

Background

CTEPH: Chronic thromboembolic pulmonary hypertension

PTE: pulmonary thromboendarterectomy, the guideline recommended¹ treatment of CTEPH

Successful PTE:

↓ **PVR** (Pulmonary vascular resistance)

$$PVR = \frac{PAP_{mean} - PCWP}{CO} \times 80$$

↑ **PAC** (Pulmonary arterial compliance)

$$PAC = \frac{SV}{PAP_{sys} - PAP_{dia}}$$

↓ **Number of diseased segments**

Key question: As CTEPH presentation diversifies,² how do we predict who benefits most from PTE?

Objectives:

- To analyze the relationships between number of diseased segments on pulmonary angiography (PAG) with PVR and PAC.
- To understand how disease clearance visualized on PAG correlates to PVR and clinical outcomes.
- To predict change in PVR to better determine risk of residual PH and perioperative surgical risk.

Methods

Patients:

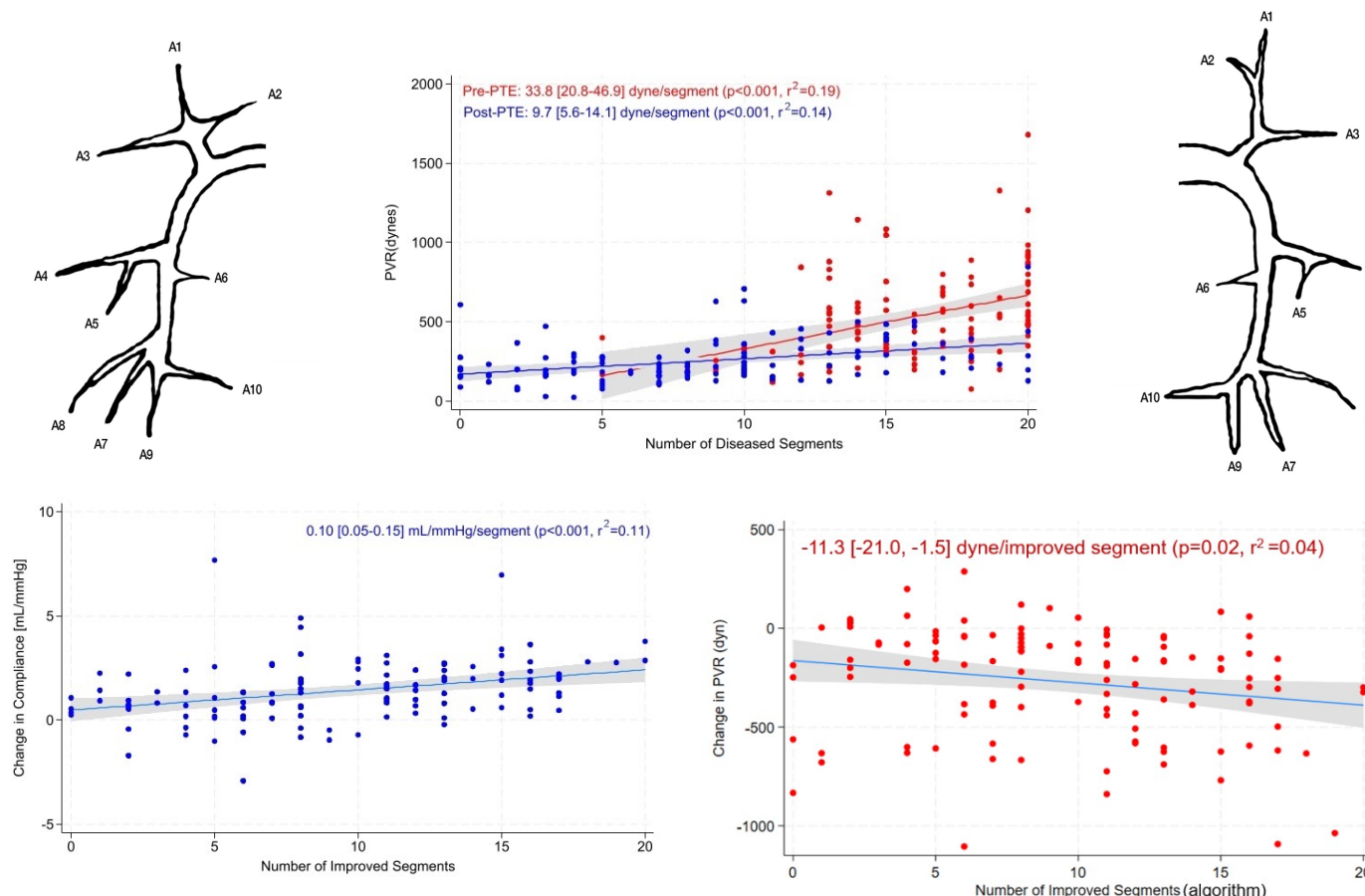
- Single institution, retrospective
- Underwent PTE 2016 – 2025
- Had pre- and post-PTE PAG with simultaneous measurement of hemodynamics
 - Standard practice at Northwestern
 - Pre-PTE: within 9 months
 - Post-PTE: mostly within 3-6 months³

Pulmonary Angiogram Scoring:

- Each segment read by interventional cardiologist
- Description converted to three-level score:
 - 0 = patent, no disease
 - 1 = partial occlusion (stenoses, webs, tapering)
 - 2 = total occlusion
- If a parent vessel (main PA, interlobar, basal trunk) was diseased, all downstream vessels were coded as diseased
- Missing values imputed by nearest neighbor method

Results

		Number of Residual Diseased Segments Post-PTE				
		Q1 [0-4] (n=28)	Q2 [5-7] (n=26)	Q3 [8-12] (n=34)	Q4 [13-20] (n=30)	p
Pre-PTE	Age (years)	47 (14)	54 (15)	59 (12)	53 (13)	0.007
	On pulmonary vasodilator	13 (46%)	9 (35%)	14 (41%)	15 (50%)	0.677
	PVR (dynes)	419 [267, 575]	424 [249, 738]	476 [312, 688]	563 [446, 753]	0.097
	Totally occluded segments	3 [1, 6]	3 [1, 7]	2 [0, 5]	5 [1, 7]	0.153
	Partially occluded segments	12 [9, 15]	13 [7, 16]	13 [9, 15]	15 [11, 17]	0.568
	Mod-sev RV failure on echo	10 (37%)	12 (46%)	16 (47%)	19 (63%)	0.246
	Borg score	3 [1, 7]	3 [1, 4]	3 [2, 4]	3 [2, 4]	0.863
	Home oxygen	9 (32%)	7 (27%)	11 (32%)	11 (37%)	0.895
	Circ arrest time (min)	40 [30, 51]	36 [33, 47]	45 [36, 53]	46 [40, 53]	0.035
Post-PTE	On pulmonary vasodilator	1 (4%)	1 (4%)	1 (3%)	6 (20%)	0.033
	PVR (dynes)	185 [156, 261]	183 [130, 235]	224 [178, 360]	298 [224, 421]	<0.001
	Totally occluded segments	0 [0, 0]	0 [0, 0]	0 [0, 0]	1 [0, 5]	0.002
	Partially occluded segments	2 [0, 3]	6 [5, 7]	9 [8, 10]	14 [12, 16]	<0.001
	Mod-severe RV failure on echo	4 (17%)	0 (0%)	7 (28%)	11 (44%)	0.003
	Borg score	0 [0, 1]	0 [0, 0.5]	2 [1, 3]	1 [0.5, 3]	0.003
	Improved segments	14 [11, 16]	13 [10, 15]	8 [6, 11]	5 [2, 7]	<0.001
	Decrease in PVR (dynes)	184 [93, 341]	206 [94, 498]	187 [36, 436]	177 [73, 573]	0.894
	Home oxygen at last follow-up	1 (4%)	0 (0%)	3 (11%)	1 (4%)	0.343
	Balloon pulmonary angioplasty	2 (7%)	4 (15%)	9 (26%)	11 (37%)	0.038
	1-year mortality	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0.712



Results

Multivariate Linear Regression Output: Change in PVR (r ² =0.82)			
Covariate	Coefficient	95% CI	p
Number of improved segments	-8.36	[-12.59, -4.13]	<0.001
On pulmonary vasodilator pre-op?	87.7	[44.3, 131.2]	<0.001
Pre-op PVR	-0.807	[-0.881, -0.733]	<0.001
Constant	195.6	[133.9, 257.3]	<0.001

$$PVR_{postPTE} = 87.7(PreOp Pulmonary Vasodilator_{yes/no}) + 0.19(PVR_{prePTE}) - 8.36(\#Improved Segments) + 195.6 \text{ dynes}$$

Conclusions

- There is a relationship between PVR and number of diseased segments on PAG
- Starting PVR, pulmonary vasodilator use, and estimated number of improved segments can be used to predict post-operative PVR
- Post-PTE, patients with fewer residual diseased segments have lower PVR and better clinical/functional outcomes
- Most benefit is achieved if the surgeon can achieve 7 or fewer residual diseased segments and no totally occluded segments
- CTEPH care teams can use these findings to guide PTE candidacy

References

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- Madani MM, Auger WR, Pretorius V, et al. Pulmonary Endarterectomy: Recent Changes in a Single Institution's Experience of More Than 2,700 Patients. Ann Thorac Surg. 2012;94(1):97-103
- Cannon JE, Su L, Kiely DG, et al. Dynamic Risk Stratification of Patient Long-Term Outcome After Pulmonary Endarterectomy: Results From the United Kingdom National Cohort. Circulation. 2016;133(18):1761-1771.