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Current state of the reimplantation technique (DAVID Operation): surgical details and results

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ABSTRACT

Valve-sparing operations are becoming more and more popular because they allow a repair of the native aortic valve and a replacement of the diseased aortic root and the ascending aorta. Previously these patients were treated with a valved-conduit and needed anticoagulation with warfarin if a mechanical valve was used or were left with uncertain long-term durability if a biological valve was used. There are two different types of valve-sparing operations available (reimplantation and remodeling technique). Of these two techniques, the reimplantation technique has several advantages but is also technically more demanding. Therefore this paper describes surgical details of the reimplantation technique and the potential pitfalls as well as some results.

Keywords: *valve-sparing operations, reimplantation technique, DAVID operation, aortic root aneurysm.*

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Valve-sparing operations are being increasingly performed and allow reconstruction of the aortic valve with simultaneous replacement of the entire aortic root and the ascending aorta with very favorable long-term results.

Two valve-sparing procedures are currently being used routinely, i.e. the reimplantation and the remodelling technique.

In this report, surgical details and results of the reimplantation technique are described.

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Preoperative diagnostics

Preoperative diagnostic procedures for the reimplantation technique (DAVID operation) include echocardiography (degree of aortic regurgitation, tricuspid vs bicuspid valve, annulus diameter, root diameter, ascending aortic diameter), coronary angiography (coronary artery disease, coronary ostia, coronary anomalies) as well as computer tomography (CT) scan.

Available grafts

Several grafts are available for the reimplantation technique:

a) Tubular dacron graft.
b) Valsalva graft (Vascutec Ltd, Leeds, Great Britain).
c) New sinus prosthesis (Braun AG, Melsungen, Germany).

Extracorporeal circulation

The operation is carried out via standard median sternotomy, cannulation of the ascending aorta and the right atrium (two-stage cannula), insertion of a left ventricular vent (via the upper right pulmonary vein) and transatrial cannulation of the coronary sinus. For myocardial protection, blood cardioplegia is used in the standard fashion (cold infusions followed by a warm reperfusate).

Sizing of the graft

The sizing of the graft is of utmost importance to achieve an optimal coaptation area of the aortic leaflets and to avoid postoperative aortic insufficiency (AI). A too small prosthesis may result in AI secondary to cusp prolapse while a too large prosthesis might produce AI with central leakage.

The first step in choosing the right size of the graft is the measurement of the aortic annulus. For this measurement different methods may be used:

1. pre- and intraoperative transoeosophageal echocardiography;
2. preoperative CT scan;
3. sizing with HEGAR rods;
4. sizing with mechanical valve sizers (St. Jude Medical, SJM) (valve sizer is seated around the annulus);
5. sizing with biological valve sizers (valve sizer is placed inside the aortic annulus);
6. height of the commissures. The height of the commissures (measured from the base of the interleaflet triangle to the top of the commisssure) remains relatively constant. The height of the commissure is equal to the external diameter of the sino-tubular junction (STJ) (*Figure 1*).

The size of the prosthesis is calculated by adding 4 mm (some surgeons prefer to add only 2-3 mm) to the diameter of the aortic annulus, because the prosthesis is seated external to the aortic annulus. As a rule of thumb, the diameter of the graft is either 26 or 28 mm. Non-Marfan male and female patients receive a 28 mm and 26 mm prosthesis, respectively, while male and female Marfan patients receive a 30 mm graft and 28 mm graft, respectively.

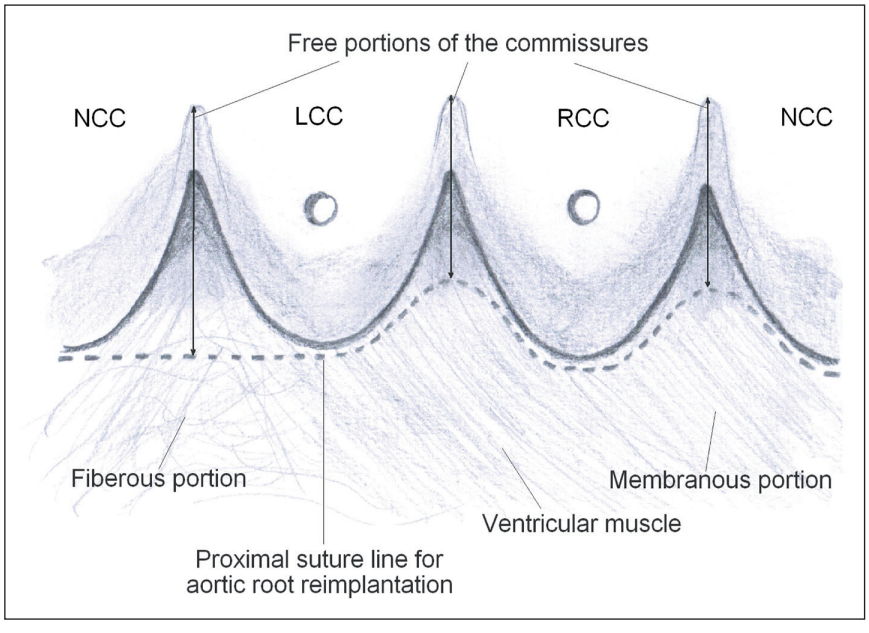

Figure 1 - *Measurement of the height of the commissure. NCC = non-coronary commissure; LCC = left-coronary commissure; RCC = right-coronary commissure.*

Preparation of the aortic root

The incision in the ascending aorta should be done at a more distal position than usual because the right coronary ostium and the commissures are often located very distally in these patients and may be injured if the aortic incision is too proximal. After preparation of both coronary ostia, the annulus has to be dissected very far down to facilitate a good positioning of the graft. In some cases, this surgical step may be quite demanding, especially in the proximity of the right sinus valsalva where the right ventricle is adherent to the aortic annulus. The aortic wall is trimmed to leave only a 5 mm remnant, large enough to allow suturing of the aortic wall into the prosthesis but not too large to prevent complications in re-anastomosing the coronary ostia into the neo-sinuses. The commissures are held up with pledgeted 4-0 Prolene sutures.

Subannular sutures

There are several different methods for this part of the operation (number of sutures used, etc.). These sutures are not done for hemostatic purposes, only for securing the prosthesis below the annulus.

Three mitral valve sutures (non-absorbable polyester sutures; Ethibond 3-0 with pledgets, Ethicon Inc., Norderstedt, Germany) are placed underneath the commissures with three similar sutures between them for each commissure (a total of 12 sutures). The suture underneath the commissure between the right and the non-coronary cusps has to be placed directly under the annulus to avoid injury to the conduction system (AV block) (*Figure 2*). These subannular sutures are anchored in the prosthesis and adjusted accordingly. The knotting of these sutures has to be done very carefully and cautiously. A HEGAR rod has to be inserted in the left ventricular outflow tract (LVOT) before knotting to avoid a purse-string effect of these sutures.

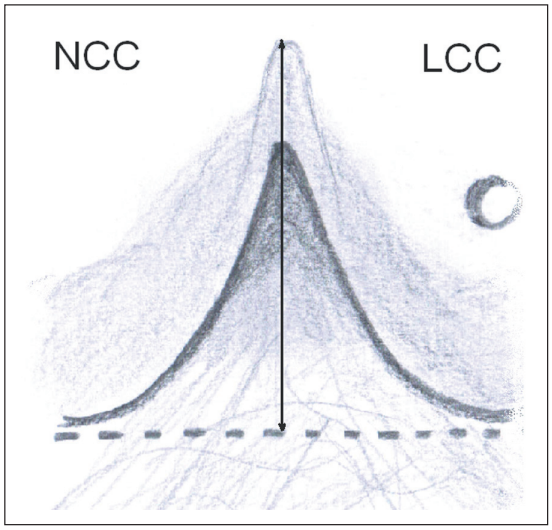

Figure 2 - *Line for the subannular suture. NCC = non-coronary commissure; LCC = left-coronary commissure.*

Reimplantation of the aortic valve inside the prosthesis

The prosthesis is cut to a length of approximately 7 cm to allow a better view inside the graft. First the commissures are sutured at the correct height and location in the prosthesis without stretching the Dacron graft. This part of the operation requires knowledge and experience to implant the valve exactly in the same position as it was before in the native aortic root. If the commissures are fixed too low in the graft, this may lead to AI secondary to prolapse of the leaflets. If it is fixed too high, AI may result because the leaflets are placed under too much tension. All three commissures should be positioned at the same height in the graft. These form the new STJ. Thereafter, the aortic remnants are sutured in the graft and this suture line is now done for hemostatic purposes (5-0 Prolene, small (TF) needle). Folds in this suture line may lead to bleeding complications. Caution has to be exercised to allow for good reimplantation of the coronary ostia in between the aortic remnants of the left and right neo-sinus.

Reimplantation of the coronary ostia in the neo-sinus

This step of the procedure is not different from coronary reimplantation in biological or mechanical conduits. The opening in the graft should be round (not elliptical) to avoid subsequent stenosis. The coronary artery has to be prepared enough to facilitate a tension-free reimplantation.

Most surgeons use a small strip of felt (5 mm) to reinforce this anastomosis.

Initial monitoring of valve function

The competence of the reimplanted valve can be evaluated at this stage by delivering antegrade cardioplegia in the new aortic root. Initially, it is a good sign if the pressure in the aortic root is satisfactory and the left ventricle does not distend.

In addition, transesophageal echocardiography (TEE) can also be used to check for AI (however, the new aortic root must be placed down in the position of the native aortic root to enable visualization of the aortic valve on the TEE).

Distal anastomosis of the graft

This suture line is done in a routine fashion with or without felt with a running stitch (3-0 Prolene).

Goal of the operation

This operation should be done with an aortic cross-clamp time of less than 180 min, AI <I, coaptations of the leaflets of >5 mm, perfect coronary blood flow and no major bleeding.

Special situations

Reimplantation technique for bicuspid aortic valves:

a) The prosthesis is usually larger as compared to those in tricuspid valves.
b) Commissures have to be reimplanted according to the native situation.
c) Pseudo-commissures have to be reimplanted at the same height as within the native valve.
d) The coronary ostia are often very close to the commissures, which require modified surgical techniques for the re-anastomosis of these ostia in the graft.

Reimplantation technique for coronary anomalies:

a) The preoperative diagnosis is the most important step.
b) Surgical techniques vary with the form of coronary anomaly (bypass, unroofing, homologous patch in the graft and suturing of the ostia to this patch, etc.

Both techniques (reimplantation and remodelling) have shown excellent mid-and long-term results. In recent years, the reimplantation technique (DAVID I) has become more popular and is being increasingly used throughout the world. Excellent long-term results have been reported by Shrestha et al. (1) with survival rates at 1, 5 and 10 years of 93%, 85% and 70%, respectively. Freedom from valve replacement at 1, 5 and 10 years was 96%, 91% and 87%, respectively (1). In addition, valve-related complications such as stroke, major bleeding and endocarditis were reported to be exceedingly low (1).

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