Updates in Aortic Valve Sparing Surgery

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Abstract

For more than 90 years ago Aortic valve sparing operations had been performed, but only recently surgeons have been able to match the aortic root disorder to the operative procedure correctly The development of aortic valve-sparing operations (re-implantation of the aortic valve and remodeling of the aortic root) expanded the surgical issues for treating patients with aortic root dilation caused by a variety of disorders. Young adults with aortic root aneurysms associated with genetic syndromes are ideal candidates for re-implantation of the aortic valve, and the long-term results have been excellent. Incompetent bicuspid aortic valves with dilated aortic annuli are also satisfactorily treated with the same type of operation. Older patients with ascending aortic aneurysm and aortic insufficiency secondary to dilated sino-tubular junction and a normal aortic annulus can be treated with remodeling of the aortic root or with re-implantation of the aortic valve. Annular dilation is often present in patients with incompetent BAV, correction of annular dilation is important, and re-implantation of the aortic valve may be the best option. There is a variety of techniques for Cusp Repair, considered as one of the valve sparing techniques. Aortic valve sparing surgery is performed to prevent hazards of Prosthetic valve implantation which is the most widely used therapeutic option for aortic regurgitation (AR), but complications associated with prosthetic valves, with an incidence of 3–5% patient/year, and the need for anticoagulation in mechanical valves, force us to consider aortic valve repair as an alternative to the prosthetic implant, especially in young people with many potential years of life for these complications.

Aim of the work:

This paper aims to have a description about surgical and dynamic anatomy of the aortic root, pathological changes that may affect it and important investigation for proper diagnosis and surgical planning. Highlights for aortic valve sparing operations and their modification

Review of Literature:

Aortic valve-sparing (AVS) operations have become established alternatives to composite valve graft (CVG) procedures for patients with aortic root aneurysms and favorable aortic cusp morphology. Theoretical benefits of AVS procedures include avoiding the complications associated with prosthetic valves, specifically the risks of systemic thromboembolism and lifelong anticoagulation associated with mechanical valves.

Summary:

The development of aortic valve-sparing operations (re-implantation of the aortic valve and remodeling of the aortic root) expanded the surgical issues for treating patients with aortic root dilation caused by a variety of disorders.

Keywords:

Aortic Valve - Sparing Surgery - Cardiothoracic Surgery - valve-sparing operation.

Introduction

The term aortic valve-sparing operation was introduced to describe an operative procedure developed to treat aortic root aneurysm whereby the aneurysmal sinuses are excised and the native aortic valve is implanted inside a tubular Dacron graft. ***(David TE. 2012)***

A series of procedures have been designed to reconstruct the aortic root of patients with aortic insufficiency, in whom the pathology and hence the surgery spares the valve leaflets. ***(Frater RW, Anderson RH. 2010)***

The two main types of AVS have been extensively used: re-implantation of the aortic valve and remodeling of the aortic root. ***(David TE. 2012)***

Review of Literature

The aortic root is the part of the aorta that attaches the left ventricle to the ascending aorta proper and it is an ensemble consisting of distinct entities including the aortic valve, leaflets, the sinuses of Valsalva, the sinotubular junction and the aortic annulus**.** ***(Sievers HH, et al., 2012).***

Normally the aortic valve is formed of three leaflets: anterior, posterior and septal. The three leaflets form the aortic valve and provide its main sealing mechanism ***(David TE and Armstrong S .2010).***

Aortic root pathology has now been reported as the most common cause of aortic valve incompetence. **(Bierbach BO, et al., 2010**)

Classification of AI depends on the aortic valve consists of two major components: the aortic annulus and the valve leaflets. **(Boodhwani M, et al., 2009).**

AI classified into: 1- Type I AI which classified into: type I A owing to STJ enlargement and dilation of the ascending aorta, type I B owing to dilation of the sinuses of Valsalva and the STJ, type I C owing to dilation of VAJ, and lastly type I D owing to cusp perforation without a primary functional aortic annulus lesion. 2-Type II AI is due to leaflet prolapse secondary to excessive cusp tissue or due to commissural disruption. 3-Type III AI is due to leaflet restriction, which can be found in bicuspid, degenerative, or rheumatic valvular disease because of calcification, thickening, and fibrosis of the aortic valve leaflets. **(Boodhwani M, et al., 2009).**

The aorta is a complex geometric structure and several measurements are useful to characterize its shape and size. Imaging options available for assessment of the aorta root include plain radiography, transthoracic echocardiography (TTE) trans-esophageal echocardiography, (TOE) multi-slices CT, MRI and invasive catheter angiography. **(Bonnafy T, et al., 2013).**

Routine CXR rarely provides a definitive diagnosis; it can provide several important diagnostic clues to aortic diseases that prompt further evaluation. **(Iskandar A, et al., 2013).**

Chest X-ray obtained for other indications may detect abnormalities of aortic contour or size as an incidental finding, prompting further imaging. **(Von Kodolitsch Y, et al., 2004)**

Echocardiographic evaluation of the aorta is a routine part of the standard examination; it is useful for the diagnosis and follow-up of some aortic segments. This provides good images of the aortic root, the ascending aorta and aortic arch in most patients, descending thoracic aorta in some patients. **(Flachskampf FA, et al., 2010).**

Transthoracic echo also permits assessment of the aortic valve, which is often involved in diseases of the ascending aorta. Aortic arch aneurysm, plaque calcification, thrombus, or a dissection membrane may be

detectable if image quality is adequate. **(Flachskampf FA, et al., 2010)**

Computed tomography plays a central role in the diagnosis, and management of aortic diseases. Its advantages over other imaging modalities include the short time required for image and processing, the ability to obtain a complete 3D dataset of the entire aorta, and its widespread availability **(Hiratzka LF, et al., 2010)**

Computed tomography allows detection of the location of the diseased segment, the maximal diameter of dilation, the presence of atheroma, thrombus, IMH, penetrating ulcers, calcifications and, in selected cases, the extension of the disease to the aortic branches **(Nienaber CA. 2013)**

Historical Introduction to aortic valve repairs, reconstructions and finally 'valve sparing' include: In 1832, Corrigan first described the 'permanent patency of the mouth of the aorta' as a consequence of dilation of the Sino-tubular junction co-existing with normal leaflets and pre-morbid diagnosis of aortic insufficiency and in 1913, Tuffier described the first aortic commissurotomy for aortic stenosis. **(Tuffier T. 1913)**

In 1956, Lewis published his technique for aortic valvulotomy and in1958, Harken reported decalcification/ repair for aortic stenosis, poor short and medium term outcomes for the repair methods applied to aortic stenosis were soon well established **(Harken D. 1958)**

In 1958, Taylor described a treatment for aortic regurgitation that could be performed off bypass which he termed 'circumclusion', which consisted of a suture circumferentially snugging the aortic annulus to reduce the size of the dilated aortic aneurysm. **(Taylor WJ, et al., 1958)**

In 1958, Garamella published the concept of aortic valve re-suspension for aortic regurgitation due to sub-aortic VSD. This successful re-suspension was critical to the evolution of the understanding of the semilunar valve function. **(Garamella JJ. 1958)**

In 1959, Starzl reported a novel technique for the management of aortic regurgitation by creating a bicuspid aortic valve. **(Starzl TC, et al., 1959)**

In 1960, Murphy described a courageous off-bypass annular plication with an umbilical tape technique for syphilitic aortic insufficiency similar to a concept by Hurwitt (1960), who described a series of suture plications of the aortic 'ring' for aortic insufficiency, which could also be performed off bypass. **(Murphy JP.1960)**

In 1980 and 1983, Wolfe published a series of acute ascending aortic dissections treated with valve re-suspension and in his 1983 update, a total of 48 patients were reported of whom 35 had successful valve re-suspension. Only one of these patients ultimately required late aortic valve replacement, 17 years following the series. **(Wolfe WG, et al., 1983)**

In 1986, Frater described and emphasized the anatomic and mechanical function of the sino-tubular junction and noted that correcting a dilated sino-tubular junction was often sufficient to repair aortic insufficiency in those cases in which valve leaflets and annulus were not enlarged. **(Frater RW. 1986)**

In 1983, Sir Magdi Yacoub first shortly described the valve sparing procedure now known as remodeling procedure , but the results were not published until the early 1990. **(De Paulis R. 2017)**

The remodeling technique for valve-sparing aortic root replacement (Yacoub procedure) involves resection of the sinus tissue and construction of

neo-sinuses using a tailored Dacron graft. The coronary arteries are re-implanted in their corresponding neo-sinuses as buttons. In this procedure, however, the aortic annulus is not supported by the Dacron graft and is best suited for patients without annular dilation or a predisposition to future annular dilation. **(Kate Hanneman, MD, et al., 2015).**

As for the remodeling technique, the greatest perceived advantage was the possibility of providing a good anatomical reconstruction of the sinuses of Valsalva while being a somewhat quicker operation and relatively easy to perform**.(De Paulis R. 2017)**

An improvement in the remodeling technique was noticed by adding a complete annuloplasty to the standard technique. Alternatively, and across the following years, this type of annuloplasty has been executed with Dacron or Teflon strips, with specifically designed compliant ring or with Goretex sutures **(Schneider U, et al., 2016)**

In 1992, David described the technique that is now known as the reimplantation procedure (or David I). In that same manuscript, unaware of Dr. Yacoub work, he also described the remodeling technique (referred as David II) and a variation of it (the David III) where a partial annuloplasty was associated with the remodeling technique**. (Sarsam MA, et al., 1993).** Several modifications of the David procedure have been described, with newer modifications attempting to construct bulging neo-sinuses to mimic the natural aortic root. See (table). **(David TE, et al., 2012)**

TABLE MODIFICATIONS OF AORTIC VALVE-SPARING PROCEDURES

	Modifications	Implications
David 1	Graft attached to annulus, AV resuspended	Cylindrical sinus, annulus reinforced
David 2	Tailored graft attached to commissural posts	No reinforcement or reduction of the "annulus" and no STJ remodeling
David 3	David 2 + Annulus reinforced (Teflon felt)	Reinforces annulus, remodels STJ
David 4	David 1 using a 4-mm larger Dacron graft plicated at STJ	STJ remodeled
David 5	David 1 using a 8-mm larger Dacron graft plicated at annulus and STJ	Neosinuses created, STJ remodeled
Yacoub	Remodeling using a tripartite crown-shaped Dacron tube graft	Neosinuses without annular support or STJ remodeling

AV, aortic valve; STJ, sinotubular junction.

There is a variety of techniques for Cusp Repair, considered as one of the valve sparing techniques Cusp prolapse is the most frequently encountered lesion and is associated with excess length of the free margin, which can be corrected using either central free margin plication or free margin re-suspension. When a single cusp is prolapsing, the two non-prolapsing cusps serve as the reference and are used to estimate the required reduction in the free margin length**. (Schafers HJ, et al., 2013)**

Summary

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Young adults with aortic root aneurysms associated with genetic syndromes are ideal candidates for re-implantation of the aortic valve, and the long-term results have been excellent. Incompetent bicuspid aortic valves with dilated aortic annuli are also satisfactorily treated with the same type of operation.

Older patients with ascending aortic aneurysm and aortic insufficiency secondary to dilated sino-tubular junction and a normal aortic annulus can be treated with remodeling of the

aortic root or with re-implantation of the aortic valve.

Annular dilation is often present in patients with incompetent BAV, correction of annular dilation is important, and re-implantation of the aortic valve may be the best option.

Prosthetic valve implantation is the most widely used therapeutic option for aortic regurgitation (AR), but complications associated with prosthetic valves, with an incidence of 3–5% patient/year, and the need for anticoagulation in mechanical valves, force us to consider aortic valve repair as an alternative to the prosthetic implant, especially in young people with many potential years of life for these complications.

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