

Anatomical Analysis of Abdominal Aortic Aneurysms among Jordanian Patients Eligible for Treatment

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Abstract

Introduction: There is no data regarding the anatomical characteristics of abdominal aortic aneurysms (AAAs) in Jordan. This study was conducted to evaluate the anatomical characteristics of AAAs in Jordanian patients who were eligible for treatment, and to compare the results to international published literature.

Materials and Methods: From February 2014 to January 2017, a total of 80 multicenter computed tomography angiograms (CTAs) with 3-D reconstruction were reviewed for patients who had abdominal aortic aneurysms and were eligible for treatment by endovascular aortic repair (EVAR). Each CTA was analyzed for a set of 18 infrarenal aortoiliac anatomy measurements initially determined in each aneurysm.

Results: The study population consisted of 80 patients in Jordan who underwent CTA sizing for EVAR eligibility. The patients were primarily men (92.5%) with an average age of 70.75 years, while female patients represented 7.5% with an average age of 75.50 years. The average maximum aneurysm diameter was 65.36 mm, average proximal neck diameter was 23.43 mm, and average proximal neck length was 25.68 mm. The average diameters of the right and left external iliac arteries were 10.07 mm and 10.02 mm, respectively.

Conclusion: Among the 18 anatomical characteristics studied, the maximum AAA size in Jordanian patients was large in comparison to that of the published data. Moreover, Jordanian patients were older at time of diagnosis. This could be explained by the fact that there is an absence of a national screening program for AAA in Jordan that would allow early diagnosis and treatment of abdominal aortic aneurysms of smaller sizes.

Keywords: Abdominal Aortic Aneurysm, CT Angiogram, Jordan, Anatomical Characteristics.

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Introduction

An abdominal aortic aneurysm (AAA) is a localized and irreversible dilation of the abdominal aorta to more than 3 cm.¹

Aneurysms are asymptomatic in the majority of individuals, although some patients present with back pain, abdominal pain, or an abdominal pulsation.² It is a potentially life-threatening medical condition³ and a leading

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cause of death in the United States.⁴ The pathogenesis of AAAs involves a complex series of events that have not been fully elucidated.⁵ It is associated with the degradation of connective tissue in the arterial wall.³

Clinical risk factors for AAA include advanced age, family history, smoking history, atherosclerosis, hypertension, and chronic obstructive pulmonary disease (COPD). It is well recognized that aneurysms are more common in men than in women.⁵ The overall prevalence estimates range from 4% to 8% in men and 1% in women, with the peak prevalence in women occurring at an older age than in men.² Women have AAAs that grow faster, a four-fold higher risk of rupture, and ruptures at smaller diameters than in men.⁶ However, women are diagnosed with AAAs about 10 years later than men are, and seem to be protected by female sex hormones.⁷

Studies have demonstrated substantially lower morbidity and mortality rates after endovascular aortic repair (EVAR) than after open repair. However, commercial use of EVAR devices in patients who do not meet the device instruction for use (IFU) could result in a greater risk of aortic rupture.⁸

The majority of infrarenal AAA repairs in the United States are performed with endovascular methods. Determining baseline aortoiliac arterial anatomic criteria is fundamental for appropriate patient selection for EVAR and is a key determinant of long-term success.⁸ Some studies suggest that anatomic features are an important reason for the decreased use and worse outcomes of EVAR in women.⁹

In this study, the anatomical characteristics

of AAAs among Jordanian patients were evaluated by examining computed tomography angiograms (CTAs) used to explore the appropriateness of EVAR. The following anatomical characteristics were evaluated: infrarenal aortic neck, diameter of the aneurysm, diameter of the landing zone in the iliac arteries, access vessel diameters, and the length of the aneurysm.

Materials and Methods

In this retrospective study, 80 CTAs of patients undergoing assessment for EVAR eligibility between February 2014 and January 2017 were assembled. The CTAs were obtained from King Abdullah University Hospital (KAUH) (15 patients) and several other institutions (65 patients) in Jordan. Each CTA was analyzed for a set of 18 infrarenal aortoiliac anatomy measurements initially determined for each aneurysm. Measurements were obtained by well-trained technicians, then supervised and checked by a vascular and endovascular surgeon. Taking into account the vessel geometry and trajectory, both diameter and length measurements were taken orthogonal to the vessel along the lumen centerline method.

All CTAs of thoracoabdominal aneurysms, ruptured AAAs and suprarenal AAAs (aneurysms involving the renal arteries and extending superiorly to the superior mesenteric artery and celiac arteries) were excluded from the study. The demographic data collected were patient age and sex.

Key anatomic measurements included the following: infrarenal aortic neck length (distance between the lowest renal artery and the origin of the aneurysm) and diameter, length of the aneurysm, maximum diameter of the aneurysm, diameter of the landing zone in the

common iliac arteries (CIAs), and access vessel diameters (external iliac).

Results

The study population consisted of 80 patients in Jordan who underwent CTA sizing for EVAR eligibility. The patients were primarily men (92.5%) with an average age of 70.75 years, while female patients represented 7.5% of the sample, with an average age of 75.50 years.

The average maximum aneurysm diameter was 65.36 mm, average proximal neck diameter was 23.43 mm, and average proximal neck length was 25.68 mm. The average diameters of the right and left external iliac arteries were 10.07 mm and 10.02 mm, respectively. Anatomic measurements are summarized in Tables 1 and 2.

Table 1. Diameters of the anatomical characteristics studied^a

Anatomical characteristic	Diameter (mm)
Proximal neck	23.43
Distal neck	25.66
Maximum aneurysm diameter	65.36
Aortic bifurcation	31.40
Right proximal CIA	17.11
Right mid CIA	17.41
Right distal CIA	15.83
Right EIA	10.07
Left proximal CIA	17.13
Left mid CIA	16.96
Left distal CIA	15.20
Left EIA	10.02

^a CIA: common iliac artery; EIA: external iliac artery.

Table 2. Lengths of the anatomical characteristics studied^a

Anatomical characteristic	Length (mm)
Proximal neck	25.68
Maximum aneurysm length	125.55
Right CIA	59.72
Left CIA	61.71
Aneurysm and right CIA	184.42
Aneurysm and left CIA	186.03

^a CIA: common iliac artery.

Discussion

Over the past 20 years, the availability of aortic stent grafts has been a major step in successful management of abdominal aortic aneurysms.¹⁰ EVAR is a procedure that has revolutionized AAA repair, making interventions safer in patients of high surgical risk, significantly reducing periprocedural mortality compared to that of open surgical repair.¹¹ Guidelines typically used in the clinical management of AAAs are based on the maximum diameter of the aneurysm. Endovascular stent-graft implantation requires proximal aortic neck anatomy and distal iliac artery anatomy that interact with the device in such a way that all blood flow is excluded from entering the aneurysm to eliminate pressurization of the aneurysm wall.⁸ Determining anatomical suitability for EVAR depends on the manufacturer's guidelines, but, in general, it requires neck angulation of more than 120 degrees, neck diameter between 19 and 32mm, neck length of more than 10 mm, CIA diameter between 8 and 25 mm, CIA length of more than 15 mm, and an access artery of more than 8 mm.¹⁰ Therefore, it is crucial to evaluate the anatomy of the aneurysm according to the IFU for each EVAR device to determine whether the aneurysm is suitable for a low-risk endovascular repair, or if it requires

a high-risk open surgical repair.

To the authors' knowledge, this is the only study to date that evaluates the anatomical characteristics of AAA among Jordanian patients. Notably, this study includes patients that had CTA sizing for EVAR selection. The exact prevalence of AAA in the Jordanian population is unknown, and the majority of cases are discovered incidentally.

The patients with AAA in this study were older upon presentation (average of 70.75 years) than patients with the same disease reported in the literature (average of 66 years).¹² This could be explained by the fact that, in Jordan, there is no national screening program for AAA, which could help diagnose the disease at an earlier age.

This study also shows that the infrarenal aortoiliac anatomy in Jordan is similar to that reported in the literature, except for the maximum aneurysm diameter. The maximum AAA diameter was significantly larger in Jordan (65.36 mm) compared to that in the literature (54.8 mm to 59 mm).^{4,6,8,9}

The size of certain anatomical features as a factor in the aneurysmatic condition of the aorta and progression of the disease has also been the basis for clinical management of AAA.³ Moreover, the percentage of patients with AAA that meet instruction for use criteria diminishes rapidly as the AAA size exceeds 65 mm.⁹ Finally, although the size is not a criterion for IFU, the larger the aneurysm, the less favorable the anatomy and the more complicated the repair.¹¹

It is worth mentioning that data regarding whether these patients were selected for EVAR, open surgical repair or observation was not

collected. There are some possible limitations of this study. Firstly, only patients who had the possibility of EVAR treatment were included in the study; patients with AAA who did not have the option of EVAR were not imaged by CTA because the regular computed tomography scan was enough to plan the surgery. Secondly, because the CTA sizing reports were collected from multiple institutions, the potential presence of interobserver variability may have biased the results. To avoid this bias, the data were reanalyzed by a single vascular surgeon. Another limitation was the small number of patients included in the study, which could be explained by the fact that Jordan is a small country, with 37% of the population below the age of 15 years. A lack of standardization between CTA machines in different hospitals could be another limiting factor. Finally, the data set did not include all clinically relevant anatomic features, such as proximal neck and iliac vessel angulations.

Conclusion

Among the 18 anatomical characteristics studied, the average maximum AAA size in Jordanian patients was large in comparison to that in the published data. Moreover, Jordanian patients were older at the time of diagnosis. These results could be explained by the fact that Jordan does not currently have a national screening program for AAA that would allow early diagnosis and treatment of abdominal aortic aneurysms of smaller sizes.

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المواصفات التشريحية للتوسع في الشريان الأبهرى البطني (الأم دم) لدى المرضى الأردنيين الذين ينطبق عليهم العلاج عن طريق وضع الشبكة المغطية بالقسطرة الشريانية

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الملخص

الهدف: يهدف هذا البحث إلى دراسة المواصفات التشريحية للتوسع في الشريان الأبهرى البطني (الأم دم) لدى المرضى الأردنيين ومقارنتها مع النتائج العالمية؛ إذ لا يوجد معلومات في الأردن عن هذه المواصفات التشريحية.

المنهجية: تم دراسة 80 صورة طبقية محورية ملونة لشرايين البطن المصابة بمرض الأم دم للشريان الأبهرى البطني إلتحت كلوي من تاريخ شباط 2014 إلى كانون الثاني 2017 التي تمت في عدة مراكز طبية اردنية لدى المرضى الأردنيين الذين ينطبق عليهم العلاج عن طريق وضع الشبكة المغطية بالقسطرة الشريانية. كل صورة تم تحليلها ال 18 مواصفة تشريحية.

النتائج: الصور التي تم دراستها تعود بالأغلبية إلى الذكور بنسبة 92.5% وبالمعدل العمري 70.75 عاما. بينما نسبة الإناث 7.5% وبمعدل عمري 75.5 عام. معدل القطر للأم دم تحت الكلوية للشريان البطني كانت 65.36 مم وقطر الرقبة تحت الكلوية 23.43 مم وطول الرقبة تحت الكلوية 25.63 مم وقطر الشريانين الحرقفي الخارجى الأيمن 10.07 مم والأيسر 10.02 مم.

الاستنتاج: من بين 18 مواصفة تشريحية، معدل القطر للأم دم تحت الكلوية عند المرضى الأردنيين الذين ينطبق عليهم العلاج عن طريق وضع الشبكة المغطية بالقسطرة الشريانية أعلى من المرضى في الدراسات العالمية. وأعمار المرضى الأردنيين أعلى من المعدل العالمي. يمكن تفسير ذلك بسبب عدم وجود برنامج وطني شامل لإجراء مسح استكشافي لمرض الأم دم الأبهرى البطني الذي يكشف المرض في عمر أصغر وقطر أقل.

الكلمات الدالة: أم دم أبهرى بطني، صورة طبقية ملونة للشرايين، الأردن، المواصفات التشريحية.