Contemporary application of the edge-to-edge repair

Alberto Pozzoli, Luca Vicentini, Michele De Bonis, Giovanna Di Giannuario, Giovanni La Canna, Ottavio Alfieri

Department of Cardiothoracic Surgery, San Raffaele University Hospital, Milan, Italy

Correspondence to: Ottavio Alfieri. Department of Cardiothoracic Surgery, San Raffaele University Hospital, Milan, Italy. Email: ottavio.alfieri@hsr.it.

Submitted Sep 30, 2014. Accepted for publication Oct 24, 2014.

doi: 10.3978/j.issn.2225-319X.2014.12.02

View this article at: http://dx.doi.org/10.3978/j.issn.2225-319X.2014.12.02

Introduction

The edge-to-edge technique was introduced into the surgical armamentarium of mitral valve repair in the early 1990s. From the beginning, it appeared to be an attractive approach because of its simplicity, reproducibility and effectiveness even in complex settings. Several institutions around the world adopted this surgical method in selected patients with mitral regurgitation due to different causes and mechanisms (1-8). More recently, the edge-to-edge concept has also become the basis of the most widespread percutaneous method of correcting mitral regurgitation (9).

Unlike traditional repair techniques, which aim for an anatomical reconstruction of the diseased valve, the basic concept behind the edge-to-edge approach is that the competence of the mitral valve can be effectively restored with a 'functional' rather than an 'anatomical' repair. Appropriate patient selection is crucial and transesophageal echocardiography (TEE) provides all the anatomical and functional features that are essential to decide whether this surgical option is suitable for a specific case. In particular, important details are given by the TEE regarding the cause and mechanism of mitral regurgitation, the degree of annular dilatation (which has important implications for the risk of stenosis after repair), the presence of annular calcification, the precise site and extension of the regurgitant jet and the likelihood of postoperative systolic anterior motion (SAM). The location of the regurgitant jet is particularly important because the free edge of one leaflet is sutured to the corresponding edge of the opposing leaflet at exactly the same level in order to restore mitral valve competence. When the regurgitation originates in the central part of the valve, the edge-to-edge repair produces a mitral valve with a double orifice configuration (double orifice repair). On the other hand, when mitral insufficiency occurs near a commissure, the edge-to-edge leads to a surgical closure of the commissure ('paracommissural edge to-edge repair'). Under these circumstances, the mitral valve will have a single orifice with a relatively smaller area when compared with the preoperative value.

The suture has to be placed in exact correspondence with the regurgitant jet and has to be as short as possible in order to eliminate mitral regurgitation without inducing stenosis. Valve distortion has to be carefully avoided as well. A ring annuloplasty should be used and a final mitral valve area of at least 2.5 cm^2 should be left in normal sized patients. The edge-to-edge technique is usually performed through a conventional midline sternotomy or a minimally invasive approach, with excellent results (10,11).

Surgical techniques

We present the case of a 49-year-old male, asymptomatic for dyspnea, with good left ventricular function and a left ventricular end diastolic diameter of 54 mm, affected by severe mitral regurgitation due to degenerative disease.

He was referred to our center for an isolated prolapse of the central scallop of the anterior mitral leaflet (A2) with coexisting annular dilatation. The isolated prolapse with flail of the anterior leaflet could be appreciated on preoperative transesophageal echocardiogram. It causes severe mitral regurgitation, with an asymmetric jet and coanda effect in the left atrium, seen in color-Doppler. Once the heart is arrested, valve analysis confirms a degenerative disease involving the central scallop of the anterior leaflet, with flail.

The anterior leaflet is redundant and can be easily mobilized. It is affected by significant prolapse of the medial aspect of A2, with flail due to chordal rupture, clearly evident when it is compared with the corresponding portion

of the posterior leaflet, which is free from prolapse.

Now, the chordae of P3 are inspected with a nerve hook. The medial scallops of both leaflets A3 and P3 are also compared again in order to verify that there are no other prolapses.

The medial portion of the central scallop of the anterior leaflet, the target area, is subsequently addressed to perform the edge-to-edge correction. The repair is elegantly carried out using a 4-0 single polypropylene suture, passed around 5 mm away from the free margins, in order to anchor the anterior leaflet to the posterior one, without the use of pledgets. Attention should be given to take big bites of leaflet tissue with this suture, to provide strength to the repair and to reduce the leaflet height.

A double orifice valve conformation is then created.

The Ti-cron 2-0 single sutures for the flexible ring are now passed into the atrio-valvular junction of the posterior mitral annulus, starting from the anterolateral commissure and proceeding to the posteromedial one in a counterclockwise fashion, in order to reshape and reduce the associated annular dilatation.

The sutures are passed one by one through the prosthetic band and carefully tied. The competence of the reconstructed valve is finally assessed by injection of saline solution into the left ventricle, demonstrating only a little oozing. Indeed, when the posteromedial and after the anterolateral orifices are evaluated, they show a wide area and total continence of the mitral valve, without any evidence of residual prolapse.

After weaning from cardiopulmonary bypass, intra-operative TEE is performed to check the valve competence, with fine calculation of the planimetric area, the transmitral flows and the morphologic analysis of the double orifice valve. In patients with mitral regurgitation due to segmental anterior leaflet prolapse, the correction with edge-to-edge repair combined with annuloplasty is excellent, as recently reported by our group in the publication of very long-term clinical and echocardiographic outcomes (12). The prolapse or flail of the anterior leaflet illustrated in this video is one of the current indications of the edge-to-edge mitral valve repair. In the setting of degenerative mitral regurgitation this approach can be effectively used to also treat bileaflet prolapse and commissural lesions with excellent long-term outcomes.

Outcomes of mitral valve repair using the edge-to-edge

Segmental prolapse of the anterior leaflet

A very good indication for the edge-to-edge technique is severe mitral regurgitation due to segmental prolapse of the anterior leaflet involving only one scallop. This mechanism of mitral regurgitation can be typically found in patients with anterior leaflet chordal elongation or rupture in the setting of degenerative mitral valve disorder (myxomatous disease or fibroelastic deficiency) or post-endocarditis mitral regurgitation. If only one scallop (usually A2) is prolapsing, the edge-to-edge repair is very effective in restoring mitral valve competence in a rapid, standardized and easily reproducible manner. Long-term results are very satisfactory, with a freedom from reoperation at 10 years of 96%±2.3% and a recurrence rate (by echocardiography) of mitral regurgitation 3+ or more of 2.2% at a mean follow-up of 4.5±3.12 years (range, 1 month-13.2 years). Stenosis has never been reported in this subgroup of patients immediately after surgery or at follow-up.

Interestingly, these results were comparable to those obtained in patients submitted to standard quadrangular resection for prolapse of the posterior leaflet (8).

Our group also published the outcomes of these patients at 17 years. The actuarial survival was 72.4%±7.89% and freedom from reoperation was 89.6%±2.74%. The recurrence of MR grade ≥3+ was documented in 17 patients (17 of 135, 12.5%). Freedom from MR grade ≥3+ at 17 years was 80.2%±5.86%. On multivariate analysis, the predictors of MR recurrence grade ≥3+ were residual MR greater than mild at hospital discharge (hazard ratio, 7.4; 95% confidence interval, 2.5-21.2; P=0.0001) (12).

Indeed, in patients with MR due to segmental anterior leaflet prolapse, the long-term results of the edge-to-edge repair combined with annuloplasty were excellent.

However, it is important to emphasize that, if the prolapsing or flailing lesions involve more than one scallop, the edge-to-edge repair alone may not be sufficient to obtain a perfectly competent valve. In this situation, a long suture would be required with the consequent risk of inducing mitral stenosis. An anatomical repair like artificial chordae implantation would be more appropriate in this setting in order to eliminate incompetence without excessively reducing the mitral valve area.

Bileaflet prolapse of facing segments in Barlow's disease

The clinical and echocardiographic long-term results of the edge-to-edge repair for bileaflet prolapse are now available. At 12 years, freedom from recurrence of mitral regurgitation 3+ or more was 86.3%±3.54%. Mitral stenosis

requiring reoperation was detected in only one patient (1/128 patients, 0.7%). The only predictor of recurrence of mitral regurgitation 3+ or more at follow-up was residual regurgitation greater than mild at hospital discharge (P=0.007) (13). Those results achieved at a mean follow-up of 11.5±2.53 years (range, 1.1-17.6 years) are at least comparable to, if not better than, those described in other series with similar follow-up length (14-18) and confirm that the double orifice technique combined with ring annuloplasty provides excellent late outcomes in patients with degenerative mitral regurgitation and bileaflet prolapse.

Percutaneous edge-to-edge repair

The edge-to-edge concept of mitral valve repair is the basis of the most currently widespread percutaneous method of correcting mitral regurgitation. The MitraClip system (Evalve, Menlo Park, California, USA) allows the implantation of one or more clips at the site of regurgitation, reproducing the surgical edge-to-edge repair (19).

Contraindications

Despite this great versatility, clinical and echocardiographic results have progressively demonstrated that there are specific subgroups of patients in whom the edge-to-edge technique leads to suboptimal results. Unsatisfactory outcomes have been reported in patients with rheumatic mitral regurgitation and in those who did not receive a concomitant annuloplasty (2,20). In the aforementioned conditions edge-to-edge repair does not represent the technique of choice.

Due to the risk of inducing stenosis, the edge-to-edge technique should not be used in patients with small mitral valve area and rheumatic mitral regurgitation. In addition, its application is not indicated in the case of bileaflet prolapse if the mitral lesions involve non-facing segments of the anterior and posterior leaflets. Finally, it should be avoided in the presence of a heavily calcified annulus and whenever annular dilatation cannot be corrected by a concomitant annuloplasty for whatever reason. Indeed, the absence of annuloplasty is likely associated with increased stresses on the suture and on the valve apparatus, leading to accelerated failure of the repair. As a matter of fact, freedom from reoperation is lower when annuloplasty is for some reason omitted (2,20).

Summary

Twenty years after its introduction, the edge-to-edge technique remains an effective and versatile method to treat mitral regurgitation due to different causes and mechanisms. Simplicity, reliability and reproducibility are the main advantages of this method and have led to its increasingly widespread application in the surgical community. Very long-term durability has recently been definitely demonstrated. The current indications and contraindications of the edge-to-edge repair, substantiated by the surgical results, have been outlined in this manuscript. If the well-established technical aspects of the procedure are respected and the indications previously described are observed, results with this type of repair are similar or even superior to those obtained with other reconstructive techniques.

Acknowledgements

The first author is grateful to his friend Dr. Enrico Rinaldi for the soundtrack.

Disclosure: The authors declare no conflict of interest.

References

1. Fucci C, Sandrelli L, Pardini A, et al. Improved results with mitral valve repair using new surgical techniques. Eur J Cardiothorac Surg 1995;9:621-6 discuss 626-7.
2. Alfieri O, Maisano F, De Bonis M, et al. The double-orifice technique in mitral valve repair: a simple solution for complex problems. J Thorac Cardiovasc Surg 2001;122:674-81.
3. Kuduvalli M, Ghotkar SV, Grayson AD, et al. Edge-to-edge technique for mitral valve repair: medium-term results with echocardiographic follow-up. Ann Thorac Surg 2006;82:1356-61.
4. Brinster DR, Unic D, D'Ambra MN, et al. Midterm results of the edge-to-edge technique for complex mitral valve repair. Ann Thorac Surg 2006;81:1612-7.
5. Bhudia SK, McCarthy PM, Smedira NG, et al. Edge-to-edge (Alfieri) mitral repair: results in diverse clinical settings. Ann Thorac Surg 2004;77:1598-606.
6. Kherani AR, Cheema FH, Casher J, et al. Edge-to-edge mitral valve repair: the Columbia Presbyterian experience. Ann Thorac Surg 2004;78:73-6.
7. De Bonis M, Lapenna E, La Canna G, et al. Mitral valve repair for functional mitral regurgitation in end-stage dilated cardiomyopathy: role of the "edge-to-edge" technique. Circulation 2005;112:I402-8.
8. De Bonis M, Lorusso R, Lapenna E, et al. Similar long-

term results of mitral valve repair for anterior compared with posterior leaflet prolapse. J Thorac Cardiovasc Surg 2006;131:364-70.
9. Feldman T, Kar S, Rinaldi M, et al. Percutaneous mitral repair with the MitraClip system: safety and midterm durability in the initial EVEREST (Endovascular Valve Edge-to-Edge REpair Study) cohort. J Am Coll Cardiol 2009;54:686-94.
10. Lapenna E, Torracca L, De Bonis M, et al. Minimally invasive mitral valve repair in the context of Barlow's disease. Ann Thorac Surg 2005;79:1496-9.
11. Glower DD, Desai B, Mackensen GB. Early Results of Edge-to-Edge Alfieri Mitral Repair Via Right Mini-Thoracotomy in 68 Consecutive Patients. Innovations (Phila) 2009;4:256-60.
12. De Bonis M, Lapenna E, Taramasso M, et al. Very long-term durability of the edge-to-edge repair for isolated anterior mitral leaflet prolapse: up to 21 years of clinical and echocardiographic results. J Thorac Cardiovasc Surg 2014;148:2027-32.
13. De Bonis M, Lapenna E, Lorusso R, et al. Very long-term results (up to 17 years) with the double-orifice mitral valve repair combined with ring annuloplasty for degenerative mitral regurgitation. J Thorac Cardiovasc Surg 2012;144:1019-24.
14. Braunberger E, Deloche A, Berrebi A, et al. Very long-term results (more than 20 years) of valve repair with carpentier's techniques in nonrheumatic mitral valve insufficiency. Circulation 2001;104:I8-11.
15. Gillinov AM, Blackstone EH, Alaulaqi A, et al. Outcomes after repair of the anterior mitral leaflet for degenerative disease. Ann Thorac Surg 2008;86:708-17; discussion 708-17.
16. David TE, Ivanov J, Armstrong S, et al. A comparison of outcomes of mitral valve repair for degenerative disease with posterior, anterior, and bileaflet prolapse. J Thorac Cardiovasc Surg 2005;130:1242-9.
17. DiBardino DJ, ElBardissi AW, McClure RS, et al. Four decades of experience with mitral valve repair: analysis of differential indications, technical evolution, and long-term outcome. J Thorac Cardiovasc Surg 2010;139:76-83; discussion 83-4.
18. Salvador L, Mirone S, Bianchini R, et al. A 20-year experience with mitral valve repair with artificial chordae in 608 patients. J Thorac Cardiovasc Surg 2008;135:1280-7.
19. Feldman T, Foster E, Glower DD, et al. Percutaneous repair or surgery for mitral regurgitation. N Engl J Med 2011;364:1395-406.
20. Maisano F, Caldarola A, Blasio A, et al. Midterm results of edge-to-edge mitral valve repair without annuloplasty. J Thorac Cardiovasc Surg 2003;126:1987-97.

Cite this article as: Pozzoli A, Vicentini L, De Bonis M, Di Giannuario G, La Canna G, Alfieri O. Contemporary application of the edge-to-edge repair. Ann Cardiothorac Surg 2015;4(4):376-379. doi: 10.3978/j.issn.2225-319X.2014.12.02

