Technical Aspects of the Aortic Root Reconstruction Procedures: Assessing the impact and the reproducibility of the Coroneo Extra-Aortic Annuloplasty Ring on Homografts

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Introduction

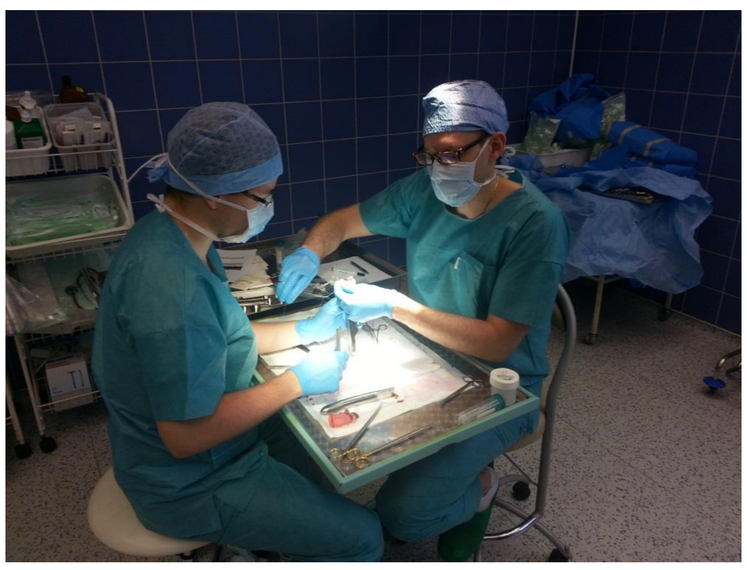
Aortic valve sparing operations were refined in order to preserve the native aortic valve during surgery for the aortic root aneurysm and surgery for the ascending aortic aneurysm with associated aortic insufficiency. The aortic root is an ensemble consisting of distinct entities: the aortic valve leaflets, the leaflet attachments, the sinuses of Valsava, the interleaflet trigones, the sinotubular junction and the annulus. It is a remarkably complex and sophisticated structure. Every single constituent of the aortic root has an optimal macroscopic, microscopic structure and anatomical architecture which contributes to the function of the aortic root: intermittent, unidirectional channeling of large volumes of fluid while maintaining laminar flow, minimal resistance, the least possible tissue stress and damage during varying hemodynamic conditions and demands. This synchronized dynamic behavior of all aortic root components has shown to be of a great importance for a specific flow characteristic, left ventricle function and coronary perfusion. When any of the aortic root components fail, it is the recognition of the complexity of the structure that has led to the development and advancements in sparing surgical procedures that respect the fundamental anatomical existence of the individual parts of the aortic root.

Dynamic anatomy

In vitro and in vivo studies have documented that cusp motion and flow patterns across the reconstructed aortic root are more physiologic after remodeling of the aortic root rather than the reimplantation of the aortic valve, as well as after procedures using a prosthetic conduit fashioned with neo- sinuses of Valsalva than without. 41-43 Dynamic anatomy reports showed that the three-dimensional a sigmoid shape of the aortic annulus could be divided into two tow-dimensional planes: one at the base of the aortic annulus also called the ventriculo-aortic junction, and the one at the sinotubular junction. 44, 45 Dilatation of both of these diameters is characteristic for lesion of the aortic root aneurysm. These advances in dynamic anatomic knowledge led to the development of different valve- sparing procedures for the treatment of the aortic root aneurysm.

Current situation

Lansac et al. proposed a standardized approach for aortic valve repair addressing both the aorta and the valve, associating physiological reconstruction of the aortic root according to the remodeling technique with the re-suspension of cusp effective height and an expansible subvalvular ring annuloplasty using expansible aortic ring in order to achieve a complete and calibrated annuloplasty in diastole, while maintaining systolic expansibility of the aortic root (Extra-Aortic TM ,CORONEO, Inc., Montreal, QC, Canada). 4 This solved a problem in the treatment of aortic root aneurism and the lack of a geometric annuloplasty ring to facilitate reconstruction of the aortic root that restores physiological annular size and geometry during aortic valve repair. Cusp coaptation height was increased, reducing the stress on the cusps, thus protecting the repair. The choice of the aortic ring and the tube graft was standardized, based on the criteria of intra- operative measurement of a native aortic annular size with the Heagar dilators. The diameter of the prosthetic aortic ring was undersized by one size to restore a normal STJ/annular base ratio of 1.2. A calibrated expansible aortic ring annuloplasty (Extra-Aortic TM ,CORONEO, Inc., Montreal, QC, Canada) in different sizes was developed in order to facilitate technical standardization.



Experimental models

Experimental thawing of cryopreserved aortic root allografts

Fractures that may arise during the thawing of a cryopreserved aortic root allografts may represent a direct threat to the life of the transplant recipient. The purpose of this work and its direct clinical outcome is to establish a uniform procedure which will minimize the damage of the graft during thawing. The following thawing protocols were tested on aortic root allografts

Protocol Thawing:
1, immersion in a water bath at + 37C
2, air at room temperature + 20-25C

Hypothesis 1a: Thawing process at the water batch at +37C produces less microfractures to the aortic root allograft
Hypothesis 1b: Thawing process at the water batch at +37C produces more microfractures to the aortic root allograft

The reproducibility of the Coroneo Extra-Aortic Annuloplasty Ring

Aortic root homograft dissection was performed in a standard manner with the removal of all the excessive tissue. Hegar's dilatators were used for the measurement of the Aorto-Ventricular Junction. Six individual stitches were used in order to implant Coroneo Extra-Aortic Annuloplasty ring in a standard manner. Above described procedure was repeated twice on each homograft. In total 20 aortic root allografts of different sizes were used.

Hypothesis 2a: The Coroneo Extra-Aortic Annuloplasty Ring implantation is reproducible
Hypothesis 2b: The Coroneo Extra-Aortic Annuloplasty Ring implantation is not reproducible
Hypothesis 3a: The muscular septum thickness has an impact on the reduction of the Aorto-Ventricular Junction.
Hypothesis 3b: The muscular septum thickness does not have an impact on the reduction of the Aorto-Ventricular Junction.

Statistical analysis of the results is currently being performed using MedCalc Version 12.2.1.0