REVIEW

Is an anterior mitral leaflet prolapse still a challenge?

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Summary Quadrangular resection is the gold standard in the treatment of posterior leaflet prolapse. Anterior leaflet prolapse has been considered a more challenging problem; several techniques are available to treat it, all with the same goal — mitral valve competency. Nowadays, good long-term results are reported, similar to those for posterior leaflet prolapse. Certain improvements may explain these results, especially improvements in transesophageal echocardiography (including three-dimensional echocardiography), which allow the detection of atypical mitral regurgitation and its mechanism.

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MOTS CLÉS Antérieur mitral ; Prolapsus ; Réparation

Résumé La résection quadrangulaire est le traitement de choix du prolapsus mitral postérieur. Le prolapsus antérieur a toujours été considéré comme un challenge chirurgical, plusieurs techniques chirur-gicales sont disponibles pour le corriger et pour atteindre le même but : la compétence de la valve. Désormais de bons résultats à long terme sont décrits, comparables à ceux obtenus après correction d’un prolapsus postérieur. Plusieurs progrès et innovations peuvent expliquer ces résultats, en particulier, ceux de l’ETO (comprenant l’échographie 3D) qui localisent précisément les fuites mitrales difficiles et précisent leurs mécanismes.

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**Abbreviations**

- AL: anterior leaflet
- 3D: three-dimensional
- PL: posterior leaflet
- TEE: transesophageal echocardiography

**Introduction**

Mitral valve repair remains the gold standard in the treatment of mitral regurgitation [1,2]. Repair rather than replacement of the mitral valve results in better life expectancy and quality of life [3]. Quadrangular resection is the gold standard in the treatment of posterior leaflet (PL) prolapse [4]. Anterior leaflet (AL) prolapse has been considered a more challenging problem and long-term results are usually not as favourable as those for PL prolapse [5]. It must be emphasized that the surgical techniques available currently for the treatment of AL prolapse involve not only the leaflets but also the subvalvular apparatus, which presents a more difficult problem than a simple leaflet resection.

**Surgical techniques**

In our opinion, the major rule in mitral repair is never to resect the AL. Indeed, the AL is the surface available for closure of the mitral orifice in systolic motion. The competence of the mitral valve is completely dependent on the AL integrity. AL prolapse can be treated with different techniques, such as chordal shortening in cases of elongated chordae, chordal transfer in cases of chordal rupture and chordal substitution in both cases. The following surgical procedures available to repair an AL prolapse involve working with the chordae or with the papillary muscles.

**Chordal shortening and chordal plication**

Chordal shortening and chordal plication were the first approaches. Nowadays, these techniques have practically been abandoned. Chordal shortening is not a direct method of shortening elongated chordae; the effective shortening involves half of the length being buried into the trench of the papillary muscle. The difficulty is in calculating the correct length. Moreover, the buried sutures in contact with the shortened and structurally weak chordae can, with time, induce rupture. An important failure rate in valve repair has been reported using this technique [6—9]. Chordal plication may be used to shorten fragile, elongated and diseased chordae but may induce the same problem of rupture with time.

**Chordal transfer**

Chordal transfer from the PL to the AL was first described by Carpentier in 1983 [4], and became common practice, providing good long-term results [9]. The main limiting factors of this technique are the number and the quality of chordae available on the PL just opposite to treat an extensive AL prolapse. Indeed, in cases of extensive leaflet prolapse due to several sites of chordal elongation or rupture, this technique is more complicated and is possible only in a limited number of situations [10]. After the transfer, the surgeon is obliged to make a quadrangular resection of the PL involved in the transfer. A case of robbing Peter to pay back Paul...

**Chordal substitution**

Chordal substitution is a technique that is increasing in acceptance. This technique requires suturing one or several artificial chordae to the head of a papillary muscle and the other extremity of the artificial chordae to the prolapsed AL. The artificial chordae made of expanded polytetrafluoroethylene or GORE-TEX® sutures (W.L. Gore & Associates, Inc., Flagstaff, AZ, USA) are flexible and strong, and last in the long-term. Chordal replacement with GORE-TEX sutures was introduced by Frater and colleagues in the early 1980s and is now widely adopted [11]. Adjusting and maintaining the height of these neochordae can be difficult. If the artificial chordae are left too short, restricted leaflet motion results, whereas if left too long, residual prolapse remains. In both cases regurgitation will not be corrected. Several methods and tactics have been described to resolve this surgical issue [12—15]. Very good long-term results using this technique with a low rate of reoperation have been reported recently [11,16]. Salvador et al. reported a series of 608 consecutive mitral repairs using artificial chordae, half of which addressed AL or AL and PL prolapses. Freedom from mitral valve reoperation was 92% at 15 years and freedom from significant mitral regurgitation was 85% at 15 years. We would like to underline that no repair failures arising from spontaneous malfunction of artificial chordae were reported in this series [11]. When reoperation was necessary, the artificial chordae extracted were still as pliable, flexible and resistant as the native chordae, without any calcification [11]. Artificial chordae showed excellent biological adaptation, retaining flexibility and tension with time.

**Papillary muscle repositioning**

Papillary muscle repositioning is a technique described by Dreyfus [6,17,18]. This approach addresses AL prolapse due to elongated chordae, irrespective of the location of the lesion. The anterior head affected by the prolapse is sutured with the posterior one deeper in the left ventricle; all the elongated chordae are shortened harmoniously by this manoeuvre and the AL prolapse is corrected. Results reported recently [18] indicate that this is a safe and durable technique, providing good long-term results in the management of degenerative pathology of the AL. Freedom from reoperation after papillary muscle repositioning was 86.7% at 15 years, which is similar to the results obtained by the substitution technique [11]. With this technique, great understanding of the chordal distribution is necessary: the appropriate chordae are to be selected and the displacement of the papillary muscle should equal the extent of the prolapse measured previously.

**Simple approach at leaflet level**

Some types of AL prolapse are exceptions that the surgeon can address with a simple approach at the level of the leaflets, without any subvalvular techniques.
Closure of commissure by separated stitches

In the case of AL prolapse close to a commissure, the simple closure of the commissure by two or three separated stitches is enough to correct the mitral insufficiency. This closure has to be non-extensive to avoid a resulting stenosis. The exact localization of the prolapse can be difficult and residual commissural prolapse may be encountered in up to one-third of cases. The echocardiographic appearance of commissural prolapse can mimic leaflet perforation. The assessment of the volume of the regurgitation is occasionally difficult due to the lateral direction of the jet along the atrial wall. Thus, echo-analysis has to be conducted by an experienced echocardiographer and careful intraoperative inspection of the valve by the surgeon is required to assess prolapse of a commissure. Whereas the most frequent aetiology of mitral disease in the case of AL or PL prolapse is degenerative insufficiency, commissural prolapse is related primarily to infective endocarditis. Using this technique, the freedom from reoperation involving the mitral valve was 96.6% at five years and 92.5% at ten years [19].

The central Alfieri stitch

In high-risk surgical patients with complex lesions (bileaflet prolapse associated with excess of tissue and/or calcified annulus), requiring complicated surgical techniques for correction, an alternative is to suture the AL with the PL, in their medial part, by approximating the free edges of the leaflets [20]. The mitral valve becomes a double orifice valve without leak or stenosis. With this simple and quickly performed technique the aortic cross-clamp time is greatly decreased, with good long-term results [20]; freedom from reoperation was 90% at five years. This is particularly convenient in patients when associated procedures are needed, and in patients with poor preoperative conditions or with advanced left ventricular dysfunction. The central double orifice repair is technically simple, but careful evaluation of the mitral valve is always mandatory. Inadequate application of the procedure may result either in residual mitral regurgitation or in mitral stenosis. In the presence of extended prolapse of the AL, involving more than one scallop, the edge-to-edge technique alone might not be sufficient and a long suture would be required, creating a possible mitral stenosis. In that particular case, the implantation of Gore-Tex sutures may be added to eliminate incompetence without reducing the mitral valve orifice excessively [21].

The edge-to-edge technique can now be reproduced by a percutaneous approach, even if the results remain quite questionable at this time [22].

Discussion

Two points have to be underlined. Firstly, it seems crucial to emphasize that billowing AL and AL prolapse are not identical. Some authors confuse these two mechanisms and recommend to neglect AL prolapse in cases of bileaflet mitral prolapse [23]. Indeed, Gillinov et al. reported a series of bileaflet prolapses with a strategy of PL prolapse correction associated with an annuloplasty, without a procedure addressing the AL prolapse. The authors supported the fact that AL prolapse was due to a loss of PL support at the zone of coaptation [23]. Billowing alone does not lead to any regurgitation and does not require any correction. A true AL prolapse, with the free edge riding above the plane of the annulus (more than 5 mm), has to be addressed specifically [18].

Secondly, in our opinion, a prosthetic ring annuloplasty is always necessary. Some surgeons, especially those involved in minimally invasive approaches, consider it useless to implant a ring in mitral repair. Not only does a prosthetic ring reshape the dilated mitral orifice but it also decreases the tension on all the sutures, improving the repair durability [5].

Another important point for better management in cases of AL prolapse may be the development of three-dimensional (3D) echocardiography, using an ultrasound probe with an array of transducers and an appropriate processing system. This enables detailed anatomical assessment of cardiac pathology, particularly valvular defects, and cardiomyopathies. The ability to slice the virtual heart in infinite planes in an anatomically appropriate manner and to reconstruct 3D images of anatomic structures make 3D echocardiography unique for the understanding of the mitral valve apparatus. Further studies are necessary to assess the exact place of 3D echocardiography in the operative room.

Several techniques are available to treat an AL prolapse. At the present time, there is not one ‘gold standard technique’, as described for PL prolapse. Some reasons lead the surgeon to prefer one technique to another:

- the availability and the quality of chordae to be transferred;
- the clinical state of the patient;
- the surgical practice.

Indeed, it is also a question of philosophy; in mitral repair, some surgeons prefer to work with native tissue, whereas others are used to working with artificial chordae. Nowadays, whatever the technique employed to fix the AL prolapse, good long-term results are reported, similar to those for PL prolapse. Certain improvements may explain these results:

- better comprehension and management of the subvalvular mitral apparatus [24,25];
- standard use of artificial chordae, with reliable techniques to calculate their length and implantation properly [14,15];
- a novel approach to managing mitral repair that includes transesophageal echocardiography (TEE) systematically.

This permits the surgeon to localize the mitral insufficiency specifically and to determine its mechanism. Moreover, TEE in the transgastric view reveals residual mitral leak, guiding the surgeon in its repair. The improvements in TEE (including 3D echocardiography) allow especially the detection of commissural insufficiency and atypical mitral regurgitation.

Conclusion

Many surgical procedures have been described, which allow the surgeon to correct an AL prolapse. These different approaches have the same goal — mitral valve competency.
Nowadays, long-term results in terms of rate of reoperation are good and are close to those reported for PL prolapse. Finally, the gold standard in the treatment of AL prolapse should be to use the more comfortable technique for the surgeon associated with a prosthetic ring annuloplasty, not to resect the AL and to be guided by TEE.

Conflict of interest

There is no conflict of interest in this paper for the two authors.

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