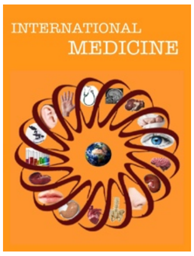

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Video Presentation

Posterior aortic root enlargement (Nick's procedure), mechanical aortic valve replacement and patch closure of the sacciform proximal aortic arch aneurysm by "open" technique without circulatory arrest: a video presentation

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Introduction

The presence of a small aortic annulus forces cardiac surgeons either to enlarge the annulus or to implant a small prosthesis. Many surgeons are reluctant to perform aortic root enlargement, out of concern that this adjunctive procedure will increase operative morbidity and mortality [1,2]. Placement of a small aortic valve prosthesis can lead to prosthesis-patient mismatch adversely affecting left ventricular mass regression and both early and late survival [3-7]. In order to circumvent the adverse effects of prosthesis-patient mismatch, it has been the authors' practice to perform pericardial posterior aortic root enlargement when needed since Stenseth and colleagues first introduced it as an approach to prevent tertiary orifice obstruction after implantation of Starr-Edwards prosthesis [8,9].

Anatomically, the aortic arch is defined as the segment of the aorta between a line at right angle proximal to the origin of the brachiocephalic artery and extending to a line drawn at right angle distal to the origin of the left subclavian artery [10]. Surgical treatment of lesions of the transverse aortic arch provides one of the most formidable challenges in aortic surgery. The major concern in aortic arch surgery is the maintenance of viability of the brain, spinal cord, kidneys, liver and intestines during the period of interruption of cerebral blood flow [10-14].

Past four decades have witnessed a number of techniques of maintenance of cerebral integrity during periods of circulatory interruption [10-16]. Many methods of antegrade and retrograde cerebral perfusion and circulatory arrest have been tried and reported with unpredictable and inconsistent results [10-16]. Because of cerebral autoregulatory physiological mechanism, there are inherent issues of cerebrovascular spasm, under and over perfusion into an elastic or expansile cerebral vasculature, causing cerebral edema or ecchymosis. Although deep hypothermic circulatory arrest without selective carotid arterial perfusion have been used for operations on the aortic arch by Randall Griepp and other investigators, the hazards of deep hypothermia and circulatory arrest continue [10-19].

The operative procedures for proximal transverse arch aneurysms are most commonly hemiarch repair, aortic arch replacement with re-

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implantation of the aortic arch vessels as a cuff or aortic arch repair with or without distal descending elephant trunk procedure with or without deep hypothermic circulatory arrest [11-19].

For aneurysms involving the transverse arch proximal to ligamentum arteriosum, the best approach is through a median sternotomy. This approach permits control of the descending thoracic aorta with the performance of the distal anastomosis. This patient required the intervention of the proximal arch and concomitant aortic valve replacement and aortic root enlargement.

In this patient, the aneurysmal disease process involved the proximal transverse arch, distal ascending aorta, the brachiocephalic artery and he required concomitant aortic root enlargement with aortic valve replacement. Therefore, a median sternotomy was the preferred approach for optimal surgical access.

Since the aneurysm was sacciform in nature with an aneurysmal opening of about 4 cm and healthy surrounding aortic tissue, the decision was taken for patch aortoplasty instead of graft interposition. The origin of the brachiocephalic artery was maintained within the neoconstructed proximal aortic arch.

We used an endoaortic balloon occlusion using a No.20 Fr Foley catheter with the following objectives:

a. Maintained the perfusion of the distal organs including the head vessels retrogradely through the femoral artery;

b.Performed the distal anastomosis by an open technique under direct vision with proper spacing of sutures, achieving perfect hemostasis;

c. Performed the procedure under mild hypothermia, thereby avoided the complications secondary to deep hypothermic circulatory arrest;

d. Incorporated the ostium of the brachiocephalic artery within the newly created neoaortic arch.

We report here-in a 55-year old hypertensive male patient presented with precordial pain, shortness of breath and palpitations (New York Heart Association class IV) of three years duration. There was no history of chest trauma or chest infection. Transthoracic two-dimensional echocardiography revealed a stiffened, stenosed, calcified tricuspid aortic valve and a small aortic annulus with a gradient of 172/94 mmHg across the aortic valve. Concentric left ventricular hypertrophy was present with good biventricular systolic function (left ventricular ejection fraction 0.6). Computerized tomographic angiography confirmed valvular aortic stenosis with calcified aortic valve and normal coronary arteries. Aortic diameters at different levels were aortic valve annulus (17 mm), siutubular junction (20 mm), proximal ascending aorta (28 mm), proximal aortic arch (10 cm), transverse aortic arch (30 mm), distal arch (30 mm), descending thoracic aorta (31 mm) and abdominal aorta proximal to aortic bifurcation (29 mm). There was a large sacciform ascending aortic aneurysm about 10 cm in diameter just below the right brachiocephalic artery. The arch vessels were arising normally and were normal in calibre.

The patient underwent aortic root enlargement using Nick's procedure, aortic valve replacement using 21 mm St. Jude Medical Mechanical Prosthesis, autologous pericardial patch enlargement of the aortic annulus, aortic aneurysmectomy and patch repair of the sacciform ascending aortic aneurysm using polytetrafluoroethylene patch by open technique under mild hypothermia without circulatory arrest.

Surgical techniques

Exposure and cannulation of the femoral artery and femoral vein

An infrainguinal vertical incision was made over the right femoral artery. Both right femoral artery and right femoral vein were dissected and looped to facilitate later cannulation. Elective femoral arteriovenous cannulation was performed using a long femoral arterial and a venous cannula (Edwards Lifesciences, LLC, One Edwards Way, Irvine, CA, USA) following systemic heparinization.

Position and surgical approach

The chest was entered through a median sternotomy. The thymus was subtotally excised taking care not to injure the stretched, compressed brachiocephalic vein. The pericardium was opened in the midline in between stay sutures using scissors and not cautery to avoid inadvertent cautery-induced ventricular fibrillation.

Cannulation of the superior vena cava and venting of the main pulmonary artery

Under cardiopulmonary bypass on a partially decompressed heart, the superior vena cava was cannulated using a No.22 angled metal-tipped venous cannula. The main pulmonary artery was vented using an 18-Fr vent catheter to prevent cardiac distension. The left ventricle was vented through the right superior pulmonary vein.

Cross-clamping of the mid ascending aorta and administration of selective ostial cold blood cardioplegia

The mid ascending aorta was cross-clamped below the aneurysm. The aorta was opened 2 cm above the right coronary sinus through an oblique horse-shoe shaped incision across the mid-portion of the non-coronary sinus into the fibrous subaortic curtain. Myocardial protection was achieved using combined selective ostial and retrograde cold St. Thomas based (1:4) blood cardioplegia and topical cooling with ice-cold saline.

Aortic root enlargement and aortic valve replacement

The stenosed and calcified aortic valve was excised. The valve sizer was placed in the neoaortic annulus to confirm proper sizing and position of the valve in the sub-coronary position. Similar to an aortic valve replacement in a native annulus, the aortic valve was replaced using a No.21 mm St. Jude Regent Mechanical Heart Valve (St. Jude Medical Inc, Saint Paul, Minnesota). We used interrupted pledgeted 2-0 braided coated Ticron Polyester Sutures (M/s Covidien, Santo Domingo, Dominican Republic, USA). In the non-coronary sinus, the pledgeted mattress sutures were placed from outside the aorta to the sewing ring of the prosthesis to facilitate proper implantation. The valve was seated in the intra-annular position ensuring no encroachment of the coronary ostia.

The enlarged aortic annulus in the non-coronary sinus was repaired using an unfixed autologous square-shaped pericardial patch by a modified Nick's procedure developed by the corresponding author (UKC). Four 4-0 pledgeted polypropylene mattress sutures were passed from the sewing ring of the prosthesis to the pericardial patch ensuring the retain a 0.5 cm pericardial cuff. After seating the pericardial patch, the newly constructed annulus over the non-coronary sinus was repaired using a second continuous layer of 4-0 polypropylene and the retained pericardial cuff, thus ensuring perfect hemostasis. The aortotomy opposite the patch was closed directly using 4-0 polypropylene suture. The patch was trimmed to the size of the remaining defect and the original 4-0 polypropylene suture was continued around the patch to complete closure of the aortotomy.

Restoration of myocardial perfusion through the retrograde coronary sinus cannula

Myocardial perfusion was restored through the retrograde coronary sinus cannula at a rate of 150-170 mL/min maintaining the coronary sinus pressure of 25-30 mmHg.

Endoaortic occlusion through the aneurysm sac using a No.20 Fr Foley catheter

The patient was placed in the Trendelenburg position. The right brachiocephalic artery was snugged and the perfusion flow rate was temporarily lowered to 1.5 L/min. The aneurysm was incised at its center and the contained intra-aneurysmal clots were evacuated. A No.20 Fr Foley catheter was advanced through the opened aneurysmal sac into the aortic arch, the balloon was inflated and the whole body perfusion was restored retrogradely through the femoral artery catheter.

Reconstruction of the proximal aortic arch

The healthy margins of the saccular aneurysm were identified. The proximal aortic arch was reconstructed by using an onlay polytetrafluoroethylene patch (W.L. Gore Inc., Elkton, MD, USA) and continuous 4-0 polypropylene suture (Johnson and Johnson Ltd., Ethicon, LLC, San Lorenzo, USA), reinforced with Teflon pledgets as and when required. Since the neck of the aneurysmal opening was 4 cm wide and the surrounding aortic tissues were healthy, the decision was taken for patch aortoplasty instead of graft interposition. Two polytetrafluoroethylene patches were used to restore continuity of the distal ascending aorta and proximal aortic arch ensuring unrestricted opening of the brachiocephalic artery. Care was taken not to narrow the segment of the aorta at the site of aortoplasty. The retrograde Foley catheter was deflated and removed. After securing hemostasis and ensuring myocardial and distal aortic perfusion, the patient was fully rewarmed and was decannulated.

Short- and long-term results

Postoperatively, transesophageal echocardiography demonstrated normal ventricular function (left ventricular ejection fraction 0.6) on dopamine 5 μg/kg/min and sodium nitroglycerine 0.5 μg/kg/min. The postoperative recovery was uneventful. At 36 months of follow-up, the patient was in New York Heart Association functional class I with normal biventricular function and no neurological deficit.

Conclusion

The patient benefits of this endoaortic occlusion techniques are excellent operative exposure, maintenance of perfusion of all the vital organs including the brain, avoidance of complications secondary to deep hypothermia and circulatory arrest and performance of the operative procedure under controlled conditions. Concomitant retrograde myocardial perfusion reduces myocardial anoxic time in these situations of prolonged surgical procedures. Aneurysmectomy and suturing of the patch can be performed under optimal visualization, achieving perfect hemostasis.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of the article.

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