VIDEO ASSISTED MINIMALLY INVASIVE MITRAL VALVE SURGERY VIA RIGHT MINITHORACOTOMY: INDICATIONS, TECHNIQUES AND RESULTS

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ABSTRACT

Background: *Minimally invasive mitral valve surgery (MIMVS) is under rapid development worldwide in recent years. The number of MIMVS is exceeding that of conventinal method via sternotomy in developped countries.*

Objectives: *Assess of indications, techniques, short term result of MIMVS and the experience in building a new technique in our center.*

Method: *Our restrospective reviewed 72 patients underwent minimally invasive mitral valve surgery at the University Medical Center at Ho Chi Minh City from 08/2014 to 08/2016.*

Results: *72 patients underwent minimally invasive mitral valve surgery. Mean age was 44.5 ± 12.2. Male to female ratio was 1.65:1. Patients with mitral valve repair included 45 degenerative valves, 3 post-rheumatic valves, 1 endocarditis and 4 congenital valves. The main mechanism was posterior leaflet prolapse (22 patients), anterior leaflet prolapse consists of 10 patients, there were 4 patients with both leaflets prolapse and 3 patients with anterior leaflet cleft. We encountered 7 complications: 4 hemothorax requiring draining, 1 annular rupture, 1 reoperation due to residual mitral regurgitation and 1 reoperation due to pericardial effusion. Goals of operation were achieved 90.5%.*

Conclusions: *In our experiences with MIMVS procedure, the early outcomes are satisfactory with low morbidity and no mortality. MIMVS is though safe and feasible, provided that patient selection is good and safety protocols are followed.*

Key words: *Minimally invasive mitral surgery, minithoracotomy, thoracic endoscopy.*

I. OVERVIEW

In the last 20 years, minimally invasive cardiac surgery (MICS) has been developping and being adopted rapidly. Benefits of MICS has been proven since the 90s of the last century. Operative techniques are optimized, which translates into better safety and outcomes compared to conventional approach [5].

Registries in developped countries (United States, France, Germany, Japan) show a paradigm shift into minimally invasive approaches. The overall rates of MICS reach 50% to 60%, up to 90% in pioneer centers [2].

MICS are interested by patients because, firstly, of its cosmetic results. However the avantages are so much more: less posoperative pain, less blood loss, no sternal complications, faster recovery and faster regain normal activities [1], [8].

However, to overcome the steep learning curve, surgeons and the other members of the team should have systematic and appropriate training. Mastering minimally invasive operative techniques peripheral

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perfusion strategies help minimize complications and improve outcomes.

In Vietnam, University Medical Center is pioneering in MICS. This study aimed at investigating the safety, feasibility and early outcomes of minimally invasive mitral valve surgery after two years of developping the technique, and to draw experiences to contribute to the implement of new techniques.

Objectives: We assessed the short-term results of minimally invasive mitral valve surgery via video assisted right minithoracotomy in our Heart Center.

II. MATERIALS AND METHODS

Study design: Retrospective descriptive study.

We reviewed patients who underwent mimally invasive mitral valve surgery with video assisted right minithoracotomy at our center from 08/2014 to 08/2016.

Selection criteria:

- Patients with mitral valve surgery indications.
- Patients underwent minimally invasive mitral valve surgery.
- Patients with Ejection Fraction > 30%, aged < 70 y.o, and PAPs < 69 mmHg.
- Patients with good right ventricle function (TAPSE > 15 mm).

Exclusion criteria:

- Concomitant cardiac disease: aortic valve disease, coronary artery disease.
- Patients with more than mild aortic regurgitation.
- Patients with stenosis or occlusion of the aortoiliofemoral trunks.
- Patients with inferior vena cava thrombosis.
- Patients with prehistory of right thoracic surgery.
- Patients with prehistory of cardiac surgery through sternotomy.

SURGICAL TECHNIQUE

Surgical instruments

We used the Karl – Storz™endoscopic system with 15 degree endoscope, cold light source, HD display screen and CO_2 pumping system.

The minimally invasive instrument set consists of an atrial lifting system with different size, thoracotomy retractor, long shaft surgical instruments and a Chitwood aortic clamp.

We used the Stockert S5 cardiopulmonary bypass machine, CPB was set up with Sorin bicaval venous cannula 22Fr or 23/25 Fr and femoral arterial cannula 18F or 20F. Skin and muscles were retracted using a soft tissue retractor.

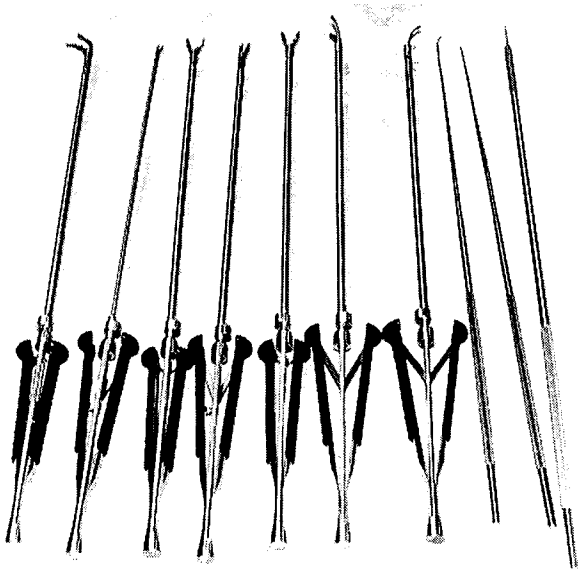

Figure 1. Long shaft instrument for MICS

Surgical steps:

After positioning the patient on their back, with the right side moderately lifted up using a folded towel under the patient's back and slightly outwards positioning of the right arm, the chest is entered in the 3th or 4th intercostal space. External shocking pads were applied to the chest. Patients were prepped exposing the whole chest and abdominal region. We used the intubation tube as normal cardiac surgery. Hence, for the beginning cases, it is advised to use an endobronchial tube to isolate the right lung without starting the cardiopulmonary bypass

Following an oblique incision of about 3 cm over the right groin, the femoral artery and vein are dissected only superficially. Purse string sutures are placed on both vessels and are cannulated using

Seldinger's technique under ultrasound guidance. In all patients undergoing isolated mitral valve surgery over 75 kg in weight, an additional venous neck cannula is placed preoperatively into the superior vena cava by the anesthetist to improve venous drainage. In cases of poor venous drainage, an additional cannula can also be placed into the superior vena cava through minimally-invasive access. If the femoral artery is not suitable for cannulation due to severe calcifications, or in cases in which retrograde aortic perfusion is not recommended, cannulation of the axillary artery may be an option. The patient is put on-pump before the right chest is entered. This enables free access to the pericardium without the need to use a double lumen tube.

A skin incision of 3 – 5 cm was done under the nipple in man and 1 cm higher than the inframammary crease in women. Asoft tissue retractor is used to open the incision and an additionalretractor is inserted to access the right chest. Retraction sutures can be placed on the pericardium near the diaphragm for better visualization or the diaphragm can be pushed away using a flexible blade, which is fixed in between the lower rip and the retractor.

The first additional incision should be positioned anteriorly in a safe distance to the right internal thoracic artery. This incision will be used for the holder of the left atrial retractor blade and may also be used for getting the cardioplegia line/root vent out. The incision for the cross-clamp should be directed towards the ascending aorta, without putting any force onto the aorta after the left atrium has been retracted. Care must be taken to avoid interference with the camera, which should be inserted anterior and superior to the cross-clamp, achieving a direct view of the mitral valve. One or two of these additional incisions can be used later for getting the chest drains out.

Following incision of the pericardium about 3 cm above the phrenic nerve, pericardial retraction sutures may be applied and brought out laterally. Using a pledgeted purse string suture, a needle vent is brought into the aortic root for application of cardioplegia and later venting of the aortic root

After aortic cross clamping, the left atrium is entered through the interatrial groove. It is advisable to apply the cross-clamp during a short duration of complete circulatory arrest to avoid the potential risk of aortic dissection. The left atrium is lifted up using a retractor blade, which is available in different sizes and lengths. In some cases, the blade used for pushing the diaphragm away can also be used to improve visualization of the mitral valve by pushing the inferior part of the left atrial incision downwards

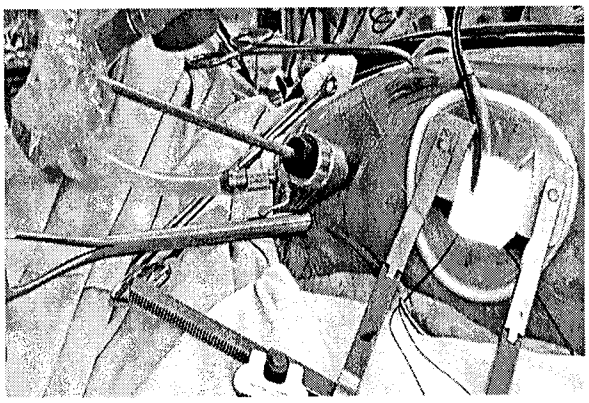

Figure 2. The surgical field with endoscope, Chitwood clamp and cardioplegia line in position

We placed a venting tube throug mitral valve before closing the left atrium to facilitate dearing of the heart. After closing the left atrium, both lungs were inflated manually to deair via the atriotomy. Pacing wires were placed before declamping.

Before closing, chest holes made by surgical manipulations should be checked thoroughly and hemostasis should be done as particular as possible. Femoral vessels were constructed using 6.0 Prolene after withdrawal of the cannulae.

III. RESULTS

From 8/2014 to 8/2016, 72 patients underwent isolated mitral valve surgery through a minimally invasive approach with an average age of 44.5,

ranging from 15 – 67 and a male: female ratio of 1.65:1

We had 63 patients with NYHA I and II heart failure and 9 patients with NYHA III and IV heart failure. 53 patiens had undergone mitral valve repair, with the etiology summerized in table 1.

Table 1. Mitral valve regurgitation etiology

Etiology	**Mitral valve repair**	**Mitral valve replacement**
Degenerative	45	4
Post rheumatic	3	15
Endocarditis	1	0
Congenital	4	0
Total	**53**	**19**

Table 2. Mitral valve repair group. Regurgitation mechanism according to A.Carpentier

Regurgitation mechanism	**No. (53)**
Anterior leaflet prolapse	10
Posterior leaflet prolapse	22
Prolapse of both leaflets	4
Leaftlet restriction	3
Anterior leaftlet cleft	4

Table 3. Early result

Results	**N=72**
Cardiopulmonary bypass time	162±42 min
Aortic cross clamp time	115±25 min
Mechanical ventilation time	15 hour
ICU time	2.3 days
Mitral annulus rupture	1
Reoperation for bleeding	1
Reoperation for mitral regurgitation	1
Chest tube drainage	4
Death	0

Table 4. Postoperative echocardiography

Echocardiography before discharging	
No regurgitation or mild regurgitation	48
Moderate regurgitation	4
More than moderate regurgitation	1 (mitral replacement)
Coaptation length	6–12mm (8,6 mm)
Follow up echocardiography (2 – 16 mo.)	
No worsening regurgitation found	
No reoperation for regurgitation needed	

IV. DISCUSSION

Minimally invasive mitral valve surgery meets the needs of many different subjects. Patients need to be operated before the heart have irreversible anatomical changes, with rapid recovery, less physical and psychological injury, no complications related full sternotomy, and highercosmetic effect. The surgeon needs to develop new techniques, increasing the number of surgeries. Cardiologists need more options for their patients, sending patients to surgery sooner. Health managers expect the hospital to be highly competitive, increasing treatment effectiveness. The reasons for minimally invasive valve surgery are gaining attention and investment. In such a situation, ensuring the safety and effectiveness of treatment for patients is the key to success in applying new technology.

Safety of minimally invasive mitral valve surgery

Over the last two years, we have performed 72 cases of minimally invasive valve repair and replacement. Minimally invasive valve surgery with video assited thoracotomy has been routinely performed at the Heart Center of the University Medical Center.

Mortality was 0%. The incidence of complications was 7 cases, of which 4 cases were pleural effusion, 1 case directly related to surgical technique and severe complications (mitral annulus

rupture) , 1 reoperation due to persistent mitral regurgitation.

According to Holzhey [3], less invasive surgery poses a number of technical challenges in the first 50 to 100 cases. In addition to the complications of conventional cardiac valve surgery, minimally invasive mitral valve surgery has specific complications. Most complications are due to one of two reasons: inappropriate patient selection or insufficient training curve.

The specific complications of minimally invasive mitral valve surgery include:

- Arterial and venous cannulation can cause damage to the blood vessels, femoral arterial dissection, or in a severe scenario, it can cause damage to the blood vessels of the pelvis or abdomen. Femoral lymphocele, sometimes can be recurrent and troublesome.

- Retrograde cardiopulmonary bypass can increase the risk of stroke in patients with severe atherosclerotic lesions or causing retrograde aortic dissection.

- Cardiopulmonary bypass time and aortic clamping time were longer than that of conventional surgery may affect ventricular function in patients with left ventricular dysfunction, severe preoperative pulmonary arterial hypertension and poor myocardial protection. Prolonged cardiopulmonary bypass can also affect the function of the organs, including the liver and kidneys [6,7].

Patient selection is important

Cardiopulmonary bypass time and aortic clamping time in minimally invasive mitral valve surgery are longer than conventional surgery. Therefore, in the initial stage, patients with good left ventricular function, no pulmonary hypertension, and no aortic regurgitation should be selected to ensure optimal cardioprotective protection in the operation. Once the training curve has been passed, the surgeon may expand beyond the indications, but one must respect the key points to ensure patient safety [5].

Our encouraging results in two years of performing minimally invasive mitral valve surgery have proved that once the correct surgical indication is applied and the safety measures taken, all the results are equalto conventional open surgery.

Mitral valve repair is the most sophisticated and demandshigh surgical skills in cardiac surgery that can be performed by less invasive methods [4]. Compared with mitral valve replacement, mitral valve repair offers many benefits to patients: Improving left ventricular function, decreasing early and long-term mortality, reducing the use of antivitamin K, reduced reoperation rate. Our successful mitral valve repair rate is 52/53 cases. Nearly all degenerative valve repair techniques can be achieved by minimally invasive methods: triangular resection, artificial chordae for the posterior leaflet, mitral annular ring... We are gradually expanding the indication of mitral valve repair to postrheumatic mitral valve disease, although the number is limited (3 cases) but the initial results are relatively positive. However, in case of complicated valve lesions that still have the ability to repair, we prefer to the conventional approach to repair the valve. If the ability to repair is limited, we recommend less invasive surgery to replace the mitral valve.

Experience in starting minimally invasive heart surgery program

Prior to the deployment of new technology, it is necessary to go through the Hospital's Board of Sciences and the Hospital's Board of Ethics. Although this is a common procedure, this approval is even more important for a technique that has a long training curve. The cost of buying appropriate tools is quite high, but good tools will make deployment easier.

Comprehensive training for the whole team including surgeons, anesthetists, and scrubbed nurses is essential. To ensure patient safety, the first case should be operated together with a specialist. In the first 50 cases, simple patients should be

selected. Once one has mastered the indications and technique, the team can begin to perform more difficult cases. The incision can be long at first and then shortened.

Custodiol cardioplegic solution helps to protect the heart for up to 120 minutes and simplifies the technique and improves postoperative results.

V. CONCLUSIONS

Minimally invasive mitral valve repair surgery with video assisted thoracotomy is feasible, safe and has an early positive results.

This type of surgery has the advantages of minimally invasive surgery: Reducing physical and psychological trauma to patients.

However, there are technical challenges, and long training curves are required, along with pathological challenges such as progressive post rheumatic mitral valve disease. Therefore, it is necessary to have adequate investment in policies, training of personnels as well as equipment. Choosing the right patient and strictly adhering to the rules of surgical safety will help bring good results and ensure the safety of patients.

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