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EDITORIAL

Surgical correction of ischaemic mitral regurgitation—still a long way to go

Philippe Kolh*

Service de Cardiochirurgie, CHU Sart Tilman, B 35 Sart Tilman, Liège 4000, Belgium

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This editorial refers to 'Five-year echocardiographic results of combined undersized mitral ring annuloplasty and coronary artery bypass grafting for chronic ischaemic mitral regurgitation' by S. Gelsomino *et al.*, on page 231

Elegant experimental work has helped in understanding the pathogenesis of chronic ischaemic mitral regurgitation (IMR), which appears to be the consequence of a combination of two distinct anatomical abnormalities.[1] Globally, annular dilatation occurs secondary to left ventricular (LV) enlargment, causing incomplete coaptation of the mitral valve despite normal leaflet motion. Locally, inferior wall remodelling produces papillary muscle displacement with restricted motion of the mitral leaflets.

Chronic IMR, an independent predictor of mortality with a reported survival of 40–60% at 5 years,[2–5] is a progressive disorder in which MR-related LV volume overload promotes further LV remodelling, leading to worsened MR. Therefore, surgical correction, either by replacement or repair, is recommended for 3+ and 4+ IMR.[6] Furthermore, repair, as compared with replacement, appears to benefit most patients with IMR, with the possible exceptions of very high hisk group, such as patients in New York Heart Association (NYHA) functional class IV or those requiring emergency surgery.[3]

Many divergent approaches to IMR repair have been used, such as undersized flexible ring annuloplasty, selective valve replacement, uniform chordal sparing valve replacement, transection of secondary chordae, suture annuloplasty, posterior leaflet patch extension, annular cinching, and papillary muscle sling.[7] For the last decade, however, most authors have pursued the consistent approach of routine rigid ring annuloplasty and complete coronary artery revascularization to treat IMR, with good short-term success.[3] However, long-term results are more difficult to obtain and analyse.

Gelsomino *et al.*[8] report 5-year echocardiographic results of combined undersized mitral ring annuloplasty and coronary artery bypass grafting (CABG) in patients with chronic IMR. Among 251 prospectively enrolled patients operated on in a single institution over a 6-year period, 14 patients with significant residual MR, either intraoperatively or at hospital discharge, were excluded from the study. There were two early and 15 late deaths. Serial echocardiograms were performed in 220 survivors at baseline, discharge, and annually thereafter, with a median follow-up of 32.9 months, while 61 patients reached 5-year control. Five-year survival and 5-year freedom from reoperation for failed repair were 83.2 ± 4.4 and $78.2 \pm 4.9\%$, respectively. LV volumes decreased and sphericity indexes improved at discharge and at 1-year follow-up, while MR remained stable, but these values worsened at 3- and 5-year follow-up, while MR reincreased. LV reverse remodelling was observed in 44.2% of patients, while 10% developed further LV dilatation. Predictive echocardiographic factors of recurrent MR were end-systolic volume, sphericity index, myocardial performance index, and wall motion score index. Gelsomino *et al.*[8] report important results that should be placed in perspective with other recent studies, in particular concerning patient population, ring morphology and size, operative results, and long-term recurrence of MR.

The cohort of patients studied by Gelsomino *et al.*[8] is homogenous, with inclusion criteria defined as myocardial infarction >16 days, coronary artery stenosis of at least 75%, corresponding regional wall motion abnormality, and type IIIb leaflet dysfunction according to Carpentier's classification,[9] with or without annular dilatation. Patients with isolated type I (normal leaflet motion with isolated annular dilatation) or type II (excessive leaflet motion) mitral valve disease were excluded.

A Carpentier's classic (rigid) ring was implanted in 133 patients, and a physio (partly flexible in the posterior part) ring in 118 patients. It should be noted that recent studies have linked flexible posterior bands with significant recurrent MR.[5] Patients with IMR can develop dilatation of the anterior annulus between the trigones. Because posterior flexible bands do not correct intertrigonal dilatation, they may not effectively ensure restoration of an adequate leaflet coaptation surface. However, the ring

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* Corresponding author. Tel: +32 4 366 7163, Fax: +32 4 221 31 58, Email: philippe.kolh@chu.ulg.ac.be

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used, classic or physio, was not predictive of recurrent MR in this study.

A downsizing of two ring sizes was performed in all patients, while no patient received a ring >30 mm. It is widely accepted that use of an appropriately downsized ring is the current single most important aspect of mitral valve repair for IMR. This is important to overcorrect the septal-lateral dimension and ensure adequate surface of coaptation between tethered leaflets. The fear of systolic anterior motion following downsizing is unnecessary because of the widened aorto-mitral angle in this type of pathology.

Operative mortality for combined mitral valve surgery and CABG, although historically high, is now in the range of 4–7%.[7,10] Gelsomino *et al.*[8] report an operative mortality of 0.8%, which is excellent. Therefore, an appropriate long-term follow-up can be obtained and analysed. Furthermore, patients with MR at discharge were excluded from the study. This should be emphasized, as freedom from reoperation, reverse ventricular remodelling, and improvements in quality of life are at least partly dependent on elimination of MR at surgery.

Certainly, significant degrees of residual MR (moderate or severe) should most often trigger a second bypass run and appropriate corrective action, such as further ring downsizing, leaflet patch extension, correction of unrecognized prolapse, or, possibly, valve replacement. It should also be remembered that post-bypass transoesophageal echocardiography underestimates MR because of low aferload during anaesthesia. This need for a second bypass run should probably not exceed 5% with experienced surgeons. Only in exceptional circumstances should patients leave the operating room with significant residual MR, such as when a valve is considered irreparable or non-replacable (i.e. massive calcification) or when the risks of a second bypass run exceed the benefits.

Long-term results of repair for IMR are difficult to obtain, partly because death is an important competing end-point in the evaluation of repair failure. Freedom from operation often overestimates the success of a procedure, because many patients with recurrent MR will not undergo reoperation for several reasons, such as good functional class, advanced age, poor left ventricular ejection fraction (LVEF), co-morbidities, or the patient's wishes. Therefore, recurrence of MR is a much more precise indicator of procedural success.

Whereas good results have been reported,[11] high late recurrence rates of MR after ring annuloplasty have recently been published.[5,12,13] McGee *et al.*[5] reported a 28% recurrence rate of 3+ or 4+ MR at 6 months. Furthermore, Serri *et al.*[13] reported a recurrence rate of 36% for 2+ MR and 20% for 3+ to 4+ MR at 28 months, while Tahta *et al.*[12] reported a recurrence rate for 2+ to 4+ MR of 29% at 35 months.

In contrast, Bax *et al.*[11] reported absent or minimal MR at 18 months, with a high proportion of patients experiencing reverse remodelling, with a significant decrease in left ventricular and left atrial diameters, and LVEF increase. Braun *et al.*[14] identified preoperative LV end-diastolic dimensions as the single best factor in predicting occurrence of reverse remodelling, with a cut-off value of 65 mm, and concluded that reverse LV remodelling occurs in the majority of patients, but is however limited by preoperative LV dimensions. Therefore, these authors[14] encourage the use of additional surgical procedures, such as the application of a CorCap cardiac support device (Acorn Cardiovascular, Inc., St Paul, MN, USA) or LV restoration therapy when LV end-diastolic diameter is >65 or >80 mm, respectively.

In the study of Gelsomino *et al.*,[8] LV volumes decreased and sphericity indexes improved at discharge and at 1-year follow-up, while MR remained stable, but these values worsened at 3- and 5-year follow-up, while MR reincreased. Such results, with patients experiencing late MR, as long as 5 years after the initial surgical procedure, emphasize the importance of long-term follow-up that should include appropriate imaging to evaluate the success of valve repair for IMR, whichever the technique used.

Longitudinal studies including regular echocardiographic follow-up should be the gold standard to define the true efficacy of mitral valve repair techniques. Echocardiographic data are the best surrogate for recurrent MR, as opposed to survival or reoperation rate. Novel surgical techniques, such as ventricular resynchronization, infarct restraint, ventricular reconstruction, posterior leaflet patch extension, annular cinching, or chordal transection, can only be evaluated in the long term using imaging techniques.

The best hope to improve outcomes in those high-risk patients may be to focus efforts on early intervention to prevent the detrimental myopathic changes consequent to ischaemic remodelling. Survival after mitral valve surgery and CABG is most probably determined primarily by the extent of coronary artery disease and LV dysfunction. Therefore, the sequence of myocardial infarction and remodelling associated with IMR has a greater impact on survival than the degree of MR. Reverse remodelling should be the ultimate goal of the surgeon, as it decreases the stress on the valvular and subvalvular apparatus and therefore consolidates the result.

Conflict of interest: none declared.

References

1. Tibayan FA, Rodriguez F, Liang D, Daughters GT, Ingels NB Jr, Miller DC. Paneth suture annuloplasty abolishes acute ischemic mitral regurgitation but preserves annular and leaflet dynamics. *Circulation* 2003;**108** Suppl 1:II128–II133.
2. Grossi EA, Goldberg JD, LaPietra A, Ye X, Zakow P, Sussman M, Delianides J, Culliford AT, Esposito RA, Ribakove GH, Galloway AC, Colvin SB. Ischemic mitral valve reconstruction and replacement: comparison of long-term survival and complications. *J Thorac Cardiovasc Surg* 2001;**122**:1107–1124.
3. Gillinov AM, Wierup PN, Blackstone EH, Bishay ES, Cosgrove DM, White J, Lytle BW, McCarthy PM. Is repair preferable to replacement for ischemic mitral regurgitation? *J Thorac Cardiovasc Surg* 2001;**122**:1125–1141.
4. Grigioni F, Enriquez-Sarano M, Zehr KJ, Bailey KR, Tajik AJ. Ischemic mitral regurgitation: long-term outcome and prognostic implications with quantitative Doppler assessment. *Circulation* 2001;**103**:1759–1764.
5. McGee EC, Gillinov AM, Blackstone EH, Rajeswaran J, Cohen G, Najam F, Shiota T, Sabik JF, Lytle BW, McCarthy PM, Cosgrove DM. Recurrent mitral regurgitation after annuloplasty for functional ischemic mitral regurgitation. *J Thorac Cardiovasc Surg* 2004;**128**:916–924.

6. Aklog L, Filsoufi F, Flores KQ, Chen RH, Cohn LH, Nathan NS, Byrne JG, Adams DH. Does coronary artery bypass grafting alone correct moderate ischemic mitral regurgitation? *Circulation* 2001;**104**:I68–I75.
7. Glower DD, Tuttle RH, Shaw LK, Orozco RE, Rankin JS. Patient survival characteristics after routine mitral valve repair for ischemic mitral regurgitation. *J Thorac Cardiovasc Surg* 2005;**129**: 860–868.
8. Gelsomino S, Lorusso R, De Cippa G, Capecchi I, Rostagno C, Caciolli S, Romagnolo S, Ferrari M, Dabroi U, Stefano P, Gensini G. Five-year echocardiographic results of combined undersized mitral ring annuloplasty and coronary artery bypass grafting for chronic ischaemic mitral regurgitation. *Eur Heart J* 2008;**29**:231–240. First published on November 7, 2007, doi: 10.1093/eurheartj/ehm468.
9. Carpentier A. Cardiac valve surgery—the 'French correction'. *J Thorac Cardiovasc Surg* 1983;**86**:323–337.
10. Gillinov AM, Blackstone EH, Rajeswaran J, Mawad M, McCarthy PM, Sabik JF III, Shiota T, Lytle BW, Cosgrove DM. Ischemic versus degenerative mitral regurgitation: does etiology affect survival? *Ann Thorac Surg* 2005;**80**:811–819.
11. Bax JJ, Braun J, Somer ST, Klautz R, Holman ER, Versteegh MI, Boersma E, Schalij MJ, van der Wall EE, Dion RA. Restrictive annuloplasty and coronary revascularization in ischemic mitral regurgitation results in reverse left ventricular remodeling. *Circulation* 2004;**110**:II103–II108.
12. Tahta SA, Oury JH, Maxwell JM, Hiro SP, Duran CM. Outcome after mitral valve repair for functional ischemic mitral regurgitation. *J Heart Valve Dis* 2002;**11**:11–18.
13. Serri K, Bouchard D, Demers P, Coutu M, Pellerin M, Carrier M, Perrault LP, Cartier R, Page P, Cossette M, Basmadjian AJ. Is a good perioperative echocardiographic result predictive of durability in ischemic mitral valve repair? *J Thorac Cardiovasc Surg* 2006;**131**:565–573.
14. Braun J, Bax JJ, Versteegh MI, Voigt PG, Holman ER, Klautz RJ, Boersma E, Dion RA. Preoperative left ventricular dimensions predict reverse remodeling following restrictive mitral annuloplasty in ischemic mitral regurgitation. *Eur J Cardiothorac Surg* 2005;**27**:847–853.

CLINICAL VIGNETTE

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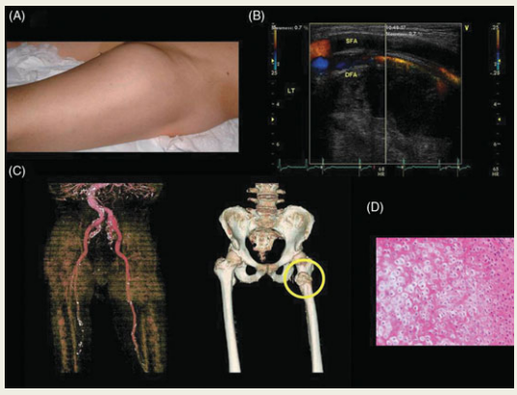
Huge pseudoaneurysm of deep femoral artery without history of catheterization

Takashi Miki, Shinobu Hosokawa*, and Yoshikazu Hiasa

Department of Cardiology, Tokushima Red Cross Hospital, Shinbiraki, 28-1 Chuden-chou, Komatsushima 773-8502, Japan

* Corresponding author. Tel: +81 8853 2 2555; Fax: +81 8853 2 3800. Email: hoso@tokushima-med.jrc.or.jp

A 60-year-old man with a history of stroke had a sudden pain and severe swelling in the left femur (Panel A). Echocardiography of the femoral artery showed a huge pseudoaneurysm of the deep femoral artery. Colour flow imaging shows a huge pseudoaneurysm (Panel B) of the deep femoral artery and the internal flow (90 × 130 × 120 mm). Three-dimensional contrast-enhanced computed tomography showed a projection of the femur bone, but no stenosis of the abdominal and iliac artery (Panel C). Operation was performed and revealed the perforation of the femoral artery by the projection of the thighbone. Microscopically, this cartilaginous tumour permeated trabecular bone. Photomicrograph of the projection of thighbone showed mildly nuclear atypia of tumour cells and increased cellularity (Panel D), suggesting chondrosarcoma (haematoxylin and eosin stain, original magnification ×40). The patient was discharged from the hospital in a good condition.



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