From a surgeon's view: the role of anesthetists in minimally invasive mitral valve surgery

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Minimally invasive mitral valve surgery (MI-MVS) has been gaining momentum since its introduction in the mid-1990s. It is a complex procedure that requires collaboration and teamwork. The anesthetists play a major role in a MI-MVS and are a cornerstone for a successful program. Their role extends from the preoperative period, all through the surgical treatment process, till discharge planning. The authors would like to highlight, in this work, the contribution of the anesthetists to the MI-MVS program and the modifications they perform to their normal setup and practice to accommodate a minimally invasive approach.

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Introduction

Minimally invasive mitral valve surgery (MI-MVS) was introduced in the mid-1990s, and with the introduction of new technologies, it has been gaining momentum [1,2]. The high complexity of this procedure requires considerable specialized training of all involved disciplines [3]. It also requires a high level of collaboration, communication, and understanding between all involved team members. MI-MVS is definitely a challenging procedure for the surgeon, and we believe it is not any less challenging for the anesthetists. The success of such a complex procedure depends on the success of the team members to employ all their technical skills with high degree of diligence and communication. The highly specialized role of the anesthetists in this process cannot be underestimated.

Preprocedure

The involvement of the anesthetists starts in the preoperative period. It is not uncommon for patients referred for mitral valve surgery to have a complex cardiac history along with multiple co-morbidities. These patients need careful preoperative assessment preferably in a dedicated anesthesia clinic. Preoperative optimization of patients' comorbid conditions might facilitate early recovery [4]. In addition, preoperative assessment would also identify patients suitable for fast tracking postoperatively. Another important role of the anesthetists before the procedure is preoperative patient counseling regarding expectations, benefits, and risks of anesthesia.

On the day of the operation, anesthetists modify their technique and include several additional steps to enable the surgeon to perform a MI-MVS efficiently and safely.

Lung isolation: employing a right lung isolation strategy

The first important modification is required to allow exposure of the pericardium, and subsequently the heart, through a limited lateral thoracotomy. The two most-commonly used methods to achieve right lung isolation are a double-lumen tube, usually left-sided, or a single-lumen tube with an endobronchial blocker. Each of which has its own advantages and disadvantages [5–7]. The details of both techniques are beyond the scope of this paper. The positioning can be confirmed by using a flexible fiberoptic bronchoscope. The anesthetists should confirm the position of the endotracheal tube after final positioning of the patient in theater (Fig. 1).

Arterial lines: Bilateral monitoring of invasive arterial blood pressure

There are two options to isolate the aortic root from the ascending aorta. The first is the transthoracic aortic

Figure 1

The positioning of the double-lumen tube is confirmed using a flexible fiberoptic bronchoscope after the patient is positioned on the operating table (original).

Figure 2

ProPlege peripheral retrograde cardioplegia. The ProPlege peripheral retrograde cardioplegia device is indicated for occlusion of the coronary sinus, delivery of cardioplegia solution, and monitoring of coronary sinus pressure during cardiopulmonary bypass (from Edwards Lifesciences, UK).

cross-clamp (Chitwood, Scanlan International Inc., Minneapolis, Minnesota, USA). The second option is the intra-aortic endoballoon device which has been withdrawn from the market early in 2019 owing to the risk of balloon rupture during use. This device occludes and vents the ascending aorta and administers antegrade cardioplegia into the aortic root. The positioning of this device depends heavily on the transoesophageal echocardiogram (TOE) guidance. Meticulous placement of the balloon in the ascending aorta is essential for this technique to work safely. If the balloon is placed too distal, it could encroach on the ostium of the brachiocephalic artery. Alternatively, too proximal application or displacement of the endoballoon (when the heart is lifted by the mitral retractor) could impede the blood flow into the right coronary artery during cardioplegia administration. An anesthetist who is highly skilled in TOE is extremely useful in this scenario. Bilateral invasive monitoring of blood pressure should be established before induction of anesthesia. If blood pressure remained equal bilaterally following balloon inflation, it denotes that the balloon is not encroaching on the brachiocephalic artery. Large discrepancy between right and left radial reading could mean distal migration of the balloon and encroachment on the brachiocephalic artery. Another method to monitor such a problem is the application of cerebral oximetry and monitoring changes in readings on the both sides. Distal displacement of the balloon will lead to encroachment on the brachiocephalic artery and subsequent drop in the cerebral oximetry readings on the right side.

Percutaneous/endovascular coronary sinus catheter

If a transthoracic aortic cross-clamp is used, the cardioplegia is usually administered antegrade through an aortic root cardioplegia cannula. Recently, a newly developed percutaneous/endovascular coronary sinus catheter is considered as an alternative way to administer retrograde cardioplegia (Fig. 2). This catheter is inserted by the anesthetist under TOE guidance through the internal jugular vein (IJV) down to the coronary sinus. Successful positioning of this catheter could be challenging and requires training to achieve competency. Eliciting coronary sinus pressure through this catheter would confirm its proper position.

Neck lines: extra line to right internal jugular vein

The next important modification is the insertion of an extra central venous line through the right IJV. To explain why this is needed, we need to go through the venous cannulation techniques in the context of MI-MVS. Venous drainage could be achieved either through a single three-stage venous cannula or two separate venous cannulae. The three-stage venous cannula is placed through the femoral vein (open or percutaneous technique) and traverses the right atrium, and its tip sits in the SVC. This could impose difficulties when lifting the interatrial septum to properly visualize the mitral valve. Moreover, additional procedures involving opening the right atrium will not

Figure 3

An 11-F introducer is inserted into the right internal jugular vein under strict sterile conditions (original).

Figure 4

The introducer is kept sterile till surgical scrubbing, covered by sterile gauze and dressing. (original).

be possible when employing this cannulation strategy. In our unit, we prefer to separately cannulate the IVC through the femoral vein (open or percutaneously) and the SVC through the right IJV, percutaneously. Given the huge experience of the anesthetist inserting lines into the IJV, our protocol for MI-MVS involves the anesthetist inserting a wide-bore cannula/sheath in the right IJV. The surgeon will later use this as a starting point for cannulation of the SVC through the IJV, percutaneously. We prefer this cannula/sheath to be inserted as low in the neck as possible and kept sterile and covered till the patient is ready for surgical scrubbing (Figs 3 and 4). Any other central venous lines, required for monitoring or infusions, should be placed through the left IJV. In some units, the role of the anesthetist goes further. They insert a 17-Fr cannula to the SVC under strict sterile condition. This cannula is used for venous drainage of the SVC, connected to the femoral venous cannula through a Y-extension, and then to the cardiopulmonary bypass machine.

Figure 5

Patient positioning on the operating table. Right chest is elevated and right shoulder dropped backward (original).

External defibrillator pads

Before skin disinfection, we always make sure that external defibrillator pads are applied. In minimally invasive surgery, our access to the heart is limited and internal defibrillation is not possible. During the surgical procedure, a shock might be required for defibrillation and/or cardioversion. It is important to place the pads in such a way that will keep the right lateral aspect of the chest clear, so it does not interfere with the surgical access, while keeping the heart in-between the pads. If a shock is required while the right lung is isolated/deflated, the conduction of the shock might be impeded. In such an instance, re-inflation of the right lung before delivering a shock is helpful.

Positioning

Once the anesthetist is satisfied with the setup, the patient is wheeled into theater. The patient is positioned supine, and the left arm is tucked as standard. The right chest is elevated by a flat-bottom chest roll inserted vertically beneath the right chest. This should be placed just caudal to the scapula allowing the right shoulder to drop backward. Accordingly, the right arm will drop, opening the right lateral chest wall for surgical access (Fig. 5). The anesthetist, with the surgeon, ensures the safe positioning of the patient and re-checks the adequacy of monitoring and the position of the endotracheal tube after positioning.

Prebypass TOE assessment

As per usual in our practice, the anesthetist would assess all valves' function before cardiopulmonary

bypass. It is important to mention that accurate assessment of the aortic valve function is important. Any degree of aortic regurgitation that is more than mild would deter us from proceeding through a minimally invasive approach. Significant aortic regurgitation could impede cardioplegia delivery and subsequently could impede myocardial protection.

Surgical conduct

After painting and draping, our first step is exposing the heart (the surgeon will ask for the right lung to be isolated and deflated before entering the right chest cavity) and exposing the femoral vessels. We proceed to cannulate the patient for cardiopulmonary bypass. TOE is an essential tool for the cannulation process in the minimally invasive setting. TOE is required to view/position the guide wires and the cannulae. The right atrium should be visualized on TOE during femoral to IVC and IJV to SVC venous cannulations, best achieved through a bi-caval view. During femoral arterial cannulation, the guide wire should be visualized on the descending aorta short-axis view. After establishing the necessary connections for the bypass circuit and performing the routine checks, cardiopulmonary bypass is commenced. The aortic root is isolated using one of the methods discussed earlier, and once a still and protected myocardium is achieved, the surgical steps proceed. When this is completed, the atrium is closed and the de-airing process is guided by TOE as standard. The aortic cross-clamp is removed and the heart restarts beating.

Post-bypass

The standard post-procedure cardiac assessment is carried out, and the patient is eventually weaned off bypass. Inadvertent injury/distortion of the circumflex artery during mitral valve surgery is a known complication. In our unit, we pay especial attention to detection this complication. Besides monitoring any ECG changes, we use TOE to demonstrate flow in the circumflex artery (prebypass and postbypass) and thorough assessment of the left ventricular wall motions. Identifying circumflex artery distortion/occlusion early allows the team to manage the situation promptly.

It is important to note that after weaning and during hemostasis and closure, the surgeon will, occasionally, require the right lung to be isolated to enable them to see the suture lines. Frequently, the patient's tolerance to single-lung ventilation while positioned supine is limited. Therefore, close monitoring of the oxygen saturations during single-lung ventilation after bypass is very important. Good communication between the surgeon and the anesthetist ensures that this step is carried out safely and smoothly.

After closure, we aim to fast track to extubation and recovery after surgery whenever possible. To achieve this, good coverage with postoperative analgesia is essential. Different options including local anesthetic, epidural anesthesia, continuous paravertebral block [8], among other options are available. The selection is based on the patient's profile and local protocols. If the patient is not to be extubated on table, the double lumen tube (DLT) should be changed to a single-lumen tube.

It is quite obvious that the role of anesthetists in MI-MVS is crucial for a successful procedure. Training and development of the anesthetic team is integral for any minimally invasive mitral program. These investments pay off in the outcomes of the surgery. In the absence of large randomized data comparing open and minimally invasive approaches for mitral valve surgery, several meta-analyses were conducted. These studies have shown that ventilation time and length of stay in intensive care unit and hospital were reduced for patients who underwent MI-MVS [9,10]. Some studies showed improvement with MI-MVS in terms of rates of transfusions, wound infection, and atrial fibrillation [11]. One of the major benefits of MI-MVS is faster recovery [1,2]. We see more patients now asking for the minimally invasive option, and we believe we should be ready to provide this approach to our patients whenever feasible.

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Conflicts of interest

There are no conflicts of interest.

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