Surgical solutions for complex aortic root pathology

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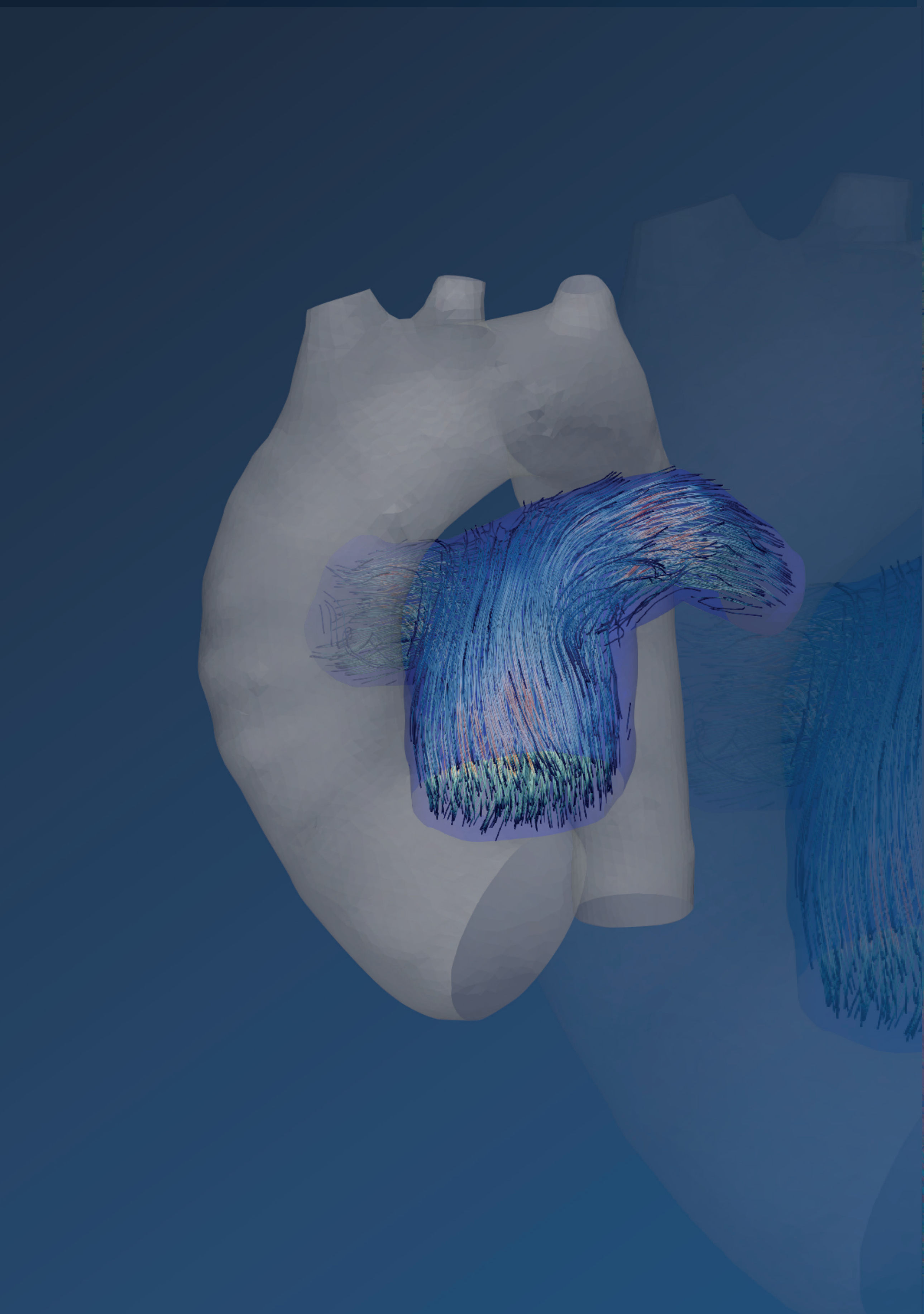

THE ROSS REIMPLANTATION TECHNIQUE

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CHAPTER 4

ABSTRACT

Pulmonary autograft replacement of a diseased aortic valve (the Ross procedure) is effective in children, where growth is essential, and in young patients for whom a biological solution is preferred. Long-term outcomes are generally good. However eventual autograft dilatation may necessitate reoperation. In order to diminish the risk of autograft dilatation, several ‘wrapping’ techniques have been developed. Here, we present our technique of choice: the reimplantation of the pulmonary autograft in a vascular tube graft, scalloping the sinuses of Valsalva. This leaves no bulky tissue inside the vascular tube graft and makes autograft dilatation impossible.

Patient Presentation

This 20-year-old male patient had a stenotic bicuspid aortic valve for which he underwent balloon valvuloplasty at the age of 6 months. This procedure resulted in moderate aortic valve regurgitation, which remained stable for over 18 years. However, the aortic regurgitation eventually increased to severe and the patient became symptomatic, with dyspnea on exertion. Preoperative echocardiography showed a dilated left ventricle (left ventricular internal end-systolic diameter of 36 mm) with good function (ejection fraction of 56%) and a severe aortic valve regurgitation with holodiastolic flow reversal. The patient was discussed in the Heart Team and accepted for surgery. The valve was considered to be unrepairable after preoperative assessment, and after providing extensive information on all treatment options, the patient opted for the Ross procedure if the valve was indeed found to be unrepairable.

Surgical Technique

1 - Aortic valve inspection and removal (0:07)

After initiation of cardiopulmonary bypass, the aorta is transected just above the sinotubular junction and cardioplegia is administered (intermittent crystalloid cardioplegia with external cooling, repeated every 30 minutes). The aortic valve is inspected. In this case, a bicuspid valve with thickened leaflets and an abnormal commissure between the right and non-coronary ‘cusp’ was seen. A repair of this valve would not have been durable. The aortic valve and cusps are removed, as well as the sinuses of Valsalva, leaving the coronary buttons. The aortic valve annulus is sized.

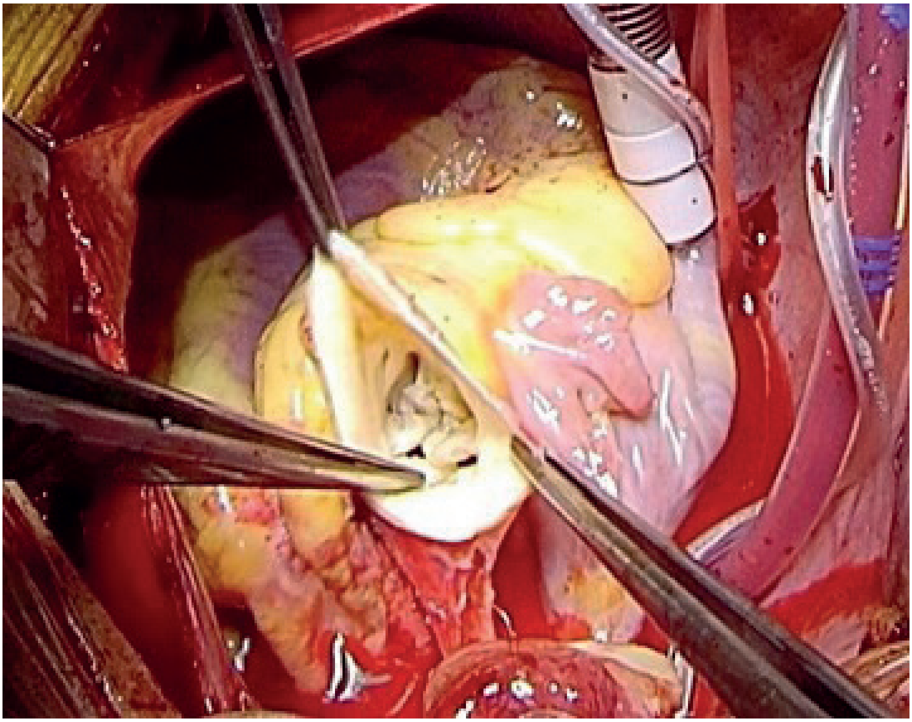

Figure 1: This bicuspid valve with thickened leaflets was deemed to be unrepairable.

2 - Autograft harvesting (0:44)

The pulmonary trunk is transected just beneath the confluence of the left and right pulmonary arteries and is dissected free from the aorta, taking care not to damage the left (main) coronary artery and left anterior descending artery (LAD). The pulmonary valve leaflets are inspected.

A right-angled clamp is guided through the pulmonary valve and positioned 5 mm below the base of the pulmonary valve leaflets in order to guide the right ventriculotomy. The right ventricular outflow tract (RVOT) is opened and, under direct sight of the pulmonary valve leaflets, this incision is continued laterally and medially.

Medially, at the level of the interventricular septum, a difference in orientation of the fibers of the right and left ventricular wall is always observed (01:28). In between these layers is the dissection plane that needs to be followed. By doing so, the first septal perforator branch of the LAD can easily be identified and preserved (in this particular case, two large perforating branches were seen (02:10 min).

The last part of dissection is next to the LAD, where small branches must be identified and closed.

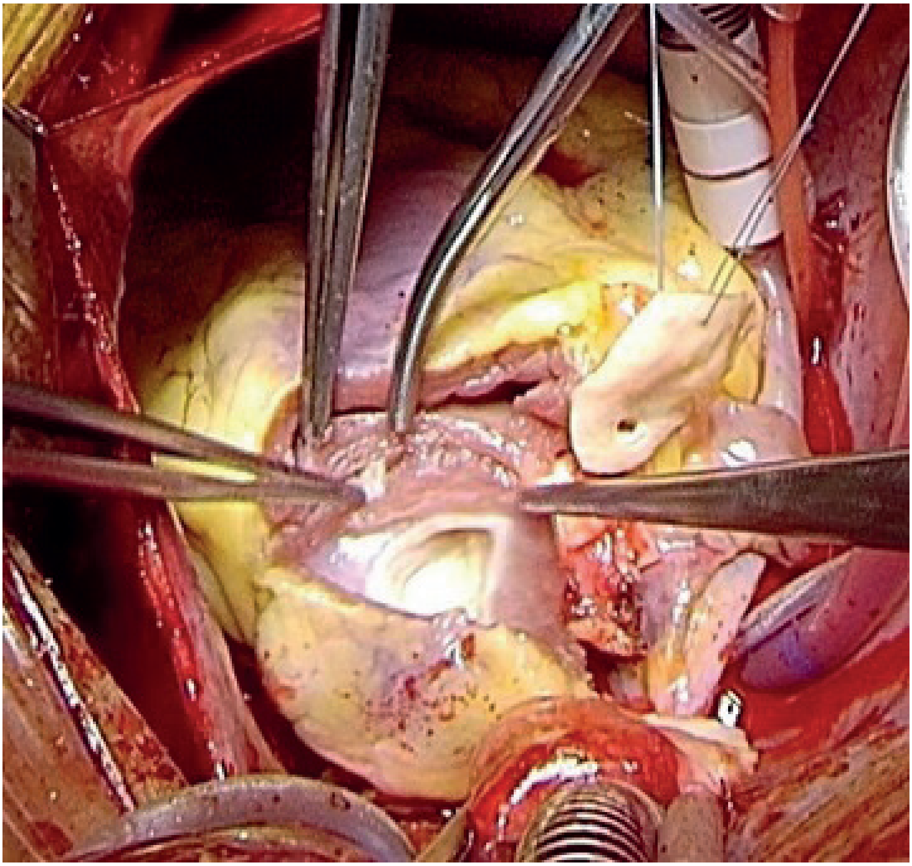

Figure 2. During dissection in the plane between the muscle fibers of the left and right chamber, two large septal perforator branches are seen.

3 - Autograft preparation and reimplantation (2:57)

The autograft is sized (26 mm) at its proximal side.It is important to trim off all excess muscle tissue (if not, this will bulge into the LVOT later). A 2-mm larger (28 mm) Valsalva vascular graft (Vascutek, Renfrewshire, Scotland, UK) is trimmed proximally, leaving 1 ring in situ. After measuring the length that we need, the rest of the Valsalva graft is removed.

The autograft is proximally fixed into the vascular prosthesis under the commissures using 3 5-0 polypropylene monofilament sutures. The proximal suture line is then run continuously using these 3 sutures. Distally, the height and the exact position of the commissures is carefully assessed and each commissure is fixed onto the vascular graft using separate 5-0 polypropylene sutures. This part of the operation must be done very carefully as distortions may cause autograft valve insufficiency later.

All 3 sinuses of Valsalva are removed (“scalloped”) and then the distal suture lines are made using 3 separate running 5-0 polypropylene sutures. Each of these 3 sutures is started at the deepest point, in between 2 commissures, to avoid misalignment and distortion.

After completion of reimplantation a water test is helpful to assess correct placement of the pulmonary autograft.

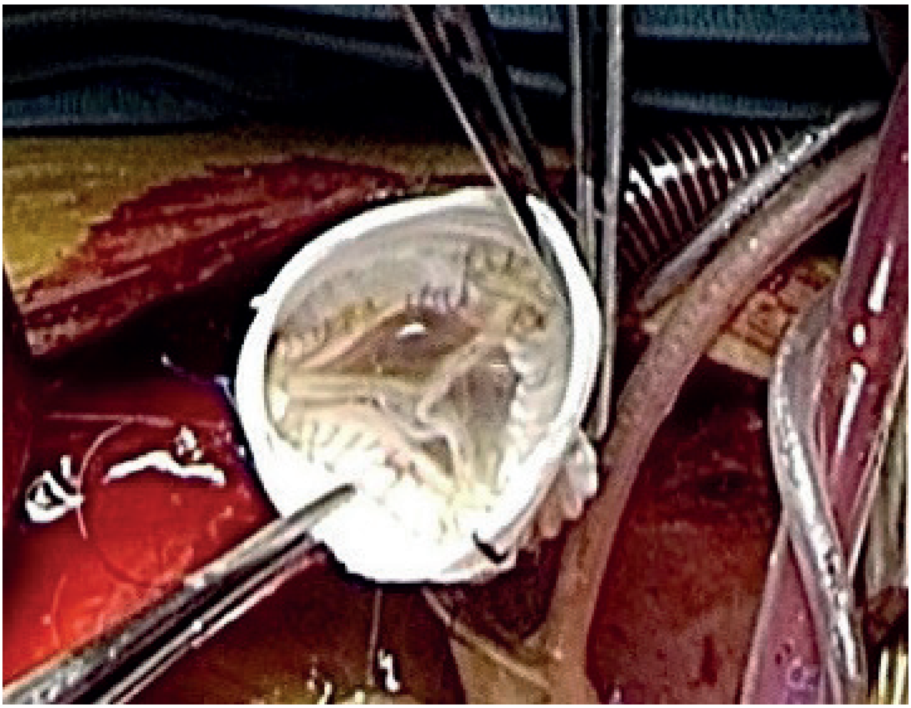

Figure 3: A watertest of the reimplanted autograft shows good function and leaflet coaptation.

4 - Autograft implantation into the LVOT (7:44)

Three polypropylene 4-0 sutures are placed at annular level in the LVOT in such a way that coronary reimplantation is easy. Usually, but not always, the position of the commissures of the original aortic valve can be used for guidance. Using these 3 sutures, the proximal suture line is made in a running fashion, passing each suture through both the vascular graft and the base of the autograft. Care is taken that the needle does not reach the valve tissue. Correct placement of the autograft is assured.

Using cautery, a hole is made in the vascular graft for reimplantation of the left coronary artery (using a 5-0 polypropylene).

5 - Distal suture lines and right coronary button reimplantation (8:59)

The distal suture line between a cryopreserved pulmonary homograft (30 mm diameter) and the pulmonary artery is made using a continuous 5-0 polypropylene suture. Then the ascending aorta is anastomosed to the Valsalva graft with the pulmonary autograft (continuous 4-0 polypropylene).

A hole in the vascular graft is made using cautery to accommodate the right coronary artery button, which is then reimplanted using a continuous 5-0 polypropylene suture. As the right coronary artery will usually be in a higher position than before, this part of the operation is not done earlier.

Ventilation is restarted and, after inserting a de-airing needle in the ascending aorta, the cross-clamp is removed.

6 - RVOT hemostasis and homograft implantation (10:33)

On the beating heart (regular sinus rhythm), careful hemostasis of the RVOT is performed. It is important to take as much time as needed to do this thoroughly now, as any remaining bleeding after proximal implantation of the homograft is very difficult to address, and may even need a breakdown of the proximal suture line.

After satisfactory hemostasis of the RVOT, the proximal suture line is made using 2 continuous 4-0 polypropylene sutures, reinforced with a strip of autologous pericardium. Reinforcement of the posterior part of this suture line is especially important as the muscle tissue can be quite fragile here.

Outcome & Discussion

The patient's recovery was uneventful. Follow-up echocardiograpy (after 2 months) showed good function of both ventricles, and good function of both the autograft (mean gradient 3.5 mmHg, no regurgitation) and the homograft (mean gradient 8 mmHg, no regurgitation).

As shown previously by our group [1], dilatation of the pulmonary autograft is the main reason for autograft failure and cause of reoperation. Reimplanting the autograft in a vascular graft makes dilatation of the autograft wall impossible. Several authors describe a technique in which the autograft is implanted into a 2–6 mm oversized graft using a 'root-inclusion technique '[2-5], or in the patient's own aortic root [6]. Other authors reinforce the annulus with a strip of graft material or pericardium, combined with sinotubular reinforcement [7] or opt for an ascending aorta replacement with a vascular graft [8]. This might not, however, prevent dilatation of the autograft root wall as dilatation also occurs in the sinus walls of the pulmonary autograft.

The technique presented here makes dilatation of the autograft impossible. Furthermore, removing the autograft sinuses results in optimal blood flow without bulky excess wall tissue. Care should be taken, though, to correctly implant the commissures into the vascular graft, as distortion might result in early or late regurgitation.

One concern might be the longer operative and cross-clamping time. However, the extra cross-clamping time did not result in any deleterious effects in our series.

It is important to note that this reimplantation technique is not possible in all patients. The diameter of the vascular graft should not interfere with somatic growth. Therefore, autograft wrapping and reimplantation techniques are only feasible in (almost) fully grown patients. This assessment should be made individually in older children.

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None declared

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