

Balloon Pulmonary Angioplasty For Chronic Thromboembolic Pulmonary Hypertension

Has This Become Mainstream

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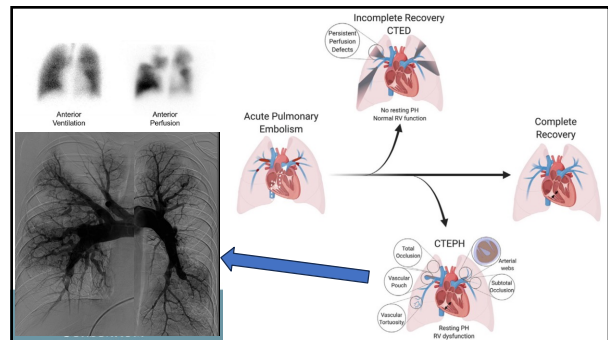
The International Crisis of PE!

- High incidence; ubiquitous
- Significant immediate morbidity/mortality and long-term sequelae
- Under-recognized & undertreated by clinicians

#3 CAUSE OF CV DEATH IN US
Up to 180,000 PE deaths/year

Kearon C et al. Chest 2008; 133: 454S-545S.

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What is Chronic Thromboembolic Disease and CTEPH?

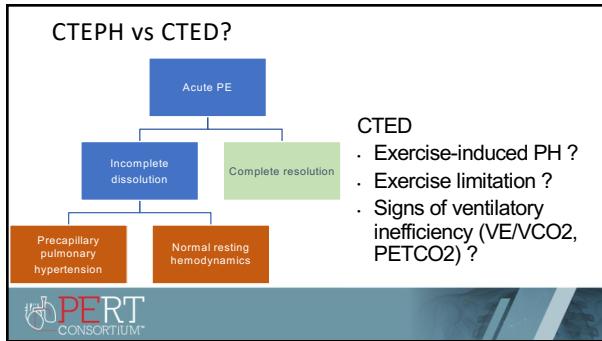
- Acute Pulmonary Embolus
- Incomplete resolution (>3 months AC)
- Fibrosis and scarring within pulmonary vasculature → Loss of distal perfusion and pulmonary vascular bed
- Progressive pulmonary hypertension (mean PA >25)
- Right heart failure

Courtesy of Fabio Jatene MD

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Post PE Syndromes – Still Not Well Categorized or Understood

Klok et al. Blood Reviews 2014; 28:221



CLINICAL RESEARCH STUDY

Rigorous follow-up after acute PE is mandatory

Monitoring for Pulmonary Hypertension Following Pulmonary Embolism: The INFORM Study

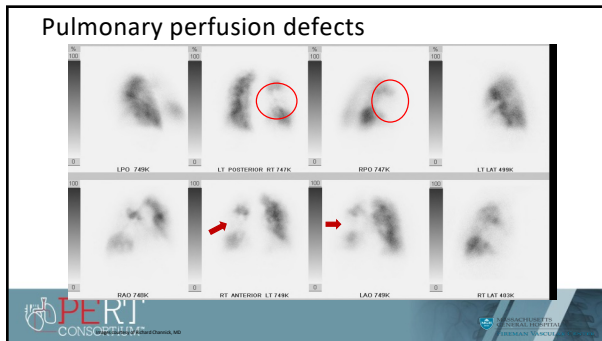
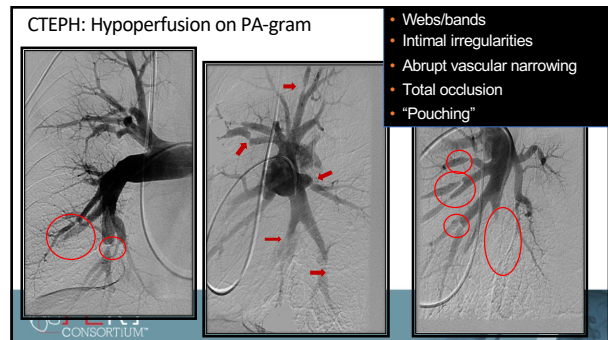
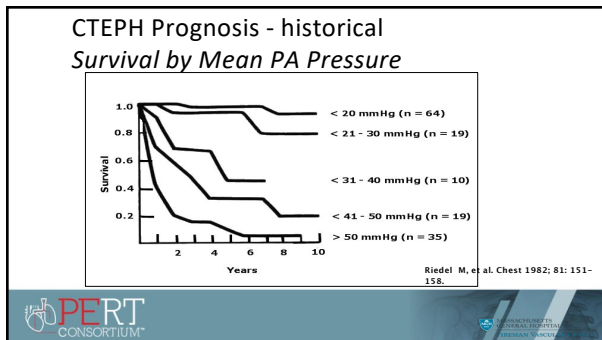
Victor F. Tapson, MD,¹ David N. Platt, MD,² Fang Xia, PhD,³ Simon A. Teal, BSc,⁴ Margarita de la Orden, MSc,¹ Christine H. Divers, PhD,⁵ Carol A. Sattler, MD, PhD,⁶ Vijay N. Joshi, PhD,⁷ Richard N. Channick, MD⁸

¹Division of Pulmonary and Critical Care Medicine, Cedars-Sinai Medical Center, Los Angeles, Calif; ²Roper Healthcare Pharmaceuticals, Bligssburg, Md; ³Boehr Ingelheim AG, Berlin, Germany; ⁴Department of Pulmonary and Critical Care Medicine, Massachusetts General Hospital, Boston

The American Journal of Medicine (2016) 129, 978-985

We are likely "missing" some!

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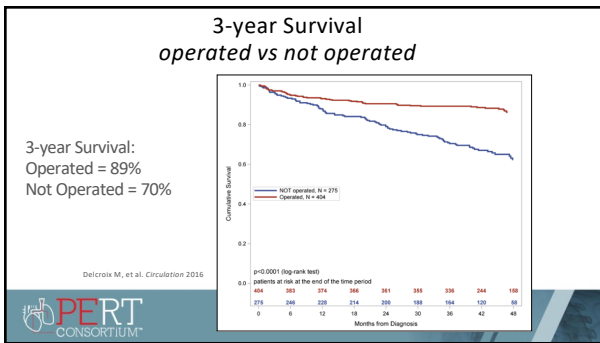
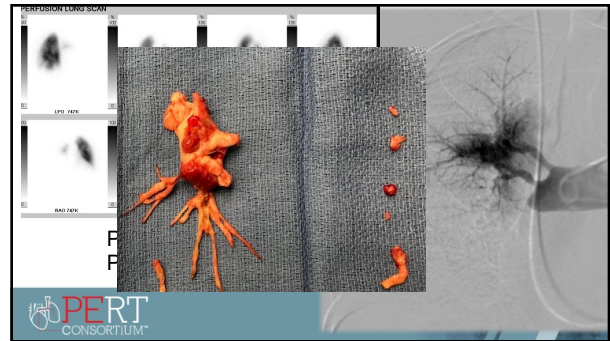


- ### CTEPH (and CTED)
- More prevalent than previously thought (Post PE sequelae underdiagnosed)
 - Frequently mis-diagnosed/not recognized (often no known prior PE)
 - Causes significant disability/functional compromise
 - Effective treatments are available
 - Medical (Riociguot, Macitentan, etc)
 - Surgical (PTE)
 - Percutaneous (BPA)
 - Management is complex → need dedicated team-based approach
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Pulmonary ThromboEndarterectomy (PTE) for CTEPH

- Highly effective for appropriately selected patients
 - 50-70% of CTEPH patients qualify
- Most often “curative” w/o additional intervention
- Bilateral endarterectomy...median sternotomy under circulatory arrest

→ Current “treatment of choice”





PTE: Limitations

- Inaccessible lesions/distal lesions
- Inability to obtain good tissue dissection planes
- Unable to tolerate deep hypothermic arrest x 6-10 hours
 - Comorbidities
 - Frailty
- Limited experience/expertise of surgeon and team

Residual CTEPH after PTE

Baseline pre- BPA (6/3/21)



Balloon Pulmonary Angioplasty

- First described in 2001 by Feinstein et. al.
- Initial high complication rates (pulmonary hemorrhage & death)
- Advances over the last decade → improved safety/outcomes

Brief Rapid Communications

Balloon Pulmonary Angioplasty for Treatment of Chronic Thromboembolic Pulmonary Hypertension


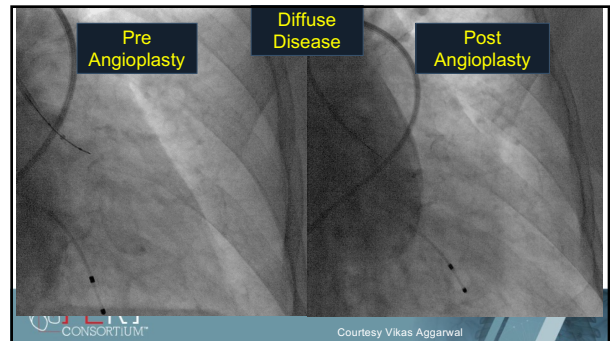
Jeffrey A. Feinstein, MD, MPH; Samuel Z. Goldhaber, MD; James E. Lock, MD; Susan M. Formanstein, PA-C; Michael J. Landolt, MD

Background: Although pulmonary thromboendarterectomy is considered standard for the definitive treatment of chronic thromboembolic pulmonary hypertension (CTEPH), not all patients have surgically accessible disease. Others are poor surgical candidates because of comorbid illness. Therefore, the current practice, for medical and endovascular an alternative interventional strategy of balloon pulmonary angioplasty (BPA).

Methods and Results: Twelve patients (mean age, 51.8 years; range, 34 to 73 years) with CTEPH underwent BPA. They were treated with 1 or 2 balloon dilations (range, 1 to 12) and 4 distal dilations (range, 1 to 2). Symptoms of pulmonary artery hypertension by disease severity (1) complete resolution, (2) 50% reduction, or (3) none of interventional weeks. After an average of 16 months of follow-up (range, 6 to 36 months), the average mean systolic blood pressure (systolic blood pressure) decreased from 113 to 90 mmHg (P<0.001), and average walking distance increased from 209 to 407 yards (P<0.0001). Pulmonary artery mean pressure decreased from 43.0 to 21.9 mmHg (P<0.001) and the 6-minute walk test (P<0.0001). There were no deaths, no major complications, 3 hospital readmissions, and 10 minor complications.

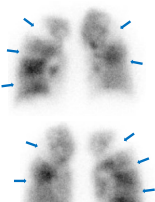
Conclusions: BPA reduces pulmonary artery hypertension in patients with CTEPH and is associated with long-term improvement in New York Heart Association class and exercise walking distance. BPA is a promising interventional technique for the medical refractory patients with medical therapy in CTEPH patients who are not surgical candidates. (Circulation. 2001;103:10-13.)

Key Words: balloon • angioplasty • endovascular • thrombosis • thrombolysis • pulmonary heart disease

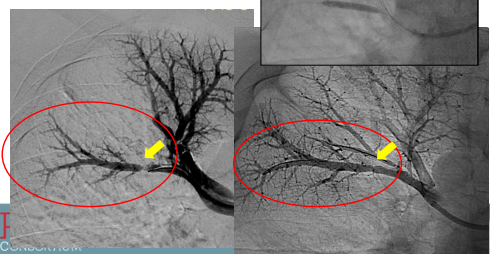



- 42-year-old male with acute PE (2011)
 - Rx Warfarin/rivaroxaban for 6 years → D/c'd in 5/2017
 - 9/2017 Admitted with dyspnea → severe PH on TTE
 - CTEPH on V/Q scan
- Hemodynamics
 - RA 9, PA 123/33 (69), PCWP 16, PVR 10.1 WU
 - CO 5.3 L/min, CI 2.9 L/min/m²
- Surgical candidate for PTE → refused
- Pulm vasodilator initiated
- Team consensus → proceed with BPA

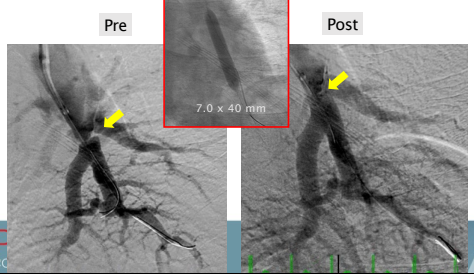
VQ Scan (12/2017)



BPA #1 Rt lung - RUL selective injection

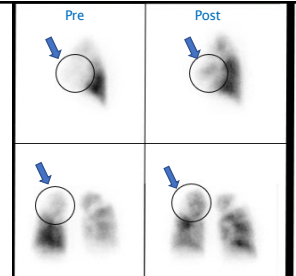


BPA #2 – 1st Left Lung session



7.0 x 40 mm

V/Q scan pre vs post



Hemodynamics

	Baseline	BPA 1 (post)	BPA 2 (post)	BPA 3 (post)	BPA 4 (post)	BPA 5 (post)	BPA 6 (post)
PA s/d	123/33	72/25	55/19	37/11	42/15	29/11	30/13
PA mean	69	44	32	21	24	18	19
PVR (wu)	10.9	8.8	4.4	2.5	2.7	1.6	2
CO/CI	5.3/2.9	4.2/2.3	5.9/3.2	6.1/3.3	6.7/3.7	7.4/4.0	6.5/3.6
RA	9	7	6				
PCWP	11	6	6				

After 7 BPA sessions

- Marked improvement in functional capacity
- Resolution of chest pressure
- Off O2 and back at work

WHO Functional Class Before and After BPA

Table 4. BPA procedural characteristics (per session)

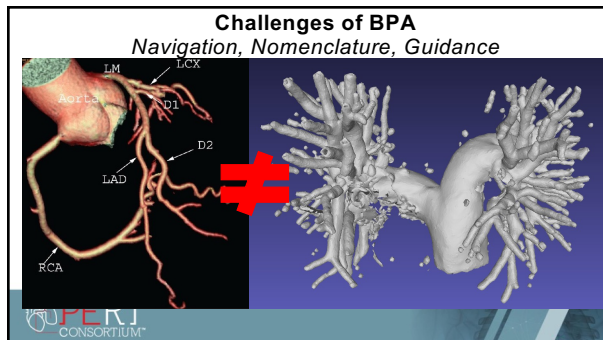
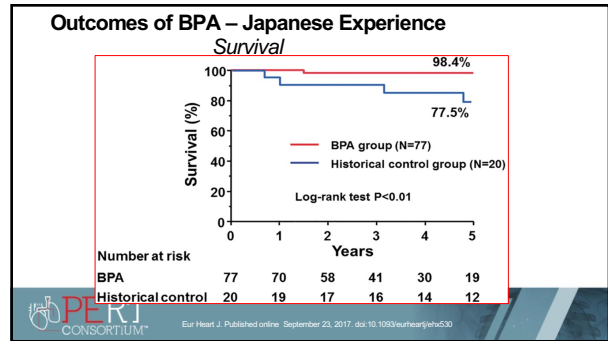
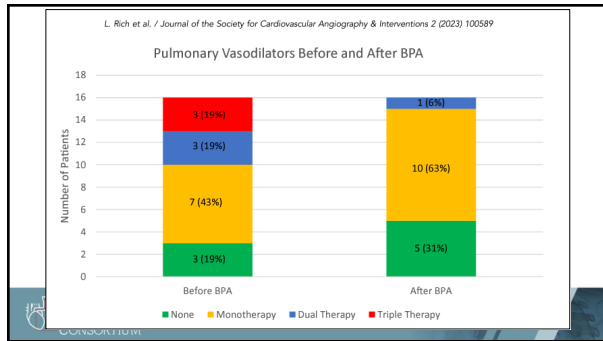
Catheter flow, mL	166.2 ± 46.5
Catheter flow (glomerular filtration rate)	2.1 ± 0.68
Radiation exposure, Gy	0.20 ± 0.01
Number of segments interwoven	2.3 ± 0.69
Number of subsegmental branches interwoven	3.7 ± 1.46
Fluoroscopy time, min	36.4 ± 12.8

Table 5. Functional and hemodynamic data before and after BPA

	Before BPA	After BPA	P
6MWD, m	363 ± 146.3	432.6 ± 114.8	.09
6M: min Hg	133 ± 5.3	9.8 ± 2.5	.012
mPAP, mm Hg	43.4 ± 11.3	35.1 ± 10.2	<.01
Cardiac index, L/min/m ²	2.8 ± 0.7	2.8 ± 0.5	.09
PVR, Wood units	5.1 ± 2.6	3.4 ± 1.4	<.01

Cardiac index reported via thermodilution.
6MWD, 6-minute walking distance; BPA, balloon pulmonary angioplasty; mPAP, mean pulmonary artery pressure; PVR, pulmonary vascular resistance; RA, right atrial pressure.

L. Rich et al. / Journal of the Society for Cardiovascular Angiography & Interventions 2 (2023) 100589



Journal of the Society for Cardiovascular Angiography & Interventions 2 (2023) 101108

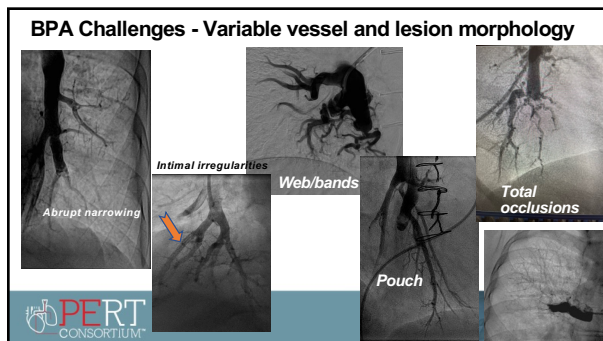
JSCAI

The official journal of the Society for Cardiovascular Angiography & Interventions

Original Research

Anatomical Variations in Pulmonary Arterial Branches in Patients Undergoing Evaluation for Chronic Thromboembolic Pulmonary Hypertension

Erinleigh Michaud, MD¹, Michael Pan, MD², Vladimir Lakhter, MD³, Anand Reddy Malgireddy, MD⁴, Syed N. Hyder, MD⁵, Nimai Patel, MD⁶, Victor M. Moles, MD⁷, Vallerie V. McLaughlin, MD⁸, Prachi P. Agarwal, MD, MS⁹, Scott H. Visovatti, MD¹⁰, Thomas M. Cascino, MD, MSc¹¹, Jonathan Haft, MD¹², Kenneth Rosenfield, MD¹³, Brahmajee K. Nallamothu, MD¹⁴, Jay S. Giri, MD, MPH¹⁵, Riyaz Bashir, MD¹⁶, Vikas Aggarwal, MD MPH^{17,18}




BPA Complications – Not a “free lunch”

- Hemoptysis
- Rupture → pulmonary hemorrhage
- Reperfusion pulmonary edema
- Pseudoaneurysm formation
- Death

Conclusions

- CTEPH occurs in 3-5% of patients after acute PE
- PTE remains treatment of choice
- BPA now "Mainstream" (non-surgical patients...and more!)
- Results will improve with better technology, navigation, operator expertise, case selection
- Need a specialized multidisciplinary CTEPH team ...cannot manage effectively without it!
- CTED incidence higher (?50%), but entity not well understood
- Can we prevent CTED/CTEPH – will more complete clot removal help??

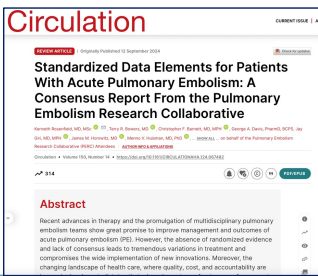



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Advancing the science and practice of BPA to improve outcomes

- Monthly meetings
- Registry
- Annual scientific session
- Centers of excellence

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Circulation | Current Issue


Standardized Data Elements for Patients With Acute Pulmonary Embolism: A Consensus Report From the Pulmonary Embolism Research Collaborative

Abstract
Recent advances in therapy and the promulgation of multidisciplinary pulmonary embolism teams show great promise to improve management and outcomes of acute pulmonary embolism (PE). However, the absence of standardized evidence and lack of consensus leads to tremendous variations in treatment and compromises the wide implementation of new innovations. Moreover, the changing landscape of health care, where quality, cost, and accountability are

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San Diego, California
Gaylord Pacific Resort & Convention Center
September 18–20, 2025

