

PERSISTENT AND RECURRENT ISCHEMIC MITRAL REGURGITATION

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Background. Ischemic mitral regurgitation (IMR) is a consequence of coronary artery disease and the main underlying mechanism is augmented leaflet tethering due to outward displacement of the papillary muscles. Although mitral annuloplasty combined with coronary revascularization is usually effective in the treatment of IMR, occasionally the regurgitation can persist or recur and this can affect patient prognosis.

Methods. We searched Medline and Google scholar database for articles published since 1996 to June 2009. Search terms included ischemic mitral regurgitation, recurrent mitral regurgitation, persistent mitral regurgitation and annuloplasty failure.

Conclusion. This article reviews current knowledge about IMR, the reasons and mechanisms of persistent and recurrent mitral regurgitation. We review clinic and echocardiographic predictive factors associated with persistence a recurrence of mitral regurgitation after annuloplasty.

INTRODUCTION

Mitral regurgitation (MR) in the absence of organic/morphological lesion of the mitral valve itself (e.g., leaflets and chordate tendinae) is classified as a functional mitral regurgitation (FMR). In reality, FMR is a ventricular disease with the phenotype of a valvular disease¹. It can be divided into 2 groups: ischemic and non-ischemic. Ischemic mitral regurgitation (IMR) is a complication of coronary artery disease with significant effect on both patient mortality and morbidity^{2,3}. The underlying mechanism of IMR is left ventricular remodelling with subsequent outward displacement of papillary muscles (PMs), mitral leaflet tethering and annular dilatation. These abnormalities lead to changes in the geometrical configuration of the mitral complex and prevention of normal leaflet coaptation^{4,5}.

The standard therapeutic approach to relieving IMR is a combined operation: myocardial revascularization with coronary artery bypass grafting (CABG) and undersizing mitral ring annuloplasty (UMRA). UMRA reduces the anteroposterior dimension of mitral annulus as well as the valve area which brings the mitral leaflets into apposition. More than trivial regurgitation persisting early after annuloplasty is called *persistent mitral regurgitation*. On the other hand, the term *recurrent mitral regurgitation* is used, when regurgitation appears later after annuloplasty. This combined procedure is usually effective⁶, however, there is a high rate of recurrence (~30%) of mitral regurgitation¹, even in patients with good early postoperative results^{7,8}. This poor long-term outcome suggests the need for a complex approach to treating ischemic mitral regurgitation which addresses not only the annular, but particularly the ventricular component of mitral regurgitation¹.

CURRENT UNDERSTANDING OF THE MECHANISM IN ISCHEMIC MITRAL REGURGITATION

Historically, it was believed that ischemic mitral regurgitation was caused by papillary muscle dysfunction⁹ or annular dilation¹⁰, but several clinical and experimental studies have shown, that neither PM dysfunction nor annular dilation alone lead to IMR development¹¹. Currently, it is widely accepted that the mechanism and etiology of ischemic mitral regurgitation are more complex: the main underlying mechanism is left ventricular remodelling leading not only to annular dilatation, but particularly to displacement of the papillary muscles, and thereby to augmented tethering of the mitral leaflets. This restricts appropriate mitral leaflet closure and regular coaptation^{12–16}. Hence, IMR is considered a ventricular disease, caused by changes in geometric configuration of the mitral complex (mitral annulus, leaflets, chordae and PMs). These geometric abnormalities are listed below and can be seen in Fig. 1:

- 1) Remodelling of the left ventricle
 - a) global with its sphericalization and dilation, or
 - b) local – often of the posterior wall with dominant restriction of the posterior leaflet.
- 2) Displacement of papillary muscles – lateral and outward dislocation of PMs and their tips
- 3) Leaflet „tethering“ or „tenting“ causing incomplete closure, also known as type III mitral regurgitation of Carpentier's classification
- 4) Annular dilatation

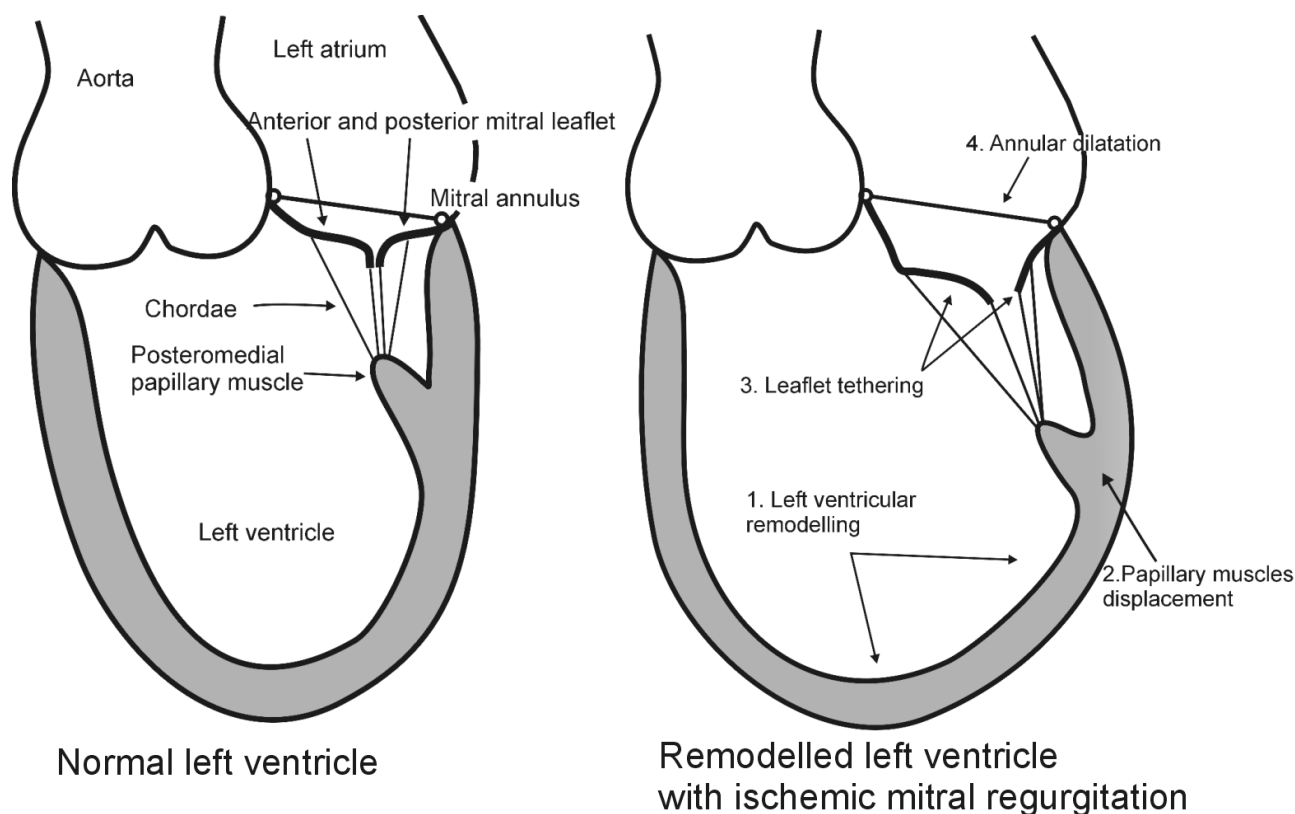


Fig. 1. Difference between normal and ischemic remodelled left ventricle.

SURGICAL TREATMENT OF ISCHEMIC MITRAL REGURGITATION

CABG alone, mitral valve replacement/repair with or without revascularization are considered the standard possibilities for surgical treatment. However, several studies have shown that CABG alone does not result in any significant decrease in IMR severity and a number of patients with mild-to moderate IMR even experienced an increase in IMR severity during follow-up¹⁷⁻¹⁹. Coronary revascularization alone appears to produce long-term survival similar to that for CABG plus annuloplasty both in patients with moderate and severe IMR albeit the risk of operative mortality is higher for the latter¹⁷. However, in patients with untreated IMR at the time of CABG there is a higher incidence of hospitalization for congestive heart failure during follow-up¹⁹. Thus, patients with mild-to-moderate IMR and high perioperative risk and/or life expectancy less than 5 years should be treated with revascularization alone while low risk patients should undergo a combined procedure²⁰. To date, no randomized trials comparing mitral valve replacement to repair were found in the literature. MVR with preservation of subvalvular apparatus can represent an adequate alternative to mitral repair in some patients²¹. Concerning mitral valve repair, the targets of repair are: mitral annulus, leaflets, chordae and left ventricle. Undersized mitral ring annuloplasty (UMRA) first introduced by Bolling et al.²² target dilated mitral annulus and is currently considered to be the standard therapeutic approach to relieving IMR and most commonly used²¹. Annuloplasty brings dilated posterior

annulus anteriorly and by reducing the antero-posterior dimension of the annulus increases leaflet coaptation. Although this procedure is usually effective in correcting IMR and even in obtaining LV reverse remodelling^{22,23} a high percentage (20–72%) of recurrence was found during long term follow-up^{7,8,24,25}.

PERSISTENT AND RECURRENT MITRAL REGURGITATION

More than trivial mitral regurgitation which persists postoperatively is called persistent ischemic mitral regurgitation (PIMR). Patients with PIMR of grade 2+ have a worse prognosis with a lower survival rate than those without persistent regurgitation^{26,27}. Some authors examined preoperative factors which could predict persistent mitral regurgitation after annuloplasty. Zhu et al.²⁴ in a case-controlled study found posterior leaflet tethering to be the predominant factor. Kuwahara et al.²⁸ also confirmed the importance of augmented posterior leaflet tethering in predicting postoperative PIMR.

In contrast to PIMR, patients with recurrent ischemic mitral regurgitation (RIMR), are free of significant regurgitation early after operation but the RIMR appears later. As mentioned above, there is a high rate of recurrence, on average 30% during the long-term follow up. To reduce the likelihood of PIMR or RIMR it is important to leave the operating room with no or trivial MR. This is crucial to prevent worsening of persistent MR during follow-up because even mild IMR can contribute to ventricular

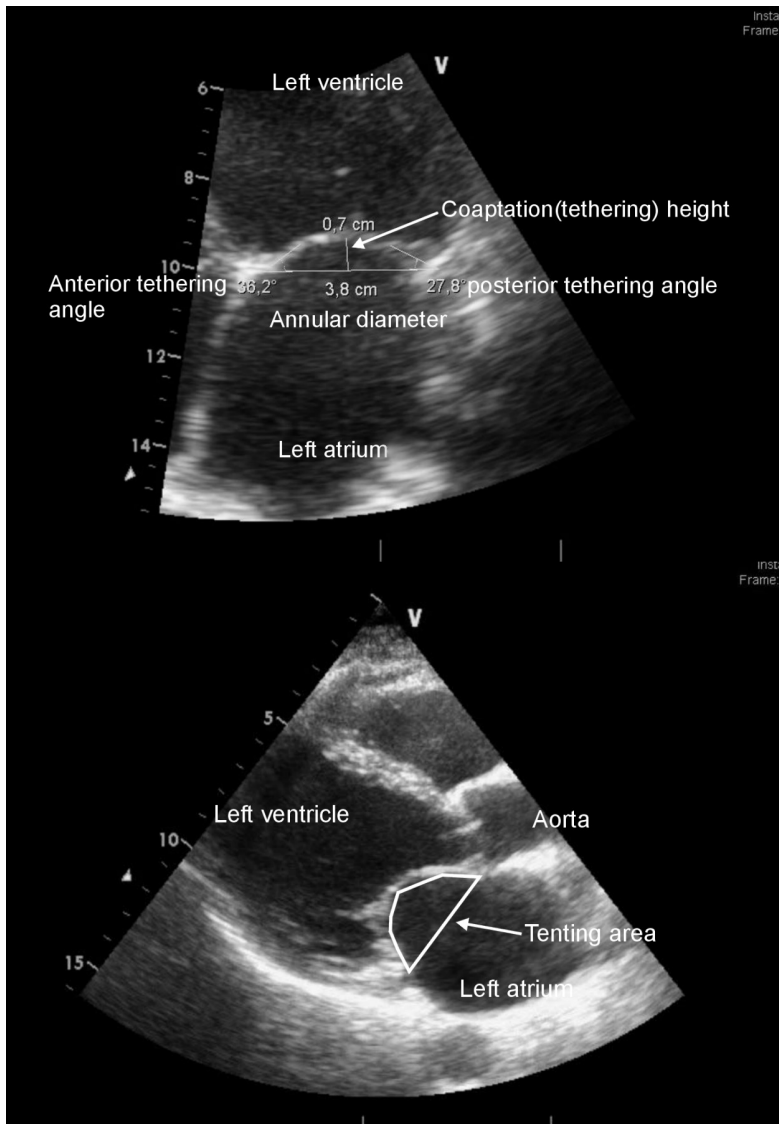


Fig. 2. Echocardiographic parameters used for description of mitral apparatus geometry.

remodelling^{23,29}. Some authors advise obtaining a coaptation length of at least 8 mm postoperatively to ensure minimal residual regurgitation²³. However, despite optimal postoperative results, mitral regurgitation may recur. We reviewed articles relevant to persistent/recurrent mitral regurgitation with a view to finding preoperative predictors, especially echocardiographic ones. Table 1 summarises the results and measurement of these echocardiographic parameters are displayed in Fig. 2. Kongsarepong et al.³⁰ analyzed the records of 365 patients who underwent CABG + UMRA and found these independent predictors for RIMR: 1. Annular diameter, 2. Tenting area, 3. Regurgitation degree. Patients with mitral annular diameter ≥ 3.7 cm with a tenting area of ≥ 1.6 cm² in long axis view and an IMR grade > 3.5 have a 50% probability of regurgitation recurrence during follow-up³⁰.

Hung et al.²⁹ reported that recurrence of IMR after ring annuloplasty is due to progression of ventricular remodelling as shown by increase in LV volume and sphericity index. This subsequently augments tethering and increases mitral regurgitation²⁹. Magne et al.²⁷ studied

Table 1. Preoperative predictors of recurrent IMR.

Tethering (tenting) area	ref. ^{30,31}
Annular diameter	ref. ^{30,31}
Regurgitation degree	ref. ^{30,31}
End-systolic sphericity	ref. ²⁹
LV volumes	ref. ²⁹
Lateral wall abnormalities	ref. ²³
Restrictive diastolic filling pattern	ref. ³⁰
Augmented posterior leaflet tethering	ref. ^{27,28}
Augmented anterior leaflet tethering, symmetric pattern of tethering	ref. ²⁵
Coaptation height of 11 mm or greater	ref. ^{25,32}
Annuloplasty type	ref. ⁸

51 consecutive patients with UMRA for ischemic MR and concluded that the best preoperative predictor of postoperative persistence of MR was a posterior leaflet angle ≥ 45 degrees, which represents high posterior leaflet restriction.

Kuwahara et al.²⁸ studied anterior and posterior leaflet tethering in 30 patients after annuloplasty for IMR. They showed, that both leaflets tethering but predominant posterior leaflet tethering is related to recurrent and persistent mitral regurgitation.

Gelsomino et al.²⁵ demonstrated that patients with RIMR had preoperatively more symmetric tethering, more accentuated anterior mitral leaflet tethering, and more restricted anterior leaflet excursion, than patients without RIMR. They also showed, that an anterior tethering angle of 39.5° or greater, an anterior/posterior tethering angle ratio of 0.76 or greater, an anterior leaflet excursion angle of 35° or less, and a coaptation height of 11 mm (according to Calafiore et al.³¹) or greater are the predictors of recurrent mitral regurgitation^{25,31}.

McGee et al.⁸ confirmed that type but not size of annuloplasty device plays a significant role. They also stated that although MVR would eliminate the risk of RIMR, this strategy has been associated with reduced survival.

Ereminiene et al.³² found that a preoperative restrictive diastolic filling pattern (indicating advanced stage of myocardial dysfunction) is associated with further negative remodelling of left ventricle and higher grade and rate of recurrence of MR after repair.

CONCLUSION

The above data allow us to conclude that main predictors of annuloplasty failure are left ventricular preoperative status with advanced ventricular remodelling, dilatation and dysfunction causing advanced mitral leaflet tethering. In reality, IMR should be considered a ventricular and not a valvular disease per se. Currently, annuloplasty (UMRA) is considered the standard approach to reducing IMR but in fact it does not address the real basis of IMR, the remodeled and sphericalized left ventricle. Even today, we have no reliable predictors of recurrent and persistent mitral regurgitation. However, the surgical treatment of IMR continues to evolve and new methods addressing ventricular structures are being introduced: left ventricular restoration, PMs relocation, sling, imbrication or reapproximation, chordal cutting or translocation¹.

Despite remarkable progress in reparative surgery, further investigation is necessary to finding the best approach to treating IMR.

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