JSCAI
The official journal of the Society for Cardiovascular Angiography & Interventions

Editorial

Balloon Pulmonary Angioplasty: Tackling the Unmet Need

Richard Tanner, MD [a], Khanjan Shah, MD [b], Amit Hooda, MD [a,*]

[a] *Division of Cardiology, Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, New York;* [b] *Division of Cardiovascular Medicine, University of Florida, Gainesville, Florida*

Chronic thromboembolic pulmonary hypertension (CTEPH), a long-term sequela of recurrent or unresolved pulmonary thrombi, represents a formidable clinical challenge with associated high morbidity and mortality.[1] It is estimated to complicate 2% to 4% of acute pulmonary emboli and is characterized by nonresolving thromboemboli, which lead to intraluminal obstruction and remodeling of the pulmonary vasculature (fibrotic transformation).[2,3] When clinically feasible, surgical pulmonary endarterectomy (PEA) is the gold standard of treatment[4]; however, 37% to 80% of patients are deemed inoperable due to frailty, anatomical limitations (eg, distal lesions), right ventricular dysfunction, severe pulmonary hypertension (PH), and other comorbidities.[1,2,4] Furthermore, PEA is limited to large metropolitan areas with expert CTEPH teams.

Balloon pulmonary angioplasty (BPA) is an attractive and less invasive approach for treating inoperable, high-risk CTEPH cases. It is also an adjunctive therapy option for patients with residual PH after PEA.[1,5] BPA aims to reestablish flow within the pulmonary vasculature using low-pressure, semicompliant balloons. Appropriate patient selection for BPA is critical and requires a thorough assessment by the multidisciplinary team (those with expertise in PH, pulmonary imaging, PEA, and BPA).[1]

BPA was first reported in a small patient series in 2001[6]; however, the high rate of complications associated with initial cases limited the widespread adoption of BPA. Subsequently, a 2012 paper by Mizoguchi et al[7] demonstrated significant hemodynamic improvements after BPA, with a more acceptable rate of complications, reigniting interest in BPA globally. BPA has since proven to be more effective than riociguat in reducing mean pulmonary artery pressure and pulmonary vascular resistance in 2 randomized control trials.[8,9] The results of the RACE trial (BPA vs riociguat for the treatment of inoperable CTEPH) also support the initiation of riociguat in advance of BPA to mitigate complications[8]; however, BPA remains underutilized, and significant variations exist in access to BPA across the world.

Based on the increasing evidence that BPA is effective in reducing mean pulmonary artery pressure, pulmonary vascular resistance, and improving quality of life, the European Society of Cardiology/European Respiratory Society guidelines now recommend BPA as a Class I treatment for inoperable CTEPH and residual chronic thromboemboli causing PH.[4] Furthermore, the American Heart Association recently published a consensus document to address the gap in the current clinical practice of BPA and provide a consensus opinion on the role of BPA in the overall care of patients with CTEPH with and without PH.[1]

For BPA, standard coronary intervention equipment is generally used. The dedicated B-pahm wire (Japan Lifeline) is not available in Europe or the United States. Typically, a nonhydrophilic, soft-tip 0.014-inch coronary wire is used as the first choice.[1] Extreme caution is needed with hydrophilic and heavy tip load wires, especially distal wire tip management, to avoid vessel perforation. Further steps to mitigate procedural complications include the use of adjunctive imaging to accurately size balloons and staging treatment over multiple sessions with sequential dilatation of lesions with larger balloons.[4]

In this issue of *JSCAI*, Perkins et al[10] demonstrate a proof-of-concept study focused on mechanistic considerations for the development of an ideal catheter-based strategy for BPA that minimizes the risk of pulmonary artery perforation. Through analysis of 26 histopathological samples procured during the PEA of 9 patients, the authors aimed to identify the differential force required to penetrate a CTEPH lesion vs the pulmonary arterial wall. The authors determined that although the pulmonary arterial wall of these samples is friable, a significantly higher force is needed to perforate the arterial wall vs cross CTEPH lesions. Furthermore, the inadequacy of standard 0.014-inch workhorse wires to penetrate the CTEPH lesions was demonstrated. The authors conclude that specific guide wires and devices should be able to function within a discrete therapeutic safety window to allow for lesion crossing with minimal risk.

The authors should be congratulated for their line of investigation that attempts to answer a clinically relevant question from bench to bedside. Translational research is equal parts onerous and necessary. Practicing cardiologists and surgeons who understand firsthand the limitations and safety considerations of current devices should feel empowered to lead research like this for continued innovation and improvement in quality of care.

DOI of original article: https://doi.org/10.1016/j.jscai.2024.102142.
Keywords: balloon pulmonary angioplasty; chronic thromboembolic pulmonary disease; pulmonary embolism; pulmonary endarterectomy; pulmonary hypertension.
* Corresponding author: amit.hooda@mountsinai.org (A. Hooda).

https://doi.org/10.1016/j.jscai.2024.102236
Received 3 June 2024; Accepted 17 June 2024
Available online 15 July 2024

Overall, BPA offers a potential alternative management option for inoperable and residual PH in CTEPH patients, although further refinement of techniques, with the development of dedicated interventional tools, will go a long way toward improving safety and efficacy. It should only be offered initially at dedicated centers of excellence after careful selection of patients by a multidisciplinary team approach. Furthermore, randomized controlled trials of BPA with long-term clinical follow-up are required to address the present knowledge gaps.

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding sources

This work was not supported by funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Aggarwal V, Giri J, Visovatti SH, et al. Status and future directions for balloon pulmonary angioplasty in chronic thromboembolic pulmonary disease with and without pulmonary hypertension: a scientific statement from the American Heart Association. *Circulation*. 2024;149(15):e1090–e1107. https://doi.org/10.1161/CIR.0000000000001197
2. Lloji A, Hooda U, Sreenivasan J, Malekan R, Aronow WS, Lanier GM. Balloon pulmonary angioplasty for chronic thromboembolic pulmonary hypertension. *Am J Cardiovasc Dis*. 2021;11(3):330–347.
3. Pengo V, Lensing AWA, Prins MH, et al. Incidence of chronic thromboembolic pulmonary hypertension after pulmonary embolism. *N Engl J Med*. 2004;350(22):2257–2264. https://doi.org/10.1056/NEJMoa032274
4. Humbert M, Kovacs G, Hoeper MM, et al. 2022 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension. *Eur Heart J*. 2022;43(38):3618–3731. https://doi.org/10.1093/eurheartj/ehac237
5. Yang J, Madani MM, Mahmud E, Kim NH. Evaluation and management of chronic thromboembolic pulmonary hypertension. *Chest*. 2023;164(2):490–502. https://doi.org/10.1016/j.chest.2023.03.029
6. Feinstein JA, Goldhaber SZ, Lock JE, Ferndandes SM, Landzberg MJ. Balloon pulmonary angioplasty for treatment of chronic thromboembolic pulmonary hypertension. *Circulation*. 2001;103(1):10–13. https://doi.org/10.1161/01.cir.103.1.10
7. Mizoguchi H, Ogawa A, Munemasa M, Mikouchi H, Ito H, Matsubara H. Refined balloon pulmonary angioplasty for inoperable patients with chronic thromboembolic pulmonary hypertension. *Circ Cardiovasc Interv*. 2012;5(6):748–755. https://doi.org/10.1161/CIRCINTERVENTIONS.112.971077
8. Jaïs X, Brenot P, Bouvaist H, et al. Balloon pulmonary angioplasty versus Riociguat for the treatment of inoperable chronic thromboembolic pulmonary hypertension (RACE): a multicentre, phase 3, open-label, randomised controlled trial and ancillary follow-up study. *Lancet Respir Med*. 2022;10(10):961–971. https://doi.org/10.1016/S2213-2600(22)00214-4
9. Kawakami T, Matsubara H, Shinke T, et al. Balloon pulmonary angioplasty versus Riociguat in inoperable chronic thromboembolic pulmonary hypertension (MR BPA): an open-label, randomised controlled trial. *Lancet Respir Med*. 2022;10(10):949–960. https://doi.org/10.1016/S2213-2600(22)00171-0
10. Perkins SJ, Funes M, Cheah D, et al. Safety window for effective lesion crossing in patients with chronic thromboembolic pulmonary hypertension. *J Soc Cardiovasc Angiogr Interv*. 2024;3:102142. https://doi.org/10.1016/j.jscai.2024.102142