Central aortic cannulation for minimally invasive mitral valve surgery through right minithoracotomy

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Submitted Nov 02, 2013. Accepted for publication Nov 04, 2013.
doi: 10.3978/j.issn.2225-319X.2013.11.03
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Clinical vignette

We present a case of a 56-year-old male who underwent cardiological investigation for exertional dyspnea. Transthoracic echocardiography revealed the presence of severe mitral regurgitation due to posterior leaflet flail, anterior leaflet prolapse and mild annular dilatation. He had a background history of systemic hypertension. Transesophageal echocardiogram (TOE) revealed mild ventricular dilatation with preserved ventricular function and normal pulmonary artery pressure. The patient was scheduled for minimally invasive mitral valve repair through a right mini-thoracotomy with central aortic cannulation.

Surgical techniques

Anaesthesia is provided according to the standard protocol used for conventional mitral valve repair or replacement. A single lumen normal tube for intubation is used. Two defibrillator pads are accurately placed across the chest wall to guarantee effective electric conduction. The patient is placed in a supine position with an air sack under the right scapula, elevating the right chest slightly in order to achieve optimal exposure of the working field. The procedure is carried out through a 5-7 cm lateral incision in the 4th intercostal space. Once the thoracotomy is made, two axillary working ports are established. One 5.5 mm working port is used for video assistance and for passing the pericardial stay sutures. Another 10.5 mm port is placed two intercostal spaces lower in the mid-axillary line. This port is used for the cardiotomy vent, CO_2 insufflation and for other pericardial stay sutures. Under direct visualization, the aorta is exposed up to the origin of the innominate artery, after which two concentric 2-0 polyester purse-string sutures for direct arterial cannulation are placed in a standard fashion into the ascending aorta. The purse-string may be reinforced with pledgets if needed. During the purse-string suture placement, the aorta can be kept steady using locking forceps to reduce physiological motion. The cannulation site is generally chosen by identifying the transverse sinus as the landmark where the aortic cross-clamp will be placed. It is adequate if the cannulation site stays at some distance above the cross-clamp level. Once the purse-strings on the ascending aorta are ready, preparation of the groin is commenced. Using the Seldinger technique, a guidewire is passed through the introducer sheath and is introduced into the superior vena cava under TOE guidance. Dedicated venous cannula dilators are essential in tunnelling the cannula path. The venous cannula is then easily introduced and advanced over the guidewire to its final position in the superior vena cava. The most informative TOE projection is the bicaval view at 120°. Next, direct ascending aorta cannulation is performed under direct vision. The lungs must be deflated prior to aortic cannulation. The adventia is prepared with scissors and the aortic cannula is advanced into the aorta. At this time is essential to avoid tension on the purse-string. After cannula deployment and while the assistant holds the cannula, the first operator must secure the cannula with two tourniquets using a silk suture. However this can be difficult in cases of a deep chest or distant cannulation sites. In these cases, a silk suture previously placed through the tourniquet can facilitate knotting into the chest. After initiation of CPB, venous drainage is achieved with vacuum assistance of approximately –40 mmHg. Subsequently, a combined Y shape cardioplegia/vent catheter is placed into the ascending aorta. The aorta is directly clamped using a dedicated minimally invasive clamp. Myocardial protection is achieved with warm blood cardioplegia or cold crystalloid solution depending on surgeon preference and patient characteristics. The left

atrium is opened at the interatrial groove and a special atrial retractor with an external mechanical arm is used to expose the mitral valve. In the present case, a triangular posterior leaflet resection associated with neo-chordae implantation on the anterior leaflet and ring annuloplasty was performed. De-airing procedures follow a standardized protocol which include the following steps: a left ventricular vent is inserted through the mitral valve and the left atriotomy is closed; the patients is lifted into the Trendelenburg position, the heart and lungs are filled and air is removed from the left atrium through the left atriotomy with the help of a pair of forceps inserted through the atriotomy suture; the patient is then positioned with their head elevated and air is removed from the aortic root vent; finally, the cross-clamp is removed and the residual air is vented through the aortic root and left ventricle. It is mandatory to confirm with TEE the absence of intracardiac air before removing the aortic root vent. After rewarming and appropriate reperfusion, CPB is stopped and the arterial cannula is removed first. At this time it is extremely important to induce systemic hypotension. If the cannulation site is particularly far from the thoracotomy, the purse-string can be knotted with the help of a knot-pusher. Our protocol for aortic cannula removal mandates snaring the first purse string immediately after cannula removal and knotting the second purse-string. The first purse-string is then released and knotted. After cannula removal, the patient is filled with residual blood via the cardiotomy and finally the venous cannula is removed. The femoral venous cannula site is temporarily placed under compression (10-15 minutes) to secure haemostasis.

Discussion

At our institution, we have been conducting a minimally invasive cardiac surgery program since 2003, and over our 9-year experience, we have seen progress in our techniques. At the beginning of our experience, right thoracotomy with femoral artery cannulation and endoaortic balloon occlusion was our preferred approach (1). Subsequently, we have moved to ascending aorta cannulation with trans-thoracic aortic clamping. Despite good results having been reported for both perfusion techniques, we have found that the antegrade perfusion strategy during MIMVS could be associated with a lower risk of neurological complications when compared with retrograde perfusion, a finding that has been reported by other institutions (2,3). In addition, routine cannulation of the ascending aorta expands the suitability of MIMVS to include those patients who have an absolute contraindication to femoral artery cannulation. Our current clinical practice attempts to restrict retrograde arterial perfusion to those surgical scenarios where there is very limited central aortic access, such as patients with significant pleuro-pericardial adhesions or ascending aorta calcification (4). We have performed direct ascending aorta cannulation for MIMVS on 1,378 patients in total. Our rate of stroke was 1.1% and in-hospital mortality was 1%. No postoperative aortic dissection was observed and intraoperative conversion to sternotomy for the cannulation site was necessary in two patients. In conclusion, despite central aortic cannulation representing a more challenging procedure than femoral artery cannulation, it can be performed safely with a very low incidence of neurological and vascular complications.

Cite this article as: Glauber M, Murzi M, Solinas M. Central aortic cannulation for minimally invasive mitral valve surgery through right minithoracotomy. Ann Cardiothorac Surg 2013;2(6):839-840. doi: 10.3978/j.issn.2225-319X.2013.11.03

Acknowledgements

Disclosure: The authors declare no conflict of interest.

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