Aortic valve repair and aortic valve--sparing operations

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See related articles on pages 112-4, 116-22, 123-9, and 129-30.

Attempts to correct aortic insufficiency by means of aortic valve repair started soon after the advent of open-chest cardiac surgery.^{1,2} Correction of cusp prolapse was performed by suturing the free margins of 2 cusps from the commissures to the central portion or by excising the noncoronary aortic cusp and sinus, transforming a tricuspid into a bicuspid aortic valve.^{1,2} In the early days of cardiac surgery, aortic cusp extension with fascia lata was also done to correct aortic insufficiency.³ The lack of adequate imaging of the aortic valve limited the application of these techniques and the development of new ones. Echocardiography changed all that and had a dramatic effect on our ability to examine the aortic valve, select patients for aortic valve repair, and assess valve function intraoperatively and postoperatively.

The aortic valve is better described as a unit, the aortic root, which is made of various components. The aortic cusps are certainly the most important, but the aortoventricular junction, the aortic sinuses, and the sinotubular junction also play a role in how the cusps open without obstruction during systole or and close without leakage during diastole. The phrase “form follows function” is certainly applicable to the aortic root, and although we have learned a great deal regarding how the various components of the aortic root interact, there is still a lot to be learned. As a student of the aortic root, I have been surprised by the variability in physical appearance of aortic root in individuals with normally functioning aortic valve as well as before and after operations that preserve the native aortic cusps.

Years ago, Feindel and I⁴ coined the term *aortic valve--sparing operations* to describe conservative procedures on the aortic valve in patients with aortic root or ascending aortic aneurysms. A few years later, we classified aortic valve--sparing operations into 2 subgroups, *aortic valve reimplantation* and *aortic root remodeling*.⁵ This new surgical nomenclature was an attempt to define the various types of operative procedures that we used to preserve the aortic

valve in patients with aneurysms. We therefore should use the term *aortic valve--sparing operations* only when we replace 1 or more aortic sinuses and preserve the native aortic cusps and the term *aortic valve repair* when the cusps are repaired and the aortic sinuses are left intact. Repair of the aortic cusps is often necessary during aortic valve--sparing operations to guarantee proper cusp coaptation.

The American Association for Thoracic Surgery Aortic Symposium, originally created by Randall Griepp and colleagues, has been an excellent forum to disseminate knowledge on management of diseases of the aortic valve and aorta. The last symposium was no exception. Several presentations focused on conservative operations on the aortic valve, and this editorial will focus on that topic.

Jasinski and colleagues⁶ from Poland described their experience with aortic valve repair in a heterogeneous group of relatively young patients (mean age, 52 years). They examined their experience with 200 patients: 140 with tricuspid aortic valves and 60 with bicuspid aortic valves. Jasinski and colleagues⁶ gave the impression that all patients had aortic insufficiency, but they did not mention the severity. A variety of operative techniques were used to restore valve competence, including cusp repair (shortening of the elongated free margin by plication of with a fine polytetrafluoroethylene suture), annular reduction by subcommissural plication, replacement of the aortic sinuses, and adjustment of the sinotubular junction, done in isolation or in combination with other procedures. The article is difficult to read and the results difficult to interpret because of the heterogeneity of the aortic valve problems and the operative techniques used. It seems that 30 patients underwent cusp repair and adjustment of the diameter of the sinotubular junction, 50 underwent remodeling of the aortic root, and 56 underwent reimplantation of the aortic valve; the remaining patients may have undergone aortic valve repair alone. The numbers of the various procedures were not clearly stated, making the evaluation of outcomes difficult. Jasinski and colleagues⁶ had 12 reoperations, and these were often associated with complex cusp repair and bicuspid aortic valves. I join Hans-Joachim Schäfers⁷ in commending Jasinski and colleagues⁶ for developing a program on aortic valve repair and continuing to follow their patients to learn the usefulness and limitations of these operations. As their experience increases, they should be able to match the procedure to the pathology more accurately because, as correctly pointed out by Schäfers in his editorial comments on that article,⁷ the classification they used to select the operative procedure has several limitations, particularly for patients with associated aortic root aneurysm, and

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should be used only as a general guideline when one is starting to do conservative aortic valve operations. I believe that the main reasons for failure after these operations are bad cusps and technical errors.⁸

D. Craig Miller has an essay on his David V reimplantation technique and the results he has obtained.⁹ I have used a similar technique for reimplantation of the aortic valve, but I don't upsize the graft as much as he does and I don't use a second graft to reduce the diameter of the sinotubular junction. Instead, I plicate the spaces between commissures to create neo-aortic sinuses in the cylindric graft used to reimplant the aortic valve. The degree of reduction in the diameter of sinotubular junction between 2 commissures is largely a function of the level of coaptation of the cusp. Thus the higher the free margin of the cusp, the deeper the plication on the graft. Miller's results have been excellent during the first decade of follow-up and comparable to that at my institution.^{8,9} Miller's patients with tricuspid aortic valve were relatively young (mean age, 36 years). Interestingly, in my group's experience with reimplantation of the aortic valve age was an independent predictor of repair durability; that is, younger patients fared better than did older ones.¹⁰ This suggests that "young cusps" may adapt to a rigid aortic root better than "older cusps."

My group's longest follow-ups after the reimplantation procedure are of patients who had the valve reimplanted into a straight graft, and although the results were excellent to 18 years, there was echocardiographic evidence of slow deterioration in the aortic valve function.⁸ Was this due to the lack of aortic sinuses, imperfect technique, or simply inevitable degenerative changes, because the valve was placed into a rigid, noncompliant structure? Because of this and other reasons, I believe that we should not abandon the technique of remodeling the aortic root. My personal experience with remodeling is limited, but I have had no failures in patients without genetic syndromes or bicuspid aortic valves. Remodeling may be inappropriate for patients with aortic root aneurysm associated with genetic syndromes, because the aortic annulus may dilate after the procedure. For older patients with primary ascending aortic aneurysm and secondarily dilated aortic sinuses and normal aortic annulus, however, remodeling may provide better long-term results than reimplantation. Schäfers and colleagues¹¹ recently published their experience with remodeling procedures in 431 patients with tricuspid and 290 with bicuspid aortic valves. Their patients' mean age was 54 years, and only 30 patients had Marfan or Loeys-Dietz syndrome. The freedoms from reoperation at 15 years were 95% for tricuspid aortic valves and 83% for bicuspid aortic valves. An aortoventricular junction of >28 mm was a predictor of valve failure, and effective coaptation height was protective against failure.

Incompetent bicuspid aortic valves are often associated with dilated aortic annulus. Although the results of Schäfers and colleagues¹¹ are outstanding, others believe that

reimplantation of the aortic valve is more appropriate for patients with bicuspid aortic valve and dilated aortic annulus.^{9,12} If the aortic sinuses are not dilated, however, the decision to do an operation as extensive as an aortic valve-sparing operation is more difficult. I continue to manage these patients by correcting the cusp prolapse and doing an aortic annuloplasty with an external strip of Dacron polyester fabric band along the fibrous portion of the left ventricular outflow tract.

Another interesting article presented at the Aortic Symposium was a study by Stamou and colleagues¹³ on perioperative outcomes of aortic root surgery, which was based on the Society of Thoracic Surgeons database. From January 2004 through early 2010, a total of 13,743 patients underwent aortic root surgery. Patients with acute type A dissection, active or healed endocarditis, and associated arch surgery were excluded. It was worrisome that the average number of aortic root operations was only 2 cases per year per participating hospital, and only 5% of the sites did more than 16 operations per year. Despite of these small numbers of cases per unit, however, the overall operative mortality was remarkably low at 4.2%. Moreover 1918 patients underwent aortic valve-sparing operations, which were associated with the lowest operative mortality at 1.9%. It would have been interesting to know whether the numbers of aortic valve-sparing operations were related to the overall numbers of aortic root operations per institution.

Conservative operations on the aortic valve are now part of the surgical armamentarium to treat patients with aortic insufficiency or aortic root aneurysms. Although some investigators believe that they confer a survival benefit,¹⁴ the duration of follow-up is too short for meaningful comparison with patients with valve replacement. I believe that these operations should only be done when the aortic cusps are reasonably normal, except perhaps in the case of children and young adults, for whom the results of replacement may not be satisfactory.

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