ELSEVIER

The Journal of
Heart and Lung
Transplantation

http://www.jhltonline.org

RESEARCH CORRESPONDENCE

Intravascular imaging-guided percutaneous transluminal pulmonary angioplasty for peripheral pulmonary stenosis and pulmonary Takayasu arteritis

Ryoji Yanagisawa, MD,[a,1]
Masaharu Kataoka, MD,[a,b,1]
Takumi Inami, MD,[a] Keiichi Fukuda, MD,[b]
Hideaki Yoshino, MD,[a] and Toru Satoh, MD[a]

From the [a]Division of Cardiology, Second Department of Internal Medicine, Kyorin University School of Medicine, Tokyo, Japan; and the [b]Department of Cardiology, Keio University School of Medicine, Tokyo, Japan

A catheter-based interventional therapy, known as percutaneous transluminal pulmonary angioplasty (PTPA) or balloon pulmonary angioplasty, was recently developed as a new promising therapeutic strategy for chronic thromboembolic pulmonary hypertension (CTEPH).[1,2] However, the efficacy and safety of this procedure for other diseases similar to CTEPH, such as peripheral pulmonary stenosis (PPS) and pulmonary Takayasu arteritis, have not been established.

In our institution, 145 patients were treated with PTPA from April 2010 to July 2015. Of these patients, the diagnosis was PPS in 7, pulmonary Takayasu arteritis in 4, and CTEPH in the other 134. This study retrospectively analyzed 11 of the 145 patients (7.6%) with PPS or pulmonary Takayasu arteritis who were treated with PTPA. Detailed methods are described in the Supplementary Materials (available on the jhltonline.org Web site). All data are presented as median (interquartile range [25th-75th percentiles]).

Angiography of the patients with PPS or pulmonary Takayasu arteritis revealed specific morphologic features (Supplementary Figure S1, available on the jhltonline.org Web site). Pulmonary angiography before PTPA demon strated significant lesions (red arrowhead in Figure 1A), and optical coherence tomography (OCT) revealed not only abnormally thickened endothelium, unevenly thickened media, and coarctation of external elastic membrane (EEM) but also an intraluminal thrombus fulfilling the lesions. The pressure wire demonstrated a significant impairment of pulmonary blood flow (Figure 1A).

No difference was apparent in OCT findings between PPS and pulmonary Takayasu arteritis before PTPA. After PTPA, OCT revealed mild intraluminal dilation with compression of the thickened endothelium and media and almost complete ablation of the intraluminal thrombus, and the pressure wire demonstrated a significant improvement in pulmonary blood flow. However, there was no clear change in the EEM size by OCT, and pulmonary angiography demonstrated no apparent changes in the stenotic effect of lesions. These important findings suggest that the therapeutic efficacy of PTPA in PPS and pulmonary Takayasu arteritis could be mediated mainly by ablation of the intraluminal thrombus and partially by the intraluminal dilation, with little effect conferred by EEM dilation.

The baseline characteristics and summary of the therapeutic efficacy of PTPA are detailed in Table 1. The median (interquartile range) numbers of PTPA sessions, dilated lesions, and observation periods were 5.0 (3.3–6.5) sessions, 14.0 (8.0–23.0) vessels, and 28.0 (13.5–41.8) months. Mean pulmonary arterial pressure and pulmonary vascular resistance significantly improved after PTPA (Figure 1B), and plasma B-type natriuretic peptide also significantly improved (Figure 1C). The difference in the distribution of New York Heart Association Functional Class between baseline and the latest follow-up ($p = 0.068$). The results of the sub-analysis in patients with PPS only are described in Supplementary Materials (available on the jhltonline.org Web site).

Importantly, the mean PAP after PTPA was 32.9 mm Hg (range, 23.8–41.0 mm Hg) in 11 patients of this study, and half of the cases did not achieve less than 30 mm Hg. In contrast, our previous report demonstrated a mean PAP after PTPA of 21 mm Hg (range, 18–28 mm Hg) in 83 CTEPH patients.[2] These findings suggest that the therapeutic effects of PTPA were smaller for the patients in this study compared with those in CTEPH, possibly due to insufficient EEM dilation, early restenosis (or recoil) of the EEM, or temporarily compressed endothelium and media. Consistent with this apparent variability of efficacy in this study, a previous study reporting the outcomes of balloon angioplasty for 12 adult patients with PPS found that vessel diameter increased by $>$ 50% in 10 patients and right ventricular pressure decreased $>$ 30% in 5 patients,[3] suggesting that balloon angioplasty is not necessarily an established therapeutic strategy for PPS. Furthermore, another study implied the possible usefulness of stent implantation for adult patients with PPS,[4] suggesting that using PTPA for adult PPS and pulmonary Takayasu arteritis is open to dispute about whether balloon angioplasty only is

[1]R.Y. and M.K. contributed equally to this work.

1053-2498/$ - see front matter
http://dx.doi.org/10.1016/j.healun.2015.12.006

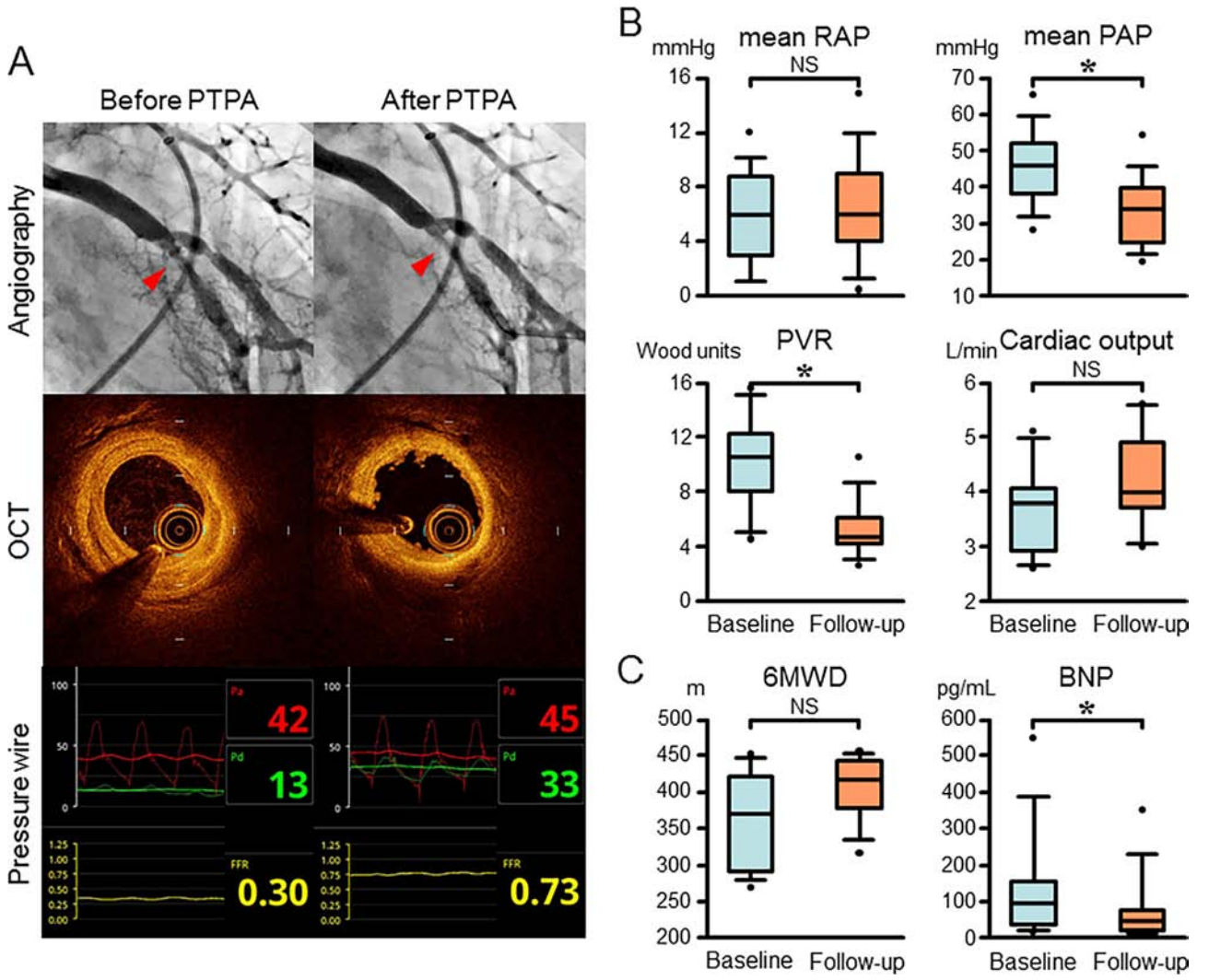

Figure 1 Therapeutic efficacy of intravascular imaging-guided percutaneous transluminal pulmonary angioplasty (PTPA) for peripheral pulmonary stenosis (PPS) and pulmonary Takayasu arteritis. (A) Representative angiography, optical coherence tomography (OCT), and the pressure ratio of the distal-to-proximal pressures across the target lesion shown by pressure wire before and after PTPA. Before PTPA, pulmonary angiography demonstrated significant stenosis at the lesion (indicated by red arrowhead). OCT revealed not only abnormally thickened endothelium, unevenly thickened media, and coarctation of the external elastic membrane (EEM) but also a significant extent of intraluminal thrombus filling within lesions, whereas the pressure wire demonstrated a significantly reduced pressure ratio of 0.30. Importantly, after PTPA, OCT revealed not only mild dilation of the intraluminal dimension due to compression of the thickened endothelium and media but also nearly complete disappearance of the intraluminal thrombus. The pressure wire demonstrated a significant improvement in the pressure ratio to 0.73, although the EEM size was not clearly changed by OCT, and pulmonary angiography demonstrated no apparent changes in stenotic degree of the target lesion. FFR, pressure ratio of the distal-to-proximal pressures across the target lesion; Pa, mean pressure in the proximal area detected by pressure wire; Pd, mean pressure in the distal area across the target lesion. (B) Hemodynamic changes after PTPA in mean right atrial pressure (RAP), mean pulmonary arterial pressure (PAP), pulmonary vascular resistance (PVR), and cardiac output at baseline and at the latest follow-up after PTPA in the 11 enrolled patients with PPS ($n = 7$) or pulmonary Takayasu arteritis ($n = 4$). *$p < 0.05$ (statistically significant difference); NS, no statistically significant difference (baseline vs. latest follow-up after PTPA). Mean PAP and PVR significantly improved after PTPA (mean [interquartile range] PAP, 46 [38–52] vs. 34 [25–40] mm Hg; PVR, 10.5 [8.0–12.3] vs. 4.6 [4.1–6.1] Wood units; baseline vs. follow-up, respectively), but there were no significant differences in mean RAP and cardiac output (mean [interquartile range] RAP, 6.0 [3.0–8.8] vs. 6.0 [4.0–9.0] mm Hg, $p = 0.636$; cardiac output, 3.8 [2.9–4.1] vs. 4.0 [3.7–4.9] liters/min, $p = 0.182$; baseline vs. follow-up, for both). (C) Changes in 6-minute walk distance (6MWD) and plasma B-type natriuretic peptide (BNP) level in the study cohort ($n = 11$). *$p < 0.05$ (statistically significant difference); NS, no statistically significant difference (baseline vs. latest follow-up after PTPA). The 6MWD was analyzed in 10 patients, because 1 patient refused the test due to dyspnea on exertion. Although the median 6MWD tended to be improved, the differences were not statistically significant (371 [292–420] vs. 416 [377–442] m, $p = 0.110$; baseline vs. after PTPA). The levels of BNP significantly improved after PTPA (92.0 [34.1–150.8] vs. 43.8 [17.7–71.6] pg/mL; baseline vs. follow-up, respectively). The horizontal line in the middle of each box indicates the median; the top and bottom borders of the box mark the 75th and 25th percentiles, respectively; and the whiskers mark the 90th and 10th percentiles.