on-valve technique). With the technique described herein, the mechanical prosthesis is not removed in its entirety because the valve housing is left in situ, and the leaflets are simply unhinged. We have found this not to be an issue with thrombus formation in this and in 2 additional cases performed at our institution because the smooth surface of the housing and the high flow within the left ventricular outflow tract are most likely protective against recurrent thrombosis after removal of the leaflets.

The technique reported is reliable, easily reproducible, and offers reduced crossclamp time, potential for bleeding, and coronary malperfusion to this challenging group of reoperative patients.

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Bovine jugular vein as a shaped alternative patch material for aortic augmentation in the Norwood procedure

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The Norwood procedure is commonly performed with a patch augmentation of the neo-aorta. Homograft pulmonary conduits are used, but the opportunity cost of this scarce resource has prompted the evaluation of alternatives. We have used bovine jugular vein as an alternative aortic patch augmentation material with early success.

Clinical Summary

The Medtronic Contegra bioprosthesis (Medtronic, Inc, Minneapolis, Minn) consists of a bovine jugular vein with a trileaflet venous valve. It is preserved under minimal pressure (<3 mm Hg) in a 0.25% buffered glutaraldehyde solution and is terminally sterilized in a formulation of glutaraldehyde and isopropyl alcohol. It is available in a range of sizes (12–22-mm internal diameter) and is between 7- and 10-cm long with the valve centered on the prosthesis. We have used this patch technique in 3 cases of hypoplastic left heart syndrome, applying the technique described by Norwood with the Sano modification.¹

The Contegra graft is prepared by being rinsed in normal saline for 15 minutes. No thawing or preclotting is required. While the patch is cooling, the surgeon prepares it as shown in Figure 1.

The reconstruction was satisfactory and bleeding was within expected limits in all 3 patients. Delayed sternal closure was adopted and none required reintervention for bleeding. Echocardiographic studies postoperatively demonstrated good anatomic reconstruction, and they have all survived to hospital discharge and are awaiting the second stage of palliation.

Discussion

The original Norwood procedure did not use a patch to reconstruct the aorta. This was instead proposed by Jonas and associates² in 1986 in a successful attempt to address the commonly associated hypoplastic arch and aortic coarctation. Contemporary attempts have even been made to reconstruct the aorta without the use of any graft material.³ However, the applicability of this technique is limited by the anatomy of the child. Fifteen percent of patients in the Ishino series³ required patch material. This group has subsequently moved to a patch aortic augmentation technique for this reason and because of the technical difficulty of a patchless technique. In addition, the neo-aorta reconstructed at this time is expected to endure for life, and a final shape with physiologic flow characteristics should continue to be the surgical aim.

Synthetic material for patch aortic augmentation has not been widely reported, and there are no randomized comparisons between synthetic material and pulmonary homograft. This may reflect the perceived established benefits of biological material as a vascular patch material. Pulmonary homograft for the reconstruction of the aorta is considered the ideal material because of its good hemostatic and handling properties and the appropriateness of using a vessel graft for vascular reconstruction. However, limited availability of pulmonary homografts has motivated the search for alternatives. Allograft material is also associated with calcification and may reduce the transplantation options, as allograft material used in Norwood procedures is associated with the generation of cytotoxic antibodies.⁴

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Figure 1. A, The tube conduit is filleted, exposing the inner surface and valve leaflets. B, The conduit is divided distal to the leaflets, and this portion is subsequently used for the patch. C, The patch is sized by the surgeon and cut from the xenograft. D, The xenograft is used as shown as a augmentation patch for the neoaorta.

Other xenografts have been proposed, such as bovine pericardium. This offers many of the advantages of the bovine jugular vein patch, but without the advantages of having an intrinsic natural conduit shape. However, there are few reports of the use of this material since the original description in 1999.⁵ Bovine jugular conduits are being widely used for reconstruction of the right ven-

tricular outflow tract. Their recent arrival precludes long-term follow-up data, but experience to date shows satisfactory performance. Where reintervention has been required, the problems have been related largely to valve degeneration and to stenosis at the anastomotic site for these tube grafts, something less likely in cases in which the material has been used as a patch augmentation. There is limited experience with the graft on the systemic side. Indeed, the manufacturer does not support the use of this venous valved device as a left-sided valve conduit. However, used as a patch material rather than a valve, the bovine jugular vein offers many advantages in the performance of the Norwood procedure. These include ready availability, a size spectrum, cost-effectiveness, and avoidance of transmission of human viral pathogens. Its most distinctive feature, however, is the tube properties of this graft material that render it a useful alternative to pulmonary homografts for reconstruction of the aorta in hypoplastic left heart syndrome.

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