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Surgical Outcome of Minimal Invasive Mitral Valve Replacement

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Abstract

Background:

Mitral valve repair and replacement depends on cardiopulmonary bypass and techniques of repair and replacement are improving continuously and a lot of surgeons contributed to the development of this field.

Aim of study:

- To determine whether minimally invasive mitral valve surgery improves clinical outcomes compared with conventional open mitral valve surgery in patients undergoing mitral valve replacement.

- To analyze the learning curve of the surgeon who has started performing minimally invasive mitral valve surgery at our institution and to provide recommendations on the necessary experience to achieve and retain high-quality outcomes in this field.

Patients and Methods:

This is a prospective study of 26 patients who underwent mitral valve replacement in Al Najaf Center for Cardiac Surgery and Trans Catheter Therapy from August 2015 to October 2016, 16 patients underwent isolated mitral valve replacement through a minimally invasive approach and 10 patients underwent isolated mitral valve replacement through a conventional sternotomy.

Statistical analysis was done by using SPSS (statistical package for social sciences) version 20. In which we use frequencies, percentages and mean as descriptive statistics. T-test, paired t-test , and Yates corrected chi square had been used according to type of variable. P value <0.05 regarded significant.

Result:

MICS was done in 16 patients (61.5%) while the remaining underwent conventional sternotomy.There was no reopening for bleeding for all patient with MIMVS while in conventional sternotomy 2 patients (20%) had been reopened for bleeding. In conventional sternotomy wound infection was seen in 2 patients (20%) while in MIMVS no infection had been reported. There are no significant differences in postoperative echocardiographic finding between MIMVS and conventional sternotomy approach.

Discussion:

In conventional sternotomy wound infection was seen in 2 patients (20%) while in MICS no infection had been reported. while in similar study done by Schmitto et al[57]wound infection in sternotomy group5.7% and 0.9% in

MIMVS group. This difference may be explained by additional risk of groin complication associated with MIMVS group in their study .

Minimally invasive mitral valve surgery patients commonly are extubated earlier and have a shorter hospital stay (mean=6.5days) than conventional sternotomy patients (mean=12.2days) which is similar to another study done by Svensson et al(59) in Cleveland Research Institute ,Ohio, in which the mean postoperative length of hospital stay was 6days after MIMVS , and 10.3 days after conventional sternotomy. The decreased intensive care unit and total hospital length of stay ,the faster physical rehabilitation, and consequently less use of hospital resources, all these make MIMVS cost effective and cost saving strategy for mitral valve surgery compared with traditional approach . The mortality rate after MIMVS versus conventional sternotomy was similar at 30 days (0 %).It is compared with another study done by Glauber et al (55) which was the same mortality at 30 days but different at 1year,5year mortality(2.1%,1.7% respectively)the only explanation is limited number of cases and short duration of our study.

Conclusion:

MIIMVS has been proven to be a feasible alternative to the conventional full sternotomy approach with low perioperative morbidity and short-term mortality.

Recommendation:

Mitral valve replacement through a small thoracotomy is technically demanding. Therefore, screening out patients who are not appropriate for performing minimally invasive surgery is the first step. Vascular disease and inadequate anatomy can be evaluated with contrast-enhanced computed tomography. Peripheral cannulation should be carefully performed. Valve replacement can be performed in minimally invasive surgery as long as cardiopulmonary bypass is stable and bloodless exposure of the valve is obtained.

Introduction

The first physician to propose that operating on the diseased mitral valve could provide symptomatic relief was Daniel Samways, who in 1898 suggested in the British Medical Journal that rheumatic mitral stenosis might be amenable to surgical correction. His comments were largely ignored until 1902, when Sir Lauder Brunton published his “Preliminary Note on the Possibility of Treating Mitral Stenosis by Surgical Methods” and any enthusiasm there may have been for the idea of mitral valve surgery disappeared.[1] It was not until 1923 that Elliott Cutler performed the operation proposed by Brunton 20 years earlier. Using a valvulotome designed for the purpose. [2]

In 1925 at the London Hospital, the English surgeon Sir Henry Souttar used a finger to perform the first closed digital commissurotomy; his 19-year-old patient lived another 5 years.[3] Souttar was referred no more patients despite the apparent success of the procedure, and after further unsuccessful attempts at mitral commissurotomy by Cutler, the procedure was abandoned in humans.

Steady improvements in both operative technique and valvulotome design, notably those designed by Tubbs, Brock, and Charles Dubost, meant that the prognostic and symptomatic relief obtained with closed mitral valvotomy improved as operative mortality fell, and by the early 1950s, hundreds of these procedures had been performed. Despite good early results in many patients, mitral regurgitation and recurrent mitral stenosis remained the two main complications of closed valvotomy. At the same time, an increasing number of patients with rheumatic disease were presenting with predominant mitral regurgitation. In 1954, Bailey reported the correction of mitral regurgitation by use of a pericardial graft.[4]

The development of cardiopulmonary bypass in the early 1950s allowed surgeons to refine techniques of mitral repair and replacement. It was Lillehei in 1957 who reported the first suture mitral anuloplasty by placing heavy silk sutures in the dilated area of the mitral anulus. [5]

Starr was the first to successfully implant a caged ball valve with good long-term results in 1960. During the following 2 decades, significant technological advances were made in the development of different types of reliable prostheses, such as porcine valves, tilting disc valves, and bileaflet mechanical valves. [6]

In the mid-1990s, research efforts further focused on the development of minimally invasive cardiac procedures. In 1996, Carpentier performed the first videoscopic mitral valve repair through a right mini-thoracotomy. [7]
In 1998, it was Carpentier and Mohr who performed the first mitral valve repair with robotic assistance.[8][9

Anatomy [10][11]

The mitral valve apparatus is composed of leaflets (valve tissue),mitral anulus, chordae tendineae, papillary muscles, and lateral wall of the left ventricle. The chordae tendineae and papillary muscles form the subvalvular apparatus.

Valvular Tissue

The mitral valve leaflet tissue, which inserts onto the entire circumference of the mitral anulus, consists of anterior and posterior leaflets as well as the posteromedial and anterolateral commissures (Fig. 1).

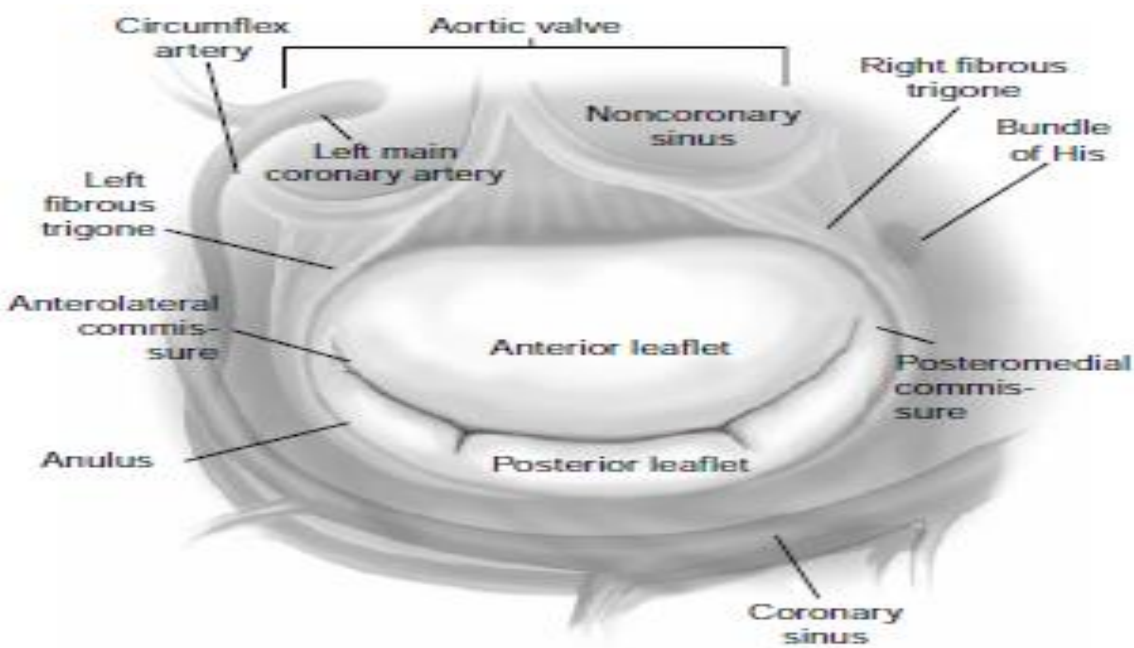

Figure (1) Surgical anatomy of the mitral valve with important structures surrounding the anulus. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

Commissures

The posteromedial and anterolateral commissures are identified by two anatomic landmarks: the axis of the corresponding papillary muscles and the commissural chordae. The distance between the free edge of the commissures and the anulus is approximately 8 mm.

The anterior leaflet (aortic leaflet) is semicircular and is attached to two fifths of the anular circumference, with fibrous continuity between the anterior leaflet of the mitral valve and the left and noncoronary cusp of the aortic valve. its free edge does not have indentations. The anterior leaflet defines an important boundary between the inflow and outflow tracts of the left ventricle.

The posterior leaflet (mural leaflet) is quadrangular and is attached to three fifths of the anular circumference.

Both the posterior and anterior leaflets have similar surface areas as the height (the distance between the anulus of the leaflet and the free edge) of the posterior leaflet is less than that of the anterior leaflet

The mitral valve leaflet tissue may be further divided into eight segments (Fig. 2). The anterolateral and posteromedial commissures constitute two segments. The posterior leaflet is divided by two large indentations on its free edge into three scallops, identified as P1 (anterior scallop), P2 (middle

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scallop), and P3 (posterior scallop). The three corresponding segments of the anterior leaflet are A1 (anterior segment), A2 (middle segment), and A3 (posterior segment). This anatomic nomenclature facilitates precise location of valve disease (leaflet prolapse or restriction).

The atrial surface of the leaflets consists of two zones, one peripheral smooth zone and one central rough zone separated by a curved line, called the coaptation line. The rough zone represents the coaptation surface of the valve, and it is the insertion site of most of the chordae tendineae.

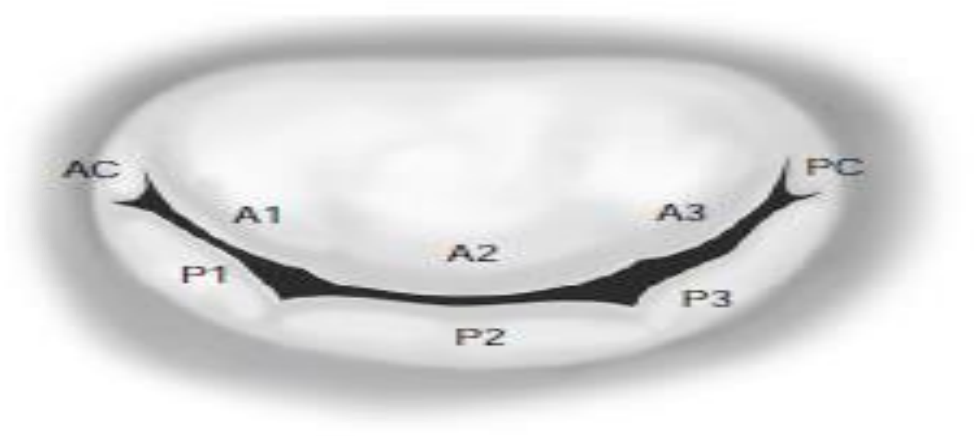

Figure (2) Segmental description of the valvular tissue. The mitral valve is divided into eight segments. Anterolateral and posteromedial commissures and posterior and anterior leaflets are divided into P1, P2, and P3 and A1, A2, and A3 segments, respectively. AC, anterolateral commissure; PC, posteromedial commissure. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

Mitral Anulus

The right fibrous trigone is a dense fibrous area of continuity between the mitral, tricuspid, noncoronary cusp of the aortic anuli and the membranous septum (see Fig.1). The left fibrous trigone is situated at the junction of both left fibrous borders of the aortic and the mitral valves. The right and left fibrous trigones mark the far ends of the area of fibrous continuity between the aortic and mitral valves. The mitral valve leaflets, unlike the tricuspid valve leaflets, are attached to an ovoid ring or anulus of fibrous tissue extending from the right and left fibrous trigones, which constitutes the junction between the left ventricle and atrium.

The mitral anulus is thinnest at the insertion site of the posterior leaflet. This segment is not attached to any rigid structures, and it is predominantly here that anular dilatation occurs. Studies have demonstrated that moderate anular dilatation can also occur at the anterior portion of the mitral annulus between the fibrous trigones.

Chordae Tendineae

The chordae tendineae are fibrous leaflet extensions connecting the papillary muscles and the leaflets. They are classified according to the site of insertion between the free margin and the base of leaflets (Fig. 3). Marginal chordae (primary chordae) insert on the free margin of the leaflets and function to limit leaflet prolapse. Intermediate chordae (secondary chordae) insert on the ventricular surface of the leaflets and reduce excess tension on the valve leaflets. Basal chordae (tertiary chordae) are limited to the posterior leaflet. They are attached to theleaflet base and connect it to the mitral annulus and the surrounding myocardial tissue.

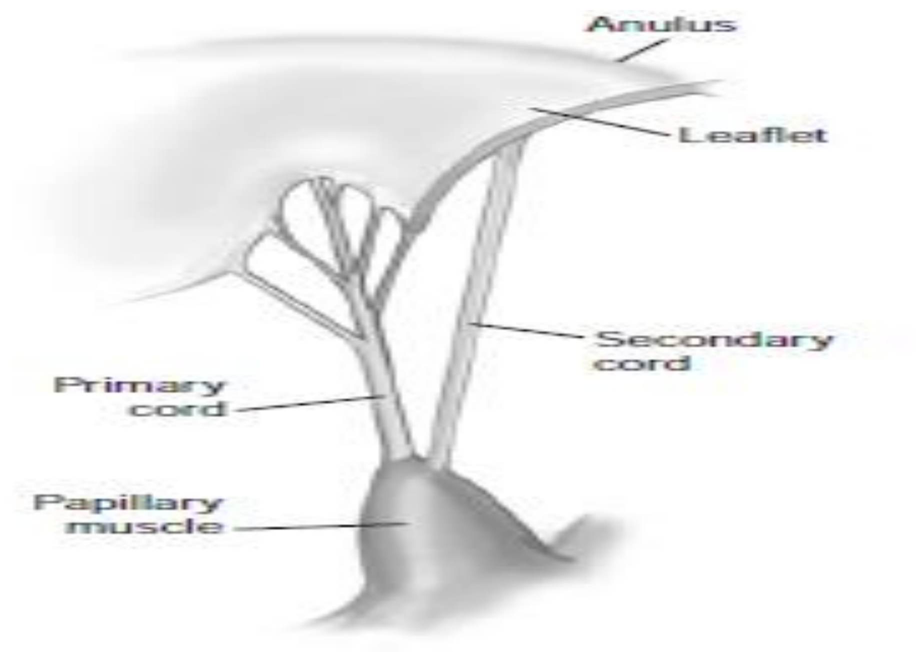

Figure (3) Subvalvular apparatus. Primary (marginal) chordae are attached to the free margin of the leaflet. Secondary chordae are attached to the ventricular side of the leaflet. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

Papillary Muscles and Left Ventricular Wall

Two papillary muscles arise from the area between the apical and middle thirds of the left ventricular wall. The anterolateral papillary muscle is usually composed of one muscle body and the posteromedial of two muscle bodies. Each papillary muscle provides chordae to both leaflets. The anterolateral papillary muscle vasculature is supplied by both the left anterior descending artery and the diagonal or a marginal branch of the circumflex artery. Either the circumflex or the right coronary artery provides the blood supply to the posteromedial papillary muscle. Because of its single system of blood supply, the posteromedial papillary muscle is affected by myocardial ischemia more commonly than the anterolateral papillary muscle is. The lateral wall of the left ventricle may be considered part of the mitral valve complex through its attachment to the base of the papillary muscles, and it plays a major role in the pathogenesis of mitral regurgitation in patients with ischemic cardiomyopathy.

Mitral Stenosis

Pathophysiology

The normal mitral valve area is 4 to 6 cm2. Narrowing of this area to less than 2.5 cm2 means that a pressure gradient across the valve is required to eject blood from the left atrium into the ventricle. Mitral stenosis is considered mild when the mitral

valve area is greater than 1.5 cm2, moderate when the mitral valve area is 1 to 1.5 cm2, and severe when the mitral valve area is less than 1.0 cm2 or the mean transvalvular gradient is more than 10 mm Hg. The transvalvular gradient results in elevated left atrial and pulmonary venous pressures. Pulmonary edema results when pulmonary venous pressure is greater than plasma oncotic pressure. Pulmonary artery hypertension may be caused by compensatory vasoconstriction and intimal hypertrophy of the pulmonary arterioles, together with direct transmission of the elevated pulmonary venous pressure. At rest, this is often asymptomatic, but any increase in flow across the mitral valve or reduction in the diastolic filling period results in an increase in the pressure gradient across the mitral valve. Dyspnea in these patients is therefore usually precipitated by exercise, stress, infection, pregnancy, or rapid atrial fibrillation. [12]
As pulmonary artery systolic pressures increase, both right ventricular end-diastolic pressure and volume rise, leading to right ventricular dilatation and tricuspid valve regurgitation. [12]
Although left ventricular diastolic pressure is usually normal in isolated mitral stenosis, left ventricular dysfunction eventually occurs in about a quarter of patients with severe, chronic mitral stenosis. [13]

Etiology

Although rheumatic valve disease remains the predominant cause of mitral stenosis in the West, with more than two thirds of patients with mitral stenosis giving a history of rheumatic fever, its prevalence has decreased in recent decades. This is in sharp contrast to the developing world, where chronic rheumatic disease is endemic and remains the most common cause of both mitral regurgitation and stenosis.[12] Around one third of all patients with rheumatic heart disease have pure mitral stenosis, and the remainder have a combination of mitral valve stenosis and regurgitation.[13]

Rheumatic disease results in an insidious fibrotic process affecting all segments of the mitral apparatus. Early valvular lesions include leaflet thickening, chordal thickening, fusion and shortening, and commissural fusion. Progressive leaflet thickening and commissural fusion eventually produce a characteristic "fish mouth" single central opening, with restricted leaflet motion during systole and diastole (Carpentier type IIIa leaflet dysfunction; Fig. 4). Chordal thickening and fusion may result in a dense fibrotic subvalvular mass that can contribute to obstruction of forward flow. Calcification, particularly at the commissural edges and occasionally extending posteriorly into the anulus and subvalvular apparatus, is common late in the disease process and in more elderly patients. Lesions that reduce the coaptation area (leaflet retraction) or restrict leaflet mobility (chordal shortening) result in mitral regurgitation as well as in stenosis. [12] Other diseases, such as malignant carcinoid and systemic lupus, very occasionally affect the mitral valve, causing varying degrees of mitral stenosis. [12]

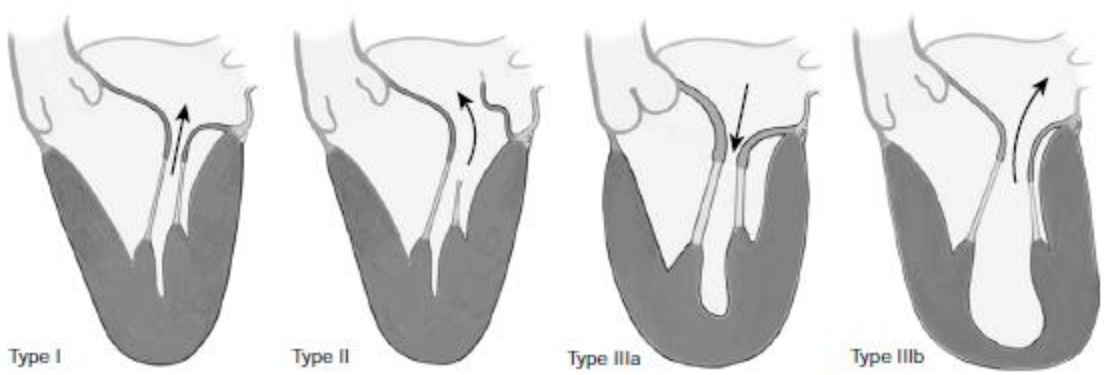

Figure (4) Carpentier's functional classification. **Type I**, normal leaflet motion. **Type II**, increased leaflet motion (leaflet prolapse). **Type III**, restricted leaflet motion; **IIIa**, during diastole and systole; **IIIb,** during systole only. The arrow shows the direction of the jet in types I, II, and IIIb; it shows the association of some degrees of mitral stenosis in type IIIa. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

Diagnosis

The diagnosis of mitral stenosis may be made on the basis of the medical history, physical examination, electrocardiography, chest radiography, and echocardiography. Women are affected by mitral stenosis twice as frequently as men are. [12]

Patients are frequently asymptomatic, although symptoms may include fatigue, dyspnea or hemoptysis, new onset of atrial fibrillation, or an embolic event. [13]

Auscultatory findings include a loud first heart sound, a diastolic murmur, and an opening snap in some patients. The diastolic murmur is a low-pitched rumble that is heard at the apex of the heart. The opening snap can be heard in patients with preserved leaflet mobility. [13]

The electrocardiogram may be normal but often demonstrates P-wave abnormalities, revealing left atrial enlargement, atrial fibrillation, or right ventricular hypertrophy. [12]

The chest radiograph may be normal; however, an enlarged left atrium is frequently seen. In patients with severe mitral stenosis and pulmonary hypertension, the right atrium and ventricle are often enlarged. [12]

The diagnostic tool of choice in the evaluation of patients with mitral stenosis is two-dimensional Doppler echocardiography. Echocardiography is used to evaluate the morphology and mobility of the mitral valve leaflets, commissures, and subvalvular apparatus, identifying calcification as well as determining the severity of mitral stenosis by measuring the mitral valve area, the transmitral gradient, and the pulmonary artery pressures. Rheumatic mitral valve disease is commonly associated

with mixed aortic valve disease as well as tricuspid regurgitation. Transthoracic echocardiography allows assessment of other valves, evaluation of right and left ventricular function, and identification of pulmonary hypertension and intracardiac thrombus; it is used to determine the suitability of the stenotic mitral valve for percutaneous balloon valvuloplasty. [14]

Left-sided heart catheterization is not normally necessary for diagnosis of mitral stenosis but may be useful when there is a discrepancy between noninvasive assessments of mitral stenosis; it is advisable in patients with risk factors for coronary artery disease in whom surgical correction is indicated. Right-sided heart catheterization is employed to obtain direct measurement of pulmonary artery pressures in patients in whom severe pulmonary hypertension is suspected; in combination with pulmonary vasodilators, it may be helpful in assessing reversibility of pulmonary hypertension.[15]

Indications for Surgery

Since the turn of the century, percutaneous mitral valvulotomy has become the first-line therapy for many patients with mitral stenosis. This procedure is indicated in symptomatic patients (New York Heart Association [NYHA] class III and IV) with isolated moderate to severe mitral stenosis (mitral valve area ≤1.5 cm2) and favorable valve morphology.[16]

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Asymptomatic patients with moderate to severe mitral stenosis and pulmonary hypertension at rest (pulmonary artery systolic pressure >50 mm Hg) or with exercise (pulmonary artery systolic pressure >60 mm Hg or pulmonary artery wedge pressure ≥25 mm Hg) or with new-onset atrial fibrillation may also benefit from percutaneous mitral valvulotomy. [17]

Percutaneous valvulotomy is contraindicated in the setting of left atrial thrombus, moderate mitral regurgitation, or valve morphology that includes moderate or severe valvular calcification.[17] Percutaneous mitral valvulotomy is associated with recurrent mitral stenosis, especially in patients undergoing repeated procedures, and with iatrogenic mitral regurgitation in patients with high valve scores. [18]

In a low-risk surgical patient with moderate to severe mitral stenosis (mitral valve area ≤1.5 cm2) who is not appropriate for or who has failed balloon valvulotomy, NYHA class III or class IV symptoms are an American College of Cardiology/ American Heart Association (ACC/AHA) class I indication for mitral valve surgery. [16] [19] There is also a subset of less-symptomatic patients with severe mitral stenosis and severe pulmonary hypertension (pulmonary artery systolic pressures >60 mm Hg) with morphology unfavorable for percutaneous balloon valvulotomy who may benefit from surgery. Mitral valve surgery is recommended in this subgroup of patients to prevent

right ventricular failure. Currently, the ACC/AHA guidelines do not recommend surgery in asymptomatic patients.

In patients with mild asymptomatic mitral stenosis (valve area >1.5 cm2 and mean gradient <5 mm Hg), no further evaluation is required after the initial workup. These patients usually remain stable for years and should be treated medically with follow-up every 6 months if they are not candidates for percutaneous balloon mitral valvotomy. [16]

Mitral Regurgitation

Pathophysiology

Mitral regurgitation, the retrograde ejection of blood from the left ventricle into the left atrium during systole, may progress through one or more of three stages: acute mitral regurgitation, chronic compensated mitral regurgitation, and chronic decompensated mitral regurgitation. Mitral regurgitation results in volume overload of the left ventricle at the end of diastole (i.e., increased preload) as well as in a reduction of afterload due to the regurgitant pathway back into the left atrium. As a result of the increased preload and reduced afterload, a larger volume of blood is ejected from the left ventricle. However, because a proportion of ejected blood enters the left atrium rather than the aorta, the forward stroke volume and consequently the cardiac output decrease. The increased blood volume in the left atrium raises the pressure from a normal left atrial pressure of about 10 mm Hg to up to 25 mm Hg. Increased preload gradually leads to ventricular remodeling through eccentric hypertrophy and dilatation, increasing the total stroke volume and the forward stroke volume, which may return to almost normal levels. This is chronic compensated mitral regurgitation. Anular dilatation occurs as a result of ventricular dilatation. The normal ratio between the anteroposterior and transverse diameters of the mitral anulus is 3:4 in systole. This ratio inverts in patients with chronic mitral regurgitation, causing poor leaflet coaptation and regurgitation even in the absence of leaflet prolapse (Fig. 5). This progressive defect affects the anterior anulus to a lesser extent than the posterior anulus. [20]

Figure (5) Anular dilatation and remodeling anuloplasty in chronic mitral regurgitation. A, Normal mitral anulus. The transverse diameter is superior to the anteroposterior (septolateral) diameter during systole (ratio 3:4). B, Dilated mitral anulus (ratio is inverted in mitral regurgitation). C, Remodeling prosthetic anuloplasty restores the physiologic ratio with maximum orifice area. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

Enlargement of the left atrium allows the volume overload there to be accommodated at a lower filling pressure (14 to 18 mm Hg) but predisposes to arrhythmias such as atrial fibrillation and the formation of mural thrombi. This atrial and ventricular accommodation is absent in acute mitral regurgitation, which therefore causes acute pulmonary edema and cardiogenic shock. [20] Chronic decompensated mitral regurgitation exists when systolic dysfunction prevents effective ventricular contraction. Stroke volume and cardiac output are reduced as blood flows preferentially into the relatively low resistance regurgitant pathway, and left atrial and pulmonary pressures rise as a result. Untreated decompensated mitral regurgitation rapidly progresses to irreversible pulmonary hypertension, pulmonary edema, and congestive cardiac failure. The presence of left ventricular dysfunction is associated with poorer prognosis regardless of the treatment modality. [20]

Carpentier's Functional Classification

Accurate description of valve disease is facilitated by the use of the pathophysiologic triad first described by Carpentier (Table 1). This triad is composed of etiology (cause of the disease), valve lesions (structural changes resulting from the disease), and leaflet dysfunction (changes in leaflet motion resulting from the structural lesion; see Fig. 4). These distinctions are relevant because long-term prognosis depends on etiology, treatment strategy depends on the valve dysfunction, and surgical techniques are dictated by the valve lesions. [21]

Table (1) Pathophysiologic Triad

Disfunction	Lesions	Etiology
Type I		
I Normal Leaflet Motion	**Anular Dilation Leaflet Perforation**	**Ischemic Cardiomyopathy (Basal Myocardial Infarction) Dilated Cardiomyopathy Endocarditis**
Type II		
Increased Leaflet Motion (Leaflet Prolapse)	**Elongation Or Rupture Of Chordae**	**Degenerative Mitral Disease Fibroelastic Deficiency Barlow's Disease Marfan Syndrome Endocarditis Rheumatic Trauma**
	Elongation Or Rupture Of Papillary Muscle	**Ischemic Cardiomyopathy**
Type Iiia		
Restricted Leaflet Motion (Systole And Diastole)	**Leaflet Thickening Or Retraction Chordal Thickening, Retraction, Or Fusion Commissural Fusion**	**Rheumatic Disease Carcinoid Disease**
Type Iiib		
Restricted Leaflet Motion (Systole)	**Papillary Muscle Displacement Leaflet Tethering**	**Ischemic Cardiomyopathy Dilated Cardiomyopathy**

Carpentier's functional classification is used to describe the mechanism of mitral regurgitation. This classification is based on the opening and closing motions of the mitral
leaflets. Patients with type I dysfunction have normal leaflet motion. Mitral regurgitation in these patients is due to anular dilatation or leaflet perforation. In type II dysfunction, leaflet
motion is increased, with the free edge of the leaflet overriding the plane of the anulus during systole (leaflet prolapse). The most common lesions responsible for type II dysfunction are chordal elongation and rupture, followed by papillary muscle elongation and rupture. In type IIIa dysfunction, leaflet motion is restricted during both diastole and systole. [22]

The most common lesions are leaflet thickening or retraction; chordal thickening, shortening, or fusion; and commissural fusion. Type IIIa regurgitation is most often associated with some degree of mitral stenosis. The mechanism of mitral regurgitation in type IIIb dysfunction is restricted leaflet motion during systole due to left ventricular enlargement with posterior displacement of the apex of the papillary muscle. [22]

Diagnosis

- History and examination

History and examination alone are of limited use to even experienced clinicians in the diagnosis of mitral regurgitation, but the presence of symptoms or evidence of atrial fibrillation, pulmonary hypertension, or embolic disease is of direct relevance to the decision of whether and when to refer for surgery. Chronic mitral regurgitation may be asymptomatic for many years. The most common presenting symptoms are fatigue, decreased exercise capacity, dyspnea, and palpitations. The history of presentation is helpful in distinguishing not only between ischemic and degenerative mitral regurgitation but also between the subtypes of degenerative mitral regurgitation; patients with Barlow's disease are typically younger, with a long history of a murmur, compared with those with fibroelastic deficiency, who are usually older, with a relatively short history of mitral regurgitation. Pulmonary hypertension is suggested by a parasternal heave on examination, and fluid retention is a sign of cor pulmonale. In advanced cases, the patient may appear cachectic. A laterally displaced apex beat suggests left ventricular dilatation. The auscultatory finding is a high-pitched systolic murmur at the apex that radiates to the axilla. An isolated late systolic murmur is in favor of mild mitral regurgitation. [23]

- Electrocardiogram

The electrocardiogram may be normal; however, in most patients, evidence of left atrial enlargement with p-wave abnormalities is present. Supraventricular arrhythmias such as atrial fibrillation are a frequent finding in these patients. The electrocardiogram may also show signs of left and right ventricular hypertrophy in patients with chronic valve disease. [23]

- Chest radiography

Chest radiography may show left atrial and ventricular dilatation in patients with severe chronic mitral regurgitation. Prominence of the pulmonary vasculature is evidence of pulmonary hypertension. In the acute setting, pulmonary edema may be present. [23]

Echocardiography

Two-dimensional echocardiography is essential to determine the mechanism and the severity of mitral regurgitation, which may be described most precisely by segmental nomenclature and Carpentier's functional classification. Semiquantitative assessment of regurgitant flow by maximal jet length, area, and ratio of jet to left atrial area has been used to grade the severity of mitral regurgitation. The degree of mitral regurgitation is determined by assessing jet geometry and area in multiple views. The severity of mitral regurgitation is graded on a scale of 1+ to 4+ (1+, trace; 2+, mild; 3+, moderate; 4+, severe mitral regurgitation with flow reversal in the pulmonary veins). [24]

Transesophageal echocardiography should be considered in selected patients including those with complex degenerative disease and those with native valve endocarditis. Transesophageal echocardiography has a significantly higher sensitivity and specificity for detection of perivalvular infection and vegetations and is routinely used in intraoperative assessment of the mitral valve. [25] Three-dimensional echocardiography and cardiac magnetic resonance imaging currently play an increasing role in the determination of the mechanism and severity of mitral regurgitation. Three-dimensional echocardiography provides a surgical view of the mitral valve in which even subtle areas of prolapse or restriction may be immediately identified. [26] [27]

Indications for Surgery

Acute severe mitral regurgitation is an indication for urgent surgery. The indications for surgery in chronic severe mitral regurgitation have evolved during the last decade, reflecting incremental improvements in safety and efficacy of mitral valve repair as well as better understanding of long-term outcomes in medically treated patients. Factors determining the timing of surgery for isolated severe mitral regurgitation in the current ACC/AHA guidelines include symptoms, left ventricular ejection fraction, left ventricular end-systolic dimension, atrial fibrillation, and pulmonary hypertension. [28]

Symptoms

Symptomatic congestive heart failure, even if it is only transient, is an indication for urgent intervention in the context of chronic severe mitral regurgitation. The annual mortality of medically managed patients in NYHA functional class III or class IV was shown in one study to be more than 30%, even if symptoms were only transient. Evidence of deteriorating left ventricular function, new-onset atrial fibrillation, and raised pulmonary artery pressures in asymptomatic and NYHA class II patients with chronic severe mitral regurgitation are ACC/AHA indications for surgery. [29]

- Left Ventricular Ejection Fraction

In patients with severe left ventricular dysfunction, long-term results after repair are significantly better compared with medical treatment. Even though the operative risk is higher in this group of patients, poor left ventricular function is therefore no longer considered a contraindication to mitral valve repair. ACC/AHA guidelines recommend medical therapy for patients with very poor left ventricular function. In asymptomatic patients with severe mitral regurgitation, the ACC/AHA guidelines recommend surgery for patients with left ventricular ejection fractions below 60% (class I) and suggest that patients with ejection fractions above 60% should be monitored with echocardiography at regular intervals if they have no other indications for surgery. Mitral valve repair should subsequently be undertaken if left ventricular ejection fraction deteriorates. [28]

- Left Ventricular End-Systolic Diameter

Patients with a left ventricular end-systolic diameter of 45 mm are highly likely to have abnormal postoperative left ventricular function. Similarly, a left ventricular end-systolic volume index above 50 mL/m2 has been shown to be predictive of persistent postoperative left ventricular dilatation as well as decreased survival. In asymptomatic patients with severe mitral regurgitation and left ventricular end-systolic diameter of 40 mm or more, ACC/AHA guidelines therefore recommend mitral repair (class I). [28]

- Atrial Fibrillation

The ACC/AHA guidelines advocate surgery in asymptomatic patients with severe mitral regurgitation and new-onset atrial fibrillation. [28]

- Raised Pulmonary Artery Pressures

ACC/AHA guidelines recommend surgery in asymptomatic patients with severe mitral regurgitation and pulmonary artery pressures above 50 mm Hg at rest or above 60 mm Hg during exercise, irrespective of left ventricular function. [28]

- Endocarditis

Current ACC/AHA class I indications for surgery in native valve endocarditis include (1) any acute valve lesion resulting in heart failure; (2) aortic or mitral insufficiency with hemodynamic evidence of elevated left ventricular end-diastolic or left atrial pressures or moderate pulmonary hypertension; (3) structural complications, such as anular or aortic abscess, or other destructive penetrating lesions, including fistulas and kissing lesions; and (4) fungal or other highly resistant organisms. [30]

Surgery

Perioperative Management

Standard techniques of monitoring are used in patients undergoing mitral valve surgery. A pulmonary artery catheter should be placed in cases of complex mitral valve reconstructive surgery, multivalve surgery, and combined mitral and coronary artery bypass grafting surgery and in patients with increased operative risk (such as patients with left ventricular dysfunction, with pulmonary hypertension, or undergoing reoperative surgery). Transesophageal echocardiography should be performed before initiating cardiopulmonary bypass in all patients to determine the mechanism and severity of mitral regurgitation and to assess left ventricular function, quality of repair, and de-airing of the cardiac cavities at the completion of the procedure. External defibrillator pads are placed in patients undergoing reoperative surgery or minimally invasive procedures for defibrillation. A doublelumen endotracheal tube is inserted in right thoracotomy approaches. An epiaortic scan of the ascending aorta is recommended in elderly patients with associated atherosclerotic risk factors and in those undergoing combined mitral valve and coronary artery bypass grafting surgery before arterial cannulation.[31]

Surgical Approaches and Cardiopulmonary Bypass

- Median Sternotomy

Median sternotomy is the most commonly used surgical approach in mitral valve surgery (Fig.6). It provides an excellent access to all cardiac Structures, allowing central cannulation with use of the ascending aorta and the superior and inferior venae cavae. It remains the surgical approach of choice in patients undergoing complex mitral valve, multivalve, combined mitral and coronary artery bypass grafting, and reoperative surgery.[32]

During the last decade, the population of patients being referred for reoperative mitral surgery has increased. The most common clinical scenarios are failed bioprosthetic mitral valves, ischemic mitral regurgitation after prior coronary artery bypass grafting, and prior aortic valve replacement.[33] The choice of cannulation sites and the indications for peripheral bypass before sternotomy are important factors in avoiding any major complications during reoperative surgery. Peripheral vessel exposure is recommended if severe mediastinal adhesions are suspected (recent reoperation, multiple previous sternotomies, mediastinitis, mediastinal irradiation) and in patients with patent grafts. Peripheral vessel cannulation with peripheral bypass at the time of sternotomy may be indicated in patients with patent left internal mammary artery graft, dilated ascending aorta, and severe right ventricular dilatation. [34]

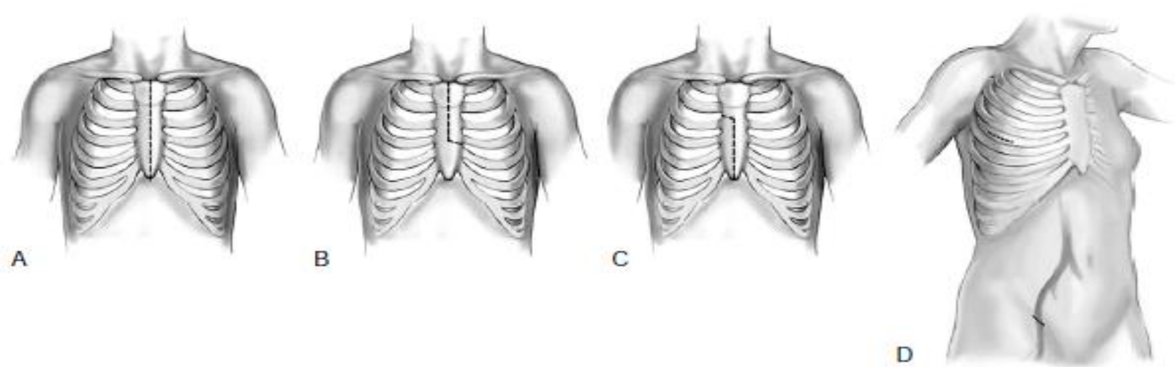


Figure (6) Surgical incisions. **A**, Limited skin incision and full sternotomy. **B**, Upper hemisternotomy. **C**, Lower hemisternotomy. **D**, Right mini-thoracotomy and groin incision for peripheral cannulation. (From Carpentier A, Adams DH, Filsoufi F. Carpentier's Reconstructive Valve Surgery. Elsevier, 2010.)

- **Right Anterolateral Thoracotomy**

The patient is rotated 30 degrees to the left side, and a 12- to 15-cm right anterolateral thoracotomy is performed through the fourth intercostal space (see Fig. 6).[35] This surgical approach is useful in patients with prior coronary artery bypass grafting and patent internal thoracic grafts and in patients with prior aortic valve replacement undergoing isolated reoperative mitral surgery.[36] Because the right thoracotomy approach does not require extensive mediastinal dissection, it is also a useful alternative if dense mediastinal adhesions are suspected. Right thoracotomy is contraindicated in patients with previous right-sided chest surgery, severe chronic obstructive pulmonary disease, and moderate to severe aortic insufficiency. Direct cannulation of the ascending aorta and percutaneous femoral vein and superior vena cava cannulation are performed whenever possible. If the ascending aorta is not suitable for cannulation (inaccessibility and inadequate exposure, presence of multiple venous grafts, or calcification), femoral and axillary arteries are other alternatives for arterial cannulation. Cardiopulmonary bypass is instituted with vacuum-assisted drainage. Mitral valve exposure can occasionally be very difficult with this approach. [37]

- **Minimally Invasive Mitral Valve Surgery**

Since the 1990s, a variety of minimally invasive surgical approaches to mitral valve surgery have been described (see Fig.6). These procedures were developed to decrease operative morbidities associated with the conventional approaches (postoperative pain, infection, transfusion requirements) as well as to reduce length of hospital stay and to accelerate the patient's recovery.[38][39]]

According to their increased difficulty, minimally invasive approaches are divided into four categories: limited incision with direct vision (level 1), video assisted (level 2), video directed and robot assisted (level 3), and robotic telemanipulation (level 4).[40]
Minimally invasive mitral surgery may be performed through the partial upper or lower hemisternotomyor a very small right anterior thoracotomy. [41][42] The right parasternal approach has been largely abandoned because of a high rate of pulmonary herniation.[43] A 6-cm skin incision is performed in both cases. The sternum is partially divided from the sternal notch to the left fourth intercostal space (upper hemisternotomy) and from the xiphoid to the second right intercostal space (lower hemisternotomy). Central arterial and venous cannulations are often possible with these approaches. [44][45] Video-assisted and robotic mitral valve surgery may be performed through a right mini-thoracotomy at the fourth intercostal space. Multiport access is obtained by additional incisions. Peripheral vessels are used to institute cardiopulmonary bypass. Additional adjunctive techniques, such as port access instrumentation, endoaortic balloon, Chitwood aortic crossclamp, carbon dioxide insufflation, and vacuum-assisted venous drainage, are commonly used to facilitate these surgical procedures. [46]

Myocardial Management

Mitral valve surgery is classically performed with cardioplegic arrest. Alternative techniques, such as beating heart and ventricular fibrillatory arrest, are available in a selected group of patients. The quality of myocardial protection provided by these techniques is not as optimal as with cardioplegic arrest. Cardioplegic arrest requires the use of cold blood high potassium cardioplegia for myocardial protection. This is achieved with intermittent antegrade or combined antegrade and retrograde infusion. Further myocardial protection can be obtained by moderate systemic hypothermia between 28°C and 30°C and local hypothermia with topical ice. In reoperative mitral valve surgery, specifically through a right anterolateral thoracotomy, it is often difficult to crossclamp the ascending aorta. Myocardial preservation strategies, such as beating heart and moderate to deep hypothermia and fibrillatory arrest, should therefore be considered as long as there is no more than trace to mild aortic regurgitation. 41,47 These noncardioplegic techniques are particularly useful in patients with prior coronary artery bypass grafting and patent internal thoracic grafts. [41][47]

Exposure of the Mitral Valve

Perfect exposition of the mitral valve is essential before any type of mitral valve surgery is undertaken. Three approaches have been described (Fig.7).

- Interatrial Approach Through Sondergaard's Groove

The interatrial approach through Sondergaard's groove is the most commonly used approach to expose the mitral valve. The interatrial groove is incised, and the two atria are dissected and divided up to the fossa ovalis. This dissection exposes the roof of the left atrium, which is opened close to the mitral valve. In patients with a small left atrium, the inferior extension of the left atrial incision between the right inferior pulmonary vein and inferior vena cava optimizes the mitral valve exposure.[10]

- Horizontal Biatrial Trans-septal Approach

The horizontal biatrial trans-septal incision is started at the level of the right atrial appendage 2 cm posterior to the atrioventricular groove. It is then extended horizontally to the right superior pulmonary vein, at which point both atria are opened. The interatrial septum at the fossa ovalis is incised and extended posteriorly and laterally to meet the inferior edge of the previous incision. The septal component of this incision should not be extended inferiorly to avoid injury to the bundle of His and the tricuspid anulus. .[48][49]

- Superior Biatrial Trans-septal Approach

In the superior biatrial trans-septal approach, the right atrium is incised longitudinally at distance from the atrioventricular groove. The interatrial septum is opened at the inferior limit of the fossa ovalis and extended superiorly about 2 cm. The right atriotomy is prolonged farther superiorly between the right atrial appendage and the atrioventricular sulcus. When the right atriotomy incision meets the septal incision, the roof of the left atrium can then be opened effectively by continuing the joined incision. The left atriotomy can be extended farther to the left at distance from the aortic root to improve valve exposure. .[50]

Trans-septal approaches, particularly the superior biatrial approach, are useful in minimally invasive direct mitral valve surgery (upper and lower hemisternotomy), in reoperative mitral surgery after prior aortic valve replacement, and in patients with a small left atrium. [42][51]

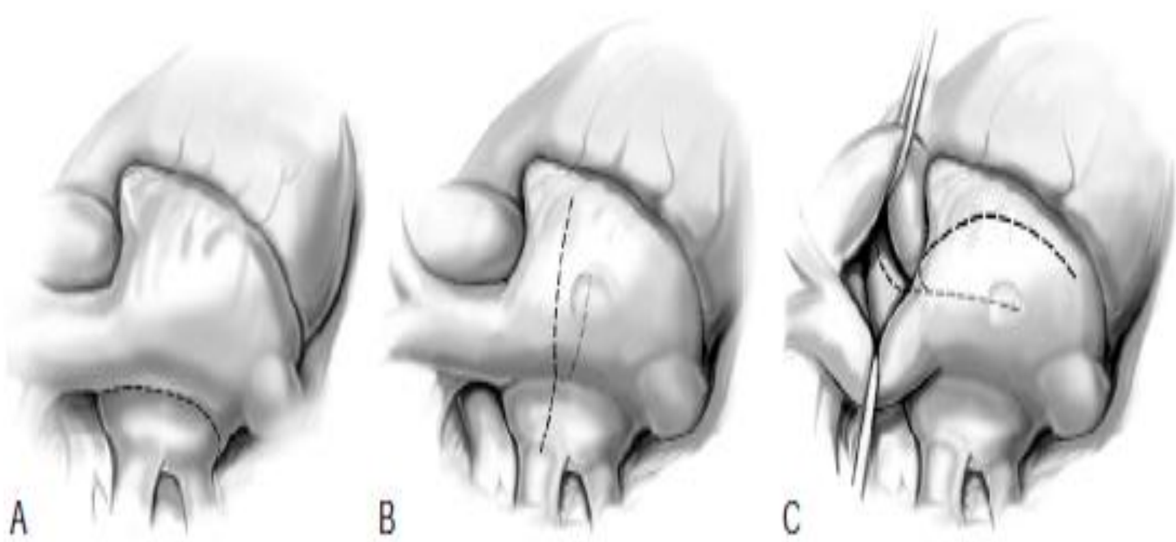


Figure (7) Left atrial incisions. **A**, Interatrial approach through Sondergaard's groove; the extension of the left atrial incision between the right inferior pulmonary vein and inferior vena cava improves valve exposure. **B**, Horizontal biatrial trans-septal approach. **C**, Superior biatrial trans-septal approach.

Aim of Study

- To determine whether minimally invasive mitral valve surgery improves clinical outcomes compared with conventional open mitral valve surgery in patients undergoing mitral valve replacement.

- To analyze the learning curve of the surgeon who has started performing minimally invasive mitral valve surgery at our institution and to provide recommendations on the necessary experience to achieve and retain high-quality outcomes in this field.

Patients and Methods

This is a prospective study of 26 patients who underwent mitral valve replacement in Al Najaf Center for Cardiac Surgery and Trans Catheter Therapy. From August 2015 to October 2016, 16 patients underwent isolated mitral valve replacement through a minimally invasive approach, and 10 patients underwent isolated mitral valve replacement through a conventional sternotomy.

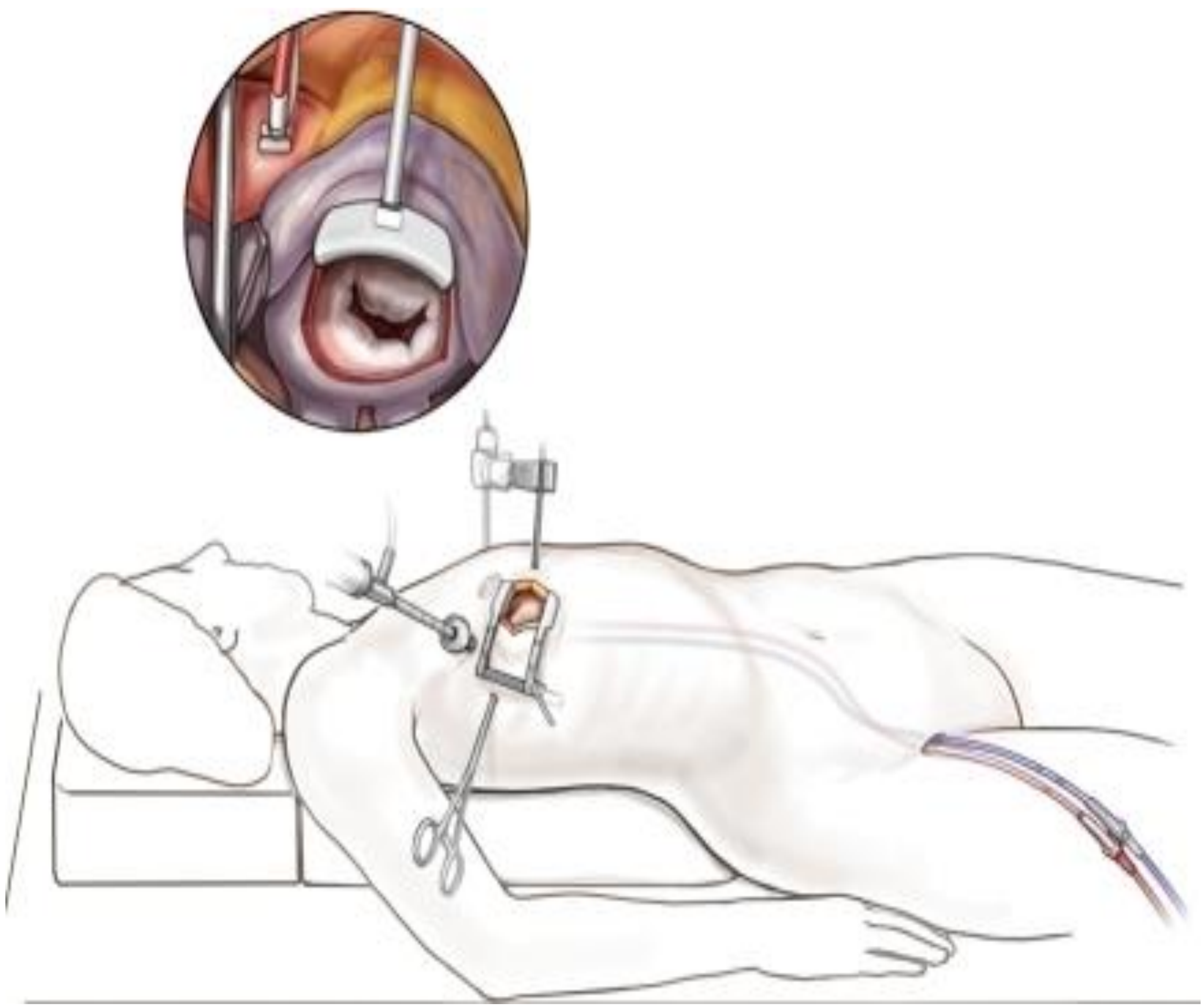
Statistical analysis was done by using SPSS (statistical package for social sciences) version 20. In which we use frequencies, percentages and mean as descriptive statistics. T-test, paired t-test , and Yates corrected chi square had been used according to type of variable. P value <0.05 regarded significant.

All the patients had been admitted in the ward and underwent general investigation including electrocardiography, echocardiography, chest x ray and other biochemical and hematological investigation. Cardiac catheterization had been done for those over fifty years old. Pulmonary function test had been done for those who suspected to have chronic obstructive pulmonary disease. Preoperative Doppler study of lower limbs was done for MIMVS group.

Exclusion criteria for minimal invasive mitral valve surgery is morbid obesity, sever chronic obstructive lung disease, strong pleural adhesions and patient with sever peripheral vascular diseases.

Conventional general anesthesia was used in all patients, apart from single lung ventilation in MIMVS group, regardless of surgical approach. In those receiving a full median sternotomy, the mitral valve was usually visualized through an incision in the left atrium anterior to the right pulmonary veins. Patients who underwent minimally invasive surgery were positioned in supine position with the right side of the chest slightly elevated (figure 8). Typically, a skin incision of 5 to 6 cm in length is created over the chosen 4th interspace with the intercostal incision being extended beyond the limits of the skin incision. This allows for specially designed ultra-light retractor to spread the ribs while minimizing the risk of breaking them in addition to MIMVS soft tissue retractor which is a doubled bell mouth shaped silicone rubber tube with clasp on both ends of the tube in order to allow perfect access (figure9). Right or left femoral artery and vein were surgically exposed through 3-4cm incision parallel to inguinal skin fold for arterial and venous cannulation(figure10) ;arterial cannulation can be done through right axillary artery or central aorta(figure11) if femoral arterial cannulations contraindicated(figure 12) after initiation of cardiopulmonary bypass, right lung was deflated, the pericardium was opened 3cm above and parallel to right phrenic nerve to expose the roof of left atrium, direct ante grade cardioplagia cannula with vent needle is placed in the ascending aorta and if necessary a retrograde cardioplagia catheter is placed trans atrialy in the coronary sinus under TEE guidance . Transthoracic sliding-rod aortic cross clamp (figure 13) was passed through 3rd intercostal space midclavicular line through 3mm port. Direct aortic cross clamping can be done through external flexible cross clamp (figure 14) The

pulmonary veins. Specially designed long instruments also used to facilitate the access (figure 15). Routine mitral valve replacement techniques were used. Vacuum-assisted cardiopulmonary was used to enhance venous drainage. Custodial-HTK(histidine-trypyhophan-ketoglutarate) cardioplagia solution was used in both groups for myocardial protection. Intraoperative transfusions, anesthetic technique, and timing of extubation were at the anesthesiologist's discretion



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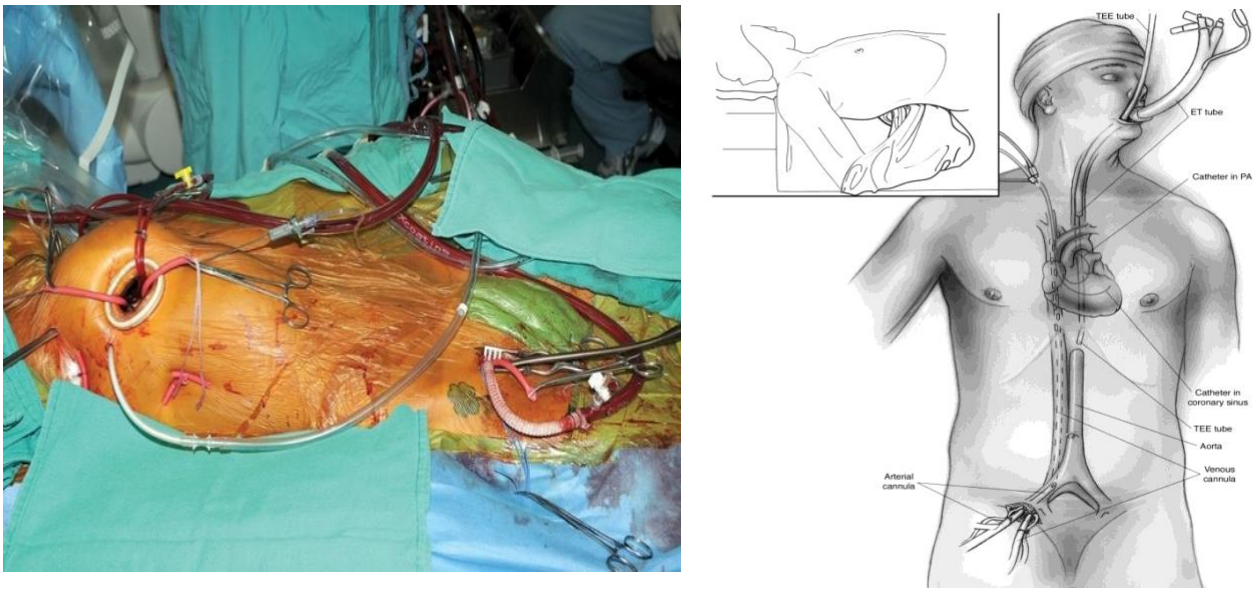
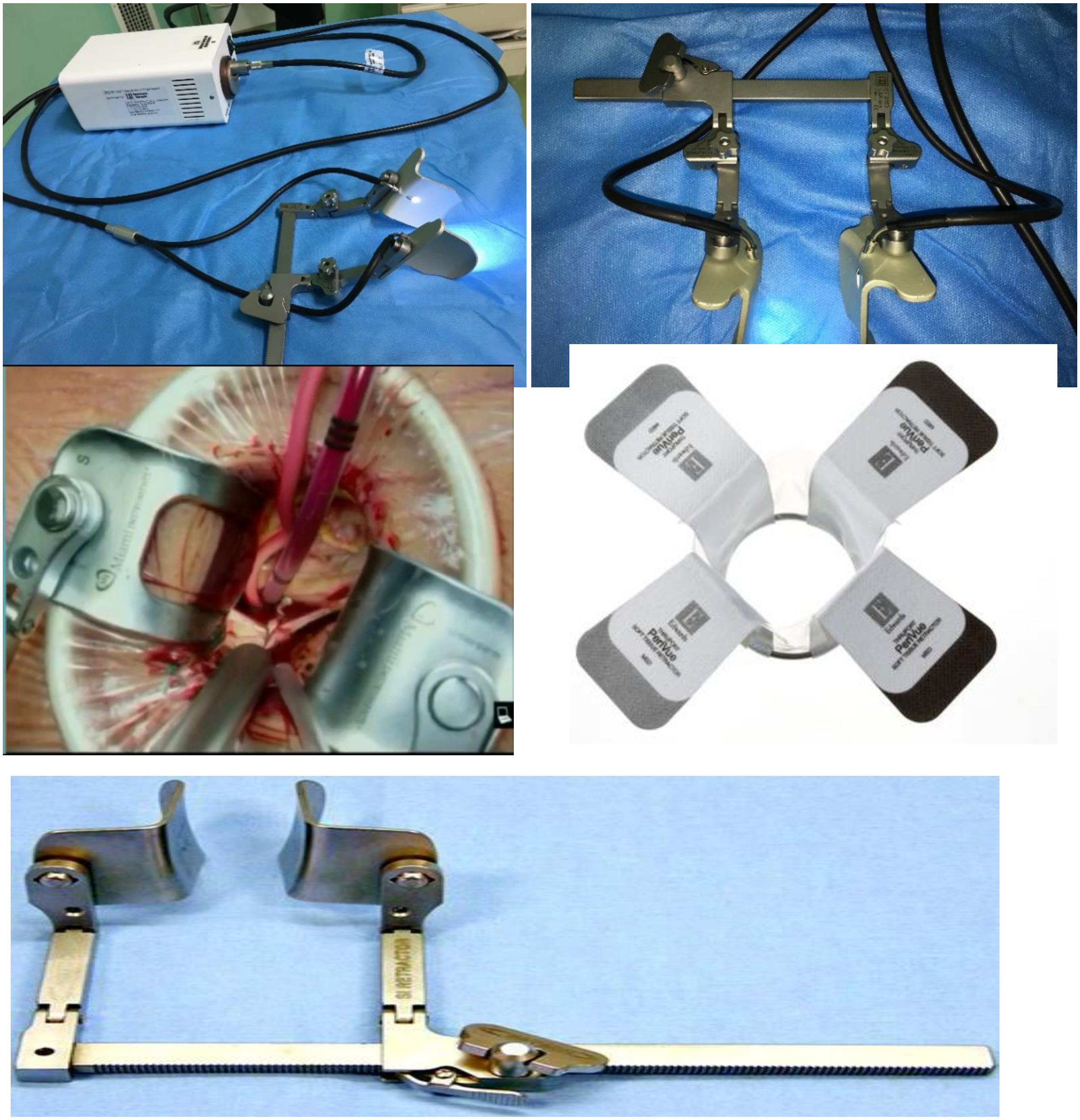


Figure (8) Position of the patient in MIMVS



Figure(9):Specially Design Mimvs Retractor

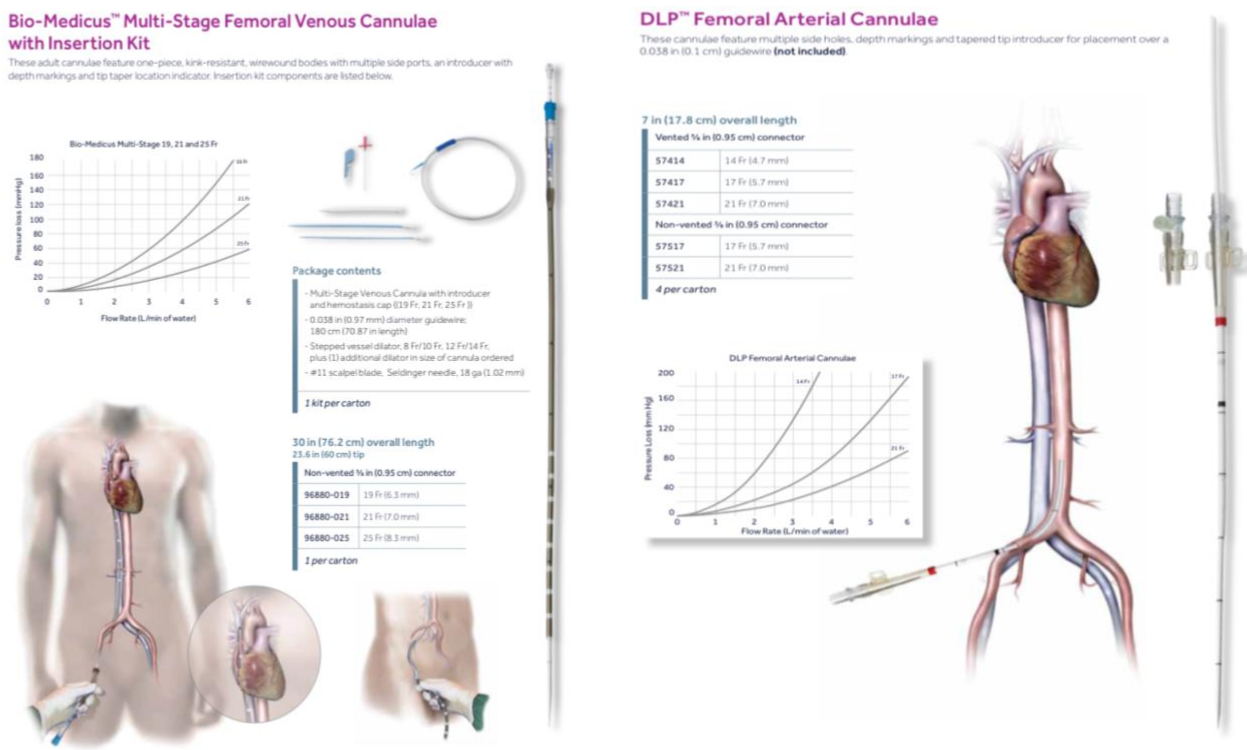


Figure (10): femoral arterial and venus cannulation

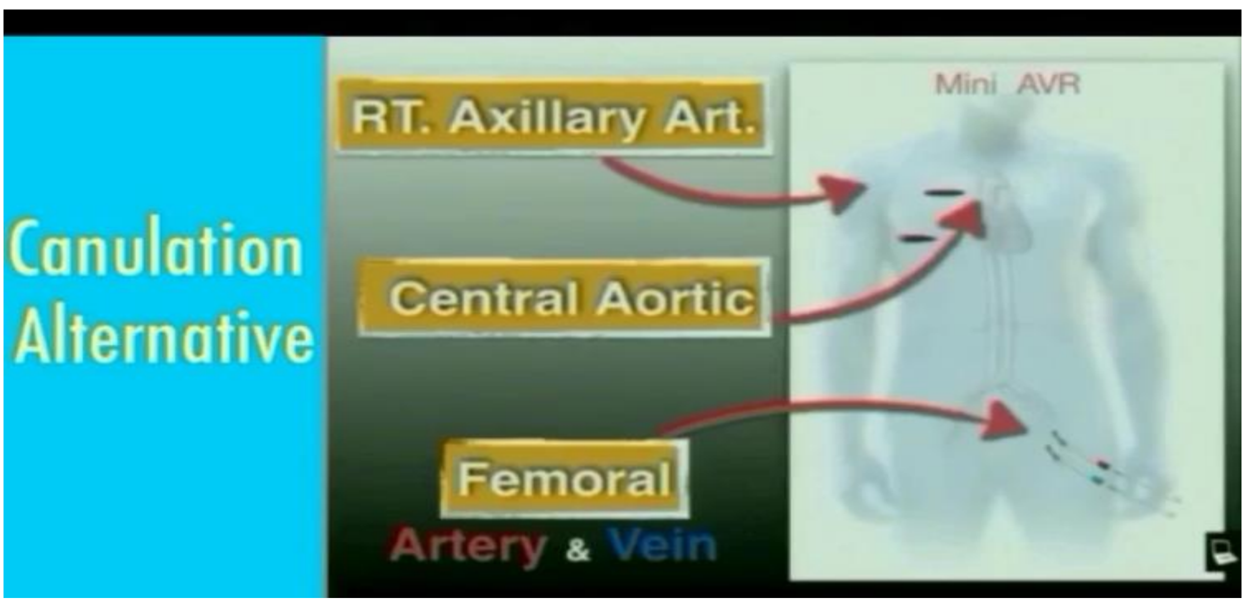
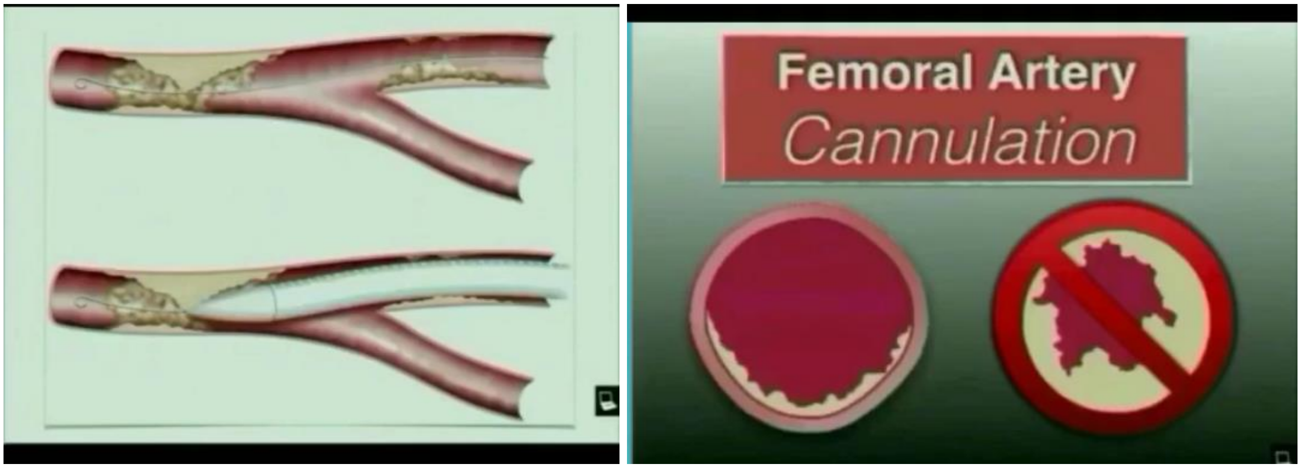
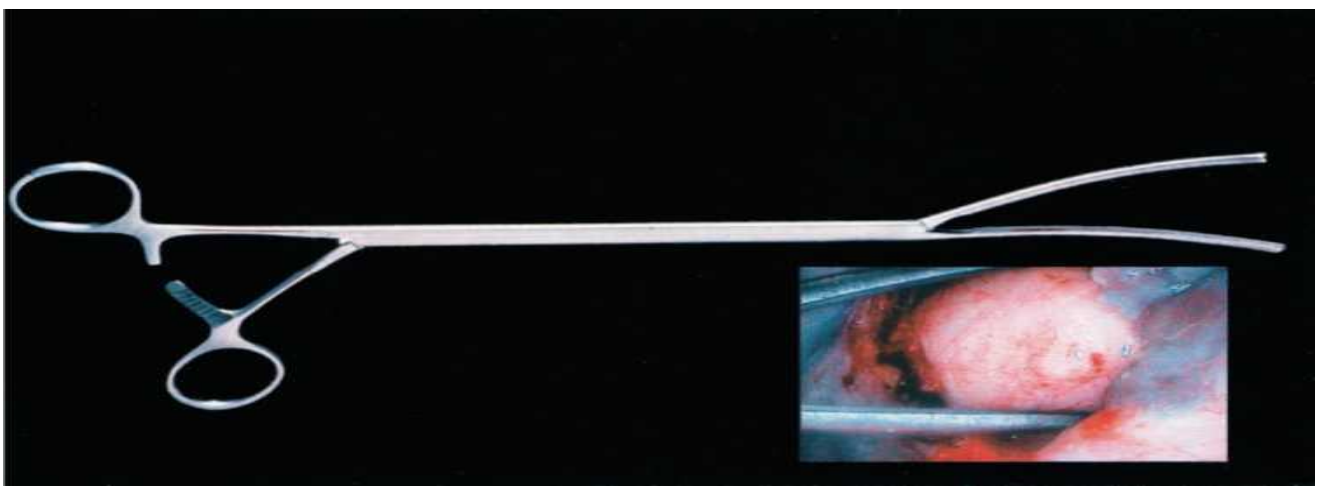


Figure (11): Alternative cannulation



Figure(12): contraindication for femoral artery cannulation



Figure(13): Chitwood aortic cross clamp

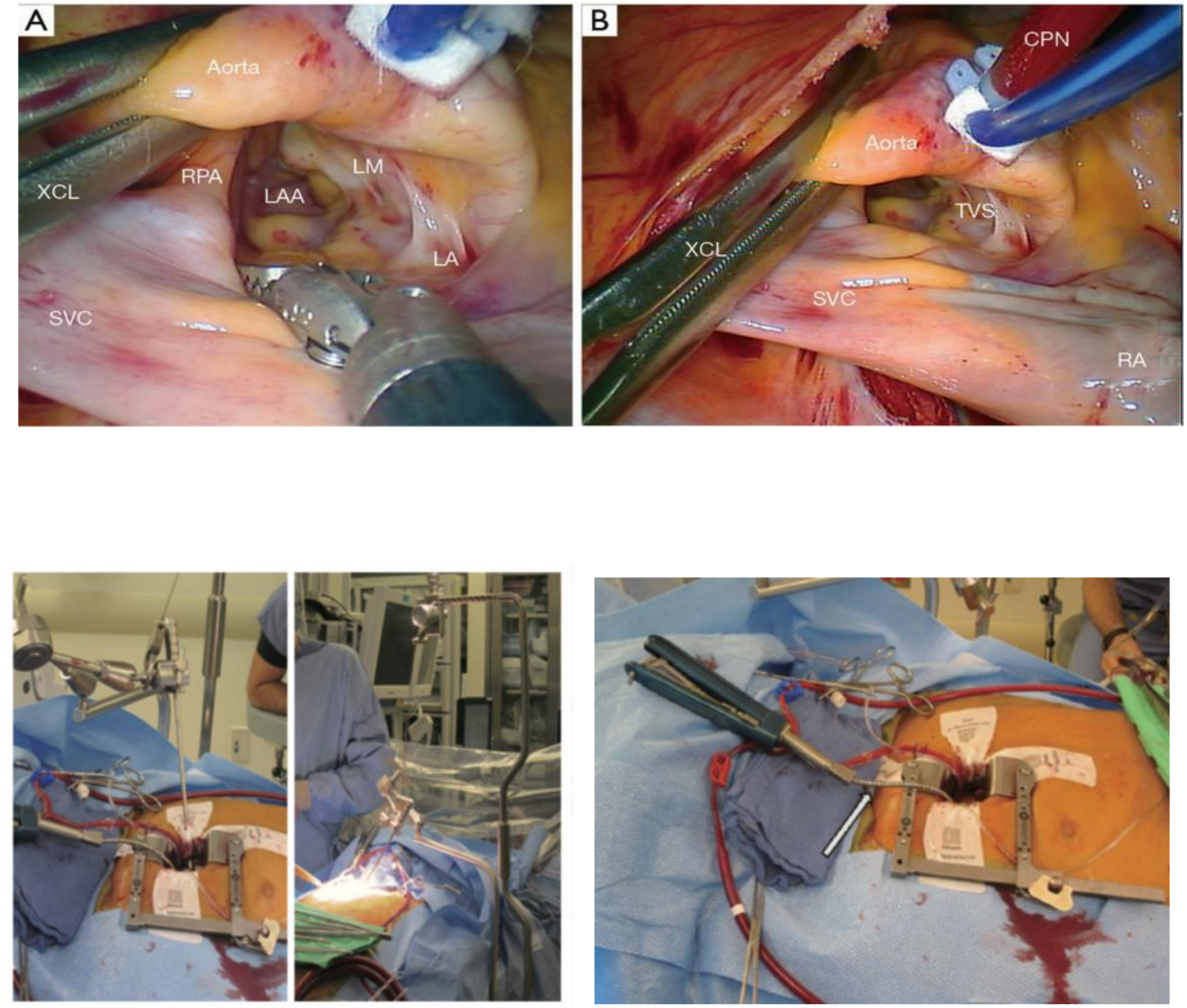


Figure (14): Direct flexible cross clamp

Figure (15): Especially designed long instrument to facilitate the access

Result

In this study 16 patients underwent MIMVS. 12 patients(75%) were females and 4 patients (25%) were males. The male to female ratio is 1:3 while the remaining 10 patients underwent conventional sternotomy, of them 1 patient was female (10%). The male to female ratio was 9:1.

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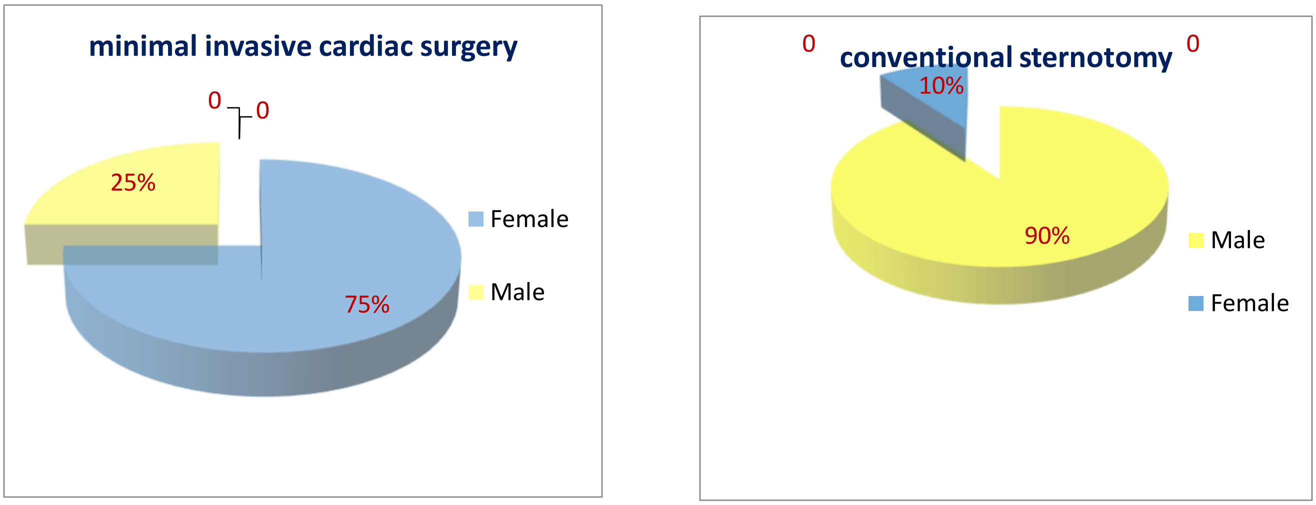


A **B**

Figure (15) The male to female ratio in **(A)** MIMVS **(B)** Conventional sternotomy

In this study the youngest patient was 18-year-old and the oldest one was 61 years old. The mean of the age was 44.7 year. Most of the patients lies between 40 and 50 years.

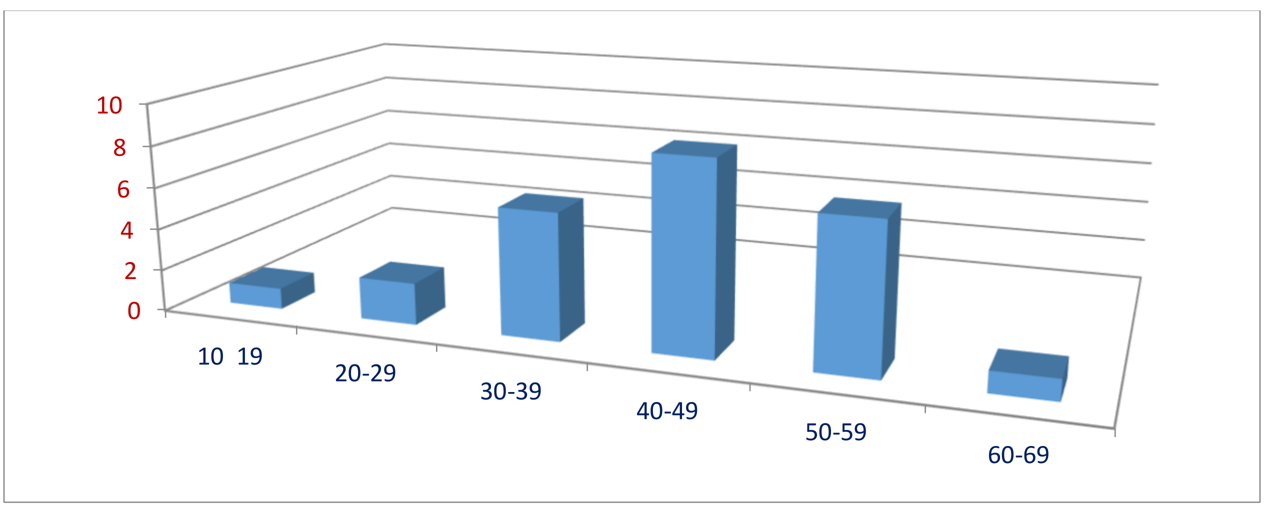


Figure (16) Age distribution of patients who underwent mitral valve replacement

Regarding valve pathology, isolated mitral stenosis was seen in 11 patients (42.3%) while the remaining 15 patients (57.7%)had combined mitral stenosis and regurgitation as seen in the table below.

Table (2)Mitral Valve Pathology

Mitral Valve Pathology	No	
Ms	11	42.3%
Ms&Mr	15	57.7%

MICS was done in 16 patients (61.5%) while the remaining underwent conventional sternotomy.

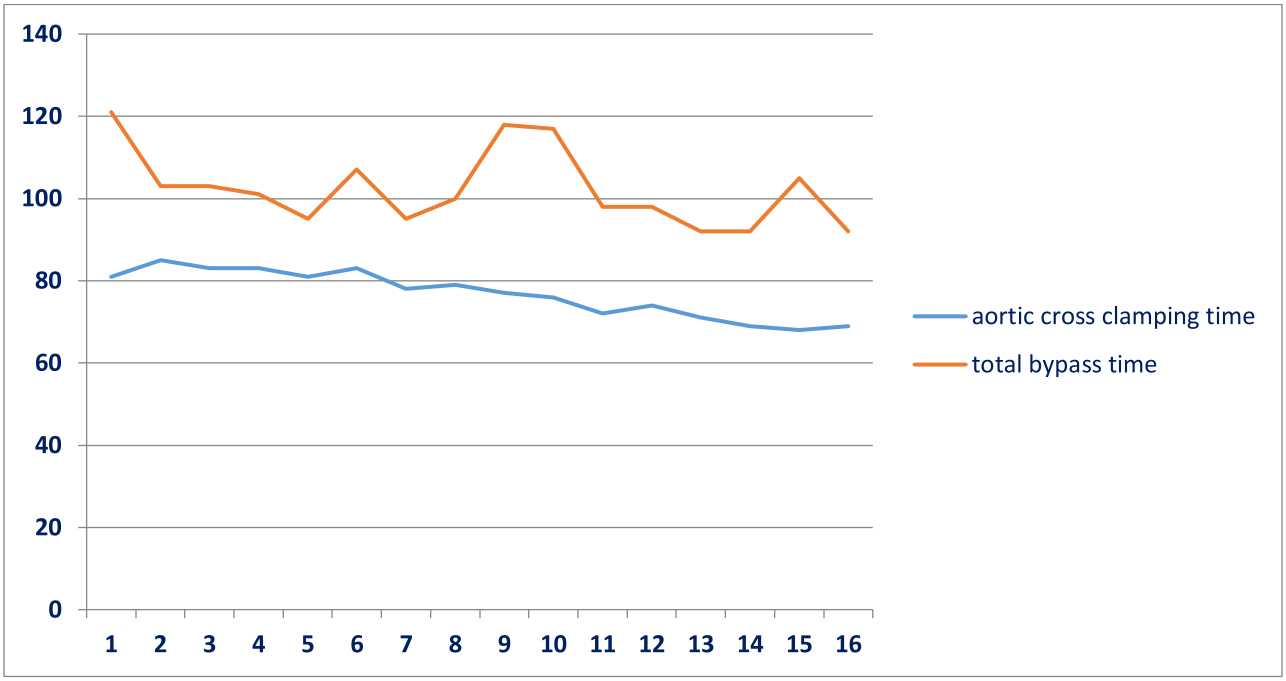
Table (3) Type Of The Surgical Approach Applied

SURGICAL TECHNIQUE		
MIMVS	16	61.5%
Median sternotomy	10	38.5%

The mean of the aortic cross clamping time and total bypass time for MIMVS and conventional sternotomy are shown in the table below:

Table (4)The mean of the aortic cross clamping time and total bypass time for MIMVS and conventional sternotomy

Time	**MIMVS (N=16)**	**Conventional Sternotomy (N=10)**	**P Value**
	Mean±SD	**Mean±SD**	
Cross Clamping Time	**76.81±5.7**	**55.8±6.62**	**<0.001**
Total Bypass Time	**102.31±9.35**	**88.5±10.88**	**0.002**



Time min case number

Figure (17) Learning curve for MIMVS show how the aortic cross clamping time and the total bypass time improve with experience.

There was no reopening for bleeding for all patient with MIMVS while in conventional sternotomy 2 patients (20%) had been reopened for bleeding as seen in the table below:

Table 5 reopening for bleeding in MIMVS and conventional sternotomy

	Reopening For Bleeding		**Total**	**P Value**
	YES	**NO**		
Mimvs	**0(0%)**	**16(100%)**	**16(100%)**	**0.041**
Conventional Sternotomy	**2(20%)**	**8(80%)**	**10(100%)**	

In conventional sternotomy wound infection was seen in 2 patients (20%) while in MIMVS no infection had been reported as seen in the table below:

Table 6 Wound infection in MIMVS and conventional sternotomy

	Wound Infection		Total	P Value
	Yes	No		
MIMVS	0(0%)	16(100%)	16(100%)	0.041
Conventional Sternotomy	2(20%)	8(80%)	10(100%)	

There are no significant differences in postoperative echocardiographic finding between MIMVS and conventional sternotomy approach as seen in tables below:

Table (7) Echo findings in patients undergo MIMVS

Variable	Preop.	Postop	P Value
	Mean±SD	Mean±SD	
EF%	57.56±3.5	59.06±3.75	0.072
EDV	6.106±0.383	5.475±0.362	<0.001
ESV	3.656±0.34	3.525±0.36	0.066
LAS	5.843±0.629	4.25±0.557	<0.001

Table (8) Echo findings in patients undergo Conventional sternotomy

Variable	Preop.	Postop	P value
	Mean±SD	Mean±SD	
EF%	56.7±5.33	59.6±4.69	0.025
EDV	6.17±0.298	5.63±0.447	<0.001
ESV	3.68±0.385	3.57±0.283	0.221
LAS	5.56±0.641	4.19±0.64	<0.001

The mean duration of hospital stay is shown in table bellow

Table(9)

	Groups	N	Mean	Std. Deviation	P Value
Duration Of Hospital Stay/Days	MIMVS	16	6.5000	0.96609	<0.001
	Conventional Sternotomy	10	12.2000	2.34758	

There is significant difference between mean duration of hospital stay which is less in MIMVS group

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Discussion

Minimally invasive heart surgery, along with its advanced technology is the most exciting evolution in the history of our specialty. We are constantly moving towards an improved, **low-impact** and **soft-touch** way to treat our cardiovascular patients. In our study among the 16 patient who underwent MICS the male to female ratio was 1:3 compared with 9:1 for patients who underwent conventional sternotomy, which were closely comparable to another study done by Alison F. Ward, et al. Department of cardiothoracic surgery ,New York University school of medicine(52),in which they were 1:4 for patient who underwent MIMVS . This mean that there is moving toward MICS among females due to the superior cosmetic results achieved in comparison to a traditional median sternotomy(figure18). There are obviously no visible scars. In women the scar is tiny and completely hidden in the skin fold underneath the breast. The other potential advantage for minimally invasive surgery is that the right chest or right rib cage incisions are not visible with the usual shirt or blouse worn post operatively.

In our study most of the patients lies between 40 and 55 years (mean age 44.7) which was similar to another study done by David TE.et al(53). that mean age was (45.78) .The majority of the patients had rheumatic valvular disease Typically, there is a latent period of 20-40 years from the occurrence of rheumatic fever to the onset of symptoms. Once symptoms develop, it is almost a decade before they become disabling. Small group of patients are less than 30 years this is due to the fact that in some patients, mitral stenosis progresses more rapidly, presumably due to either a more severe rheumatic insult or repeated episodes of rheumatic carditis due to new streptococcal infections, which results in severe symptomatic mitral stenosis in the late teens and early 20s.

At our institution the current preferred approach for right mini-thoracotomy MV operation is through the 3rd or 4th interspace mini-thoracotomy incision. In men, a 3rd interspace approach allows both excellent mitral viewing and easy access to the aorta for cardioplegia/venting needle placement. In women, our preferred approach is placing the skin incision below the infra-mammary fold with a 4th interspace incision. This approach provides cosmoses for women with a direct view from a lateral perspective into the left atrium and MV.

Typically, the use of specially designed ultra-light retractor to spread the ribs in addition to MIMVS soft tissue retractor in order to allow perfect access, Right or left femoral artery and vein exploration for arterial and venous cannulation; this compared with the operative technique done by Lamelas J, et al(54)in division of cardiac surgery, mount Sinai medical center, Florida which is not different apart from that they used thoracoscopic light instead of ultralight retractor which give the same result .

The means of the aortic cross clamping time and total bypass time for MIMVS were 76.81 min and 102.31 min respectively while in conventional sternotomy they were 55.8 min and 88.5min respectively. Among these two group of patients, ischemic time and cardiopulmonary bypass time were slightly longer after a minimally invasive approach as compared with conventional sternotomy. It is compared with another study done by Glauber et al (55) in cardiothoracic department in Italy (mean aortic cross clamping time88.7 and total by pass time131.4for MIMVS group and 61.4min. and 89.7min.for conventional sternotomy),MIMVS is still has longer ischemic and cardiopulmonary bypass time than conventional sternotomy, and the variation in numbers between two MIMVS groups is due to concomitant procedures including atrial fibrillation ablation and atrial septal defect closure.

Learning curves for the aortic cross clamping time and total bypass time for MIIMVS were calculated. A total of 16 operations by single surgeon performing his first minimally invasive surgery of the mitral valve operation at our institution could be evaluated. We also analyzed operative times (aortic cross-clamp time and total bypass time) according to surgeon experience. The operative times were quite stable from the beginning for the surgeon's experience, with dramatic improvement over time.

There is no reported re thoracotomy for bleeding in MICS group as compared with re sternotomy for conventional sternotomy (20%),while in another study done by Iribarne et al[56]in Columbia university in New York, rethoracotomy for bleeding was2.1% in MIMVS and 8.4%in sternotomy group .the only explanation of this deference is due to small number of patients of our study. The reduction in post-operative hemorrhage, transfusion requirement and reopening has been suggested for as a potential advantage of minimally invasive valve surgery. This benefit is important given the significant morbidity and mortality associated with transfusion and re exploration for bleeding.

In conventional sternotomy wound infection was seen in 2 patients (20%) while in MICS no infection had been reported. while in similar study done by Schmitto et al[57]wound infection in sternotomy group5.7% and 0.9% in MIMVS group. This difference may be explained by additional risk of groin complication associated with MIMVS group in their study .

there are no significant differences Regarding the echocardiographic finding post operatively in both procedure. It is closely compared to other study done by Mishra et al[58].in Escorts Heart institute, New Delhi, India that provide clear evidence to the safety and efficacy of this approach similar to those of conventional sternotomy approach. However ,the extra cardiopulmonary bypass time is mostly due to extra precautions necessary to properly remove air from heart.

Minimally invasive mitral valve surgery patients commonly are extubated earlier and have a shorter hospital stay (mean=6.5days) than conventional sternotomy patients (mean=12.2days) which is similar to another study done by Svensson et al[59] in Cleveland Research Institute ,Ohio, in which the mean postoperative length of hospital stay was 6days after MIMVS , and 10.3 days after conventional sternotomy. The decreased intensive care unit and total hospital length of stay ,the faster physical rehabilitation, and consequently less use of hospital resources, all these make MIMVS cost effective and cost saving strategy for mitral valve surgery compared with traditional approach .

The mortality rate after MIMVS versus conventional sternotomy was similar at 30 days (0 %).it compared with another study done by Glauber et al [55] which was the same mortality at 30days,but different at 1year,5year mortality(2.1%,1.7% respectively)the only explanation is limited number of cases and short duration of our study.

A number of clinical outcomes were significantly improved with MIMVS versus conventional sternotomy including chest tube drainage, transfusions, sternal infection (0% vs 20%), time to return to normal activity, and patient scar satisfaction.

Conclusion

- MIIMVS has been proven to be a feasible alternative to the conventional full sternotomy approach with low perioperative morbidity and short-term mortality.

- In comparison with conventional sternotomy, MIMVS is associated with decreased bleeding, blood product transfusion, sternal wound infection, scar dissatisfaction, ventilation time, intensive care unit stay, hospital length of stay, and reduced time to return to normal activity, without detected adverse impact on long-term.
- MIMVS is associated with increased aortic cross-clamp, cardiopulmonary bypass when compared with conventional sternotomy.
- Return to the operating room for bleeding was lower in MIMVS group compared with conventional sternotomy. Transfusion was less frequent after minimally invasive surgery than after conventional surgery.
- Comparisons of the 2 techniques observed similarly excellent outcomes for both types of operations, with no apparent drawbacks of the MIMVS approach.
- A true learning curve exists for minimally invasive surgery of the mitral valve. Such information could be very helpful in structuring future training and maintenance of competence programs for this kind of surgery.

Recommendation

- Mitral valve replacement through a small thoracotomy is technically demanding. Therefore, screening out patients who are not appropriate for performing minimally invasive surgery is the first step. Vascular disease and inadequate anatomy can be evaluated with contrast-enhanced computed tomography. Peripheral cannulation should be carefully performed. Valve replacement can be performed in minimally invasive surgery as long as cardiopulmonary bypass is stable and bloodless exposure of the valve is obtained.
- In spite of low our rethoracotomy rate, we should incorporate other methods to minimize the chance of this complication occurring (eg, using the thoracoscope to inspect the inner thoracic wall thoroughly before closing the incision).

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