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Review Article

The role of transesophageal echocardiography in aortic valve preserving procedures

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ABSTRACT

In selected cases of aortic regurgitation, aortic valve (AV) repair and AV sparing root reconstruction viable alternatives to aortic valve replacement. Repair and preservation of the native valve avoids the use of long-term anticoagulation, lowers the incidence of subsequent thromboembolic events and reduces the risk of endocarditis. Additionally repair has a low operative mortality with reasonable mid-term durability. The success and longer term durability of AVPP has improved with surgical experience. An understanding of the mechanism of the AR is integral to determining feasibility and success of an AVPP. Assessment of AV morphology, anatomy of the functional aortic annulus (FAA) and the aortic root with transesophageal echocardiography (TEE) improves the understanding of the mechanisms of AR. Pre- and intra-operative TEE plays a pivotal role in guiding case selection, surgical planning, and in evaluating procedural success. Post-operative transthoracic echocardiography is useful to determine long-term success and monitor for recurrence of AR.

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1. Introduction

In selected cases AV repair and AV sparing root reconstruction are proving to be viable alternatives for the surgical management of significant AR. These procedures, collectively known as AVPP offer additional benefits over the traditional AVR with a mechanical or bioprosthesis. Repair and preservation of the native valve avoids the use of long-term anticoagulation, lowers the incidence of subsequent thromboembolic events and reduces the overall risk of endocarditis. Additionally, repair has a relatively low operative mortality with reasonable mid-term durability.[1–4] The success rate and longer term durability of AVPP has, however, been a source of conjecture since its inception.[1] Over time it has become increasingly clear that along with surgical experience, a thorough

Abbreviations: AV, aortic valve; AR, aortic regurgitation; AVPP, aortic valve preserving procedure; TEE, transesophageal echocardiogram; STJ, sino-tubular junction; AVJ, aorto-ventricular junction; FAA, functional aortic annulus; ME LAX, mid-esophageal long axis; ME SAX, mid-esophageal short axis; LVOT, left ventricular outflow tract; BAV, bicuspid aortic valve.

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understanding of the mechanism and etiology of the AR is integral to determining feasibility and success of an AVPP.[5–7] Pre and post-operative TEE plays a pivotal role in guiding the surgeon with case selection, surgical planning and in evaluating procedural success. This article aims to outline the comprehensive TEE assessment needed to provide this guidance. In doing so we review aortic valve and aortic root anatomy, the classification system of AR, typical echocardiographic appearance of each lesion and the stepwise approach to postoperative evaluation of success.

2. Anatomy of the AV and aortic root

The aortic root is a direct continuation of the left ventricular outflow tract (LVOT). It acts as a stent to support the three cusps of the aortic valve.[8] The aortic root is demarcated by the sino-tubular junction (STJ) superiorly and the aorto-ventricular junction (AVJ) inferiorly.[8] Just under half of the circumference of the aortic root is connected to the muscular septum with the remaining portion (55%) attached to a fibrous membrane.[9] Part of this fibrous membrane is in direct connection with the anterior mitral valve leaflet. The aortic root comprises the sinuses of Valsalva, the leaflets, commissures and inter-leaflet triangles.[10] The leaflets insert into the aorta in a semi-lunar crown-like manner. The base of attachment within the ventricular myocardium forms a virtual basal ring often termed the "aortic annulus" in echocardiography. The peripheral attachment of the leaflets marks the STJ. The point at which the ventricular components give rise to the fibro-elastic walls of the aortic sinuses marks the anatomic AVJ. Thus there are multiple "rings" rather than one true annulus within the aortic root – the virtual basal ring formed by the leaflet attachments, the AVJ, the crown-like ring of leaflet attachments and the STJ. It is this structure of rings which makes up the complex FAA (Fig. 1) as described by Piazza et al[11]

The three components of the aortic root – the leaflets, the annulus and the STJ are imperative for valve function and competence. All elements must be considered when evaluating the mechanism and etiology of the AR.

3. Pre-repair TEE

TEE has been shown to provide a highly accurate anatomic assessment of all types of AR lesions and has proven to be strongly predictive of valve repairability and postoperative success.[7] Pre-repair TEE imaging should focus on a combination of function and anatomy to determine feasibility of AVPP.

3.1. *Functional classification of AR*

AR can be caused by either dilatation of the FAA or primary disease of the AV leaflets. Dilatation of the ascending aorta distal to the aortic root will not cause AR unless the STJ is involved.[12] Primary leaflet problems include prolapse, perforation or leaflet restriction. El Khoury et al proposed a classification of AV and/or aortic root pathologies similar to the Carpentier classification for mitral valve disease (Fig. 2).[5,6] A

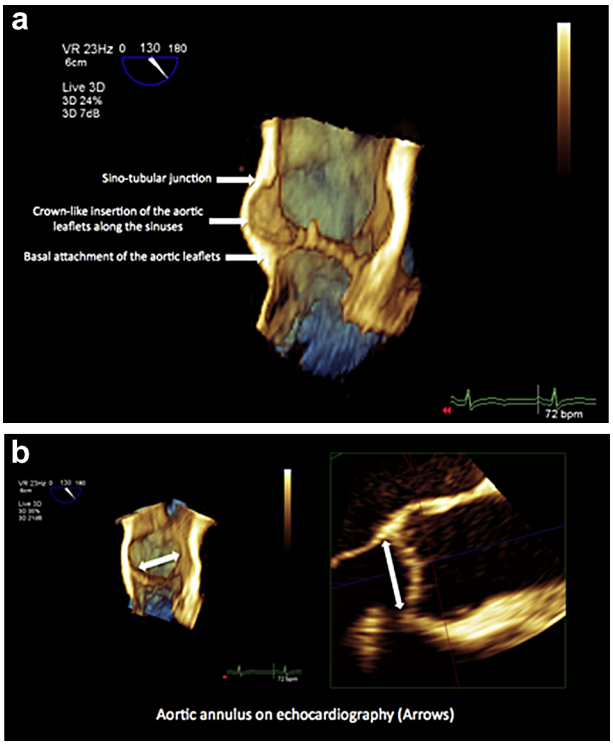

Fig. 1 – a & b: The functional aortic annulus (FAA).

subsequent study by le Polaine de Waroux et al has shown this functional classification provided by TEE is a strong predictor of repairability and outcome (4 year freedom from >grade 2 AR, reoperation or death, $p = 0.04$).[7]

3.1.1. *Type I lesions*

Type 1 mechanism of AR implies regurgitation due to FAA dilatation or cusp perforation with *normal leaflet motion*. This pathology produces a central regurgitant jet of AR. Dilatation of the FAA causes outward displacement of the commissures and decreased coaptation. This mechanism is further categorized into four subtypes. Type 1a describes STJ enlargement and dilatation of the ascending aorta. Type 1b AR results from dilatation of the sinuses of Valsalva and the STJ. Type 1c is related to dilatation of the AVJ. Type 1d is a specific category which indicates cusp perforation.[5]

Type 1a lesions are usually the result of progressive atherosclerotic disease of the ascending aorta with dilatation of the STJ. They can often be associated with aneurysms of the ascending aorta.[5] Surgical correction aims at restoration or refashioning of the STJ and replacing aneurysmal portions of the thoracic aorta.[8]

Type Ib lesions involve aneurysms of the aortic root (Fig. 3) that are frequently associated with degenerative conditions of the media such as Marfan's or Ehlers-Danlos syndrome.[13,14] Historically, surgical treatment of this pathology involved concomitant aortic root and AV replacement (Bentall procedure).[15] The valve-sparing alternative exists in two main forms: AV reimplantation (David procedure) and AV remodeling (Yacoub procedure).[2,16] The degree of aortic root dilatation has not been shown to be a factor in predicting repair

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