Abstract
In rare cases of extensive aortic root or mitral valve infective endocarditis (IE), severe calcification of the aortic and mitral valves, or double-valve procedures in patients with small aortic and mitral annuli, surgical reconstruction of the inter-valvular fibrous body (IVFB) is required. A high mortality is generally associated with this procedure, and it is frequently avoided by surgeons due to a lack of experience. It is crucial to radically resect all tissues that are severely affected by IE to prevent recurrence in the patient. Our experience with the Commando procedure in patients with extensive double-valve IE involving the IVFB is presented in this article.

KEYWORDS
Commando procedure, intervalvular fibrous body, IVFB reconstruction, valve surgery

1 | INTRODUCTION
Extensive aortic root or mitral valve pathologies often involve the intervalvular fibrous body (IVFB). Anatomically, this structure is formed by the interleaflet trigon between the left and non-coronary aortic sinuses, anterior mitral leaflet (AML), and the roof of the left atrium. In rare cases of extensive aortic root of mitral valve infective endocarditis (IE), severe calcification of the aortic and mitral valves, or valve procedures in patients with small aortic and mitral annuli, surgical reconstruction of the IVFB is required. This is a highly challenging surgical procedure, associated with a 20%–30% 1-year mortality rate and a high incidence of intraprocedural complications. In particular, IVFB reconstruction in patients with active extensive IE is especially challenging. Thus, since the introduction of the procedure in 1979, several modifications to the original technique exist, depending on the pathology and the operating surgeon.

In the following article, we present our experience with the Commando procedure. Technical steps that are used to provide successful surgical outcomes in cases of extensive IE with pathology in the IVFB are described.

2 | MATERIALS AND METHODS
2.1 | Patients selection and preoperative planning
While patients requiring the Commando procedure may present with different pathologies, fundamentally there is also pathological involvement of the IVFB.

During the preoperative workup, patients routinely undergo coronary angiography and transesophageal or transthoracal echocardiography to determine the morphological features, to rule out abscess formation, and to confirm the anatomical location in cases of severe IE. If echocardiography fails to provide sufficient information, a computerized tomography scan can be used to further the preoperative planning.
2.2 | Operative technique

The patient is positioned supine and intubated with a single-lumen endotracheal tube. A standard median sternotomy is performed and the cardiopulmonary bypass (CPB) is established using bicaval cannulation. In the case of redo procedures or other complicated chest access, cannulation can be performed via axillary or groin vessels with adequately sized arterial cannulas and a long venous two-stage line, which enables the establishment of a total CPB.

After cross-clamping the aorta, cardioplegic solution is administered antegrade into the aortic root or, depending on the aortic valve pathology, selectively into the coronary ostia.

An oblique aortotomy is performed to expose and excise the aortic valve and is extended past the noncoronary sinus and aortic annulus until it reaches the roof of the left atrium. The incision line is proceeded up to the level of the right pulmonary artery toward the AML. The left atrium and mitral valve are then exposed, and the mitral valve and IVFB are resected. The extent of this resection depends on the individual patients’ pathology. It is crucial that all the infected tissue and abscess formation are radically resected to prevent a recurrent IE. In case of insufficient visualization or in patients with the IE extending toward the tricuspid valve, incision into the right atrium toward the tricuspid valve can be performed to release tension after the full reconstruction. After the IVFB is resected and both left ventricular inflow and outflow tracts are exposed, the reconstruction begins (Figure 1A). In cases of an extensive IE, a radical approach consisting of the aortic root replacement, mitral valve replacement, and the reconstruction of the IVFB is preferred. The aortic sinuses are excised, coronary buttons are prepared, and all the instruments and gloves are changed. The operative field is thoroughly washed with gentamycin solution.

2.3 | Mitral valve replacement and IVFB reconstruction

The reconstruction of the left ventricular inflow and outflow begins with the mitral valve replacement. Pledged 2/0 sutures are placed in the posterior part of the mitral annulus between the medial and lateral fibrous trigones and passed through the corresponding part of the mitral valve prosthesis (Figure 2A). The valve prosthesis is then positioned into the mitral valve annulus (Figure 2B). The IVFB reconstruction begins with the tailoring of the folded double-patch. The width of the patch corresponds to the distance of the lateral and medial fibrous trigones. The patch is sewed with the 4/0 pledged suture to the corresponding side of the sewing ring of the mitral valve prosthesis and knots are tied (Figure 1B). These areas are at risk of bleeding after the reconstruction is complete, especially in cases of IE where the tissues can be more fragile. Sandwiching the patch between the sewing ring of the mitral valve prosthesis and the native annulus before lowering the prosthesis and then tying the suture helps to prevent leakage in this area and provide hemostasis. The anterior aspect of the double-patch is commonly used to repair the non-coronary aortic sinus, but as this technique includes aortic root replacement, the anterior aspect of the patch is used to close the right atrium without tension on both the implanted valve prostheses. The posterior aspect of the double-patch is used to close the defect in the dome of the left atrium (Figure 3A,B).

2.4 | Aortic root replacement

As previously mentioned, in cases of severe IE, a root replacement procedure is inevitable to rebuild the radically resected structures of the IVFB and aortic annulus. As the anterior aspect of the double patch is used to close the right atrium, an IVFB no longer exists between the aortic and mitral valve prostheses. Care should be taken in sizing the valve prostheses to provide adequate space for the aortic and mitral valves. For the aortic root reconstruction, we use a stentless porcine root prosthesis (Freestyle). Due to its flexibility, it offers perfect hemostatic qualities and excellent hemodynamic performance. Moreover, it also offers better outcomes in patients with...
destructive IE as valvular conduits. The conduit is attached to the anterior part of the mitral valve prosthesis and to the rest of the native aortic annulus. In this procedural step, we use the same technique with 2/0 pledgeted interrupted sutures as for a conventional aortic valve replacement. It is important to ensure that the proximal suture line is hemostatic as it is not accessible later in cases of bleeding. Coronary buttons are directly re-implanted with 4/0 Prolene running sutures (Figure 4A–C).

After assessment of the prosthetic valves performance and de-airing using transesophageal echocardiography, the patient is separated from the CPB. The anticoagulation is reversed and subsequently to securing the hemostasis, the chest is closed in routine fashion.
CONCLUSIONS

The Commando procedure is a high-risk procedure associated with a 20%–30% 1-year mortality rate. In most patients, this operation is performed as a result of the extensive IE involving the IVFB, which, without surgical intervention, has a mortality of 100%. Therefore, no reason exists in refusing a patient an ultima ratio Commando procedure, as surgery can only increase the patients’ chance of survival. However, it is crucial that the procedure be performed by an experienced surgeon with substantial knowledge of the anatomy and topography of the heart.

Based on our experience, we suggest using stentless xenografts to radically replace the aortic root in patients with extensive IE. We argue that these prostheses offer better hemostatic qualities, are easier to implant, and have an excellent hemodynamic performance in double-valve procedures.

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AUTHOR CONTRIBUTIONS

All authors made contributions to the development of the mentioned method, contributed their intellectual content, and reviewed and approved the final version of the manuscript.

ETHICS STATEMENT

At admission, all the patients in our institution signed an informed consent on using their anonymized data for research and publication.

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