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1. Introduction

Ischemic mitral regurgitation remains an underestimated and important clinical problem. It is a complex multifactorial disease that involves global and regional left ventricular remodeling as well as dysfunction and distortion of the components of the mitral valve including the chordae, annulus and leaflets. The prevalence rate of development of mild or more severe degree of mitral insufficiency after myocardial infarction has been estimated to be up to 50% and is associated with worse prognosis (Stevenson 1987, Lamas 1997, Grigioni 2001).

Based on the clinical presentation, the ischemic mitral regurgitation was classified as acute or chronic (Mitesh, 2009). Although the acute ischemic mitral regurgitation is relatively rare, whenever present, it has a rapid evolution, with an extremely poor survival rate. On the other hand, the chronic ischemic mitral regurgitation is much more frequent, but it’s the consequence of a slower pathological process, with a better survival rate. The echocardiography identifies all patterns of ischemic mitral regurgitation; nonetheless the classification as acute, sub-acute or chronic ischemic mitral regurgitation is rather clinical, than an echocardiographic one. Beside the complete rupture of papillary muscle, other patterns of ischemic mitral regurgitation cannot be practically located in time by echo. It is possible to have the same echocardiographic feature of the lesion in acute and in chronic settings; only the clinical presentation of the patient helps in the diagnosis of acute / sub-acute or chronic ischemic mitral regurgitation. So the echo exam has to be seen as complementary to clinical data, rather than a singular method of diagnosis.

In everyday practice the management of ischemic mitral regurgitation represents a combined problem of physiopathology, quantification and diagnosis that, together, drive the individual
patient prognosis but, in case of patients candidate to open heart surgery this becomes a very complex issue. With intraoperative TEE echocardiography, the exact identification of the mechanism of ischemic mitral regurgitation represents a cornerstone element for surgical planning and patient management. In case of significant residual mitral regurgitation a second run of the extracorporeal circulation may be necessary requiring a well-founded experience from the echocardiographer as the TEE intraoperative findings may be sometimes misleading.

The relation between the ischemic mitral regurgitation, surgery and echocardiography, as tool for surgical planning and postoperative control, will be addressed in this chapter. The suboptimal results obtained by the most commonly used surgical strategy, that is, restrictive annuloplasty combined with coronary artery bypass graft, emphasizes the need to develop alternative or concomitant surgical techniques that directly target the causal mechanisms of the disease. Recent data show that this procedure is associated with a 10% to 20% rate of persistent mitral regurgitation soon after operation and a 50% to 70% rate of recurrent mitral insufficiency at five years (Hashim 2012, Magne 2009). Hereafter, the topics will be focused mainly on the echo assessment of the patients candidate for open-heart surgery. A particular attention will be paid to the papillary muscle and to the mitral valve geometry and their role in the pathophysiology of ischemic mitral insufficiency. Understanding the mechanisms of the different types of ischemic mitral regurgitation is mandatory for echocardiographer and surgeon to tailor the right strategy for the valve repair, and it is indeed a challenging task for both.

2. Physiopathology: Concepts regarding post-myocardial left ventricular remodeling, acute and chronic ischemic mitral valve and the valve geometry

It is generally assumed that the ischemic mitral regurgitation is not a valve disease, the ‘engine’ of valve insufficiency being the remodeling process of the left ventricle, depending on the localization and extension of the myocardial infarction. In ischemic heart disease, the mitral leaflets (and also the chordae) are typically structurally normal, but the leaflets are tethered and their motion is relatively restricted, owing to regional and global ventricular remodeling, with apical displacement of the posteromedial papillary muscle.

Sometimes the remodeling process starts immediately after the onset of myocardial infarction causing structural ischemic mitral regurgitation, which is associated with a poor prognosis, due to the concomitant acute infarction, acute papillary muscle remodeling and acute ischemic mitral regurgitation. For a successful management of this acute mechanical complication the key point is the early diagnosis, which has to be done before the complete rupture of the papillary muscle occurs. This life-threatening complication has otherwise to be considered a failure due to late echocardiographic and clinic diagnosis.

Overall, there is only scanty literature concerning the echocardiographic assessment of the papillary muscle and it is no surprising then to see that its use in the everyday practice is, so
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The acute ischemic mitral regurgitation is a rare mechanical complication after myocardial infarction, due to elongation, partial or complete rupture of papillary muscle but has a poor prognosis and it needs urgent diagnosis and surgery. A careful echocardiographic exam, performed in ICU, is mandatory in acute patients with myocardial infarction, focusing the attention on the presence of mitral regurgitation. In case of any suspicion of structural acute ischemic mitral regurgitation the transesophageal exam must be done, to avoid the transformation of partial rupture of papillary muscle in a complete one. The complete rupture of papillary muscle is often fatal and has to be considered a too late clinical and echocardiographic diagnosis; these patients need an emergent operation and very intensive perioperative pharmacologic and mechanical support.

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From a conceptual point of view, chronic ischemic mitral regurgitation witnesses the loss of contractile myocardial tissue parallel with the presence of the post-infarction remodeling process. As known, ischemic mitral insufficiency develops on normally mitral leaflets. As the myocardial mass loss is larger, the remodeling processes and regurgitation become greater. Recognizing the mechanism of valve incompetence is an essential point for the surgical planning and for a good result of the mitral repair. In the patient's candidates to surgery, the role of the echocardiographic exam is to identify the mechanisms of valve regurgitation and to quantify it. As noted, in most cases of chronic ischemic mitral regurgitation the mechanism is the restriction of one or both leaflets, caused by the tethering exercised by the displaced papillary muscle.

The transthoracic exam is commonly enough to clarify the mechanism of the chronic ischemic mitral regurgitation. Only patients with papillary muscle elongation may raise difficulties in diagnosis. Loss of the normal shape of the 'triangle of coaptation' is one of the key characteristics of chronic ischemic mitral regurgitation. In case of post-ischemic elongation of the papillary muscle, the clue of the diagnosis is obtained by looking not only to the mitral valve, but by focusing the exam on the papillary muscles, particularly when the patient presents a deformation of the 'coaptation triangle'. In patients with type II° Carpentier's classifications (elongated papillary muscle and leaflets prolapse), alongside of ring annuloplasty use of PTFE Gore-Tex chordae is often required.

In patients with chronic ischemic mitral insufficiency the echocardiography may identify two different patterns of post infarction remodeling: a limited process of post infarction remodeling and an extensive one. The mitral repair is usually more challenging in patients with extensive pattern of post infarction remodeling, where, due to left heart cavity enlargement a phenomenon of "mitral valve – LV chamber mismatch" is present.

Although the mechanisms of ischemic mitral regurgitation are often complex, currently, undersized annuloplasty is considered the standard approach to reducing mitral insufficiency. Unfortunately this technique does not resolve the real mechanism of disease, the remodeled and sphericalized left ventricle. By this technique the persistence of ischemic mitral regurgitation is often encountered.
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tation is considered to range between 10 to 20% of the cases, and, at five years of follow up, half of the patient may develop recurrence.

Thus, in advanced stage of left ventricular post infarction remodeling with over dilatation and important mitral valve tethering, the ring annuloplasty has to be completed with leaflet extension. This approach seems coherent with the mechanism of mitral regurgitation, with the echocardiographic data and with the concept of “mitral valve – LV chamber mismatch”.

The major challenge for cardiologists and surgeons is how to integrate data from different imaging techniques that assess mitral valve geometry and left ventricular size, geometry, function and potential functional recovery. This in order to tailor and optimize the surgical approach to patients with chronic ischemic mitral regurgitation.

Even today, we have no reliable predictors of recurrent and persistent mitral regurgitation. However, the surgical treatment of ischemic mitral insufficiency continues to evolve and new methods addressing ventricular structures are being introduced: left ventricular restoration, papillary muscle’s relocation, sling, imbrication or reapproximation, chordal cutting or translocation. Despite remarkable progress in reparative surgery, further investigation is still necessary to find the best approach to treat ischemic mitral regurgitation.

Author details

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