Operative Techniques in
Thoracic and
Cardiovascular Surgery

Valve-Sparing Root Reconstruction

Thoralf M. Sundt, MD

Over the last decade, valve-sparing aortic root reconstruction has evolved into an important technique in our surgical armamentarium for dealing with aneurysmal disease of the thoracic aorta. The technique was originally developed largely with Marfan syndrome in mind; however, it is now becoming clear that it has perhaps an even broader application among individuals with degenerative disease, bicuspid aortic valve disease with root dilation, and even acute aortic dissection. The early and mid-term results appear promising, although the true late durability will only be known in the fullness of time.

In broad terms, two approaches to the repair of such root aneurysms have developed. My own exposure to these techniques began in the early 1990s with the Yacoub technique. The details of this technique were provided by Professor Yacoub in the very first volume of *Operative Techniques in Thoracic and Cardiovascular Surgery*. His own results have been outstanding. Professor Yacoub's method of excising the sinuses and replacing them with a scalloped graft using a single suture line above the surgical annulus permits great flexibility in establishing the heights of the commissural posts and creates full artificial sinuses of Valsalva, which are readily appreciable on postoperative studies. While the functional significance of such sinuses remains to be proven, they may be important for preventing contact of the fragile native leaflet against the Dacron graft during systole. At a minimum they are appealing from an esthetic basis and are, I feel, an important aspect of this procedure. The disadvantage of this technique is lack of stabilization of the diameter of the aortoventricular junction. Several authors have suggested dilation of the aortoventricular junction as a mechanism of late failure after the valve-sparing procedure.

A competing approach was developed essentially simultaneously and independently by Dr. Tirone David. Dr. David was also a contributor to the first issue of this journal and his original technique is described there as well. In this technique the entire aortic valvular apparatus is reimplanted within a Dacron tube graft. Accordingly, this technique involves two proximal suture lines, one beneath the aortic annulus and the other essentially subcoronary akin to the suture line used in free-hand homograft implantation. In addition to stabilizing the aortoventricular junction, this is a more readily hemostatic technique as intraaortic and intraventricular pressure tend to seal the suture lines by pressing the aorta against the Dacron graft. The disadvantage of this technique has been less full development of sinuses of Valsalva.

A number of variations on David's technique have been developed. A Dacron graft specifically designed to re-create sinuses of Valsalva is now commercially available and has found a number of ardent supporters. The technique we have found to be simpler and more economical is a two graft method as suggested by Dr. Craig Miller of Stanford University. We have been pleased with the application of this approach in all of the aforementioned settings including acute aortic dissection.

Division of Cardiovascular Surgery, Mayo Clinic, Rochester, MN.
Address reprint requests to Thoralf M. Sundt, MD, Mayo Clinic and Foundation, 200 First Street, SW, Rochester, MN 55905. E-mail: sundt.thoralf@mayo.edu.

1522-2942/05/$-see front matter
doi:10.1053/j.optechstcvs.2005.10.004

Operative Technique

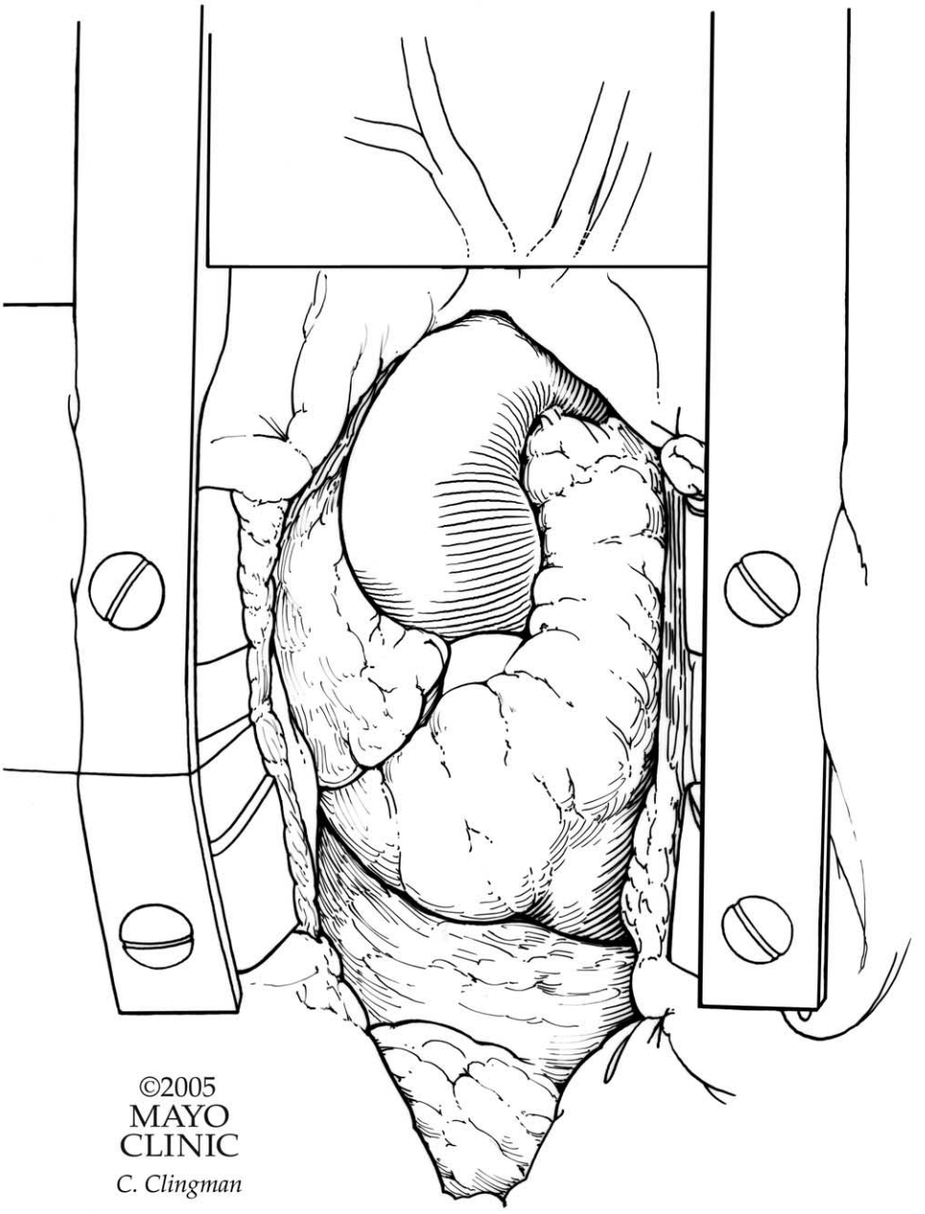

Figure 1 The heart is approached through a standard median sternotomy incision with cannulation of either the right axillary artery or the mid arch. The aorta is cross-clamped immediately below the innominate artery. If there is little aortic regurgitation, the first dose of cardioplegia may be delivered antegrade, with subsequent doses retrograde. If there is aortic insufficiency, I initiate cardioplegia retrograde, but after opening the aorta, deliver an initial dose antegrade directly down the coronary arteries with hand-held cannulae.

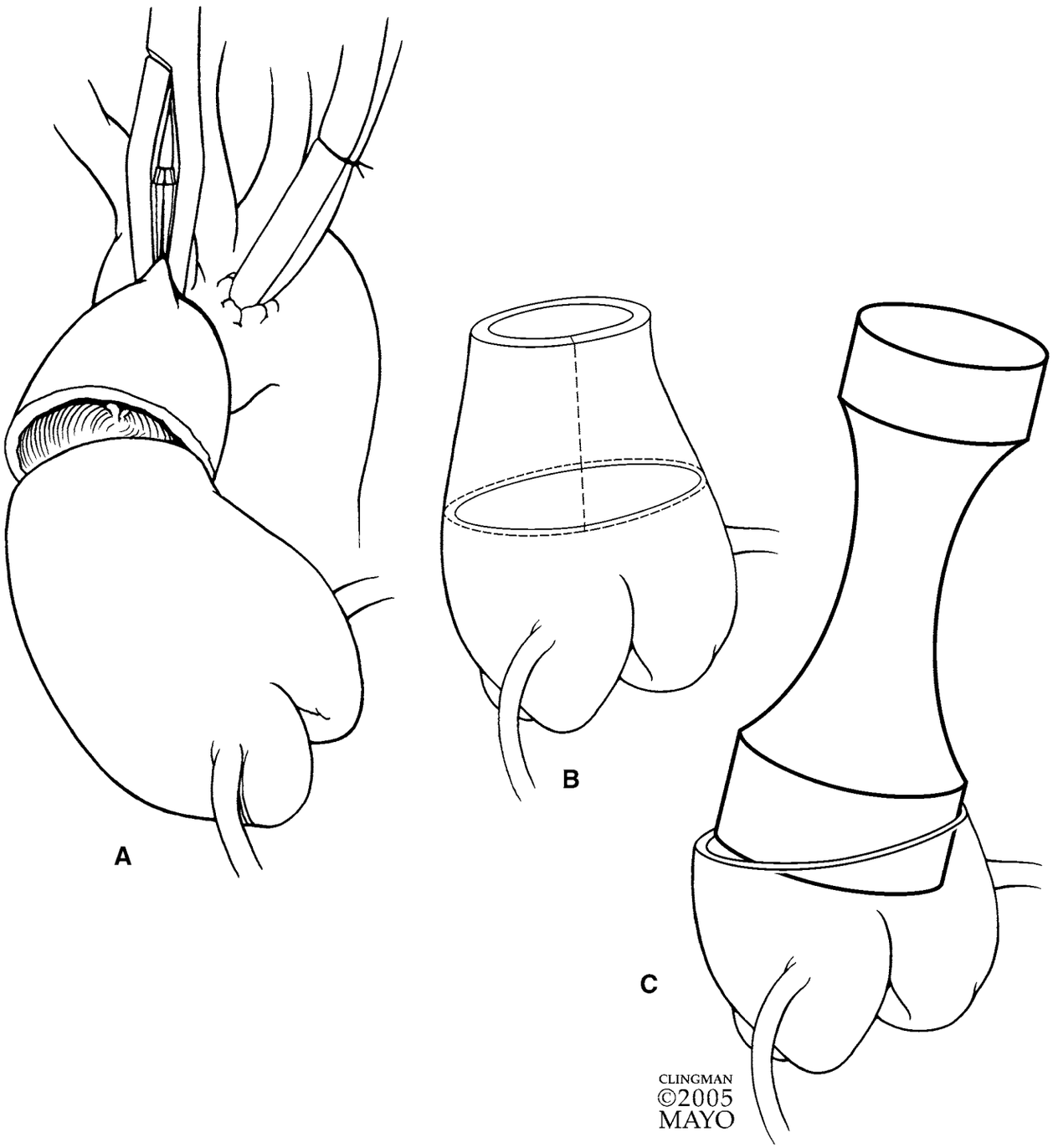

Figure 2 The aorta is transected and debrided down to the level of the sinotubular junction. Before disrupting the sinotubular junction to excise the coronary buttons, I prefer to use a universal sizer to estimate the optimal target sinotubular diameter. This will depend, in part, on the appearance of the free edges of the leaflets themselves and competence of the valve preoperatively. If the valve is quite competent, I will want to re-create the same diameter at the end of the procedure. If there is central regurgitation with normal looking leaflets, I will want to downsize a bit. If the free edges of the aortic leaflets are somewhat elongated, I will tend to make this diameter a bit larger. I find it easier to estimate this optimal diameter before excising the sinus tissue.

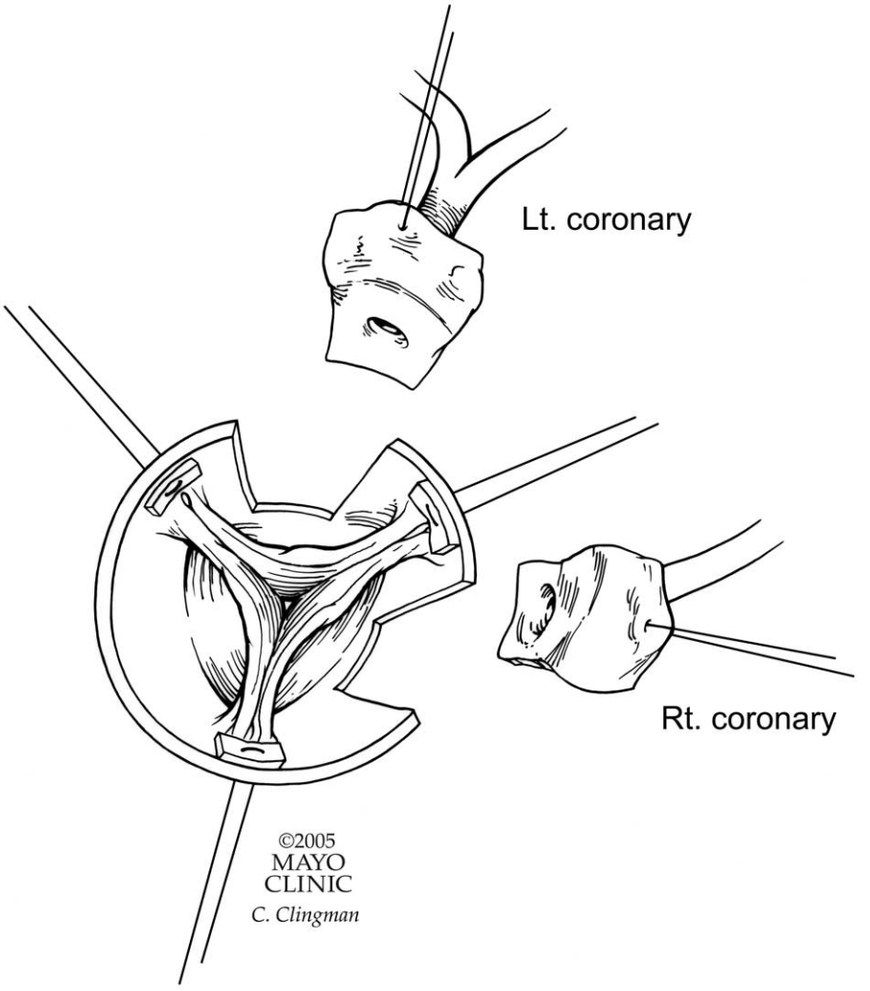

Figure 3 I place pledgeted mattress sutures above all three commissural posts and suspend the valve with traction on them. Coronary buttons are then excised in the usual manner. As each button is excised, I place a suture at the 12 o'clock position to maintain appropriate orientation of the button for ultimate implantation.

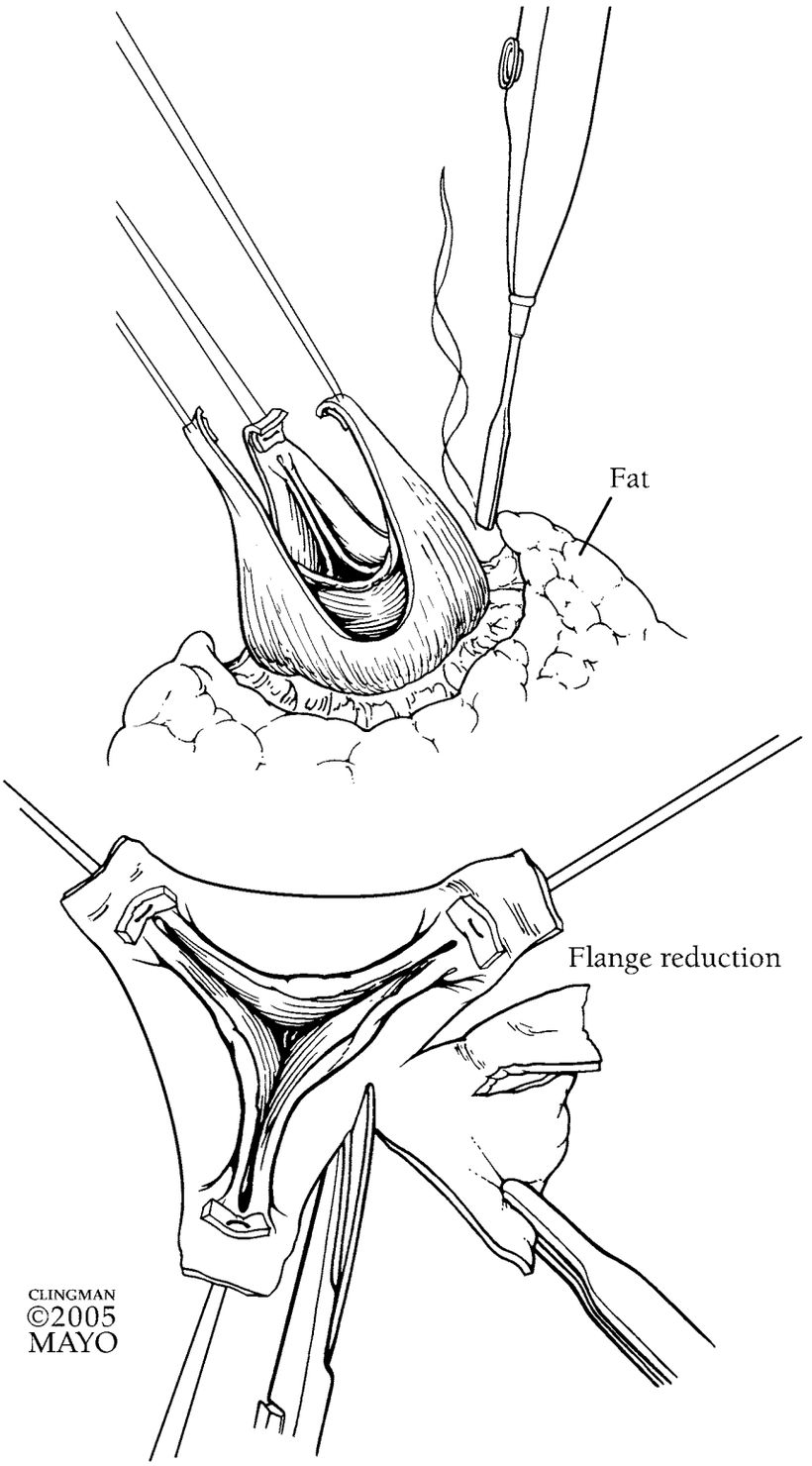

Figure 4 The excess sinus tissue is then resected down close to the level of the surgical annulus. I like to leave 2 to 3 mm of aortic wall tissue above the annulus to facilitate the second suture line. Simultaneous with resection of this tissue, I dissect outside of the aorta down to the level of the aortoventricular junction. This can usually be done with electrocautery on a low setting. By looking alternately inside and out, one can judge how deep into the root one must dissect to permit the subvalvular sutures to pass comfortably.

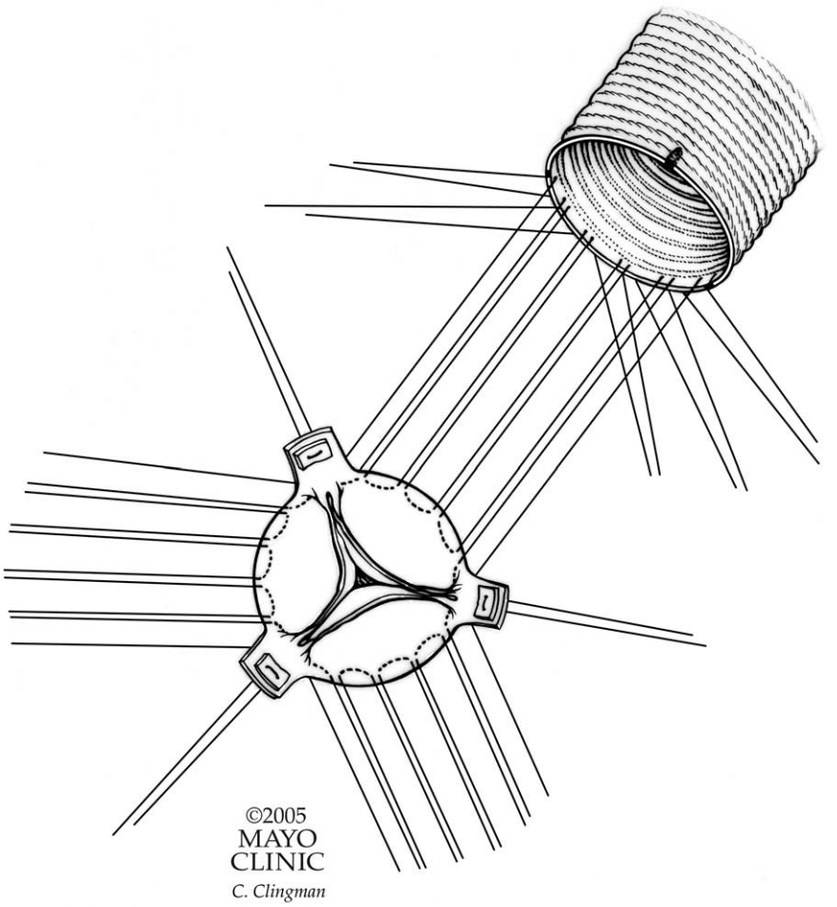

Figure 5 Horizontal mattress sutures of 3-O braided polyester suture are then passed through the aortoventricular junction several millimeters below the surgical annulus taking particular care to be well below the base of the leaflet at its nadir. Sutures can then be passed through the Dacron graft. This usually requires five sutures in each sinus.

I prefer to use a large-diameter graft for this portion of the reconstruction. An oversized graft here augments the effect of creating sinuses of Valsalva. In addition it greatly facilitates the second, subcoronary anastomosis. I prefer to size the native annulus with a universal sizer and then upsize my graft by 5 or 6 mm. This decision is also informed by my target final desired sinotubular diameter determined as described above. Again I want to use a graft that will exceed that final sinotubular diameter so that by reducing to the desired dimensions, a neosinotubular junction and sinuses of Valsalva will be created.

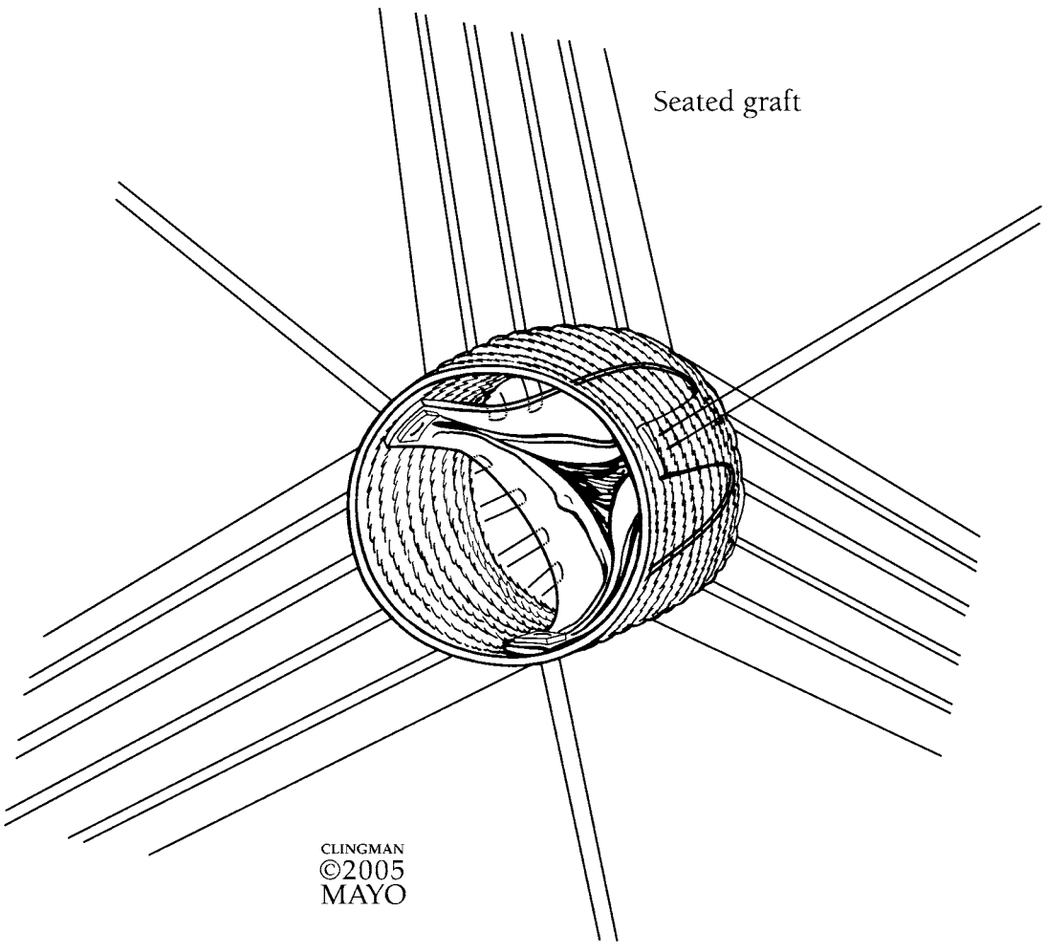

Figure 6 The graft is then seated around the valve and the commissural posts resuspended at an appropriate height. Setting the sinuses high in the graft augments the creation of adequate sinuses of Valsalva.

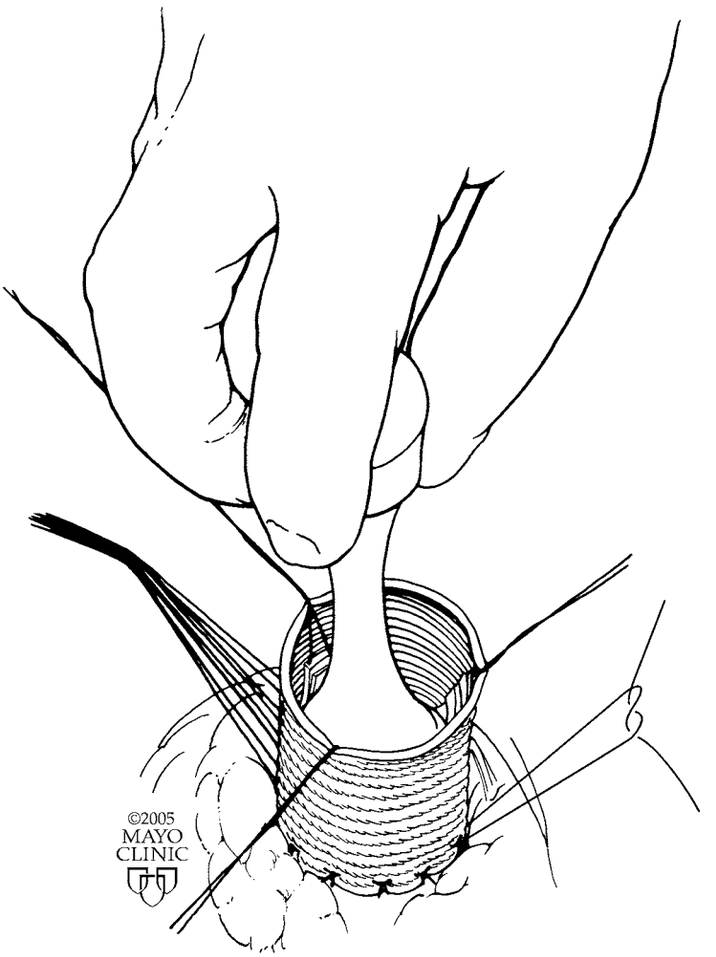

Figure 7 The subvalvular sutures are then gently tied taking care not to gather the annulus excessively. I personally have found it useful to place a universal sizer across the valve as I tie the sutures to prevent excessive gathering. It also assures me of a precisely measured annulus.

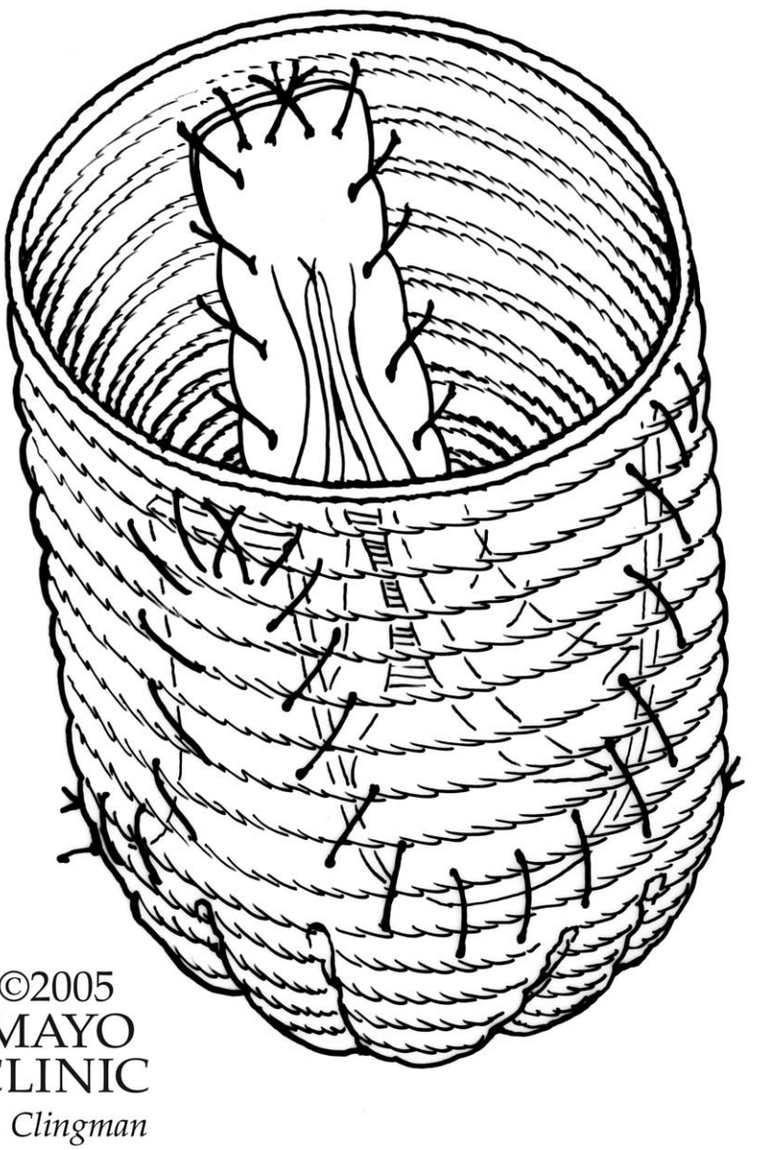

Figure 8 After tying the subvalvular sutures, the valve sizer is removed and the subcoronary anastomosis performed with running 4-O prolene. I prefer to initiate that anastomosis at the nadir of each sinus, passing my first suture as a horizontal mattress with the knot on the outside of the graft. I then pass the needle inside of the Dacron graft and sew each subcoronary suture line from aorta to graft such that the leaflets are protected and the natural pass of the needle will tend to gather graft with each stitch. This gathering is critical to creating adequate sinuses.

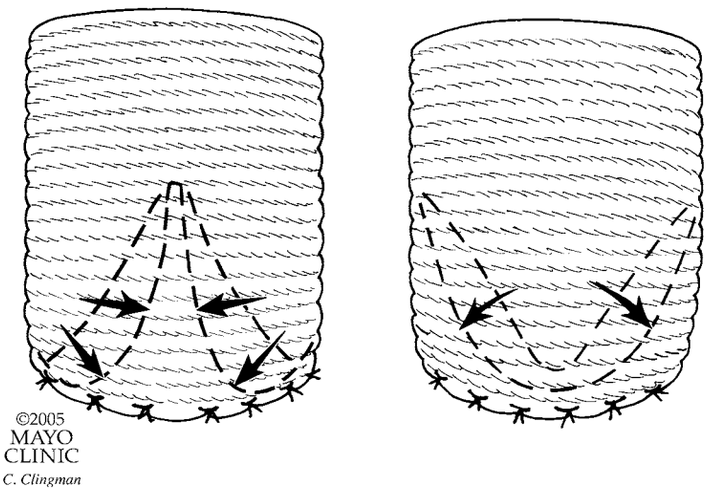

Figure 9 It is also important when constructing this suture line to keep this anastomosis low and horizontal at the base of the cusp and then climb quite vertically to the top of the commissural posts. One wants to leave as much Dacron in the belly of the neosinuses as possible and not gather Dacron up behind the commissure. Any Dacron that is included within the commissures lessens your neosinuses.

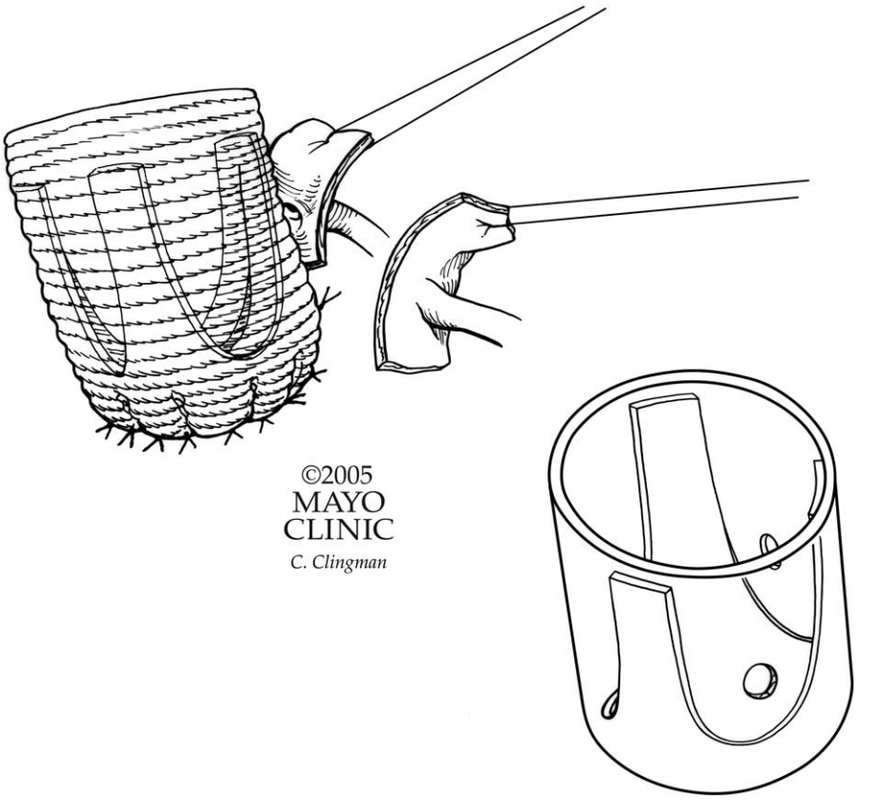

Figure 10 Coronary buttons are then reimplanted at an appropriate height in the usual manner with running 5-O prolene.

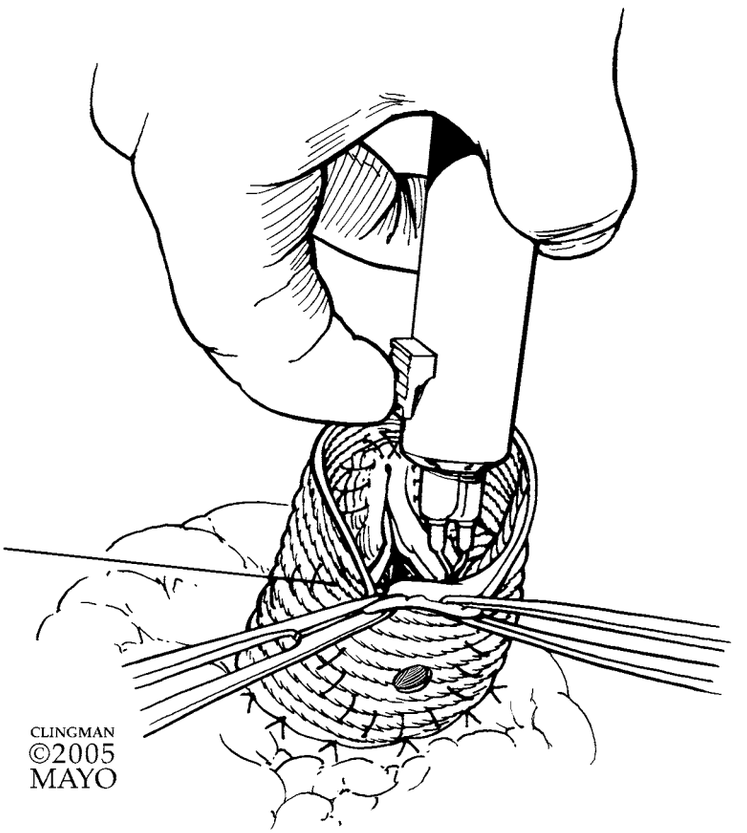

Figure 11 It is worth noting that in creating the openings for the coronary buttons one must be careful not to injure the leaflets. I often cut this opening from the inside out for just this reason.

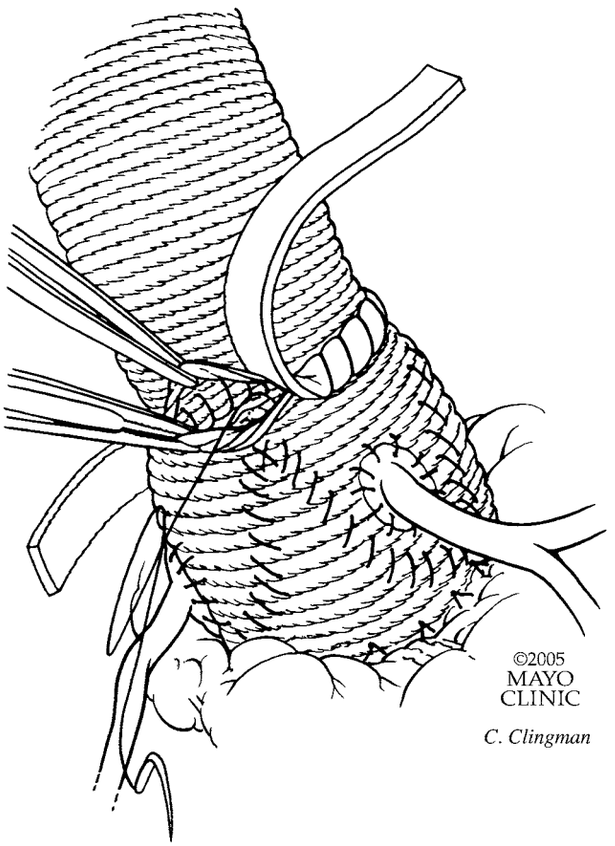

Figure 12 I then create my neosinotubular junction using a second Dacron graft of an appropriate diameter to create my neosinotubular junction of the diameter determined at the beginning of the case. The graft-to-graft anastomosis tends to leak less with a strip of Teflon felt as a gasket.

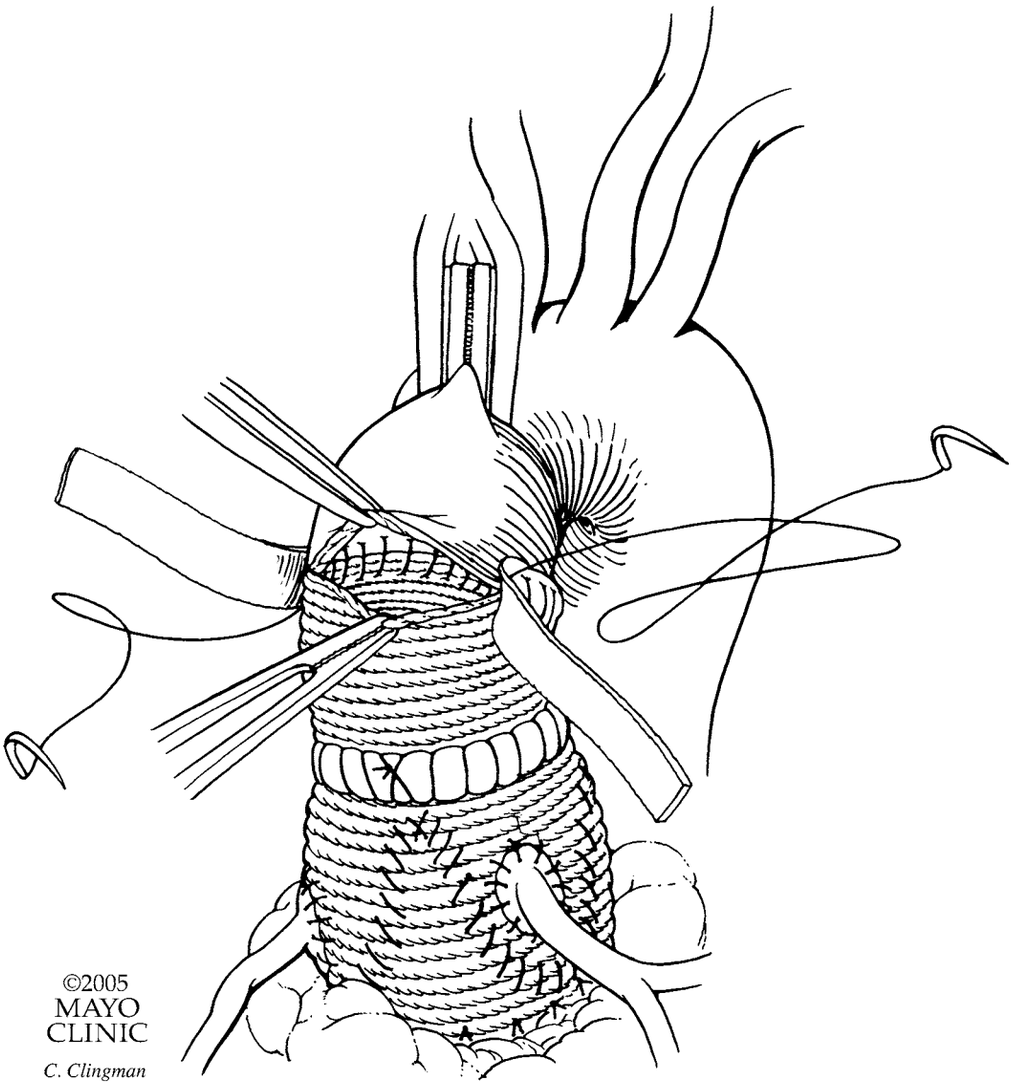

Figure 13 The distal anastomosis is also facilitated by the use of a smaller Dacron graft as very frequently the distal ascending aorta is of relatively normal diameter.

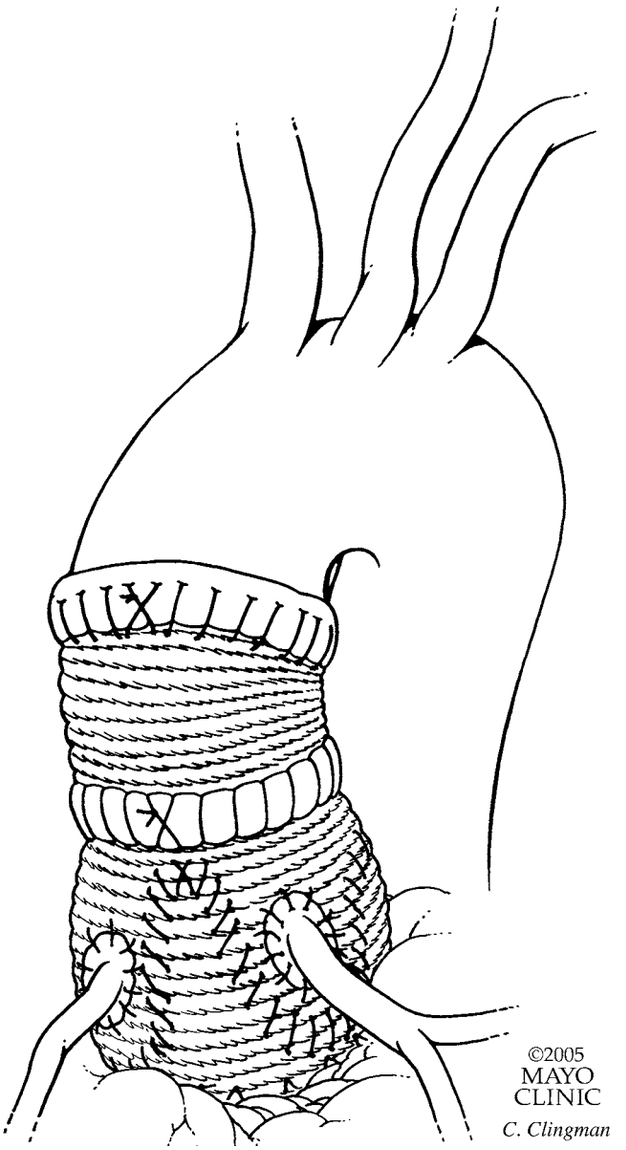

Figure 14 The final product should create a relatively normal-appearing root with full sinuses of Valsalva.

Discussion

The described approach to valve re-implantation within a Dacron graft has proven a reliable technique for us in a variety of settings. We have been impressed that bleeding is minimal once the clamp is removed. The technique appears to be reliably guided by the use of universal sizers to determine and then reconstruct the desired annular and sinotubular dimension. We have not found a mathematical formula related to leaflet geometry to be useful as the pathologic anatomy itself is often abnormal. A valve that is competent within a greatly enlarged root, for example, may be rendered centrally incompetent by excessive reduction of the sinotubular dimension such that prolapse is created. The use of sizers and a two graft technique makes the approach reproducible in our experience. We have also been pleased with the neosinuses created. This technique has been a useful addition to our armamentarium and we use it frequently, selecting between this and the Yacoub reconstruction based on circumstances.