Percutaneous Transluminal Angioplasty and Stenting for Pulmonary Stenosis Due to Takayasu's Arteritis: Clinical Outcome and Four-year Follow-up

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ABSTRACT

Background: Percutaneous transluminal angioplasty and stent implantation for stenotic lesions of renal arteries and other branches of the aorta in Takayasu's arteritis have been reported to show good outcomes. However, this form of therapy has been reported in few cases with pulmonary artery involvement.

Hypothesis: The aim of this study was to evaluate the role of this interventional treatment for pulmonary stenosis due to Takayasu's arteritis.

Methods: A total of 4 patients (3 female and 1 male, ages 30–40 yrs) with Takayasu's pulmonary arteritis underwent percutaneous transluminal balloon angioplasty and stent implantation and were followed up for 1 to 4 years.

Results: One patient underwent balloon angioplasty alone, 3 patients underwent balloon angioplasty and stent implantation. The stenoses were relieved acutely, oxygen saturation improved immediately due to improvement in lung perfusion and relief of dyspnea. The pressure gradient fell from 58.3 ± 8.7 mm Hg to 14 ± 3.2 mm Hg and mean pulmonary arterial pressure decreased from 48.5 ± 12.0 mm Hg to 37.3 ± 6.0 mm Hg. At a follow-up period of 34.5 ± 15.8 months, the patient with balloon angioplasty alone developed a recurrence of symptoms 18 months after the procedure. The other 3 patients continued to be asymptomatic and the stent remained patent without restenosis after the procedure.

Conclusion: Percutaneous transluminal angioplasty and stent implantation is a safe and effective treatment in patients with pulmonary stenosis caused by Takayasu's arteritis.

Introduction

Takayasu's arteritis (TA) is a chronic inflammatory disease which mainly affects the aorta and its major branches. The management strategies for TA include medical therapy with steroids or immunosuppressive agents and revascularization procedures. During the active phase of the disease, steroids have been shown to improve the systemic inflammatory symptoms within a few days to weeks. In the chronic stage, the principle treatment is revascularization of the affected organ. Percutaneous transluminal angioplasty (PTA) and stent implantation have been successfully used to relieve stenotic lesions of the aorta and its branches, and can improve long-term outcomes.[1,2] However, reports about PTA and stenting for pulmonary stenosis due to TA are limited. In this article, we describe interventional therapy including PTA and stent implantation for 4 patients with TA involving the pulmonary artery and present the follow-up results.

Methods

Patients

A total of 4 patients (3 female and 1 male) with pulmonary arterial stenoses due to TA underwent PTA and stent implantation at our center. Exertional dyspnea and edema of both lower limbs appeared in all patients. A classification of New York Heart Association (NYHA) class III was found in 3 patients and a NYHA class IV in 1 patient. Lung scan showed multiple bilateral perfusion defects. Computed tomography (CT) angiography showed thickness of the arterial wall and occlusion or stenoses of multiple pulmonary arterial branches. Catheterization and angiography reconfirmed the stenoses and severe pulmonary hypertension. Medical records, hemodynamics, and angiograms are summarized in this article.

Catheterization Procedure

Informed, written consent was obtained from each patient. Using the Seldinger technique, an 8 French (Fr) sheath was positioned in the femoral vein and a 5 Fr in the femoral artery. A 5 Fr diagnosis catheter (Cordis Corporation,) was used to obtain right-sided and left-sided hemodynamics and to perform pulmonary and aortic angiography. The pigtail catheter was passed through the stenotic lesion over a 0.035. Amplatz extrastiff guide wire (Boston Scientific Corporation, St. Paul, MN) and the pressure gradient across the stenosis was measured. An 8 Fr delivery catheter (MP A1, Cordis Corporation, Warren, NJ) was advanced to the target area

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over the extrastiff guide wire. The balloon diameters were chosen to match the normal vessel adjacent to the stenoses. After graded balloon dilation of the stenotic lesions, stents were implanted. Then pulmonary pressure was measured again. The patients were given 5000 IU of heparin during the procedure. Aspirin and/or clopidogrel started before the procedure, was continued for 3 to 6 months after discharge for those with a stent.

Results

There were 3 women and 1 man, with a median age of 32 years (range, 30–40 yrs). See Table 1 for the case history, clinical characteristics, and laboratory test results of the patients. Case 4 had an increased erythrocyte sedimentation rate (ESR) of 45 mm/h when she first came to our center; she was administered corticosteroid for 6 months. All the patients had a normal ESR when procedures were performed.

An aortogram showed that the aorta and its major branches were normal in all patients. Pulmonary angiogram showed occlusion of the right dorsal and medial basal segment artery and stenosis of the left lower pulmonary artery in case 1. Case 2 presented with occlusion of the right upper pulmonary artery and left upper pulmonary artery, and severe stenosis at the beginning of the right lower pulmonary artery trunk (Figure 1). Occlusion of the right lower pulmonary artery and left lingual lobar artery, and severe stenosis of the left lower pulmonary artery was seen in case 3; and occlusion of the right pulmonary artery and severe stenosis at the beginning of the left lower pulmonary artery was seen in case 4. After the procedure, repeated angiogram showed that the stenoses were relieved (Figure 2). The pressure gradient across the stenosis decreased from 58.3 ± 8.7 mm Hg to 14 ± 3.2 mm Hg, mean pulmonary arterial pressure decreased from 48.5 ± 12.0 mm Hg to 37.3 ± 6.0 mm Hg, and arterial oxygen saturation increased from 90% ± 0.8% to 94% ± 0.8%. There was no complication associated with interventional therapy. All the patients were administered oral corticosteroid.

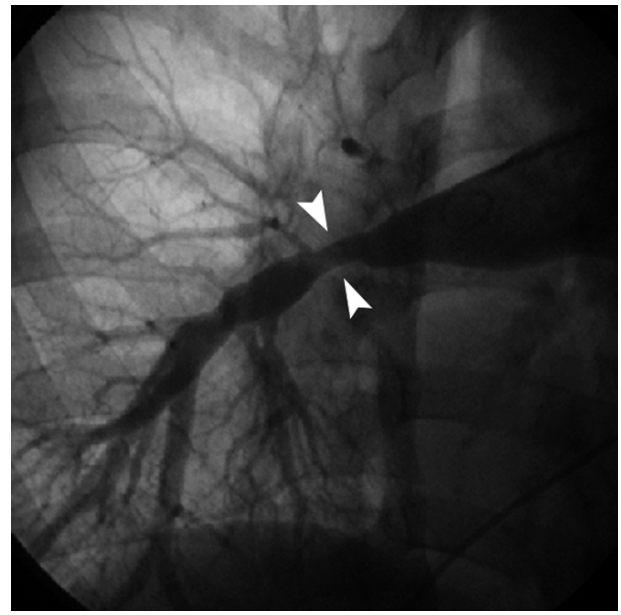

Figure 1. Selective right pulmonary angiograms showed the severe stenosis at the beginning of the right inferior pulmonary artery trunk (arrow), complete occlusion in the right upper pulmonary artery, and mild stenosis at the beginning of the right inferior branches.

Table 1. Clinical Features of All Patients

Case	1	2	3	4
Gender	F	M	F	F
Age (yrs)	30	30	40	34
Course (yrs)	4	2	8	2
HT history	N	N	N	N
Cyanosis	Y	Y	Y	Y
Arterial pulsation	symmetry	symmetry	symmetry	symmetry
NYHA	III	III	IV	III
ESR (mm/h)	7	15	8	1
CRP (mg/dL)	2.3	3.3	4.9	1.99
Serological markers[a]	(–)	(–)	(–)	(–)
Urinary sediment	(–)	(–)	(–)	(–)
Period of follow-up	48 mo	40 mo	36 mo	12 mo

Abbreviations: CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; HT, hypertension; N, no; NYHA, New York Heart Association; SPAP, systolic pulmonary artery pressure; Y, yes; (–), negative.
[a]Serological markers: serological markers of connective diseases, including antinuclear antibody, anti-dsDNA antibody, anti-extractable nuclear antigen antibodies, antineutrophilic cytoplasmic antibodies, anticentromere antibodies, antiphospholipid antibodies, and so forth.

The patients were followed up for 1 to 4 years. After discharge, cases 2 and 3 withdrew from corticosteroid treatment by themselves. The erythrocyte sedimentation rate was elevated in both patients 1 to 1.5 years after the procedure, they restarted oral corticosteroid and ESR became normal. Case 4 took corticosteroid regularly and had a normal ESR. On follow-up, these 3 patients had a NYHA class I. A CT 3 years later in cases 2 and 3 and 1 year later in case 4 showed that the stents were all fully patent and well positioned (Figure 3). Ultracardiography showed that systolic pulmonary artery pressures were all decreased and a lung scan showed perfusion greatly improved. Case 1, with just angioplasty, had a recurrence of dyspnea 18 months

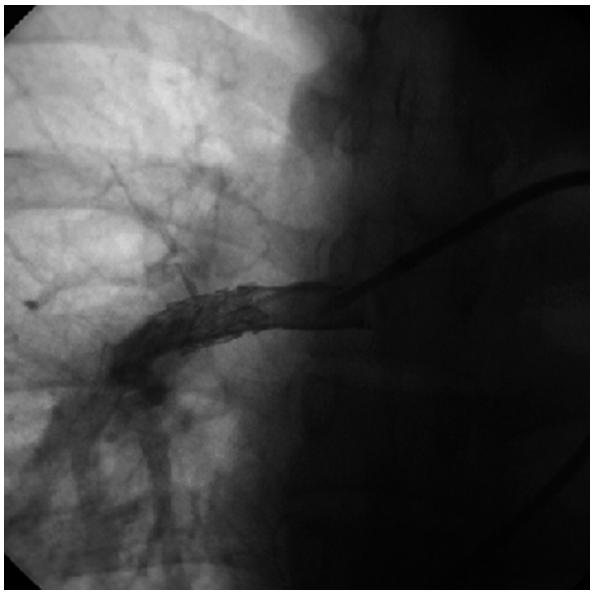

Figure 2. Angiogram after a self-expanding JOSTENT stent (8 mm × 1.7 cm, JoMed, Rangendingen, Germany) was implanted showed the stenosis disappeared.

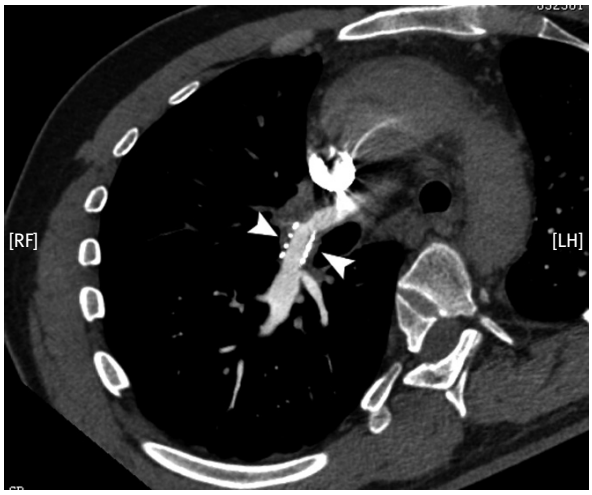

Figure 3. Multiplain reconstruction (MPR) image of CT showed a good adhesion with the wall of the vessel and no restenosis on follow-up 3 years after stent implantation (arrow).

later, and had NYHA functional class of II and III at the end of follow-up. She did not agree to undergo further angioplasty and was still on corticosteroid.

Discussion

Takayasu's arteritis is a progressive inflammatory disease mainly involving the media and adventitia, with secondary intimal hyperplasia, leading to wall thickening, luminal stenosis, and occlusion.[3] Pulmonary artery involvement in Takayasu's arteritis is well-known, the incidence has been reported from 14% to 86%.[4–6] However, it usually accompanies aortic involvement. Isolated pulmonary involvement was rarely reported.[7–11] In the classification of Takayasu's arteritis, concomitance with the pulmonary artery is described as IV type.[12] We diagnosed these patients with isolated Takayasu's pulmonary arteritis according to the following points: (1) onset age was young. According to the American College of Rheumatology Criteria for the Classification of Takayasu's Arteritis, a main criterion was onset age $\leqslant 40$ years;[13] (2) pulmonary angiographic findings were consistent with Takayasu's arteritis, which presented with vessel wall thickness and narrowing and occlusion of the vessel lumen;[12] (3) there was no evidence of other systemic vasculitises. Urinary sediment was normal and serological markers of connective diseases were negative.

Patients are usually asymptomatic because of only pulmonary artery involvement, which leads to delayed diagnosis. Progressive dyspnea, fatigue, or hemoptysis may occur until pulmonary artery hypertension and right heart failure develops as a late complication. At this phase, medical therapy alone was not actually effective. Blood flow reconstruction was needed to improve symptoms. To restore pulmonary blood flow, surgical revascularization of severe stenosis due to pulmonary arteritis by reconstruction, patch enlargement, or bypass of the obstructed pulmonary arteries has been reported in few cases.[10,11,14] However, the problems of these surgical procedures including graft reocclusion, anastmotic site aneurysm, and morbidity have precluded the widespread use of reconstructive surgery. Kreutzer et al[15] performed balloon dilation of multiple vessels in 11 patients. The authors suggested that balloon dilation offered successful short-term reduction in right ventricular hypertension and alleviation of symptomatology. Rothman et al[16] reported that 4 adult patients with multiple intralobar pulmonary arterial stenoses all responded acutely to balloon angioplasty and stent placement. In our series, 4 patients were shown to be acutely successful after the procedure. Three patients with stent placement had sustained improvement of symptoms in long-term follow-up (Table 2).

In the interventional treatment of pulmonary arteritis, some problems remain unclear, such as indications and timing of interventional procedure. We think that the below points are critical. First, selecting the timing of the procedure: PTA and stent implantation should not be performed at the stage of active inflammation. Pack et al[17] observed that the restenosis rate was lower when vascular interventions were performed at the stable stage of TA. Second, selecting proper balloon and stent: balloon inflation at high pressure is required for rigid stenotic lesions in pulmonary arteritis. In order to avoid vascular damage,

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Table 2. Hemodynamic and Angiographic Parameters Preprocedure and Postprocedure and During Follow-up

Case	1	2	3	4
Vessel of angioplasty	LLA	RPA	LLA	LLA
Interventional procedure	Balloon	Balloon/stent	Balloon/stent	Balloon/stent
Stent type	. . .	JOSTENT (JoMed, Germany)	EV3 (EV3,)	PRECISE (Cordis,)
Size of stent	. . .	8 mm × 1.7 cm	10 mm × 4.0 cm	9 mm × 3.0 cm
Preangioplasty				
PG (mm Hg)	54	52	56	71
PAP (S/D/M) (mm Hg)	110/30/55	82/9/34	95/36/61	100/16/44
Postangioplasty				
PG (mm Hg)	15	11	12	18
PAP (S/D/M) (mm Hg)	106/26/52	56/14/23	65/22/34	78/14/36
SPAP on admission (mm Hg)	60	115	65	80
SPAP on follow-up (mm Hg)	72	72	55	56

Abbreviations: D, diastolic pulmonary artery pressure; LLA, left lower artery; M, mean pulmonary artery pressure; PAP, pulmonary artery pressure; PG, pressure gradient across stenosis; RPA, right pulmonary artery; S, systolic pulmonary artery pressure; SPAP, systolic pulmonary artery pressure measured by ultracardiography.

matched balloons should be selected and pressure increased step-by-step. Self-expanding stents had some characteristics such as invulnerability to compression, precise deployment and high-vessel wall surface coverage, which may be advantageous for maintaining vessel patency.[18] Hence, after self-expanding stents came to our hospital, they were selected in subsequent patients. Third, corticosteroid maintenance and regular follow-up: As TA is a progressive inflammatory disease, corticosteroid and regular follow-up are needed to prevent restenosis and new lesions.

In conclusion, for patients with severe pulmonary hypertension due to Takayasu's pulmonary arteritis, PTA and stent implantation may be a safe and effective reconstruction procedure. After the procedure, patients should be regularly followed up and given proper medication.

References

1. Tyagi S, Verma PK, Gambhir DS, Kaul UA, Saha R, Arora R. Early and long-term results of subclavian angioplasty in aortoarteritis (Takayasu disease): comparison with atherosclerosis. *Cardiovasc Intervent Radiol*. 1998;21:219–224.
2. Min PK, Park S, Jung JH, et al. Endovascular therapy combined with immunosuppressive treatment for occlusive arterial disease in patients with Takayasu's arteritis. *J Endovasc Ther*. 2005;12:28–34.
3. Hotchi M: Pathological studies on Takayasu arteries. *Heart Vessels Suppl*. 1992;7:11–17.
4. Yamada I, Shibuya H, Matsubara O, et al. Pulmonary artery disease in Takayasu's arteritis: angiographic findings. *Am J Roentgenol*. 1992;159:263–269.
5. Liu YQ, Jin BL, Ling J. Pulmonary artery involvement in aortoarteritis: an angiographic study. *Cardiovasc Interv Radiol*. 1994;17:2–6.
6. Elsasser S, Solér M, Bolliger C, Jäger K, Steiger U, Perruchoud AP. Takayasu disease with predominant pulmonary involvement. *Respiration*. 2000;67:213–215.
7. Hayashi K, Nagasaki M, Matsunaga N, Hombo Z, Imamura T. Initial pulmonary artery involvement in Takayasu arteritis. *Radiology*. 1986;159:29–40.
8. Brugiere O, Mal H, Sleiman C, Groussard O, Mellot F, Fournier M. Isolated pulmonary arteries involvement in a patient with Takayasu's arteritis. *Eur Respir J*. 1998;11:767–770.
9. Hara M, Sobue R, Ohba S, et al. Diffuse pulmonary lesions in early phase of Takayasu arteritis predominately involving pulmonary artery. *J Comput Assist Tomogr*. 1998;22:801–803.
10. Yamazaki I, Ichikawa Y, Ishii M, Hamada T, Kajiwara H. Surgical case of isolated pulmonary Takayasu's arteritis. *Circ J*. 2005;69:500–502.
11. Nakajima N, Masuda M, Imamaki M, Ishida A, Tanabe N, Kuriyama T. A case of pulmonary artery bypass surgery for a patient with isolated Takayasu pulmonary ateritis and a review of literature. *Ann Thorac Cardiovasc Surg*. 2007;13:267–271.
12. Hata A, Noda M, Moriwaki R, Numano F. Angiographic findings of Takayasu arteritis new classification. *Int J Cardiol*. 1996;54(suppl):S155–163.
13. Arend WP, Michel BA, Bloch DA, et al. The American College of Rheumatology 1990 criteria for the classification of Takayasu arteritis. *Arthritis Rheum*. 1990;33:1129–1134.
14. Shikata H, Sakamoto S, Ueda Y, et al. Reconstruction of bilateral branch pulmonary artery stenosis caused by Takayasu's aortitis. *Circ J*. 2004;68:791–794.
15. Kreutzer J, Landzberg MJ, Preminger TJ, et al. Isolated peripheral pulmonary artery stenoses in the adult. *Circulation*. 1996;93:1417–1423.

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DOI:10.1002/clc.20665

16. Rothman A, Levy DJ, Sklansky MS, et al. Balloon angioplasty and stenting of multiple intralobar pulmonary arterial stenoses in adult patients. *Catheter Cardiovasc Interv*. 2003;58: 252–260.
17. Park MC, Lee SW, Park YB, Lee SK, Choi D, Shim WH. Post-interventional immunosuppressive treatment and vascular restenosis in Takayasu's arteritis. *Rheumatology*. 2006;45: 600–605.
18. Verheye S, Salame MY, Robinson KA, et al. Short- and long-term histopathologic evaluation of stenting using a self-expanding nitinol stent in pig carotid and lilac arteries. *Catheter Cardiovasc Interv*. 1999;48:316–323.

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