

Prolapse of the posterior leaflet: resect or respect

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Prolapse of the posterior leaflet (PPL) is the most frequent dysfunction of the mitral valve in the western world. Quadrangular resection, first proposed by Alain Carpentier, has progressed to become the gold standard modality to repair posterior leaflet prolapse. Although this “resection technique” is safe, reproducible, and offers favorable long term results, it presents major drawbacks. Firstly, it leads to a reduced surface of coaptation, the ultimate goal of mitral valve repair; secondly, it does not respect the anatomy of the mitral valve; thirdly, it leads to a deformation of the base of the ventricle; and finally, degenerative disease of the mitral valve is a spectrum of lesions depending on the amount of excess tissue, and hence, a one technique-fits-all strategy cannot meet the absolute necessity to repair all mitral valve patients with PPL. Therefore, new approaches which have been proposed place greater emphasis on respecting, rather than only resecting, the leaflet tissue in order to avoid the drawbacks of the “resection” approach. The use of artificial chordae to correct the leaflet prolapse restores the normal anatomy and physiology of the mitral valve, thus producing an optimal surface of coaptation. However, this approach is limited by anatomical variances. As a community, we should expand our vision and define a clear and helpful strategy for PPL: to obtain a high, smooth and regular surface of coaptation located in the inflow of the left ventricle. To achieve this goal, it is necessary to have a high level of respect for the leaflet tissue in order to obtain the best surface of coaptation. Nonetheless, a limited resection may be needed to remodel the posterior leaflet, so that it will be smooth and regular.

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Prolapse of the posterior leaflet (PPL) was the first lesion of the regurgitant mitral valve amenable to repair (1) and is the most common cause of mitral regurgitation in the Western population. Carpentier developed and conceptualized the functional approach for repairing the failed mitral valve with a goal of restoring the coaptation surface, the essence of the “French correction” (2). The classic quadrangular resection technique became the gold standard to treat PPL.

Progressively alternative approaches have been proposed to repair PPL, including techniques that have focused on preserving leaflet tissue. Schematically, two categories of approaches exist: the “resection techniques” and the “respect approach”. The article entitled “respect rather than resect” (RRR) (3) is misleading in suggesting that these approaches are opposing, when in actual fact, they should be employed

to complement each other.

The “resection techniques”

Repair of the posterior leaflet has been traditionally performed by undisputed techniques of leaflet resection. This section presents the different techniques, their specific advantages and limitations.

The quadrangular resection

This approach has been developed and promoted by Carpentier *et al.* (4), to repair PPL, whether the result of ruptured or elongated chordae is treated by extensive quadrangular resection of the prolapsed area.

There is no doubt that this technique is easily reproducible, especially in the case of standard prolapse of P2 with no excess of tissue. Long term results have been very gratifying, showing a minimal operative mortality, an excellent long term survival equal to the survival rate for a normal age- and sex-matched population and a long-lasting durability (5,6).

On the other hand, unexpected technical difficulties, due to special anatomical conditions may be encountered leading to a non-satisfactory result.

- (I) The loss of surface of coaptation, secondary to leaflet prolapse may lead to excess tension and stress on the chordae adjacent to the prolapsed area. In case of a long-standing mitral regurgitation, these chordae may become elongated. In such a situation, blindly applying the technique may lead to a certain degree of residual prolapse and the possibility of excess motion of the free edge of the posterior leaflet;
- (II) Numerous chordae may be ruptured or elongated and thus responsible for a very large prolapse. Leaflet resection of the prolapsed area would leave insignificant remnants of the posterior leaflet to satisfactorily repair the mitral valve;
- (III) Annulus plication induces a deformation of the sub annular region of the left ventricle. This may be responsible for a temporary dysfunction of the base of the left ventricle;
- (IV) In case of extensive resection and lengthy annulus plication, cases of kinking of the circumflex artery have been described (7);
- (V) PPL frequently involves P2, which by nature is the highest and most developed scallop. This portion of the posterior leaflet is the one sustaining the greatest stress during systole (8). Resection of this area decreases the height of the posterior leaflet precisely where it is the most needed;
- (VI) Muroid degeneration associated with degenerative mitral valve may lead to excess of tissue. Mihaileanu has shown that excess of tissue predominantly involving the posterior leaflet in one of the main factors responsible for left outflow tract obstruction (LVOT) with systolic anterior motion (SAM) (9). Carpentier has subsequently described the “sliding plasty” to reduce the height of the posterior leaflet and subsequently prevent SAM (10).

Quadrangular resection with sliding plasty

The goal of the sliding plasty is to reduce the height of the

posterior leaflet, in circumstances where there is excess tissue, to restore the normal two-thirds to one-third ratio between the respective height of the anterior and posterior leaflets. This technique has proved to be efficient to prevent or treat LVOT with SAM (11,12). The main advantages of this technique include: (I) it allows the resection of any amount of excess tissue of the posterior leaflet; and (II) it achieves a regular and progressive narrowing of the annulus, thereby avoiding any major changes in the geometry of the left ventricle.

Drawbacks of this technique are identical to these of leaflet resection presented with the quadrangular resection technique.

The triangular resection

This technique has been promoted by the Mayo Clinic (13). It is the logical evolution of the original technique used by MacGoon (1). Long-term results of this technique are very satisfactory (14). The triangular resection has several distinct benefits over quadrangular resection. Triangular resection does not alter the geometry of the base of the left ventricle. Triangular resection removes less normal tissue, and is technically less demanding.

Nonetheless, the triangular resection has obvious limitations: (I) in cases of extensive PPL involving more than one scallop; (II) in cases of excess leaflet tissue, the reduction of the height of the posterior leaflet may require additional steps that have been described (15).

Other resection techniques

The folding technique has been described by Grossi *et al.* (7) and the butterfly technique by Asai *et al.* (16).

The need for annulus plication is reduced with the use of these techniques. The height of the posterior leaflet is reduced and leaflet coaptation is moved posteriorly. These techniques share the disadvantages of the “resection techniques”.

The “respect approach”

The rationale of this approach is to preserve the leaflet tissue that is critically important for the coaptation surface and to correct the prolapse by using expanded polytetrafluoroethylene (e-PTFE) suture neochordae without the employment of leaflet resection to resuspend the free edge of the posterior leaflet (3). The goal of the

RRR approach is to intentionally transform the posterior leaflet into a smooth, flat and regular buttress hanging vertically from the mitral annulus and against which the anterior leaflet will come in apposition.

Long-term results have shown that this approach presents the same durability and stability as the gold standard “quadrangular resection” (17-19). This technique offers numerous advantages:

- (I) The goal of mitral valve repair is to restore a good surface of coaptation to ensure a satisfactory function of the mitral valve. Leaflet tissue is the primary component defining the surface of coaptation and thus it may be more logical to preserve as much of the leaflet tissue, as opposed to resecting a large portion of it;
- (II) Respecting the leaflet tissue allows for a high surface of coaptation, especially when P2 is involved, as shown in a previous study (20);
- (III) It is a safe method, allowing pursuit of another technique at any time, as nothing is resected or irreversibly altered;
- (IV) Artificial chordae have been used to repair mitral valve for 25 years, and excellent long-term durability has been reported (21);
- (V) From time to time, lesions are extensive with involvement of more than one scallop. This situation is easily addressed by the use of as many artificial chordae as necessary to resuspend all the prolapsed area;
- (VI) Not only does this approach correct the leaflet prolapse, but it also helps to prevent the occurrence of postoperative SAM. As seen above, at the time of adjusting the length of the artificial chordae it is necessary to take into account any excess of tissue so that the free edge of the posterior leaflet cannot move anteriorly and push the surface of coaptation in the outflow tract. Simply stated, if the excess tissue is large, the resulting artificial chordae should be made shorter. It is important to ensure that the surface of coaptation remains in the inflow parallel to the wall of the left ventricle;
- (VII) Artificial chordae not only correct the leaflet prolapse, but also maintain the posterior leaflet and the surface of coaptation in the inflow of the left ventricle.

The RRR approach may be the technique of choice when quality and quantity of posterior leaflet tissue is adequate to achieve a smooth and regular surface. However, there are

some limitations to this technique. Excessive and exuberant myxomatous degeneration can render the posterior leaflet irregular with bulging deformations that need to be resected to obtain a regular surface of coaptation. Excess of tissue affects not only the height of the posterior leaflet, but more importantly its width, and may transform the normally rectangular P2 into a trapezoidal element. The placement of the annuloplasty ring may result in folds of the posterior leaflet that alter the coaptation surface smoothness. Again in this situation, a localized resection is necessary to reshape the posterior leaflet. Accumulation of myxomatous material at the base of the posterior leaflet should be removed with leaflet resection, as it deforms and prevents the leaflet from hanging vertically, causing it to protrude anteriorly and increasing the risk of SAM.

Surgical strategy

Quadrangular resection has the reputation of being a “straightforward technique” that any surgeon should be able to apply. However, a surgeon may face a myriad of questions during the course of such an operation. “How large should the resection be?”, “What if the prolapse involves a very large P2?”, “Should an annulus plication be performed with its subsequent deformation of the subannular area?”, “Should a sliding plasty be undertaken to have a more regular distribution of stresses and minimize the risks of systolic motion in case of excess of tissue?”

On the other hand, as described above, a RRR approach cannot be applied in all cases, due to anatomical variations of the posterior leaflet.

As it is observed in clinical practice, PPL encompasses a spectrum of scenarios if one considers the parameter of excess of tissue, which clearly influences the difficulty of the operation. Hence the doctrine that advocates one technique to fit all scenarios is unable to meet the goal that we should pursue: repair them all. Concentrating on surgical techniques may be misleading as stated by Sun Tzu (500 BC): “Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat”. Instead of debating on surgical techniques, we should concentrate on our strategy, which is to restore a high, regular surface of coaptation located in the inflow. It may be necessary to combine a limited triangular resection to remodel the posterior leaflet, and then to correct the remaining prolapse through the use of artificial chordae. The repair of posterior leaflet prolapse, guided by such a strategy should become a patient-specific spectrum of techniques ranging from

respect to resect.

In every day practice, a careful surgical analysis of the valve is necessary, not only to localize the prolapsed area, but also to thoroughly analyze the posterior leaflet. The characteristic pattern of degenerative disease is the production of mucoid material leading to excess of tissue, not only affecting the height of the leaflet, but also its width. This excess of tissue in width will lead to an irregular posterior leaflet with areas of bulging. The posterior leaflet should be observed when lying on the posterior wall of the left ventricle. If it is flat, smooth and regular, the lateral excess of tissue is reduced and a “respect approach” can be applied. On the contrary, when the posterior is irregular presenting with areas protruding anteriorly, a limited resection should be carried out, to obtain a smooth posterior leaflet. If there is a persistent PPL, artificial chordae should be used to correct it and to maintain the coaptation area in the inflow of the left ventricle.

In conclusion, the successful outcome of mitral valve repair for PPL is influenced by the action of a team: echocardiographers and surgeon. Many surgical techniques have shown their efficiency in achieving stable long-term results. The challenge we have to face is to be able to repair all mitral valves presenting with PPL efficiently and safely. There is no doubt that an open mind when selecting the technique(s) to be used is necessary, and that it should be focused on one goal, the remodeling of the posterior leaflet to create the best coaptation surface as possible.

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