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Research Article

Aortic Root Surgery: A single center experience

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ABSTRACT

Background

Aortic root surgery varies widely in techniques and from institution to institution. Success requires precision and superb post-operative care. The purpose of this study was to evaluate the indications and outcomes of this procedure at a single small volume academic medical center.

Methods

The study was carried out with IRB approval, consisting of 99 patients undergoing aortic root surgery from January 2013 to June 2015. 45 underwent procedures for aneurysm, 11 for infective native valve endocarditis, 16 for prosthetic valve endocarditis, 21 for aortic root dissection, and 14 for other etiologies. The procedures were performed using homograft (10), composite (8), or biologic (81) valves. 28 of the operations included a second procedure, and 39 of the operations were redo procedures.

Results

Complications analyzed included operative death (8.9%), stroke (10%), surgical site infection (1.1%), and cardiac arrest (6.5%). Mortality rates were: aneurysm 2.2%, infective endocarditis 7.4%, dissection 19%, and other etiologies 7.1%.

Conclusions

In comparing our institution to others, we found that complications were on average within the range of published studies.

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Introduction

Aortic root replacement is a complex operative procedure. Bentall and DeBono introduced a technique for the replacement of the aortic valve and ascending aorta in 1968, and since that time multiple operative techniques and prosthesis options have evolved [1]. Each developed for particular pathologies and varying in technical difficulty; the Ross, David and Yacoub procedures [2-4]. The outcomes of the Bentall procedure and the newer procedures have been compared extensively among individual institutions, however no clear consensus has been

reached as to which procedure is preferred for certain indications [5-11]. Currently, the type of procedure and choice of graft is based not only the clinical characteristics of the patient but the skill level and preference of the surgeon as well. The Bentall procedure has emerged as the most common for repair of ascending aortic pathology, and this study focuses on the outcomes of this procedure at one small-volume academic medical center [12]. When comparing complications of aortic root replacement among institutions, statistics can vary drastically from a superficial examination, however it is apparent that these statistics need to be evaluated from the perspective of the etiology rather than the

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outcomes of aortic root replacements as a whole. Additionally, there has been evidence to suggest that complex procedures such as the Bentall procedure, have better outcomes at large volume centers [13-17]. The objective of this study was to determine if the outcomes of a small volume center are acceptable when compared to published benchmarks.

Clinical Materials

This retrospective case series of 99 patients was carried out with IRB approval, and consisted of all patients who underwent aortic root replacement using the Bentall procedure at the University of Kentucky Medical Center from January 2013 to June 2015. All procedures were performed by two experienced cardiothoracic surgeons at this institution. Patients were identified using the STS Adult Cardiac Surgery Database. 105 patients were identified initially, however 6 were excluded based on incomplete medical records, leaving a total of 99 patients for inclusion in the study.

Comparison of results was performed through a review of published studies contained within PubMed that had reported outcomes for the Bentall procedure using biologic, composite or homograft valve prostheses. A systematic review was utilized for the comparison of outcomes with biologic valve prostheses, and mechanical valve, however no such studies existed for homograft valve replacements, and large volume case series were utilized. Outcomes for 30-day mortality and stroke were compared.

Our patient population had a mean age of 56, 69 male and 67 were active smokers at the time of their procedure. The demographics of the patients are listed in (Table 1) and in (Table 2) broken down by indication. Patients with either native or prosthetic valve endocarditis were younger, more likely to be current or former smokers, and less likely to have hypertension, dyslipidemia, or diabetes. The most common indication was aneurysm (44) followed by aortic dissection (16) and prosthetic valve endocarditis (16).

Table 1

Demographic	Value
Age	55.6
% Male	69.7%
Smokers	67.9%
Hypertension	72.4%
Dyslipidemia	59.6%
Diabetes	20.5%
Previous Cardiac Intervention	38.6%

Table 2

Procedure	Aneurysm	Endocarditis (native)	Endocarditis (prosthetic)	Dissection	AI/AS
Homograft	0	6(54.5%)	4(25%)	0	0
Mechanical	8(18.2%)	0	0	0	0
Biologic	36(81.8%)	5(45.5%)	12(75%)	16(100%)	12(100%)

Results

The two most common complications were prolonged ventilation (45) and atrial fibrillation (40). The primary endpoints of the study were thirty-day mortality and stroke, which were 8% and 3% respectively for all patients. Thirty-day mortality was lowest for native valve endocarditis (0) and highest for aortic dissection (4) with all deaths for any indication occurring with biologic valve operations. The results are listed in (Table 3 and 4).

Comparison of complications at this institution and others can be found in (Table 5). The systematic review performed by Castrovinci et. al consisted of 29 series and 3,298 patients [18]. Mookhoek et. al found a mortality rate of 5.6% for 7,629 patients in 46 series of patients undergoing aortic root replacement with mechanical valved prosthesis [19]. Several case series of homograft valve replacements were utilized for comparison due to the absence of a systematic review, including Yankah et. al (161 patients), Sabik et al. (103), and Grinda et. al (104) which found 30-day mortality rates of 9.3%, 3.9%, and 5% respectively [20-22].

Table 3 (Death)

Procedure	Aneurysm	Endocarditis (native)	Endocarditis (prosthetic)	Dissection	AI/AS
Homograft	0	0	0	0	0
Mechanical	0	0	0	0	0
Biologic	1(2.3%)	0	2(12.5%)	4(25%)	1(8.3%)

Table 4 (Stroke)

Procedure	Aneurysm	Endocarditis (native)	Endocarditis (prosthetic)	Dissection	AI/AS
Homograft	0	0	0	0	0
Mechanical	0	0	0	0	0
Biologic	0	0	1	2	0

Table 5

Analysis	30-day Mortality	Stroke Rate
Biologic- Valve	9.9%	3.7%
Mechanical-Valve	0%	0%
Homograft	0%	0%
Castrovinci et. al ¹⁸ (Biologic-Valve)	6.7%	3.7%
Mookhoek et. al ³⁰ (Mechanical-Valve)	5.6%	-
Yankah et. al ²⁸ (Homograft)	9.3%	-
Sabik et al. ²⁹ (Homograft)	3.9%	-
Grinda et al. ³⁰ (Homograft)	5%	-

Discussion

The Bentall procedure, developed in 1968, has been considered the gold standard for aortic root replacement since its introduction and consists of removal and replacement of the aortic valve and root with a mechanical or bio-prosthesis, with re-implantation of the coronary artery ostia¹. The mechanical prosthesis has advantages of longevity, however requires lifelong anticoagulation therapy and has a significant risk of hemorrhage per year [23]. The composite bio-prosthesis are xenograft valve-grafts that offer the advantage of not requiring life-long anticoagulation. One alternative that is less commonly used is the homograft root replacement, which offers a lower rate of infection and freedom from anti-coagulation, however it is limited by longevity and more technical implantation [24, 25].

The primary outcome of this study was 30-day mortality and stroke, which were analyzed according to etiology. The 30-day mortality at our institution for biologic valve prosthesis was 9.9% which compared to the 6.7% of the systematic review performed by Castrovinci et al., was within a suitable range for the authors of this paper [18]. While the 30-day mortality was higher, it was similar, and the stroke rate of 3.7% was the same between our institution and the systematic review. A similar method of comparison was utilized for the mechanical valve replacements. Our 30-day mortality rate was found to be 0% while the

systematic review performed by Mookhoek et. al found a mortality rate of 5.6% [19]. These results indicate our institution is performed better or as good as published data regarding 30-day mortality for mechanical valve procedures. As stated previously, the lack of a systematic review for homograft procedures limited the comparison of our institution, however three large retrospective studies conducted by Yankah et. al, Sabik et. al, and Grinda et. al found greater rates than at our institution [20-22]. All of the studies besides Castrovinci et. al did not report stroke as a major outcome, however our rates were the same for biologic-valves and were acceptably low at 0% for mechanical and homograft valves. Complication rates reported in the majority of the literature typically involve only one or two types of valved conduit at any one institution, however the authors of this paper sought to compare our outcomes to benchmarks for all types of valved conduit utilized for aortic root replacement.

The technical complexity of aortic root replacement necessitates that a combination of surgeon skill, root pathology, and patient demographics determine the type of procedure that is performed. Aortic root replacement is increasingly a procedure performed on an aging population, and as such the use of a biologic composite prosthesis has been considered a reasonable choice. Benefits of the biologic composite conduit include increasing evidence of long-term durability and the avoidance of life-long anticoagulation. Long term survival of this

procedure at 1, 2, 3, 5, and 10 years survival is 88%, 86%, 82%, 76%, and 58%, respectively [18]. The analysis of long-term outcomes is not robust, and this is a critical outcome that warrants future evaluation.

Infective endocarditis has been rapidly progressing as a major healthcare issue in this country. In our study the incidence of native or prosthetic root replacements due to infective endocarditis tripled from 2013 to 2014 and was on pace to nearly double again by the end of 2015. This rate of progression is more rapid than the national increase in incidence of infective endocarditis, which was estimated to be 6-8% of hospitalizations between 2000-2008 and increased to 12% in 2013 [26]. A potential explanation of our finding is the increased prevalence of drug abuse in Kentucky relative to the rest of the country [27]. Outcomes for infective endocarditis have improved over the past 5 years, however for aortic root replacement it still carries a significant risk. In our study infective endocarditis carried a 30-day mortality of 7.4%. It seems that infective endocarditis will continue to be an important risk factor for outcomes in aortic root replacement and solutions to this growing epidemic are needed quickly.

Presentation of outcomes of aortic root procedures is variable, and consideration of the procedural etiology is essential to an accurate comparison. It is difficult to compare institutions even when directly comparing the etiology and procedure due to the unknown severity of etiology necessitating operation, and outcomes are greatly influenced by the pathology of the root. However, when comparing our institution to systematic review and large case series we have shown acceptable rate of adverse events for a variety of root pathologies. This paper provides evidence that outcomes of aortic root replacement are acceptable at a small-volume academic medical center when operations are conducted by skilled and experienced surgeons, and that transfer to a larger-volume center may not result in better outcomes.

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