Novel Use of the Perceval Valve for Prosthetic Aortic Valve Endocarditis Requiring Root Replacement

Holly N. Smith¹, MD, MBA, Ali Fatehi Hassanabad¹, MD, MSc, and William D.T. Kent¹, MD, MSc

Abstract
The surgical management of aortic valve endocarditis can be challenging. Infection with abscess formation can destroy the root and annulus, making it difficult to anchor a valve conduit. In this article, we present a novel and efficient strategy for proximal aortic reconstruction. We used a Dacron tube graft and anchored it proximally with a running suture line deep in the left ventricular outflow tract. The coronary buttons were attached, and a Perceval valve was then deployed inside the neo-root to create a bio-Bentall.

Keywords
Perceval valve, Bentall procedure, infective endocarditis, neo-root

Introduction
Reoperative aortic root replacement for endocarditis is a complex operation with significant risk. For cases requiring root reconstruction with a tissue valve, a stented bioprosthetic is commonly sutured into a Dacron graft. Alternatively, a porcine or homograft root can be used, and more recently, bioprosthetic composite valve conduits are available. In many cases, the valved conduit is seated into infected, devitalized tissue, with an associated risk of dehiscence and late pseudoaneurysm formation. These are difficult cases, often with a long cross-clamp time, adding to the operative risk. In the following case, a simplified, innovative approach was used to construct a bio-Bentall with an inverted Dacron graft sutured with a robust running, hemostatic, proximal suture line. After attachment of the coronary buttons, a sutureless Perceval valve (LivaNova PLC, London, UK) was deployed in the neo-root. We believe this strategy is useful in complex cases to mitigate the risk of anastomotic dehiscence, and to reduce cross-clamp time.

Case Report
A 58-year-old man presented with progressive symptoms of fever, malaise, and dyspnea. He had a history of multiple cardiac operations, initially presenting with infective endocarditis of a bicuspid aortic valve at age 28. He chose a bioprosthetic aortic valve replacement (AVR) to avoid anticoagulation. He subsequently had 2 reoperations for structural valve deterioration. The third operation was a Freestyle (Medtronic, Dublin, Ireland) xenograft root replacement. He later required a pacemaker and implantable cardioverter defibrillator (ICD) for ventricular fibrillation and heart block.

His blood cultures were positive for Propionibacterium acnes, and an echocardiogram revealed a “rocking” bioprosthetic valve, suggesting annular dehiscence, with thickened and restricted leaflets. There was severe paravalvular aortic regurgitation and a large aortic root abscess (Supplemental Video). Vegetations were present on the aortic valve leaflets and the pacemaker leads. After laser lead extraction, the patient was brought to the operating room for fourth-time redo sternotomy and a planned bio-Bentall procedure.

Femoral arterial and venous cannulation was performed. Following sternal reentry, the distal portion of the Freestyle root was dissected circumferentially through dense adhesions to the pulmonary artery and right ventricle. Cardiopulmonary bypass was initiated, the aortic cross-clamp was applied, and del Nido cardioplegia was administered directly in the coronary ostia. A large abscess cavity was found to extend around the proximal portion of the Freestyle root. The cavity was drained

¹Section of Cardiac Surgery, Department of Cardiac Sciences, Libin Cardiovascular Institute, Cumming School of Medicine, University of Calgary, Canada.

Corresponding Author:
William D.T. Kent, Cumming School of Medicine, University of Calgary, 1403 29th Street NW, Foothills Medical Centre, Main Building, Room C880, Calgary, AB, Canada.
Email: william.kent@ahs.ca
and debrided, and the Freestyle root was removed with preservation of the coronary buttons. There was extensive tissue destruction at the level of the annulus, which was so severe it was difficult to seat a conventional valved conduit in the necrotic and devitalized tissue. The only tissue robust enough to hold sutures was deep in the left ventricular outflow tract (LVOT), including septum and aortomitral curtain. A 30 mm Dacron Valsalva graft was selected, and the graft was inverted with the distal end placed into the ventricular cavity, like an elephant trunk procedure (Fig. 1). This allowed construction of the proximal suture line deep in the LVOT, below the level of the annulus, where it could be sutured with big, hemostatic bites of 3-0 running prolene. The majority of the skirt at the proximal end of the Valsalva graft was incorporated (Fig. 2a). In this case, this was the best way to achieve hemostasis below the devitalized tissue of the annulus. The technique has previously been described in the context of fibrous skeletal reconstruction of the heart.1 The distal end of the graft was then pulled out of the ventricular cavity (Fig. 2b-c). The thickened and calcified coronary buttons were anastomosed to the neo-root. A large Perceval aortic valve was selected and deployed into the graft at the proximal suture line (Fig. 2d). Since the usual anatomic markers of the annulus were absent, guiding sutures were placed about 2 mm above the proximal running suture line, spaced 120° apart, according to the marks on a Freestyle sizer. Although this case was performed with a Valsalva graft, it could be done with a straight Dacron tube graft as shown in Figure 2. The reconstructed annulus was sized in the same way that Perceval valve sizers are used in a native valve annulus. Following Perceval valve deployment, the distal graft to native aorta anastomosis was performed, and the cross-clamp was removed. Cardiopulmonary bypass time was 204 min with an aortic cross-clamp time of 168 min.

Intraoperative echocardiography demonstrated a well-seated Perceval valve in appropriate anatomic position with no paravalvular leak and a mean gradient of 14 mm Hg. The patient was extubated on postoperative day 1 and transferred from the intensive care unit to the step-down unit. He remained in the hospital until postoperative day 10 with his discharge delayed for ICD lead replacement. The patient did well clinically, and a follow-up echocardiogram at 3 months demonstrated a well-seated valve with no paravalvular leak and a mean gradient of 9 mm Hg.

**Discussion**

Compared to conventional stented AVR, the Perceval sutureless valve is associated with shorter bypass and aortic cross-clamp times, lower rates of acute kidney injury, and lower mean gradients, with no difference in postoperative mortality.2 Ease of deployment has increased the adoption of this valve, and it can simplify minimally invasive approaches with its collapsible, low-profile design. For redo AVR and multiple valve
operations, it can also save cross-clamp time, and can be deployed in a calcified annulus.\textsuperscript{3,4} It is also beneficial for patients with a small aortic annulus, and as a valve-in-valve option for larger bioprostheses with structural valve deterioration.\textsuperscript{5}

This case represents another use of sutureless valve technology to simplify a complex operation for endocarditis. In this case there was extensive tissue destruction at the native annulus. A novel bio-Bentall procedure was performed using a Dacron tube graft with a running proximal suture, followed by coronary button attachment and then deployment of a sutureless Perceval valve inside the neo-root. We believe the inverted Dacron graft technique with a robust running suture line is particularly hemostatic in endocarditis cases with large abscess and massive tissue destruction. However, many surgeons may prefer a standard technique with interrupted mattress for the proximal suture line. Furthermore, surgeons can consider adopting our approach in other complex root reconstructions, such as a type A aortic dissection involving the root. Although we used a Perceval sutureless valve in this case, an Intuity rapid deployment valve (Edwards Lifesciences, Irvine, CA, USA) may also provide a potential alternative.

Given that this is one case, it is difficult to make any generalized comments with respect to sizing the sutureless valve inside the Dacron graft at this time. We can note that, unlike a preconstructed tissue Bentall with stented valve, stentless valve size cannot be determined preoperatively. Many surgeons know to implant a 27 mm stented valve in a 30 mm graft. This is not the case with this novel tissue Bentall technique because annular size may vary depending on how deep the proximal suture line is in the outflow tract, or how bulky the proximal suture line is constructed. This may cause downsizing of the neo-annulus. However, it is likely that the lack of sewing ring and relative larger effective orifice area of the Perceval valve will mitigate any risk of prosthesis patient mismatch. Future studies are needed to better assess different sizing parameters when this approach is employed.

We believe this strategy, which has not been described previously, has the advantage of simplicity with a reduced cross-clamp time. However, it is important to emphasize that this novel bio-Bentall was used to circumvent the challenges of a complex case of infective endocarditis, with massive tissue destruction. Also, we do not suggest this method reduces the future risk of prosthetic valve endocarditis. Our technique has the potential to be a good option, and a method that could become standard practice, but experience and long-term results are needed to determine how the Perceval performs over time inside a Dacron root.

Finally, it is important to note some pitfalls. Although it seems unlikely, follow-up data will be necessary to ensure that the sutureless valve continues to seat well in the reconstructed annulus, without long-term risk of paravalvular leak. In addition, it will be essential to understand the results of redo operations for structural valve deterioration. In a conventional Bentall with a sutured valve, the valve can often be removed by cutting the running suture line, allowing preservation of the Dacron root and implantation of a new valve. This may not be possible with the Perceval valve, or alternatively, the Perceval valve and cage may be easy to remove from the Dacron root. Therefore, our strategy may offer an alternative option when standard methods are not feasible. It may not be indicated when conventional, established proximal reconstruction techniques can be used.

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