



Case Series

Surgical aspects of thoracic aortic aneurysms: A case series from a real-world setting

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ABSTRACT

Background: The objective of the present study is to review different surgical features and treatment modalities of thoracic aortic aneurysms.

Methods: This was a retrospective study of 17 patients operated on for thoracic aortic aneurysm in the Department of Cardiovascular Surgery of the Military Hospital of Rabat (Morocco) over a 10-year period, from January 2007 to December 2016. All patients with aneurysms located in the thoracic aorta or extended to the abdominal aorta were included in the study.

Results: The mean age of the patients was 49 ± 6 years. 58% of the patients were symptomatic. 10 patients (62%) had an aneurysm of the ascending thoracic aorta and 2 patients had an aneurysm of the ascending aorta extended to the arch. In 2 patients, the aneurysm was located in the descending thoracic aorta. Three patients (18%) had a post-traumatic false aneurysm of the aortic isthmus. Six patients underwent a Bentall procedure. One patient underwent the Yacoub technique. Two patients underwent ascending aorta replacement using the Wheat technique. In addition, two patients underwent ascending aorta and arch replacement and five patients (29%) underwent descending thoracic aorta replacement. In-hospital mortality was 12%. Two patients (12%) developed paraplegia and two developed renal failure (12%).

Conclusion: Thoracic aortic aneurysms are a serious pathology requiring surgical treatment before complications arise. Replacement of the arch and the descending thoracic aorta still remain a challenge for cardiovascular surgeons because of neurological complications.

1. Introduction

Chronic pathology of the thoracic aorta has two main aspects: aneurysms and chronic dissections. The exact incidence of aneurysms is difficult to establish but it is estimated at 20%. Atheromatous aneurysms are found electively in the aortic arch and the descending thoracic aorta, whereas elastic tissue diseases are found mainly in the first segment of the aorta in younger people [1]. The assessment of the thoracic aorta is based primarily on noninvasive imaging [2,3]. The replacement of the ascending aorta is well mastered, however; the surgery of the arch and descending thoracic aorta still remain a challenge for cardiovascular surgeons despite the progress made in the fields of anesthesia-intensive care, surgical techniques and circulatory assistance. In this paper, we share our experience in a real-world setting in order to improve knowledge on the challenges associated with surgical management of

thoracic aortic aneurysms and also the advances in this field from a specialized center in Morocco.

2. Patients and methods

This was a retrospective study of 17 patients, including 4 women, all operated in the cardiovascular surgery department of the Mohamed V military training hospital in Rabat (Morocco) over a period of 10 years, from January 2007 to December 2016. All patients with aneurysms located in the thoracic aorta and/or extended to the abdominal aorta were included in the study. Patients' data were retrieved retrospectively from the database of the medical records.

Ethical approval was provided by the local committee of the hospital. Data were anonymously collected as per international ethical guidelines. Our study was registered on the Research Registry under the

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number: 7279. Descriptive statistics were used for data reporting including count and frequencies for categorical data and means with their standard deviations (SD) for quantitative data. SPSS software was used for all analyses. The study findings were reported in line with the recommendations of PROCESS [4].

3. Results

The clinic-pathological parameters of our case series can be found in Table 1. The mean age was 49 years ±6 months [14–72 years]. Five patients were hypertensive and seven were chronic smokers (41%). Chest pain was the revealing symptom in 10 patients (58%). In three patients (17%), the aneurysm was discovered during the preoperative assessment of aortic valve disease. Two patients were asymptomatic and the aneurysm was discovered incidentally on a chest radiograph performed during a medical check-up for military reenlistment. Two patients had complications at the time of diagnosis (hemoptysis, congestive heart failure). Moreover, 12 patients (70%) had an abnormal chest radiograph. Echocardiography was performed in 12 patients and CT scan made the diagnosis in 13 patients (75%). Aortography was performed in 8 patients (routinely performed in the 1990s and when other investigations could not determine the topography of the aneurysm). Coronary angiography was performed in 3 patients (17%) [smokers and age >50 years]. Arterial Doppler ultrasound of the supra-aortic trunks and lower limbs was performed in 6 patients (35%) and did not reveal any significant lesion.

The aneurysm was located in the ascending aorta in 10 cases (58%) (Fig. 1). Furthermore, it was extended to the arch in one patient and to the entire thoracic aorta in another. Four patients (23%) had an aneurysm of the descending thoracic aorta and two patients had a thoracoabdominal aneurysm (TAA) Crawford type II (Fig. 2). Among the patients with aneurysms of the ascending thoracic aorta, seven had significant aortic leakage, and in two patients with aortic stenosis, the aneurysm was the consequence of jet lesions. Five patients (29%) had criteria for Marfan disease. Three patients had a dissecting aneurysm and three others (17%) had a post-traumatic false aneurysm of the isthmus [trauma in one patient 10 years after a traffic accident; in another: 15 years after a knee blow during a group sports activity, and in one case 8 years after a slip from a height of 4 m and a collision against an obstacle]. One patient had an ascending aortic aneurysm of syphilitic origin. Four patients had left ventricular dysfunction and 1 patient had functional renal failure.

All patients with ascending aortic aneurysms underwent surgery under general anesthesia and extracorporeal circulation (ECC) by senior cardiothoracic surgeons with the aid of junior trainees in this field in a

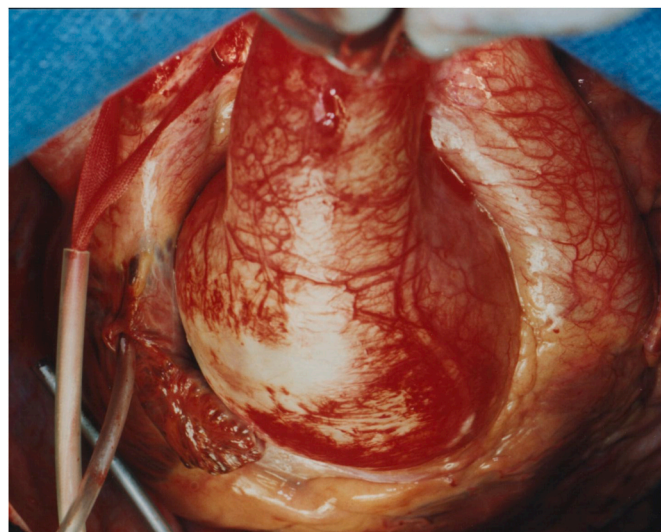


Fig. 1. Surgical view showing the typical aspect of an aneurysm of the ascending aorta (pear-shaped) in a patient with Marfan syndrome.

university teaching hospital. Six patients underwent a Bentall procedure, associated with mitral valve replacement in one case. One patient underwent conservative surgery using the Yacoub technique. Two patients underwent surgery using the Wheat technique and two other patients underwent ascending aorta and arch replacement with reimplantation of the supra-aortic trunks, under ECC, deep hypothermia and circulatory arrest. The three post-traumatic false isthmus aneurysms and the two cases of Crawford type II aneurysm were treated with Dacron tube and simple aortic clamping. The patient with a Crawford type II thoracoabdominal aneurysm underwent flattening of the aneurysm, tube replacement of the aorta, and reimplantation of the visceral arteries under partial femoral-femoral ECC. For the patient with a Crawford type III aneurysm, the treatment consisted of flattening and prosthetic grafting under simple clamping.

The postoperative course was marked by two deaths. The causes of death were severe sepsis and renal failure. The average duration of the ECC was 136 min (75–243 min), the average duration of the aortic clamping was 105 min (48–204 min). In addition, the duration of the circulatory arrest, performed in two patients, was 30 min.

Patients with preoperative left ventricular dysfunction all required positive inotropic support upon discharge from ECC. The average total bleeding was 710 ml and nine patients were transfused. The mean

Table 1
Clinical and pathological features of our case series.

Patients and gender	Age	Symptoms	Chest X-ray	US	CT scan	Arteriography	Diagnosis	Treatment procedures
1. Male	45	Pain	+	+	-	-	AAA	Bentall
2. Male	60	-	+	+	-	+	AAA	Bentall
3. Female	58	Dyspnea	+	+	+	+	AAA	Bentall
4. Male	68	Pain	+	+	-	-	AAA	Wheat
5. Male	43	Pain	+	+	+	+	AAA	Bentall
6. Male	47	Dyspnea	+	+	+	+	AAA	Yacoub
7. Male	49	Dyspnea	-	+	+	-	AAA	Bentall + MVR
8. Male	72	Dyspnea	+	+	+	+	AAA	Bentall
9. Male	51	Pain	+	+	+	+	AAA	Wheat + AVR
10. Male	53	Pain	+	-	+	-	ADA	Tube
11. Female	34	Pain	+	+	+	-	ADA	Tube
12. Male	57	Pain	+	-	+	-	ADA	Tube
13. Male	46	-	+	+	+	-	PAI	Tube
14. Male	52	Hemoptysis	-	-	+	-	PAI	Tube
15. Female	14	Pain	+	-	-	+	PAI	Tube
16. Male	64	Pain	+	+	+	-	EA	Tube
17. Female	46	Pain	+	+	+	-	EA	T Elephant

Abbreviations: AAA: aneurysm of the ascending aorta, ADA: aneurysm of the descending aorta, PAI: pseudoaneurysm of the aortic isthmus, EA: extensive aneurysm, MVR: mitral valve replacement, AVR: Aortic valve replacement.



Fig. 2. Frontal chest radiograph showing a huge aneurysm of the descending thoracic aorta in a patient with Marfan syndrome.

duration of mechanical ventilation was 22 h (4–96 H) and the average length of stay in the intensive care unit was 56 h (20–120 H).

Eleven patients were followed up and four were lost to follow-up. Moreover, two patients operated on for Bentall died, including one after 4 months and the other after 2 years following a hemorrhagic accident due to overdose of antivitamin K. No cases of infective endocarditis on prosthesis were recorded.

4. Discussion

Aneurysms of the thoracic aorta are uncommon and represent 20% of all aortic aneurysms. Their annual incidence is estimated at 6 cases/100,000 inhabitants and they seem to be more common in the elderly. They are more frequent in men than in women with a sex ratio of 2–4 [5]. In the absence of surgical treatment, the evolution is towards the aggravation explained by Laplace's law. The main complications are rupture and acute dissection. The location of the aneurysm in the different segments of the thoracic aorta depends mainly on age and etiology. Almost in half of the cases, the aneurysm is atheromatous and located in the arch or in the descending thoracic aorta [1]. Some authors do not share this opinion and estimate that dissecting aneurysms represent 55% of the etiologies while atheromatous aneurysms only constitute 26.3% [1,6]. Dissecting aneurysms represented 23% in our series. One of the characteristics of thoracic aortic aneurysms is the clinical silence for a long period of time, the aneurysm is discovered only after a complication as it was the case in 3 patients of our series. Pain remains the main symptom that reveals the disease and its frequency varies according to the series [5]. It is mainly described in aortic arch aneurysms. 56% of our patients presented with thoracic pain syndrome at the time of diagnosis. The other clinical signs are related to the compression of the surrounding structures. When the aneurysm is large and undiagnosed, it may erode the chest wall or even become externalized and flush with the skin [7]. The diagnosis of acquired diseases of the thoracic aorta has benefited greatly from modern medical imaging techniques [2,3]. In recent years, minimally invasive examinations giving a very precise anatomical description of the thoracic aorta have

been developed.

The standard chest X-ray has not lost its importance, although it allows a rough study of the thoracic aorta; it often attracts the attention of the clinician by its abnormalities and leads to specific explorations. Chest radiography was suggestive in 68% of our patients. Transthoracic echocardiography allows easy exploration of the first segment of the aorta and the advent of transesophageal echocardiography has made the other segments (arch and descending aorta) easily accessible [3]. The other non-invasive imaging techniques, namely computed tomography (CT) and magnetic resonance imaging (MRI), have become the examinations of choice because of their multiple advantages and allow a multiplanar approach and a three-dimensional study [2]. Conventional aortography is increasingly overshadowed by the previously described techniques.

The indication of surgery is retained when the diameter reaches or exceeds 50 mm, but other criteria may lead to an earlier indication for surgery (pain, worsening of the aortic insufficiency, age, etiology) because of the risk of fatal complications [1]. The surgical treatment consists of flattening the aneurysm and replacing the affected segment with prosthesis. Surgery of the 1st segment of the aorta is currently mastered and performed under ECC. The choice of technique depends on various parameters including age, etiology, dilatation of the sinuses of Valsalva and the condition of the aortic valve. The Bentall procedure is the gold standard in ascending aortic surgery. Despite satisfactory long-term results, it is still burdened with the disadvantages of aortic valve replacement [8]. The conservative approach according to the Yacoub remodeling technique or the Tirone-David inclusion technique is based on the principle of replacing the ascending aorta with a prosthesis and reimplanting the coronary arteries while preserving the native aortic valve [9]. Recently, other surgical procedures have been performed using biological valves (Freestyle) as replacement [10] with attractive medium-term results (hospital mortality = 0.6%; 10-year survival 96%) compared to Bentall's procedure (operative mortality around 4.5–10% and 10-year survival 87% [11]). Aortic arch replacement uses complex protocols to address the neurologic risk during supra-aortic trunk exclusion. Deep hypothermia associated with circulatory arrest is the usual method of cerebral protection during aortic arch surgery. However, this technique provides the surgeon with only a limited amount of time (≤ 45 min) to perform the aortic repair. It also requires a prolonged duration of ECC to cool and specially to warm the patient, which can be the cause of numerous complications, in particular disorders of hemostasis with abundant bleeding requiring massive transfusion. There are also other brain protection techniques including cold cerebroplegia, which appears to be a promising and attractive technique with encouraging results. Despite the progress made in recent years in neurological protection, mortality and morbidity are still significant. In a series of 156 cases of aortic arch replacement that compared the different cerebral protection techniques and reported an in-hospital mortality rate varying between 14% and 16% and an incidence of neurological events between 11% and 33% [12].

Aneurysms of the descending thoracic aorta accounted for 30–40% of thoracic aortic aneurysms and their incidence was estimated at 10/10,000 patients [13]. Surgical treatment of this aortic segment is still a challenge for cardiovascular surgeons with a hospital mortality rate of 10% [13,14]. The main complication is paraplegia, the etiopathogenic mechanism of which involves several factors. As for the transverse aorta, various protocols have been used to combat spinal cord ischemia. The results have improved significantly in recent years thanks to the development of spinal cord protection techniques such as cerebrospinal fluid drainage. However, no codified consensus has been established to avoid this spinal cord risk outside of clamping times remaining within safety limits (< 30 min). In-hospital mortality has decreased from 50% between 1982 and 1985 to 13% in recent years, the incidence of paraplegia from 0 to 9% and that of renal failure from 0 to 7% [13,14]. The occurrence of postoperative renal failure increases the mortality rate to 53% [15]. The surgical approach to extensive aneurysms, also called polysegmental

aneurysms, has developed recently and many surgical teams opt for the replacement of the entire aneurysmal aorta in a single step. The results are encouraging in comparison with the classical two-stage approach known as the “elephant trunk” technique whose cumulative mortality exceeds 20%. Nicholas et al. [16] treated 46 patients with extensive aneurysms and found a hospital mortality rate of 6.5%. The other postoperative complications were significantly reduced (respiratory complications 13%, rebleeding 17%, renal failure 9%) [16].

The introduction of endovascular techniques in the therapeutic arsenal has given satisfactory results and their indications are constantly expanding [16]. Thus, it is currently possible to propose a hybrid approach associating at the same time the replacement of the ascending aorta and the arch completed by an endoprosthesis in the descending aorta [17]. This combined approach has shown encouraging results in patients at high surgical risk [18]. Our real-world study has several limitations, particularly the small sample size that may bias our conclusion. Other reports with prospective patients’ enrollment and adequate sample size are awaited to improve surgical knowledge on the management of thoracic aortic aneurysms.

5. Conclusion

Aneurysms of the thoracic aorta are serious diseases. Their spontaneous evolution is dominated by the risk of rupture and dissection. Despite the progress of surgical techniques and intensive care anesthesia, their treatment is still marred by a relatively high morbidity-mortality.

Ethical approval

The study was approved by the local ethic committee of Mohammed V Training Hospital.

Sources of funding

None.

Author contribution

Conceptualization: MAH and AS. Data curation: MAH and AS. Supervision: YEB and MAH. Validation: AS, NA, and YM. Writing: AS. All authors read and approved the final version of the manuscript.

Consent

Given the retrospective nature of this study, no consents were needed.

Registration of research studies

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Provenance and peer review

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Declaration of competing interest

The authors state that they have no conflicts of interest for this case series.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.103099>.

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