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Experience in ascending aorta surgery in a Tertiary Level Hospital

Experiencia en cirugía de aorta ascendente en un Centro Hospitalario de Tercer Nivel

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ABSTRACT

Introduction: ascending aorta surgery has a mortality rate of 8.1%, whose main indications are aortic dissection, dilation and rupture with mortalities between 94-100%. **Objective:** to describe a case series of ascending aorta surgery. **Material and methods:** patients admitted between 2020-2024 were studied, identifying sociodemographic data, comorbidities, procedures, and findings. **Results:** of 12 patients, 66.6% were male, the predominant ages were between 20 and 40 years (58%), with New York Heart Association functional class II (66.6%) and left ventricle ejection fraction between 40 and 60% (66.6%). The congenital pathologies found were: Marfan (25%), patent ductus arteriosus (8.3%) and coarctation of the aorta (8.3%). The main findings were: aortic root dilation (66.6%), Stanford A aortic dissection 33.3%, and endocarditis (25%) with perforation of an abscessed non-coronary sinus aneurysm (16.6%). The Bentall procedure was the most frequently performed surgical intervention, accounting for 75% of cases, and was associated with a mortality rate of 16.6%. **Conclusions:** surgery of the ascending aorta is reproducible and safe. Studies with larger samples are required in order to obtain stronger conclusions.

Keywords: aortic aneurysm, aortic dissection, ascending aorta surgery, sinus of Valsalva perforation.

RESUMEN

Introducción: *la cirugía de aorta ascendente tiene una mortalidad de 8.1%, cuyas principales indicaciones son disección, dilatación y rotura aórtica con mortalidades entre 94-100%.* ***Objetivo:*** *describir una serie de casos de cirugía de aorta ascendente.* ***Material y métodos:*** *se estudiaron pacientes ingresados entre 2020-2024 identificando datos sociodemográficos, comorbilidades, procedimientos y hallazgos.* ***Resultados:*** *de 12 pacientes, 66.6% fueron masculinos, las edades predominantes fueron entre los 20 y 40 años (58%), con clase funcional II de la New York Heart Association (66.6%) y fracción de eyección del ventrículo izquierdo entre 40 y 60% (66.6%). Las patologías congénitas encontradas fueron: Marfan (25%), persistencia del conducto arterioso (8.3%) y coartación aórtica (8.3%). Los principales hallazgos fueron: dilatación de raíz aórtica (66.6%), disección aórtica Stanford A 33.3% y endocarditis (25%) con perforación de aneurisma de seno no coronariano abscedado (16.6%). El procedimiento de Bentall fue la cirugía más realizada (75%) con una mortalidad de 16.6%.* ***Conclusión:*** *la cirugía de la aorta ascendente es reproducible y segura. Se requieren estudios con muestras mayores para obtener conclusiones más robustas.*

Palabras clave: *aneurisma aórtico, disección aórtica, cirugía de aorta ascendente, perforación de seno de Valsalva.*

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Ascending aorta surgery is a complex procedure due to its relationship with anatomical structures such as the aortic leaflets, coronary ostia, coronary arteries and because it is one of the areas of greatest pressure in the circulatory system. The main indications for these procedures are dissection, dilation, aneurysm, intramural hematoma, penetrating atherosclerotic ulcer, blunt trauma, which are associated with a mortality rate between 94-100%.[1,2]

Aortic dissection consists of the rupture of the intimate layer with separation of it and the middle layer, forming a false lumen that causes aortic regurgitation and haemodynamic compromise. The most frequent are Stanford A or DeBakey type I (50%), type II (35%), type III (15%). Aneurysm is defined as the dilation of the aortic root greater than 5.25 cm, in Marfan Syndrome with a diameter less than or equal to 5 cm. Patients with root diameters greater than 4.5 cm have an 89-fold increased risk of type A dissection, aneurysm, sudden death.[3,4]

The characteristics associated with increased risk of aortic dissection in patients with no identified genetic causes are family history of dissection with aortic diameter < 5 cm, sudden unexplained death in < 50 years, rapid aortic growth > 0.5 cm in 1 year and 0.3 cm in 2 consecutive years, and coarctation of the aorta. Patients with Marfan syndrome are associated with an increased risk of aortic complications when they have a family history of dissection, rapid aortic growth > 0.3 cm per year, diffuse dilation of the root and ascending aorta, and marked tortuosity of vertebral arteries.[5,6]

The main objectives of ascending aorta surgery are to restore the flow in the true lumen, eliminate tears or ruptures, reestablish anatomy and valve competence, in order to treat and avoid life-threatening complications, such as rupture, shock, poor visceral perfusion, persistence of false lumen in 60%, and early mortality in 20-30%. The need for reoperation after surgery at 10-year ranges around 5%, significantly impacting quality of life and complications in the short and medium term, making it the treatment of choice. The main complications to be assessed are the formation of a pseudoaneurysm between the aortic wall and the vascular graft, the presence of significant aortic regurgitation, and the persistence of dissection of the descending aorta.[4,7,8]

The Bentall operation is one of the most well-known ascending aorta procedures. It consists of aortic root replacement with a Dacron tube including a prosthetic valve inside, and the reinsertion of the coronary ostia. It has a reoperation rate of 1.01%, with an in-hospital mortality related to the procedure of 5.6%, the main causes being low cardiac output in 29.4% and hemorrhage in 8.5%. The most common complication at 10 years of follow-up is valve dysfunction (26.6%), due to degeneration or obstruction by pannus or thrombus and, to a lesser extent, graft infection or pseudoaneurysm.[9,10]

MATERIAL AND METHODS

In this case series study, information was collected prospectively from primary sources of patients who underwent ascending aorta surgery at our institution from March 2020 to February 2024. All patients with an indication for ascending aorta surgery were included, representing a total of 12 patients. Patients' ages were between 23 and 67 years, 8 of whom were male and 4 female. Sociodemographic data were taken into account as variables: age, sex, functional class, comorbidities, type of dissection, type of surgery, risk and mortality. Clinical and sociodemographic characteristics of the cases are shown in *Table 1*. The collected information was entered into a database, a collection form was used as a data collection instrument. In relation to ethical aspects, the patients authorized the use of their information for the present study.

RESULTS

Sociodemographic analysis revealed that the majority of ascending aorta surgeries were performed on individuals between 20 and 40 years old (58.3%). Males predominated,

Table 1: Clinical and sociodemographic data of patients with ascending aorta surgery in a tertiary level hospital. N = 12.

Variables	n (%)
Age	
20-30	4 (33.3)
31-40	3 (25.0)
41-50	2 (16.6)
51-60	1 (8.3)
> 60	2 (16.6)
Sex	
Male	8 (66.6)
Female	4 (33.3)
Risk factors	
Hypertension	4 (33.3)
Smoking	3 (25.0)
Dyslipidemia	2 (16.6)
None	3 (25.0)
NYHA functional class	
I	1 (8.3)
II	8 (66.6)
III	3 (25.0)
LVEF	
31-40	1 (8.3)
41-50	3 (25.0)
51-60	5 (41.6)
> 60	3 (25.0)

LVEF = Left Ventricular Ejection Fraction. NYHA = New York Heart Association.

Figure 1: A 23-year-old male with ascending aorta aneurysm, with a 60 mm root, severe aortic regurgitation, Marfan, Pectus excavatum.

accounting for 66.6% of cases (8/12). The most common risk factors present were hypertension (33.3%, 4 cases), smoking (25%, 3 cases), and dyslipidemia (16.6%, 2 cases). The functional class of most patients was NYHA II in 8 cases (66.6%), and NYHA III in 3 cases (25%). Regarding left ventricular ejection fraction (LVEF), 5 patients (41.6%) had an LVEF between 51-60%, 3 patients (25%) had an LVEF between 41-50%, and only 1 case (8.3%) had an LVEF below 31% *(Table 1)*.

The most frequently found congenital pathologies were Marfan syndrome *(Figure 1)* with 3 cases (25%) and then patent ductus arteriosus, coarctation of the aorta, ventricular septal defect and bivalve aorta, all of them with 1 case (8.3%) each, adding up to a total of 7 cases (58.3%) with congenital pathologies present in patients with ascending aorta surgery.

Of the intraoperative findings, 10 cases (83.3%) had moderate to severe secondary aortic regurgitation. Regarding aortic dilation, 8 cases (66.5%) presented it, of which the majority 5 cases (41.6%) were dilated between 50 mm and 60 mm, 2 cases (16.6%) were dilated between 61mm -70 mm and 1 case (8.3%) presented dilation > 71 mm. The most common aortic dissection was the Stanford A type in 4 patients (33.3%), the rest had no dissection. Endocarditis was observed in 3 patients (25%), out of these 2 cases (16.6%) presented perforation of an abscessed non-coronary sinus aneurysm. Postoperative hemorrhage occurred in 3 cases (25%).

Regarding the procedures performed, 9 cases (75%) underwent Bentall procedure *(Figure 2)* and 3 cases (25%) underwent ascending aortic replacement without valve replacement or coronary ostia reinsertion. Of the total number of patients, 3 cases (25%) were reoperated, of which 2 (16.6%) were due to postoperative chest bleeding, and 1 (8.3%) due to retained hemothorax. Among the total number of cases, simultaneous procedures were performed in 4 instances (33.3%). These included supra-aortic vessel grafting in 1 case (8.3%) *(Figure 3)*, coronary revascularization in 1 case (8.3%), mitral valve replacement in 1 case (8.3%), and Ravitch surgery for pectus excavatum using the stratos system in 1 case (8.3%).

The mortality rate in this case series was 16.6% (2 patients), with the primary causes of death being hemorrhage in 1 case (8.3%) and friable tissues in 1 case (8.3%).

DISCUSSION

Aortic root replacement offers numerous technical options, thanks to decades of research and development yielding

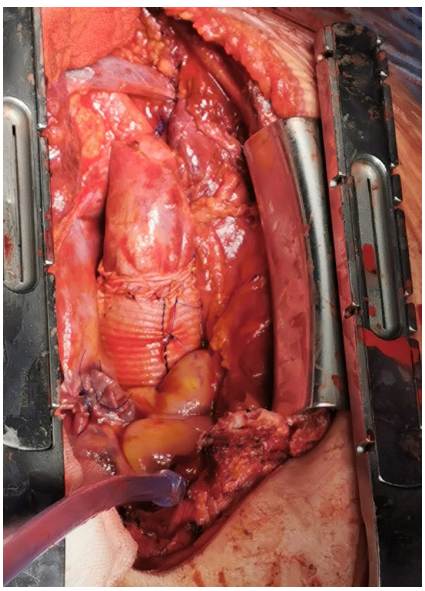

Figure 2:

A 23-year-old male with Bentall De-Bono surgery, with a 31 mm mechanical valved tube.

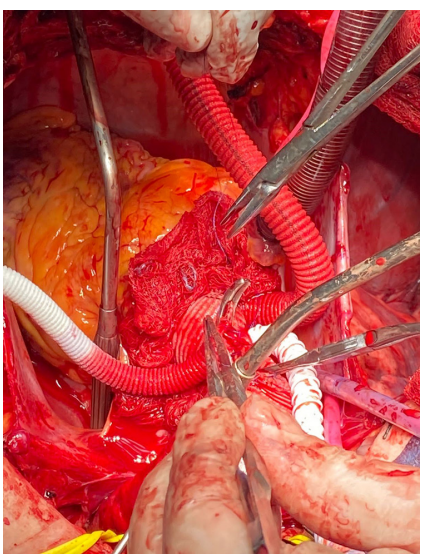

Figure 3:

A 74-year-old male with aortic valve endocarditis, with abscess in the non-coronary sinus and left coronary sinus, friable aorta, Bentall plus supra-aortic vessel grafting was performed.

favorable outcomes. These options address the individual patient needs, considering anatomical characteristics and risk factors to manage aortic pathology, prevent recurrence, valve dysfunction, progressive dilation, and dissection. Our 4-year experience with 12 consecutive patients undergoing ascending aorta surgery showed satisfactory surgical outcomes, with an early mortality rate of 16.6%, lower than previously reported at our hospital.[11]

Our findings align with current literature, indicating a twofold increase in males, predominantly in productive ages (average 30 years). Hypertension was the prevailing risk factor, increasing absolute tension on the arterial wall, leading to intima deterioration and middle layer weakening, creating conditions for progressive dilation or rupture. Smoking, a risk factor for hemostasis and atherosclerosis, exposes patients to toxicants, promoting cell proliferation, lipid accumulation, and atheromatous plaque formation. Dyslipidemia, particularly elevated low-density lipoprotein cholesterol and triglycerides, correlates with aortic dilation.

Marfan syndrome was the predominant congenital pathology, affecting 60-80% of adults, with aortic pathology being the most prognostically significant. The typical involvement is dilation of the root, starting in the sinuses of Valsalva, with histological findings showing middle layer degeneration, elastic lamina loss, and proteoglycan disorganization, leading to elastic fiber destruction, dilation, thinning, and aortic stiffness. Other connective tissue disorders, such as bicuspid aortic valve and coarctation of the aorta, are often associated with dissection.

Regarding intraoperative findings, aortic valve regurgitation in the presence of aortic root dilation (40-60%) is quite frequent, as in our results. According to literature, it is characterized by a regurgitating flow from the aorta to the left ventricle, giving way to an overload of diastolic volume, increased stroke ejection volume and elevated intra-aortic systolic pressures with probable dilation. Therefore, surgical intervention is justified with the aim of preventing acute aortic dissection.[12]

Aortic dilatation is more frequent in patients in the sixth decade of life who have a history of hypertension, smoking; however, patients with connective tissue or bicuspid aortic valve diseases present dilatation at younger ages. In most of the published series, aneurysms of the ascending aorta are the most frequent, their main etiology is arteriosclerosis and degenerative aorta. Histologically, they present degenerative changes of the elastic fibers and collagen of the middle layer of the wall, constituting an entity called cystic necrosis of the media, the surgical decision should be based on symptoms, comorbidities, imaging tests and risk-benefit.[13]

According to the literature, Stanford A type aortic dissection is the most common, accounting for approximately 70% of cases. In our study, however, it occurred in only 33.3% of patients. This type of dissection involves the proximal arch, extending to the left subclavian artery, and is influenced by anatomical and hemodynamic factors.

A common underlying factor in aortic dissections is the deterioration of the mechanical properties of the aortic wall, resulting from alterations in the middle layer. Frequently, this is accompanied by changes in the elastic component, including fragmentation of elastic fibers, similar to those seen in Marfan syndrome. Haemodynamically, most of them present hypertension with left ventricular hypertrophy. Death can occur within minutes to hours due to rupture or dissection of the pericardial sac, or dissection of the coronary arteries resulting in infarction, the Stanford A type invariably must be operated on.[14]

The evidence in the current clinical guidelines recommends evaluating urgent surgery when there is endocarditis in the presence of acute aortic dissection, Class of Recommendation I, Level of Evidence B.[1,15] Endocarditis is a complex disease with high morbidity and mortality; it leads to heart failure, perivalvular extension, embolic events; in contrast, its association with aortic dissection is not very frequent. In two case report studies, each one shows a patient with perivalvular abscess, severe aortic root dilation (52 mm), dilatation of the ascending aorta with root dissection,[15,16] similar to the cases presented in our study, in which we also report two cases that presented perforation of an abscessed non-coronary sinus.

The most performed operation was the Bentall-De Bono procedure, which has demonstrated its effectiveness for decades, and now remains as the "gold standard" for type A aortic dissection because it is safe and feasible (Evidence IB). Since in dissection the aortic leaflets remain intact, some literature considers the use of techniques that preserve the native leaflets such as the Yacoub technique; however, the lack of stabilization of the annulus can lead to recurrent aortic regurgitation, and due to the long anastomotic line, it increases the risk of bleeding, limiting the experience to perform this operation, especially in tissue dissection. David's modified technique shows advantages by not requiring long-term anticoagulation with complete restoration of the aortic root, which is why it is especially recommended in young patients.[17] In our study, the main complications were haemorrhage that required chest-packing in 25% of the cases, which were accompanied by endocarditis with friable tissues. Both of them were the most frequent causes of mortality.

The International Registry of Aortic Diseases (IRAD) reported 682 surgical cases across 18 centers, with only 5.8% of patients undergoing replacement surgery. Similarly, the German Registry of Acute Aortic Dissection Type A (GERAADA), which compiled data from 56 centers, found that merely 8.2% of patients received aortic replacement surgery. This low percentage is attributed to the technical complexity of these procedures, which involve prolonged surgical times,

extensive tissue dissection, and pose a significant challenge even for experienced surgeons, particularly during the acute phase of this pathology.[17]

CONCLUSIONS

The findings in our study allow us to suggest that the benefits of ascending aorta surgery are evident, being a reliable procedure in expert hands. A wide variety of techniques can be performed depending on the type of pathology and the factors related to each patient. We emphasize that it is necessary to carry out studies with larger samples for future generations of surgeons.

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