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Totally endoscopic mitral valve repair without robotic assistance: A case report

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ABSTRACT

INTRODUCTION: Totally endoscopic mitral valve repair (TEMVR) is the highest level of minimally invasive cardiac surgery (MICS). It brings many benefits to patients but the downside is that a robotic system is always required. The deployment of robotic surgery is very complicated and expensive. Therefore, we improvised, making it possible to perform TEMVR without the aid of a robotic system.
PRESENTATION OF CASE: A 66-year-old male patient presented with severe mitral valve regurgitation due to posterior leaflet prolapse. He was treated with TEMVR without robotic assistance. No chest incision was over 1.2 cm. The repair techniques included posterior leaflet resection and annuloplasty with ring implantation.
DISCUSSION: A midline sternotomy is still the standard approach for mitral valve repair. In recent years, MICS has gradually replaced conventional surgery with the most advanced strategy being totally robotic mitral valve repair. However, complex surgical techniques and high cost make it less accessible for the majority of patients. Instead of using robot, we improved mitral valve exposure techniques, surgical port placement and therefore were able to perform TEMVR with MICS instruments.
CONCLUSION: TEMVR without robotic assistance is a safe, effective and cost-efficient procedure, which can be adopted in most cardiac centers.

1. Introduction

The first successful mitral valve repair (MVR) was reported over 50 years ago [1]. However, not until Carpentier described the surgical treatment of mitral valve prolapse in 1978 and the “French correction” method in 1983, did MVR become a primary goal for cardiac surgeons. Successful MVR can improve quality of life and help patients avoid the chronic use of anticoagulation medication [2].

MVR can be performed using techniques including sternotomy, mini-invasive right thoracotomy, and the totally endoscopic surgery (TES). One of the merits of TES is that it minimizes surgical trauma and blood transfusion, reduces hospital stay, and helps patients return to normal activities more quickly with good cosmetic outcome. These results can be achieved with an equivalent morbidity and mortality in comparison with standard mitral valve surgery [3,4]. With some improved techniques, we have performed TEMVR using no robotic system, which yielded excellent results. This work has been reported in line with the SCARE criteria [5].

2. Case presentation

A 66-year-old male patient with the history of percutaneous coronary intervention (PCI) for left anterior descending artery was admitted to hospital after a chest pain. The patient had been diagnosed to have a moderate mitral valve regurgitation after PCI six months ago. For the last month, his dyspnea on exertion had increased considerably and he complained of early fatigue while climbing stairs. Clinical examination revealed a regular heart rate of 89 bpm, blood pressure of 122/70 mmHg, and a 4/6 mid-systolic murmur audible at the cardiac apex. Transthoracic echocardiography (TTE) showed severe mitral valve regurgitation caused by the prolapse of the posterior leaflet – P2 and an enlarged left ventricular size (Dd) of 60 mm. Left ventricular ejection fraction was 71% (Simpson). No aortic valve lesion and other cardiac malformation were found on preoperative TTE. Coronary angiography indicated no restenosis intra-stent. MVR was performed by the totally endoscopic procedure without robotic assistance.

3. Operative technique

3.1. Preoperative preparation

The patients were placed in a supine position with the right hemithorax elevated approximately 30 degrees, and draped for

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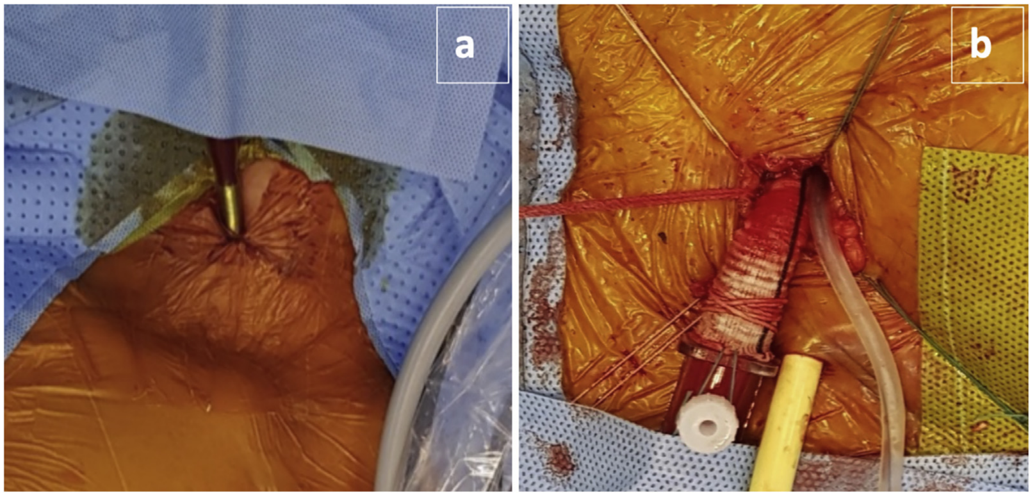

Fig. 1. Peripheral Cardiopulmonary Bypass. Cannulation of the superior vena cava and the inferior vena cava into the right internal jugular (a) and femoral vein (b) by Seldinger technique. Femoral artery cannula was established indirectly through a 8 mm Dacron graft.

exposure of the entire chest and groin. External defibrillation pads were placed at the left lateral chest wall and right shoulder. Anesthesia was induced by a standard technique with a double-lumen tube for left lung ventilation. Intraoperative transesophageal echocardiography (TEE) was prepared to evaluate the repair result.

3.2. Cannulation, cardiopulmonary bypass (CPB)

Peripheral extracorporeal circulation was established via the right femoral vessels. The femoral artery was cannulated indirectly through a 8 mm Dacron graft. Superior vena cava and inferior vena cava cannulae were placed through the right internal jugular vein and femoral vein, respectively, using Seldinger technique under TEE guidance (Fig. 1).

3.3. Surgical port placement

Five small incisions <1.2 cm were necessary for the procedure:

A 12 mm working port in the 5th intercostal space between the right midclavicular and anterior axillary line for surgical instruments (tissue forceps, needle holder, or electric surgical knife) and the implantation of prosthetic ring.

A 5 mm port in the 3rd intercostal space in the midaxillary line (for tissue forceps).

One 10 mm port in the fourth or fifth intercostal space for the 3D endoscope.

A 5 mm incision in the 2nd intercostal space in the midaxillary or anterior axillary line for aortic clamping (Chitwood Clamp).

One 5 mm incision in the 6th intercostal space in the midaxillary line for the left venting line (Fig. 2).

3.4. Myocardial protection

We used a long aortic root vent cardioplegia needle inserted in the 3rd intercostal space in the right parasternal area or directly through the working port incision across a 2-0 braided pursestring, securing it in the proximal ascending aorta for antegrade cardioplegia. Our preferred method for myocardial protection was transthoracic aortic cross clamp (Chitwood Clamp - Scanlan International Inc, Minneapolis, MN) and antegrade cardioplegia with Custodiol® HTK Solution.

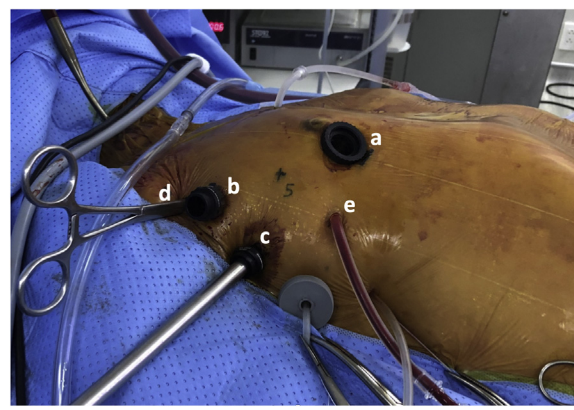

Fig. 2. Endoscopic port placement: (a) working port was for the main surgical instruments and prosthetic ring, (b) port for tissue forceps, (c) 3D endoscope, (d) Chitwood clamp, (e) left venting line.

3.5. Mitral valve's exposure technique and repair

Our method to expose mitral valve during TES was completely different from that described for robotic approach. There was no Robotic-Controlled Atrial Retractor and the conventional retractors of MICS (trans-thoracic retractor) were not suitable for insertion through the ports under 12 mm. Therefore, we improved the techniques for mitral valve exposure by only using sutures to lift and hang the atrium's wall.

After the dissection of Sondergaard's groove, the first suture was to hang the anterior wall of right atrium to thorax. This suture helped surgeons open the left atrium more easily. Subsequently, mitral valve was exposed. The second and third sutures were to hang the anterior wall of the left atrium to thorax, normally at 10 o'clock and 2 o'clock, 2–3 cm away from anterior mitral annulus. The fourth suture was to pull the posterior wall of the left atrium to the right diaphragm. Additional sutures could be used to fully expose the mitral valve (Fig. 3).

Once the left atrium was fully opened and the mitral valve exposed, we evaluated the lesions and then selected the appropriate reconstructive techniques. In this case, the repair techniques were posterior leaflet resection and remodeling annuloplasty using the CG Future^{TM} band size 32. We measured the base and height of the anterior leaflet with small tapelines and then compared them with the ring sizer (Fig. 4).

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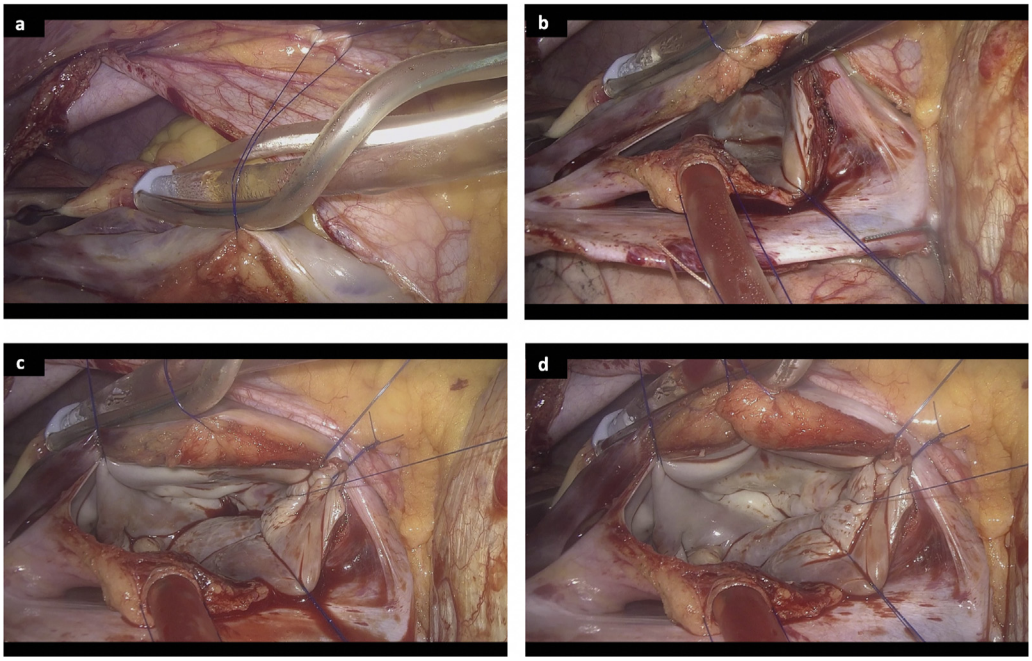

Fig. 3. Mitral valve exposure by using the hanging sutures.

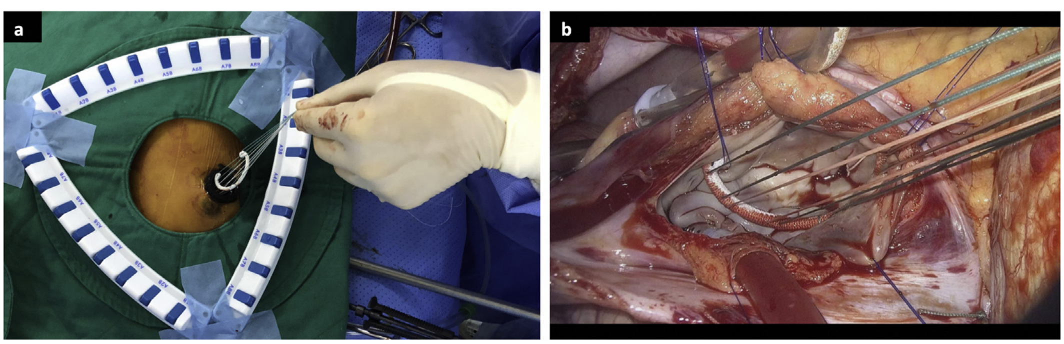

Fig. 4. Annuloplasty with a semi-rigid ring.

4. Discussion

TEMVR is the highest level of MICS (level 4) [6]. Its advantages have been proven in numerous studies. However, the conversion of all surgical maneuvers from being based on direct vision to endoscopic screen presents a challenge to surgeons. Besides, a narrower surgical field with no chest incisions over 1.2 cm requires many changes in surgical maneuvers and flexible usage of available instruments. Due to this complex characteristic, totally endoscopic cardiac surgery generally requires robotic assistance. Many authors even defined level 4 of MICS as a robotic procedure [7]. In the past decade, the development of robotic system has brought many enhancements including articulated wristed instruments and three-dimensional vision with magnification of the operative site in high resolution and accuracy [8]. However, disadvantages of a robotic approach include equipment cost and complexity, size and bulk of current technology, and difficulty with knot tying [7], which are barriers for cardiac centers in developing countries like Vietnam.

Without a robotic system, we performed TEMVR with some technical improvements to suit the available surgical instruments. The patient underwent TEMVR with peripheral CPB, antegrade cardioplegia, transthoracic aortic cross clamp. The used equipment included MICS instruments and a 3D Endoscopic system. The technical changes were differences in positions of trocars and mitral valve exposure method. The determination of port positions is essential because MICS instruments are less flexible than robotic ones. The mitral valve exposure techniques must change in the absence of Robotic-controlled atrial retractor and transthoracic retractor. We used sutures as a left atrial retractor, a simple method to optimize mitral valve exposure in TES. Generally, five 5/0 prolene sutures are used. The number of sutures can be changed in order to clearly expose the mitral valve. We have applied this technique routinely in 315 patients undergoing minimally invasive mitral valve surgery in the past 3 years. Successful mitral valve exposure was achieved in all patients, with no complications such as bleeding, tissue tearing, arrythmias, ischemic damage, or conversion to other retractors.

After the mitral valve has been exposed, repair techniques were adopted depending on the lesions. Prosthetic rings with optimal shape and size are used to restore the normal annular configuration. Semi-rigid ring is preferable to be put through the 12 mm working port. The sizing techniques must also change to fit the narrow operative site.

This patient underwent successful TEMVR with the aortic cross-clamp (ACC) and CPB times were 95 min and 152 min, respectively. Patient was extubated after 8 h and the time spent in ICU was 24 h. He was discharged 9 days following the intervention without any

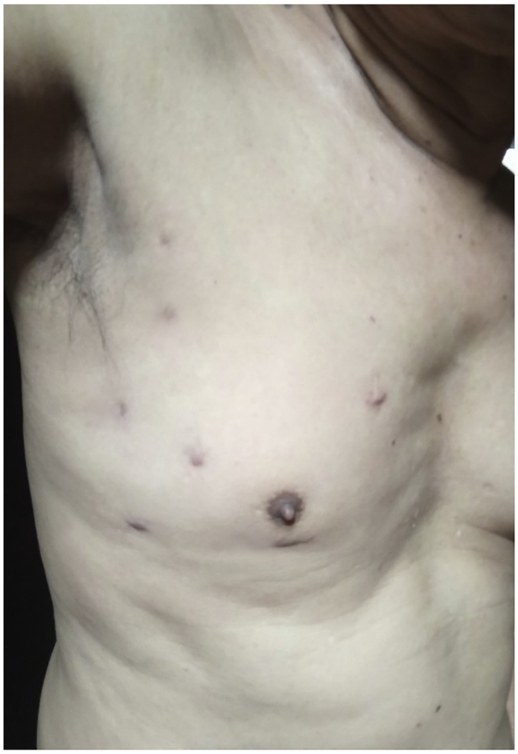

Fig. 5. The surgical outcome after 30 days.

complications. Post-operative echocardiography showed no mitral regurgitation. Patient experienced a decrease in pain, faster recoveries and good cosmetic outcome without enduring a high cost (Fig. 5).

5. Conclusion

TES is the goal and also the trend of all cardiac surgeries in the future. Our procedure is safe, effective and can be performed with regular endoscopic instruments. The ACC and CPB times of this approach could be shortened with experience.

Declaration of Competing Interest

None.

Funding

None.

Ethical approval

The study was approved by our research committee, E Hospital, Hanoi, Vietnam.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Dat T. Pham: Surgeon performed this case, wrote manuscript.
Huu C. Nguyen: Concept and design a surgical procedure.
Thanh N. Le: Chief responsibility surgeon for the operation.
Hung Q. Doan: Full responsibility for scientific method and publication.

Registration of research studies

This is a case report. Thus, we don't need a registration of research study.

Guarantor

Dat T. Pham, M.D.

Provenance and peer review

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