



## A Comparison of Aortoiliac Disease between Eastern and Western Countries

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A variety of diseases are known to develop in the aortoiliac segment; these include abdominal aortic aneurysm (AAA) and aortoiliac occlusive disease. This review summarizes several differences of aortoiliac diseases between eastern and western populations. The prevalence of AAA was higher in western countries (4.57% to 19%) than in eastern countries (0.89% to 4.9%). Greater aortic bifurcation angles were observed in the eastern population, while longer common iliac arteries and aneurysm necks were found in the western population with AAA. However, the angle of the aneurysm was found to be more acute in patients from western countries. Several differences were found between patients from western countries and those from eastern countries regarding the diseases that occur in the aortoiliac segment and their anatomical characteristics. Therefore, different approaches to the treatment of aortoiliac diseases in these two groups should be considered.

**Key Words:** Aneurysm, Occlusion, Abdominal aorta, Vascular calcification, Atherosclerosis

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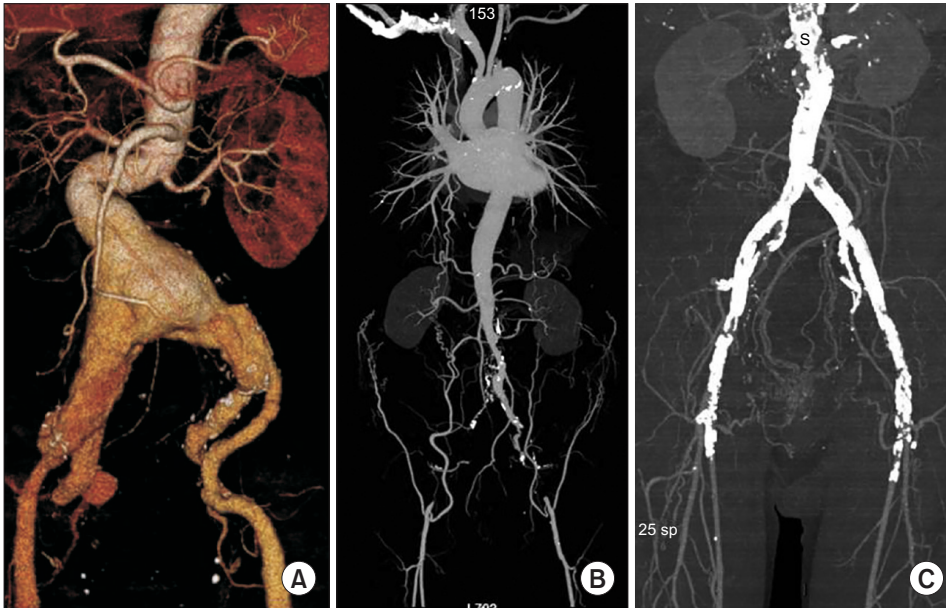
### INTRODUCTION

Various diseases are known to develop in the aortoiliac segment including abdominal aortic aneurysm (AAA), aortoiliac occlusive disease (AIOD), and aortoiliac calcification (Fig. 1). An AAA is a dilatation of the abdominal aorta of at least 30 mm based on angiographic studies [1]. Previous studies have evaluated interracial differences in aortic diameter. Laughlin et al. [2] reported that the aortic diameter of people with Chinese, African, and Hispanic descent is smaller than those of Caucasians even after adjusting for differences in body size and other factors. However, until now, available evidence was reported in terms of racial differences regarding aortoiliac aneurysms.

AIOD is an inflow lesion that can occur anywhere from the distal aorta to the common femoral arteries. Stenoses may be short- or long-segment, calcified, ulcerated, concentric, eccentric, single, multiple, unilateral, bilateral, and

can involve the aorta or iliac arteries alone or together. Focal infrarenal aortic stenosis that excludes the aortic bifurcation is rare [3]. Aortoiliac calcification is commonly observed in computed tomography scanning. Calcifications within the aortoiliac segment have a significant impact on medical and surgical treatment by potentially impairing the outcome of aortic stenting and aneurysmal repair [4].

Small aorta syndrome (SAS) is a rare disease entity that is most commonly seen in female smokers, in whom intrinsically small aorta and iliac arteries can be narrowed even further by the atherosclerotic effects of smoking. While there are currently various treatment modalities available for this disease, such treatments should be adopted according to differences in disease presentation and patient anatomic characteristics. This review summarizes the racial differences of aortoiliac diseases between eastern and western countries.



**Fig. 1.** Aortoiliac disease. (A) Abdominal aortic aneurysm. (B) Aortoiliac occlusive disease. (C) Aortoiliac calcification.

## PREVALENCE OF AAA

The multicenter aneurysm screening study was the largest study that evaluated the prevalence of AAA and the benefits of screening for the disease in the United Kingdom (UK) [5]. From 1997 to 1999, 67,800 men aged 65 to 74 years from four centers in the UK were individually randomized into two groups: those who will be invited for AAA screening (intervention arm), and those who will not (control arm). AAA was detected in 1,333 patients (4.9%) of the 27,147 men who accepted the invitation for screening. In France, Bernard et al. [6] collected data from 1,106 patients who were referred for echocardiography and observed that the prevalence of AAA with a diameter  $>35$  mm was 1.0% (11 patients). Darwood et al. [7] reported that in the Gloucestershire Aneurysm Screening Program, which screened for aneurysms in men aged more than 65 years, 2,412 (4.57%) were found to have AAA from abdominal ultrasound. A study by Norman et al. [8] attempted to establish the prevalence of AAA in a group of 41,000 men aged 65 to 83 years from Western Australia. Those with an aortic diameter  $\geq 3$  cm and  $\geq 5.5$  cm had an AAA prevalence of 7.2% and 0.5%, respectively.

During an ultrasound-based AAA screening program we conducted in Korea, AAA was detected in 11 (0.89%) people among the 1,229 patients screened [9]. AAAs with a diameter  $\geq 5.5$  cm, for which elective repair was suggested, was detected in 2 patients (0.16%). Of the 223 patients classified under the high-risk group according to the Center for Medicare and Medicaid Service, 10 (4.5%) were found to have AAA [10]. In China, a prospective observational study was conducted to evaluate the prevalence of AAA us-

ing abdominal aortic ultrasound images of 1,541 patients. Abdominal aortic ultrasound was found to have a prevalence of 1.6% in the whole study population and 2.9% in male patients aged over 65 years [11]. Matsumura et al. [12] evaluated the prevalence of AAA using transthoracic echocardiography. AAA was identified in 47 of the 1,818 participants (2.6%). Table 1 summarizes the prevalence of AAA in western and eastern countries [5-9,11-13].

Interestingly, several studies have reported a marked reduction in the prevalence of AAA in previous years, which was attributed mainly to a significant decrease in smoking frequency [14,15]. Wanhainen et al. [16] reported an AAA prevalence of 1.5% in a group of 302,957 men aged 65 years from Sweden. Persson et al. [17] screened a total of 602 subjects for AAA in 2010 and determined the prevalence to be 5.7%, which represents a decrease in disease numbers when compared to the 1999 prevalence of 16.9% ( $P < 0.001$ ). During this period, treatment for hypertension using statins was more frequent and smoking habits remained low.

## RISK FACTORS FOR THE DEVELOPMENT OF AAA

Limited data exist regarding the ethnical differences in risk factors for AAA. Kent et al. [18] reported risk factors for AAA using data from a retrospective cohort of 3.1 million patients who were asked to complete a medical and lifestyle questionnaire. A positive association between AAA and the amount and duration of cigarette smoking was observed; likewise, a negative association was found between AAA and smoking cessation. In terms of racial differences,

**Table 1.** Incidence of abdominal aortic aneurysm from population-based screening studies

Global	Countries	Author	Screened numbers	Selection	Mean age (y)	Definition (maximal diameter, cm)	Prevalence (n, %)
Western	UK	MASS Study Group [5]	678,000	Men, 65–74 years	69	≥3	1,333 (4.9)
	France	Bernard et al. [6]	1,106	Unselected	61	≥3.5	11 (1.0)
	UK	Darwood et al. [7]	52,690	Men, ≥65 years	NA	≥3	2,412 (4.5)
	Australia	Norman et al. [8]	41,000	Men, 65–83 years	72	≥3	875 (7.2)
Eastern	Korea	Joh et al. [9]	1,229	≥50 years	63	≥3	11 (0.9)
	Korea	Han et al. [13]	2,035	≥50 years	66	≥3	22 (1.1)
	China	Li et al. [11]	1,541	Unselected	64	≥3	25 (1.6)
	Japan	Matsumura et al. [12]	1,818	Unselected	67	≥3	47 (2.6)

UK, United Kingdom; MASS, multicenter aneurysm screening study; NA, not available.

Blacks, Hispanics, and Asians had a lower risk of AAA than Caucasians and Native Americans. We report data regarding the risk factors of AAA in eastern countries using information gathered during ultrasound screening [13]. The presence of AAA was significantly positive correlated with male sex ( $P<0.001$ ), advanced age ( $P=0.01$ ), smoking ( $P<0.001$ ), alcohol consumption ( $P<0.01$ ), and the presence of pulmonary disease ( $P=0.01$ ). However, multivariate analysis revealed that smoking was the only significant risk factor for AAA. Ultrasound screening for AAA in eastern countries is needed especially for high-risk populations.

## ANATOMIC DIFFERENCES IN AAA

Currently, there are two approaches to treat AAA: the classic surgical approach and endovascular abdominal aortic aneurysm repair (EVAR). The advantages of EVAR over classic surgical repair in terms of recovery time and survival benefit make it viable to use as the main method of treatment. The anatomic characteristics of the patient and the affected aortoiliac segment are critical factors that affect the chance for a successful EVAR. Incompatibilities were frequently found regarding the aortic stent-grafts, particularly the adjustment of graft dimension, for EVAR of eastern patients [19]. Mladenovic et al. [20] analyzed morphologic differences of the infra-renal segment of the abdominal aorta and iliac arteries between Asian patients (AP) and European patients (EP) using computed tomography. The study found statistically significant differences in the length of the common iliac artery (CIA) between the two races with significantly longer CIAs in the EP group (59 vs. 47 mm,  $P<0.001$ ). Additionally, the neck of the aneurysm in the EP group was found to be significantly longer than in the AP group (38 vs. 22 mm,  $P=0.013$ ). The mean angle formed by the aneurysm was found to be significantly smaller in the EP group ( $78^\circ$  vs.  $118^\circ$ ,  $P=0.011$ ). A study by

Banzic et al. [21] quantified aortoiliac morphologic differences between AAA patients of Caucasian and Asian origin. According to the results of the study, Caucasian patients had longer common iliac arteries (right: 65.0 vs. 33.1 mm,  $P<0.001$ , left: 65.0 vs. 35.2 mm,  $P<0.001$ ), longer aneurysm necks (33.0 vs. 28.4 mm,  $P<0.001$ ), greater aneurysm to aortic axis angles ( $153.0^\circ$  vs.  $142.2^\circ$ ,  $P<0.001$ ), and longer combined aortoiliac lengths (195.7 vs. 189.2 mm,  $P<0.001$ ). However, AP had a longer infrarenal abdominal aorta (152.0 vs. 130.0 mm,  $P<0.001$ ), longer AAAs (126.2 vs. 93.0 mm), and greater linear distance from the renal artery to the aortoiliac bifurcation (143.6 vs. 116.0 mm,  $P<0.001$ ). Caucasian patients were noted to have larger inner CIA diameters (right: 16.0 vs. 14.9 mm,  $P<0.001$ , left: 16.0 vs. 15.2 mm,  $P<0.001$ ), larger inner external iliac artery diameters (right: 9.0 vs. 7.5 mm,  $P<0.001$ , left: 9.0 vs. 7.7 mm,  $P<0.001$ ), and larger inner CIA diameters (right: 10.0 vs. 5.9 mm,  $P<0.001$ , left: 10.0 vs. 6.1 mm,  $P<0.001$ ). No difference was observed regarding AAA transverse diameters (62.0 vs. 63.1 mm,  $P=0.492$ ). From these results, the length of endografts should be evaluated before use to accommodate anatomic differences between eastern and western populations.

## AORTOILIAC OCCLUSIVE DISEASE

AIOD is a syndrome caused by narrowing of the lumen or closing of the distal part of the abdominal aorta due to embolism or atherosclerosis. This obstructs the distal part of the abdominal aorta and/or iliac arteries leading to loss of blood flow in both lower limbs. Complications of this disease include gangrene, lower limb amputation, impotence, cardiovascular complications, and death. Symptoms of AIOD may manifest as systemic atherosclerosis or may be localized to the abdominal aorta [22]. Mikołajczyk-Stecyna et al. [23] reported that the risk factors of AIOD in the Polish population were male sex, advanced age, history of

myocardial infarction, diabetes type II, and smoking habits.

The aortic bifurcation is a complex anatomic area that divides the highly-pressurized blood of the descending abdominal aorta into the lower limbs and pelvis. Previous studies have reported that the bifurcation angle was both independent and significant as a risk factor for the development of aortoiliac atherosclerosis [19]. In a study of patients from western countries, the mean bifurcation angle was  $34.6^{\circ} \pm 7.3^{\circ}$  in normal individuals and  $58.2^{\circ} \pm 11.2^{\circ}$  in patients with aortoiliac atherosclerosis [24]. However, a study by Thai reported that the mean bifurcation angle in normal cadavers was  $54^{\circ}$  [25].

## AORTIC STIFFNESS AND CALCIFICATION

Aortic stiffness is caused by structural changes in the aorta; these changes include fragmentation and degeneration of elastin, increase in collagen deposition, and aortic calcification [26,27]. Aortic stiffness is a risk factor for cardiovascular disease (CVD), all-cause mortality independent of blood pressure, and other CVD risk factors [28]. Sekikawa et al. [29] examined the association of aortic calcification and aortic stiffness in multi-ethnic population-based samples of relatively young men and found that aortic calcification category was positively associated with pulse wave velocity. However, no statistically significant difference was found between races.

## SMALL AORTA SYNDROME

Aortoiliac steno-occlusions in young or middle-aged patients are relatively rare and are reported in literature as SAS or hypoplastic aortoiliac syndrome [30,31]. SAS symptoms arise from stenotic or occlusive lesions and frequently present as intermittent claudication. In western countries,

approximately 5% to 16% of AIODs are attributable to SAS. However, SAS is very rare in eastern countries [32].

## CONCLUSION

We described studies that provided adequate data on aortoiliac morphologic differences between eastern and western populations. The bifurcation angle was found to be a significant independent risk factor for aortoiliac atherosclerosis. However, no statistically significant interracial differences were found. In conclusion, AAA is more common in western countries, and the aortic bifurcation angle is greater in eastern populations. In patients from western countries, the lengths of the CIA and aneurysm neck are significantly longer but the angle formed by aneurysms is smaller. Treatment modalities, including EVAR devices, should be modified to adapt to anatomic differences between eastern and western populations.

## CONFLICTS OF INTEREST

The authors have nothing to disclose.

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Concept and design, writing the article, overall responsibility: JHJ. Data collection: SC.

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