

Stenosis or Occlusion of the Right Subclavian and Common Carotid Arteries Is More Common than That of the Innominate Artery in Takayasu Arteritis

Bong Won Park¹, Sang Jun Park¹, Hojong Park¹, Jae Chol Hwang², Young Woo Seo², and Hong Rae Cho¹

Departments of ¹Surgery and ²Radiology, Ulsan University Hospital, University of Ulsan College of Medicine, Ulsan, Korea

Purpose: The aim of this study was to introduce the phenomenon that stenosis or occlusion occurs less frequently in the innominate artery than in the right subclavian and common carotid arteries, which are not first-order branches of the aorta, in Takayasu arteritis (TA).

Materials and Methods: We retrospectively reviewed the medical records and image findings of all patients who were diagnosed with TA from 2006 to 2014. Two vascular surgeons and two radiologists interpreted the images by disease character, location, and extent of occlusion based on computed tomography angiography, magnetic resonance angiography, or digital subtraction arteriography. We have also reviewed the literature on arterial involvement in TA.

Results: A total of 42 patients were diagnosed with TA. The mean age was 43.9 years, and 83.3% (35/42) of the patients were women. The left subclavian artery was the most common stenosis or occlusion site (17, 40.5%) among the aortic branches. The innominate artery was a less common site (3, 7.1%) than the right subclavian artery (4, 9.5%) and the right common carotid artery (9, 21.4%). All innominate artery cases were found after endovascular procedures of the right subclavian or common carotid arteries.

Conclusion: The innominate artery might develop stenosis or occlusion less frequently than the right subclavian and common carotid arteries in Korean TA patients.

Key Words: Takayasu arteritis, Brachiocephalic trunk, Aorta, Pathologic constriction, Cerebrovascular disorders

Received August 14, 2015

Revised September 12, 2015

Accepted September 14, 2015

Corresponding author: Sang Jun Park

Department of Surgery, Ulsan University Hospital, University of Ulsan College of Medicine, 877 Bangeojinsunwhan-doro, Dong-gu, Ulsan 44033, Korea
Tel: 82-52-250-7109

Fax: 82-52-250-7350

E-mail: ud3012md@medimail.co.kr

Conflict of interest: None.

Copyright © 2015, The Korean Society for Vascular Surgery

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Vasc Spec Int 2015;31(4):120-124 • <http://dx.doi.org/10.5758/vsi.2015.31.4.120>

INTRODUCTION

Takayasu arteritis (TA) is a rare chronic inflammatory disease characterized by pan-arteritis of the aorta and its main branches. Although rare, it is an important disease in Korea owing to its relatively high prevalence in Asia and the young age of patients at its onset [1]. The etiology

and pathogenesis of this disease is not yet fully known [2]. The clinical features, which are slightly different in each country, are not well-known because of the rarity of this disease [3]. The following was an incidental finding in our hospital; innominate artery stenosis or occlusion occurred less frequently than stenosis or occlusion of the right subclavian artery or right common carotid artery in

TA patients. This finding was very interesting because the right subclavian artery and right common carotid artery are not first-order branches of the aorta. We investigated patients with TA at our institution and evaluated their arterial stenosis or occlusion patterns. We also reviewed the literature on TA.

MATERIALS AND METHODS

We retrospectively reviewed the medical records from the database of all patients diagnosed with or managed for TA from March 2006 to December 2014 in Ulsan University Hospital (Ulsan, Korea). Diagnosis was confirmed after reviewing medical records and imaging studies of patients who were diagnosed with TA with an International Classification of Diseases code M34. We also applied the criteria of the American College of Rheumatology 1990 to further confirm the diagnosis [4]. This study was approved by institute review board of Ulsan University Hospital (IRB No. 2015-06-018).

Imaging studies of the arteries were reviewed by two vascular surgeons and two radiologists. An arterial lesion was defined as luminal narrowing or occlusion of the aorta and its major branches, or aneurysmal changes on computed tomography (CT) angiography, magnetic resonance angiography, or conventional arteriography. For the coronary arteries, coronary CT arteriography scans or conventional coronary arteriography findings were used. Left and right arteries were considered separately.

We also conducted a comprehensive review of the literature for English articles published between 1966 and 2014. The keyword for searching the PubMed database was "Takayasu arteritis." We also manually searched the references of the selected articles for any relevant articles that we could find on arterial stenosis or occlusion patterns and the race or country of origin of TA patients.

Table 1. Demographic data and clinical characteristics (n=42)

Characteristic	Data
Age (y)	43.9 (5-75)
Gender, female	35 (83.3)
Aneurysmal change	4 (9.5)
Arterial stenosis	42 (100)
Arterial occlusion	31 (73.8)
Use of immunosuppressants	36 (85.7)
Invasive treatment ^a	8 (19.1)

Values are presented as mean (range) or number (%).

^aThe treatments were undergone only in our institute, and they involved aneurysm resection, arterial bypass, endovascular treatment or a combination of them.

RESULTS

During the study period, 44 patients with TA were identified, and 42 patients were investigated after excluding two patients with an unclear diagnosis. The demographic and clinical features of the patients are summarized in Table 1. The mean age of the patients was 43.9 years (range 5-75 years), and 35 of the patients (83.3%) were women. All of the patients had at least one arterial stenosis or occlusion in the aorta or its main branches. Four patients (9.5%) had aneurysmal changes. Thirty-six patients (85.7%) had taken immunosuppressants such as steroids, methotrexate, or azathioprine. The others had never taken immunosuppressants because they were diagnosed with TA when they were older and were not showing any disease activity.

Eight patients (19.1%) underwent invasive treatments such as aneurysm resection, arterial bypass, or endovascular surgery in our hospital. Six patients who underwent invasive treatment had at least two target lesions to correct. The arterial stenoses or occlusions in the TA patients are shown in Table 2. The affected arteries included 5 coronary arteries, 3 innominate arteries, 4 right subclavian arteries, 9 right common carotid arteries, 11 left common carotid arteries, 17 left subclavian arteries, 2 celiac arteries, 2 superior mesenteric arteries, 1 inferior mesenteric artery, 6 renal arteries (all with bilateral involvement), and 0 iliac

Table 2. Arterial stenosis or occlusion and involvement of aortic segment in Takayasu arteritis (n=42)

Involved artery	Number (%)
Coronary artery	5 (11.9)
Innominate artery ^a	3 (7.1)
Right subclavian artery ^a	4 (9.5)
Right common carotid artery ^a	9 (21.4)
Left common carotid artery	11 (26.2)
Left subclavian artery	17 (40.5)
Celiac artery	2 (4.8)
Superior mesenteric artery	2 (4.8)
Renal artery ^b	6 (14.3)
Inferior mesenteric artery	1 (2.4)
Iliac artery	0 (0)
Ascending aorta	0 (0)
Aortic arch	0 (0)
Descending aorta	17 (40.5)
Abdominal aorta	9 (21.4)
Total	86

^aAll innominate arteries were simultaneously involved with the right subclavian or carotid arteries; ^ball renal arteries were involved on both sides.

Table 3. Arterial involvement patterns of Takayasu arteritis

Year	Country	Case (n)	Most common aortic branch	Most common aortic segment	Least common aortic segment	Innominate artery involvement	Reference
2013	United States	126	LCA	Infrarenal aorta	Aortic arch	25%	Schmidt et al. [15]
2012	United States	62	LSA	Thoracic aorta	Abdominal aorta	Unknown	Grayson et al. [5]
2011	France	82	CCA	Abdominal aorta	Aortic arch	28%	Arnaud et al. [16]
2007	Korea	85	CCA	DTA	Ascending aorta	70% ^a	Chung et al. [13]
2007	United States	75	Abdominal aorta	Unknown	Unknown	Unknown	Maksimowicz-McKinnon et al. [22]
2005	Korea	108	SA	DTA	Ascending aorta	3%	Park et al. [6]
2005	Italy	104	LSA	DTA	Aortic arch	8%	Vanoli et al. [7]
2004	Turkey	45	Unknown	Unknown	Unknown	Unknown	Ureten et al. [17]
1998	India	10	Renal artery	Abdominal aorta	Ascending aorta	20%	Sharma et al. [9]
1997	India/Japan	182	CCA	DTA	Aortic arch	Unknown	Moriwaki et al. [12]
1996	Japan	182	CCA	DTA	Aortic arch	20%	Hata et al. [11]
1996	India	106	Renal artery	DTA	Ascending aorta	Unknown	Jain et al. [8]
1995	Kuwait	13	Unknown	Unknown	Unknown	Unknown	el-Reshaid et al. [23]
1992	Israel	50	Unknown	Unknown	Unknown	Unknown	Rosenthal et al. [24]
1992	Japan	2,738	Unknown	Unknown	Unknown	Unknown	Koide [25]
1985	United States	32	Renal artery	Unknown	Unknown	43%	Hall et al. [10]
1983	Sweden	15	Unknown	Unknown	Unknown	Unknown	Waern et al. [26]
1977	Mexico	107	Abdominal aorta	Abdominal aorta	Ascending aorta	Unknown	Lupi-Herrera et al. [14]

LCA, left carotid artery; LSA, left subclavian artery; CCA, common carotid artery; DTA, descending thoracic aorta; SA, subclavian artery.

^aThey counted arterial wall thickness as well as arterial stenosis or occlusion.

arteries. All innominate artery cases were diagnosed as arterial stenosis after endovascular procedure for right subclavian artery or right common carotid artery, branches of the innominate artery.

We reviewed 18 papers to investigate the arterial involvement of TA and the results are summarized in Table 3. There were 13 papers from which we could identify the most common affected aortic branch arteries and 11 papers which reported the affected aortic segment. Three papers (from the United States, Korea, and Italy) reported that the left subclavian artery was the most commonly affected artery among a total of 274 patients [5-7]. Three other papers (from the United States and two from India) reported that the renal artery was most commonly affected among a total of 146 patients [8-10]. Two papers (from Japan and India) reported that the common carotid artery was the most commonly affected site among a total of 364 patients [11,12]. There were 10 papers from which we could identify the most commonly affected aortic segment. Six of the 10 papers reported the descending aorta was the most commonly affected aortic segment [6-8,11-13]. Five out of the 10 papers reported that the ascending aorta was the least commonly affected aortic segment [6,8,9,13,14]. We could identify the frequency of innominate artery involvement in eight papers. The innominate artery was

involved in 3% (Korea) [6], 8% (Korea, only occlusion cases) [13], 8% (Italy) [7], 20% (India) [9], 20% (Japan) [11], 25% (United States) [15], 28% (France) [16], and 43% (United States) [10]. Two Korean papers and one Italian paper showed that the right subclavian artery and right carotid artery were more commonly affected by stenosis or occlusion than the innominate artery [6,7,13]. We could not find any other papers reporting the comparison between the frequencies of stenosis or occlusion of the innominate, right subclavian and common carotid arteries.

DISCUSSION

TA is a very rare disease, and its incidence and arterial involvement pattern vary depending on ethnicity and nationality [5,9,12,13,16-18]. We had an interest in the arterial stenosis or occlusion patterns of this disease because TA is known to affect the aorta and its main branches, but in our study, stenosis or occlusion of the innominate artery was less common (3 patients, 7.1%) than the right subclavian artery (4, 9.5%) and the right common carotid artery (9, 21.4%); the innominate artery was spared as a first-order aortic branch (Fig. 1).

The three innominate artery cases of our study occurred after stent insertion at other hospitals. Previously published



Fig. 1. Magnetic resonance angiogram shows stenosis of the right common carotid artery (white arrow), patent innominate artery (white arrowhead), and complete occlusion of the left common carotid artery (black arrow).

studies have reported high restenosis or occlusion rates after endovascular procedures performed on patients with TA [1,19,20]. We suspect that the innominate artery occlusions might have occurred because of previous endovascular procedures for the right subclavian artery or the right common carotid artery.

According to reports from Japanese populations and Caucasian populations in France, innominate artery involvement accounted for approximately 30% of cases; they did not show innominate-artery sparing compared to involvement of the right subclavian or common carotid arteries [11,16]. Park et al. [6] reported that the innominate artery was less frequently (3%) affected in Korean patients with TA than the right subclavian artery (48%) and the right common carotid artery (31%). Vanoli et al. (Italy) [7] also reported that the innominate artery (8%) was involved less frequently than the right subclavian artery (30%) and the right carotid artery (23%).

Some papers have reported that involvement of the innominate artery was common [13,21]. However, Chung et al. [13] included even pathologic changes of the arterial wall on CT scan as involvement, while Park et al. [6] and our group only counted lesions with stenosis or occlusion.

In the study of Chung et al. [13], if only occlusive lesions were to be counted, the arterial involvement rate would have been as follows: innominate artery 7.4%; right subclavian artery 25.3%; and right common carotid artery 32.9%. Chung et al. [13] also studied for Korean patients. These results suggest that the arterial stenosis or occlusion patterns of Korean patients with TA might be different from that of patients in Japan or other countries [4,5,7,8,10,11,14,15,22-26].

Among patients in Asian countries, arterial involvement patterns have been shown to be different between patients in Japan and India [11,12,25]. In our literature review, we found that the arterial occlusion or stenosis patterns of Italy were different from those in France and the United States [7,15,16]. Therefore, we believe that the arterial stenosis or occlusion patterns of TA patients might vary depending on race or nationality. In addition, when we restore the blood flow of the right subclavian artery or the right common carotid artery by endovascular procedures for Korean patients, we should be careful to preserve the innominate artery for the future.

Sparing of the ascending aorta is another notable feature. This is one of the well-known features of TA, with similar results reported from both Eastern and Western countries [6,8,9,13,14]. Considering that TA is a progressive disease, the ascending aorta should be used as the inflow artery when an arterial lesion occurs, which makes it possible to maintain a stable flow even if the disease progresses in the future [21].

A major limitation of this study was that the number of cases was small and all the cases were collected retrospectively. While adding a review of other Korean or foreign papers, we believe that prospective and large number of observations will be necessary to confirm the pattern of innominate artery sparing in Korean TA patients.

CONCLUSION

Despite being a first-order branch of the aorta, the innominate artery might be developing stenosis or occlusion less commonly than the right subclavian artery and right common carotid artery, second-order branches of the aorta. We should focus more attention on avoiding damage to the innominate artery when we perform interventions for the right subclavian artery or the right common carotid artery in patients with Takayasu arteritis.

REFERENCES

- 1) Isobe M. Takayasu arteritis revisited: current diagnosis and treatment. *Int J Cardiol* 2013;168:3-10.
- 2) Numano F. Hereditary factors of Takayasu arteritis. *Heart Vessels Suppl* 1992;7:68-72.
- 3) Numano F, Okawara M, Inomata H, Kobayashi Y. Takayasu's arteritis. *Lancet* 2000;356:1023-1025.
- 4) Arend WP, Michel BA, Bloch DA, Hunder GG, Calabrese LH, Edworthy SM, et al. The American College of Rheumatology 1990 criteria for the classification of Takayasu arteritis. *Arthritis Rheum* 1990;33:1129-1134.
- 5) Grayson PC, Maksimowicz-McKinnon K, Clark TM, Tomasson G, Cuthbertson D, Carette S, et al; Vasculitis Clinical Research Consortium. Distribution of arterial lesions in Takayasu's arteritis and giant cell arteritis. *Ann Rheum Dis* 2012;71:1329-1334.
- 6) Park MC, Lee SW, Park YB, Chung NS, Lee SK. Clinical characteristics and outcomes of Takayasu's arteritis: analysis of 108 patients using standardized criteria for diagnosis, activity assessment, and angiographic classification. *Scand J Rheumatol* 2005;34:284-292.
- 7) Vanoli M, Daina E, Salvarani C, Sabbadini MG, Rossi C, Bacchiani G, et al; Itaka Study Group. Takayasu's arteritis: a study of 104 Italian patients. *Arthritis Rheum* 2005;53:100-107.
- 8) Jain S, Kumari S, Ganguly NK, Sharma BK. Current status of Takayasu arteritis in India. *Int J Cardiol* 1996;54 Suppl:S111-S116.
- 9) Sharma BK, Jain S, Radotra BD. An autopsy study of Takayasu arteritis in India. *Int J Cardiol* 1998;66 Suppl 1:S85-S90; discussion S91.
- 10) Hall S, Barr W, Lie JT, Stanson AW, Kazmier FJ, Hunder GG. Takayasu arteritis. A study of 32 North American patients. *Medicine (Baltimore)* 1985;64:89-99.
- 11) Hata A, Noda M, Moriwaki R, Numano F. Angiographic findings of Takayasu arteritis: new classification. *Int J Cardiol* 1996;54 Suppl:S155-S163.
- 12) Moriwaki R, Noda M, Yajima M, Sharma BK, Numano F. Clinical manifestations of Takayasu arteritis in India and Japan: new classification of angiographic findings. *Angiology* 1997;48:369-379.
- 13) Chung JW, Kim HC, Choi YH, Kim SJ, Lee W, Park JH. Patterns of aortic involvement in Takayasu arteritis and its clinical implications: evaluation with spiral computed tomography angiography. *J Vasc Surg* 2007;45:906-914.
- 14) Lupi-Herrera E, Sánchez-Torres G, Marcushamer J, Mispireta J, Horwitz S, Vela JE. Takayasu's arteritis. Clinical study of 107 cases. *Am Heart J* 1977;93:94-103.
- 15) Schmidt J, Kermani TA, Bacani AK, Crowson CS, Cooper LT, Matteson EL, et al. Diagnostic features, treatment, and outcomes of Takayasu arteritis in a US cohort of 126 patients. *Mayo Clin Proc* 2013;88:822-830.
- 16) Arnaud L, Haroche J, Toledano D, Cacoub P, Mathian A, Costedoat-Chalumeau N, et al. Cluster analysis of arterial involvement in Takayasu arteritis reveals symmetric extension of the lesions in paired arterial beds. *Arthritis Rheum* 2011;63:1136-1140.
- 17) Ureten K, Oztürk MA, Onat AM, Oztürk MH, Ozbalkan Z, Güvener M, et al. Takayasu's arteritis: results of a university hospital of 45 patients in Turkey. *Int J Cardiol* 2004;96:259-264.
- 18) Numano F, Kobayashi Y. Takayasu arteritis: beyond pulselessness. *Intern Med* 1999;38:226-232.
- 19) Saadoun D, Lambert M, Mirault T, Resche-Rigon M, Koskas F, Cluzel P, et al. Retrospective analysis of surgery versus endovascular intervention in Takayasu arteritis: a multicenter experience. *Circulation* 2012;125:813-819.
- 20) Liang P, Tan-Ong M, Hoffman GS. Takayasu's arteritis: vascular interventions and outcomes. *J Rheumatol* 2004;31:102-106.
- 21) Giordano JM. Surgical treatment of Takayasu's arteritis. *Int J Cardiol* 2000;75 Suppl 1:S123-S128.
- 22) Maksimowicz-McKinnon K, Clark TM, Hoffman GS. Limitations of therapy and a guarded prognosis in an American cohort of Takayasu arteritis patients. *Arthritis Rheum* 2007;56:1000-1009.
- 23) el-Reshaid K, Varro J, al-Duwairi Q, Anim JT. Takayasu's arteritis in Kuwait. *J Trop Med Hyg* 1995;98:299-305.
- 24) Rosenthal T, Morag B, Itzchak Y. Takayasu arteritis in Israel. *Heart Vessels Suppl* 1992;7:44-47.
- 25) Koide K. Takayasu arteritis in Japan. *Heart Vessels Suppl* 1992;7:48-54.
- 26) Waern AU, Andersson P, Hemmingsson A. Takayasu's arteritis: a hospital-region based study on occurrence, treatment and prognosis. *Angiology* 1983;34:311-320.