

## 1. Introduction

Mitral regurgitation (MR) remains the second dominant defect in the structure of valvular cardiac diseases [1].

It affects more than 2 million people in the USA. Basic causes are classified as degenerative (with valve prolapse) and ischemic (due to ischemic heart disease) in advanced countries or rheumatic ones (in developing countries) [2, 3].

Annual mortality of the patients aged more than 50 who receive only drug therapy is around 3 % for moderate MR and over 6 % for severe organic MR [2].

Alone radical method of MR treatment is surgical correction through mitral valve repair (MVRe) or replacement (MVR) yielding definitely higher survival percentage and improvement of heart failure (HF) class comparing to pharmacotherapy [4].

Evolution of approaches to the management of non-ischemic MR passed through some stages, starting from predominantly MVR to organ-preserving approaches like plastic repair [5], which are optional methods right now. These approaches proved their value because numerous studies showed that MVRe was associated with lower operative mortality comparing to MVR [6].

The aim of this study is the prospective assessment of the features or discrepancies referring to the results of surgical management of the patients with primary mitral regurgitation (MR).

## 2. Methods

In the prospective single-center study are the results of treatment among 72 patients with primary MR, who were subjected to MVR or plastic repair in the Department of cardiac surgery affiliated with Lviv regional clinical hospital since October, 2013 till February, 2016. Registration of all parameters was performed 3 times (pre-op, early post-op period and in 3 months after the operation) using special patient's visit registration form have been analyzed.

The stages of MR and TR were defined – mild, moderate and severe ones. Therefore, a ratio between regurgitation jet area and area of left atrium, vena contracta index and PISA method have been determined.

Echocardiography was performed before the operation, in 5–7 days and in 3 months after the operation. Echocardiograph Sonos 5500 (Phillips) was used with multifrequency cardiac probe (1–2,5 MHz).

## PRIMARY MITRAL REGURGITATION AND RESULTS OF SURGICAL MANAGEMENT IN A PROSPECTIVE STUDY

**Oleksiy Myshakivskyy**

*Cardiac surgeon*

*Department of cardiac surgery*

*Lviv Regional Clinical Hospital*

*7 Chernihivska str., Lviv, Ukraine, 79000*

*Danylo Halytsky Lviv National Medical University*

*69 Pekarska str., Lviv, Ukraine, 79010*

*oleksijmy@gmail.com*

**Abstract:** Mitral regurgitation (MR) remains the second dominant defect in the structure of valvular cardiac diseases [1].

It affects more than 2 million people in the USA. Basic causes are classified as degenerative (with valve prolapse) and ischemic (due to ischemic heart disease) in advanced countries or rheumatic ones (in developing countries) [2, 3].

Alone radical method of MR treatment is surgical correction through mitral valve repair (MVRe) or replacement (MVR) yielding definitely higher survival percentage and improvement of heart failure (HF) class comparing to pharmacotherapy [4].

Evolution of approaches to the management of non-ischemic MR passed through some stages, starting from predominantly MVR to organ-preserving approaches like plastic repair [5].

In the prospective single-center study the results of treatment of 72 patients with primary MR (PMR) who were subjected to mitral valve replacement (MVR) or plastic mitral valve repair (MVRe) performed in the Department of cardiac surgery affiliated with Lviv regional clinical hospital (Ukraine) since October, 2013 till February, 2016 were analyzed.

The conclusions of performed study are the following:

1) Key direct cause of MR is the chordal rupture of MV cusps, etiological factor in the majority of advanced countries is degenerative changes in contrast to rheumatic changes in the developing countries.

2) Principal method of MR surgical correction in our center is MVR, though the preferable global trend is MVRe.

3) Complications and lethality percentages in this study were higher among the patients from MVR group. Improvement of HF class according to NYHA was more evident in the MVRe group.

This corresponds to results of other studies and guidelines that recommend MVRe as optional method for MR correction.

**Keywords:** primary mitral regurgitation, mitral valve replacement, mitral valve repair, tricuspid valve repair, heart failure, effective ejection fraction.

Besides ejection fraction (EF) measurement using Simpson method and Teicholz method so-called “effective” (Doppler-derived) EF of LV was also determined. The essence of this method is based upon the fact that LV stroke volume (SV) is determined with Doppler method and LV end-diastolic volume (EDV) is determined with Teicholz method. EF is calculated by the formula  $LV\ SV/EDV$ .

Statistical analysis was accomplished with an advanced analytics software package “Statistica for Windows 5.0”. Because the studied groups were not equal and parametric variables distributions were not normality (according to Shapiro-Wilk’ W test), they were described with median (lower-upper quartiles). Between-group differences were evaluated using Mann-Whitney U test for continuous and ranked variables or Fisher’s exact test for categorical variables. For qualitative parameters’ (frequency tables) comparison  $\chi^2$ -test was used. Difference between parameters was significant when  $p < 0,05$ .

## 3. Results

Males prevailed in the MVRe group – 12 persons (66,67 %), female prevailed in the MVR group – 29 persons (53,7 %). Age median (minimum-maximum) was 58 years (19–79 years).

The most often etiological factor of MR were MV degenerative changes – 41 patients (56,9 %). The most often direct cause of MR was chordal rupture – 43 cases (59,7 %).

In all patients surgical access was performed through median sternotomy. After the full heparinization heart-lung machine

was connected through cannulation of ascending aorta and both vena cava separately. Moderate hypothermia (28 °C) and cold potassium-blood cardioplegy were used. Applied approaches to the MV were trans-septal one and through the left atrium.

Plastic repair of MV was done in 18 patients (25 %), MVR was performed in 54 patients (75 %).

In the MVRe group before the operation among all patients moderate MR was revealed – 19 persons (100 %).

In the MVR group before the operation moderate MR also was revealed – 54 patients (100 %).

On the 1<sup>st</sup> and 2<sup>nd</sup> control post-op examinations in the MVRe group MR was absent among 16 patients (88,89 %), only 2 patients (11,11 %) had mild MR.

On the 1<sup>st</sup> and 2<sup>nd</sup> control post-op examinations in the MVR group MR was absent among all 51 patients (100 %).

In the MVR group predominantly two cusps were affected – 20 patients (35 %), in the MVRe group posterolateral cusp was involved – 11 patients (23,5 %).

Plastic repair with usage of annuloplasty ring was performed among 17 patients, plastic repair without annuloplasty ring was performed only in 1 patient. Plastic rings produced by “Carpentier Edwards” (n=3 [17,6 %]) and “St. Jude” (n=14 [82,4]) have been used. Rings’ sizes were 36 mm (n=1 [5,88 %]); 34 mm (n=1 [5,88 %]); 32 mm (n=6 [35,29 %]); 30 mm (n=7 [41,18 %]); 29 mm (n=1 [5,88 %]); 28 mm (n=1 [5,88 %]). For neochoords’ preparation Gore-Tex and Ethibond have been used.

4 patients, who underwent MVRe, did not yield satisfactory result during Hydraulic test, so they immediately were subjected to MVR. During the statistical analysis these patients were included into MVR group.

Among the MV prostheses most often ones produced by “St. Jude” – 36 cases (70,6 %), “ATS” – 8 patients (15,7 %), and other companies (“Medtronic”, “Carbomedics”, “Bjork”) – 7 patients have been used. In 1 patient bioprosthesis St. Jude Epic (29 mm) was implanted.

Sizes of the used prostheses were 33 mm (n=1 (1,85 %)); 31 mm (n=1 (1,85 %)); 29 mm (n=20 (38,89)); 27 mm (n=19 (38,89 %)); 26 mm (n=2 (3,70)); 25 mm (n=8 (14,81 %)).

De Vega tricuspid valve repair was performed among 60 patients (83,3 %) (1 patient required additional suturing of TV cusp), among 12 patients (16,7 %) this approach was not used.

Next concomitant procedures at the time of mitral valve repair were performed: 1 coronary artery bypass surgery and 1 PFO closure.

Signs of chronic heart failure (according to NYHA classification) were observed among all 72 pre-op patients.

Among pre-op patients subjected to MVR HF class 2 was dominant – 10 patients (55,56 %).

After the intervention on the 1<sup>st</sup> control examination in MVR group 9 patients (50 %) had HF class 1 and 2.

On the 2<sup>nd</sup> control examination dominated patients with HF class 1 – 14 persons (77,78 %), 2 patients (11,11 %) had HF class 2 and 2 patients (11,11 %) had HF class 0 according to NYHA.

Among pre-op patients from MVR group dominated HF class 3 – 38 persons (70,37 %).

After the operation on the 1<sup>st</sup> control examination among the patients subjected to MVR dominated persons with HF class 2 – 40 patients (74,07 %); also 9 patients (16,67 %) had HF class 3 and 5 patients (9,26 %) had HF class 1.

After the operation on the 2<sup>nd</sup> control examination in this group of patients 29 persons (56,86 %) had HF class 2, 2 persons (3,92 %) had HF class 3 and 20 persons (39,22 %) had HF class 1.

Positive trend referring to restoration of normal cardiac rhythm after the surgical intervention was observed only among the patients subjected to MVRe: 14 pre-op persons (77,78 %) and 16 persons (88,89 %) on the 1<sup>st</sup> and 2<sup>nd</sup> pos-op examination had sinus rhythm.

Negative trend referring to restoration of normal cardiac rhythm after the surgical intervention was observed in the group of patients exposed to MVR: 32 pre-op patients (59,26 %), 31 patients (57,42 %) on the 1<sup>st</sup> post op examination and 29 patients (56,86 %) on the 2<sup>nd</sup> post-op one had sinus rhythm.

Absolute majority of pre-op patients had left ventricular dilatation (LVD), increase of LV and RV end-diastolic volume (EDV) and significant increase of pulmonary artery (PA) systolic pressure. These parameters clearly diminished in several days after the operation and such a dynamics for some indices (size of

right atrium [RA], RV plus PA systolic pressure) and statistically significant improvement of mentioned above echocardiographic post op parameters persisted up to 2<sup>nd</sup> post op examination that testifies about positive remodeling after surgery.

EF measured with Simpson method and Teicholz method has decreased in the early post-op period and subsequently did not significantly change; some increase of EF measured with Simpson method on the 3<sup>rd</sup> examination comparing to the 2<sup>nd</sup> one have been noted. In contrast, the pre-op effective (Doppler-derived) EF was significantly decreased comparing to normal parameters, clearly has increased in the early post op period and has been reliably increasing up to the 3<sup>rd</sup> examination.

In the MVR group one complication (acute dynamic ileus) occurred that required laparotomy and small intestine’s decompression.

In the MVR next complications were observed: pericardial drainage (1 patient); two successive pericardial drainages (1 patient); axillary artery embolism with subsequent thrombectomy (1 patient); acute ischemic stroke (1 patient).

In the MVR group after the operation 3 persons died: one female patient died on the 60<sup>th</sup> day after the surgery (infectious endocarditis with embologenic vegetations of the MV posterolateral cusp and abscess of the LV posterior wall) due to polyorganic (in particular, renal) insufficiency; one male patient (pre-op infectious endocarditis with vegetations and perforation of MV anteromedial cusp); one male patient died due to sudden cardiac arrest with subsequent failed cardiopulmonary resuscitation.

In the group of patients subjected to MVRe due to primary MR during in-patient department stay and next two control visits no lethal cases were revealed.

#### 4. Discussion

MVRe comparing to MVR yields better results and among patients with severe organic MR diminished mortality down to 70%. These results stress the importance of early detection, assessment and management of MR [2].

Long-term studies showed that comparing to medical treatment early surgical intervention on MV among patients with prolapse of cusps was associated with significantly lower risk of the future death due to cardiac causes or HF and longer life expectancy [4].

Echocardiographic methods of MR allow to specify the timely indications for surgical intervention during repeated examinations aimed at regurgitation’s stage assessment [7].

In the study conducted by James et al. [8] it was proved, that during 8 years among 58370 patients subjected to isolated primary operations on MV due to MR (n=47,126) prevalence of MVRe comparing to MVR increased from 51 % to 69 % ( $p<0.0001$ ). Among the patients from MVR group (n=24,404) evident decrease of mechanic prostheses’ usage was observed: from 68 % to 37 % ( $p<0.0001$ ). Surgical mortality in MVR group was significantly higher comparing to MVRe (3.8 % versus 1.4 %,  $p<0.0001$ ) that corresponds to this study results. Among the patients subjected to selective isolated MVRe (n=28,140) surgical mortality was 1,2 %. For non-symptomatic (class I) patients surgical mortality was 0,6 %.

By Catherine M. Otto [6] it was confirmed that surgical mortality is lower in MVRe comparing to MVR (2–4 % versus 5–10 %). Among the patients with MV prolapse remote clinical outcomes were wonderful, survival rate was 80 and 94 % during the next 5 and 10 years in MVRe group comparing to 40 and 60 % in MVR group. There trends correspond to the results of this study, characterized by lower mortality in MVRe group.

Gillinov et al. noted, that in 10 years after the MVRe reoperation absence rate was 93 %. Among 30 patients, who required reoperations due to late valvular dysfunction, repair was unsuccessful in 16 persons (53 %) owing to progressive degenerative disease [3]. Independent (as the single method) chordal shortening, annuloplasty and resection of cusps without annuloplasty jeopardized positive remote results of surgical management.

Interestingly, according to some studies [9] surgical intervention was denied for 49 % patients with severe symptomatic MR. Diminution of LV EF, old age, comorbid conditions were the basic striking features of the patients who were denied. Importance of age and LV EF referring to patients' operability are still discussible.

Negative dynamics concerning restoration of sinus rhythm among the patients subjected to MVR probably may be explained by more severe preceding pre-op state, more prolonged medical history and consequently larger size of LA and prolonged medical history of atrial fibrillation. These factors are known negative predictors of preservation and restoration of sinus rhythm after the surgical correction of MR. Along with MV correction these patients were not exposed to simultaneous open-surgery isolation of pulmonary veins, ablation of caval-tricuspid isthmus and areas of possible arrhythmias expansion on the basis of MV. Open ablation in atrial fibrillation improves post op outcome referring preservation of sinus rhythm and non-recurrence period's duration [10].

### References

1. Iung, B. (2003). A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. *European Heart Journal*, 24 (13), 1231–1243. doi: 10.1016/s0195-668x(03)00201-x
2. Enriquez-Sarano, M., Akins, C. W., Vahanian, A. (2009). Mitral regurgitation. *The Lancet*, 373 (9672), 1382–1394. doi: 10.1016/s0140-6736(09)60692-9
3. Gillinov, A. M., Cosgrove, D. M., Blackstone, E. H., Diaz, R., Arnold, J. H., Lytle, B. W. et. al. (1998). Durability of mitral valve repair for degenerative disease. *The Journal of Thoracic and Cardiovascular Surgery*, 116 (5), 734–743. doi: 10.1016/s0022-5223(98)00450-4
4. Ling, L. H., Enriquez-Sarano, M., Seward, J. B., Orszulak, T. A., Schaff, H. V., Bailey, K. R. et. al. (1997). Early Surgery in Patients With Mitral Regurgitation Due to Flail Leaflets : A Long-term Outcome Study. *Circulation*, 96 (6), 1819–1825. doi: 10.1161/01.cir.96.6.1819
5. Adams, D. H., Rosenhek, R., Falk, V. (2010). Degenerative mitral valve regurgitation: best practice revolution. *European Heart Journal*, 31 (16), 1958–1966. doi: 10.1093/eurheartj/ehq222
6. Otto, C. M. (2001). Evaluation and Management of Chronic Mitral Regurgitation. *New England Journal of Medicine*, 345 (10), 740–746. doi: 10.1056/nejmcp003331
7. Enriquez-Sarano, M., Basmadjian, A.-J., Rossi, A., Bailey, K. R., Seward, J. B., Tajik, A. J. (1999). Progression of mitral regurgitation. *Journal of the American College of Cardiology*, 34 (4), 1137–1144. doi: 10.1016/s0735-1097(99)00313-7
8. Gammie, J. S., Sheng, S., Griffith, B. P., Peterson, E. D., Rankin, J. S., O'Brien, S. M., Brown, J. M. (2009). Trends in Mitral Valve Surgery in the United States: Results From The Society of Thoracic Surgeons Adult Cardiac Database. *The Annals of Thoracic Surgery*, 87 (5), 1431–1439. doi: 10.1016/j.athoracsur.2009.01.064
9. Mirabel, M., Iung, B., Baron, G., Messika-Zeitoun, D., Detaint, D., Vanoverschelde, J.-L. et. al. (2007). What are the characteristics of patients with severe, symptomatic, mitral regurgitation who are denied surgery? *European Heart Journal*, 28 (11), 1358–1365. doi: 10.1093/eurheartj/ehm001
10. Lazopoulos, G., Mihas, C., Manns-Kantartzis, M., Kantartzis, M. (2013). Radiofrequency ablation for atrial fibrillation during concomitant cardiac surgery. *Herz*, 39 (2), 206–211. doi: 10.1007/s00059-013-3787-1