Aortic root replacement to treat type A aortic dissection: a comparison of mid-term outcomes between composite-valve-grafts and porcine aortic roots

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Abstract

Background Porcine aortic roots (PAR) have been reported in the literature with acceptable short and long-term outcomes for the treatment of aortic root aneurysms. However, their efficacy in type A aortic dissection (TAAD) is yet to be defined. Methods Using data from a locally collated aortic dissection registry, we compared the outcomes in patients undergoing aortic root replacement for TAAD using either of two surgical options: i) PAR or ii) composite valve grafts (CVG). A retrospective analysis was conducted for all procedures in the period 2005-2018. Results A total of 252 patients underwent procedures for TAAD in the time period. Sixty-five patients had aortic root replacements (PAR n=30, CVG n=35). Between group comparisons identified a younger CVG group (50.5 vs 64.5, p<0.05) although all other covariates were comparable. Operative parameters were comparable between the two groups. The use of PAR did not significantly impact operative mortality (OR 0.93, 95% CI 0.22-3.61, p=0.992), stroke (OR 2.91, 0.25 – 34.09, p=0.395), re-operation (OR 0.91, 95% CI 0.22 – 3.62, p=0.882) or length of stay (coef 2.33, -8.23 – 12.90, p=0.659) compared to CVG. Five-year survival was similar between both groups (PAR 59% vs CVG 69%, p=0.153) and re-operation was negligible. Echocardiography revealed significantly lower aortic valve gradients in the PAR group (8.69 vs 15.45 mmHg, p<0.0001), and smaller left ventricular dimensions both at 6 weeks and 1 year follow up (p<0.05). Conclusions This study highlights the comparable short and mid-term outcomes of PAR in cases of TAAD, in comparison to established therapy.

Title: Aortic Root Replacement to treat Type A Aortic dissection: a comparison of mid-term outcomes between composite-valve-grafts and Porcine Aortic Roots

Authors

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ABSTRACT

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Methods

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Results

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Conclusions

This study highlights the comparable short and mid-term outcomes of PAR in cases of TAAD, in comparison to established therapy.

INTRODUCTION

The primary aim of surgery for acute type A aortic dissection (TAAD) is the prevention of death from aortic rupture, which is mainly accomplished by excision of the proximal intimal tear, supra-coronary ascending aorta replacement and re-establishment of dominant flow in the distal true lumen(1–3). Ensuring a competent aortic valve is an equally vital goal of surgery, although the methods of how to address this is a matter of debate.

The decision to replace the aortic root depends on the proximal extent of the dissection flap, degree of aortic regurgitation and the surgeon's choice. The operative strategies can be broadly divided between a conservative root repair and a complete root replacement with re-implantation of coronaries. Specifically, the variations in management include: i) interposition graft only; ii) interposition graft with aortic valve resuspension(4); iii) interposition graft with aortic valve replacement; iv) valve sparing root replacement(5,6); or v) root replacement with a valve-graft composite (first described by Bentall and De Bono)(7). Aortic root replacement (ARR) has most commonly involved mechanical composite valve grafts (CVG), which have excellent durability but necessitate lifelong anticoagulation(8).

The rationale for stentless aortic valve replacement was born out of the pioneering use of homografts and pulmonary autografts over the last few decades. Acceptable valve durability and improved valve haemodynamics compared to stentless valves were important characteristics that stimulated continued uptake of stentless technology(9,10). Stentless porcine aortic roots (PAR) also have an established role in clinical practice, primarily in the treatment of aortic valve disease and proximal aortopathy, although their use in TAAD is less well characterised in the literature.

This study aims to compare the outcomes between PAR and CVG in patients undergoing aortic root replacement for acute TAAD.

MATERIALS AND METHODS

The study was approved by the Research Ethics Office at the Royal Brompton and Harefield Foundation Trust. Perioperative data was retrospectively analysed from a prospectively collated database at a single cardiothoracic institution between 2005 and 2018.

Study population

In this period, a total of 252 patients underwent repair for acute TAAD. The institution operates a regional referral system from associated nearby emergency departments for cases with TAAD. The on-call cardiothoracic consultant alternates on a rota basis. The standard care is immediate transfer upon discussion with the referring physician and review of relevant imaging, followed by planning for emergent surgery.

Only patients undergoing aortic root replacement (ARR) were included. Patients were subclassified as having i) porcine ARR (PAR); or ii) composite valve-graft (CVG) root replacement. The prosthesis used in the former group was the Freestyle porcine aortic root (Medtronic, Minneapolis, MN).

The primary indication for ARR was the presence of an intimal tear in the aortic root. Other indications were aortic root diameter >4.5cm, known connective tissue disease, aortic valve pathology and coronary dissection. For the purpose of this study, patients undergoing a valve-sparing root replacement or interposition graft (with or with aortic valve replacement) were excluded.

Operative Technique

All patients underwent median sternotomy for access. Cannulation strategies varied: venous cannulation of the right atrium was usually attempted. Arterial cannulation usually involved the femoral or right axillary artery cannulation. For the latter, a tube graft was usually anastomosed to the target vessel in order to receive the cannula. Myocardial protection was achieved with cold-blood cardioplegia solution, infused retrogradely via the coronary sinus or antegrade directly through the coronary ostia. A left ventricular vent was commonly inserted via the right superior pulmonary vein. Hypothermic circulatory arrest was used in most cases, and the arch was inspected for tears.

The goal of surgery was to resect the intimal tear, replace the ascending aorta with a prosthetic graft, and restore the anatomy of the aortic root. This study included patients in whom the aortic root or valve was deemed to be diseased beyond repair, necessitating ARR. The majority of patients requiring ARR with biological substitutes received a Freestyle graft, compared to patients selected for mechanical prosthesis who underwent ARR with a mechanical CVG. Patients receiving a bioprosthetic CVG, although few, were not excluded.

Following excision of the native aortic root and sizing of the annulus, the graft (either PAR or CVG) was sewn into the aortic annulus with interrupted sutures. The method for reimplantation of the left coronary button on the Freestyle prosthesis was left to the discretion of the surgeon, either to the left or right coronary stump of the graft (the remaining stump is usually oversewn). For the right coronary button, a new ostium is fashioned on a suitable region of the graft for anastomosis.

Where appropriate, hemiarch or arch replacement with reimplantation of one- to three-branch vessels was performed based on the arch pathology. Antegrade or retrograde cerebral perfusion was used for cerebral protection during hypothermic circulatory arrest.

Data collection

The cardiac surgical database is locally managed and centrally overseen at a national level, following national guidelines for minimal perioperative data collection, including pre-operative co-variates, detailed operative characteristics and short-term post-operative outcomes.

In our centre, patients undergo routine trans-oesophageal echocardiography in theatre peri-operatively followed by computerised tomography scans before discharge, and then every year on their follow up. Early and mid-term outcomes were assessed based on echocardiographic findings and grading of aortic regurgitation.

Statistical analysis

Results were analysed and presented as means and standard deviations. Pre-operative covariates were assessed for normal distribution using the Shapiro-Wilk test. Between group characteristics were assessed for statistical differences using the Student T test or Wilcoxon Rank Test for non-parametric variables. Multivariate logistic regression models were constructed to assess the influence of a variety of covariates on short term outcomes. Linear regression was used to assess the influence of covariates on parametric outcomes, namely hospital stay. Adjusted

odds ratio with 95% confidence interval (CI) of binary outcomes were calculated. Crude survival curves were estimated using the nonparametric Kaplan-Meier

method, and log rank tests were used to compare the survival distribution among groups. Cox proportional hazard regression was conducted to calculate the adjusted hazards ratio with 95% CI. Stepwise selection was performed using age, sex, COPD, Euroscore, NYHA class and LV function in the model. Statistical analyses were conducted using the Stata 13.0 software (Stata Corp., College Station, TX, USA).

RESULTS

During the study period, out of 252 patients, 65 patients underwent aortic root replacement (ARR), out of which 35 patients underwent root replacement with a CVG and 30 patients underwent root replacement with the Freestyle porcine root (PAR).

Preoperative characteristics are presented in Table 1. There was a significant difference in mean age between the two operative groups (CVG vs PAR: 50.5 vs 64.5 years). All other pre-operative co-variates (gender, diabetes, hypertension, chronic obstructive pulmonary disease (COPD), renal failure and Euroscore.

Operative Characteristics

Operative characteristics are presented in Table 2. Cardiopulmonary bypass time was similar between the two groups (CVG vs PAR, 228±19 vs 211±34 min, p=0.678), as was aortic cross clamp time (197±16 vs 210±19, p=0.291) and circulatory arrest time (19±4 vs 22±5, p=0.328).

Similarly, cannulation strategy was also comparable, with n=12 vs 9 (CVG vs PAR) receiving femoral cannulation, and n=8 vs 10 (CVG vs PAR) receiving axillary cannulation. Two patients in either group underwent a hemiarch replacement, whereas 3 patients required a total arch replacement in the CVG group, compared to none from the PAR group.

Short term outcomes

Postoperative characteristics are shown in Table 3. Operative deaths occurred in 6 of the CVG patients, compared to 4 of the PAR patients (p>0.05). The most common cause of death was cardiac. Two (5.7%) patients in the CVG group and 4 (13.3%) patients in the PAR group had a new post-operative neurological deficit. There was no statistically significant difference between both groups.

Multivariate regression analysis: short-term outcomes

Stepwise multivariate regression models were constructed to assess the effects of covariates on the main outcomes of interest, namely mortality, length of stay, re-operation and composite measure of complications (Table 4).

Importantly, the use of PAR over CVG did not increase the risk of operative death, re-operation, composite complications or length of hospital stay.

The only co-variate found to be a predictor of short-term complications was the Euroscore (odd ratio, OR 0.91, 95% CI 0.84–0.99, p=0.033).

Survival and reoperation

Results were available for up to 5 years follow up for survival analysis (total follow up time = 164 patient years). Mean follow up time was 2.9±3.9 years. Kaplan Meier analysis (Figure 1) showed similar survival between the two surgical cohorts: PAR 59% survival (95% CI 26–80%), CVG 69% survival (95% CI 37–82%), Logrank test p=0.158.

The Cox proportional hazards model analysis found the Euroscore and pre-operative haemodynamic instability function to be predictors of worse survival (Hazard Ratio (HR) 1.03, 95% CI 1.01–1.07, p=0.046) and (HR 3.74, 95% CI 1.19–11.80, p=0.024). After controlling for age, sex, history of renal failure, the influence of PAR on survival compared to CVG remained to be non-inferior (HR 1.05, 95% CI 0.39–2.81, p=0.920) (Table 5).

Reoperation

Throughout the follow-up period only one patient required re-intervention on the aortic root at 3 years following the index procedure (mechanical CVG). This was due to recurrent mediastinitis resulting in a false aneurysm around the left coronary button and dehiscence of the proximal suture-line. The patient died shortly after the re-intervention. No patient from the PAR required re-intervention within the 5-year follow-up period.

Echocardiographic follow-up

Pre-operative echocardiography was unavailable for most patient, being emergent cases. Follow up echocardiography data was available for >85% of patients, with both 6 weeks and 1-year follow-up available, allowing for a comparative analysis between both time points (Figure 2)(Table 6).

Aortic valve gradient

At 6 weeks post-operatively, the PAR group had a significantly lower transvalvular peak gradient (PG) (8.69 vs 15.45, p<0.0001) compared to the CVG group, which persisted at 1 year (7.52 vs 13.70, p=0.001). None of the patients in either group were found to have more than mild aortic regurgitation.

Left ventricle

Patients in the PAR group demonstrated echocardiographic signs of early positive left ventricular remodeling (Table 6). At 6 weeks, left ventricular end diastolic diameter (LVEDD) was significantly lower in the PAR group (4.64 vs 5.01 cm, p=0.039) compared to the CVG group. By one year, LVEDD was not different (4.65 vs 4.94 cm, p=0.144) although the left ventricular end systolic diameter (LVESD) was found to be significantly smaller in the PAR group (3.04 vs 3.53 cm, p=0.024). The overall mean net change in LVESD between 6 weeks and 1 year was also more negative in the PAR group (-0.11 vs +0.13 cm, p=0.05). Left ventricular function at 6 weeks and 1 year was not different between the treatment groups, nor was the net change in function.

DISCUSSION

In our experience, root replacement in TAAD with stentless PAR is a feasible alternative to the CVG, especially in older patients. Our decision for root replacement in TAAD was based primarily on the requirement for biological substitutes, either due to the patient's age or known contraindication to anticoagulation, as a suitable alternative to a bio-Bentall. The need for clarity on patient and procedure selection is crucial in TAAD, especially given the excellent outcomes reported by several institutions using widely varying techniques(11).

Acute type A aortic dissection (TAAD) has a mortality of 50% within the first 48 hours if not operated on(12). The choice of root replacement versus conservation varies from centre to centre, although certain cases render the need for root replacement in TAAD quite necessary, especially if the dissection extends to at least one sinus of Valsalva. Avoiding root replacement in such cases is associated with late dilation of the aortic sinuses and recurrence of aortic regurgitation, making the risk of re-operation unacceptably high(13).

Root replacement using a CVG has been considered the gold standard for all acute TAAD when the aortic root is dilated greater than 4.5 cm, contains an intimal tear, or if there is known connective tissue disease(14,15). A mechanical CVG is usually offered to younger patients, due to proven valve durability(16). However, the need for surgical alternatives is important, especially in cases where anticoagulation may be contraindicated. Furthermore, the impact of anticoagulation on the prognosis of the distal aorta is important to consider and may in fact increase the incidence of false lumen patency(17). This claim has however been refuted by other studies, finding that anticoagulation did not lead to an increased incidence of distal aortic events or impact false lumen thrombosis(18,19). The present study has demonstrated that the performance of aortic root replacements (ARR) using porcine stentless aortic roots (PAR) have comparable short and midterm outcomes to composite valve grafts (CVG) and can be safely used for the management of type A aortic dissection (TAAD).

The Freestyle bioprosthesis (Medtronic, Minneapolis, MN) is a complete porcine aortic root with ligated coronary arteries and a thin skirt over the porcine septal muscle bar. Their design have very comparable advantages to stented bioprosthetic valves, including suitable durability in the elderly population whilst making anticoagulation redundant (20). Furthermore, stentless valve technology has long been shown to offer superior hemodynamic performance when compared to stented counterparts(9,21). Flow patterns are remarkably similar to normal native aortic valves(22). Echocardiographic studies have demonstrated lower mean aortic valve gradient and improved left ventricular mass regression at 6 months post operatively(23). This is supported by our data (Table 4) which demonstrates that the improved valve haemodynamic profile and consequent positive LV remodeling is achievable in emergency TAAD cases, with results potentially evident by 6 weeks follow up.

In the literature, evidence for the use of PAR in patients with TAAD has been sporadic. Smith et al(24) demonstrated the use of the Medtronic Freestyle bioprosthesis in TAAD with satisfactory early and midterm outcomes in 24 patients, although this was not compared with a valid control. Similarly, larger centres have reported the use of porcine stentless aortic roots as the biological conduit of choice in TAAD with good results(25,26). Despite this, there is limited evidence comparing the use of porcine stentless aortic bioprosthesis with alternative root surgery in TAAD.

Strengths and limitations

The present study is the first to assimilate clinical data in TAAD directly comparing the use of PAR to best practice. Our analysis included survival, as well as echocardiographic data at separate time-points. However, the retrospective design and small sample size (n=30 in PAR group, n=35 in CVG group) renders this analysis relatively underpowered. As our follow-up time was limited to 5 years, valve durability, especially of PAR could not be adequately analysed, which may have important relevance beyond 10 years, including the incidence of structural valve degeneration and need for re-intervention. Future studies would benefit from long-term echocardiographic and outcome analysis as well as the effect of either treatment on the prognosis of the distal aorta and need for intervention on the descending portion.

Conclusion

Our data illustrates that the use of PAR, such as the Freestyle, can be used to replace the diseased aortic root at the time of repair of TAAD with acceptable intra- and post-operative mortality & morbidity. Mid-term survival are satisfactory echocardiographic outcomes are more favourable than CVG in the early phase. Especially in the elderly population, PAR can be considered as a first line option when indicated. More studies are required to confirm the durability, freedom from structural valve degeneration, and long-term clinical outcomes of this group of patients.

Conflicts of interest

None to declare

REFERENCES

1. Berretta P, Patel HJ, Gleason TG, Sundt TM, Myrmel T, Desai N, et al. IRAD experience on surgical type A acute dissection patients: Results and predictors of mortality. Annals of Cardiothoracic Surgery. 2016.

2. Hiratzka LF, Bakris GL, Beckman JA, Bersin RM, Carr VF, Casey DE, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SC Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease. Circulation. 2010 Apr;121(13).

3. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo R Di, Eggebrecht H, et al. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European. Eur Heart J. 2014 Nov;35(41):2873–926.

4. Beckmann E, Martens A, Alhadi F, Ius F, Koigeldiyev N, Fleissner F, et al. Is Bentall Procedure Still the Gold Standard for Acute Aortic Dissection with Aortic Root Involvement? Thorac Cardiovasc Surg. 2015 Jun;64(02):116–23.

5. David TE, Feindel CM. An Aortic-Valve Sparing Operation for Patients with Aortic Incompetence and Aneurysm of the Ascending Aorta. J Thorac Cardiovasc Surg. 1992;

6. Sarsam MAI, Yacoub M. Remodeling of the Aortic-Valve Anulus. J Thorac Cardiovasc Surg. 1993;

7. Bentall H, De Bono A. A technique for complete replacement of the ascending aorta. Thorax. 1968;

8. LeMaire SA, Green SY, Sharma K, Cheung CK, Sameri A, Tsai PI, et al. Aortic Root Replacement With Stentless Porcine Xenografts: Early and Late Outcomes in 132 Patients. Ann Thorac Surg. 2009;

9. Westaby S, Huysmans HA, David TE. Stentless aortic bioprostheses: Compelling data from the Second International Symposium. In: Annals of Thoracic Surgery. 1998.

10. Borger MA, Moustafine V, Conradi L, Knosalla C, Richter M, Merk DR, et al. A randomized multicenter trial of minimally invasive rapid deployment versus conventional full sternotomy aortic valve replacement. In: Annals of Thoracic Surgery. 2015.

11. Chiu P, Trojan J, Tsou S, Goldstone AB, Woo YJ, Fischbein MP. Limited root repair in acute type A aortic dissection is safe but results in increased risk of reoperation. J Thorac Cardiovasc Surg. 2018;

12. Howard DPJ, Banerjee A, Fairhead JF, Perkins J, Silver LE, Rothwell PM. Population-Based Study of Incidence and Outcome of Acute Aortic Dissection and Pre-Morbid Risk-Factor Control: 10-Year Results from the Oxford Vascular Study. Circulation. 2013;

13. Kon ND, Riley RD, Adair SM, Kitzman DW, Cordell AR. Eight-year results of aortic root replacement with the freestyle stentless porcine aortic root bioprosthesis. Ann Thorac Surg. 2002;

14. Kunihara T, Neumann N, Kriechbaum SD, Aicher D, Schäfers HJ. Aortic root remodeling leads to good valve stability in acute aortic dissection and preexistent root dilatation. J Thorac Cardiovasc Surg. 2016;

15. Yang B, Patel HJ, Sorek C, Hornsby WE, Wu X, Ward S, et al. Sixteen-Year Experience of David and Bentall Procedures in Acute Type A Aortic Dissection. Ann Thorac Surg. 2018 Mar;105(3):779–84.

16. Chikwe J, Chiang YP, Egorova NN, Itagaki S, Adams DH. Survival and outcomes following bioprosthetic vs mechanical mitral valve replacement in patients aged 50 to 69 years. JAMA - J Am Med Assoc. 2015;

17. Zhao X, Sun LZ, Zheng J, Chang Q, Zhu JM, Liu YM, et al. Early influence of valve-related anticoagulation on false lumen thrombosis in aortic dissection patients after stented elephant trunk surgery. Thorac Cardiovasc Surg. 2010;

18. Song SW, Yoo KJ, Kim DK, Cho BK, Yi G, Chang BC. Effects of early anticoagulation on the degree of thrombosis after repair of acute DeBakey type i aortic dissection. Ann Thorac Surg. 2011;

19. Von Kodolitsch Y, Wilson O, Schüler H, Larena-Avellaneda A, Kölbel T, Wipper S, et al. Warfarin anticoagulation in acute type A aortic dissection survivors (WATAS). Cardiovasc Diagn Ther. 2017;

20. Pibarot P, Dumesnil JG, Jobin J, Cartier P, Honos G, Durand LG. Hemodynamic and physical performance during maximal exercise in patients with an aortic bioprosthetic valve: Comparison of stentless versus stented bioprostheses. J Am Coll Cardiol. 1999;

21. Borger MA, Carson SM, Ivanov J, Rao V, Scully HE, Feindel CM, et al. Stentless aortic valves are hemodynamically superior to stented valves during mid-term follow-up: A large retrospective study. Ann Thorac Surg. 2005;

22. Bach DS, David T, Yacoub M, Pepper J, Goldman B, Wood J, et al. Hemodynamics and left ventricular mass regression following implantation of the Toronto SPV stentless porcine valve. Am J Cardiol. 1998;

23. Kunadian B, Vijayalakshmi K, Thornley AR, de Belder MA, Hunter S, Kendall S, et al. Meta-Analysis of Valve Hemodynamics and Left Ventricular Mass Regression for Stentless Versus Stented Aortic Valves. Ann Thorac Surg. 2007;

24. Smith CR, Stamou SC, Hooker RL, Willekes CC, Heiser JC, Patzelt LH, et al. Stentless root bioprosthesis for repair of acute type A aortic dissection. J Thorac Cardiovasc Surg. 2013;

25. Easo J, Weymann A, Hölzl P, Horst M, Eichstaedt H, Mashhour A, et al. Hospital Results of a Single Center Database for Stentless Xenograft Use in a Full Root Technique in Over 970 Patients. Sci Rep. 2019;

26. Bavaria JE, Brinster DR, Gorman RC, Woo YJ, Gleason T, Pochettino A. Advances in the treatment of acute type A dissection: An integrated approach. In: Annals of Thoracic Surgery. 2002.

Table 1

Pre-operative patient characteristics

Covariates	Composite valve graft (n=35)	Porcine aortic root (n=30)	P value
Age	50.5±15.8	64.5±12.6	0.003
Female	8(22.8%)	15(50%)	0.290
Male	27(77.1%)	15(50%)	
Connective tissue disease	6(2.9%)	2(6.7%)	
Hypercholesterolaemia	10(28.5%)	12(40%)	0.407
Diabetes	4(11.4%)	4(13.3%)	0.968
Hypertension	24(68.6%)	21(70%)	0.982
Congestive cardiac failure	5(14.3%)	5(16.7%)	0.889
Myocardial infarction	5(14.3%)	4(13.3%)	0.996
Acute Kidney Injury	2(5.7%)	1(3.3%)	
Chronic Kidney Disease	0(0%)	0(0%)	0.990
Dialysis	1(2.9%)	0(0%)	

Covariates	Composite valve graft (n=35)	Porcine aortic root (n=30)	P value
Chronic obstructive pulmonary disease	4(11.4%)	2(6.7%)	0.948
Arrhythmia	2(5.7%)	2(6.7%)	0.986
Previous Cardiac Surgery	2(5.7%)	4(13.3%)	0.873
Smoking	18(51.4%)	13(43.3%)	0.981
Haemodynamic instability	29(82.9%)	25(83.3%)	0.889

Table 2

Intra operative characteristics

Intraoperative	*Composite valve graft (n= 35)*	*Porcine aortic root (n= 30)*	*P value*
Cardiopulmonary bypass Time (mins)	228 ± 19	211 ± 34	0.678
Cross clamp time (mins)	197 ± 16	210 ± 19	0.291
Circulatory arrest time (mins)	19 ± 4	22 ± 5	0.328
Valve size implanted (mm)	25.6 ± 2.0	26.2 ± 2.7	0.390
Concomitant CABG	7	5	0.673
Redo sternotomy	2	5	0.211
Femoral Cannulation	12	9	0.340
Axillary/left subclavian	8	10	0.491
Hemiarch replacement	2	2	0.810
Total arch replacement	3	1	0.150

Short-term complication	Composite valve graft (n=35)	Porcine aortic root (n=30)
IABP	2(5.7%)	0(0%)
VAD	1(2.9%)	0(0%)
Permanent Pacemaker	3(8.6%)	1(3.3%)
Re-operation	6(17.1%)	4(13.3%)
Reintubation	10(28.6%)	3(10%)
Sepsis	1(2.9%)	2(6.7%)
Wound Infection	1(2.9%)	1(3.3%)
Pericardial effusion	1(2.9%)	1(3.3%)
Pleural effusion	5(14.3%)	2(6.7%)
New Neurological deficit	2(5.7%)	4(13.3%)
Renal dialysis	8(22.9%)	8(26.7%)
Average Length of Stay	17.4 days	22.1 days
Death	6(17.1%)	4(13.3%)

Table 3

Post-operative complications of Patients in Bentall group vs. Porcine aortic root group.

Table 4

Multivariate model assessing the influence of relevant covariates on short-term outcomes. Statistical models used were as follows:

For mortality and reoperation = binary logistic regression

For length of stay: Poisson regression

For composite complication: ordinal logistic regression

	Mortality	Mortality	Mortality	Length of stay	Length of stay	Length of stay	Po
COVARIATE	**OR**	**95% CI**	**P value**	**Coeff**	**95% CI**	**P value**	**O**
Use of porcine aortic root	0.9	0.22 – 3.61	0.992	2.33	-8.23 – 12.90	0.659	0.
Patient Age	1.01	0.94 – 1.09	0.669	0.0081	-0.33 – 0.35	0.962	0.
Euroscore	1.05	0.98 – 1.14	0.180	0.43	-0.061 – 0.923	0.085	0.
Pre op NYHA class	0.52	0.19 – 1.44	0.209	-3.11	-7.31 - .109	0.143	1.

Table 5:

Cox proportional hazards, influence of covariates on mid-long-term survival

Covariate	**Hazard ratio**	**Standard error**	**95% confidence interval**	**P value**
Porcine root	0.29	0.29	0.044 – 1.97	0.208
Mechanical valve	0.52	0.46	0.092 – 2.96	0.462
Age	1.02	0.022	0.98 – 1.07	0.214
Euroscore	1.03	0.023	1.01 – 1.07	**0.046**
NYHA score	1.03	0.20	0.70 – 1.50	0.894
Haemodynamic instability	3.74	2.19	1.19 – 11.80	**0.024**
COPD	2.12	1.13	0.74 – 6.03	0.159

NYHA = New York Heart Association COPD = chronic obstructive pulmonary disease

Table 6

Echocardiographic outcomes following aortic root replacement for type A aortic dissection at 6 weeks and 1 year, and average change between the earlier and later follow up time.

	Aortic valve PG (mmHg)	**LVEF (%)**	**LVESD (cm)**	**LVEDD (cm)**
6 weeks	**6 weeks**	**6 weeks**	**6 weeks**	**6 weeks**
Porcine root	8.69 ± 2.89	60.15 ± 8.18	3.18 ± 0.89	4.64 ± 0.66
Composite valve graft	15.45 ± 5.51	55.30 ± 13.66	3.11 ± 1.13	5.01 ± 0.55
P value	**<0.0001**	0.894	0.578	**0.039**
1 year	**1 year**	**1 year**	**1 year**	**1 year**
Porcine root	7.52 ± 3.63	62.39 ± 7.76	3.04 ± 0.79	4.65 ± 0.64
Composite valve graft	13.70 ± 6.78	56.43 ± 10.98	3.53 ± 0.80	4.94 ± 1.07
P value	**0.001**	0.673	**0.024**	0.144
Change	**Change**	**Change**	**Change**	**Change**
Porcine root	-0.98 ± 5.59	+1.68 ± 8.83	-0.11 ± 0.42	+0.04 ± 0.28
Composite valve graft	+0.87 ± 4.33	+1.90 ± 9.48	+0.13 ± 0.67	+0.01 ± 0.42
P value	0.163	0.472	**0.050**	0.614

LVEF = left ventricular ejection fraction LVESD = left ventricular end systolic diameter LVEDD = left ventricular end diastolic diameter PG = peak gradient

Figure legends

Figure 1

Kaplan-Meier survival analysis comparing composite valve graft with porcine aortic root replacement (PAR). PAR 5 year survival 59% (95% CI 26 - 80%), Bentall 5 year survival 69% (95% CI 37 - 82%)

Figure 2

Plots displaying changes in echocardiographic data for patients between 6 weeks and 1 year follow up following Porcine aortic root replacement (A, B and C) and composite valve graft (D, E and F) for type A aortic dissection.

LVEF = left ventricular ejection fraction LVESD = left ventricular end systolic diameter LVEDD = left ventricular end diastolic diameter

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