The Outcomes of Intraoperative Transesophageal Echocardiography-Guided Mitral Valvuloplasty

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Objective: *To analyze the result of mitral valve repair after intraoperative transesophageal echocardiography (TEE), performed by certified individuals, being used as a routine standard intraoperative monitoring.*
Material and Method: *A single center, retrospective chart review combined with prospective cohort study of 325 consecutive patients undergoing mitral valve repair from March 2009 to November 2013 was conducted. Survival rate, mitral regurgitation (MR) recurrence and other adverse events were collected and analyzed.*
Results: *There were a total of 266 patients with complete data included in the study. Early perioperative mortality was 2.6% (7 deaths, 0 to 30th postoperative day) and late mortality was 3.8%. The MR recurrence was 3.9% per year. Annular dilatation (53%), prolapsed (36.8%) and flail (19.6%) posterior mitral valve leaflet were the 3 most common causes of MR. The most frequently employed surgical techniques were ring annuloplasty in 250 (94%) patients and quadrangular resection in 57 (21.4%) patients. Kaplan-Meier analysis demonstrated freedom from death and recurrent MR were 89.7% at 1 year, 86.9% at 2 year, and 81.4% at 4 years after the procedure. Univariate analysis identified the chordal transfer technique a risk factor for MR recurrence (RR 8.976, 95% CI 1.64 to 32.67, p>0.01).*
Conclusion: *The outcome of mitral valve repair at our institution in the era of standard TEE guidance is favorable. The chordal transfer repair technique was identified as a risk factor for MR recurrence.*

Keywords: *Mitral regurgitation, Mitral valvuloplasty, Mitral valve repair, MR recurrence, Transesophageal echocardiography, Intraoperative transesophageal echocardiography*

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Mitral regurgitation (MR) is the most common valvular pathology in adult patients[1]. Mitral valve (MV) repair has been accepted as the procedure of choice for the treatment of mitral regurgitation[2,3]. The advantages over MV replacement include greater freedom from re-operation and endocarditis, superior preservation of left ventricular (LV) morphology and function, decrease in thromboembolic complications and improved survival[3-6]. Transesophageal echocardiography (TEE) is proven valuable for mitral valve assessment[7]. Despite an after load reduction associated with general anesthesia, intraoperative TEE can be performed with hemodynamic adjustment[8]. The intraoperative TEE is currently considered a standard practice for mitral valve repair[9-11].

Ten-year survival with freedom from redo mitral valve surgery varies from 72% to 90%[12-14]. Risk factors influencing the early and late outcomes of patients with mitral valve regurgitation should be assessed to facilitate perioperative decision making. However, there was no available national outcomes of TEE guided MV repair. We, therefore, conducted this study to report the outcomes of TEE guided mitral valve repair and also to identify the variables which may potentially be associated with adverse outcomes including death, re-operation and re-hospitalization.

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Material and Method

Patients selection

This study design was approved by the Institutional Review Board (Si 219/2013), the inpatient database was searched for all patients who had MV repair between March 2009 and November 2013 in which the TEE was performed routinely. There were

325 consecutive adult patients who underwent MV repair with or without other concomitant procedures included in the study. Patients with isolated mitral stenosis were excluded.

Transesophageal echocardiography

All intraoperative TEE examinations were performed according to the ASE/SCA guideline[14] using Philips iE33 and digitally acquired and archived on the Xcelera system. All studies were independently read by anesthesiologists certified in perioperative echocardiography. MR was graded as none or trace (grade 0), mild (grade 1), moderate (grade 2), moderate to severe (grade 3) or severe (grade 4). If conflicting results were reported, the senior TEE certified anesthesiologist would review and determine the final grade of MR.

Operative techniques

Operations were performed through median sternotomy, bicaval cannulations, and the standard technique of cardiopulmonary bypass with moderate hypothermia. Myocardial protection was obtained with combined intermittent anterograde and retrograde cold blood cardioplegia through the aortic root and the coronary sinus without topical cooling.

Follow-up

Data on intermediate outcomes were obtained from medical records, mailed questionnaire and phone interview. Postoperative transthoracic echocardiography (TTE) was performed by cardiologist prior to discharge and periodically at 1 or 12 or 24 or 36 months (no institutional standard practice). Recurrence of MR was defined as MR greater than moderate to severe (grade 3) or severe (grade 4) from the most recent follow-up TTE. Adverse outcomes such as death, reoperation, re-hospitalization, were acquired from hospital databases and also from patient family telephone interview. The primary outcome is the composite death rate combined with MR recurrence, whereas the secondary outcome defines other morbidities that mandate re-hospitalization.

Statistical analysis

Sample size was calculated by nQuery Advisor (version 7.0). We used the MR recurrence rate previously reported in Asian population at 10%[15]. At 95% confidence interval (CI) with the distance from proportion to limit at 4%, the actual calculated sample size was 217. Since the majority of cases were analyzed retrospectively, we estimated 50% probability of data losses, the final adjusted sample size then became 325 patients.

Data were presented as frequency distributions and percentages. Descriptive statistics are reported as a mean $\pm$ standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Univariate analysis was performed to identify the independent risk factors for recurrent MR, presented with incidence (100 person-year) and relative risk (RR). Unadjusted survival curve and freedom from MR recurrence were calculated with the Kaplan-Meier method and were univariately compared using the log-rank statistic. A p-value <0.05 was considered statistically significant. The adjusted risk ratios for the independent predictors and their 95% confidence intervals are presented in the tables. All data were analyzed using PASW Statistics for Windows, version 18.0 Chicago: SPSS, Inc.

Results

There were 325 patients who initially met the study criteria. We excluded 59 patients because of data loss and follow-up failure, which yielded 266 patients (81.9%) with complete follow-up and represented 407.74 person-years. The median length of follow-up was 18.4 months. The mean age was 57.9$\pm$16.4 years. There were 149 (56%) men and 117 (44%) women. Preoperative echocardiography revealed moderate to severe MR (grade III) in 6 (2.3%) and severe MR (grade IV) in 223 (83.8%) patients (Table 1). There were 7 patients (2.6%) with preoperative mild MR who underwent coronary artery bypass graft with MV repair. The MR etiologies are listed in Table 2. Myxomatous degeneration and ischemic heart disease were accounted for the two most common etiologies of MR in the study population.

Mechanisms of MR, surgical repair techniques and other concomitant operation(s) were also shown in Table 2. Annular dilatation was the most common cause, followed by prolapsed posterior mitral valve leaflet (PML) and flail PML. Predominantly, MV repair with quadrangular resection or triangular resection with ring annuloplasty were performed in over 94% of cases.

There were 7 (2.6%) early in-hospital mortality from sepsis as a consequence of ventilator associated pneumonia (VAP) (n = 5) and intracerebral hemorrhage (n = 2). There were also 10 late deaths (3.8%). Common causes of death include sepsis, pneumonia, intracerebral hemorrhage, and acute myocardial infarction. The most common cause of re-hospitalization was non-cardiac causes i.e.

Table 1. Preoperative patient and echocardiographic data

Demographic data	Total (n = 266)
Age (yr)	57.9±16.4
BMI (kg/m^2)	23.3±4.2
Gender: Male	149 (56)
NYHA classification	
I-II	160 (60.2)
III	102 (38.3)
IV	4 (1.5)
Cardiac rhythm	
Sinus rhythm	165 (62)
Atrial fibrillation	92 (34.6)
Pacing	5 (1.9)
Atrial flutter	4 (1.5)
Co-morbidity	
Hypertension	142 (53.4)
Coronary artery disease	83 (31.2)
Congestive heart failure	77 (28.9)
Diabetes mellitus	48 (18)
Renal impairment (Creatinine >2 mg/dL)	26 (9.8)
Previous stroke	12 (4.5)
Chronic obstructive lung disease	6 (2.3)
Other concomitant diseases	36 (13.5)
Preoperative left ventricular ejection fraction	
≥60%	197 (74.1)
31 to 59%	53 (19.9)
≤30%	16 (6.0)
Severity of mitral regurgitation	
Mild	7 (2.6)
Moderate	30 (11.3)
Moderate to Severe	6 (2.3)
Severe	223 (83.8)
Pulmonary artery systolic pressure (mmHg)	50.9±18.1
Left atrial size (cm)	5.29±1.04

Data are presented as mean ± SD or n (%)

Table 2. Etiology, mechanisms of mitral regurgitation, mitral valve repair techniques and concomitant operation(s)

	Total (n = 266)
Etiology of mitral regurgitation	
Myxomatous degeneration	169 (63.5)
Ischemic heart disease	55 (20.7)
Infective endocarditis	17 (6.4)
Congenital mitral valve cleft	11 (4.1)
Unknown	9 (3.4)
Rheumatic heart disease	4 (1.5)
Dilated cardiomyopathy	1 (0.4)
Mechanism of mitral regurgitation	
Annular dilatation	141 (53.0)
Prolapsed posterior mitral leaflet	98 (36.8)
Flail posterior mitral leaflet	52 (19.6)
Prolapsed anterior mitral leaflet	39 (14.7)
Restricted posterior mitral leaflet	19 (7.2)
Cleft	12 (4.5)
Flail anterior mitral leaflet	10 (3.8)
Leaflet perforation	4 (1.5)
Restricted anterior mitral leaflet	1 (0.4)
Mitral valve repair techniques	
Ring annuloplasty	250 (94.0)
Quadrangular resection of posterior mitral leaflet	57 (21.4)
Triangular resection of posterior mitral leaflet	52 (19.5)
Commissuroplasty	22 (8.3)
Sliding plasty	20 (7.5)
New chordae formation	20 (7.5)
Chordal transfer	12 (4.5)
Triangular resection anterior mitral leaflet	11 (4.1)
Funnel shape resection	7 (2.6)
Quadrangular resection anterior mitral leaflet	5 (1.9)
Concomitant procedures	
Coronary artery bypass surgery	80 (30.1)
Tricuspid valve repair	53 (19.9)
Aortic valve surgery	21 (7.9)
Maze operation	15 (5.6)
Atrial septal defect closure	11 (4.1)
Patent foramen ovale closure	9 (3.4)
Ascending aortic replacement	5 (1.9)
Ventricular septal defect closure	2 (0.8)

Data presented as n (%)

pneumonia, pleural effusion and cerebrovascular accident (Table 3). Using the classical Kaplan-Meier approach, freedom from death and recurrent MR were 89.7% at 1 year, 86.9% at 2 years, and 81.4% at 4 years (Fig. 1). Recurrent MR (moderate to severe or severe; grade III-IV) was noted in 16 patients from the follow-up 407.74 person-years (3.9% per year, 95% CI 2.24 to 6.37). There were 10 patients (3.8%) who required redo MV surgery (8 patients for valve replacement and 2 patients for redo MV repair). Common clinical presentations for recurrent MR were intravascular hemolysis and congestive heart failure. The intraoperative and postoperative echocardiographic data are summarized in Table 4.

Intraoperatively, the pre-Cardio Pulmonary Bypass (CPB) TEE identified an undiagnosed patent

foramen ovale (PFO) in 5 patients (1.9%). The intraoperative post-CPB TEE identified 2 patients with grade 3 or more residual MR and 1 patient with residual severe tricuspid regurgitation (TR). All of these patients were immediately returned to CPB for redo MV or tricuspid repair. Those 2 patients with immediate residual MR suffered early hospital death with intracerebral hemorrhage as described above. The relationship between co-morbidity, etiology, mechanism of MR, surgical technique and MR recurrence are shown in Table 5. Chordal transfer technique was found to be a major risk factor for MR recurrence (RR 8.98, 95% CI 1.64 to 32.67, $p<0.01$). Concomitant coronary artery disease (CAD) also showed statistical significance by p-value (RR 0.16; 95% CI 0.003 to 1.06, $p = 0.04$) but the 95% confidence interval has crossed the null hypothesis (1).

Table 3. Postoperative complications

Complications	Total (n = 266)
Death	
Early (<30 day)	7 (2.6)
Late (≥30 day)	10 (3.8)
Re-operation	
Mitral valve replacement	8 (3)
Re-operation for bleeding	5 (1.9)
Mitral valve repair	2 (0.8)
Others	5 (1.9)
Re-hospitalization	
Non-cardiac causes	28 (10.5)
Heart failure	15 (5.6)
Other cardiac causes	9 (3.4)

Data presented as n (%)

Discussion

Intraoperative TEE of modern technology (the ultrasound system that can display more than M-mode) has been used since early 1980's[16]. The early guidelines recommended TEE in cardiac surgeries that involve valve repairs[17]. The later guidelines have broaden the recommendation to use TEE for all open heart surgeries and also suggested its role for certain non-cardiac surgeries[18].

At our institution, the earliest use of intraoperative TEE can be traced back to early 1990's. At the beginning, the cardiologists were frequently

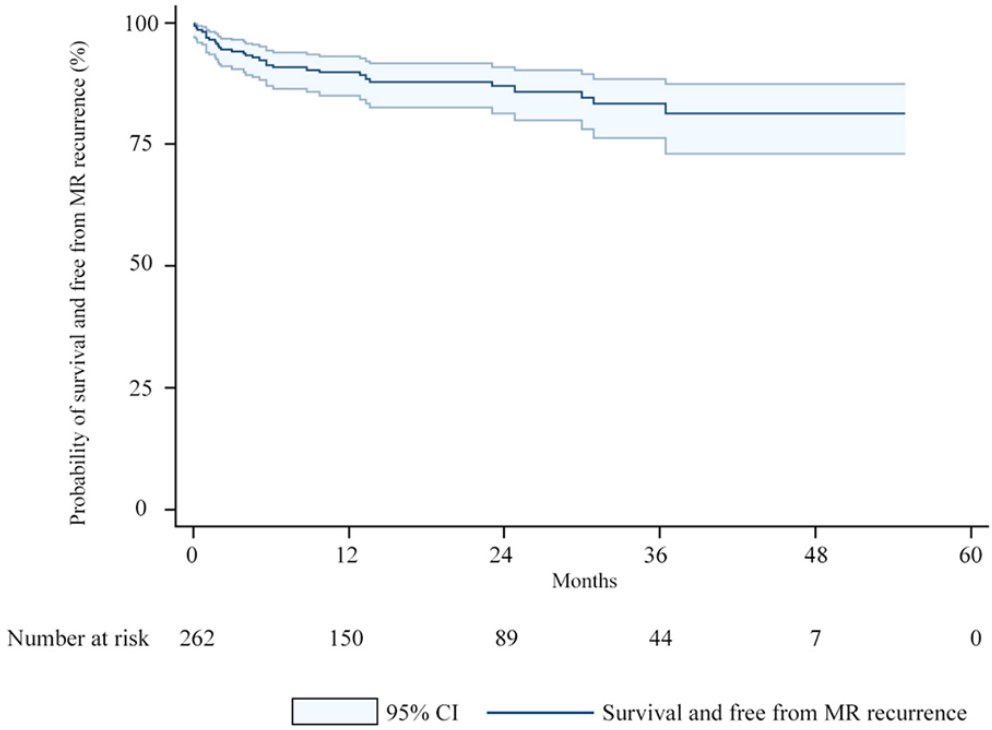

Fig. 1 Kaplan-Meier estimates of the probability for primary outcomes (composite rate of survival and free from MR recurrence).

Table 4. Intraoperative and postoperative echocardiographic data

Parameter	Pre-CPB	Post-CPB	1 month	12 months	24 months	36 months
Ejection fraction (%)	60 (19 to 88)	57 (15 to 70)	55.5 (12 to 79)	62 (16 to 80)	62 (22 to 77)	61 (40 to 69)
Mitral regurgitation (grade)	4 (1 to 4)	0 (0 to 2)	0 (0 to 4)	1 (0 to 4)	0 (0 to 4)	1 (0 to 4)

Data presented as median (min-max), CPB = Cardiopulmonary bypass
Mitral regurgitation grading: grade 0 = none or trace, grade 1 = mild, grade 2 = moderate, grade 3 = moderate to severe, grade 4 = severe

summoned to the operating room to perform TEE during the critical period i.e. post repair, etc. It was not until 2006 that the standardized intraoperative TEE practice begun. It was the time when a group of newer generation of anesthesiologists who were officially trained and certified in perioperative TEE joined the team. This is when all our valve repair cases were guided by TEE.

This study demonstrated satisfactory intermediate results for MV repair, with early (2.6%) and late (3.8%) mortalities which are comparable to other recent European and American studies which reported mortality rates ranging from 1.3% to 5.5%[3,6,19,20]. Our re-operation rate for recurrent MR (3.9% per year) was similar with the study of Flameng et al[21] and other recent series[5,22,23]. Their severe MR recurrence were at 3.7% per year. It is important to note that the MR etiology has changed in the last decades[24] as in our study in which the causes of MR were from degenerative and ischemic nature. In our study, 91.5% of ischemic MV repair were performed in patients undergoing coronary artery bypass grafting in which the MR is less severe and more feasible to repair when compared to other subgroups.

Typically, mitral regurgitation from PML lesions are more feasible to repair and have better outcomes[3,6]. Partial resection of prolapsed segments, sliding plasty combined with uses of annuloplasty ring or annuloplasty band are the most commonly used techniques for PML defects as reported in our study. Chordal transfer technique was done in most AML lesions (83.3%). Preferably, this technique is used to repair a prolapsed AML, however, its technical complexity contributes to the majority of MR recurrence[12]. One large published series from De Bonis et al[25] which included 133 patients, followed for a median of 3 years, in whom prolapsed AML was treated with the edge-to-edge technique, a relatively new repair strategy, they estimated a 10-year freedom from re-operation of 96.5%.

This study has several limitations. The retrospective nature does not allow us to control many variables which may influence the severity of MR presented intraoperatively i.e. fluid status, uses of preoperative diuretics, anesthetic techniques, control of hemodynamic variables, etc. There was also no standard institutional TTE follow-up practice guideline which resulted in our postoperative follow-up TTE data as a non-uniform and incomplete specific time interval among patients. Our analysis of MR recurrence was reported as crude relative risk from univariate analysis based on the composite person-years follow-up data. We were unable to provide analysis based on specific time point of event using Cox proportional Hazard ratio. The study was also not designed to compare between different operative techniques directly and it may be unjustified to make assumptions regarding those aspects. There were also variable personal preferences of each surgeon to proceed with MV repair or replacement, especially for MR from AML lesions.

We also encountered the problem of interpreting the concomitant CAD as the risk factor since its $p<0.05$ but the 95% CI had crossed the null hypothesis. We have reviewed the numbers to exclude errors and obtained another statistical analysis, which yielded the same results. The raw data revealed that in the concomitant CAD subgroup of 83 patients, in which 7 of them were labeled with mild MR preoperatively, 80 of them underwent combined CABG with MV repair (Table 3). There was only 1 patient with MR recurrence in this subgroup. It is not impossible to assume that concomitant CAD may be a protective factor for MR recurrence based on the fact that majority of these MRs were functional MR. Hence, cardiac revascularization along with MV repair could result in a better outcome when compared to those isolated MRs which were caused by leaflet pathology. However, the study was not designed to prove this hypothesis and the sample number was too underpowered. After a thorough discussion with experts and statisticians, we decided that we are unable to make a conclusion that a

Table 5. Relationship between co-morbidities of patient, etiology, mechanisms of mitral regurgitation, repair techniques and recurrent mitral regurgitation

Factors	Total (n = 266)	Person-years of follow-up	Incidence (100 person -years)	Crude Relative Risk	95% CI	*p*-value
Co-morbidities						
Hypertension	142 (53.4)	221.56	3.16	0.65	0.21 to 1.97	0.41
Coronary artery disease	83 (31.2)	118.16	0.84	0.16	0.003 to 1.06	0.04
CHF	77 (28.9)	102.26	4.88	1.36	0.37 to 4.24	0.56
Diabetes	48 (18)	81.82	1.22	0.27	0.01 to 1.73	0.17
Renal impairment (Creatinine >2 mg/dL)	26 (9.8)	102.26	4.89	0.78	0.02 to 5.05	0.90
Etiology of mitral regurgitation						
Myxomatous degeneration	169 (63.5)	265.44	5.27	-	-	-
Ischemic heart disease	55 (20.7)	81.88	1.22	-	-	-
Infective endocarditis	17 (6.4)	18.36	5.44	-	-	-
Congenital mitral valve cleft	11 (4.1)	-	-	-	-	-
Unknown	9 (3.4)	-	-	-	-	-
Rheumatic heart disease	4 (1.5)	-	-	-	-	-
Dilated cardiomyopathy	1 (0.4)	-	-	-	-	-
Mechanisms of mitral regurgitation						
Annular dilatation	141 (53)	228.08	2.63	0.47	0.14 to 1.44	0.15
Prolapsed posterior mitral leaflet	98 (36.8)	142.03	3.52	0.85	0.23 to 2.65	0.79
Flail posterior mitral leaflet	52 (19.6)	85.35	4.68	1.24	0.29 to 4.11	0.68
Prolapsed anterior mitral leaflet	39 (14.7)	48.25	8.29	2.48	0.58 to 8.19	0.14
Restricted posterior mitral leaflet	19 (7.2)	28.48	3.51	0.88	0.02 to 5.72	0.99
Cleft	12 (4.5)	-	-	-	-	-
Flail anterior mitral leaflet	10 (3.8)	-	-	-	-	-
Leaflet perforation	4 (1.5)	-	-	-	-	-
Restricted anterior mitral leaflet	1 (0.4)	-	-	-	-	-
Mitral repair techniques						
Ring annuloplasty	250 (94.0)	382.65	3.92	0.98	0.15 to 41.41	0.90
Quadrangular resection posterior mitral leaflet	57 (21.4)	83.71	2.39	0.55	0.06 to 2.41	0.46
Triangular resection posterior mitral leaflet	52 (19.5)	81.65	4.89	1.33	0.31 to 4.39	0.65
Commissuroplasty	22 (8.3)	33.70	2.96	0.74	0.02 to 4.81	0.87
Sliding plasty	20 (7.5)	34.40	5.82	1.55	0.17 to 6.75	0.54
New chord formation	20 (7.5)	25.90	3.86	0.98	0.02 to 6.39	0.54
Chordal transfer	12 (4.5)	10.16	29.52	8.98	1.64 to 32.67	<0.01
Triangular resection anterior mitral leaflet	11 (4.1)	19.73	5.06	1.31	0.03 to 8.52	0.28
Funnel shape resection	7 (2.6)	14.26	7.01	1.84	0.04 to 11.95	0.54
Quadrangular resection anterior mitral leaflet	5 (1.9)	-	-	-	-	-

Data presented as n (%)

concomitant CAD is a protective factor for MR recurrence.

Conclusion

This study revealed favorable clinical intermediate results following mitral valve repair with TEE guidance by certified anesthesiologists. Risk factor associated with recurrent MR was chordal transfer surgical technique. We appreciate the role of intraoperative TEE and the availability of TEE board

certified anesthesiologists. Further study is needed to prove whether concomitant CAD can be a protective factor for MR recurrence.

What is already known in this topic?

The outcome of mitral valvuloplasty in modern era when TEE is routinely used as reported from the western populations.

What is this study adds?

The outcome of mitral valvuloplasty guided with TEE from a single center. Chordal transfer technique was identified as a risk factor for postoperative MR recurrence.

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Potential conflicts of interest

None.

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ผลการรักษาผ่าตัดซ่อมแซมลิ้นไมตรัลที่มีการตรวจด้วยคลื่นเสียงสะท้อนความถี่สูงผ่านหลอดอาหาร

กฤษณะ นองเนือง, กำแหง วัชรักษะ, กษณา รักษมณี, ศิริลักษณ์ สุขสมปอง, ประเสริฐ สวัสดิ์วิภาชัย

วัตถุประสงค์: *การศึกษาครั้งนี้ทำขึ้นเพื่อวิเคราะห์และรายงานผลการผ่าตัดซ่อมแซมลิ้นไมตรัลในสถาบันการแพทย์ที่มีการใช้การตรวจหัวใจด้วยคลื่นเสียงสะท้อนความถี่สูงผ่านหลอดอาหารโดยผู้ที่มีวุฒิบัตรดังกล่าว*

วัสดุและวิธีการ: *เป็นการศึกษาโดยค้นข้อมูลผู้ป่วย 325 รายที่เข้ารับการผ่าตัดซ่อมแซมลิ้นไมตรัลที่โรงพยาบาลศิริราช ตั้งแต่เดือนมีนาคม พ.ศ. 2552 ถึงเดือนพฤศจิกายน พ.ศ. 2556 ข้อมูลการศึกษาได้จากการสืบค้นแฟ้มผู้ป่วยแบบย้อนหลัง การตอบแบบสอบถามและติดตามแบบไปข้างหน้าเพื่อประเมินอัตราตาย อัตราการเกิดลิ้นหัวใจไมตรัลรั่วซ้ำ รวมทั้งภาวะแทรกซ้อนอื่น ๆ*

ผลการศึกษา: *อัตราการเสียชีวิตเท่ากับร้อยละ 2.6 (เสียชีวิต 7 คนในระยะ 30 วันแรกหลังผ่าตัด) อัตราตายระยะหลัง เท่ากับร้อยละ 3.8 อัตราการเกิดภาวะลิ้นหัวใจไมตรัลรั่วซ้ำอีกเท่ากับร้อยละ 3.9 ต่อปี กลไกของการเกิดภาวะลิ้นหัวใจไมตรัลรั่วที่พบบ่อยได้แก่ ภาวะขอบนอกลิ้นไมตรัลขยายตัว (ร้อยละ 53) ภาวะแผ่นลิ้นด้านหลังโพล่แลบ (ร้อยละ 36.8) และภาวะแผ่นลิ้นด้านหลังเผละ (ร้อยละ 19.6) เทคนิคการผ่าตัดที่ใช้บ่อยได้แก่ การเย็บซ่อม โดยใช้วงแหวน (ร้อยละ 94) การตัดทิ้งขอบลิ้นรูปสี่เหลี่ยมเพื่อซ่อมแซม (ร้อยละ 21.4) การวิเคราะห์แบบแคปแปลนไมเออร์พบผู้ป่วยที่ยังมีชีวิตอยู่และไม่มีลิ้นไมตรัลรั่วซ้ำเท่ากับร้อยละ 89.7 ที่ระยะเวลา 1 ปี ร้อยละ 86.9 ที่ระยะเวลา 2 ปี และร้อยละ 81.4 ที่ระยะเวลา 4 ปี ผลการวิเคราะห์ยูนิวาริเอตบ่งชี้ว่าปัจจัยเสี่ยงที่ทำให้เกิดการรั่วซ้ำคือเทคนิคการซ่อมโดยการย้ายสายโยงขอบลิ้น (RR 8.98, 95% CI 1.64 ถึง 32.67, p>0.01)*

สรุป: *ผลการรักษาด้วยวิธีผ่าตัดซ่อมแซมลิ้นไมตรัลในสถาบันการแพทย์ที่มีการใช้การตรวจหัวใจด้วยคลื่นเสียงสะท้อนความถี่สูงผ่านหลอดอาหาร ในห้องผ่าตัดได้ผลการรักษาเป็นที่น่าพอใจ การศึกษาพบว่าเทคนิคการซ่อมแซมด้วยวิธีการย้ายเส้นสายโยงขอบลิ้นไมตรับเป็นปัจจัยเสี่ยงที่ทำให้เกิด ภาวะลิ้นไมตรัลรั่วซ้ำ*