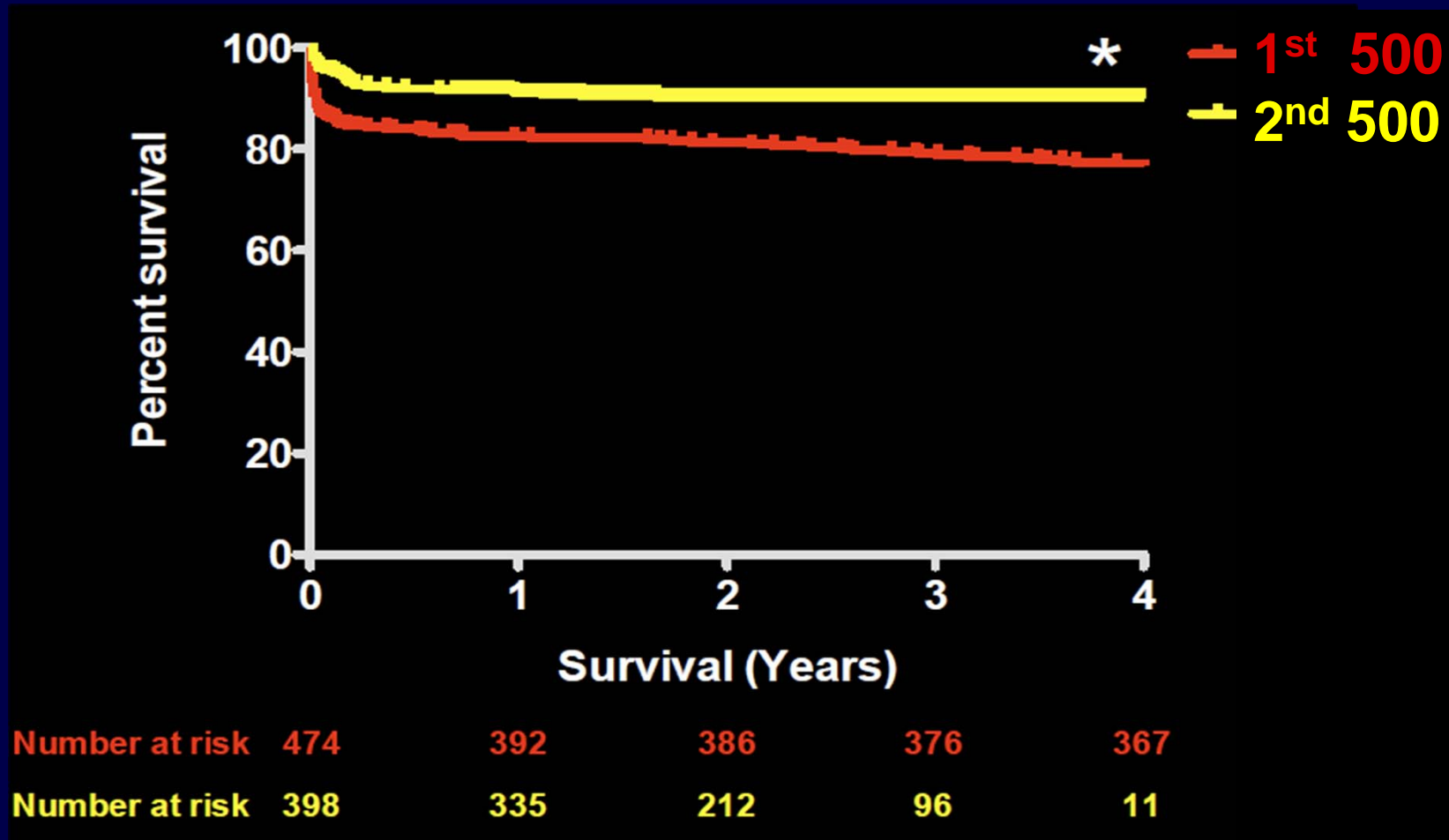
# CAMPHOR QOL scores



# Papworth Hospital PEA Programme: *Annual Activity vs. In-hospital Mortality (N>1,300)*



# Mid-term Survival Post-PEA



\* $p < 0.0001$  (log rank test) 1<sup>st</sup> vs 2<sup>nd</sup> cohort

# Conclusions

- CTEPH is under recognised/diagnosed
- PEA is a surgical cure for CTEPH:
  - Improves haemodynamics
  - Improves symptoms
  - Increases life expectancy
- Excellent early and late survival
- PEA also for symptomatic CTEPD without PH

# The Papworth PEA Team

- **Surgeons**

- David Jenkins
- Steven Tsui
- John Dunning
- Choo Ng

- **PVDU Physicians**

- Joanna Pepke-Zaba
- Karen Sheares
- John Cannon
- Mark Toshner
- Dolores Taboda
- Nick Morrell

- **Anaesthetists**

- Alain Vuylsteke
- Roger Hall
- Joe Arrowsmith
- Andrew Klein
- Barbora Parizkova
- Kamen Valchanov
- Guillermo Martinez
- Stephen Webb

- **Nurse Specialist**

- Anie Ponnaberanam
- Maxine Leitch

- **Radiology**

- Nick Screatton