IV Congresso

Novas Fronteiras em Cardiologia

DOENÇA TROMBOEMBÓLICA CRÓNICA

7 a 9 de Fevereiro 2014

Hotel Vila Galé Ericeira

Maria José Loureiro

Unidade de Hipertensão Pulmonar | Serviço de Cardiologia

Hospital Garcia de Orta | Almada

Classificação da Hipertensão Pulmonar

1. Hipertensão arterial pulmonar

- **Idiopática**
- **Hereditária**
- **Drogas e toxinas**
- **Associada a**
  - **doença do tecido conjuntivo**
  - **HIV/SIDA**
  - **hipertensão portal**
  - ***shunt* sist-pulmon congénito**
  - **shistosomíase**
  - **anemia hemolítica crónica**
- **HP persistente do RN**

1´ DVO e/ou Hemangiomatose Cap Pulm

2. HP por doença coração esquerdo

- **Doença sistólica VE**
- **Doença diastólica VE**
- **Doença valvular**

3. HP por doença pulmonar e/ou

- **DPOC**
- **Doença pulmonar intersticial**
- **Outra doença pulmonar**
- **Patologia respiratória do sono**
- **Exposição crónica a elevada altitude**

4. HP tromboembólica crónica

5. HP por mecanismo desconhecido ou multifactorial

- **Doenças hematológicas**
- **Doenças sistémicas, sarcoidose**
- **Doenças metabólicas**
- **Outras**

AEIOU

Definição

Epidemiologia

Fisiopatologia

Diagnóstico

Tratamento

Definição

≥ 3 meses anticoagulação oral

PAPm ≥ 25mmHg, PCWP <15 mmHg (HP pré-capilar)

+

1 ou mais defeitos de perfusão por múltiplos trombos organizados nas artérias pulmonares elásticas

Epidemiologia

Incidência de TEP 20 por 100.000 habitantes

Doença tromboembólica crónica (DTEC) em 0.57-3.8% TEP

Incidência teórica anual 28 casos/milhão de habitantes?

1/3 doentes com DTEC sem episódio clínico agudo prévio de TEP → doença subdiagnosticada

Pengo V. Thromboembolic Pulmonary Hypertension Study Group. Incidence of chronic thromboembolic pulmonary hypertension after pulmonary embolism. N Engl J Med 2004
Becattini C. Incidence of chronic thromboembolic pulmonary hypertension after a first episode of pulmonary embolism. Chest 2006

Factores de risco

Esplenectomia

Neoplasia

Shunt ventriculo-auricular

Doença inflamatória intestinal

Terapêutica substituição tiroideia

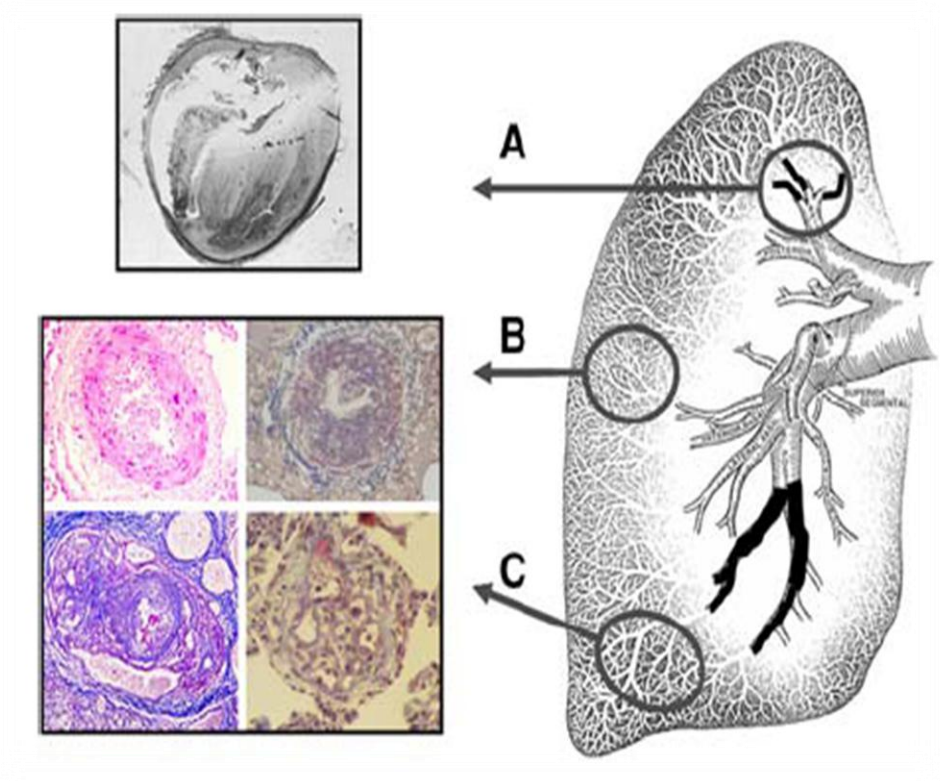
Síndroma Ac anti-fosfolípidico (20%)

Grupo sanguíneo não-0

PMD com infecção/ CVC implantado

Metha s, et al. Diagnostic evaluation and management of chronic thromboembolic pulmonary hypertension: a clinical practiceguideline. Can Resp J. 2010 Nov-Dec;17(6):301-34”

Fisiopatologia



Doença vascular pulmonar dupla

1. OBSTRUÇÃO EMBÓLICA DOS VASOS PULMONARES DE MAIOR CALIBRE

   Fibrinólise ineficaz (resolução trombótica incompleta e organização/endotelização do trombo)

2. ARTERIOPATIA DE PEQUENOS VASOS

   Trombose *in situ*

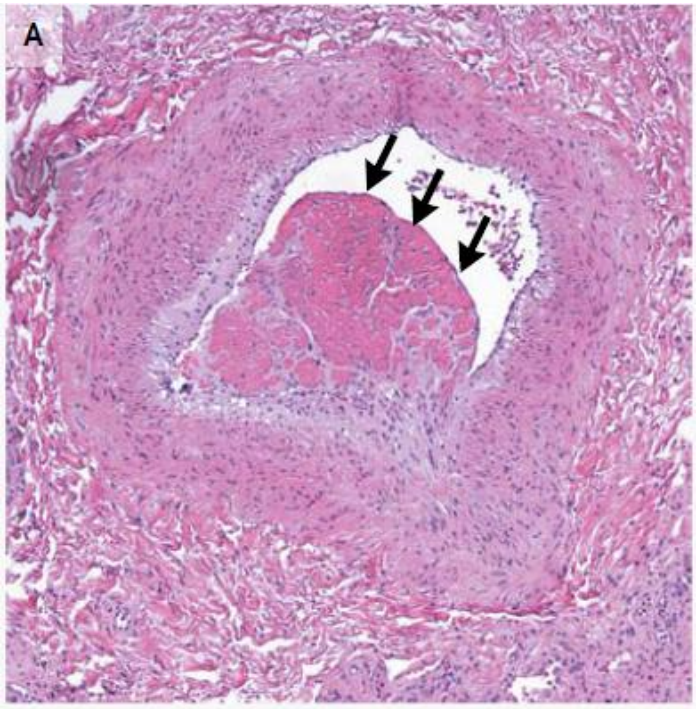
   Hipertrofia da média e hiperplasia da íntima

   Lesões plexiformes

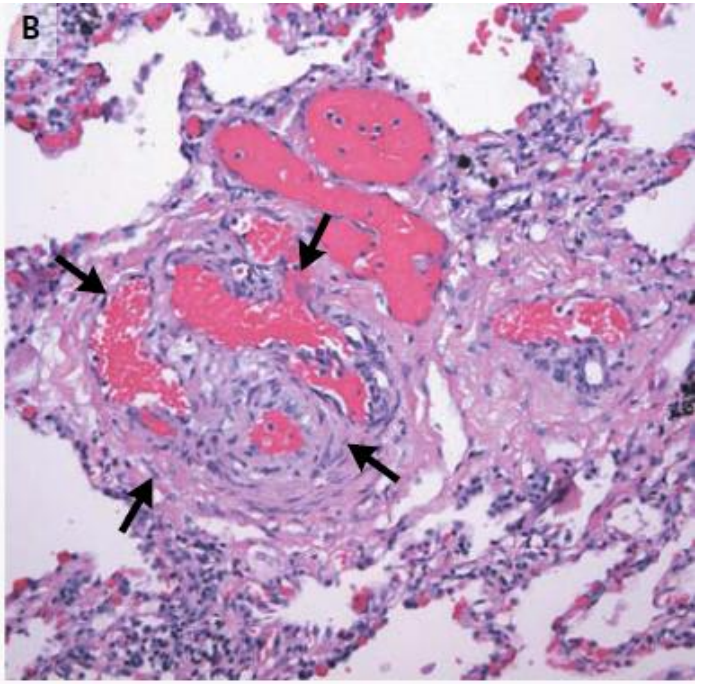
Piazza G, et al. CTEPH - Current Concepts. N Engl J Med 2011

Proc Am Thorac Soc 2006;3:564-7

Histopatologia



Trombo organizado



Lesão plexiforme

Adaptado de Piazza G, et al. CTEPH - Current Concepts. N Engl J Med 2011

Diagnóstico

1. SUSPEITA

   clínica

   ecocardiográfica

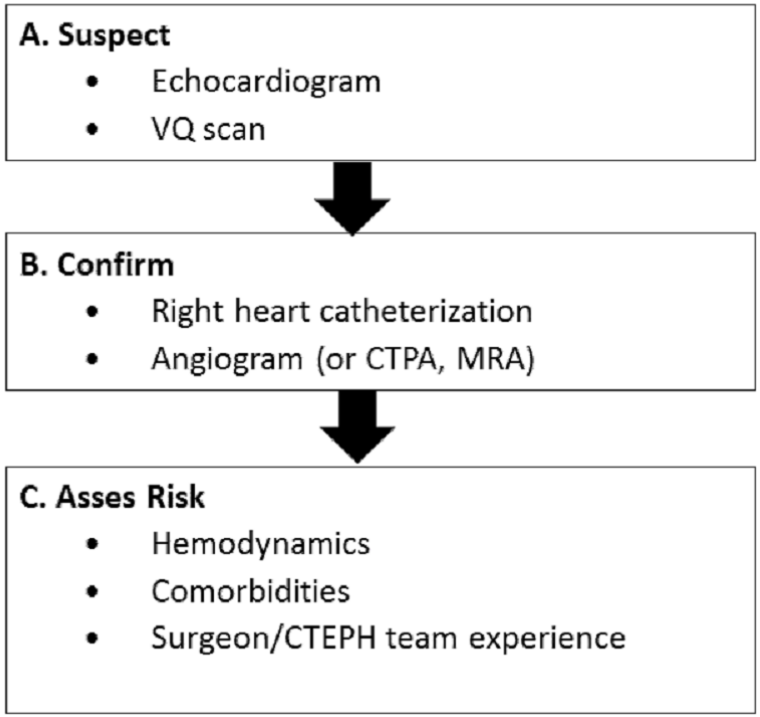
   imagiológica

2. CONFIRMAÇÃO

   hemodinâmica

   anatómica

ALGORITMO SCAR

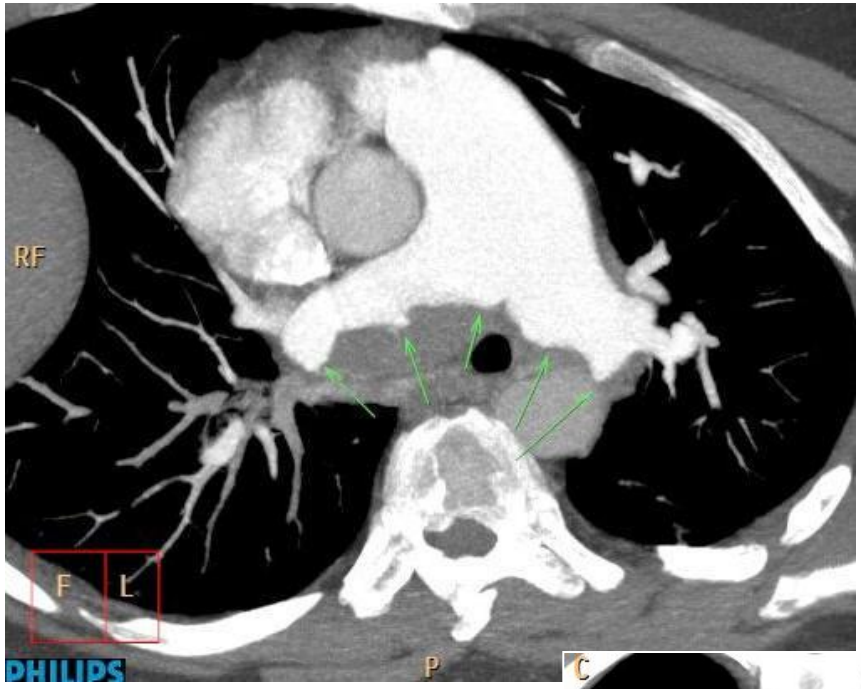


Kim et al. JACC Vol. 62, No. 25, Suppl D, 2013
December 24, 2013:D92–9

Diagnóstico

As diferentes técnicas de imagem são complementares:

- Cintigrafia de V/Q pulmonar recomendada para screening (sensibilidade superior a angio-TC) e se normal exclui DTEC
- Angiografia pulmonar "gold standard" (recurso mais importante para avaliação de operabilidade)
- AngioTC MS e angioRM podem vir a ser superiores às técnicas convencionais na avaliação da DTEC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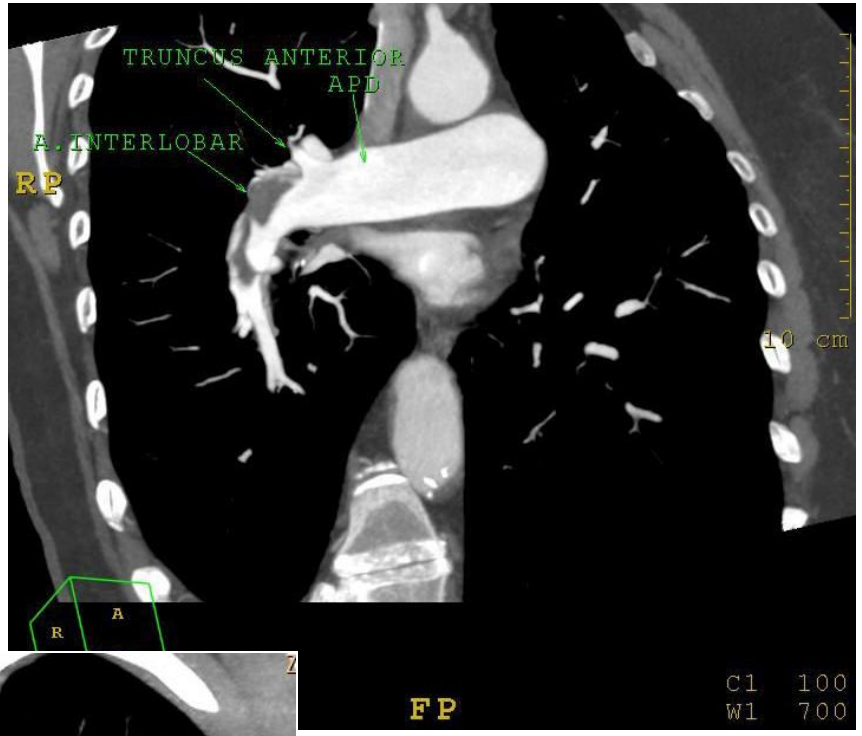
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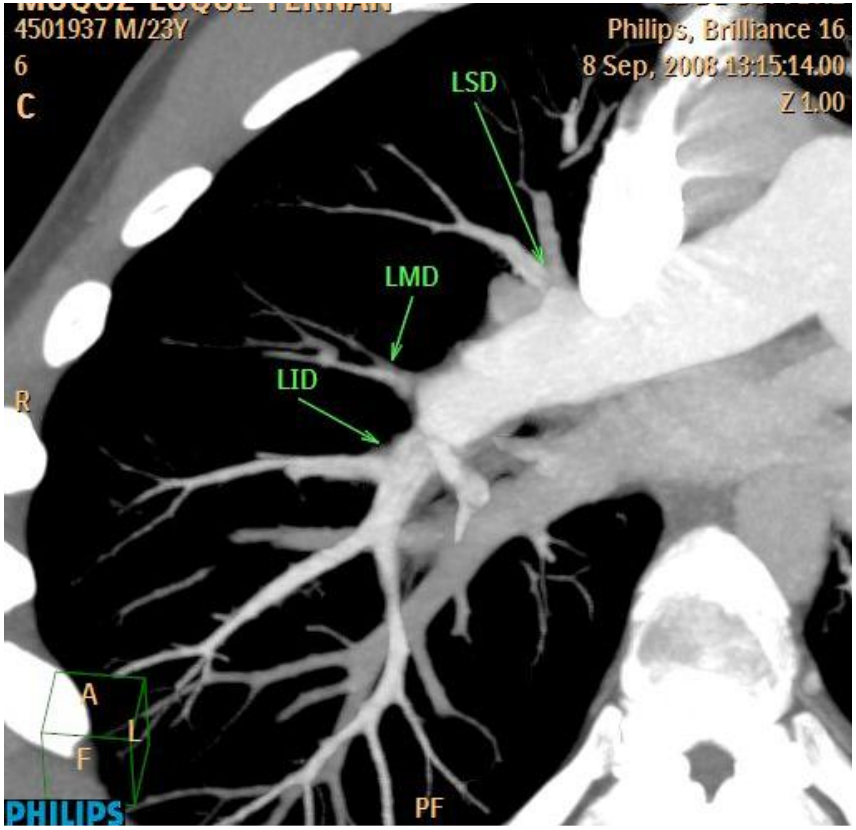
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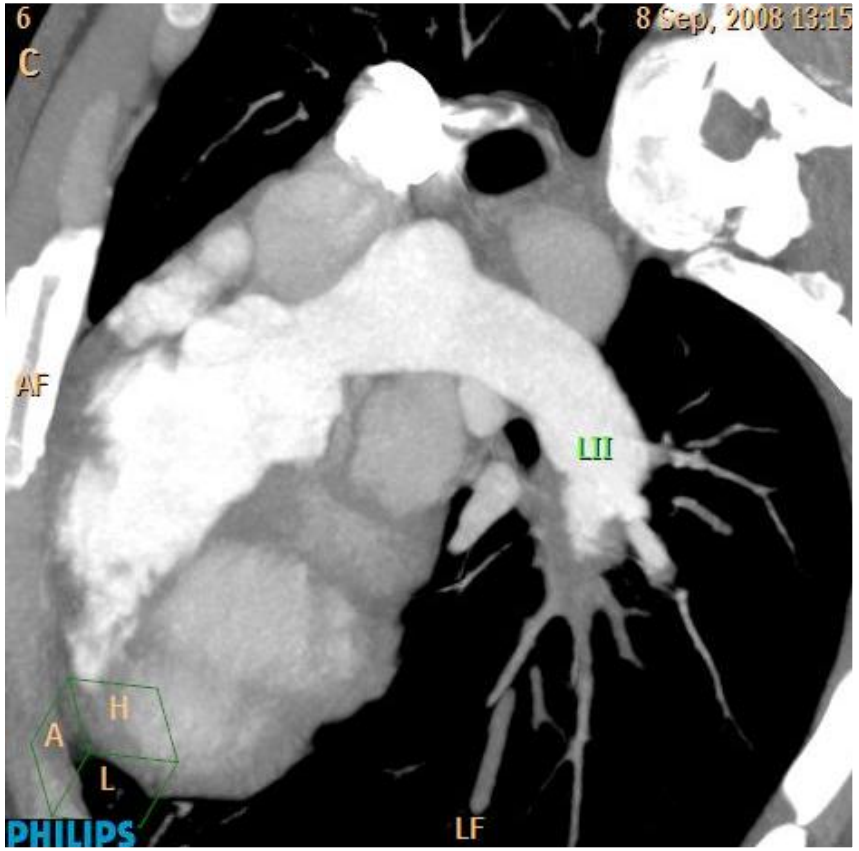
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Tratamento

Medidas gerais

Correcção de hipoxémia

Anticoagulação oral

Diuréticos

Digoxina ?

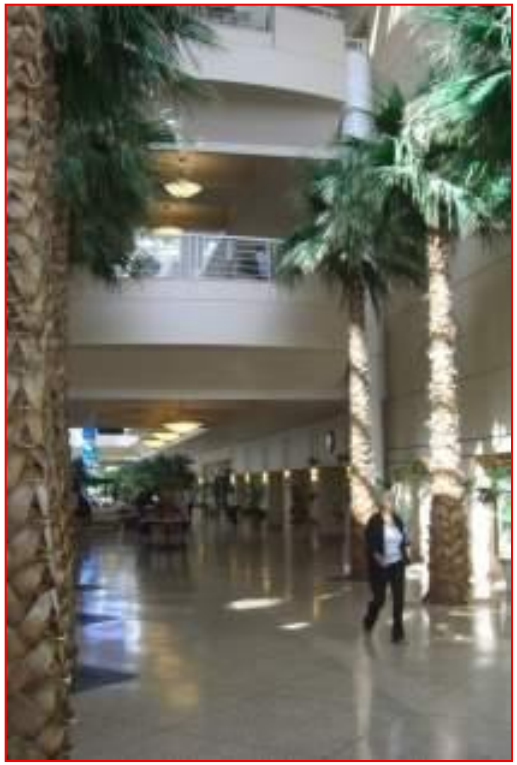
Filtro veia cava inferior ?

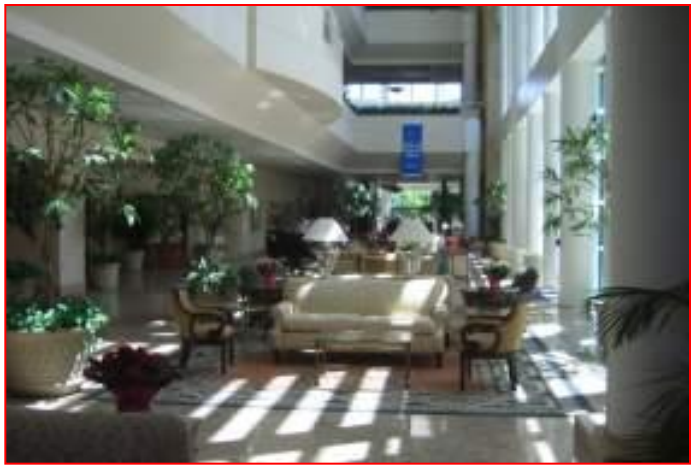
Tratamento dirigido

Curativo/ potencialmente curativo → normalização hemodinâmica e recuperação funcional

Paliativo/ vasodilatador específico → melhoria da qualidade de vida

PULMONARY THROMBOENDOARTERECTOMY





University of California,
San Diego Medical Center
La Jolla, CA

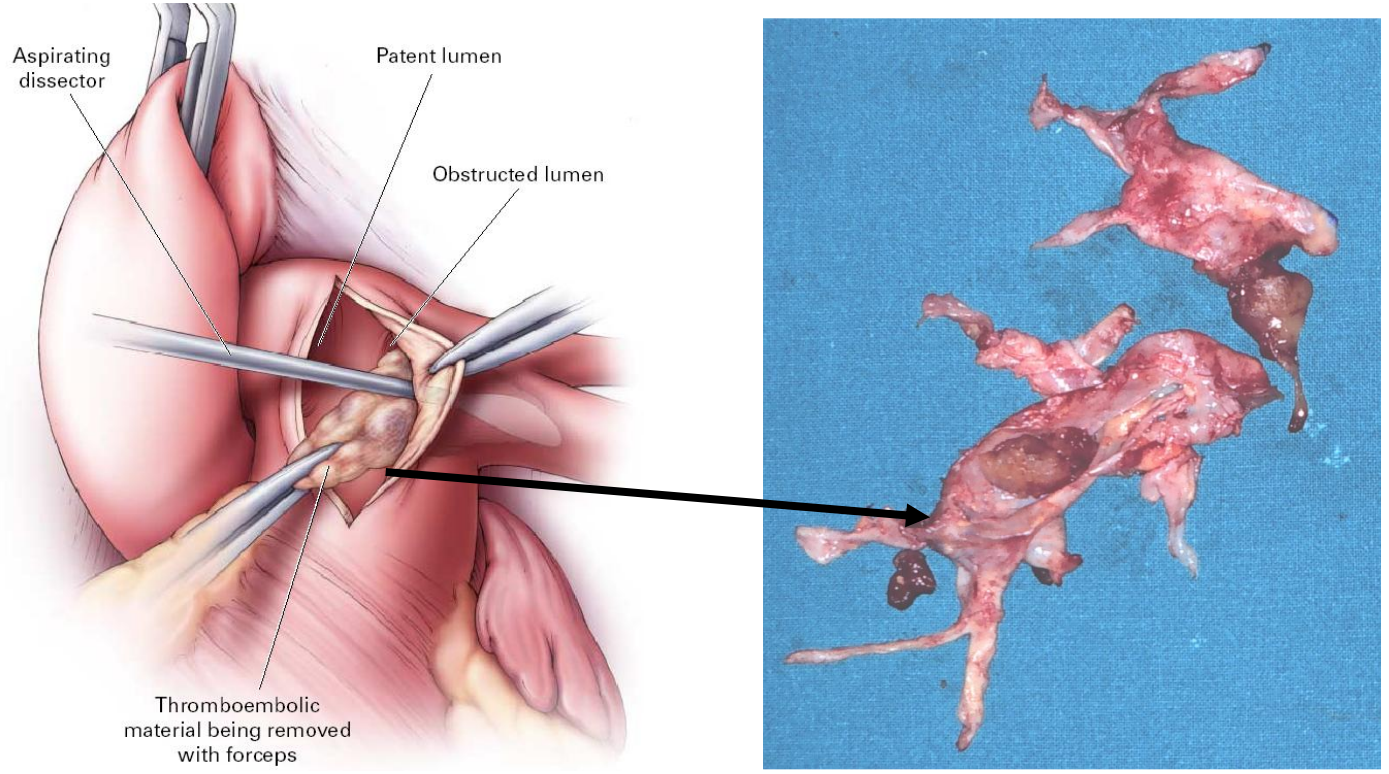
Tromboendarterectomia Pulmonar

- Curativa/ potencialmente curativa → abordagem terapêutica ***gold standard***
- > 5000 procedimentos
- Mortalidade peri-operatória (30d) 4-7%
- Melhoria clínica, ecocardiográfica e hemodinâmica imediata (redução 70% RVP)
- Normalização/ melhoria substancial das trocas gasosas, FVD, capacidade funcional e qualidade de vida
- HTP residual pós EAP (5-35%)

Princípios Orientadores da EAP

- Doença bilateral → endarterectomia bilateral (esternotomia mediana)
- Paragem circulatória para visibilidade perfeita e endarterectomia completa bilateral
- Paragem circulatória limitada a períodos de 20 min, com restauração de fluxo entre cada paragem de 20min (cirurgião experiente – 20min/pulmão)
- Bypass cardiopulmonar e hipotermia profunda para permitir paragem circulatória
- Verdadeira endarterectomia → plano de dissecção ao nível da média desde tronco proximal até aos vasos distais

Tromboendarterectomia Pulmonar

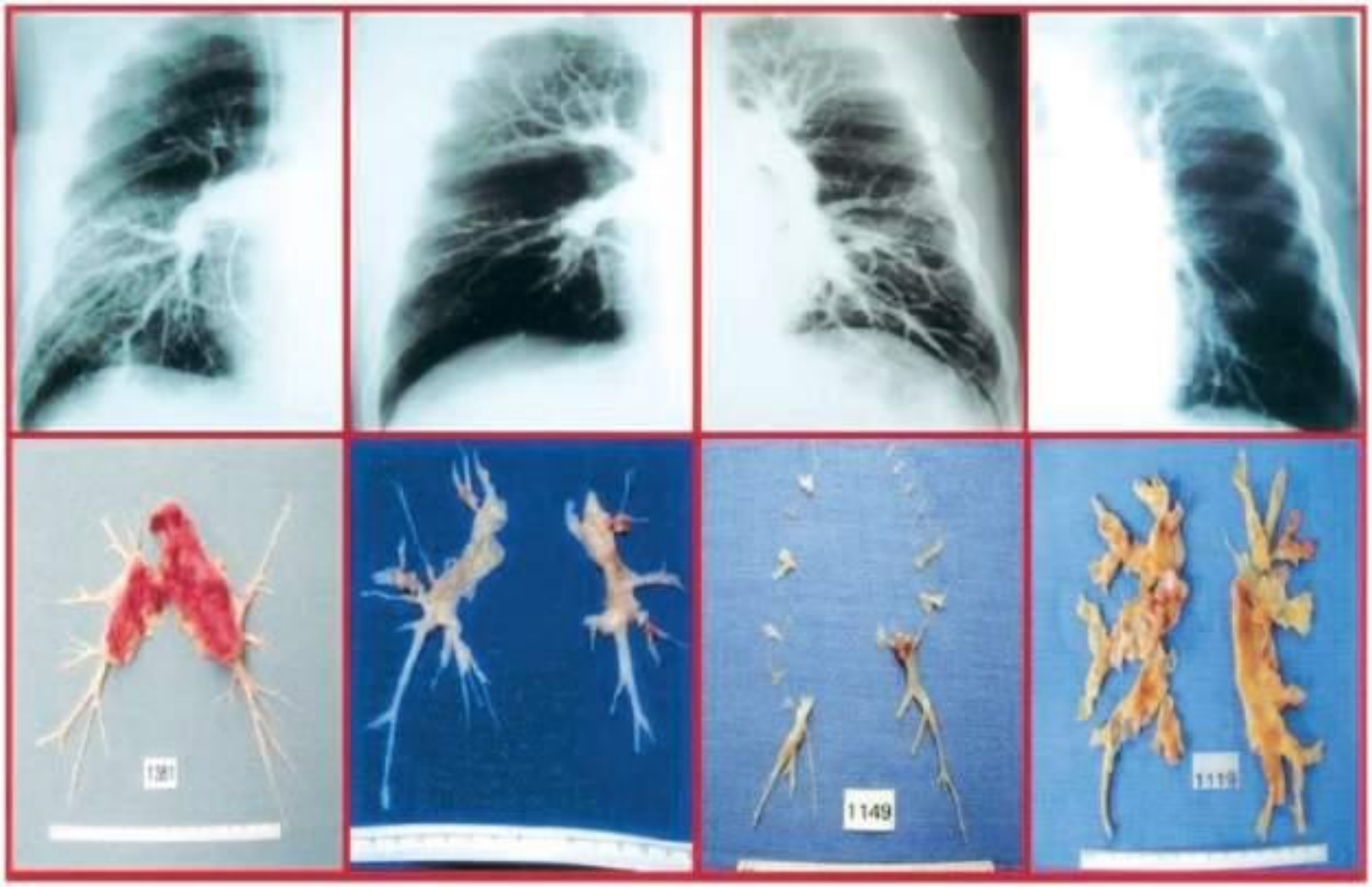


Opção terapêutica de primeira linha na doença tromboembólica crónica

Trombos organizados aderentes à camada média das artérias pulmonares elásticas

PULMONARY THROMBOENDOARTERECTOMY

UCSD OPERATIVE CLASSIFICATION



Tratamento

Tromboendarterectomia pulmonar

Critérios de selecção

Classe funcional II, III e IV

RVP pré operatória > 300 dyn-seg-cm5

Acessibilidade cirúrgica (artérias principais, lobares, segmentares proximais)

Ausência de comorbilidades significativas

Consentimento do doente

Tratamento

Tromboendarterectomia pulmonar

Contraindicações

Doença de pequenos vasos (doença distal)

Redução pós-operatória esperada RVP < 50%

Risco operatório inaceitável

Tratamento

Operável → tromboendarterectomia pulmonar

Não operável/ HP residual → vasodilatador pulmonar específico

- Cirurgia contra-indicada/ doente não operável (European CTEPH registry 36.6%)
- HP persistente ou residual pós tromboendarterectomia (30%)
- Ponte optimização para cirurgia?

Tratamento Médico HAP/DTEC

INITIAL THERAPY WITH PAH APPROVED DRUGS				
YELLOW: Morbidity and mortality as primary end-point in randomized controlled study or reduction in all-cause mortality (prospectively defined) *Level of evidence is based on the WHO-FC of the majority of the patients of the studies. †Approved only: by the FDA (macitentan, riociguat, treprostinil inhaled); in New Zealand (iloprost i.v); in Japan and S.Korea(beraprost). ‡ Positive opinion for approval of the CHMP of EMA				
Recommendation	**Evidence***	**WHO-FC II**	**WHO-FC III**	**WHO-FC IV**
I	A or B	Ambrisentan Bosentan Macitentan†‡ Riociguat† Sildenafil Tadalafil	Ambrisentan Bosentan Epoprostenol i.v. Iloprost inhaled Macitentan†‡ Riociguat† Sildenafil Tadalafil Treprostinil s.c., inhaled†	Epoprostenol i.v.
IIa	C		Iloprost i.v. † Treprostinil i.v.	Ambrisentan, Bosentan Iloprost inhaled and i.v† Macitentan†‡ Riociguat† Sildenafil, Tadalafil Treprostinil s.c., i.v., Inhaled†
IIb	B		Beraprost†	
	C		Initial Combination Therapy	Initial Combination Therapy

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Tratamento Médico DTEC

Indicação terapêutica

- Riociguat (Adempas®) → 1º fármaco aprovado com esta indicação
- Potenciador da guanilato ciclase solúvel (mecanismo de acção independente da disponibilidade de NO)
- CHEST 1/CHEST 2 → Classe de recomendação I/ Nível de evidência A ou B

Off-label

- Inibidores da fosfodiesterase-5 (sildenafil, tadalafil)
- Antagonistas do receptor da endotelina (bosentano, ambrisentano)
- Prostanóides (iloprost, treprostinil, epoprostenol)

CHEST-1

- Age 18–80 years
- Patients with inoperable CTEPH (WHO Group 4, independently assessed) or persistent/recurrent PH after PEA
- CTEPH was diagnosed using 2 or more of the following imaging methods: VQ scan, pulmonary angiogram, spiral CT, MRI
- 6MWD at baseline 150–450 m
- PVR >300 dyn·sec·cm–5 and mPAP ≥25 mmHg
- Patients were excluded from the study if they had received
- treatment with ERAs, prostacyclin analogs, PDE5is, and/or
- NO donors within 3 months prior to study entry

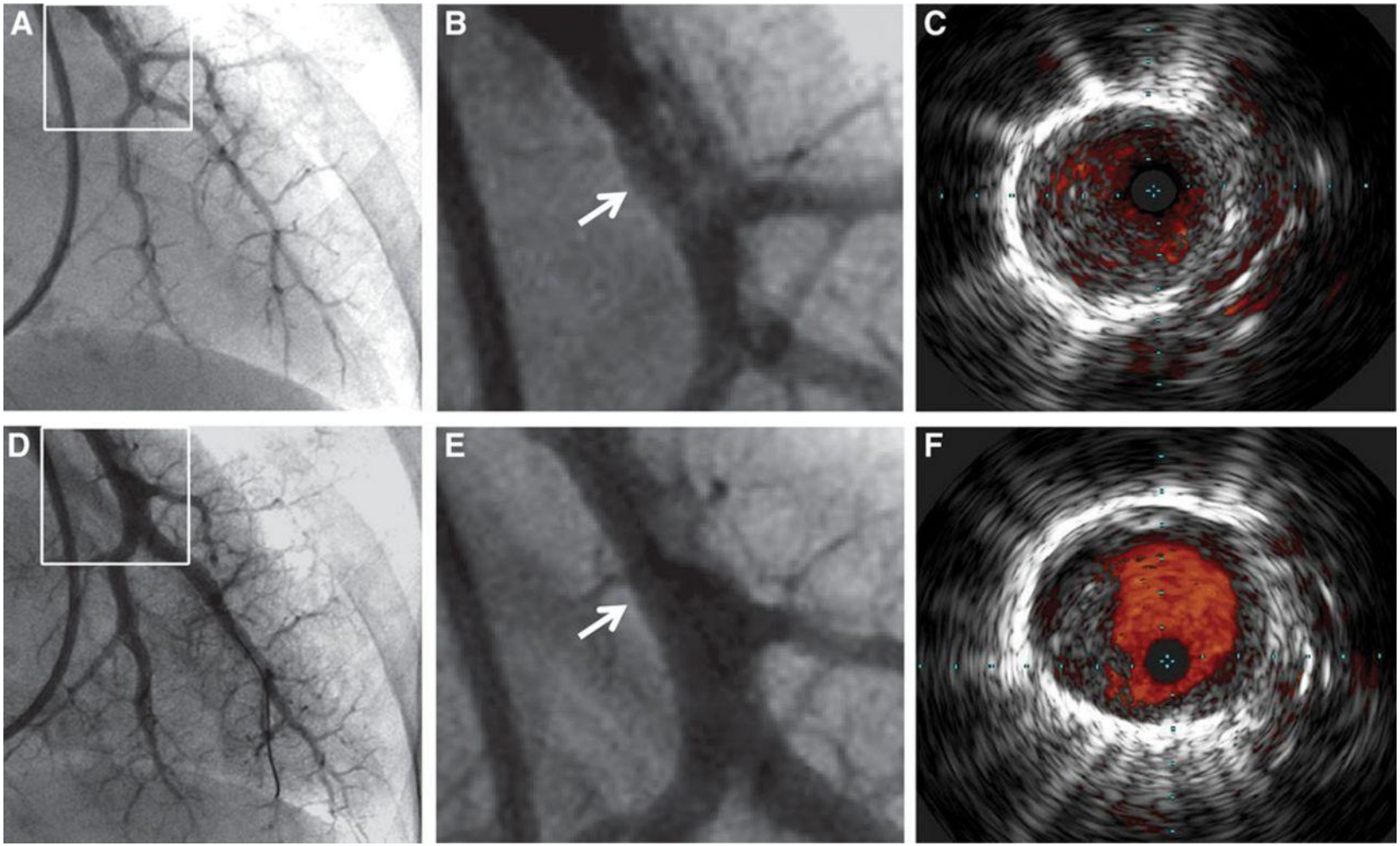
Angioplastia?

Não operável → angioplastia por balão?

- Doença distal cirurgicamente inacessível
- HP persistente ou recorrente após EAP
- Experiência limitada

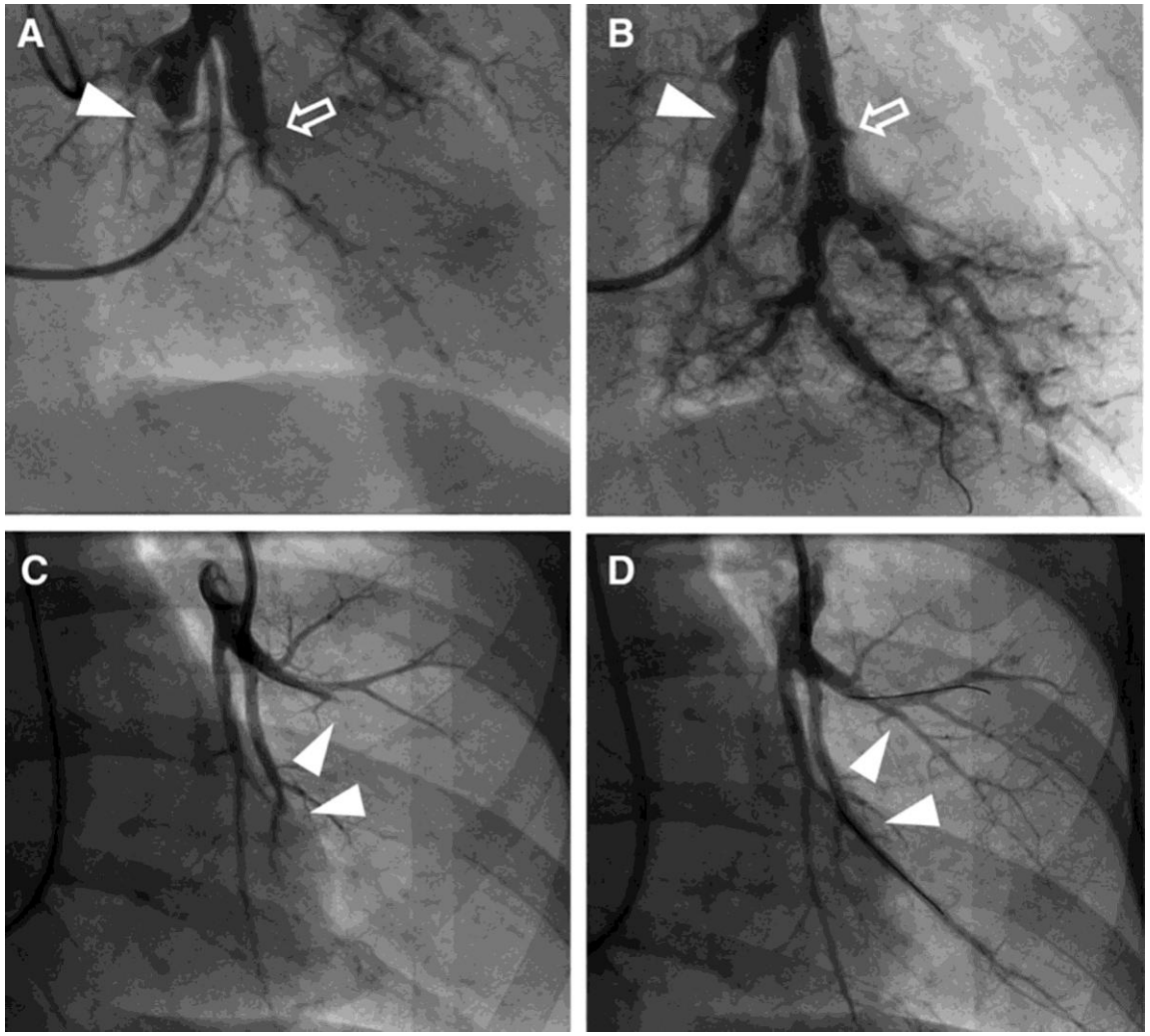
Heart 2013;**99**:19 1415-1420 Published Online First: 11 July 2013
Mizoguchi H et al. *Circ Cardiovasc Interv*. 2012;5:748-755

Representative angiographic and intravascular ultrasound (IVUS) images of balloon pulmonary angioplasty (BPA).



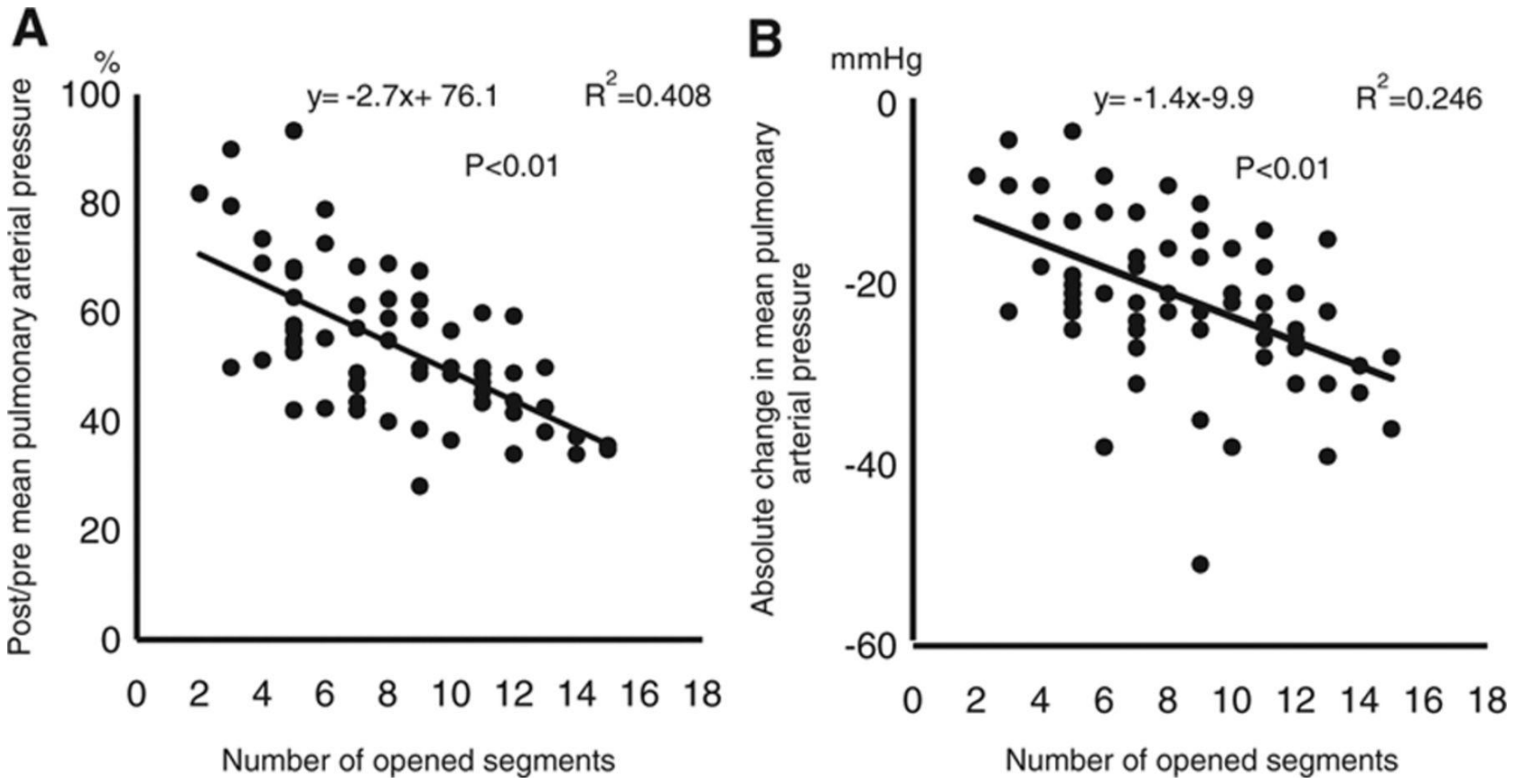
Mizoguchi H et al. *Circ Cardiovasc Interv*. 2012;5:748-755

Representative pulmonary angiograms before and after balloon pulmonary angioplasty (BPA).



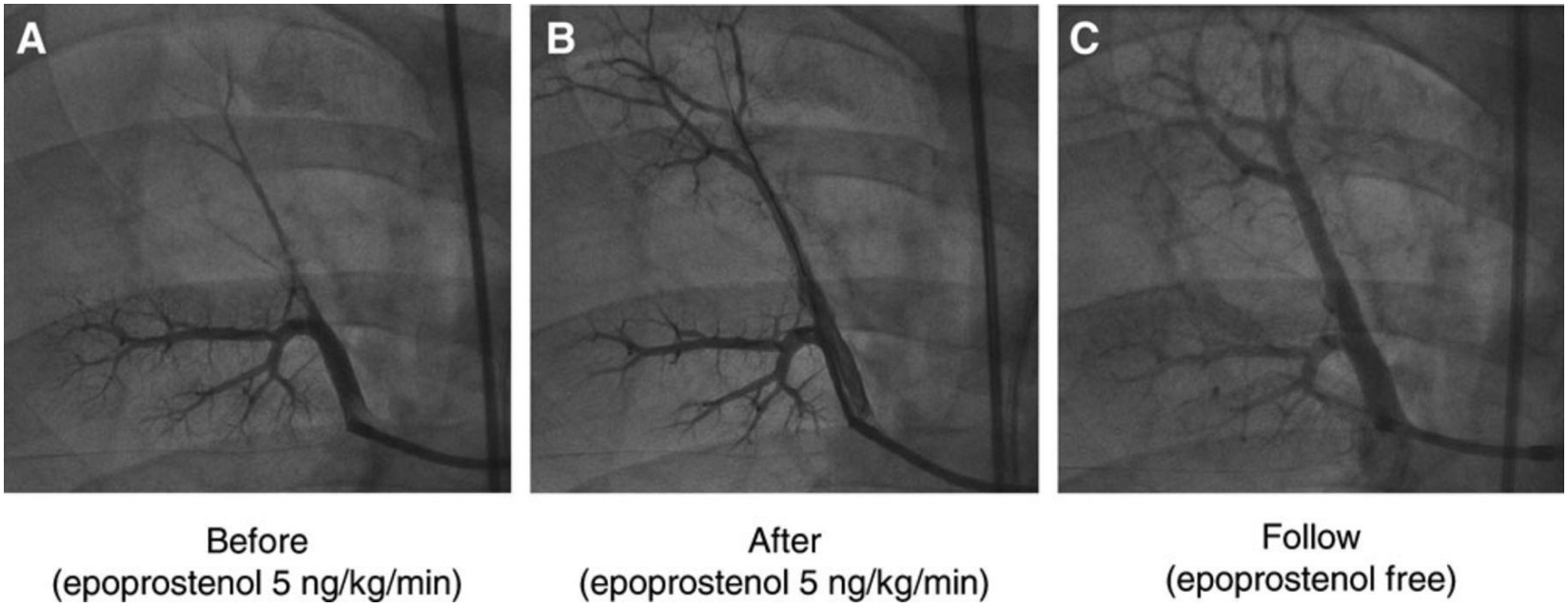
Mizoguchi H et al. *Circ Cardiovasc Interv*. 2012;5:748-755

Correlation between the number of opened segments and the decrease in mean pulmonary arterial pressure.



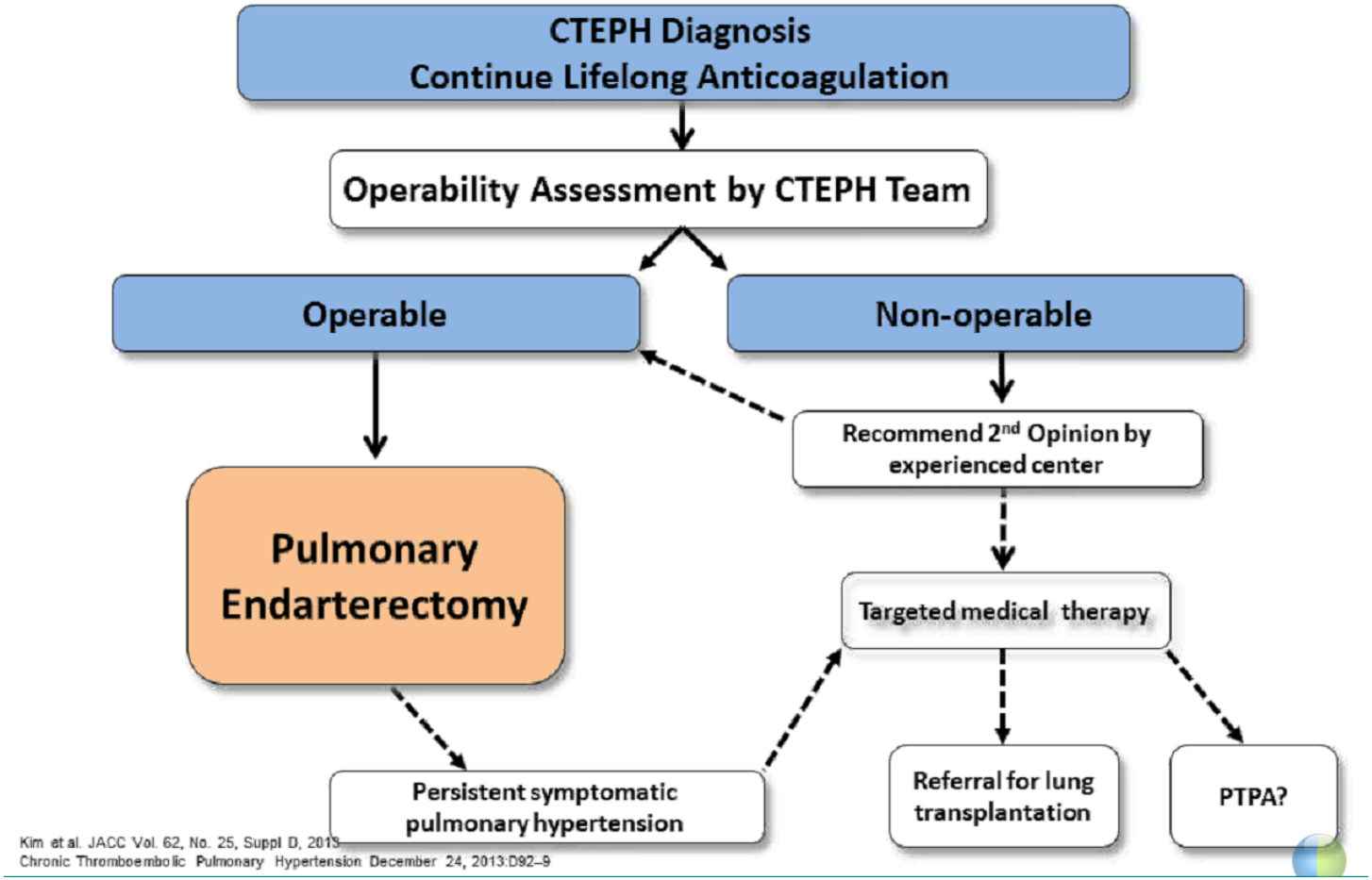
Mizoguchi H et al. *Circ Cardiovasc Interv*. 2012;5:748-755

Representative pulmonary angiograms before balloon pulmonary angioplasty (BPA), after BPA, and at follow-up.



Mizoguchi H et al. *Circ Cardiovasc Interv*. 2012;5:748-755

ALGORITMO DE TRATAMENTO DTEC



Kim et al. JACC Vol. 62, No. 25, Suppl D, 2013
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Unidade de Hipertensão Pulmonar
Hospital Garcia de Orta

10 doentes operados

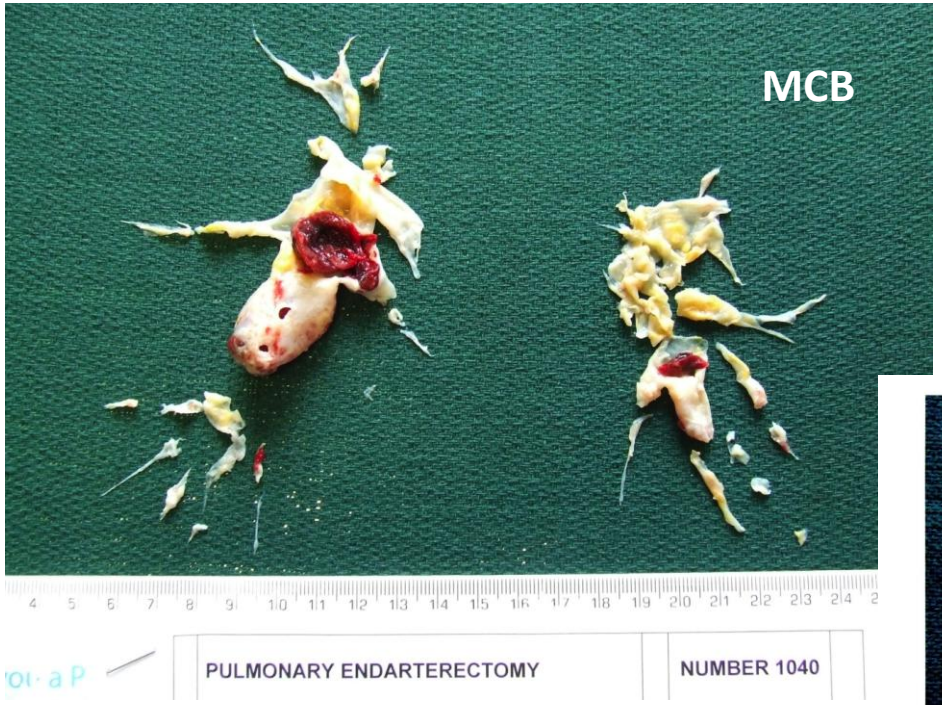
- 7 doentes “curados”
- 3 doentes HP residual sob terapêutica

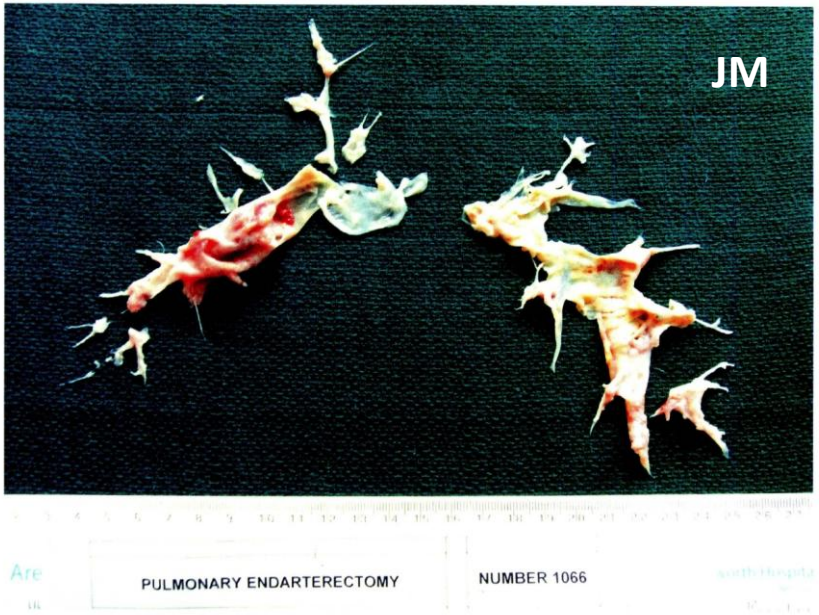
6 doentes recusados motivo de recusa

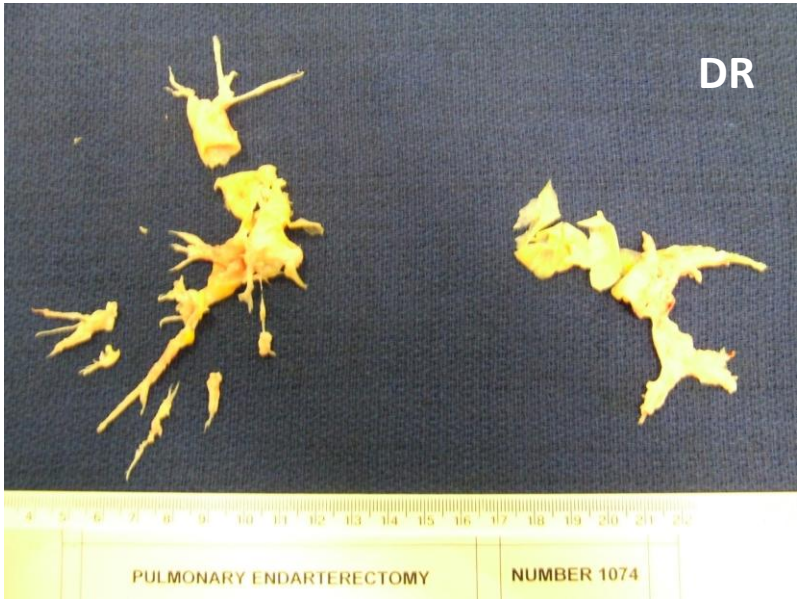
- 4 doentes anatomia desfavorável » doença distal
- 2 doentes risco > benefício

3 doentes elegíveis recusam EAP

- sob terapêutica vasodilatadora pulmonar


MCB
PULMONARY ENDARTERECTOMY
NUMBER 1040


JM
PULMONARY ENDARTERECTOMY
NUMBER 1066


DR
PULMONARY ENDARTERECTOMY
NUMBER 1074

Conclusões

Incidência de DTEC não negligenciável (rastreio em doentes sintomáticos pós TEP)

Mortalidade elevada sem tratamento

Tromboendarterectomia pulmonar curativa

Terapêutica vasodilatadora pulmonar

Angioplastia por balão?

Maria José Loureiro

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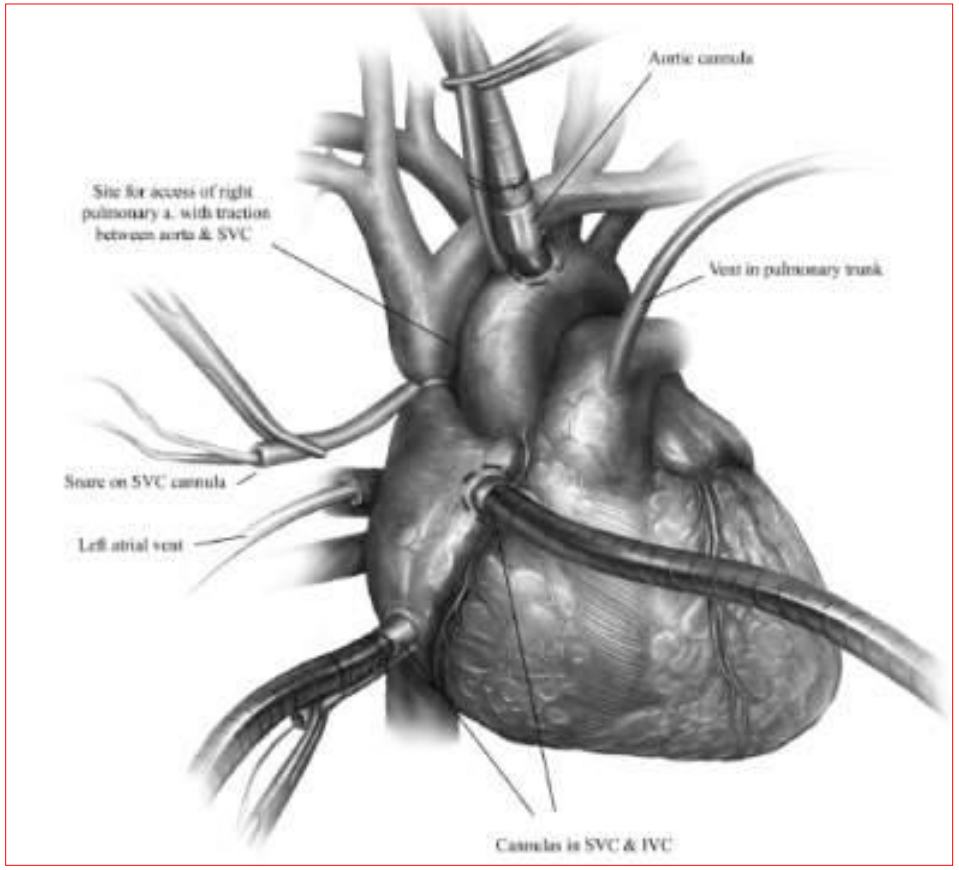
Hospital Garcia de Orta | Almada

loureiro.mj@netcabo.pt

PULMONARY THROMBOENDOARTERECTOMY

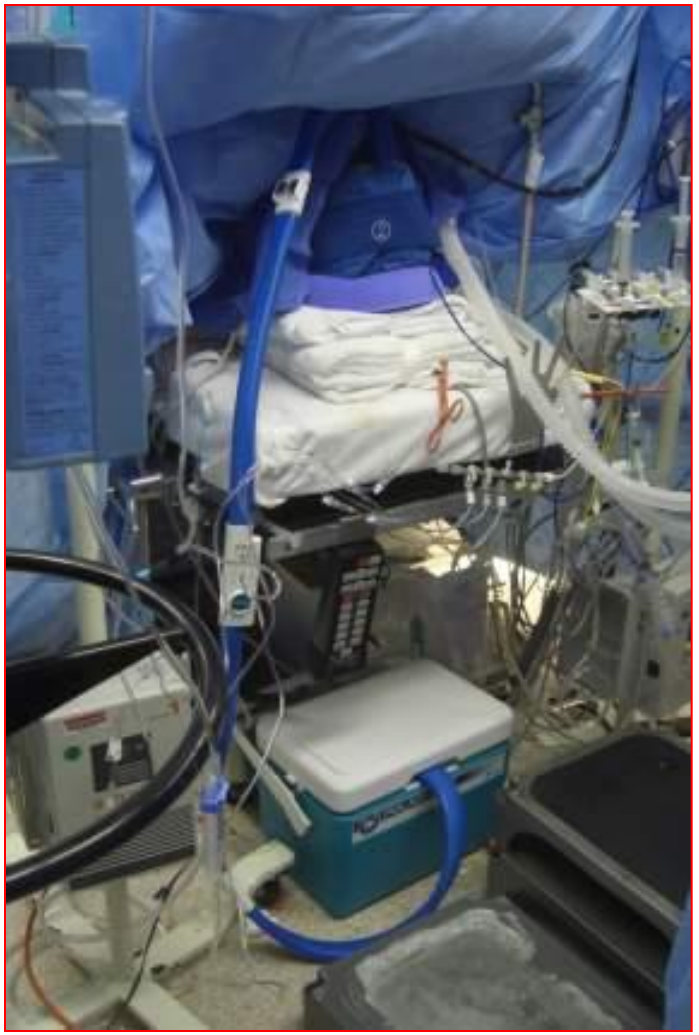
SURGICAL TECHNIQUE



- AORTIC AND BICAVAL CANNULATON
- PULMONARY ARTERY VENT
- COOLING CORE TEMPERATURE 20 ° C
- LEFT VENTRICULAR VENT
- AORTIC CROSS CLAMP
- MYOCARDIAL PROTECTION
- SNARING IVC - SVC

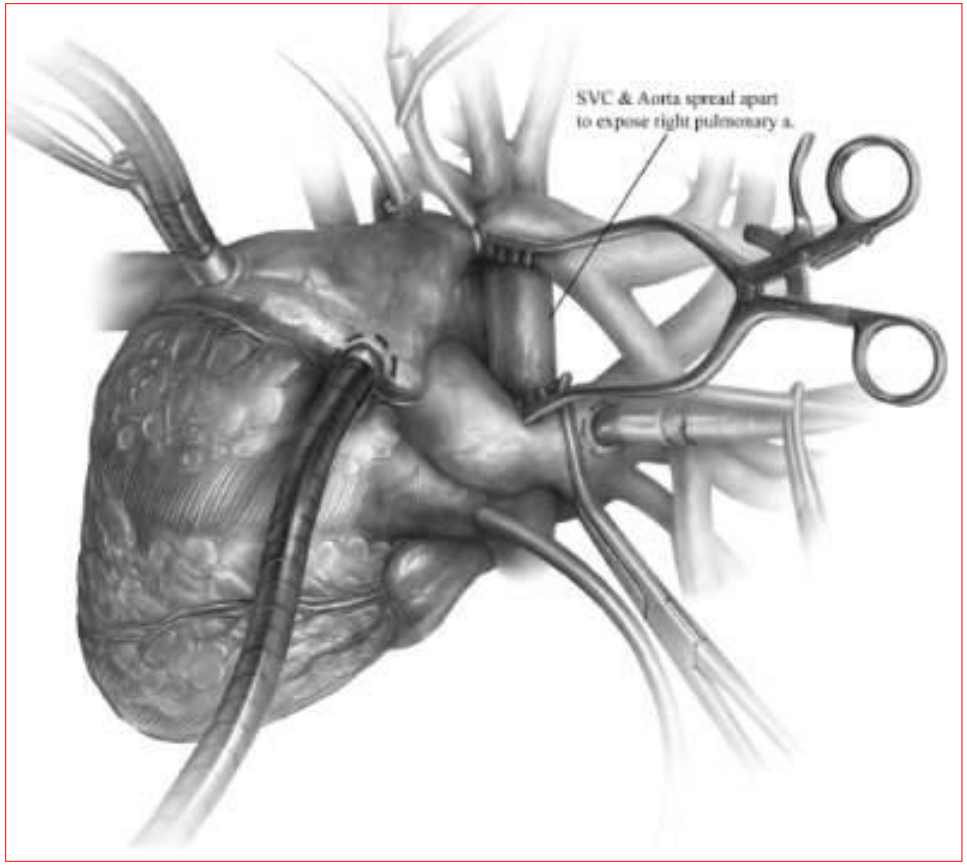
PULMONARY THROMBOENDOARTERECTOMY

SURGICAL TECHNIQUE: SET-UP



PULMONARY THROMBOENDOARTERECTOMY

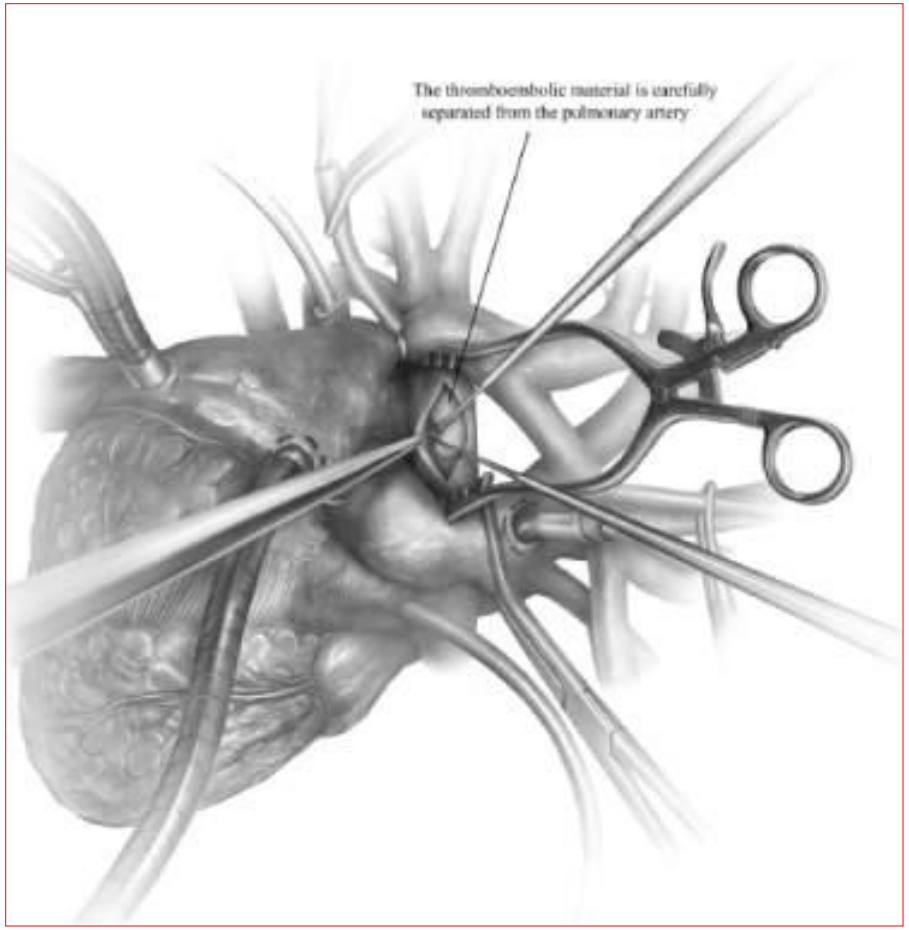
SURGICAL TECHNIQUE



- START FIRST WITH THE RIGHT PULMONARY ARTERY THEN THE LEFT.
- FULLY MOBILIZATION OF SVC AND RIGHT PULMONARY ARTERY WITH MODIFIED CEREBRAL RETRACTOR
- DO NOT ENTER THE PLEURAL SPACE

PULMONARY THROMBOENDOARTERECTOMY

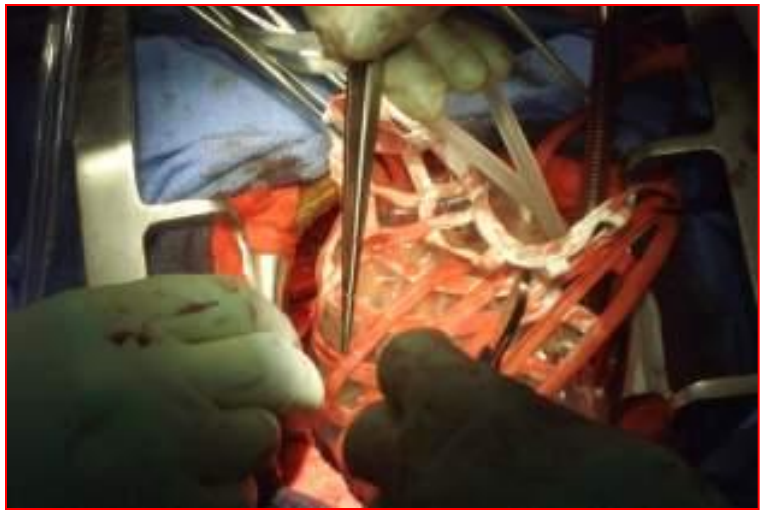
SURGICAL TECHNIQUE: RIGHT PULMONARY ARTERY (PA)



- INCISION OF THE RIGHT PULMONARY ARTERY
- EMBOLECTOMY (IN MOST PATIENTS NO OBVIOUS EMBOLIC MATERIAL)
- ENDARTERECTOMY(BETWEEN INTIMA AND MEDIA) WITH EVERSION TECHNIQUE
- AREA OF FULL THICKNESS NEXT TO INCISION FOR CLOSURE
- PERFECT VISIBILITY WITH DEEP HYPOTHERMIC CIRCULATORY ARREST (2 min. FOR EACH SIDE)

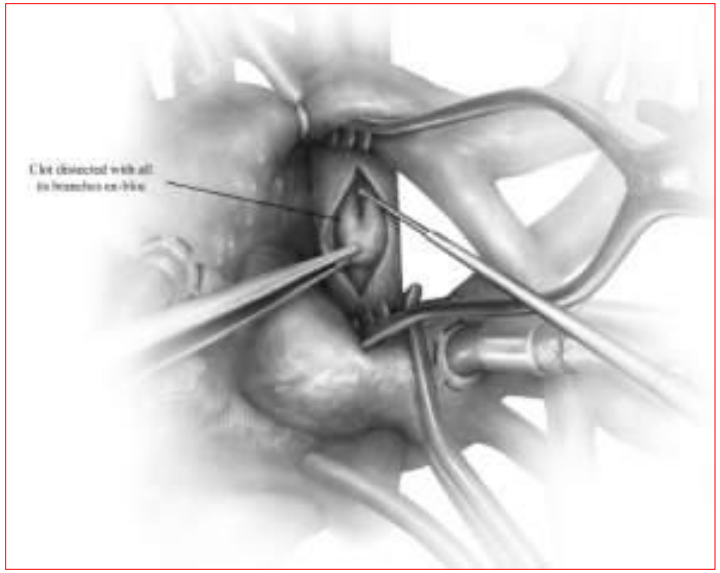
PULMONARY THROMBOENDOARTERECTOMY

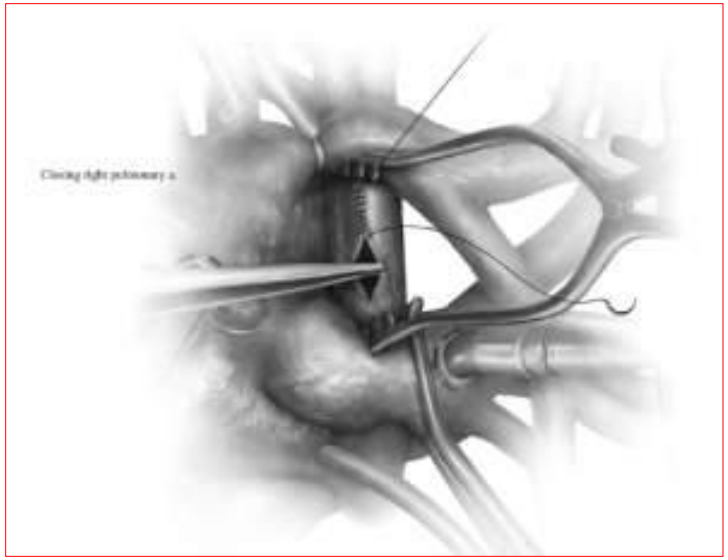
SURGICAL TECHNIQUE: INSTRUMENTS



PULMONARY THROMBOENDOARTERECTOMY

SURGICAL TECHNIQUE: RIGHT PA

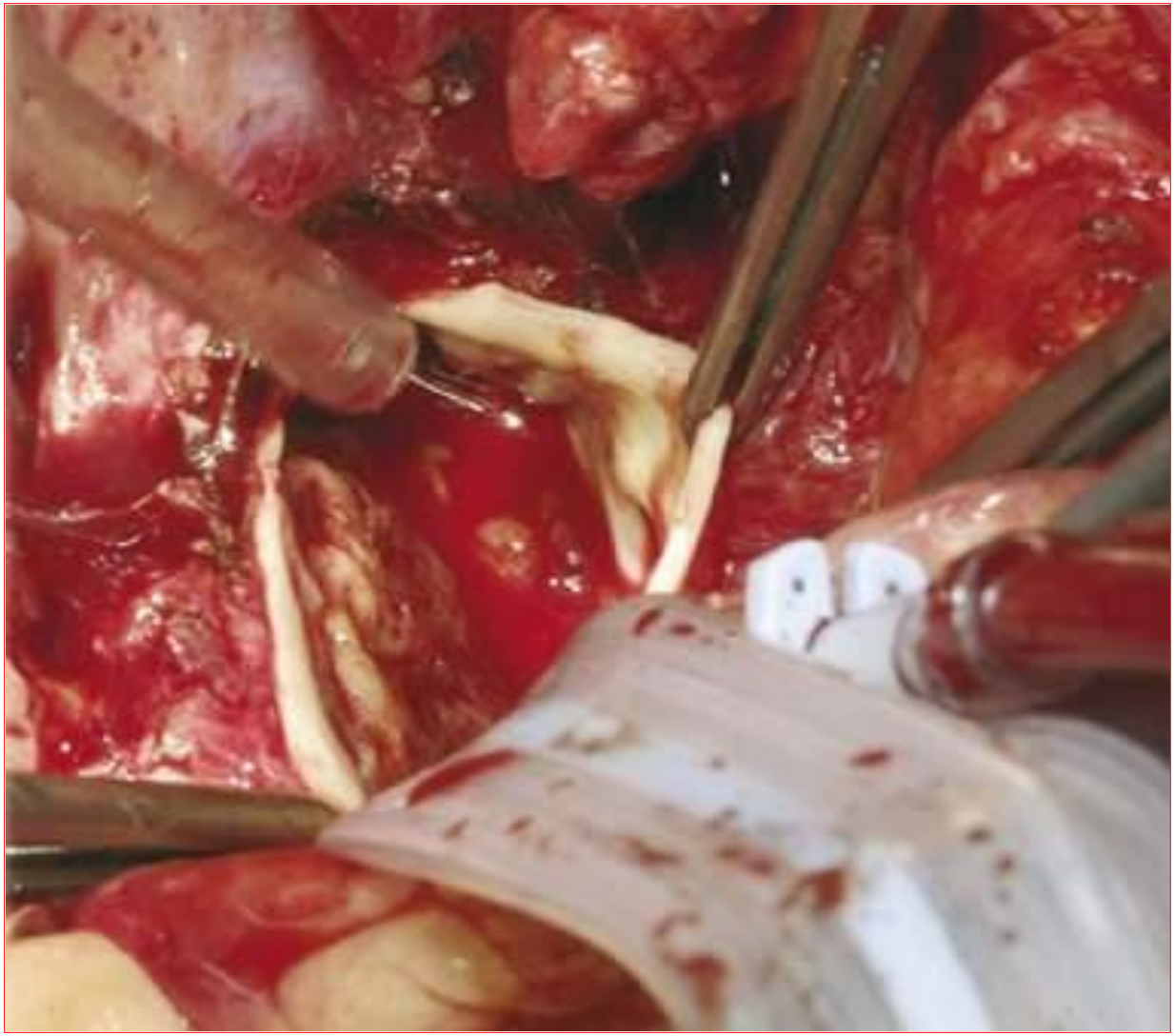




- **PLANE FOLLOWED AND FREED UNTIL IT ENDS IN A "TAIL"**
- **A PERFORATION IN SUBSEGMENTAL BRANCHES BECOMES COMPLETELY INACCESSIBILE AND INVISIBILE LATER**
- **ARTERIOTOMY REPAIRED WITH A CONTINUOUS 6/0 POLYPROPYLENE SUTURE**
- **HEMOSTASIS**
- **CIRCULATION TEMPORARY RESTARTED**

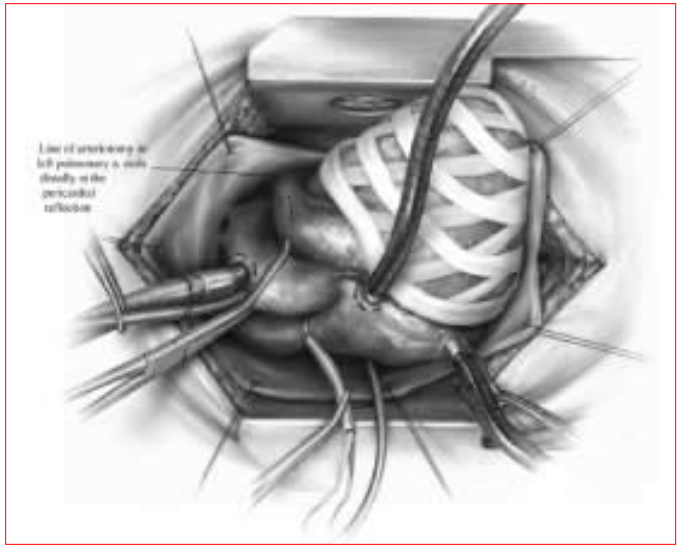
PULMONARY THROMBOENDOARTERECTOMY

SURGICAL TECHNIQUE: RIGHT PA

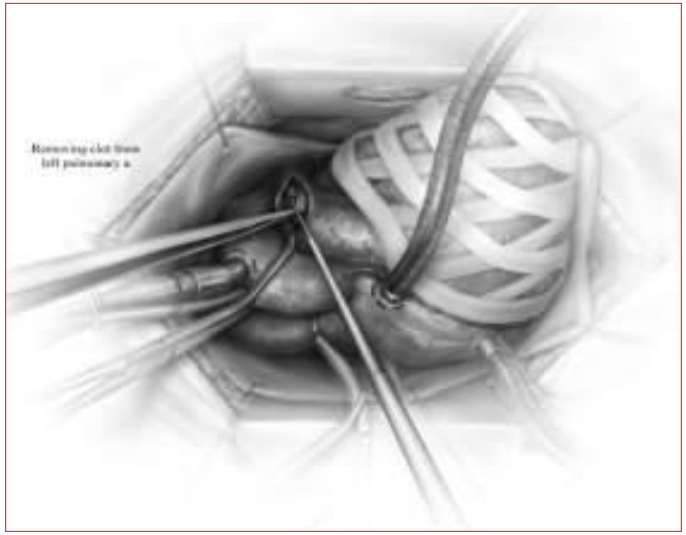


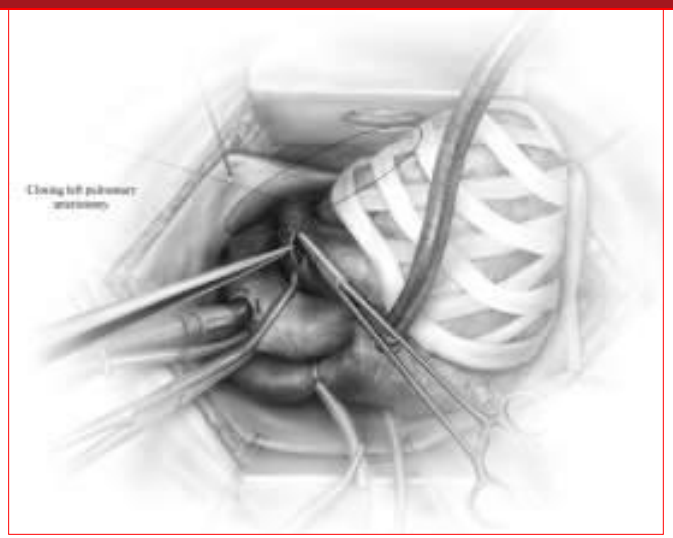
PULMONARY THROMBOENDOARTERECTOMY

SURGICAL TECHNIQUE: LEFT PA



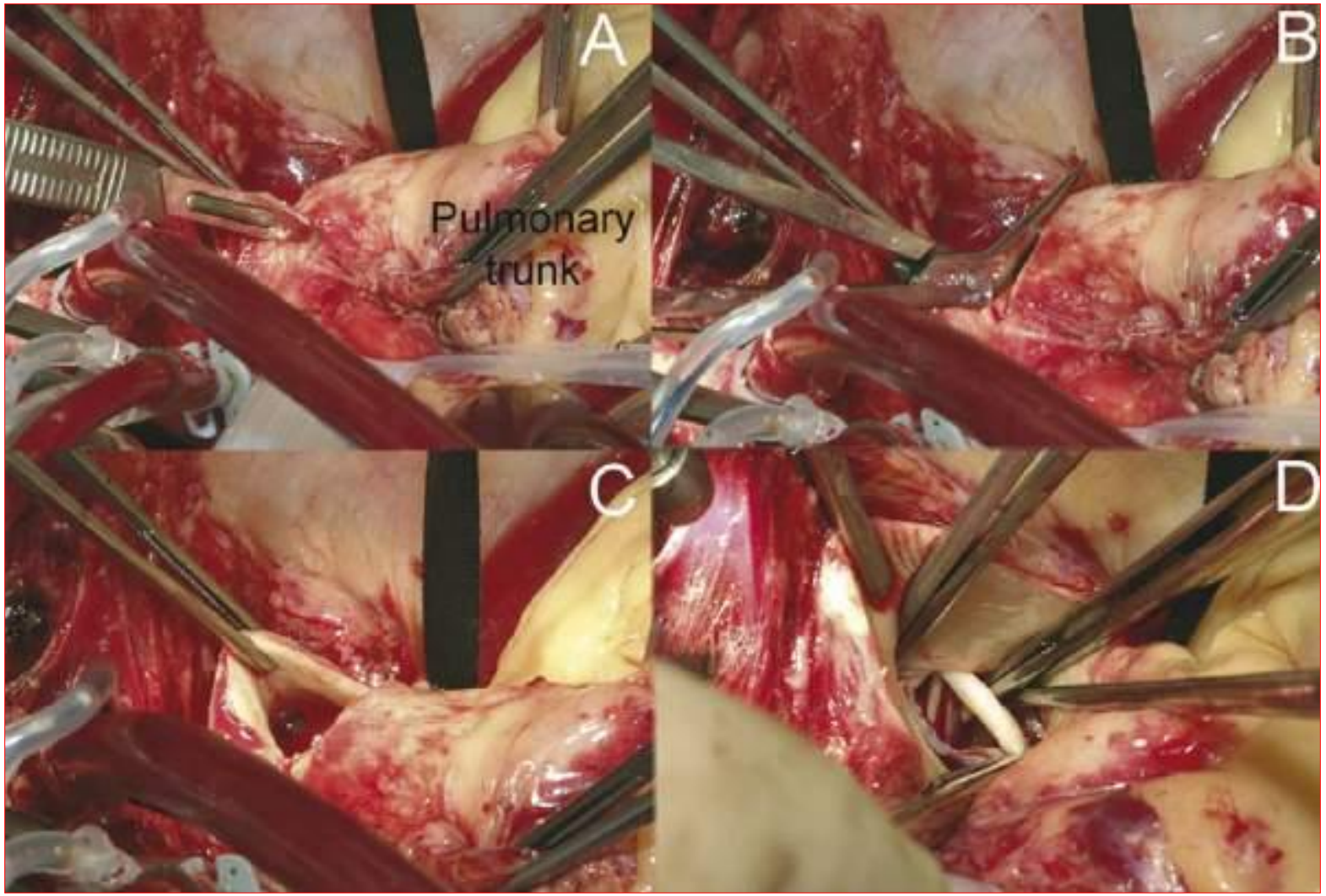
- SAME PRINCIPLES AS FOR THE RIGHT PA
- ARTERIOTOMY FROM THE SITE OF VENT HOLE TO THE PERICARDIAL REFLECTION
- HEART WRAPPED AND RETRACTED USING A MESH-LIKE BASKET RETRACTOR
- REWARMING (90-120 min.) AND WEANING FROM CPB





PULMONARY THROMBOENDOARTERECTOMY

SURGICAL TECHNIQUE: LEFT PA



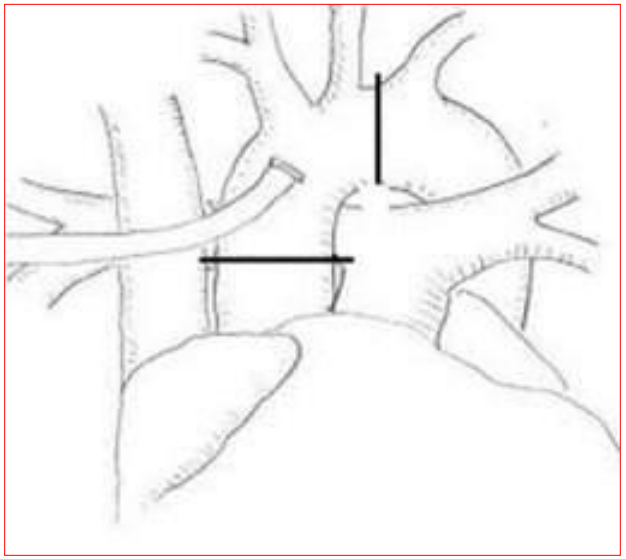
PULMONARY THROMBOENDOARTERECTOMY

ALTERNATIVE SURGICAL TECHNIQUES

- DOUBLE CLAMP TECHNIQUE
- MODERATE HYPOTHERMIA AND SHORT PERIOD OF CIRCULATORY ARREST WITHOUT THE NEED OF PROFOUND HYPOTHERMIA
- DOUBLE VENTING
- SIMULTANEOUS SELECTIVE ANTEGRADE CEREBRAL PERFUSION
- OCCLUSION OF THE BRONCHIAL ARTERIES WITH AN OCCLUSIVE BALLOON CATHETER INTO DESCENDING AORTA

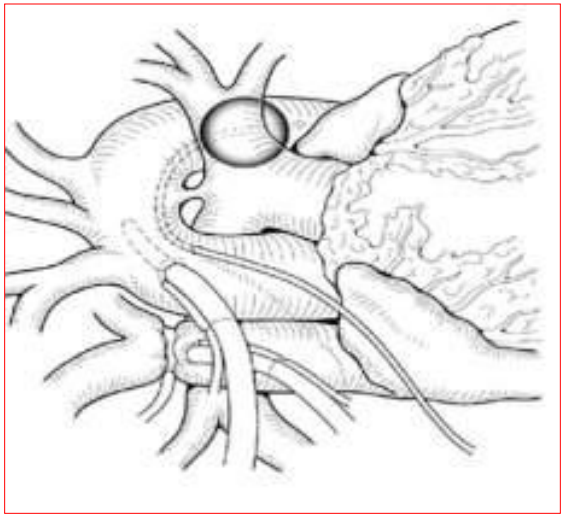
PULMONARY THROMBOENDOARTERECTOMY

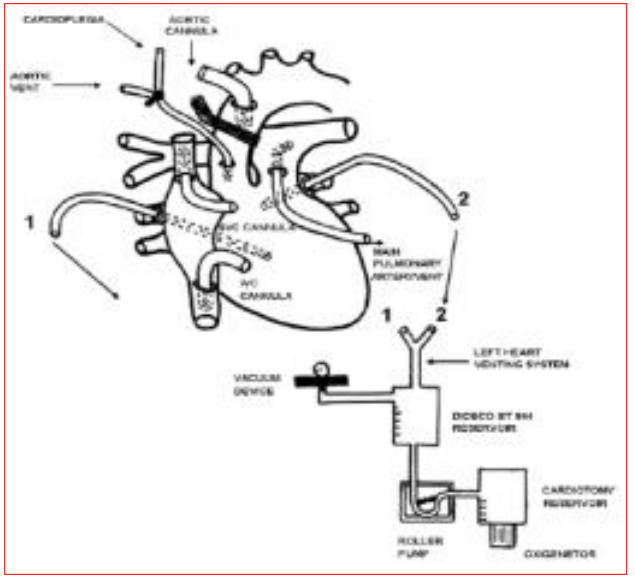
ALTERNATIVE SURGICAL TECHNIQUES



DOUBLE CLAMP TECHNIQUE

OCCLUSIVE BALLOON CATHETER





DOUBLE VENT TECHNIQUE

PULMONARY THROMBOENDOARTERECTOMY

POSTOPERATIVE CARE

- DEMANDING POSTOPERATIVE MANAGEMENT

    1. MECHANICALLY VENTILATION FOR AT LEAST 24 HOURS
    2. EXTUBATION ON THE FIRST POSTOPOPERATIVE DAY WHENEVER POSSIBLE
    3. HIGHER TIDAL VOLUMES MINUTE VENTILATION THAN AFTER CONVENTIONAL CARDIAC SURGERY
    4. MAINTEINED DIURESIS (PATIENT PREOPERATIVE WEIGHT WITHIN 24 HOURS)
    5. MINIMIZE FLUID ADMINISTRATION
    6. HEMATOCRIT LEVEL ABOVE 30%

- POSTOPERATIVE VENOUS THROMBOSIS PROPHYLAXIS

    1. INTERMITTENT PNEUMATIC COMPRESSION DEVICES
    2. SUBCUTANEOUS HEPARIN ON THE EVENING OF SURGERY
    3. ANTICOAGULATION WITH A TARGET INR OF 2,5 TO 3

PULMONARY THROMBOENDOARTERECTOMY

POSTOPERATIVE CARE: VENOUS THROMBOSIS PROPHYLAXIS

PULMONARY THROMBOENDOARTERECTOMY

COMPLICATIONS

- **PERSISTENT PULMONARY HYPERTENSION**
  1. SODIUM NITROPRUSSIDE, EPOPROSTENOL OR INHALED NO ARE GENERALLY NOT EFFECTIVE
  2. MECHANICAL CIRCULATORY SUPPORT OR EXTRACORPOREAL MEMBRANE OXIGENATOR (ECMO) USE NOT APPROPRIATE

- **REPERFUSION INJURY: LOCALIZED AND "DRAMATIC" FORM OF PULMONARY EDEMA**
  1. CAREFUL MANAGEMENT OF VENTILATION
  2. FLUID BALANCE (AGGRESSIVE DIURESIS OR ULTRAFILTRATION, HIGH HEMATOCRIT)
  3. VENOVENOUS EXTRACORPOREAL LIFE SUPPORT (V-V ECLS)
  4. MORTALITY 30 % (PULMONARY HEMORRHAGE)

- **DELIRIUM (CIRCULATORY ARREST TIME >55 min.)**
- **PERICARDIAL EFFUSION**
- **ATRIAL ARRHYTHMIAS IN 10 % OF PATIENTS**

PULMONARY THROMBOENDOARTERECTOMY

OUTCOMES: OPERATIVE MORTALITY

Terapia chirurgica dell'ipertensione polmonare cronica tromboembolica mediante endoarteriectomia polmonare

Andrea Maria D'Armini(G Ital Cardiol 2006; 7 (7): 454-463)

Tabella 6. L'endoarteriectomia polmonare nel mondo.

	Anno	N. pazienti	PVR (dynes*s*cm^{-5})		Mortalità
			Preoperatorie	Postoperatorie	%
Mares et al.[43]	2000	14	1334 ± 135§	759 ± 99	21
Mares et al.[43]	2000	33	1478 ± 107§	975 ± 93	9
Rubens et al.[44]	2000	21	765 ± 372	208 ± 92	5
D'Armini et al.[45]	2000	33	1056 ± 344	196 ± 39	9
Masuda et al.[46]	2001	50	869 ± 299	344 ± 174	18
Tscholl et al.[47]	2001	69	988 ± 554	324 ± 188	10
Hagl et al.[48]	2002	30	873 ± 248	290 ± 117	10
Jamieson et al.[16]	2003	500	893 ± 444	285 ± 215	4.4§§
Dartevelle et al.[22]	2004	245	1206 ± 61	ND	10.9
D'Armini et al.[49]	2005	134	1149 ± 535	322 ± 229	9.8§§§

ND = Non disponibile; § resistenze vascolari polmonari indicizzate; §§ ultimi 500 casi; §§§ 4.5% nel 2004.

PULMONARY THROMBOENDOARTERECTOMY

OUTCOMES 1

Outcomes of pulmonary endarterectomy for treatment of extreme thromboembolic pulmonary hypertension

Patricia A. Thistlethwaite, MD, PhD, Aaron Kemp, BA, Lingling Du, MD, Michael M. Madani, MD, and Stuart W. Jamieson, MB, FRCS

TABLE 2. Comparison of perioperative hemodynamic parameters

Variable	All patients (n = 743)	Group 1: PAS >100 mm Hg (n = 65)	Group 2: PAS <100 mm Hg (n = 678)	*P* value*
Mean decrease in PAS (mm Hg)	29.1 ± 19.7	50.5 ± 18.7	27.2 ± 18.6	.040
Mean decrease in PAD (mm Hg)	10.4 ± 10.3	19.3 ± 10.3	9.6 ± 9.9	.467
Mean decrease in PVR (dynes · sec · cm^{-5})	577.6 ± 393.8	926.7 ± 511.1	546.4 ± 365.1	.002
Mean increase in CO (L/min)	1.54 ± 1.57	1.53 ± 1.47	1.55 ± 1.58	.500
Mean decrease in tricuspid regurgitant velocity (M/s)	1.16 ± 0.80	1.86 ± 0.84	1.11 ± 0.78	.492

Data are shown as means ± standard deviation. *PAS*, Pulmonary artery systolic pressure; *PAD*, pulmonary artery diastolic pressure; *PVR*, pulmonary vascular resistance; *CO*, cardiac output. **P* value compares groups 1 and 2.

Conclusions: Pulmonary endarterectomy can be performed safely in patients with severe thromboembolic pulmonary hypertension. The magnitude of preoperative pulmonary artery systolic pressure or pulmonary vascular resistance is not a contraindication for surgical intervention. Indeed, patients with extreme pulmonary hypertension might benefit the most from this operation.

PULMONARY THROMBOENDOARTERECTOMY

UCSD OPERATIVE CLASSIFICATION

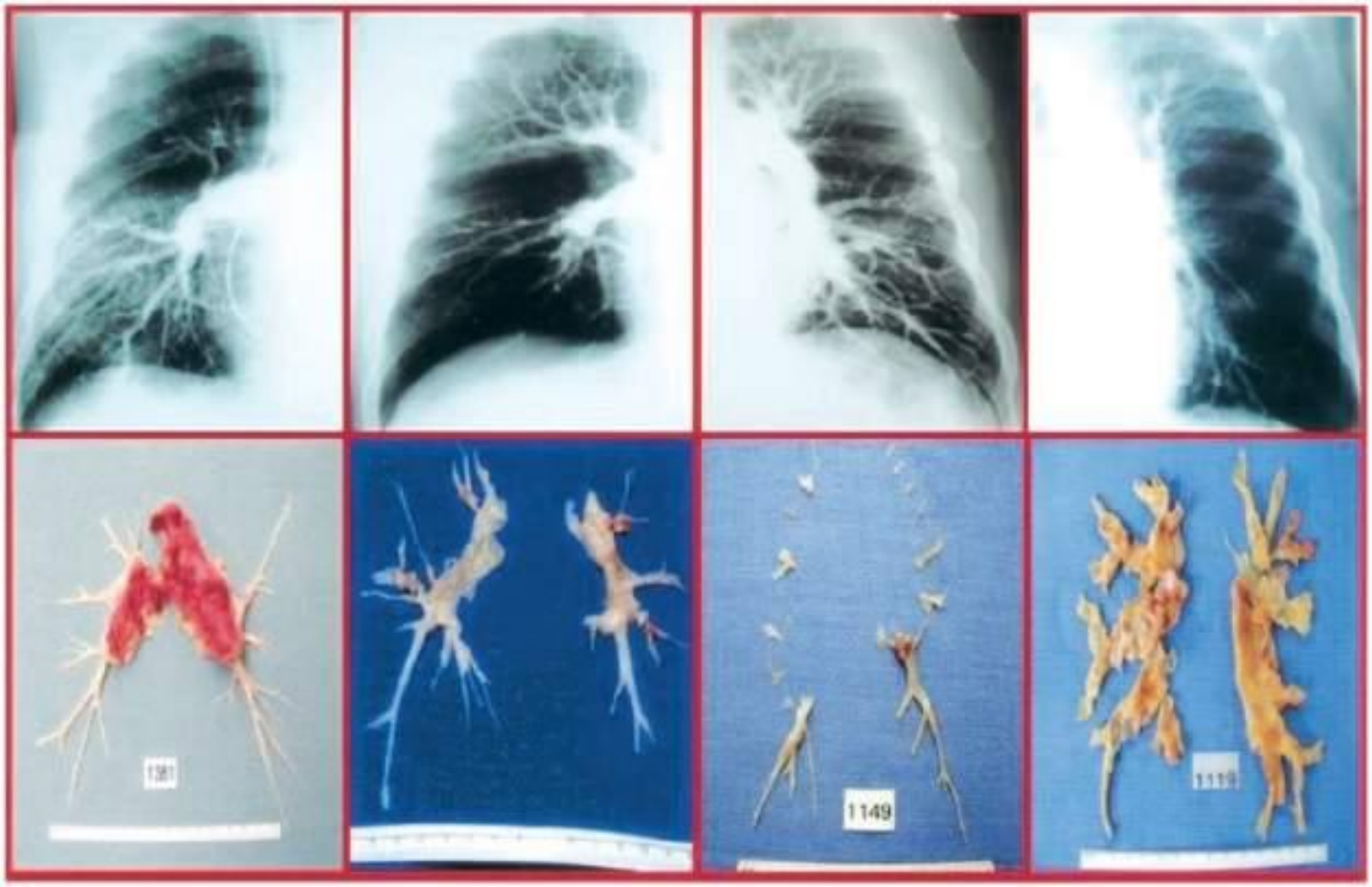
PREOPERATIVE PULMONARY ANGIOGRAM
PVR 768 DYNE*S*CM^{-5}

POSTOPERATIVE PULMONARY ANGIOGRAM (10 DAYS AS)
PVR 196 DYNE*S*CM^{-5}

≠

PULMONARY THROMBOENDOARTERECTOMY

UCSD OPERATIVE CLASSIFICATION



PULMONARY THROMBOENDOARTERECTOMY

UCSD OPERATIVE CLASSIFICATION

- TYPE I: FRESH (ACUTE) THROMBUS IN THE MAIN-LOBAR PULMONARY ARTERIES.
- TYPE II: INTIMAL THICKENING AND FIBROSIS WITH OR WITHOUT ORGANIZED THROMBUS PROXIMAL TO SEGMENTAL ARTERIES ONLY.
- TYPE III: FIBROSIS, INTIMAL WEBBING AND THICKENING WITH OR WITHOUT ORGANIZED THROMBUS WITHIN DISTAL SEGMENTAL ARTERIES ONLY.
- TYPE IV: MICROSCOPIC DISTAL ARTERIOLAR VASCULOPATHY WITHOUT VISIBLE THROMBOEMBOLIC DISEASE.

PULMONARY THROMBOENDOARTERECTOMY

OPERATIVE CLASSIFICATION: TYPE III and IV vs TYPE I and II

- MORE RESIDUAL TRICUSPID REGURGITATION
- HIGHER POSTOPERATIVE (PO) PULMONARY ARTERY SYSTOLIC PRESSURE
- GREATER PO PULMONARY VASCULAR RESISTANCE
- HIGHER PO MORTALITY
- LONGER INOTROPIC SUPPORT
- LONGER HOSPITAL STAYS

PULMONARY THROMBOENDOARTERECTOMY

OUTCOMES

Outcomes of Pulmonary Endarterectomy Surgery

Patricia A. Thistlethwaite, MD, PhD, Michael Madani, MD, and Stuart W. Jamieson, MB, FRCS

Semin Thorac Cardiovasc Surg 18:257-264 © 2006

Table 4 Thromboembolic Classification—Hemodynamic Results

Variable	All Patients (n = 956, 100%)	Type 1 (n = 372, 38.0%)	Type 2 (n = 415, 43.4%)	Type 3 (n = 152, 15.9%)	Type 4 (n = 17, 1.8%)
PVR (dynes-sec-cm^{-5})	861.3 ± 439.1	924.8 ± 443.9	794.6 ± 417.4	878.2 ± 463.9	940.8 ± 424.7
	288.9 ± 196.5	271.1 ± 180.3	273.1 ± 197.7	344.3 ± 184.5	604.6 ± 368.2
CO (L/min)	4.0 ± 1.4	3.7 ± 1.4	4.1 ± 1.3	4.0 ± 1.5	3.7 ± 1.1
	5.5 ± 1.5	5.5 ± 1.5	5.5 ± 1.5	5.3 ± 1.4	4.7 ± 1.2
Systolic PA pressure (mm Hg)	76.1 ± 18.4	76.9 ± 17.8	75.4 ± 19.4	76.0 ± 17.1	78.8 ± 16.1
	46.8 ± 16.7	45.0 ± 15.4	45.2 ± 15.3	52.3 ± 16.8	78.1 ± 34.1
Diastolic PA pressure (mm Hg)	29.0 ± 9.8	30.1 ± 9.7	27.9 ± 10.1	28.8 ± 9.1	33.3 ± 10.4
	18.6 ± 7.4	17.9 ± 6.8	18.1 ± 6.9	20.4 ± 8.0	28.4 ± 13.5
Mean PA pressure (mm Hg)	46.4 ± 11.2	47.0 ± 11.0	45.4 ± 11.6	46.7 ± 10.6	50.6 ± 11.1
	28.5 ± 9.7	27.5 ± 9.0	27.8 ± 9.3	31.4 ± 9.9	44.7 ± 15.1
Mortality	47 (4.9)	14 (3.8)	19 (4.6)	10 (6.6)	4 (23.5)

Data are shown as means ± standard deviation or number (percentage). Top numbers are preoperative values and bottom numbers are postoperative values obtained just prior to removal of the Swan-Ganz catheter. PVR, pulmonary vascular resistance; CO, cardiac output; PA, pulmonary artery.

However, despite favorable results in our series of over 2000 pulmonary endarterectomies performed over the last 36 years (1849 operations in the last 15 years), we have come to realize that a small subset of patients do not benefit from this operation, as they manifest solely arteriolar-capillary vasculopathy similar to idiopathic pulmonary arterial hyperten-

PULMONARY THROMBOENDOARTERECTOMY

- IN ALMOST EVERY CASE, THROMBOEMBOLIC PUMONARY HYPERTENSION SHOULD BE CONSIDERED A BILATERAL DISEASE.

- PATIENTS WITH TYPE I AND II THROMBOEMBOLIC DISEASE HAVE THE MOST FAVORABLE HEMODYNAMIC RESULT.

- PATIENTS WITH TYPE III THROMBOEMBOLIC DISEASE HAVE A WORSE POSTOPERATIVE OUTCOME.

- PATIENTS WITH TYPE IV THROMBOEMBOLIC DISEASE DO NOT HAVE SURGICAL CORRECTABLE DISEASE.

PULMONARY THROMBOENDOARTERECTOMY

- PATIENT AGE , DEGREE OF PULMONARY HYPERTENSION, CIRCULATORY ARREST TIME ARE RISK FACTORS FOR EARLY MORBIDITY AND MORTALITY.
- PREOPERATIVE PVR > 1100 DYNE*S*CM-5 AND MEAN PAP > 50 MMHG: HIGHER OPERATIVE MORTALITY.
- FAILURE TO LOWER PULMONARY ARTERY PRESSURE IS MOST PREDICTIVE OF IN-HOSPITAL MORTALITY.
- PNEUMONIA AND GASTROINTESTINAL COMPLICATIONS ARE THE POSTOPERATIVE COMPLICATIONS MOST ASSOCIATED WITH PERIOPERATIVE DEATH.

PULMONARY THROMBOENDOARTERECTOMY

CONCLUSIONS

THE THREE MOST IMPORTANT DETERMINANTS OF CARDIAC SURGICAL OUTCOMES ("ESPECIALLY PTE") ARE:

1. **PATIENT SELECTION**
2. **PATIENT SELECTION**
3. **PATIENT SELECTION**

"A Heart Surgeon's little instruction book"

PULMONARY THROMBOENDOARTERECTOMY

PREOPERATIVE IMAGING EVALUATION