

Original Article

Post-operative results of Bentall surgery at a national reference center in Peru

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ABSTRACT

Objectives. To determine the mortality and postoperative complications of patients undergoing Bentall-DeBono surgery at the Cardiovascular Surgery Service of the National Cardiovascular Institute, EsSalud, Lima, Peru, between 2019 and 2024. **Materials and methods.** This was a single-center, retrospective, descriptive, case series observational study of patients undergoing composite valve-conduit replacement (Bentall-De Bono procedure) for aortic root pathology between January 2019 and December 2024. The primary objective was to determine all-cause mortality and major complications. **Results.** Sixty-three patients underwent Bentall-De Bono surgery. The median age was 58 years (IQR: 40–71), and 19% of patients had Marfan syndrome. The 30-day mortality rate was 7.9% (5 patients). The main complications were: stroke (6.3%), perioperative myocardial infarction (4.8%), permanent pacemaker implantation (11%), and excessive postoperative bleeding (6.3%). The median length of hospital stay was 17 days, and the median length of stay in the ICU was 4 days. In a median follow-up of 745 days (403-1060), the mortality rate was 14%, the stroke rate was 7.9%, the myocardial infarction rate was 4.8%, and the definitive pacemaker implantation rate was 14%. **Conclusions:** Our results for the Bentall-De Bono procedure are acceptable and comparable to those reported in the international literature.

Keywords: Cardiac Surgery; Aortic Root Replacement; Mortality; Peru (Source: MeSH-NLM).

RESUMEN

Resultados posoperatorios de la cirugía de Bentall en un centro de referencia nacional del Perú

Objetivos. Determinar la mortalidad y las complicaciones posoperatorias de pacientes sometidos a cirugía de Bentall-De Bono en el Servicio de Cirugía Cardiovascular del Instituto Nacional Cardiovascular-EsSalud, Lima, Perú, en los años 2019-2024. **Materiales y métodos.** Estudio observacional, retrospectivo, descriptivo, de tipo serie de casos; unicéntrico, de pacientes sometidos a reemplazo compuesto valvular-tubo (procedimiento de Bentall-De Bono) por patología de la raíz aórtica entre enero de 2019 y diciembre de 2024. El objetivo principal fue determinar la mortalidad por todas las causas y las complicaciones mayores. **Resultados.** Sesenta y tres pacientes fueron sometidos a cirugía de Bentall-De Bono; la mediana de edad fue de 58 años (RIC: 40-71); el 19% de los pacientes tenía enfermedad de Marfan. La mortalidad a 30 días fue de 7,9% (5 pacientes) y las principales complicaciones fueron: accidente cerebrovascular (ACV) 6,3%, infarto de miocardio perioperatorio 4,8%, marcapasos definitivo 11% y sangrado excesivo posoperatorio 6,3%. La mediana de hospitalización fue de 17 días y la estancia en UCI fue de 4 días. En una mediana de seguimiento de 745 días (403-1060), la mortalidad fue de 9/63 pacientes (14,3%), el ACV fue de 7,9%, el infarto de miocardio fue de 4,8% y la necesidad de marcapasos definitivo fue de 14,3%. **Conclusiones.** Nuestros resultados de la cirugía de Bentall-De Bono son aceptables y comparables con la literatura internacional.

Palabras clave: Cirugía Cardíaca; Reemplazo de la Raíz Aórtica; Mortalidad; Perú (Fuente: DeCS-BIREME).

Introduction

Aortic root aneurysms (ARA) are associated with high mortality owing to the risk of rupture. ARA are often accompanied by aortic valve involvement, which can cause severe aortic regurgitation ⁽¹⁾. Surgery is the treatment of choice for ARA, with aortic root replacement being the conventional surgical approach. The decision to operate is based on aneurysm diameter and the risk of complications, such as Stanford type A aortic dissection, which increases with aneurysm size ⁽²⁾.

The Bentall procedure is a surgical technique used to treat aortic root disease and aortic valve dysfunction. First described by Bentall and De Bono in 1968, it was initially used to treat aneurysms ⁽³⁾. Over time, the procedure underwent several modifications to reduce the risk of major bleeding and postoperative aneurysm formation. It involves replacing the aortic root with a Dacron conduit incorporating a prosthetic aortic valve and reimplanting both coronary buttons. It is considered a procedure of choice in critically ill patients because it can be performed more rapidly ⁽⁴⁾. Compared with earlier surgical techniques, the Bentall procedure improves life expectancy in patients with aortic root disease ⁽⁵⁾.

Valve-sparing procedures are generally the preferred approach; however, the Bentall procedure remains applicable because it does not require favourable valve morphology. Despite being well established, the procedure is still associated with substantial perioperative mortality, with rates of 4-5%, more bleeding than conventional cardiac surgery, and postoperative complications ⁽⁴⁾.

In Peru, follow-up data are unavailable for patients undergoing this procedure with either mechanical or bioprosthetic valves. We aimed to assess immediate complications, mortality, and short-term outcomes of the modified Bentall procedure at our centre over the past five years. This study is essential for assessing the benefits of this technique relative to more contemporary approaches, such as native valve-sparing procedures.

Materials and methods

Study population

We conducted a retrospective descriptive study of consecutive patients who underwent composite valve-graft replacement (the Bentall-De Bono procedure) for aortic root disease between January 2019 and December 2024 at the Instituto Nacional Cardiovascular, a referral centre within Peru's social security health system (EsSalud), in Lima, Peru. All patients older than 18 years and younger than 80 years were included. We excluded patients who underwent aortic root surgery other than the Bentall procedure, such as the David procedure or other valve-sparing techniques; patients whose procedures were incomplete or converted and did not involve composite

valve-graft replacement; and patients with incomplete medical records that precluded ascertainment of key study variables, including mortality, postoperative complications, cardiopulmonary bypass time, aortic cross-clamp time, or follow-up.

Surgical technique

All procedures were performed under cardioplegic arrest using HTK Custodiol® (histidine-tryptophan-ketoglutarate solution), with intraoperative transoesophageal echocardiography, mild-to-moderate hypothermia (32°C), and standard monitoring for cardiac surgery.

Median sternotomy was used in all cases. For the Bentall procedure, a Carbo-Seal Valsalva conduit (Corcym) was used for mechanical valve replacement, whereas Crown (LivaNova) or Avalus (Medtronic) bioprosthetic valves were used for biological valve replacement. For bioprosthetic procedures, the composite conduit was assembled manually by suturing a bioprosthetic valve to a Dacron graft (**Figure 1**).

Assessment periods

Three assessment periods were defined: baseline (t0), from hospital admission until immediately before surgery; the perioperative period (t1), comprising the first 30 postoperative days; and extended follow-up (t2), continuing until the last recorded healthcare encounter within EsSalud.

Patients were followed up through a review of electronic medical records within the EsSalud system. At our hospital, a national referral centre, patients remain under follow-up for a maximum of six months after surgery before returning to their referring centres. Electronic records nevertheless enabled continued assessment of their subsequent clinical course.

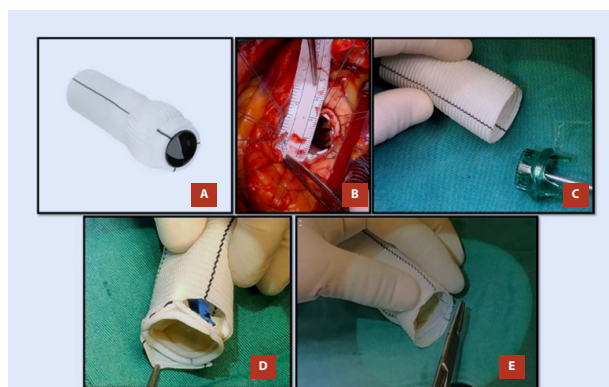


Figure 1. **A)** Mechanical valved conduit used for the Bentall procedure. **B)** For the Bentall procedure with a bioprosthetic valve, the aortic root is measured after excision of the aortic valve and root. In this case, the measured diameter was 28 mm; therefore, a 28 mm Dacron graft was used. **C)** The bioprosthetic valve to be sutured into the graft is then sized, typically with a diameter 3 mm smaller than that of the graft. **D)** Bioprosthetic valve positioned within the graft. **E)** Fixation of the valve to the graft using three 4-0 polypropylene sutures.

Outcomes

The primary outcomes, assessed during t1 and t2, were:

- All-cause mortality: death during the immediate postoperative period or follow-up.
- Major complications: i) stroke, defined as an ischaemic or haemorrhagic neurological event confirmed by computed tomography and resulting in motor, sensory, or cognitive sequelae; ii) perioperative myocardial infarction, defined according to the Fourth Universal Definition of Myocardial Infarction; iii) permanent pacemaker implantation; and iv) excessive postoperative bleeding, defined according to Valve Academic Research Consortium 3 (VARC-3) criteria for types 3 and 4. Type 3 includes bleeding associated with a substantial decrease in haemoglobin concentration, requiring transfusion or therapeutic intervention, whereas type 4 comprises bleeding related to cardiac surgery that requires reoperation or causes haemodynamic instability.

Secondary outcomes, assessed only during t1, included: i) hospital and intensive care unit lengths of stay, measured in days from the date of surgery; ii) mediastinitis, defined as a deep infection requiring reoperation; and iii) echocardiographic findings assessed by transthoracic echocardiography before discharge.

Statistical analysis

The normality of continuous variables was assessed using the Shapiro-Wilk test and visual inspection of histograms and normal probability plots. Normally distributed variables were summarised as means and standard deviations (SD), whereas non-normally distributed variables were summarised as medians and interquartile ranges (IQRs). Categorical variables were summarised as frequencies and percentages for the baseline, perioperative, and follow-up periods. Cumulative incidence was estimated for mortality and complications during the perioperative period and throughout follow-up. Time-to-event outcomes, such as mortality, were analysed using Kaplan-Meier curves. All analyses were performed using R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

Ethical aspects

The study was approved by the Ethics Committee of the Instituto Nacional Cardiovascular (INCOR-EsSalud). All data were kept anonymous and analysed retrospectively using the institute's cardiac surgery registry. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

A total of 63 patients were assessed during the study period. Preoperative risk factors are summarised in **Table 1**. There were

47 men and 16 women, with a median age of 58 years (IQR: 40-71). Hypertension was present in 47.6% of patients and Marfan syndrome in 19.0%. At presentation, New York Heart Association (NYHA) functional class II was the most common category, accounting for 50.8% of patients, and left ventricular ejection fraction (LVEF) was preserved in 69.8%. The mean ascending aortic diameter was 52 mm (IQR: 45-60.5).

Several patients underwent concomitant procedures: 11 (17.5%) underwent aortic arch surgery, 12 (19.0%) underwent coronary artery bypass grafting, and nine (14.2%) underwent mitral valve surgery. The mean aortic cross-clamp time was 169.2 min (SD: 46.2), and cardiopulmonary bypass time was 209 min (IQR: 184.5-248.5). Additional operative characteristics are reported in **Table 2**.

Thirty-day mortality was 7.9% (**Table 3**). One patient died in the operating theatre from refractory shock, three died

Table 1. Baseline characteristics of the study population (n = 63).

Variable	n (%)
Age (years), median (IQR)	58 [40-71]
Male sex	47 (74.6%)
BMI	
Underweight	4 (6.35%)
Normal weight	20 (31.75%)
Overweight	23 (36.5%)
Obesity	16 (25.4%)
Comorbidities	
Hypertension	30 (47.6%)
Diabetes mellitus	5 (7.9%)
Marfan syndrome	12 (19%)
Chronic kidney disease	6 (9.5%)
Stroke	3 (4.8)
NYHA	
I	16 (25.4%)
II	32 (50.8%)
III	11 (17.5%)
IV	4 (6.3%)
Infective endocarditis	4 (6.3%)
LVEF	
≥50%	44 (69.8%)
41-49%	10 (15.9%)
≤40%	9 (14.3%)
Bicuspid aortic valve	14 (22.2%)
Aortic annular diameter (mm), median (IQR)	28 (25.5-32)
Ascending aortic diameter (mm), median (IQR)	52 (45-60.5)

BMI: body mass index. NYHA: New York Heart Association. LVEF: left ventricular ejection fraction. IQR: interquartile range.

in the intensive care unit (ICU) from mixed cardiogenic and hypovolaemic shock, and one died from distributive shock due to infection. In the subgroup analysis, 30-day mortality was higher among patients undergoing emergency surgery than among those undergoing elective surgery (25.0% vs. 3.9%; $p = 0.044$). Emergency surgery was associated with higher odds of mortality (OR: 7.76, 95% CI: 0.78-105.42), although the wide confidence interval indicates limited precision owing to the small number of events.

Regarding major complications, postoperative myocardial infarction occurred in three patients (4.8%) and stroke in four (6.3%). Seven patients (11.1%) required permanent pacemaker implantation after surgery.

Regarding secondary outcomes, 11 patients (17.5%) developed acute kidney injury, of whom four (6.3% of the total cohort) required renal replacement therapy with dialysis. The median total hospital stay was 17 days (IQR: 10-30), and the median ICU stay was 4 days (IQR: 2.5-6). Postoperatively, 36 patients (56.7%) had an LVEF of $\geq 50\%$, 13 (21.7%) had an LVEF of 41-49%, and 13 (21.7%) had an LVEF of $\leq 40\%$. Postoperative bleeding occurred in four patients (6.3%). Other secondary outcomes are reported in **Table 3**.

The median follow-up duration was 745 days (IQR: 403-1060). No patients were lost to follow-up during the available

Table 2. Intraoperative characteristics (n = 63)

Variable	n (%)
Emergency	12 (19%)
Graft size	
26 mm	7 (11.1%)
28 mm	36 (57.1%)
30 mm	13 (20.6%)
32 mm	7 (11.1%)
Cardiopulmonary bypass time (min), median (IQR)	209 [184.5-248.5]
Aortic cross-clamp time (min), mean $\pm$ SD	169.2 $\pm$ 46.2
Prosthetic valve type	
Bioprosthetic	31 (49.2%)
Mechanical	32 (50.8%)
Concomitant surgery	
Aortic arch surgery	11 (17.5%)
Coronary artery bypass grafting	12 (19%)
Mitral valve repair	5 (7.9%)
Mitral valve replacement	4 (6.3%)
Tricuspid valve repair	3 (4.8%)
Intraoperative blood loss (mL), median (IQR)	800 [525-1200]

IQR: interquartile range. SD: standard deviation.

Table 3. Outcomes after the Bentall procedure

30-day outcomes (t1: immediate postoperative period)	
Primary outcomes	n (%)
Mortality	5 (7.9%)
Major complications	
Stroke	4 (6.3%)
Postoperative myocardial infarction	3 (4.8%)
Permanent pacemaker implantation	7 (11.1%)
Excessive postoperative bleeding	4 (6.3%)
Secondary outcomes	
ICU stay (days), median (IQR)	4 [2.5-6]
Acute kidney injury	11 (17.5%)
Dialysis	4 (6.3%)
Sepsis	3 (4.8%)
Shock	4 (6.3%)
LVEF	
$\geq 50\%$	36 (56.7%)
41-49%	13 (21.7%)
$\leq 40\%$	13 (21.7%)
Hospital stay (days), median (IQR)	17 [10-30]
Follow-up outcomes (t2: median 745 days; IQR: 403-1060)	
Primary outcomes	n (%)
Mortality	9 (14.3%)
Major complications	
Stroke	5 (7.9%)
Myocardial infarction	3 (4.8%)
Permanent pacemaker implantation	9 (14.3%)

LVEF: left ventricular ejection fraction. IQR: interquartile range. ICU: intensive care unit.

observation period. At medium-term follow-up, cumulative mortality had increased to 14.3%. The Kaplan-Meier survival curve is shown in **Figure 2**.

The cumulative incidence of stroke was 7.9% (five patients), and nine patients (14.3%) required permanent pacemaker implantation (**Table 3**).

Discussion

In this series of patients undergoing the Bentall procedure at a national referral centre, postoperative mortality was 7.9%, stroke incidence was 6.3%, and postoperative myocardial infarction incidence was 4.8% in a predominantly male population. Concomitant procedures were frequent, increasing the complexity of individual cases. The mean ICU stay was 4 days, suggesting an internationally acceptable recovery course

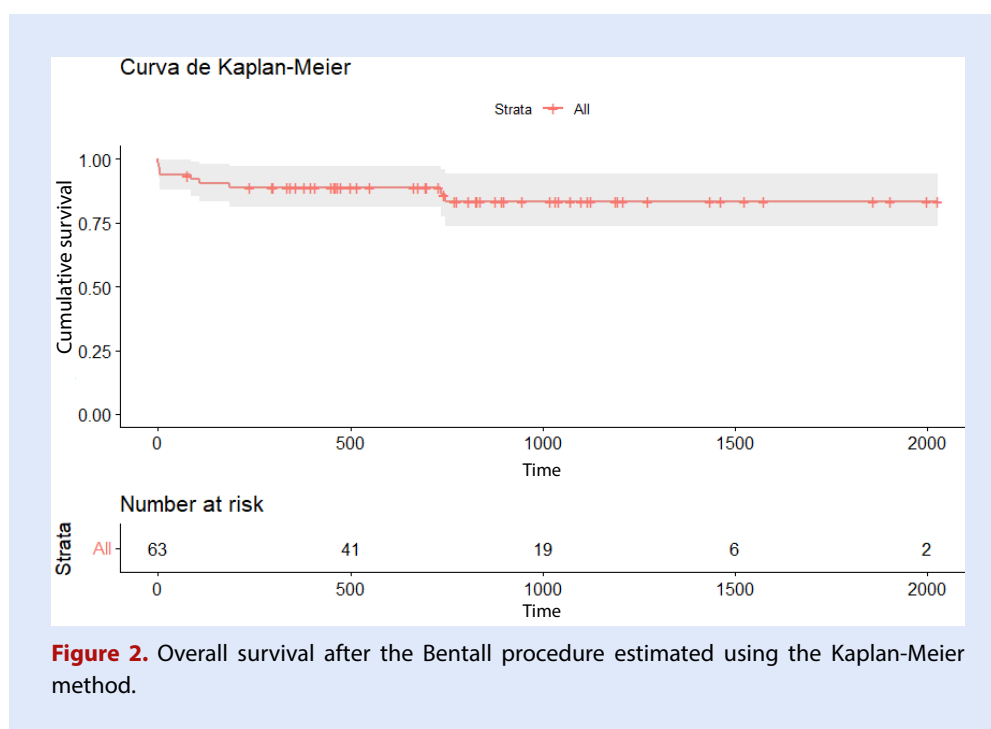


Figure 2. Overall survival after the Bentall procedure estimated using the Kaplan-Meier method.

given the complexity of aortic root surgery. Taken together, these findings indicate favourable outcomes at our institution, with mortality and complication rates comparable to those reported in contemporary series from other specialist centres.

Patients undergoing the Bentall procedure in this study had a median age of 58 years, were predominantly male, and had a high prevalence of hypertension. This profile is consistent with previous studies, in which the mean age ranged from 55 to 65 years and most patients were male ^(6,7).

Regarding functional status, most patients were in NYHA class I-II, suggesting that surgery was predominantly elective and performed at an early stage of disease. Current guidelines recommend prophylactic intervention at aortic diameters of ≥ 55 mm in the general population and ≥ 50 mm in patients with risk factors or a bicuspid aortic valve, with lower thresholds when aortic valve surgery is indicated ^(8,9). The observed median diameter of 52 mm falls within these thresholds, indicating consistency with international recommendations.

Regarding ventricular function, 69.8% of patients had preserved LVEF. Previous studies have shown that severe ventricular dysfunction is associated with higher operative mortality in aortic root surgery ⁽⁶⁾. The low proportion of patients with severe dysfunction in this series might have contributed to favourable perioperative outcomes.

A bicuspid aortic valve was present in 22.2% of patients, a proportion comparable to reports in which it accounts for 20-40% of indications for aortic root surgery ^(10,11). In this population, associated aortopathy increases the risk of progressive dilatation and dissection, warranting close surveillance and early intervention.

Infective endocarditis represents a subgroup with greater technical complexity. Contemporary series show that patients

undergoing the Bentall procedure for active endocarditis have a higher risk of complications and mortality, although outcomes remain acceptable at specialist centres ⁽¹²⁾.

Emergency procedures accounted for 19.0% of operations. In large registries, urgent or emergency surgery accounts for 15-30% of procedures for aortic root disease, particularly when acute type A dissections are included. Published evidence indicates that operative mortality can be two to three times higher in emergency settings than in elective surgery ⁽⁶⁾.

The most commonly used graft size was 28 mm, followed by 30 mm. This finding is consistent with the median aortic diameter of 52 mm reported in our study. In published series, the most frequently used graft sizes range from 26 to 30 mm, depending on sex, body surface area, and aortic annular diameter ⁽¹³⁾. The predominance of 28 mm grafts suggests an appropriate anatomical fit for the population studied.

The median cardiopulmonary bypass time of 209 min and aortic cross-clamp time of 169.2 min were slightly longer than those reported for the Bentall procedure, for which cardiopulmonary bypass times generally range from 120 to 200 min and cross-clamp times from 100 to 150 min ^(12,14). Prolonged cardiopulmonary bypass has been associated with an increased risk of complications, including ventricular dysfunction, renal impairment, and postoperative bleeding. In our study, these times remained within acceptable ranges for complex aortic root surgery, particularly given the frequency of concomitant procedures.

The proportion of patients requiring concomitant coronary artery bypass grafting (19.0%) was comparable to that reported in other series, ranging from 15 to 25%, particularly in populations with a substantial prevalence of coronary artery disease ⁽¹²⁾. Concomitant aortic arch surgery substantially

increases surgical complexity and cardiopulmonary bypass time. In this series, aortic arch surgery was performed in the context of type A aortic dissection. Concomitant mitral or tricuspid valve surgery suggests coexisting structural disease or secondary dilatation, further increasing technical complexity and operative duration.

Median intraoperative blood loss was 800 mL. Published reports indicate that blood loss during aortic root surgery commonly exceeds 500 mL after separation from cardiopulmonary bypass⁽¹⁵⁾. The aortic root is an anatomically complex region with multiple suture lines at the annulus, coronary buttons, and distal anastomosis, increasing the risk of bleeding. Hospital stay was 17 days, within the range reported in contemporary series of aortic root replacement, in which hospital stays generally range from 10 to 20 days after elective surgery and are prolonged by complications or concomitant aortic arch surgery^(6,16).

Acute kidney injury occurred in 17.5% of patients, and 6.3% required dialysis. In aortic root surgery, the reported incidence of acute kidney injury ranges from 10% to 25%, whereas renal replacement therapy is required in 3-8% of patients^(2,3). Prolonged cardiopulmonary bypass time, emergency surgery, and concomitant procedures have been identified as independent predictors of postoperative renal dysfunction⁽¹⁷⁾. Stroke incidence was 6.3%. In large Bentall series, major neurological event rates range from 3 to 8%, with higher rates when concomitant aortic arch surgery or acute type A dissection is present⁽¹⁸⁾. Given that 17.5% of patients in our study required aortic arch intervention, the observed incidence is consistent with the literature.

Postoperative myocardial infarction occurred in 4.8% of patients. Contemporary series report perioperative myocardial infarction rates of 3-7% after aortic root replacement, particularly when coronary reimplantation is technically demanding or concomitant coronary surgery is performed⁽⁶⁾. Postoperative bleeding occurred in 6.3% of patients. Reported rates of re-exploration for bleeding after the Bentall procedure range from 9 to 10%^(18,19). The anatomical complexity of the aortic root and the presence of multiple suture lines account for the inherent bleeding risk associated with this procedure.

Thirty-day mortality was 7.9%. Contemporary mortality rates after elective Bentall surgery at high-volume centres range from 3 to 6%, whereas rates after urgent surgery or surgery associated with dissection can reach 8-15%, and up to 25% in patients with endocarditis^(6,18). Given that 19.0% of procedures were performed as emergencies and concomitant surgery was frequent, the observed mortality was comparable

to international benchmarks. The Kaplan-Meier curve showed that estimated survival remained high throughout follow-up, with an initial decline during the first postoperative months, consistent with the reported 30-day mortality, followed by a prolonged period of stability. Survival at the end of follow-up exceeded 80%, suggesting favourable medium-term outcomes comparable to those reported in contemporary series of aortic root replacement. Major complications remained infrequent during follow-up, with stroke occurring in 1.59% of patients, permanent pacemaker implantation required in 3.17%, and no additional postoperative myocardial infarctions recorded^(6,18).

Our study reports surgical outcomes comparable to those of international referral centres specialising in aortic root surgery. Despite the anatomical complexity and substantial frequency of concomitant procedures, perioperative outcomes remained within the ranges reported in the literature. The predominantly elective nature of the procedures, generally preserved ventricular function, and adherence to established surgical thresholds probably contributed to favourable outcomes.

However, this study has several limitations. Its descriptive design precludes comparison with other surgical approaches to aortic root disease, such as valve reimplantation. Data were extracted from medical records, and their completeness and accuracy cannot be guaranteed. Nevertheless, our institution is a referral hospital where medical records are maintained according to accredited quality standards. Follow-up duration varied across patients. The small, single-centre sample limits the generalisability of the findings, and the study is inherently susceptible to selection bias. A major strength, however, is that this might be the first published study in Peru to report outcomes after the Bentall procedure.

In conclusion, the Bentall-De Bono procedure yielded perioperative outcomes consistent with international benchmarks, with mortality and complication rates comparable to those reported in the contemporary literature. Appropriate preoperative patient selection, systematic intraoperative management, and surgical team experience are key factors in optimising outcomes.

Author contributions

FMN: conceptualisation, methodology, formal analysis, investigation, writing-original draft, writing-review and editing. **KHB:** conceptualisation, methodology, formal analysis. **JMC y YPV:** conceptualisation, methodology, formal analysis. **JRO:** conceptualisation, methodology, formal analysis, writing-review and editing, validation.

References

1. Du T, Wang W, Wang Y, Piao H, Liu K. Research progress on aortic root aneurysms. *Med Sci Monit.* 2024;30:e943216. doi: 10.12659/MSM.943216.
2. David TE. Surgical treatment of ascending aorta and aortic root aneurysms. *Prog Cardiovasc Dis.* 2010;52(5):438-444. doi: 10.1016/j.pcad.2009.12.005.
3. Bentall H, De Bono A. A technique for complete replacement of the ascending aorta. *Thorax.* 1968;23(4):338-339. doi: 10.1136/thx.23.4.338.
4. Al-Mudhaffar SS, Alwan A, Ouj R, Mowaffaq A, Kakamad FH, Ahmad OF, *et al.* Bentall procedure as a lifesaving surgery: a single center experience. *Med Int (Lond).* 2023;3(1):8. doi: 10.3892/mi.2023.68.
5. Borulu F, Erkut B. Tratamiento y resultados quirúrgicos en pacientes operados de aneurismas de aorta ascendente. *CorSalud.* 2019;11(2):104-112.
6. Etz CD, Bischoff MS, Bodian C, Roder F, Brenner R, Griep RB, *et al.* The Bentall procedure: is it the gold standard? A series of 597 consecutive cases. *J Thorac Cardiovasc Surg.* 2010;140(6 Suppl):S64-S70. doi: 10.1016/j.jtcvs.2010.07.033.
7. Sheikh DA, Bhiwapurkar DA, Nayanar DUR. Bentall procedure: a ten-year single-center case series of 15 patients. *Eur J Cardiovasc Med.* 2025;15:464-467. doi: 10.61336/ejcm/25-12-49.
8. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, 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. *Eur Heart J.* 2014;35(41):2873-2926. doi: 10.1093/eurheartj/ehu281.
9. Isselbacher EM, Preventza O, Hamilton Black J 3rd, Augoustides JGT, Beck AW, Bolen MA, *et al.* 2022 ACC/AHA Guideline for the diagnosis and management of aortic disease: a report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. *Circulation.* 2022;146(24):e334-e482. doi: 10.1161/CIR.0000000000001106.
10. Michelena HI, Khanna AD, Mahoney D, Margaryan E, Topilsky Y, Suri RM, *et al.* Incidence of aortic complications in patients with bicuspid aortic valves. *JAMA.* 2011;306(10):1104-1112. doi: 10.1001/jama.2011.1286.
11. Verma S, Siu SC. Aortic dilatation in patients with bicuspid aortic valve. *N Engl J Med.* 2014;370(20):1920-1929. doi: 10.1056/NEJMra1207059.
12. Leontyev S, Borger MA, Modi P, Lehmann S, Seeburger J, Doenst T, *et al.* Surgical management of aortic root abscess: a 13-year experience in 172 patients with 100% follow-up. *J Thorac Cardiovasc Surg.* 2012;143(2):332-337. doi: 10.1016/j.jtcvs.2010.10.064.
13. Etz CD, Homann T, Silovitz D, Bodian CA, Luehr M, Luzzo GD, *et al.* Vascular graft replacement of the ascending and descending aorta: do Dacron grafts grow? *Ann Thorac Surg.* 2007;84(4):1206-1212. doi: 10.1016/j.athoracsur.2007.05.034.
14. Ruvolo G, Altieri C, Bassano C, Buioni D, Nardi P, Pisano C. How refined surgical technical solutions can make Bentall operation a low-risk procedure: 20-year personal experience at the "root" of the aortic diseases—it is time to change surgical guidelines. *J Clin Med.* 2023;12(23):7330. doi: 10.3390/jcm12237330.
15. De León Sánchez MR, Herrera V, Camacho González C, Soto Solís E. Procedimiento de Bio-Bentall: resultados iniciales. *Rev Guatem Cir.* 2018;24:1-9.
16. He X, Guo F, Li J, Li Y, Yan Y. The safety and feasibility of mini-invasive Bentall surgery via right anterior mini-thoracotomy. *J Thorac Dis.* 2024;16(5):2918-2926. doi: 10.21037/jtd-23-1757.
17. Rosner MH, Okusa MD. Acute kidney injury associated with cardiac surgery. *Clin J Am Soc Nephrol.* 2006;1(1):19-32. doi: 10.2215/CJN.00240605.
18. Preventza O, Garcia A, Cooley DA, Haywood-Watson RJL, Simpson K, Bakaeen FG, *et al.* Total aortic arch replacement: a comparative study of zone 0 hybrid arch exclusion versus traditional open repair. *J Thorac Cardiovasc Surg.* 2015;150(6):1591-1600. doi: 10.1016/j.jtcvs.2015.08.117.
19. Joo HC, Chang BC, Youn YN, Yoo KJ, Lee S. Clinical experience with the Bentall procedure: 28 years. *Yonsei Med J.* 2012;53(5):915-923. doi: 10.3349/ymj.2012.53.5.915.