David procedure through an upper partial sternotomy

Malakh L. Shrestha, Anna Junge, Axel Haverich, Andreas Martens

Clinic for Cardiothoracic, Transplantation and Vascular Surgery, Hannover Medical School, Hannover, Germany

Correspondence to: Malakh L. Shrestha, MD. Clinic for Cardiothoracic, Transplantation and Vascular Surgery, Hannover Medical School, Carl-Neuberg-Str. 1, 30625 Hannover, Germany. Email: Shrestha.Malakh.Lal@mh-hannover.de.

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Clinical vignette

A 47-year-old female patient presented with congestive heart failure [New York Heart Association (NYHA) Class III]. A coronary angiogram showed calcified coronary arteries without any significant stenosis. Echocardiography showed a tricuspid aortic valve with grade III aortic insufficiency. A computed tomography (CT) scan of the thorax showed an aneurysm of the aortic root and the ascending aorta with a maximum diameter of 60 mm. The aortic arch was not involved.

Surgical procedure

Preparation

The patient is prepared as per standard protocol for sternotomy cases. Additionally, external defibrillator pads are placed in every minimally invasive case. We try to maintain the routine that has been established for the same procedures using a full sternotomy approach. One groin and leg are always prepped to allow for easy femoral and saphenous vein access if needed in certain situations. Since venous cannulation of the right atrium is our routine approach, femoral access is only arranged for in individual cases.

Exposure

The ascending aorta and the aortic root are exposed via an upper J mini-sternotomy (up to the 3rd intercostal space). The innominate vein is identified and carefully mobilized. The pericardium is opened and the aorta is visualized. After systemic heparinization, purse string sutures are placed in the aortic arch (usually between the innominate artery and the left carotid artery) and the right auricular appendage. Depending on the condition of the aorta and its exposure, the aorta is cannulated with a standard aortic cannula or by Seldinger's technique using a guide wire. In most cases, the right atrium can be cannulated directly through the mini-sternotomy by temporarily pushing the aorta upward and to the assistant's side. We use a standard two-stage cannula with a flat profile. After cannulation, the patient is put on cardiopulmonary bypass (CPB) and the heart is unloaded. Depending upon the extent of surgery, the patient is cooled down to 32 ℃.

Under these conditions, a mediastinal drainage tube and temporary pacing wires are placed via a small sub-xiphoidal incision into the pericardium. A line for CO_2 sufflation is placed into the chest tube to flood the surgical field with CO_2.

Operation

A venting catheter is placed into the upper right pulmonary vein after fibrillating the heart. The aorta is cross-clamped and opened longitudinally. Cold blood cardioplegia (Buckberg) is given selectively through both coronary ostia. Blood cardioplegia is repeated every 30 minutes.

After assessment of the aortic valve, coronary ostia are excised as buttons. The aortic root is mobilized from the outside to a level immediately below the nadir of the aortic annulus. Small vessels are meticulously occluded using electro-cautery. Care is taken to ensure absolute hemostasis at every step of the operation.

The aortic sinuses are resected up to a rim of approximately 5 mm of the aortic wall. If necessary, leaflet repair is performed to ensure optimal coaptation. In the presented case, removal of leaflet thickening was performed.

The diameter of the aortic annulus is determined with a Hegar's dilator. The diameter of the prosthesis is then calculated. The diameter of the Hegar's dilator plus

two sizes bigger determines the diameter of the graft. In the presented case, the diameter of the Valsalva Dacron prosthesis used was 28 mm.

Thereafter, 12 threads of 2-0 coated polyester fiber (Ethibond, Ethicon Inc.) are placed inside-out and horizontally below the valve in a circumferential fashion and anchored in the Dacron graft with the aortic root inside the graft. The Dacron graft is fixed by tying these threads loosely, to prevent development of a sub-valvular stenosis.

If a Valsalva graft is used, the commissures are re-implanted at the level of the 'neo ST junction'. If a straight graft is used, the commissures are pulled up as high as possible without stretching the graft. The mobilized aortic root with remnants of the aortic sinuses are then sutured to the inside of the Dacron graft using three double-armoured 4-0 polypropylene sutures (Prolene, Ethicon Inc.) starting at the nadir of each sinus and tying the corresponding sutures at the level of the commissure. This is the hemostatic suture line and has to be absolutely blood tight.

A 'water-test' is performed to test the patency of the reimplanted aortic valve. Leaflet coaptation is controlled again. Additional leaflet repair is performed as necessary.

The coronary ostia are then reimplanted into their respective neo-sinuses by using a 5-0 polypropylene suture. Hemostasis of the coronary ostia anastomoses and performance of the aortic valve are tested by pressurizing the aortic root with cardioplegia. Biological glue or fibrin glue is used at the discretion of the surgeon to impregnate the aortic root anastomoses.

The distal anastomosis is performed and after meticulously 'de-airing' the left ventricle, the aortic clamp is removed.

The surgical result is controlled by intra-operative trans-oesophageal echocardiography. After weaning the patient from CPB, meticulous hemostasis is performed before closing the chest.

Comment

Clinical results and advantages

Our early series of patients in which we performed the David operation using a minimally invasive approach has been published recently (1). We demonstrated that the technique can be performed safely and with similar cross-clamp and CPB times compared to the full sternotomy approach. In our view, patients suffer from less pain and can by mobilized earlier and more aggressively, with improved cosmetic results. Future studies are needed to validate this new approach.

Caveats

Exposure of the aortic root can be cumbersome using a minimally invasive approach through an upper mini-sternotomy. Depending on the anatomy of the patient, the surgeon needs to decide whether opening the sternum up to the 4th intercostal space improves exposure and decreases the length of the procedure. In the initial learning phase, we established venous drainage via femoral access. Although this may further improve exposure, in our experience the procedure can be performed using standard cannulation via minimal sternal access. Adequate venting of the left heart can be achieved in most cases by placing the vent catheter into the pulmonary artery (PA). If one wants to ensure left heart venting, the vent should be placed through the upper right pulmonary vein into the left atrium, although this might be technically difficult in some minimally invasive cases. With increasing experience, we are using PA venting more often to facilitate the procedural access. Since exposure of the aortic root is more difficult in a minimally invasive setting, adequate hemostasis is absolutely vital. One major issue during minimal access aortic root surgery is sufficient de-airing of the heart. We usually place a venting cannula in the ascending aorta after initial de-airing via the anastomosis. Since complete de-airing of the heart is virtually impossible through a mini-sternotomy before unclamping, we continue to vent the aorta until CPB flow has been reduced significantly (<50%). In addition, CO_2 sufflation is mandatory in these cases.

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