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journal homepage: <http://www.elsevier.com/locate/crvasa>Review article – *Special issue: Cardiovascular Surgery*

A history of the surgical treatment of aortic regurgitation[☆]



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ARTICLE INFO

Article history:

Received 20 February 2015

Accepted 1 March 2015

Available online 25 March 2015

Keywords:

Aortic regurgitation

Cardiac surgery

Aortic repair

Cardiopulmonary bypass

ABSTRACT

Aortic valve sparing strategies have a valuable potential to treat the patient's valvular disease. In contrast to the mitral and tricuspid valve, aortic repair is more difficult with respect to specific valve features. Authors give a historical overview of the evolution of surgical concepts to achieve the valve competency. Over the period of 70 years, manifold innovative approaches were tested in relation to contemporary level of knowledge in search of effective, standardized, safe and durable reconstructive procedures. Current focus on three geometrical components of aortic valve competency is a logical heir to this long-lasting effort.

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[☆] From a book in progress 'Vojáček, J., Žáček P.: Treatment of aortic incompetence (Grada 2016)'.

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<http://dx.doi.org/10.1016/j.crvasa.2015.03.002>

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Introduction

Restitution of the aortic valve competence and avoiding its replacement belongs to the hot topics of modern cardiac surgery. The history of such surgical efforts, however, has been remarkably long. Almost 70 years have elapsed since the first surgical attempt to perform an aortic valve repair. The development of surgical concepts of correcting the aortic incompetence, concurrent with the growing body of knowledge, is most exciting. First surgical attempts were performed in the era when diagnostic imaging methods were scarce, experience with open-heart surgery and cardiopulmonary bypass minute, myocardial protection during the surgery deficient and possibilities to cope with serious complications limited.

Early 1960s

In 1958, Taylor has published his experience with so-called circumclusion of the aortic root which he had performed in 11 patients since 1955 [1]. In the days of the very beginning of cardiopulmonary bypass introduction in the routine clinical practice he performed on the beating heart an encircling suture of the aortic root base by a heavy silk ligature. He did it in a blind manner with only an indirect palpation by the index finger inserted in the right atrium. Taylor's pioneering proposal documented his surgical audacity and dexterity as well as a visionary perception of the role of the dilated aortic annulus. In the reality of his era, however, he was limited by the availability of the diagnostic tools – he dosed the tightening of the ligature only in correlation to the level of diastolic pressure.

Bahnson described in 1960 the development and first clinical impressions with the use of the prosthetic aortic cusps [2]. Teflon (tetrafluoroethylene) fabric was sewn in a form of blind thumb and pulled over a spherical mold (cast from cadaverous aortic roots) and then heated on 288 °C. Teflon fabric retracted over the ovoid mold and after its dissection the concave cusps were obtained. Bahnson reported 4 operation findings of replacement of one aortic cusp because of the aortic regurgitation, stenosis or a combined lesion. It is interesting that one of his operative descriptions would be interpreted in the recent era as a typical bicuspid valve with the fusion of the coronary cusps and a prolapse of the noncoronary cusp. Operations were performed on a beating heart and continuous myocardial perfusion by means of cannulae inserted directly in the coronary ostia. Three patients survived and enjoyed improved cardiac condition after a few months despite a persistent diastolic murmur.

Harken reported skeptically his own experience with Teflon extension of the noncoronary cusp (repair failure, late rigidity of the Teflon) and addressed his attention to the aortic valve replacement by a ball-caged artificial valve (which he successfully performed first-in-man in 1960) [3]. Later, the use of Teflon has led to the same disappointment when employed for the whole artificial valves (tears, retractions and rigidity due to fibrous invasion) [4].

In the same period the aortic valvuloplasty has been considered also in case of severe aortic stenosis [5]. Mulder described his attempts of surgical decalcination of the stenotic aortic valves and in case of appearance of regurgitation he recommended suturing of the commissure and annular reduction achieved by the endoluminal invagination of the aortic wall. In some tricuspid valves he performed bicuspidalization by suturing of the commissure, however – analyzed from the historical drawings – even these were again the cases of bicuspid valves with incomplete fusion of the right and left cusp [6].

The interrelation of a subaortic ventricular septal defect and a prolapse of the “medial” aortic cusp was noticed already by Gross [7]. Garamella described in 1960 a successful correction in a 13-years old girl in the heart failure unresponsive to digitalization. Surgery was indicated for a severe aortic regurgitation. As a surprise, a subaortally located ventricular septal defect was found covered by a redundant, deeply prolapsing and partially adherent right aortic cusp. The closure of the defect and plication of the cusp resulted in a complete functional recovery of the patient (including the capability of a horse-riding) [8].

Ross published in 1963 his first experience with a reconstruction of the aortic valve in 9 patients and a whole specter of interventions: extension of one or all three cusps by Teflon fabric, replacement of one cusp by Teflon according to Bahnson, paracommissural plication of the cusp prolapse, valve replacement by a homograft (in a “freehand” manner) and also a complete excision of the noncoronary cusp together with a tear-drop excision of the adjacent aortic wall and conversion into a bicuspid valve. This patient (with Marfan syndrome) died on 4th postoperative day due to the rupture of the aortic wall [9]. The original author of the bicuspidalization technique of tricuspid aortic valve was Garamella who had developed this concept since 1958 in animal experiment and later in 1963 summarized the results of his 4 patients and other 19 patients operated in other U.S. centers. Despite a balanced optimism of his conclusions the results were dismal due to surgical problems and technical imperfections of contemporary cardiopulmonary bypass [10].

Senning has sought a material suitable for aortic valve repair in fascia lata. His initial results from 1966 (replacement of one cusp or a whole valve) [11] were re-evaluated in 1973 in the analysis of 100 patients [12]. Endocarditis (13%) and recurrence of regurgitation in almost all patients (severe incompetence in 2/3 of the population) posed a serious problem.

A manifold variety of so far proposed surgical concepts has not yield consistent and impressive results that could rival the fast improving results of the valve replacements even in the light of their early drawbacks (high incidence of thromboembolism, hemolysis). Nevertheless, some new ideas have appeared that have enriched the modern armamentarium of the reconstructive aortic valve surgery.

In 1966, Christian Cabrol published a pioneering work analyzing the role of so-called upper aortic diameter (currently the sinotubular junction) and lower diameter (ventriculo-aortic junction). Cabrol tested experimentally and in first 6 patients the intervention at the commissural area. For reduction of the aortic base (“annulus”) he performed a

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