

Ring-first Mitral Valve Repair

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Abstract

Mitral valve repair is one of the most frequent interventions in cardiac surgery. It involves eliminating the dysfunctional part(s) of the mitral valve and reconstructing, using the residual tissue or with the addition of prosthetic components, a properly functioning valve, without residual stenosis or regurgitation. A fundamental component of mitral repair is the implantation of a ring (annuloplasty) which reconstitutes the normal, saddle-shaped geometry of the valve. Such ring is usually implanted at the end of the surgical reconstruction regardless of the repair techniques. The implantation of the ring can however change the final anatomy of the valve in an unexpected way and therefore force new corrective surgical actions. We therefore propose a research project that plans the execution of annuloplasty as the first surgical step and then the correction of the valvular disease affecting the leaflets and chordae. The sizing of the ring is always performed on parts of the valve that are usually not changed during the reconstructive surgery, therefore it is possible to decide its size before surgically correcting the valve. In this way we could act on the leaflets and chordae in the definitive geometrical arrangement of the mitral valve.

Keywords

Mitral valve repair, cardiac surgery, annuloplasty, chordal flail

Overview and background

The mitral valve is the atrioventricular valve of the left heart and allows the passage of blood from the left atrium into the left ventricle, preventing its regurgitation in the systolic phase of the cardiac cycle (Fig. 1). When it loses its function it can become stenotic or insufficient. The second pathological picture can be frequently surgically repaired without replacing the valve with a prosthesis [Jouan 2015].

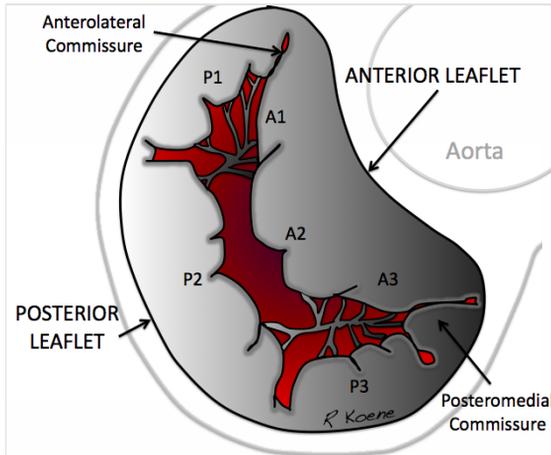


Figure 1. [doi](#)

Normal anatomy of the left heart atrioventricular mitral valve (from https://commons.wikimedia.org/wiki/File:Mitral_Valve_RK.png, licensed [CC0](#)).

Since Carpentier's seminal works of the 1970s and 1980s and his pathophysiological classification of mitral disease [Carpentier 1983], mitral repair has been standardized and applied by an ever-increasing number of cardiac surgeons [Schubert et al. 2017, Allen et al. 2020]. Carpentier distinguished 3 classes of mitral disease: type 1, characterized by normal leaflet movement, due to annular dilation or leaflet perforation; type 2, characterized by excessive leaflet movement (valvular prolapse), due to papillary muscle rupture, chordal rupture or redundant chordae and type 3, characterized by restricted leaflet movement, due to rheumatic heart disease, papillary muscle dysfunction or left ventricular dilation. The valvular repair techniques consist of correcting the dysfunctional part(s) of the mitral valve and then [Cohn 1998] implanting a prosthetic ring that reshapes the mitral annulus to a physiological layout [Rausch et al. 2012], preventing a recurrence of annular dilation.

This research project is based on the implantation of the prosthetic ring **before** mitral repair (ring-first repair), to be able to repair the valve already in its definitive geometric arrangement.

Objectives and Project layout

The main objectives of implanting the ring as the first surgical step are:

- a) judge the necessary corrections in the final valve geometry;
- b) prevent the repaired valve tissue from being abundant (still prolapsing) or scarce (restricted) after the placement of the ring at the end of the surgical correction;
- c) avoid having to add extra sutures on leaflets or valve clefts after implantation of the ring, increasing the overall stiffness of the valve.

This procedure is compatible with cases where the ring is implanted prior to valve repair anyway (artificial chordae) and can be limited in cases of anular plication or small mitral valve (rare in valvular regurgitation disease).

The research project has the following key phases:

- 1) measurement and implantation of the suitable prosthetic ring before repair (**ring-first**);
- 2) completion of mitral repair according to the choice of each surgeon.

The size of the ring is always based on the anterior leaflet [Bothe et al. 2013] that is usually not significantly modified by reparative surgery. Therefore, sizing can be done as well as the first surgical step. After the implantation of the ring the valve will be in its final geometric arrangement and it will be easier to judge the extent of a resection or other surgical acts.

Implementation

The project can easily be developed within a prospective multicenter study with voluntary participation and may lead to a peer-reviewed publication in a surgical journal.

Impact

This project slightly alters the habits of individual operating surgeons adding the great advantage of being able to judge mitral valve repair in the definitive geometric shape of the valve itself, with a more reliable overview (Fig. 2).

Furthermore, a valve test is performed during each mitral valve repair surgery by filling the ventricle with saline solution: this inflates the valve and allows to better evaluate the type of lesion. By implanting the ring first, the valve area is reduced and the test can therefore be more reliable. Finally, it is very important to avoid adding sutures that weld parts of the leaflets or scallops together [Varghese and Adams 2011; Gillinov et al. 2005], as they stiffen the valve and alter the flow dynamics, theoretically limiting the duration of the repair.

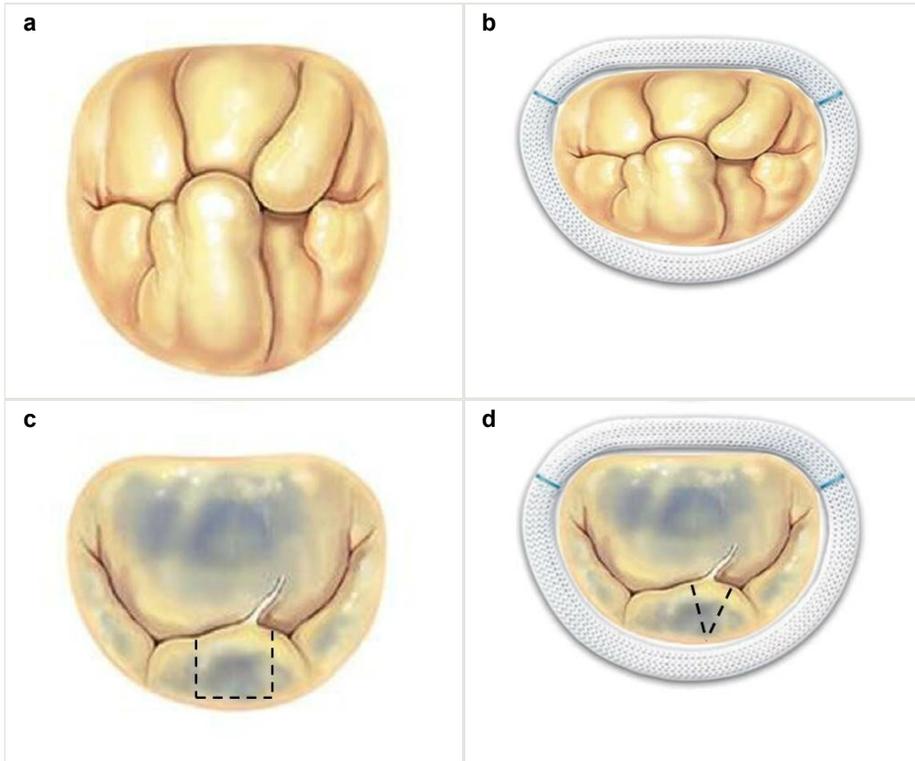


Figure 2.

The two most frequent types of mitral pathology: Barlow's disease (a and b) and fibroelastic deficiency (c and d). The pathological pictures are shown and the advantage of implanting the prosthetic ring **before** performing the repair of the valve leaflets is illustrated.

a: In Barlow's disease, the mitral valve takes on a more rounded shape than the normal elliptical one and the tissue is very redundant; [doi](#)

b: By implanting the ring as a first step, the valve is arranged in the correct elliptical shape, the leaflets are spatially redistributed, then the judgment on any other necessary surgical act is taken in the final shape of the valve. [doi](#)

c: In fibroelastic deficiency the mitral annulus is dilated by chronic regurgitation, widening the valvular area and this may induce a quite large (quadrangular, dashed lines) resection; [doi](#)

d: By implanting the ring as the first step, the valve area is reduced and assumes a more correct geometry, therefore the resection can be less extensive (triangular, dashed lines). [doi](#)

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