Influence of Preoperative Pulmonary Vascular Resistance on Postoperative Functional Class in Patients Undergoing Pulmonary Thromboendarterectomy: A Single-Center Analysis

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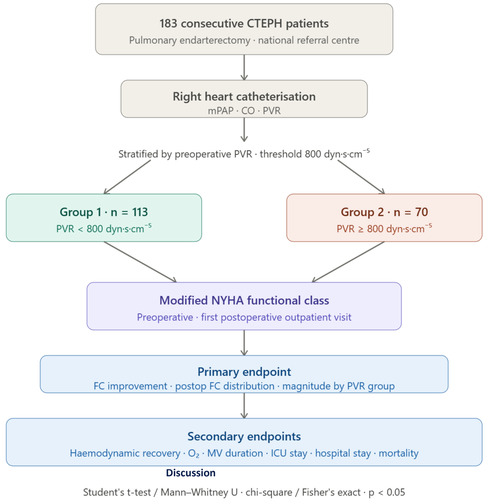
Introduction

- Chronic thromboembolic pulmonary hypertension (CTEPH) is a progressive and potentially fatal condition caused by incomplete resolution of pulmonary thromboemboli, leading to organised fibrotic obstruction of the pulmonary vasculature, sustained elevation of pulmonary vascular resistance (PVR), right ventricular pressure overload, and, if untreated, right heart failure and death. Functional status, assessed using the modified New York Heart Association (NYHA) classification, represents a clinically meaningful and patient-centred measure of disease burden in CTEPH.

- Improvement in functional class following PEA reflects the integrated effect of haemodynamic normalisation on exercise capacity, dyspnoea, and quality of life. The aim of this study was therefore to evaluate whether preoperative haemodynamic severity, stratified by a PVR threshold of 800 dyn·s·cm^{-5}, influences the magnitude of functional class improvement following PEA in a consecutive cohort of patients treated at a national referral centre.

Methods



Results

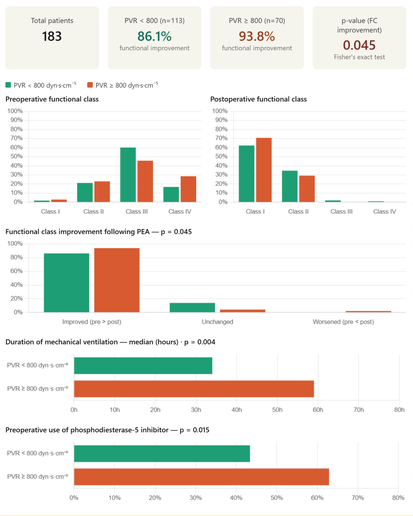


Table 2 — Categorical variables by PVR group

Variable	PVR < 800 (n = 113)		PVR ≥ 800 (n = 70)		Total (n = 183)	p
	n	%	n	%	%	
Female sex[1]	66	58.4%	42	60.0%	59.0%	0.878
Supplemental O_2 preoperatively[1]	27	23.9%	20	28.6%	25.7%	0.491
Supplemental O_2 postoperatively[1]	8	8.3%	5	10.4%	9.0%	0.760
Lower limb oedema preoperatively[1]	44	38.9%	37	52.9%	44.3%	0.069
Lower limb oedema postoperatively[1]	15	15.5%	12	24.5%	18.5%	0.258
FC preop: NYHA class III-IV[1]	87	77.0%	52	74.3%	75.9%	0.165
FC postop: NYHA class I-II[1]	98	97.0%	48	100.0%	98.0%	0.671
FC improvement (pre > post)[1]	87	86.1%	45	93.8%	88.6%	0.045*
Prostacyclins preoperatively[1]	3	2.7%	0	0.0%	1.6%	0.288
Endothelin receptor antagonists preop[1]	46	40.7%	31	44.3%	42.1%	0.647
Phosphodiesterase-5 inhibitor preop[1]	49	43.4%	44	62.9%	50.8%	0.015*
Any PAH-specific therapy preop[1]	60	53.1%	48	68.6%	59.0%	0.045*
Proximal dissection (right)[1]	74	66.1%	44	63.8%	65.2%	0.872
Proximal dissection (left)[1]	50	50.0%	31	47.0%	48.8%	0.752

[1] Pearson's chi-square test · [2] Fisher's exact test · * p < 0.05

Table 3 — Continuous variables by PVR group

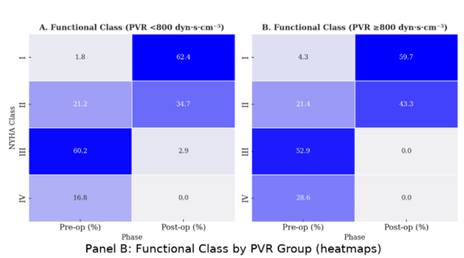
Variable	Group	n	Mean	Median	IQR	SD	p
Age at surgery (years)[1]	<800	113	46.2	45	38-56	12.8	0.257
	≥800	70	44	44	34-53	13.4	
Body mass index (kg/m²)[1]	<800	113	27.6	27.6	24.7-32.0	—	0.097
	≥800	70	26.8	26.1	23.2-29.5	6.4	
Preoperative mPAP (mmHg)[1]	<800	113	44.1	43	35-53	11.4	<0.001*
	≥800	69	57.3	57	50-64	9.3	
Preoperative cardiac output (L/min)[1]	<800	112	5	4.9	4.2-5.5	1.4	<0.001*
	≥800	67	3.7	3.5	2.9-4.2	1	
Cardiopulmonary bypass time (min)[1]	<800	113	278.6	279	250-308	39.4	0.425
	≥800	70	286.6	280	265-304	43.2	
Total circulatory arrest time (min)[1]	<800	113	45.5	43	36-58	16.6	0.504
	≥800	70	46.9	45	41-54	11.3	
Postoperative mPAP (mmHg)[1]	<800	81	29.8	27	22-35	11.8	0.504
	≥800	46	29.2	25	20-36	14.1	
Postoperative cardiac output (L/min)[1]	<800	81	5.3	5.3	4.3-6.0	1.4	0.093
	≥800	45	4.8	4.8	4.0-5.7	1.5	
Postoperative PVR (dyn·s·cm⁻⁵)[1]	<800	78	304.7	230	160-359	230.5	0.856
	≥800	45	348.4	240	170-316	390.6	
ICU length of stay (days)[1]	<800	113	11.5	7	5.8-12.0	13.8	0.203
	≥800	69	13.4	8	5.8-16.4	12.1	
Total postoperative hospital stay (days)[1]	<800	113	23.7	20.7	15.3-27.3	14.3	0.244
	≥800	69	26.4	22.3	16.3-34.9	15.5	
Duration of mechanical ventilation (h)[1]	<800	113	59	34	29-66	54.8	0.004*
	≥800	70	107.2	59	31-155	119.4	

Discussion

• This study evaluated the impact of preoperative haemodynamic severity, as defined by pulmonary vascular resistance, on functional outcomes following. The principal finding is that patients with severe preoperative haemodynamic impairment — defined by a PVR ≥ 800 dyn·s·cm^{-5} — achieved significantly greater functional class improvement after PEA compared with those with lower resistance, while demonstrating equivalent postoperative haemodynamic normalisation. These results challenge the assumption that high preoperative PVR necessarily portends inferior functional recovery and support the role of PEA as an effective intervention across a broad spectrum of haemodynamic severity. The finding that 93.8% of high-PVR patients experienced improvement in modified NYHA functional class — compared with 86.1% in the low-PVR group (p = 0.045) — is clinically meaningful and deserves careful interpretation. Patients with a PVR ≥ 800 dyn·s·cm^{-5} were more likely to present in NYHA class III or IV preoperatively (74.3% vs 77.0%), establishing a higher absolute ceiling for symptomatic gain. This near-complete functional normalisation in the most severely affected patients underscores the transformative potential of PEA when performed at experienced centers, where high preoperative PVR has not precluded excellent functional results in appropriately selected patients.

Conclusions

- In this single-center series of 183 consecutive CTEPH patients undergoing pulmonary endarterectomy, preoperative haemodynamic severity defined by PVR ≥ 800 dyn·s·cm^{-5} was associated with significantly greater functional class improvement after surgery, while postoperative haemodynamic normalisation was equivalent between groups. High preoperative PVR was associated with prolonged mechanical ventilation but did not adversely affect functional recovery, hospital course, or early mortality.
- These findings support the referral of CTEPH patients with severe haemodynamic impairment to experienced surgical centres, where PEA can be performed with acceptable risk and excellent functional outcomes across the full spectrum of disease severity.
- Pulmonary endarterectomy provides substantial clinical benefit even in patients with severe pulmonary hypertension, reinforcing the importance of timely surgical intervention in this high-risk population.



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