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REVIEW

Guidance of the MitraClip® procedure by 2D and 3D imaging

Implantation du Mitraclip® sous contrôle échographique en imagerie 2D et 3D

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Summary Percutaneous edge-to-edge repair using MitraClip® (Abbott Laboratories, Abbott Park, IL, USA) can be used to treat mitral regurgitation. However, real-time echocardiographic guidance is vital; and use of 3D transoesophageal echocardiography to guide the procedure has improved reproducibility, reliability and safety. This review describes the MitraClip® device — which is composed of a steerable guide catheter (SGC) and a Clip Delivery System (CDS) — and the MitraClip® procedure. The procedure consists of six steps: (1) transseptal approach and puncture; (2) introduction of the SGC into the left atrium; (3) navigation with the CDS into the left atrium to place the MitraClip® above the mitral valve; (4) crossing the valve and advancing the CDS into the left ventricle; (5) grasping the leaflets and assessment of the quality of the grasping; and (6) final mitral regurgitation assessment. This review also describes which imaging techniques are applicable to each stage of the procedure; and contains examples of the various images obtained during these steps.

Abbreviations: Ant, anterior; CDS, Clip Delivery System; L, lateral; LVOT, left ventricular outflow tract; M, medial; Post, posterior; SGC, steerable guide catheter; TOE, transoesophageal echocardiography.

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Résumé La mise en place percutanée du Mitraclip® (Abbott Laboratories, Abbott Park, IL, États-Unis) est devenu depuis quelques années une technique validée pour le traitement des fuites de la valve mitrale (Chiarito et al., 2018 ; Beigel et al., 2014 ; Boekstegers et al., 2014). L'amélioration des résultats et la diffusion de cette technique ont été en partie facilitées par l'amélioration du guidage échographique peropératoire. L'augmentation de la qualité des images 3D temps réel a en particulier rendu cette technique plus simple, plus rapide et plus reproductible (Swaans et al., 2009 ; Ciobanu et al., 2011 ; Altiok et al., 2012), ce qui a permis d'élargir les indications. L'objectif de cet article est de décrire l'utilisation de l'échographie 2D et 3D à chaque étape de la mise en place d'un Mitraclip®.

Introduction

Percutaneous edge-to-edge repair using MitraClip® (Abbott Laboratories, Abbott Park, IL, USA) is becoming a validated option for the treatment of mitral regurgitation [1—3]. Its acceptance and use have largely been prompted by improvements in perioperative echocardiography, making guidance of the device easier and more precise. The MitraClip® procedure requires real-time echocardiographic guidance and full collaboration between the echocardiographer and the physician in charge of the device. When the MitraClip® was first used in 2006, echocardiographic guidance was based on standard 2D visualization [4]. This technique was associated with a long procedural time and it was difficult to guide the catheter and position the clip precisely. Since 2009, real-time 3D transoesophageal echocardiography (TEE) has improved the guidance of the procedure and has increased safety, reproducibility and reliability [5—7]. This led to increased physician confidence in this technique and an expansion of its indications to the most challenging patients [1—3]. This review aims to describe how 2D and 3D real-time echocardiography are used in clinical practice to optimize the guidance of the procedure.

The MitraClip® device

The original MitraClip® device has two components: the steerable guide catheter (SGC) and Clip Delivery System (CDS). The SGC is introduced first, via the femoral vein, across the atrial septum. The SGC acts as a support for the CDS, which is introduced into its longitudinal lumen. The CDS is a steerable catheter with the clip itself positioned at its distal part. Control of the clip (opening, closing and delivery) and the grippers (opening and closing) is done by handling control sticks on the proximal part of the CDS.

Once in the left atrium, clip mobilization is achieved by pushing/pulling the whole system (SGC and CDS together) by rotating handles positioned on the SGC (labelled + and —) or the CDS (labelled M/L for medial/lateral and Ant/Post for anterior/posterior). However, the steerable qualities of both the SGC and the CDS are imperfect, and each action on a handle is associated with secondary effects. For example, rotating the M handle on the CDS induces mobilization of the clip in the medial direction, but also results in a concomitant anterior motion of a distal part of the CDS, which has to be compensated by posterior action on the SGC, which also induces a back motion. These points explain why real-time 3D TEE visualization allows more precise and safer navigation into the left atrium compared to 2D imaging. It also allows much faster control of the movements of the CDS, thereby reducing the procedure duration. Of note, the new generation of the device — MitraClip® NT — has more precise steerable properties, which limit these side effects. In our experience, this vastly improves the speed and safety of the CDS navigation into the left atrium.

The key to a successful procedure using MitraClip® is full, confident bidirectional communication between the echocardiographer and the physician manipulating the MitraClip®, both of whom must use the anatomical language shown in Fig. 1A. Both must also have a dedicated screen to visualize the echocardiographic pictures in front of them. Similarly, the fluoroscopy images should be sent to both screens. If fluoroscopy is used to perform MitraClip® implantation, its use, combined with TEE guidance, is helpful in some situations (e.g. 'straddling' or when adding a second or third clip [see Step 3 below]), and pictures from both technologies have to be understood and assessed by the entire medical team.

Concerning 3D visualization, X-plan and real-time 3D views are used, depending on the step of the procedure. Fig. 1B shows a pre-implantation real-time 3D view from a surgical atrial view. From this view, both the echocardiographist and the physician in charge of the implantation can communicate using the same language. The different segments of the valve are named following Carpentier's description [8] (Fig. 1A), with the anterior commissure said to be lateral and the posterior commissure to be medial (Fig. 1B).

Pre-implantation mitral valve assessment is critical before the procedure. Usual mitral regurgitation function and abnormalities (tenting and restriction,