Operative Techniques in Thoracic and Cardiovascular Surgery

Suture Relocation of the Posterior Papillary Muscle in Ischemic Mitral Regurgitation

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Despite advances in our understanding of the pathophysiology of ischemic mitral regurgitation as well as advances in surgical technique and perioperative care, surgical treatment of ischemic mitral regurgitation is associated with mortality rates as high as 20% in some series. It is generally agreed that in the majority of cases, mitral valve repair results in superior short- and mid-term outcomes when compared with mitral valve replacement. In our own series of patients with ischemic mitral regurgitation, the hospital mortality rate for patients undergoing concomitant coronary artery bypass grafting and mitral valve repair was significantly less (1.9%) than patients undergoing coronary artery bypass grafting/mitral valve replacement (10.7%).[1] There is some debate remaining as to whether repair or replacement is best suited for the sickest patients. Given the fact that ischemic mitral regurgitation occurs in the substrate of an often poorly functioning ventricle, it is not surprising that surgical mortality rates are higher for this lesion than for other causes of mitral regurgitation. However, in many cases, failure of the mitral valve repair technique to adequately treat the mechanism of the individual patient's ischemic mitral regurgitation may significantly impact the clinical outcome.

Observational studies in both experimental animals and clinical patients reveal that the mechanisms of ischemic mitral regurgitation are varied. Carpentier's classification of leaflet motion reveals 2 plausible mechanisms. In patients with Carpentier's type I dysfunction (Fig. 1), leaflet motion is unrestricted and ischemic mitral regurgitation occurs on the basis of annular dilation, with resultant failure of leaflet coaptation. This is ordinarily treated adequately by ring annuloplasty. In the case of Carpentier's type IIIb dysfunction (Fig. 2), there is tethering of A3 and P3 segments to the anterior and posterior leaflets, respectively. This results from posterior displacement of the posterior papillary muscle and subjacent left ventricle as a product of myocardial infarction. This mechanism is poorly treated by simple mitral annuloplasty as abundant clinical experience has shown. Ring annuloplasty fails to restore adequate leaflet coaptation as the leaflet edges remain tethered below the annular level. Adequate treatment will only result if the leaflet edges can be allowed to return to the annular level. In addition, the combination of annular dilation as well as leaflet tethering may be at play with individual patients. These patients are also inadequately treated by ring annuloplasty alone. These latter 2 mechanisms are likely the mechanisms responsible for reports of up to 20% residual and/or progressive mitral regurgitation after annuloplasty alone.

A number of procedures have been developed to try to improve results of mitral repair in these cases. Asymmetric mitral rings have been developed which attempt to deal with the more eccentric mitral leak. The Alfieri repair, in which the anterior and posterior leaflets are sewn together, has been used by us and others with mixed results. In our hands, long-term improvement in mitral regurgitation has been poor. Kon's method of patch anterior leaflet augmentation attempts to let the level of leaflet coaptation fall more posteriorly toward the level of the displaced papillary muscles.[2]

Various types of ventricular modeling procedures also have been tried to restore papillary muscle geometry. We developed a method of suture relocation of the posterior papillary muscle that relieves A3 and P3 leaflet restriction. The procedure is simple and quick, which is of benefit in these generally unhealthy patients. In cases where the left ventricle is markedly enlarged, a Dor procedure is added to both stabilize the position of the papillary muscles and prevent late apical migration of the subvavular apparatus.

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doi:10.1053/j.optechstcvs.2005.05.001

Surgical Technique

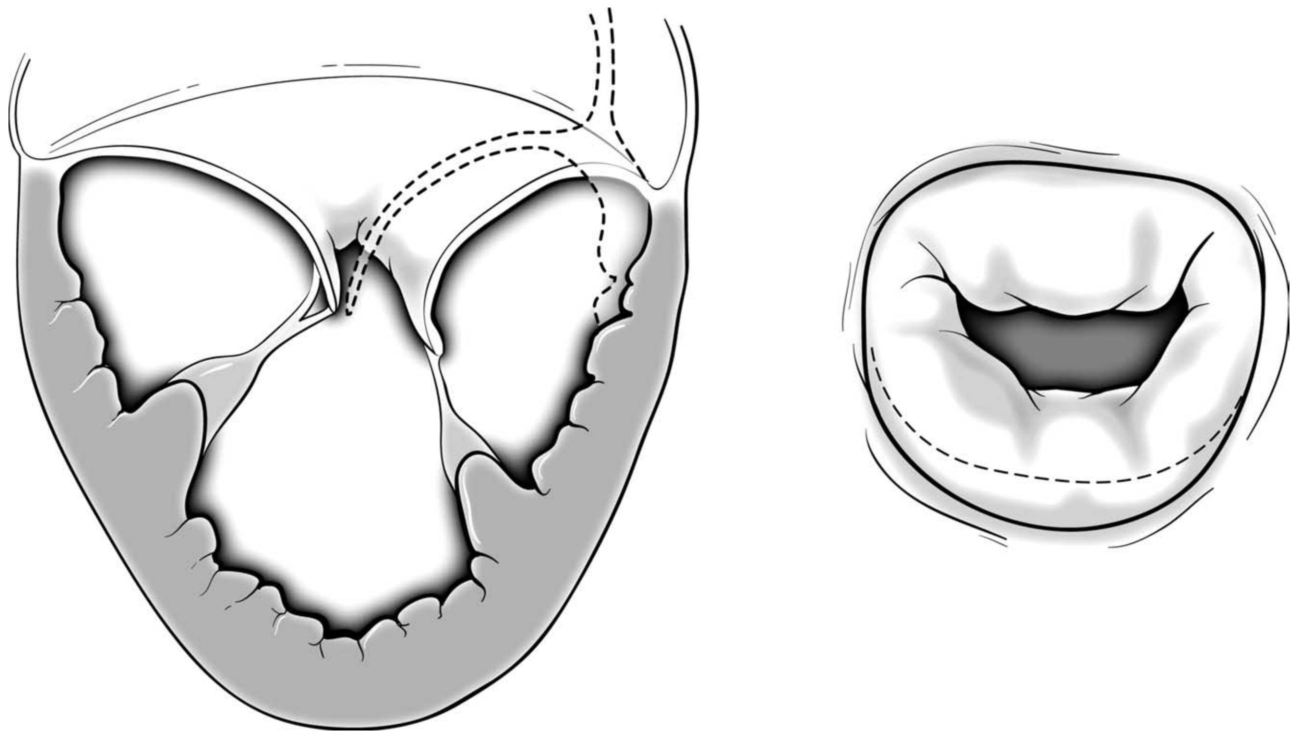

Figure 1 Carpentier's type I leaflet dysfunction. Mitral annular dilation results in failure of leaflet coaptation and a broad central jet of mitral regurgitation.

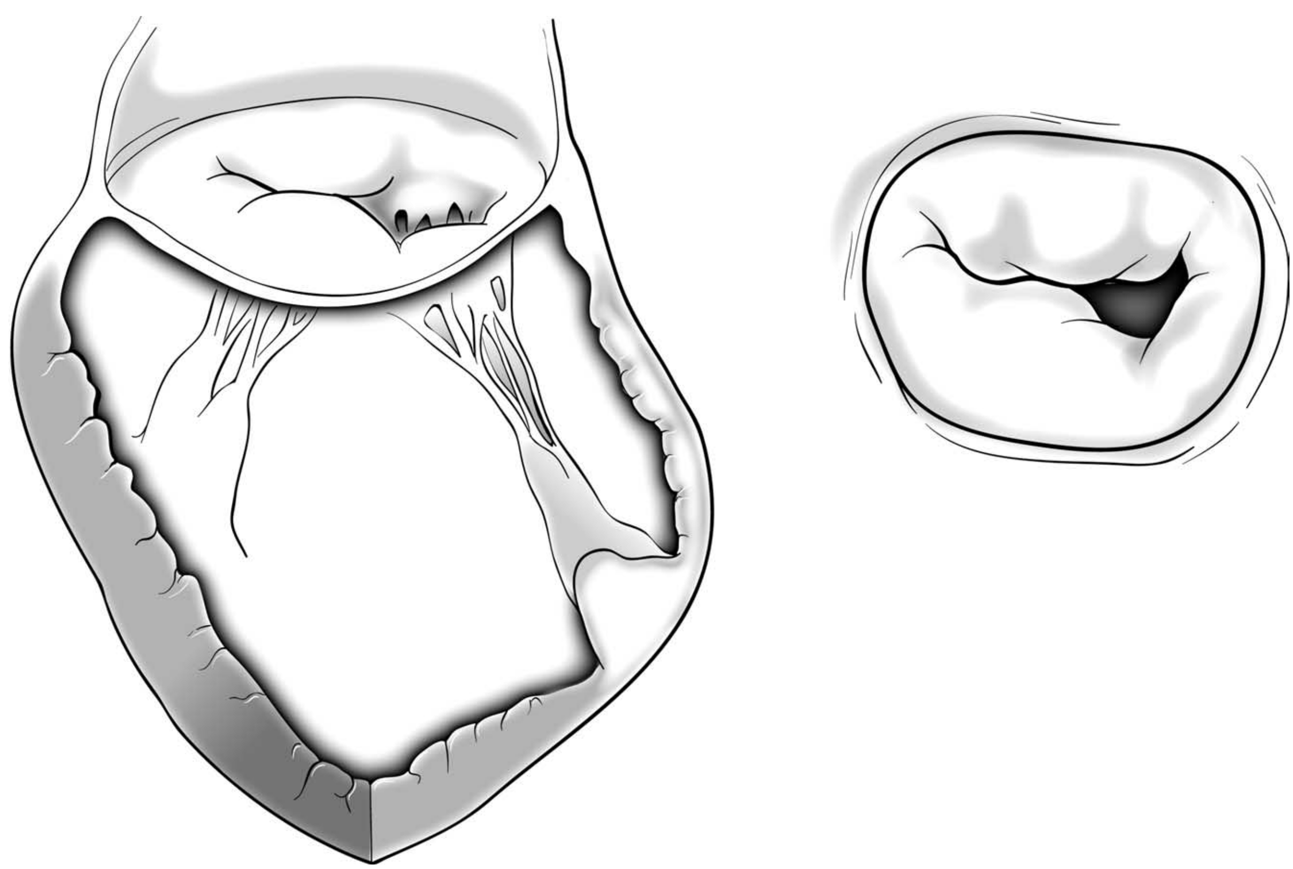

Figure 2 Carpentier's type IIIb leaflet dysfunction. Posterior displacement of the posterior papillary muscle causes tethering of the A3 and P3 segments of the mitral valve, resulting in an eccentric jet of mitral regurgitation.

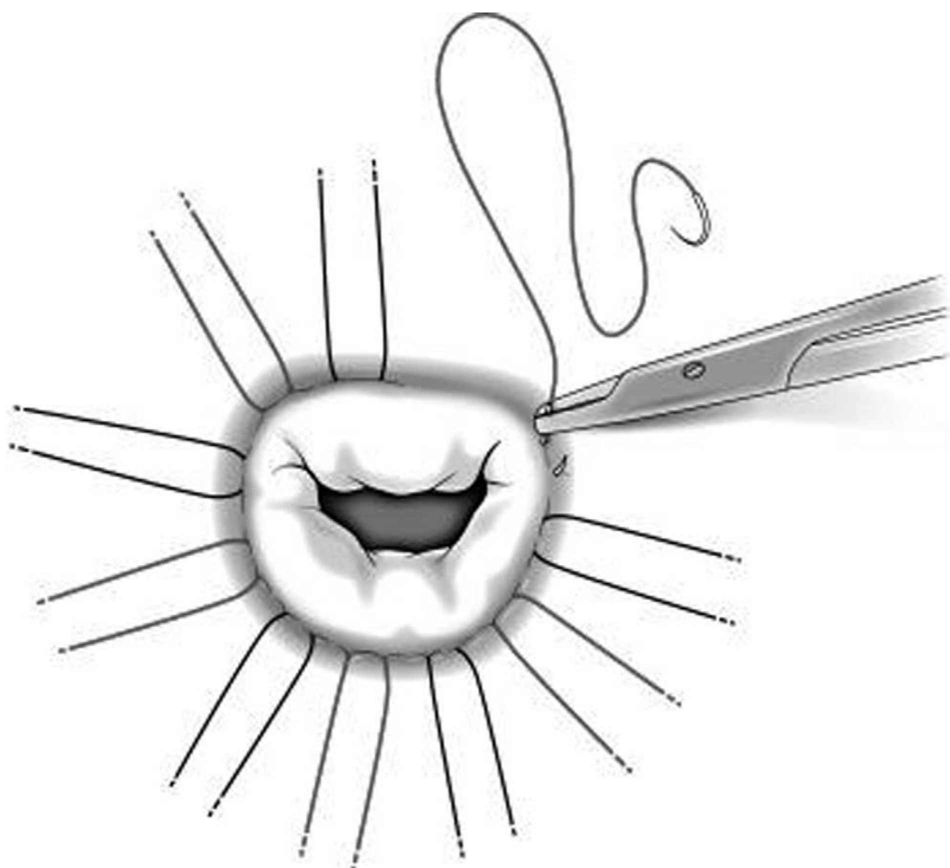

Figure 3 Ring annuloplasty. The mitral ring is sized with ring sizers measuring the intertrigonal distance (usually 26-28 mm). Ten to 12 annuloplasty sutures are generally used and are placed in horizontal mattress fashion around the mitral annulus.

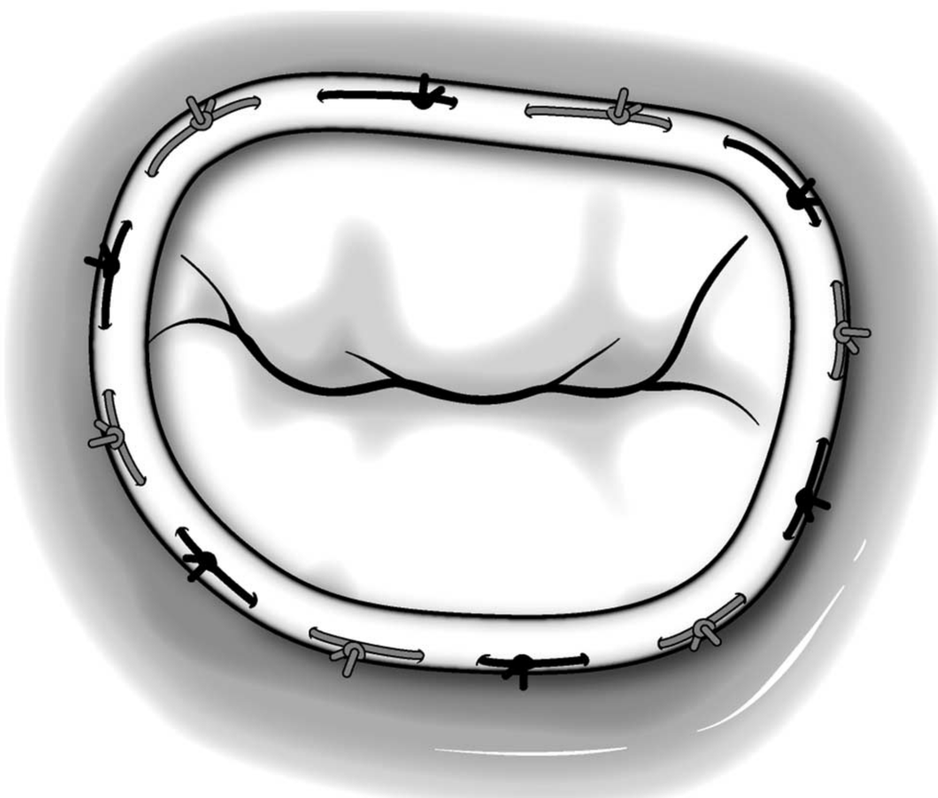

Figure 4 Ring annuloplasty (cont'd). A complete semirigid ring is used. Sutures are passed through the ring fabric at appropriate intervals to produce an even annular reduction. This results in proper coaptation of the anterior and posterior leaflets.

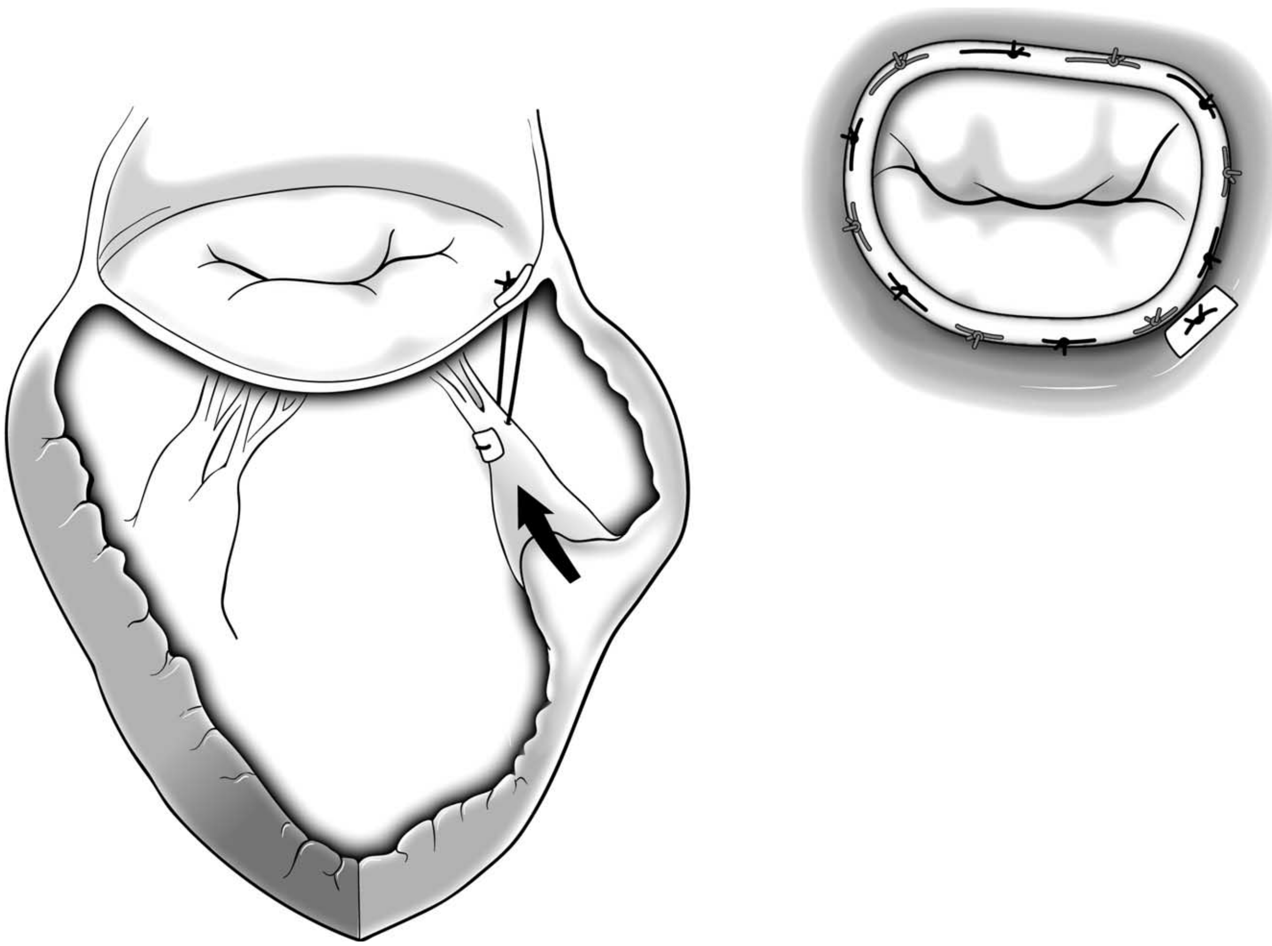

Figure 5 Posterior papillary muscle relocation. Mitral repair begins with preoperative and intraoperative echocardiographic assessment of the mechanism of mitral regurgitation, confirming regurgitation secondary to type IIIb leaflet motion. The amount of leaflet tethering is estimated by intraoperative transesophageal echocardiography. With a standard left atrial approach, the head of the posterior papillary muscle is relocated anteriorly by passing both needles of a 3-0 polypropylene suture through the fibrous portion of the posterior papillary muscle tip. Unless the papillary muscle tip is particularly fibrous, a pledgetted suture is used. Each needle of the double armed 3-0 prolene is then passed up through the adjacent mitral annulus usually posterior to the right fibrous trigone at P3. The final position of the posterior papillary muscle tip is estimated by determining the point at which leaflet coaptation occurs in the plane of the mitral annulus. Mitral annuloplasty is then performed as previously described. The adequacy of repair is tested with the left ventricular saline infusion test and the repair completed by ring placement as described above, if the valve is competent.

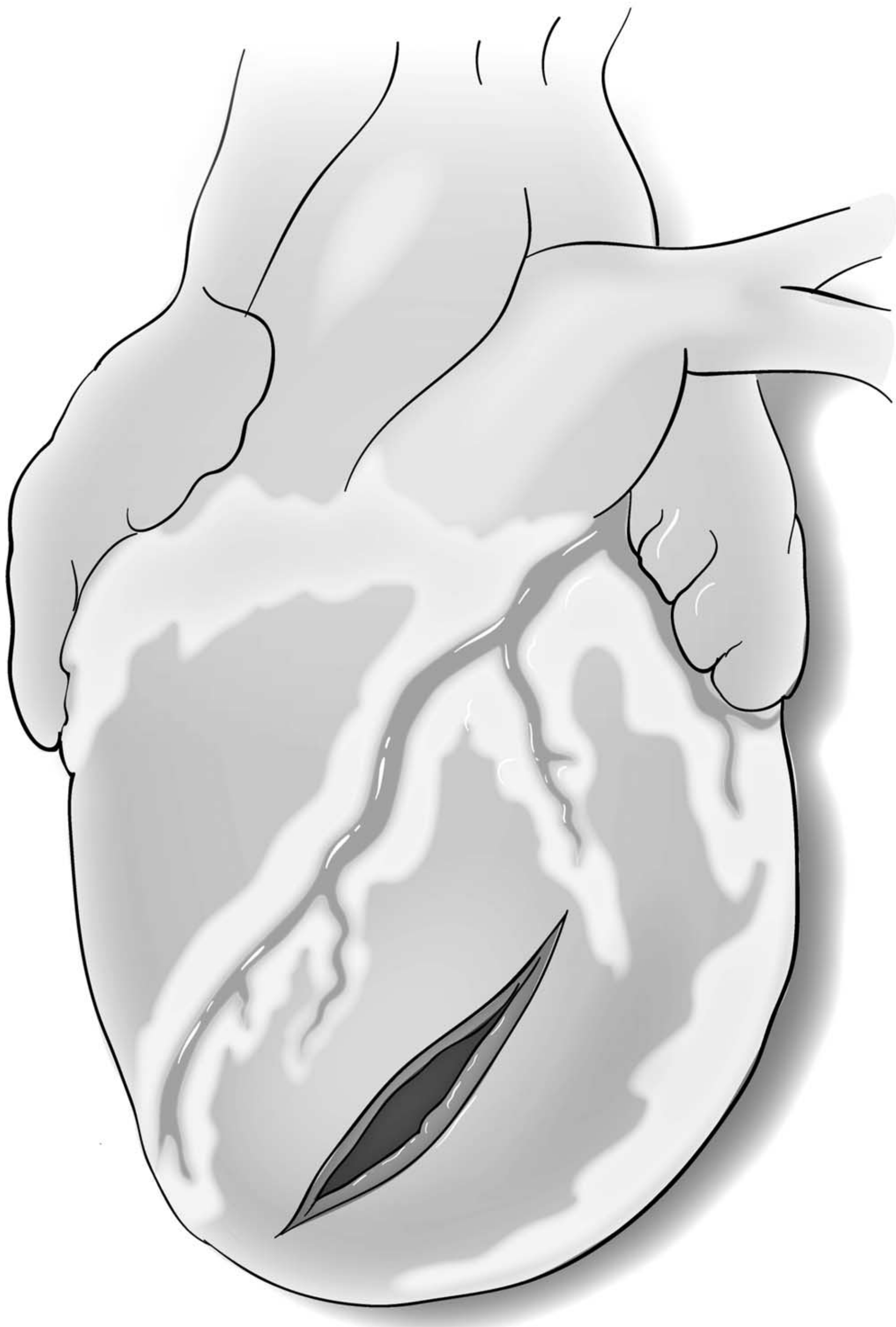

Figure 6 Dor procedure and relocation of the papillary muscle tip. In cases where the left ventricle is markedly enlarged, a Dor procedure is added to both stabilize the position of the papillary muscles and prevent late apical migration of the subvalvular apparatus. Surgical location of the posterior papillary muscle tip is performed through the left ventricle in these cases. The typical ventriculotomy parallel to the left anterior descending artery is made generally within the area of myocardial thinning. This is usually about 1 fingerbreadth lateral to the artery as it courses toward the apex of the heart.

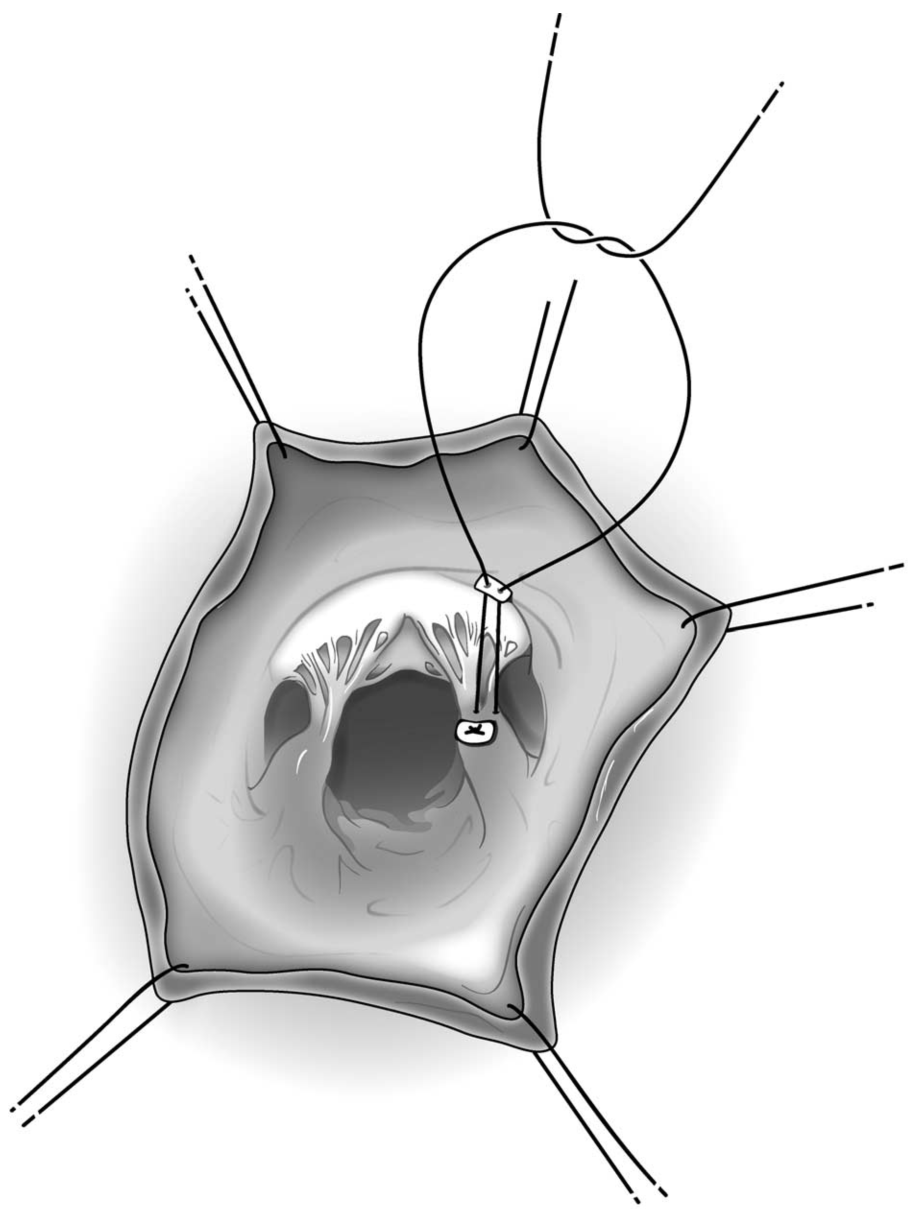

Figure 7 Dor procedure and relocation of the papillary muscle tip (cont'd). Via the left ventricular exposure, the posterior papillary muscle stitch (3-0 polypropylene) is placed first through the head of the papillary muscle and then through the adjacent posterior mitral annulus. The suture is then tied on the ventricular side.

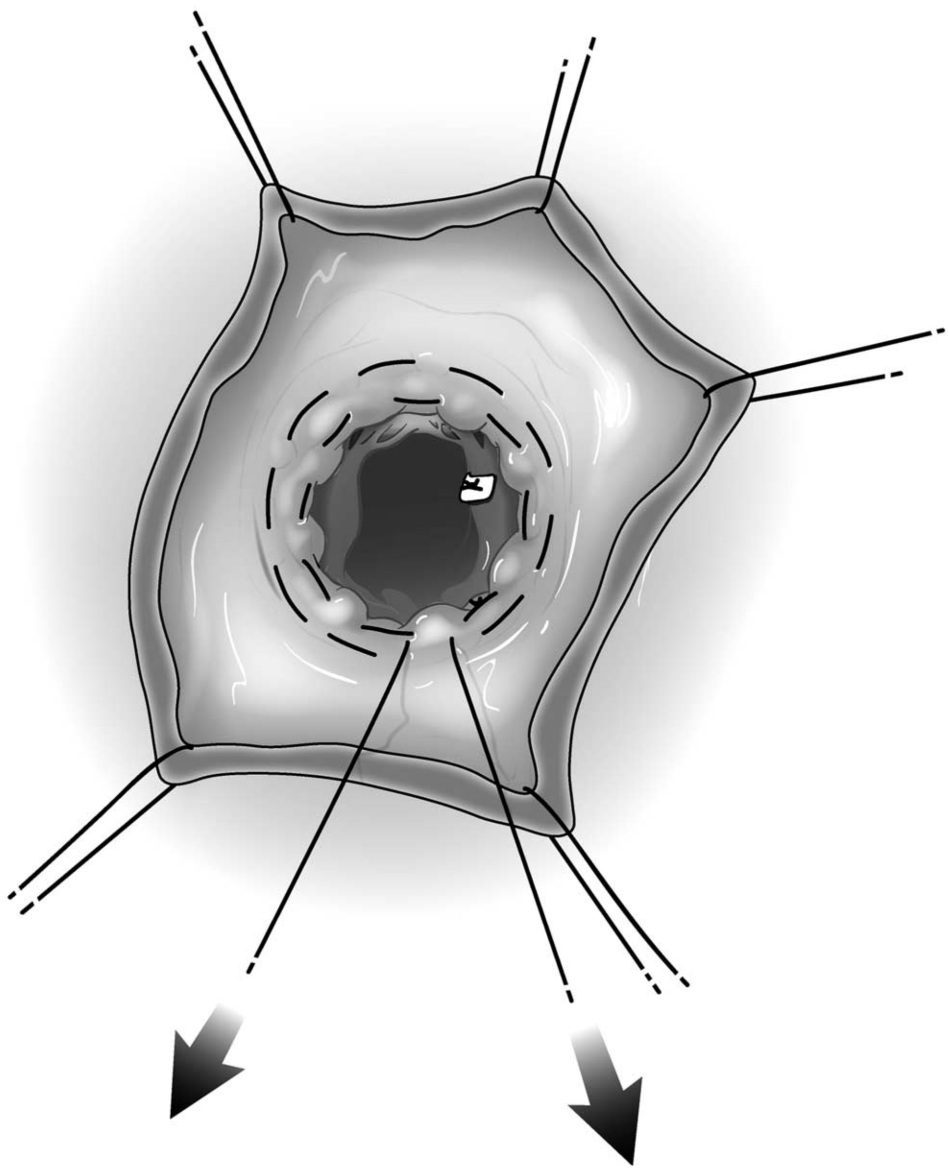

Figure 8 Dor procedure and relocation of the papillary muscle tip (cont'd). One or 2 concentric Fontan stitches are then placed at the border zone between viable left ventricular myocardium and scar.

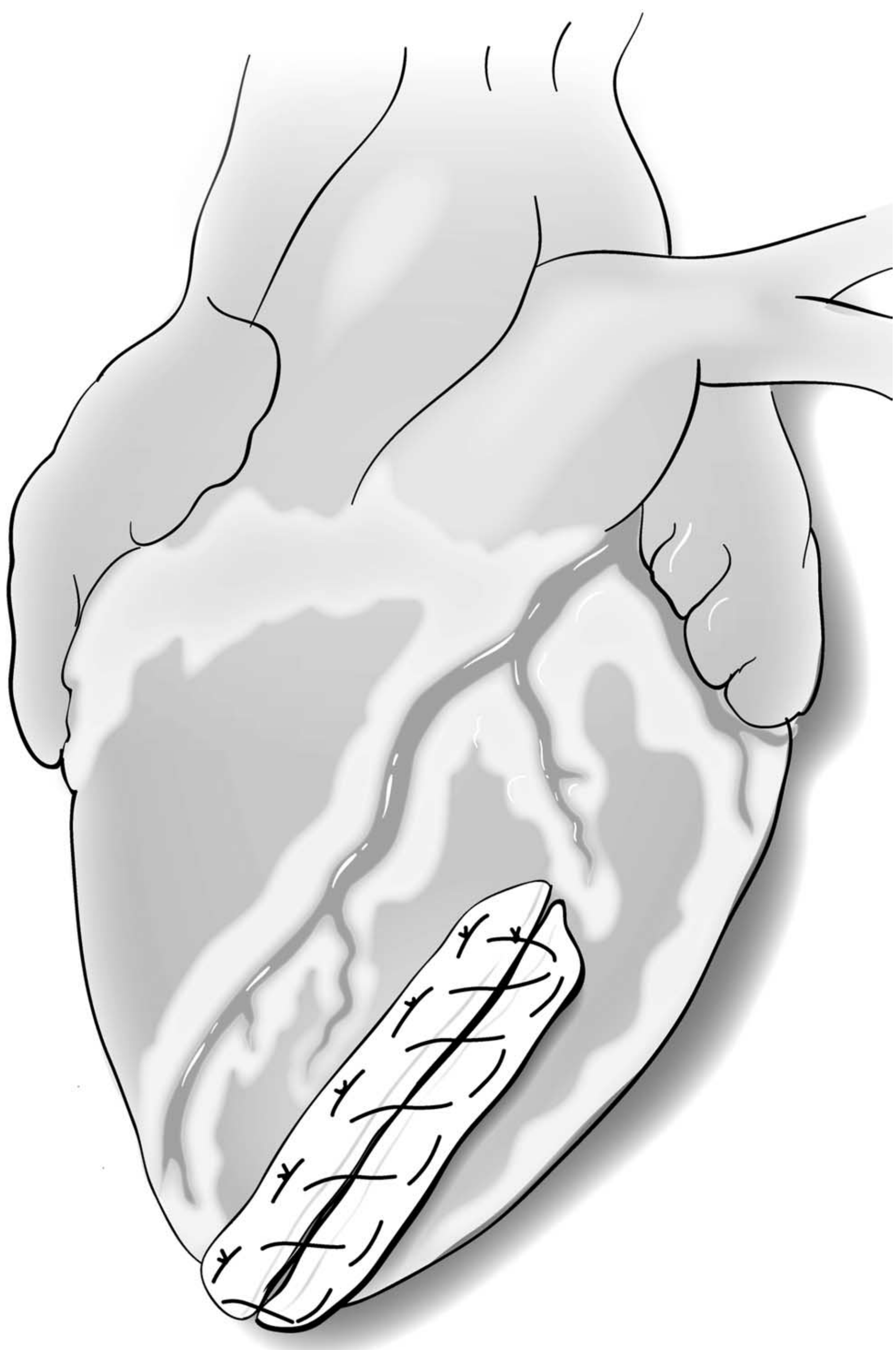

Figure 9 Dor procedure and relocation of the papillary muscle tip (cont'd). The left ventriculotomy is closed with a 3-0 polyproylene running double layer closure buttressed 2 felt strips.

Conclusion

Mitral replacement clearly has a higher mortality rate than repair and should be used only rarely for ischemic mitral regurgitation We feel strongly that surgery for ischemic mitral regurgitation should be based on the mechanism. If significant leaflet tethering exists, mitral ring annuloplasty alone is not enough. A number of repair techniques for ischemic mitral regurgitation have been described, but few deal with the mechanism of leaflet tethering. The technique we describe here attempts to deal with the physiologic mechanism of, in many cases, ischemic mitral regurgitation (ie, leaflet tethering). In cases in which the left ventricle is markedly enlarged, a Dor procedure is added. Long-term data will be necessary to determine whether this repair technique is durable, and will validate our short-term success in improving the generally poor results in patients with surgically treated ischemic mitral regurgitation.

Acknowledgment

We thank Anita Impagliazzo for her expert medical illustration.

References

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