» **Case Report** «

Anatomical Similarity of Abdominal Aortic Aneurysms in Monozygotic Twins

Atsushi Kitagawa, MD, Hiroaki Komatsu, MD, and Toshihiko Nagao, MD, PhD

We report the anatomical similarity of abdominal aortic aneurysms (AAAs) regarding morphology and visceral vessel relations with three-dimensional computed tomography in monozygotic twins, both of whom had the left accessory renal artery, patent inferior mesenteric artery and bilateral common iliac artery aneurysms without aortic wall calcification and mural thrombus in the same fashion. Both twins underwent AAA open repair for enlargement of it at the same age. Genetic contributions might be strongly associated with morphology and visceral vessel relations of AAAs in monozygotic twins.

Keywords: anatomical similarity, abdominal aortic aneurysm, monozygotic twin

Introduction

There have been several reports of abdominal aortic aneurysm (AAA) in identical twins.^{1–4)} These reports suggested genetic contributions might be associated with AAA development in addition to environmental contributions with atherosclerosis, smoking and hypertension.⁵⁾ A positive family history is a well-known risk factor for developing AAA and especially affects the first-degree relatives.^{6,7)} However, there had been no reports depicting the details of anatomical involvements or characteristics of AAAs in twin studies.

Here, we report the anatomical similarity of AAA regarding aortic morphology and visceral vessel relations in monozygotic twins who had been grown separately and underwent AAA open repair at the same age.

Case Report

Case 1

A 71-year-old male with hypertension, hyperlipidemia and past smoking (quit 30 years ago) presented

acute myocardial ischemia and underwent urgent percutaneous coronary artery intervention for total occlusion of left anterior descending coronary artery. His weight and body mass index (BMI) were 65.5 kg and 23.9, respectively. His hypertension and hyperlipidemia were well controlled medically. He was married and already retired from his job (an elementary school teacher). The computed tomography (CT) at that time showed 36 mm × 35 mm in diameter infrarenal AAA with bilateral common iliac artery aneurysms (BCIAAs) without aortic wall calcification and mural thrombus. He also had one left accessory renal artery (LARA), a patent inferior mesenteric artery (IMA) (Fig. 1A and 1C). Serial surveillance of AAA with CT scan had been performed annually. The diameter of his AAA reached 45 mm × 41 mm at the age of 75. He requested us to treat AAA with his fear of AAA rupture in the future and underwent open repair of it uneventfully.

Case 2

A 74-year-old another twin male, who had been adopted in the different family, with hypertension, hyperlipidemia and past smoking (quit 20 years ago) was detected the infrarenal AAA; 34 mm × 33 mm in diameter by abdominal ultrasound test. His weight and BMI were 57 kg and 21.2, respectively. His hypertension and hyperlipidemia were well controlled medically. He was married and already retired from his job (an office worker). The size of AAA reached

Department of Cardiovascular Surgery, Ako Central Hospital, Ako, Hyogo, Japan

Received: March 6, 2014; Accepted: April 16, 2014
Corresponding author: Atsushi Kitagawa, MD. Department of Cardiovascular Surgery, Ako Central Hospital, 52-6 Somon-cho, Ako, Hyogo 678-0241, Japan
Tel: +81-791-45-1111, Fax: +81-791-45-1124
E-mail: akitaga1nc@gmail.com

Fig. 1 The three-dimensional computed tomography images of abdominal aorta and visceral vessels of the twins: (A) case 1 and (B) case 2. The magnified images of visceral vessels of the twins: (C) case 1 and (D) case 2. Each twin had left accessory renal artery (black arrow) and a patent inferior mesenteric artery (white arrow) in the same fashion.

40 mm × 36 mm by the CT scan one year later, with detection of BCIAAs (right 24 mm, left 25 mm), together with the same characteristics of the twin in case 1; a LARA, a patent IMA, no aortic wall calcification and no mural thrombus in the same fashion (Fig. 1B and 1D). The patient was also diagnosed as coronary artery stenosis with double vessels involving right (90% stenosis) and left anterior descending coronary arteries (75% stenosis) by the preoperative coronary angiogram. He also requested us to treat the AAA because his another twin (case 1) already had AAA open repair in fear of AAA rupture in the future. He underwent open repair of AAA at the same age of 75 as the twin of case 1, uneventfully.

We conducted the anatomical analysis of abdominal aorta and visceral vessel characteristics in order to clarify the similarity of aortic morphology and visceral vessel relations in each twin according to the centerline of flow algorithms based on the three-dimensional CT data using Aquarius Workstation

(TeraRecon, Inc., Foster City, California, USA) (Fig. 2). The details of the measurement data were AAA diameter, AAA longitudinal length, diameter of BCIAAs (right/left), the distance from the lowest renal artery to the LARA/the IMA/the aortic bifurcation. The clock positions of the renal arteries (right/left), the LARA and the IMA were also analyzed (Table 1). AAA longitudinal length, the distances from the LARA/IMA/aortic bifurcation and clock position of each visceral vessel are almost same between the twins, although the diameters of AAA and BCIAA were different with each other.

Discussion

The development of AAA is associated with age, smoking, hypertension and family history of AAA.⁵⁾ Familial tendency of AAA development has been supported by several articles.^{6,7)} Johansen, et al.⁶⁾ compared the family histories of 250 patients with AAA with those

Fig. 2 The images of abdominal aorta and iliac arteries of the twins according to the analysis with centerline of flow algorithm based on the three-dimensional computed tomography scan: (A) case 1 and (B) case 2. The clock positions of the left accessory renal artery (LARA) and inferior mesenteric artery (IMA) are similar according to the center-line flow analysis: (A, upper) case 1 and (B, upper) case 2.

Table 1 The measurement data of the abdominal aorta and visceral vessel relations of the twins

	Case 1	Case 2
Abdominal aortic aneurysm		
Diameter (mm)	45 × 41	40 × 36
Length (mm)	58	54
Bilateral common iliac artery aneurysm diameter (mm)		
Right	16	24
Left	15	25
Distance from the lowest renal artery to (mm)		
Left accessory renal artery	44	43
Inferior mesenteric artery	49	52
Aortic bifurcation	116	114
Clock position of the visceral vessel		
Right renal artery	10:00	10:00
Left renal artery	3:30	3:15
Left accessory renal artery	2:30	2:00
Inferior mesenteric artery	12:30	12:30

of 250 control subjects. Among the control subjects, six (2.4%) having a first-degree relative with an aneurysm, compared with 48 (19.2%) of the patients with AAA. This corresponds to an estimated 11.6-fold increase in AAA risk among persons with an affected first-degree relative. In a population-based case control study with 3183 AAA cases and 15943 age-,

gender- and region-matched controls,⁷⁾ the overall relative risk of AAA associated with family history compared to no family history was 1.9 (95% confidence interval [CI], 1.6–2.2), which concluded that the relative risk of developing AAA for first-degree relatives to persons diagnosed with AAA was approximately doubled compared to persons with no family history.

The genetic contribution to AAA development focused on twins was described in a large-population Swedish twin registry by Wahlgren, et al.⁸⁾ This study used 172980 twins, 265 of whom were twins with AAA. Among AAA concordant pairs (both of twins had AAA), there were 7 monozygotic and 5 dizygotic twins. Corresponding numbers for discordant pairs were 44 monozygotic and 197 dizygotic twins. The odds ratio (relative risk of AAA for persons whose twin had AAA compared with persons whose twin did not) was 71.1 (95% CI, 27.5–183.4) for monozygotic twins and 7.6 (95% CI, 3.0–9.2) for dizygotic twins. This study provided robust epidemiologic evidence that heritability contributes to aneurysm formation. AAA concordances and correlations were significantly higher in monozygotic twins compared to dizygotic twins, indicating genetic effects.

In addition, genome-wide association studies^{9,10} were conducted as an unbiased genetic approach to identify the genetic basis for AAA. In one such study, five different vascular phenotypes, AAA, intracranial aneurysms, coronary artery disease, peripheral vascular disease and stroke were analyzed for single nucleotide polymorphisms (SNPs) found to be associated with myocardial infarction and type 2 diabetes mellitus.⁹ The AAA study samples were from seven different geographical regions and included 2836 AAA cases and 16732 controls. The SNP previously associated with myocardial infarction and located in the CDKN2BAS gene on chromosome 9p21 was strongly associated with AAA. Another genome-wide association study on AAA¹⁰ was carried out with 1292 AAA patients and 30503 controls from Iceland and Netherlands, which clarified that SNPs on chromosome 9p33 was strongly associated with AAA (Odds ratio of 1.21, $P = 4.6 \times 10^{-10}$). This SNP is located within DAB2IP gene, which encodes an inhibitor of cell growth and survival.

Our case report described the anatomical similarity of AAA and visceral vessel relations in the monozygotic twins. Each twin had aneurysm involvement of AAA and BCIAA with one LARA and a patent IMA. Indeed, there were many anatomical similar points between each twin based on the center-line flow analysis; AAA longitudinal length, the distance from the lowest renal artery to the LARA/IMA/aortic bifurcation, with the similar clock positions of visceral vessels; right/left renal arteries, LARA and IMA. Anatomical similarity of AAA, coupled with equivalent visceral vessel relations in monozygotic twins, makes this article a worthwhile report regarding a strong genetic contribution to AAA development.

Conclusions

We report the anatomical similarity of AAAs regarding morphology and visceral vessel relations with three-dimensional computed tomography in monozygotic twins. Genetic contributions might be strongly associated with morphology and visceral vessel relations of

AAAs in monozygotic twins. Serial surveillance of abdominal aorta with CT scan or ultrasonography is mandatory in twins if one of the twins had an AAA.

Disclosure Statement

The authors have no financial conflicts of interest to disclose concerning the presentation.

References

- 1) Tilson MD, Seashore MR. Fifty families with abdominal aortic aneurysms in two or more first-order relatives. *Am J Surg* 1984; **147**: 551-3.
- 2) Borkett-Jones HJ, Stewart G, Chilvers AS. Abdominal aortic aneurysms in identical twins. *J R Soc Med* 1988; **81**: 471-2.
- 3) Inzaghi A, Montemezzani M, Zappa M, et al. Atherosclerotic aortic-bisiliac aneurysms in two monocorial twins. *Int Angiol* 1990; **9**: 292-4.
- 4) Ricci MA, Nutter B, McDonald I, et al. Abdominal aortic aneurysm with left iliac aneurysm in identical twins. *Ann N Y Acad Sci* 1996; **800**: 254-5.
- 5) Lederle FA, Johnson GR, Wilson SE, et al. Prevalence and associations of abdominal aortic aneurysm detected through screening. Aneurysm Detection and Management (ADAM) Veterans Affairs Cooperative Study Group. *Ann Intern Med* 1997; **126**: 441-9.
- 6) Johansen K, Koepsell T. Familial tendency for abdominal aortic aneurysms. *JAMA* 1986; **256**: 1934-6.
- 7) Larsson E, Granath F, Swedenborg J, et al. A population-based case-control study of the familial risk of abdominal aortic aneurysm. *J Vasc Surg* 2009; **49**: 47-50; discussion 51.
- 8) Wahlgren CM, Larsson E, Magnusson PK, et al. Genetic and environmental contributions to abdominal aortic aneurysm development in a twin population. *J Vasc Surg* 2010; **51**: 3-7; discussion 7.
- 9) Helgadottir A, Thorleifsson G, Magnusson KP, et al. The same sequence variant on 9p21 associates with myocardial infarction, abdominal aortic aneurysm and intracranial aneurysm. *Nat Genet* 2008; **40**: 217-24.
- 10) Gretarsdottir S, Baas AF, Thorleifsson G, et al. Genome-wide association study identifies a sequence variant within the DAB2IP gene conferring susceptibility to abdominal aortic aneurysm. *Nat Genet* 2010; **42**: 692-7.