Percutaneous cardioplegia delivery using the miniport in minimally invasive mitral valve surgery

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Minimally invasive cardiac surgery involves limited exposure of cardiac structures. Extracorporeal circulation is usually conducted by peripheral cannulation. Cross-clamp can be achieved by remote ways of either balloon endoclamp or transthoracic clamp. Effective delivery of cardioplegic solution is somewhat more difficult than those abovementioned tasks. In order to prevent additional expenses, we sought to deliver cardioplegic solution in a simple, reproducible, and cost-effective way. The miniport is used for this application. The procedures are reported in detail.

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1. Introduction

Minimally invasive cardiac surgery is becoming popular. Among them, sternum-sparing mitral valve operations provide the most promising cosmetic results.

In most cases, increased resource usage in the operation room is not uncommon. Specially designed cannulae for peripheral cannulation, transthoracic clamp or balloon endoclamp, and even the extended-length instruments, are all different to conventional approach. Delivery of cardioplegia is a crucial step in the context of minimally invasive mitral valve surgery. In this technical report, we introduced our experience of using a readily available miniport to accomplish the task.

2. Surgical techniques

Less invasive mitral valve surgery was employed in our institute since 2004. Up to the present time, 127 patients have undergone this procedure with technical success. From the beginning of this series, cardioplegic solution was delivered through the AutoSuture MiniPort\textsuperscript{TM} 2 mm introducer (Fig. 1a) (USSC, Norwalk, CT). The miniport is used for mini-laparoscopic procedures. A trocar is formed from a cannula and an interfitting obturator. The obturator is provided with a piercing tip having a pointed blade and a locking shield design. The cannula has seals to maintain gas insufflation of the body cavity. However, a cardioplegic line was connected instead of carbon dioxide in our practice.

The patient was placed in a supine position with a small pillow under the right shoulder. Cardiopulmonary bypass was commenced via right femoral cannulation. A 6–7 cm right anterior-lateral thoracotomy was performed through the 4th intercostal space. After one-lung ventilation, the pericardium was opened parallel to the right phrenic nerve under direct vision through the mini-thoracotomy. Then a purse-string, plegetted suture was made on the top of the ascending aorta. The chest wall was then pierced by a 2-mm miniport toward the pre-made purse-string suture (Fig. 2a). Since there was no stopper in the miniport, the depth of insertion was controlled by marking the miniport. Then the central obturator was withdrawn and the side arm of the miniport was connected to the cardioplegic line. After application of a transthoracic aortic crossclamp, cardioplegia was delivered via the miniport (Figs. 1b and 2b). Before removal of the cross-clamp, the miniport was withdrawn. Ambu-bagging and compression of ventricles using a malleable plate helped to expel residual air. After removal of the cross-clamp, the puncture hole was kept open for de-airing purposes in a head down position. After a final check by trans-esophageal echocardiography, the purse-string suture was tied down using a knot-pusher before conclusion of cardiopulmonary bypass.

3. Discussion

Most cardiac surgeries are conducted with the assist of cardiopulmonary bypass. Cardiopulmonary arrest is usually a necessity. Delivery of cardioplegic solution in sternum-sparing procedures is a difficult task. The ascending aorta is remote from the surgeon’s access. Techniques to achieve aortic occlusion, like transthoracic clamp [1] and endoaortic balloon clamp [2], are well demonstrated. However, techniques to deliver cardioplegic solution are seldom men-
tourniquet over the ascending aorta for the miniport. C: Chitwood transthoracic clamp; M: miniport; T: snaring tourniquet somewhat block the surgical field. Some surgeons use the angiocath which is inserted by direct trans-tourniquet. Under direct vision, the miniport is inserted through the chest wall and aimed at the preformed purse-string suture over the ascending aorta using a pump sucker. (b) The schematic drawing shows the transthoracic clamp, the miniport and the wound.

Cardioplegic delivery associated with the balloon endoclamp is through an extended and narrow catheter. High delivery pressure and limited flow usually prolong the cardioplegia delivery time. Several precautions remain as clinical obstacles. The proper position of the endoaortic balloon, completeness of balloon occlusion, slow rate and high delivery pressure of cardioplegic solution, and effectiveness of left ventricular venting are all influential to this practice. Direct aortic root cannulation with the extended-length cardioplegic needle via the thoracotomy wound is as well. Both the cardioplegic needle and snaring tourniquet somewhat block the surgical field. Some surgeons use the angiocath which is inserted by direct trans-thoracic puncture. The diameter of the angiocath limits the flow of cardioplegic solution and also the efficacy of de-airing process after de-clamping. Loss of stiffness while removing the needle inside increases the difficulty of manipulation or re-positioning.

In the application of the miniport to deliver cardioplegia, care should be taken not to injure the right internal mammary artery during transthoracic puncture and the posterior aortic wall. In our technique we used to avoid this complication by guiding the puncture with a right-angle clamp. The right-angle clamp is inserted through the thoracotomy wound and pointed against the chest wall lateral to the right internal mammary artery from the inside out. A stab wound is made followed by transthoracic puncture. The miniport is then inserted in the center of the purse-string suture toward the aortic root by the surgeon’s left hand. In order to provide counter-resistance, the surgeon’s right hand is holding a forceps to grasp the adventitia or ascending aorta to facilitate the penetration. The depth of miniport insertion is marked in advance and penetration of the posterior aortic wall should be always prevented.

During the procedure, the miniport is allowed to be manipulated without difficulty in case of mal-position. Care should be taken that the tip of the miniport should not point against the left atrial lift system. For every shot of cardioplegia, the left atrial lift system was loosened to facilitate the cardioplegia delivery. In our experience, there was one posterior wall injury, which was repaired by pledgetted sutures without difficulty. After de-clamping, blood as well as air bubbles was allowed to eject freely from the puncture hole in the Trendelenburg position before termination of extracorporeal circulation. The reasons why we do not use the miniport for de-airing purposes are as follows. First, the tip of the miniport was usually in the center of the ascending aorta, which reduced the efficiency of removing floating air above. Second, the long and narrow cannula and extension arm limited the flow under aspiration. However, using the miniport to vent the aortic root directly was still practical.

Minimally invasive mitral valve surgery now-a-days provides low peri-operative risks and equivalent long-term outcomes [4]. Our application using the miniport provides advantages in easy handling, manipulation, re-positioning and high-flow delivery in regard to cardioplegic delivery. To adopt this simple technique in routine minimally invasive mitral valve surgery is recommended.

References