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Original paper

Emergency aortic root replacement with the Bioconduit stentless aortic valve conduit

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Abstract This report concerns a 73-year-old woman who presented with asymptomatic aortic root an-eurysm with severe aortic regurgitation. The purpose of this article is to present our first successful case for emergency aortic root replacement (Bentall operation) that involves annular implantation of a pericardial valved conduit (Bioconduit TM, Biointegral Surgical, Inc., Ontario, Canada) and to discuss some essential technical clue issues related to this approach.

Keywords Aortic, Aneurysm, Bentall, Bioconduit, Biointegral.

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Introduction

The Bentall procedure using mechanical valve conduits has become the traditional treatment for patients with aortic valve diseases and annuloaortic ectasia and represents one of the most using intervention. In last years aortic valve-sparing operations in such patients have reduced the number of suitable candidates for Bentall procedure. In elderly patients with symptomatic aortic root aneurysm with severe aortic regurgitation in whom the David's or Yacoub's operation cannot be safely performed, Bentall procedure may be still required in a relatively large number. For patients requiring a mechanical prosthesis, the main problem is bleeding risks and the lifelong need for anticoagulants. In the last decades, efforts have been made to find a safety and durability alternative to mechanical valve conduits without requiring long-term anticoagulation. Pericardial valve conduits are very promising and are currently increasingly being considered suitable procedures for elderly patients requiring Bentall procedures.

Case report

A 69-year-old woman with known arterial hypertension was admitted to our clinic from a regional hospital with significant acute chest pain, a feeling of suffocation and fear, palpitation, and tachycardia. On admission, the patient was hemodynamically stable, and she was transferred to the intensive care unit (ICU). Transthoracic and transesophageal echocardiography found normal cardiac function, a giant aneurysm of the aortic root with severe aortic regurgitation, and mild tricuspid regurgitation. Chest radiography (X-ray) showed an enlarged aortic silhouette, the electrocardiogram (ECG) showed sinus rhythm with 93 bpm and left ventricular hypertrophy signs. Standard blood tests showed normal findings. Furthermore, a computed tomography angiography (CTA) performed at the referring center described the largest diameter of the ascending aorta was 69 mm with adession with the posterior sternum without a sign of acute rupture (Figure 1).

Figure 1. CT-scan revealed the presence of an aortic root aneurysm without signs of rupture or active bleeding.

Coronarography revealed nonstenotic lesions. Doppler ultrasound assessment of femoral and supraortic vessels showed permeable arteries and veins, without any associated lesions. An emergent surgical indication is retained. The risks were communicated to the patient, and the patient agreed to surgical treatment. The patient was referred to the operating room for emergent surgery. Standard monitoring of the patient included temperature monitoring, venous catheter, double intraarterial blood pressure monitoring the left radial artery and left femoral artery, and near-infrared spectroscopy (NIRS) for reflecting cerebral oxygenation of the frontal cortex to detect any potential cerebral malperfusion. During the surgical procedure, we adopted the peripheral cardiopulmonary bypass (CPB). The common right femoral artery and left common femoral vein were cannulated (femoral cannula kit, Medtronic-DLP, Minneapolis, MN, USA), and normothermic CPB was installed under full heparinization (3-4 mg/kg intravenously). A median sternotomy was performed without any incident (Figure 2).

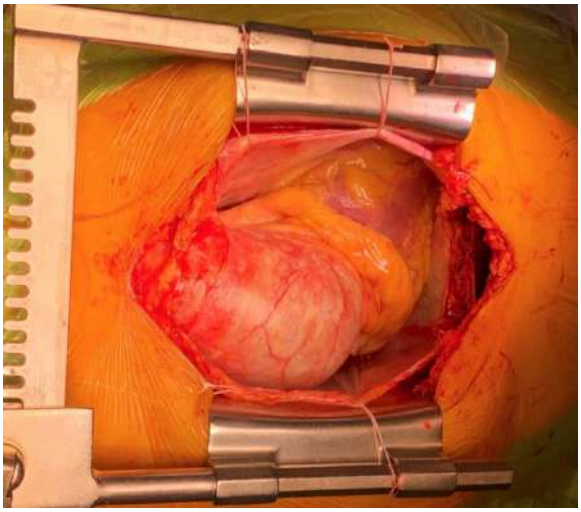

Figure 2. Intraoperative view of aortic root aneurysm.

After the initiation of CPB, the gradual, moderate cooling of the patient was initiated. When the rectal temperature reached 32°C, CPB was interrupted seconds to perform the median sternotomy. A left ventricular drain was inserted through the right superior pulmonary vein. A complete transverse aortotomy was made 2 to 3 cm distal to the origin of the right and left coronary arteries, the myocardial protection was achieved using a retrograde and antegrade single dose of Custodiol (2 liters) cardioplegia.

The diseased aortic valve was visualized, and the valve leaflets were carefully excised. The Bioconduit was sized, selected, and sewn to the aortic annulus with 16 sutures pledgeted 2-0 Ti-Cron sutures (Covidien) with pre-made pledgets were placed in a horizontal mattress fashion, placing the sutures from the aortic side of the annulus to the ventricular side of the annulus. The entire aortic root were removed, and the buttons of coronary ostia were dissected free. Note for an excellent coaptation with Bioconduit (Biointegral) without any kinking or tension, free mobilization of the coronary buttons exceeds two cm. The orientation of the pericardial sutures on the body must be in the middle of the noncoronary sinus. We do not use a second layer of 4-0 polypropylene suture to reinforce the remaining aortic root tissue onto the skirt. The hole for the left coronary button reimplantation was made in the pericardial conduit using a knife and a 4 mm punch (Figure 3).

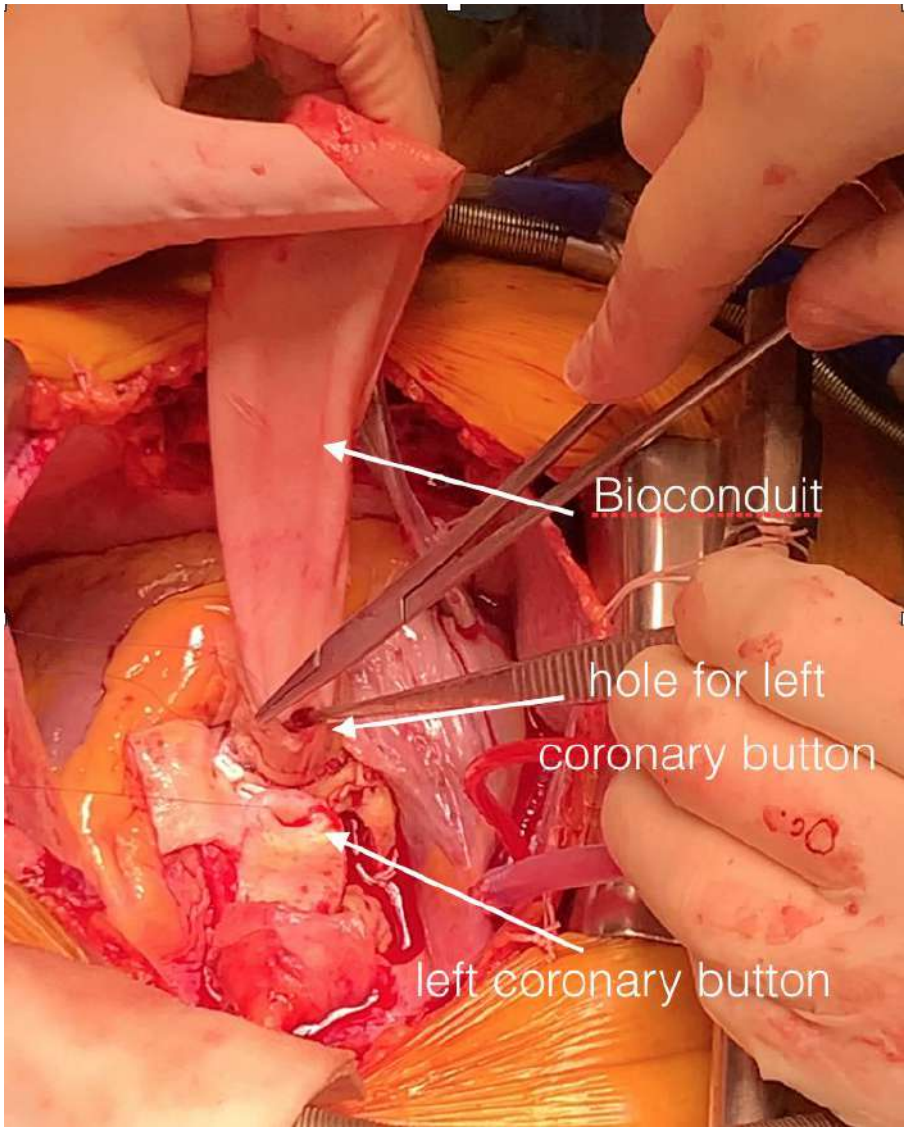

Figure 3. The Bioconduit (Biointegral) is sewn onto the aortic valve annulus. We do not use the second layer of polypropylene suture to reinforce the remaining aortic root tissue onto the skirt. The hole for the left coronary button reimplantation was made in the pericardial conduit.

The proper position of the hole must be obtained after full fill the heart, and the body of the conduit. After that, the left coronary button was trimmed, keeping a minimum of 2-3 mm aortic cuff, anastomosis was performed with a 5-0 polypropylene running suture. The right coronary button was then reattached in the same manner. The distal end of the Bioconduit was trimmed to approximate it to the distal end of the aorta and was sutured to the distal aorta with a continuous 4.0 polypropylene (Figure 4).

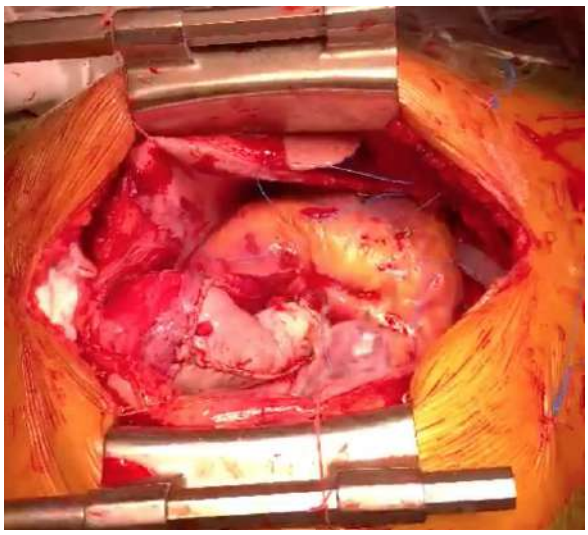

Figure 4. Intraoperative view of complete replacement of ascending aortic root aneurysm with no. 23 Bioconduit (Biointegral).

After the surgery was completed and the patient was weaned off CPB, no significant bleeding was detected. CPB time was 70 min, and cross-clamping time was 56 min. Echocardiographic exams were performed daily postoperatively. The ICU stay was three days, and the hospital stay was nine days. The left ventricular ejection fraction postoperatively was 50%. The peak and mean transvalvular gradients were 14.2 mm Hg and 7.0 mm Hg, respectively. The aortic valve area (AVA) and the indexed AVA (iAVA) were 2.55 cm^2 and 1.7 cm^2/m^2, respectively. CT scan control at three months after the procedure revealed proper implantation with no evidence of any complication (Figure 5).

Figure 5. CT-scan showed Biontegral complete integrated without any sign of complications.

Discussion

The "ideal" Bioconduit should require no anticoagulation, can be implanted in patients of all ages, and should have no structural changes over the years and should resist infection (GALINANES et al, 2011 [1]). Bentall procedure with aortic valve conduit is used for destroyed aortic root, and valve-sparing techniques are used for diseased aortic root with the conservable aortic valve (ZEHR et al, 2004 [2]; OKA et al, 2011 [3]). There are in use composite grafts with mechanical valves or biological valves. Each type of conduit has advantages or disadvantages, their technical implant difficulties, require or not long term anticoagulation, they are easy to find or is a lack of availability on the market, as well as once implanted suffer late or early degeneration. Biological conduits used for aortic root replacement are allografts (homografts) and pulmonary autografts (Ross procedure). There are multiple options for homograft; Medtronic Freestyle Root, Vascutek Gelweave Valsalva graft (Terumo, Ann Arbor, MI), Mitroflow Valsalva conduit (LivaNova, London, England), and hand-sewn composite graft. The xenograft Freestyle aortic root valve prosthesis mismatches with the ascending aorta and potential calcification may complicate future surgery (URBANSKI et al, 2015 [4]]. It is also worth mentioning that the preparation of hand-sewn composite grafts during the operation, has resulted in prolonged CPB and aortic cross-clamp times. A separate chapter is represented by human allografts that are high resistance to infection, most physiologic hemodynamics, low thromboembolic event rates, and do not require anticoagulation (KHALADJ et al, 2013 [5]). Unfortunate allograft has limited availability by a lack of donor organs, and the term of delivery of an appropriate transplant restricts the use in emergency or emergency operations, suffer from calcification, degeneration, and dilatation, which limits their use in especially young patients (KHALADJ et al, 2013 [5]). Due to frequent aortic leaflet pathology in the aging population, complex valve-sparing root replacement intervention is not always possible and represents less attractive options in the aged population. Also, the durability of the composite graft with biological valve prostheses may be superior to that of spared aortic valves in elderly patients. Allografts and pulmonary autografts have advantages only early after implantation (LUCIANI et al, 1998 [6]), allografts seem to have limited age-related durability (TAKKENBERG et al, 2003 [7]). Other studies have shown that pulmonary autografts in the aortic position dilate for up to 60% of patients at six years follow-up (PASQUALI et al, 2007 [8]). The increased incidence of the aortic root diseases in the aging population caused the need for the development of alternative biological root substitutes. There are available two types of bioprostheses, stented and stentless valve. Stentless bioprostheses valve provides better hemodynamic characteristics and difficult implantation than stent bioprostheses (CARREL et al, 2003 [9]). The stentless porcine xenograft Bioconduit (Shelhigh, No-React®) was introduced in current practice in 2000. In a series between 2000-2003, A. Carrel concluded the Shelhigh stentless valved conduit is easy to handle and show excellent hemodynamic characteristics, and in older patients, this conduit is an

alternative to composite graft with mechanical valve (CARREL et al, 2003 [9]). Other studies have shown that the No-React® BioConduit does not dilate or deteriorate and resists infection after a 10-year follow-up (GALINANES et al, 2011 [1]). The duration of Bioconduit implantation is not longer than the Bentall procedure using mechanical valve conduits, maybe an excellent alternative for a surgeon who has experience with stentless valves. The procedure may be particularly beneficial in elderly patients who are at risk of bleeding, acute aortic dissection type A, women with childbearing potential, and even in those younger patients with Marfan diseases, aortic regurgitation due to a quatricuspid aortic or patients who have contraindications to anticoagulation (ADAM et al, 2003 [10]; STIRU et al, 2016 [11]; GINGHINA et al, 2012 [12]). Bioconduit is an additional alternative to homografts that extends the armamentarium for treating patients with aortic root aneurysm. Emergency root reconstruction with Bioconduit in elderly patients represents a great surgical challenge. Tissue fragility, tension, or kinking at the reimplanted coronary arteries in Bioconduit represent the major technical concerns. The advantage of the Bioconduit is the absence of the valvular stent, which makes it foldable and pliable and adapts very well to the annulus, and could be much more hemostatic. This skirt of Bioconduit is the part that is used to attach the conduit onto the aortic valve annulus. Because root annulus is anastomosed with a pericardial skirt, a few millimeters of mismatch could be easily corrected or accommodated. Exact size matching between the Bioconduit and aortic valve annulus is no longer necessary. The durability of the stentless bioprosthesis may be increased, and transaortic valve implantation (TAVI) valve-in-valve implantation can be performed if recalcification occurs (SIRAJUDDIN et al. 2019, [13]). Our results are promising and suggest the safety of this approach.

Conclusions

Pericardial valve conduits (Bioconduit, Biontegral) are suitable in an emergency for elderly patients with aortic root aneurysm requiring Bentall procedures. The Bentall operation with Bioconduit represents a valid surgical option, with satisfactory short-term results. This approach may stimulate use with confidence and increasing frequency of this alternative to homografts.

Conflict of Interest

The authors declare no conflict of interest.

All authors contributed equally to the present work and thus are the principal authors.

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