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Arturas
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A comparison of postoperative outcomes between transapical and conventional mitral valve repair

SUMMARY OF DOCTORAL DISSERTATION

Biomedical sciences
Medicine (06 B)

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This dissertation was written between 2014 and 2018 at Vilnius University, Faculty of Medicine, Clinic of Cardiac and Vascular Diseases.

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VILNIAUS UNIVERSITETAS

Artūras
LIPNEVIČIUS

Transapikalinės ir klasikinės mitralinio vožtuvo plastikos pooperacinių rezultatų palyginimas

DAKTARO DISERTACIJOS SANTRAUKA

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Medicina (06 B)

VILNIUS 2018

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ABBREVIATIONS

ACC/AHA – The American College of Cardiology and American Heart Association
AF – atrial fibrillation
ACT – activated clotting time
AMVL – anterior mitral valve leaflet
BMI – body mass index
BSA – body surface area
CMVR – conventional mitral valve repair
CMV – controlled mechanical ventilation
COPD – chronic obstructive pulmonary disease
CPB – cardiopulmonary bypass
ECMO – extracorporeal membrane oxygenation
ePTFE – expanded polytetrafluoroethylene
FED – fibroelastic deficiency
GFR – glomerular filtration rate
IABP – intra-aortic balloon pump
ICU – intensive care unit
IQR – interquartile range
LA – left atrium
LV – left ventricle
LVEDD – left ventricular end-diastolic diameter
LVEF – left ventricular ejection fraction
LVESD – left ventricular end-systolic diameter
MI – myocardial infarction
MIMV repair – minimally invasive mitral valve repair
MR – mitral regurgitation
MV – mitral valve
MVARC - Mitral Valve Academic Research Consortium
MVR – mitral valve replacement
MVr. – mitral valve repair
NYHA – New York Heart Association

PMVL – posterior mitral valve leaflet
PPM – permanent pacemaker
RA – right atrium
RF – renal failure
RV – right ventricle
SAM – systolic anterior motion
TAMVR – transapical mitral valve repair
TR – tricuspid regurgitation
TV – tricuspid valve
VUHSK – Vilnius University Hospital Santaros Klinikos

INTRODUCTION

1. RELEVANCE OF THE PROBLEM. IMPORTANCE AND NOVELTY OF THE RESEARCH.

Mitral regurgitation (MR) caused by degenerative mitral valve (MV) disease is the most common valvular heart disease in developed countries and affects 2-3% of the population. The main cause of MR is a prolapse of one or both leaflets due to changes in the morphology of MV leaflets and subvalvular apparatus. Left untreated, MR often causes arrhythmia and heart failure, and worsens the quality of the patient's life.

Reconstructive MV surgery became an established gold standard treatment of degenerative MR. The aim of MV repair is a restoration of the normal anatomy and function. Compared with MV replacement, MV repair is associated with better long-term survival and more preserved LV function, it restores normal life quality and reduces the risk of infective endocarditis and thromboembolic events.

The traditional and most popular method of MV repair is conventional MV repair through median sternotomy. This procedure is always performed using cardiopulmonary bypass (CPB) and cardioplegia; therefore, the patient is exposed to the risks related to CPB and cardioplegia, i.e. stroke, systemic inflammatory response, postoperative cardiac and multiorgan failure, arrhythmias, infection and increased postoperative bleeding.

In the 1980s, ePTFE artificial chords were introduced for use in MV surgery. The implantation of artificial chords allowed the valve to be repaired without resecting the prolapsing segment and can be used to correct prolapse of both anterior and posterior leaflets.

Over the next few decades, artificial chords have become very popular and developed into a standard tool in modern MV surgery.

Over the past 20 years, several less-invasive MV repair approaches have emerged. They were designed to decrease the morbidity of MV surgery, whilst maintaining an acceptable level of safety and quality of repair. These techniques also aimed to minimise surgical trauma, enhance recovery and reduce the length of in-hospital stays. Although these techniques undoubtedly have certain advantages, they still carry risks associated with the use of CPB.

One of the recently presented innovative minimally invasive techniques is transapical off-pump implantation of artificial chords using the NeoChord DS1000 system. The system allows transoesophageal echocardiography (TEE)–guided delivery of the ePTFE chordae to the prolapsing or flailing mitral leaflet and restores the normal function of the valve. This procedure is performed through a small left thoracotomy under beating-heart conditions without CPB, so the patient is not exposed to the complications related to CPB. Transapical MV repairs have been performed at Vilnius University Hospital Santaros Klinikos since 2011. Within the same time frame, conventional MV repairs were also performed.

Transapical MV repair is a novel procedure which is not common in the world, therefore, there is an insufficient amount of data on this method of treatment. Publications describing postoperative results are also rare. There has only been one publication (Colli et al., 2018) presenting European long-term (12 months) results after this procedure and data on the long-term durability of the repair. For that reason, new data are particularly relevant and interesting, as they have an impact on the further use and development of this technology.

Although single centres have published their experience of transapical mitral repair, there have been no publications comparing the results of conventional and transapical MV repair. Certainly,

such a comparison would be very useful and relevant for assessing the safety and effectiveness of this new technique.

2. THE AIM OF THE RESEARCH

The purpose of this study was to evaluate and compare the efficacy and early and long-term postoperative outcomes of conventional and transapical mitral valve repair.

3. THE OBJECTIVES OF THE RESEARCH

1. An assessment of the effectiveness and safety of transapical MV repair (the incidence of adverse events in the early postoperative period) and comparison with the results of conventional MV repair.
2. An assessment of the long-term durability of the transapical MV repair and comparison with the results of conventional MV repair.
3. Determination of the association between the anatomical type of MV pathology and long-term durability of the MV repair.
4. Analysis of the causes leading to recurrent MR following transapical and conventional MV repair.

4. SCIENTIFIC NOVELTY

Currently, there is only one available publication (Colli et al., 2018) reporting long-term outcomes after transapical MV repair (12 months follow-up). At Vilnius University Hospital Santaros Klinikos, transapical MV repair was first performed in 2011, and the median follow-up for the patients included in this study was 39 months (IQR 20-51 months). This dissertation presents the long-term

results of transapical MV repair, and demonstrates the long-term durability of the repair and its association with the initial anatomy of the MV. It also investigates the causes of recurrent MR after transapical and conventional MV repair.

Both transapical and conventional MV repair are used to treat degenerative MV disease. However, transapical MV repair is a completely new technique, while conventional MV repair has been already recognised as safe and effective way to treat degenerative MR. The dissertation compares the early and long-term outcomes of these two methods of treatment.

5. PRACTICAL SIGNIFICANCE OF THE RESEARCH

The practical significance of this study lies in the possibility of using the results to optimise the selection of patients for transapical MV repair. This study demonstrates the long-term durability of transapical MV repair and its association with the initial MV anatomy. The best long-term durability of transapical MV repair was found to be achieved in patients with an isolated prolapse of the P2 segment.

It was also found that although the incidence of adverse events in the early postoperative period was lower after transapical MV repair, the long-term durability of conventional MV repair was better and did not relate to the initial anatomy of the MV.

SUBJECTS AND METHODS OF THE RESEARCH

6. RESEARCH SUBJECTS

This retrospective non-randomised study was performed on a single centre's patient cohort at Vilnius University Hospital Santaros Klinikos during the period from 2014-2018. In order to conduct the study, permission No. 158200-16-829-345 was obtained from the Vilnius Regional Committee for the Ethics of Biomedical Research.

The study involved 202 patients who underwent surgical MV repair (both transapical and conventional) for severe MR of degenerative origin between December 2011 and December 2017 at the Centre of Cardiac and Thoracic Surgery of Vilnius University. Data were collected from in-patient and out-patient medical notes, including surgical and anaesthetic notes. Data collection was completed on 1st January 2018.

There were 266 patients who underwent MV repair for severe MR during the period of study. All patients had indications for surgical treatment according to ACC/AHA and ESC/EACTS guidelines. This study included only those patients (n=202) who underwent MV repair for degenerative MV disease. MV pathology in this group included single or bi-leaflet MV prolapse or flail, with or without chordal rupture. All patients (n=64) who had a restrictive mechanism of regurgitation (rheumatic disease, cardiomyopathy), ischemic mitral regurgitation, or MV infectious lesions, and patients with a central regurgitation jet were excluded from this study.

All patients with degenerative MV disease were discussed by the heart team. Patients who had a favourable MV anatomy and agreed to undergo transapical MV repair were selected for the NeoChord procedure (n = 94). The rest of the patients were selected for conventional MV repair (n = 108). Patients who underwent MV replacement were not involved in this study.

There were 3 patients who underwent transapical off-pump mitral repair following the failure of conventional MV repair with an annuloplasty ring. These three patients were not excluded from the study; however, they were described separately.

Thus, all patients were divided into two groups:

1. Conventional surgical MV repair (CS) group – 108 patients.
2. Transapical MV repair (TA) group – 91 patients.

Clinical examination of the patients, as well as laboratory and instrumental studies, was performed:

- prior to the procedure;
- at discharge;
- at follow-up visits at 1, 6 and 12 months after the procedure, and every 12 months after that.

Follow-up was not considered complete if patients missed last two or more visits.

All data collected after evaluation and analysis were presented as:

- Preoperative data and description of mitral pathology;
- Intraoperative results;
- Early postoperative outcomes (up to 30 days after the procedure);
- Late postoperative outcomes (1 month – until the end of the follow-up).

7. STATISTICAL ANALYSIS

Statistical analysis was performed using the data collection and analysis software package SPSS 22.0 (IBM Corp., Armonk, NY, USA). The quantitative normality of continuous data was evaluated using the criteria of histograms, rectangular diagrams, and the Shapiro–Wilk's test ($p<0.05$). Quantitative data with a normal distribution are presented as a mean value ± standard deviation. The quantitative continuous data distributed outside the normal distribution were presented as the median and quartile intervals. The categorical data were expressed as a percentage. Freedom from mitral regurgitation >2+, freedom from reoperations and long-term survival in each group were estimated using the Kaplan–Meier method and compared using the Log Rank test. The censored data include patients who had their follow-up terminated. P-values <0.05 are considered statistically significant.

RESULTS

8. PREOPERATIVE DATA: DEMOGRAPHICS AND COMORBIDITIES

The study included 202 patients who underwent MV repair for degenerative MR between 1st December 2011 and 1st January 2018 at VUHSK. There were 108 patients in the CS group and 91 patients in the TA group. One patient from the TA group had undergone an aortic valve replacement 9 years ago. The rest of the patients had no history of previous cardiac surgery.

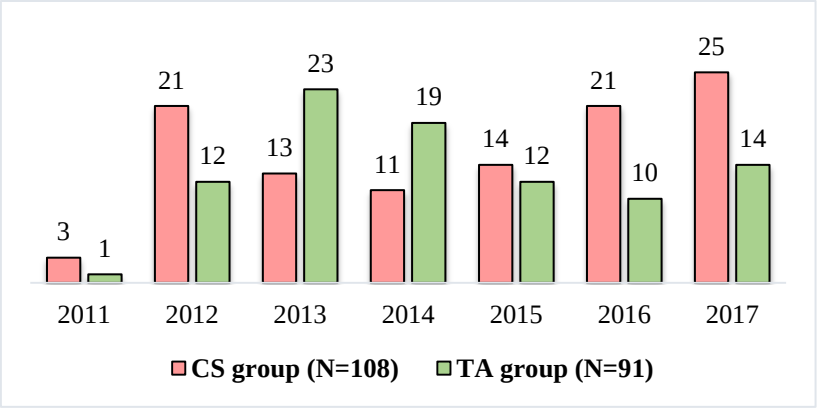
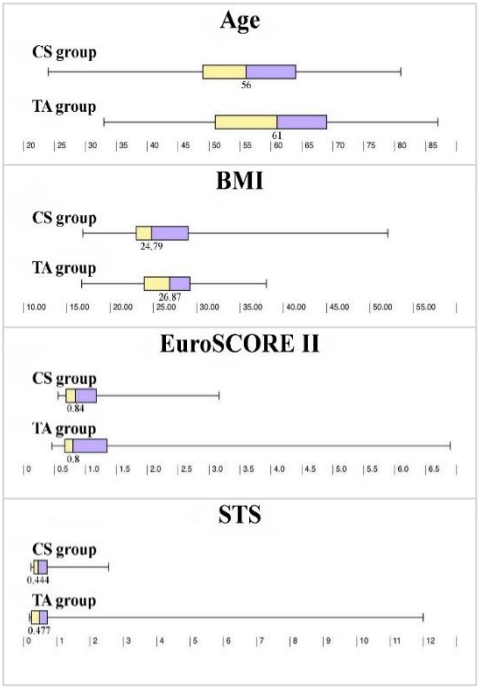


Figure 1. *Number of procedures performed in each group during the study period*

Preoperative characteristics of the patients are shown in Table 1. Patients in the TA group were slightly older (61 y.o. vs. 56 y.o.) and had a slightly higher body mass index (27 vs. 25). Male gender was dominant in both groups.



The preoperative risk was evaluated using STS and EuroSCORE II calculators of preoperative risk. The risk score in both the CS and TA groups was low: 0.44% and 0.48%, respectively, according to STS, and 0.84% and 0.8%, respectively, according to EuroSCORE II, with no significant difference between patient groups.

There were more patients with paroxysmal and chronic atrial fibrillation in the CS group: 21% and 19%, respectively, compared to the TA group: 2% and 3%, respectively ($p<0.001$).

The incidence of severe pulmonary hypertension (>55mmHg) was the same in both groups and was found in 15% of patients.

Preoperative renal function was similar in both groups. The median creatinine level was 80 μmol/l in the CS and 74 μmol/l in the TA group, with a different degree of renal insufficiency (GFR<85 ml/min) revealed in one-third of the patients in both groups.

The most common comorbidity in both groups was primary arterial hypertension, with a higher frequency in the TA group (39% vs. 54%). There was no statistically significant difference in the incidence of coronary artery disease, diabetes, chronic obstructive pulmonary disease and stroke. The incidence of these diseases was <10% in each of the groups.

Table 1. *Demographics and comorbidities*

		CS group	TA group	p value
Patients, n		108	91	
Male gender, n (%)		64 (59 %)	63 (69 %)	0.145
Age (years), median (IQR)		56 (49–64)	61 (51–69)	**0.008**
BMI (kg/m^2), median (IQR)		25 (23–29)	27 (24–29)	0.079
BSA (m^2), median (IQR)		1.9 (1.8–2.1)	2 (1.8–2.1)	0.315
STS score (%), median (IQR)		0.44 (0.32–0.71)	0.48 (0.24–0.72)	0.138
EuroSCORE II (%), median (IQR)		0.84 (0.69–1.18)	0.8 (0.67–1.35)	0.151
Functional classification	NYHA I, n (%)	2 (1.8%)	5 (5.5%)	0.165
	NYHA II, n (%)	21 (19.4%)	49 (53.8%)	**<0.001**
	NYHA III, n (%)	84 (77.8%)	36 (39.6%)	**<0.001**
	NYHA IV, n (%)	1 (0.9%)	1 (1.1%)	0.903
Paroxysmal AF, n (%)		23 (21%)	2 (2%)	**<0.001**
Permanent AF, n (%)		21 (19%)	3 (3%)	**<0.001**
Pulmonary hypertension (>55 mmHg), n (%)		16 (15%)	14 (15%)	0.911
Creatinine (μmol/l), median (IQR)		80 (68–92)	74 (69–88)	0.353
GFR (ml/min.), median (IQR)		98 (81–119)	98 (79–120)	0.804
GFR <85 ml/min., n (%)		30 (32%)	29 (32%)	0.995
Hypertension, n (%)		42 (39%)	45 (54%)	**0.024**
Coronary artery disease, n (%)		7 (6%)	8 (9%)	0.539
Diabetes, n (%)		5 (5%)	2 (2%)	0.354
Stroke, n (%)		2 (2%)	4 (4%)	0.296
COPD, n (%)		2 (2%)	3 (3%)	0.516
Permanent pacemaker, n (%)		1 (1%)	0	0.357
Previous cardiac surgery, n (%)		0	1 (1%)	0.275

9. PREOPERATIVE ECHOCARDIOGRAPHIC DATA

All patients had standard transthoracic and transoesophageal 2D and 3D echocardiography before surgery (Table 2).

The LV ejection fraction was similar in both groups, with a median of 55%. There was also no significant difference in LV systolic or diastolic measurements, as well as LA volume. The anteroposterior diameter of the MV annulus was bigger in the CS group: 39 mm vs. 36 mm (p=0.020). Also, there was a higher incidence of significant tricuspid regurgitation (≥2+) in the CS group: 13% vs. 4% (p=0.036).

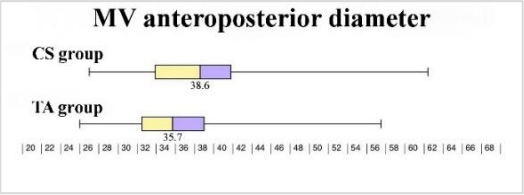


Table 2. *Preoperative echocardiographic data*

		CS group	TA group	p value
LVEF (%), median (IQR)		55 (55–60)	55 (55–55)	0.885
LVEDD (mm), median (IQR)		58 (56–63)	59 (54–63)	0.936
LVESD (mm), median (IQR)		36 (32–40)	35 (31–39)	0.537
LA volume (ml), median (IQR)		127 (102–168)	139 (110–166)	0.455
LA volume index (ml/m^2), median (IQR)		68 (56–83)	68 (56–82)	0.904
MV annulus anteroposterior diameter (mm), median (IQR)		39 (34–42)	36 (33–39)	**0.020**
MV annulus mediolateral diameter (mm), median (IQR)		46 (42–52)	45 (42–49)	0.152
MR	3+, n (%)	81 (75%)	65 (71.4%)	0.570
	4+, n (%)	27 (25%)	26 (28.6%)	0.570
TR ≥2+, n (%)		14 (13%)	4 (4%)	**0.036**

10. MITRAL VALVE PATHOLOGY AND ANATOMICAL STRATIFICATION

The most common cause of MR in both groups was a chordal rupture in one of the MV segments. It was more common in the TA group compared to the CS group: 78% vs. 56% (p<0.001) (Table 3).

Table 3. *Causes of mitral regurgitation*

	CS group	TA group	p value
n	108	91	
Prolapse without chordal rupture	48 (44%)	20 (22%)	**<0.001**
Chordal rupture	60 (56%)	71 (78%)	**<0.001**

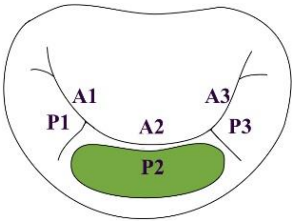
The majority of the patients had pathology of the posterior MV leaflet: 89% in the TA group and 54% in the CS group (p<0.001) (Table 4).

Table 4. *Location of MV pathology*

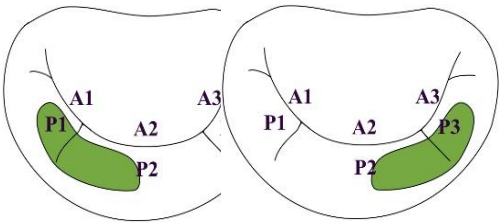
	CS group	TA group	p value
n	108	91	
AMVL	14 (13%)	5 (5%)	0.074
PMVL	58 (54%)	81 (89%)	**<0.001**
AMVL and PMVL	36 (33%)	5 (5%)	**<0.001**

According to the MV pathology location, all patients were stratified into four anatomical types (Figure 2):

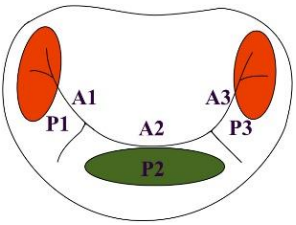
- **Type A** – isolated P2 prolapse. These patients are ideal for the transapical MV repair. There were 22 (24%) patients of this anatomical type in the TA group and 15 (14%) patients in the CS group.



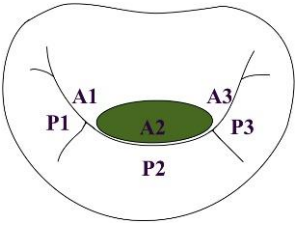
- **Type B** – P2 and adjacent segments disease. More than half (48 pts - 53%) of the patients in the TA group had this type of MV anatomy and 20 pts (19%) in the CS group.



- **Type C** – single or bi-leaflet prolapse with the pericommissural segments involved. The majority of patients in the CS group (70 pts - 65%), were stratified as type C. There were 16 pts (18%) of this type in the TA group.



- **Type D** – isolated A2 prolapse. It was the smallest anatomical group in this study: only 5 (5%) patients in the TA group and 3 (3%) patients in the CS group.



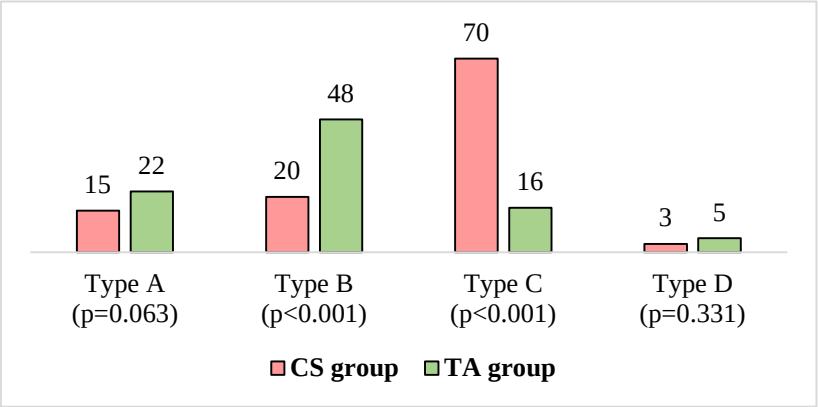


Figure 2. *Anatomical stratification of the patients*

All patients involved in this study were treated at the same centre; they were selected for one of the procedures and underwent surgery during the same time-frame. Therefore, patients with more favourable anatomy (type A and B) were mostly selected for transapical repair and patients with more complex anatomy (type C) – for conventional MV repair.

11. INTRAOPERATIVE RESULTS

Duration of the procedure

The overall duration of the procedure in the TA group was much shorter: 120 min vs. 310 min (p<0.001). In the CS group, CPB time and aortic cross-clamp time were 176 min and 118 min, respectively (Table 5).

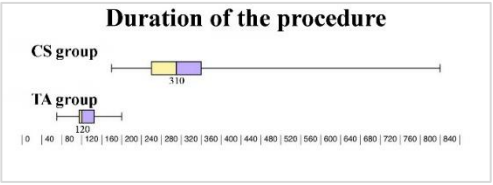


Table 5. *Duration of the procedure*

	CS group	TA group	p value
Duration of the procedure (min.), median (IQR)	310 (260–360)	120 (115–145)	**<0.001**
CPB time (min.), median (IQR)	176 (149–207)	-	-
Aortic cross-clamp time (min.), median (IQR)	118 (94–147)	-	-

Conventional MV repair and its components

Conventional MV repair was performed through median sternotomy in the majority of cases – 99 (91.7%) patients. In 8 (7.4%) cases it was done through lower partial sternotomy and 1 (0.9%) patient underwent a conventional repair through the right thoracotomy (Table 6).

One of the essential components of modern MV repair, annuloplasty ring, was implanted in 104 (96.3%) patients and the size of the rings ranged from 26 mm to 40 mm (Figure 3). In the rest of the patients, the annuloplasty ring has not been implanted due to a small MV annulus and unfavourable anatomical conditions.

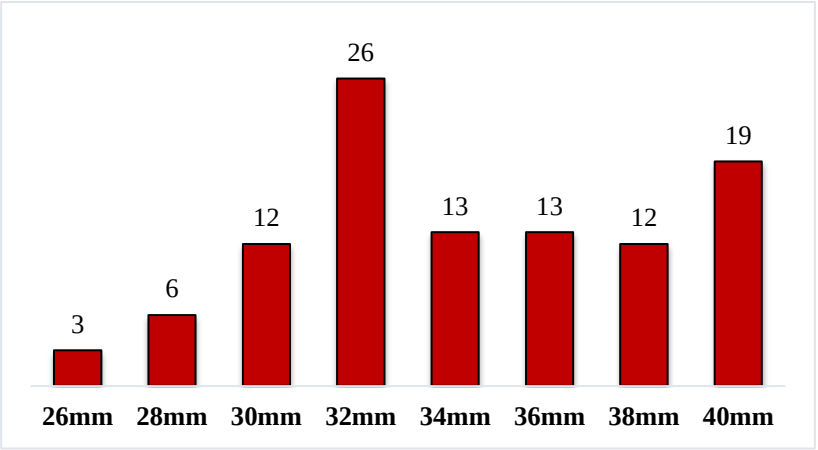


Figure 3. *Conventional MV repair: range of anuloplasty ring sizes*

Artificial ePTFE chords were implanted in 90 (83.3%) patients. Among the other MV repair components, there were triangular and quadrangular leaflet resections, closure of fissures, paracomissural stitches and central Alfieri stitch (Table 6).

Intraoperative TOE revealed a significant residual MR in five patients. For that reason, the aorta was cross-clamped again and MV repair was corrected. Systolic anterior motion caused a residual MR in one of the patients and Alfieri stitch was placed to fix it. In another 3 patients, SAM was managed medically.

Forty-nine (45.5%) patients in the CS group also had LA appendage occlusion performed as part of the procedure. TV repair was performed in 94 (87%) cases: ring annuloplasty in 5 (4.6%) patients and bicuspidalisation for the rest of the patients.

Table 6. *Intraoperative results: conventional MV repair and its components*

		n (%)
Approach	Median sternotomy	90 (91.7%)
	Lower partial sternotomy	8 (7.4%)
	Right thoracotomy	1 (0.9%)
Components of the repair	Annuloplasty ring	104 (96.3%)
	ePTFE chords	90 (83.3%)
	Resection of the leaflet	13 (12.5%)
	Closure of fissures	35 (32.4%)
	Paracomissural stitch	18 (16.7%)
	Alfieri stitch ("edge-to-edge" repair)	6 (5.6%)
Repeated cardioplegia		5 (4.6%)
LA appendage occlusion		49 (45.4%)
TV repair	Bicuspidalisation	89 (82%)
	Ring annuloplasty	5 (4.6%)

Transapical MV repair

Transapical MV repair was performed through a small left thoracotomy at the level of the LV apex in all patients. Two standard purse-string sutures were placed at the entry site, which was determined by the echocardiographic guidance. After ventriculotomy, a NeoChord DS1000 device with an ePTFE suture was inserted into the LV and pushed towards the MV. All movements of the device as well as deployment of the artificial chordae to the edge of the prolapsing segment were performed under 2D and 3D TEE guidance.

The number of implanted ePTFE chordae ranged from 2 to 7 in the TA group (Figure 4). Two thirds of the patients received 3 or 4 chords. This number was assumed to be optimal for distribution of the load per artificial chord.

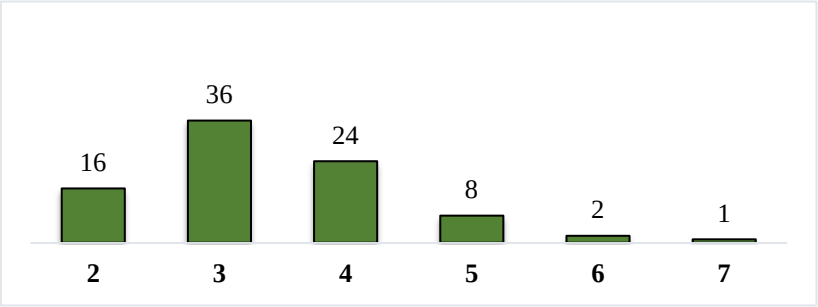


Figure 4. *Number of implanted chords in TA group (N=87)*

Transapical MV repair is performed without CPB; thus, it is associated with intraoperative blood loss. Median intraoperative blood loss in this group was 500ml (Table 7). Forty-five (52%) patients needed auto-transfusion of "Cell Caver" recycled blood and a median of 250 ml of washed erythrocytes were transfused. In 11 (12.6%) cases, intraoperative blood loss exceeded 1000 mL. This shows that severe intraoperative bleeding is one of the possible risks of the procedure.

Comparing the first 25 patients and the last 25 patients in the TA group, the median intraoperative blood loss decreased from 700 ml to 400 ml (p=0.001); however, the rate of blood transfusions remained the same - two patients in each of the groups.

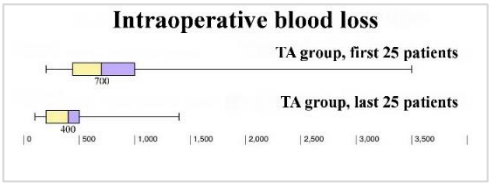


Table 7. *Intraoperative blood loss in TA group*

Intraoperative blood loss (ml), median (IQR)	500 (300–700)
Intraoperative blood loss >1000 ml, n (%)	11 (12.6%)
Re-transfusion of washed erythrocytes (ml), median (IQR)	250 (180–400)
Re-transfusion of washed erythrocytes, n (%)	45 (52%)

Evaluation of intraoperative result: concept of a successful procedure

Intraoperative result of MV repair was evaluated on the basis of MVARC (Mitral Valve Academic Research Consortium) recommendations. According to them, MR reduction is considered optimal when post-procedure MR is reduced to trace or absent. MR reduction is considered acceptable when post-procedure MR is reduced by at least 1 class or grade from baseline and to no more than moderate (2+) in severity.

Mitral repair with an acceptable result in this study was considered to be a successful procedure.

All patients in the CS group underwent successful MV repair and achieved residual MR of less than 2+. In the case of failed MV repair, MV was replaced with a prosthetic valve; these patients were not included in this study.

Transapical MV repair was unsuccessful in 4 (4.4%) cases. Intraoperative conversion to median sternotomy followed by conventional MV repair was performed in two patients. Also, non-acceptable intraprocedural MR >2+ was achieved in two patients. One of the patients who underwent intraoperative conversion was stratified as anatomical type B, while the other three patients were type C.

The aim of this study was a comparison of early (up to 30 days) and late outcomes of successful conventional MV repair and successful transapical MV repair. For that reason, 108 patients from CS group and 87 patients from TA group (Diagram 1) were included for the further calculation of intraoperative and postoperative results.

Intraoperative residual MR

Intraoperative echocardiography revealed completely competent MV or trivial mitral regurgitation in 62.1% of patients after successful transapical repair and in 76.8% of patients in the CS

group. Residual MR 1+ was achieved in one-third of patients in the TA group and 23.2% of patients in the CS group. MR 2+ was revealed in five patients after transapical MV repair and an acceptable result was not achieved in two patients (Table 8).

There were two cases where transapical MV repair was converted to the conventional MV repair. In the first case, it happened due to an iatrogenic injury of the posterior MV leaflet caused by the "NeoChord" device. This complication happened only once, in the very first patient of the NeoChord program at VUHSK. In the second patient, despite successful transapical implantation of artificial chords, conversion was performed due to the dehiscence of the chords from the MV leaflet alongside with severe bleeding from the apex of the LV.

Table 8. *Intraoperative residual mitral regurgitation*

MR	**CS group (n = 108)**	**TA group (n = 87)**	**p value**
0+, n (%)	83 (76.8%)	54 (62.1%)	**0.025**
1+, n (%)	25 (23.2%)	28 (32.2%)	0.159
2+, n (%)	0	5 (5.7%)	
>2+, n (%)	0	2 (2.2%) *	
Intraoperative conversion, n (%)	–	2 (2.2%) *	

** – unsuccessful TA procedures; calculated for 91 pts*

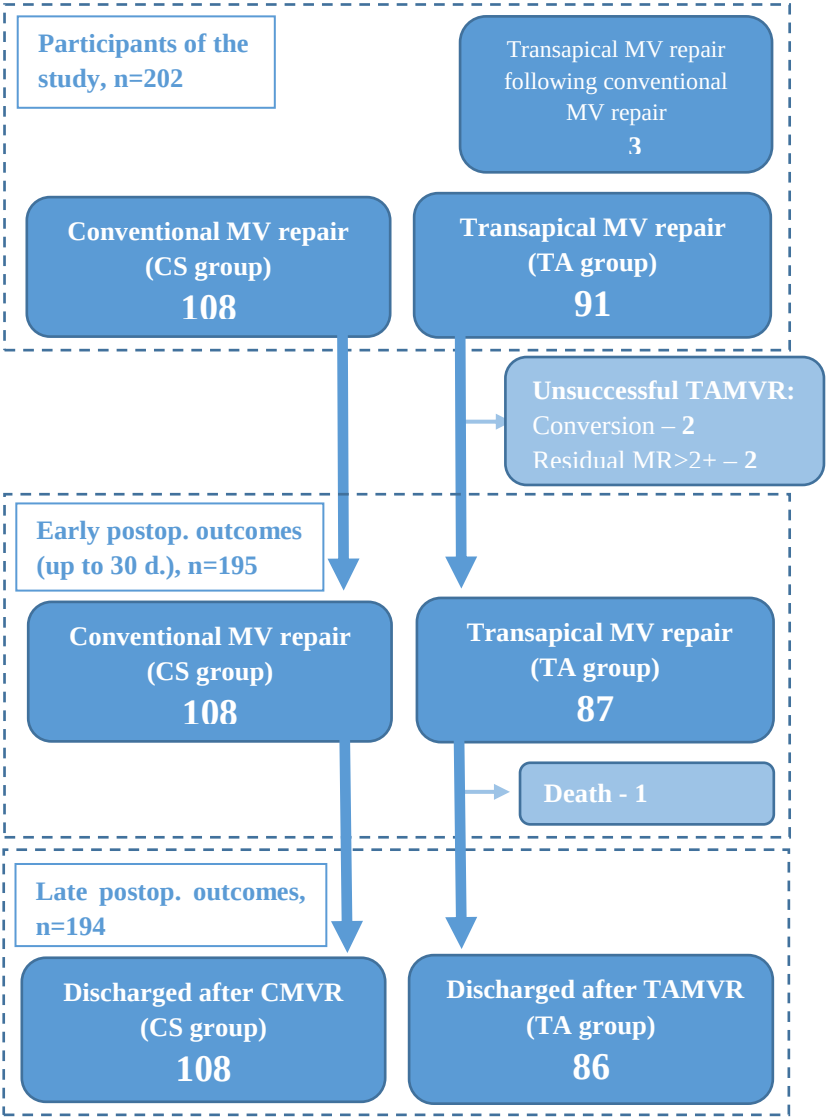


Diagram 1. *Patients included in the calculation of early and late postoperative outcomes*

12. EARLY POSTOPERATIVE OUTCOMES

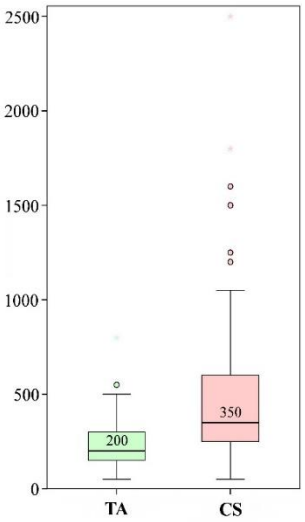


Figure 5. *Postoperative drainage (ml)*

Postoperative bleeding and transfusion of blood products

Postoperative drainage was much lower in the TA group - the median was 200 ml vs. 350 ml in the CS group ($p<0.001$) (Figure 5). Also, surgical wound revision due to postoperative bleeding was less frequent in the TA group: 2.3% vs. 2.8% (Table 9).

One patient from the TA group (the patient was stratified as anatomical type D) underwent surgical re-exploration for severe bleeding on the second postoperative day. Large volume of blood and blood clots was found in the left pleural cavity; however, no obvious source of bleeding was found. The patient had massive transfusion of blood products due to hypovolaemia. After that, the patient developed asystole and direct cardiac compressions were carried out. During CPR, the front wall of the RV ruptured, and the procedure was converted to the median sternotomy. The front wall of the RV was repaired; however, the patient died of acute heart failure. This was the only death in the TA group and among all of the participants in the study.

The rate of blood product transfusions was much lower in the TA group – 5.8% vs. 43.5% ($p<0.001$). The transfusion of red blood cells was performed in only 4.6% of patients in this group, fresh frozen plasma was used in 3.4% of patients, and thrombocytes were transfused in only one (1.1%) patient (Figure 6).

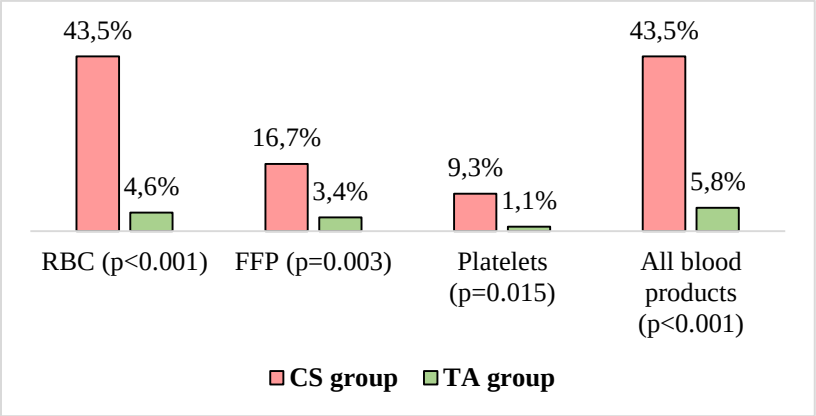


Figure 6. *Transfusion of blood products*

BARC (Bleeding Academic Research Consortium) classification was introduced in 2011 for the evaluation of postoperative bleeding following cardiac surgery. The majority of patients in the TA group (82 pts – 94.3%) were classified as Type 2 (prompting evaluation),

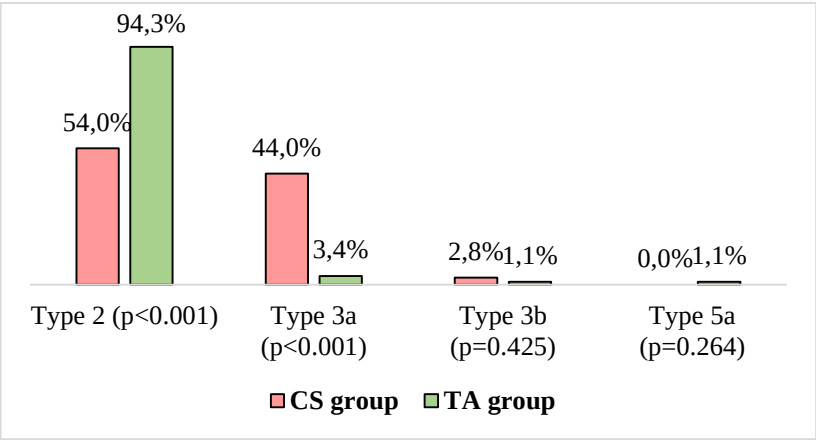


Figure 7. *Postoperative bleeding: BARC classification*

3 (3.4 %) patients as Type 3a (transfusion of blood products), 1 (1.1%) patient as Type 3b (bleeding requiring surgical intervention for control) and 1 (1.1%) patient as Type 5a (fatal bleeding). Transfusions of blood products were required more frequently in the CS group; therefore, more patients (47 pts – 44%) were classified as type 3a compared to the TA group.

Postoperative adverse events

The incidence of new atrial fibrillation and renal failure was much lower in the TA group (Table 9). Compared to the CS group, the rate of new AF was twice as low in the TA group: 37% *vs.* 17.4% (p=0.003). The postoperative elevation of creatinine level above 150% of the baseline was found in 3 (3.6%) patients of the TA group and in 17 (15.7%) patients of the CS group (p=0.006). No patients in the TA group required hemofiltration compared to three (2.8%) patients in the CS group.

Table 9. *Postoperative adverse events*

Adverse event	CS group (n = 108)	TA group (n = 87)	p value
Surgical wound re-exploration for bleeding, n (%)	3 (2.8%)	2 (2.3%)	0.833
New AF, n (%)	40 (37%)	15 (17.4%)	**0.003**
Renal failure (creatinine elevation 150% and above from baseline), n (%)	17 (15.7%)	3 (3.6%)	**0.006**
Haemofiltration, n (%)	3 (2.8%)	0	0.117
Stroke, n (%)	2 (1.9%)	1 (1.1%)	0.692
Myocardial infarction, n (%)	0	0	
Wound infection, n (%)	1 (0.9%)	0	0.368
Mortality, n (%)	0	1 (1.1%)	0.368
PPM insertion, n (%)	13 (12%)	2 (2.3%)	**0.011**

The rate of postoperative stroke in the CS group and the TA group was 1.9% and 1.1%, respectively. The patient who had a stroke post-transapical repair developed speech difficulties on the day after the operation, but he had completely recovered prior to discharge.

None of the patients in this study had postoperative myocardial infarction. There was one patient who had superficial (above sternum) wound infection following conventional MV repair. There were no wound infections in the TA group.

Permanent pacemakers (PPM) were implanted in 13 (12%) patients following conventional repair and 2 (2.3%) patients in the TA group. Both patients from the TA group had a PPM implanted for preoperatively known sick sinus syndrome.

Postoperative course

Inotropic support postoperatively was required in almost all, 106 (98%) patients following conventional MV repair and in 22 (25.3%) patients in the TA group ($p<0.001$).

Table 10. *Postoperative course*

	CS group	TA group	p value
Inotropic support, n (%)	106 (98%)	22 (25.3%)	**<0.001**
IABP, n (%)	7 (6.5%)	0	**0.015**
ECMO, n (%)	1	0	0.368
CMV (h), median (IQR)	7 (5–13)	4 (3–5)	**<0.001**
Length of ICU stay (h), median (IQR)	67 (45–112)	22 (21–24)	**<0.001**
Post-procedure length of stay in hospital (days), median (IQR)	12 (10–15)	8 (7–11)	**<0.001**

The duration of postoperative mechanical ventilation in the TA group was much shorter – 4 hours vs. 7 hours. Besides that, postoperative stay in ICU in this group was also shorter – 22 hours vs. 67 hours (p<0.001), as well as postoperative in-hospital stay – 8 days vs. 12 days (p<0.001) (Table 10, Figures 8-10).

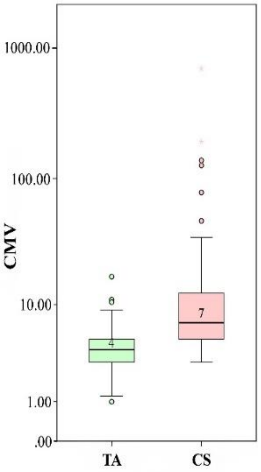


Figure 8. *CMV duration (hours)*

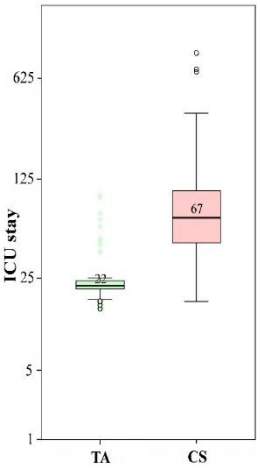


Figure 9. *ICU stay (hours)*

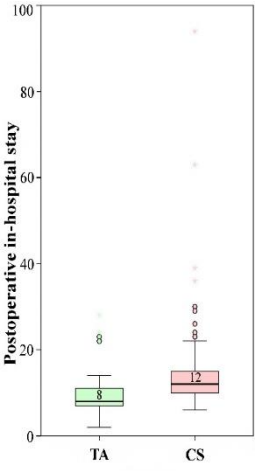


Figure 10. *Postoperative in-hospital stay (days)*

13. LATE POSTOPERATIVE OUTCOMES

Postoperative follow-up

Follow-up visits for all patients were scheduled at 1, 6, 12 months and then every 12 months after surgery. All patients who were discharged from the hospital were involved in the postoperative follow-up: 108 pts in the CS group and 86 pts in the TA group. The median follow-up was similar in both groups: 34 months (IQR 19–64 months) in the CS group and 39 months (IQR 20–51 months) in the

TA group. The follow-up was complete for 101 (94%) patients in the CS group and 82 (95%) in the TA group.

Long-term durability of the repair

Long-term durability of the repair in each group was assessed using the Kaplan–Meier method and compared using Log Rank test.

Long-term durability of the repair was considered to be good if MR did not exceed 2+. A comparison of the long-term durability of the MV repair between the two groups is presented in Figure 11. The long-term durability of the conventional MV repair was much better comparing to transapical MV repair. MR did not exceed 2+ in 99%, 97%, 97%, 95%, 92%, 90%, and 90% of the patients at 6, 12, 24, 36, 48, 60, and 72 months after surgery respectively. In the TA group, freedom from MR>2+ was 82%, 77%, 69%, respectively, and 68% for the remaining period of the follow-up. These data were obtained regardless of the anatomical stratification within the groups. The difference of long-term durability was statistically significant between the two groups ($\chi 2$ - 19.214, p=0.000).

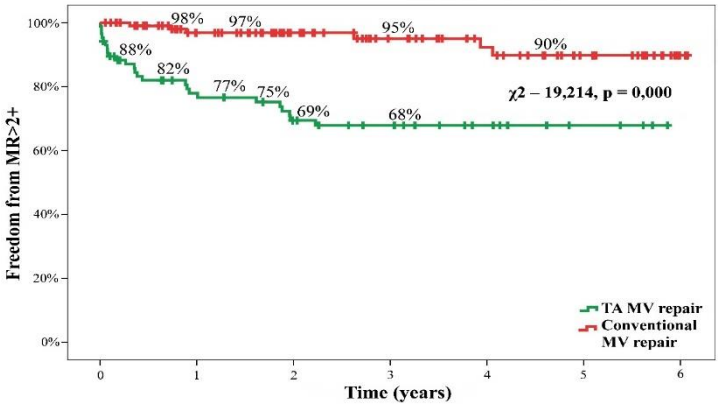


Figure 11. *Long-term durability of the MV repair: TA and CS groups*

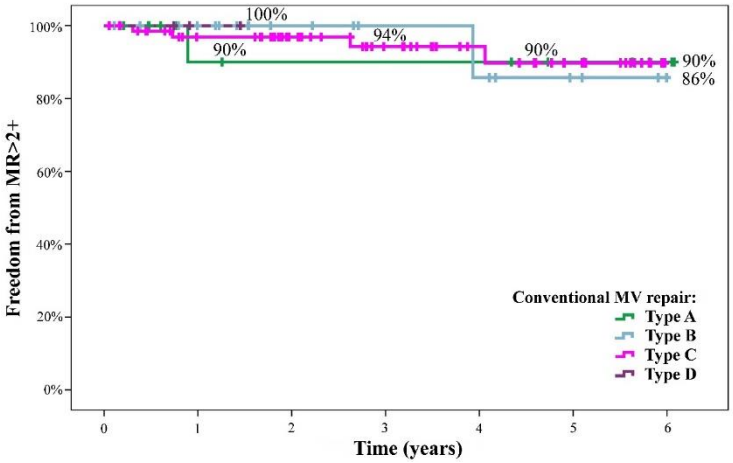


Figure 12. *Long-term durability of the MV repair: CS group, anatomical types*

There was a significant difference in long-term durability of the repair in both groups, therefore, long-term durability was compared between the CS group and each of the anatomical types in the TA group. Splitting the results of the CS group according to the anatomical types showed no major difference between the groups ($\chi 2$ - 0.106, p=0.991); for that reason, the results of the entire CS group were evaluated without grouping. The results are shown in Figures 12 and 13.

The best results were achieved in the group of anatomical type A– freedom from MR>2+ dropped down to 85% over first 6 months; later, this number remained stable throughout the observation period.

The long-term durability was worse in the group of anatomical type B: freedom from MR>2+ was observed in 87% after 6 months, in 80% after a year, and 74% from 24 months until the end of the observation.

The results of anatomical group C, compared to groups A and B, are the worst. Severe recurrent MR was revealed in about half of the

patients after six months, and freedom from severe MR was only 23% after 24 months.

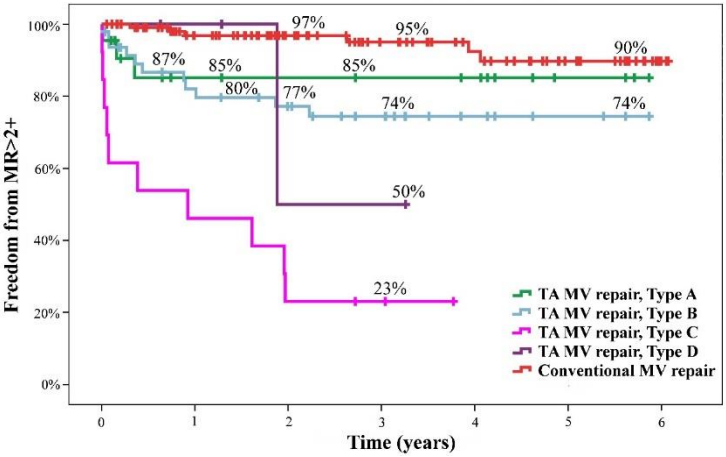


Figure 13. *Long-term durability of the MV repair: CS and TA groups (anatomical types of the TA group shown separately)*

There were only four patients in anatomical group D. Severe MR recurred in one of them. Due to the small number of patients, the long-term durability of the repair in this group was not analysed further.

The long-term durability of the repair in the CS group and different anatomical types of the TA group was compared using the Log Rank test. The results are shown in Table 11. A statistically significant difference was obtained between the CS group and anatomical types B, C and D.

Table 11. *Comparison of the long-term durability between the groups*

Compared groups	Log Rank test
CS vs. Type A (TA)	(χ2 – 1.646, p = 0.200)
CS vs. Type B (TA)	(χ2 – 10.736, **p = 0.001**)
CS vs. Type C (TA)	(χ2 – 78.788, **p = 0.000**)
CS vs. Type D (TA)	(χ2 – 4.961, **p = 0.026**)
Type A (TA) vs. Type B (TA)	(χ2 – 0.483, p = 0.487)

The presented results show that the long-term durability of the repair in type C group is very poor; therefore, TA repair should not be performed in these patients. Group D was not analysed further due to the small number of patients. For the reasons mentioned above,

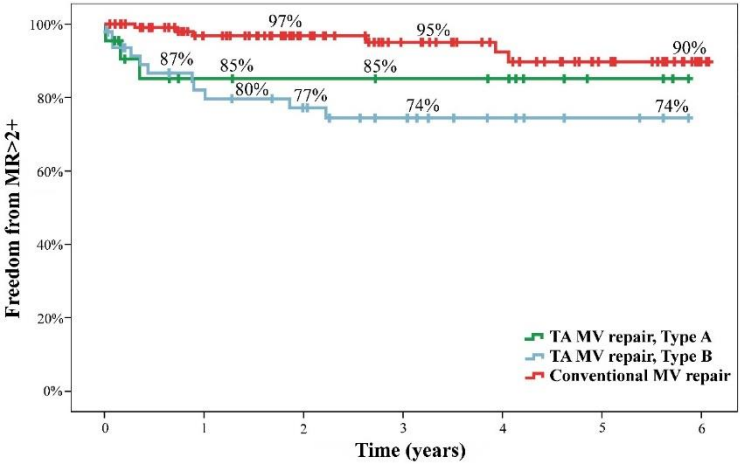


Figure 14. *Long-term durability of the MV repair: CS and TA groups (Types A and B of the TA group shown separately).*

long-term repair durability was further compared between the CS group and the two best anatomical types of the TA group – A and B. Long-term durability for these types is shown separately in Figure 14. The combined results of groups A and B are shown in Figure 15. Freedom from severe MR in the combined A and B group remained 81% after 12 months and 77% after 28 months. It remains unchanged until the end of the observation.

The difference in long-term durability between the CS group and the TA group (combined results of the types A and B) was statistically significant ($\chi 2$ – 9.006, p = 0.003).

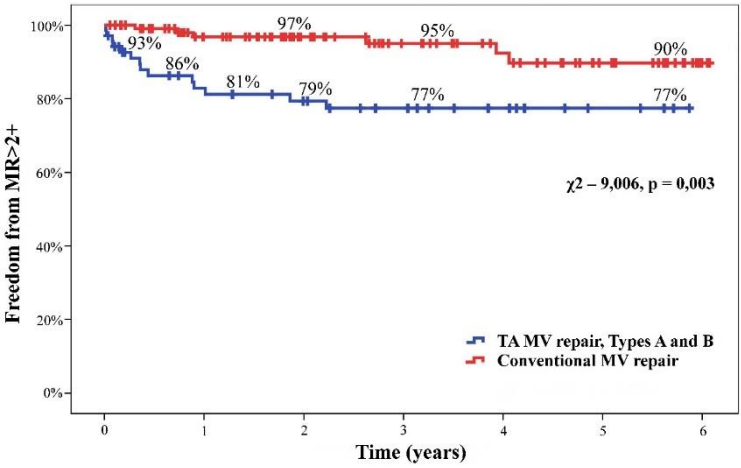


Figure 15. *Long-term durability of the MV repair: CS and TA groups (Types A and B of the TA group are shown combined).*

Rehospitalisation and its causes

One of the MVARC-recommended indicators of successful MV pathology treatment is rehospitalisation of the patient during the first 12 months after surgery. Suggested classification of the rehospitalisation causes includes three groups:

- Heart failure hospitalisation, cardiac-related or non-cardiac-related (for example, recurrence of MR);
- Other cardiovascular hospitalisation (for example, cardiac arrhythmias);
- Non-cardiovascular hospitalisation.

About 10% of the patients in each group were readmitted to hospital within the first 12 months after the procedure; however, the causes of rehospitalisation were different.

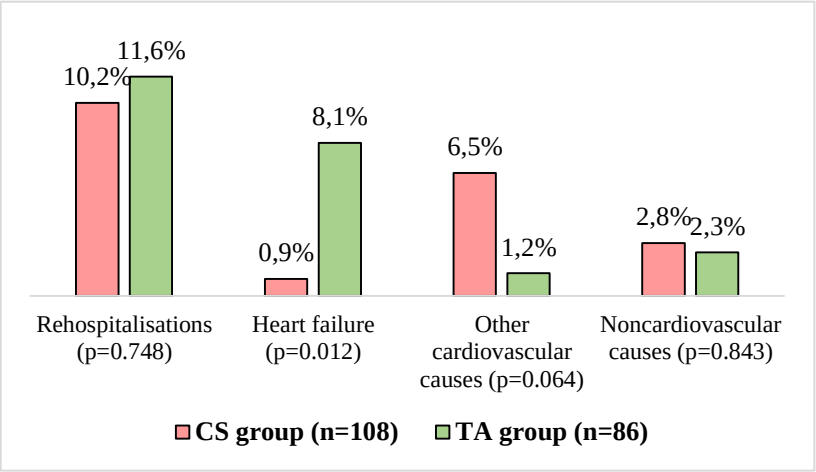


Figure 16. *Causes of rehospitalisation*

Seven (8.1%) patients after transapical MV repair were readmitted due to the recurrence of high-grade MR and 4 of them underwent surgical interventions during the same rehospitalisation.

Only one (0.9%) patient was readmitted for that reason in the CS group and he underwent redo mitral surgery.

Atrial fibrillation and other rhythm disturbances were the main cause of rehospitalisation in the CS group, with 7 (6.5%) patients, while only one (1.2%) patient had this issue in the TA group.

The number of rehospitalisations for non-cardiovascular reasons was similar in both groups: 3 (2.8%) patients in the CS group and 2 (2.3%) in the TA group. Two patients were rehospitalised due to a wound infection several months after the conventional MV repair, while the third patient in this group was readmitted due to neurological deterioration (dizziness). One patient in the TA group underwent thyroid surgery and another patient was treated for cholangitis.

Recurrent MR and redo surgery: CS group

High-grade recurrent MR was revealed in 6 (5.5%) patients after conventional MV repair. Four of them underwent repeat surgical procedure: one underwent conventional MV repair and 3 patients were treated with transapical MV repair. Two other patients are currently under medical management (Diagram 2).

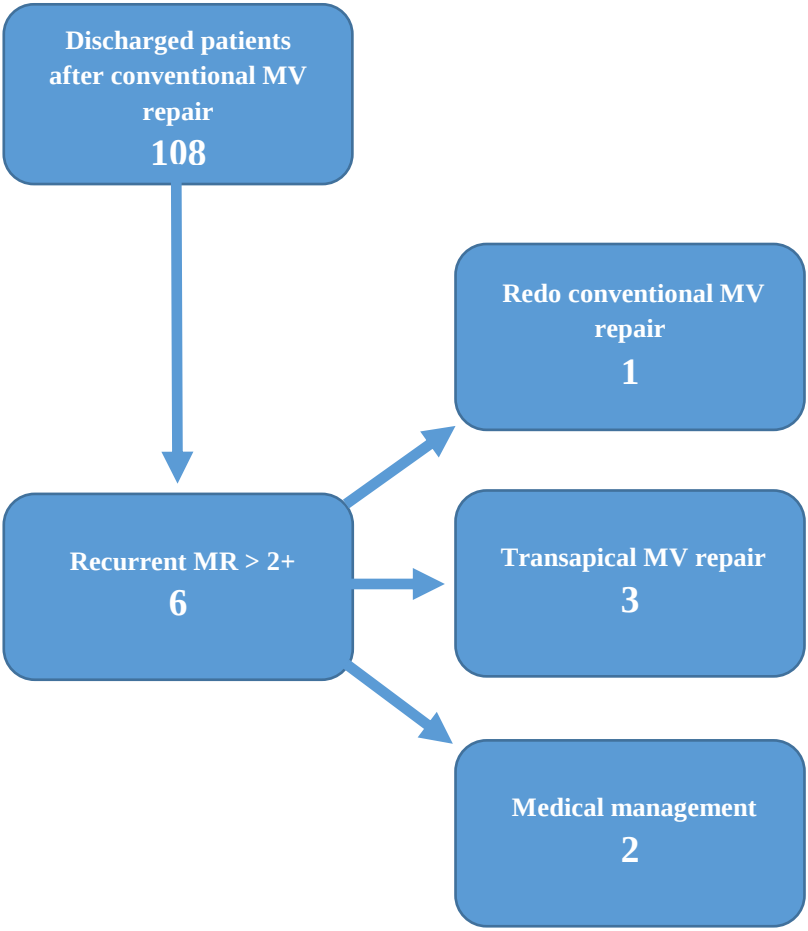


Diagram 2. *Management of the recurrent MR: CS group*

Recurrent MR and redo surgery: TA group

TA repair was unsuccessful in 4 patients. Also, there was one early postoperative death in this group. Therefore, 86 patients were discharged from the hospital out of the initial group of 91 patients. Twenty-two patients were stratified as anatomical type A, 47 as type B, 13 as type C and 4 as type D. Severe recurrent MR was revealed in 25 patients: 3 patients were categorised as anatomical type A, 11 as type B, 10 as type C and 1 as type D.

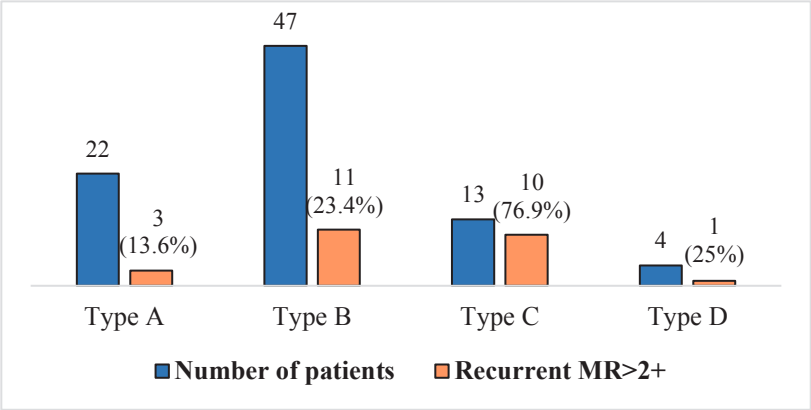


Figure 17. *Recurrent MR: TA group, anatomical types*

Table 12. *Recurrent MR: comparison of the anatomical types of the TA group*

Groups in comparison	p value
A vs. B	0.347
A vs. C	**<0.001**
A vs. D	0.562
B vs. C	**<0.001**
B vs. D	0.942
C vs. D	0.057

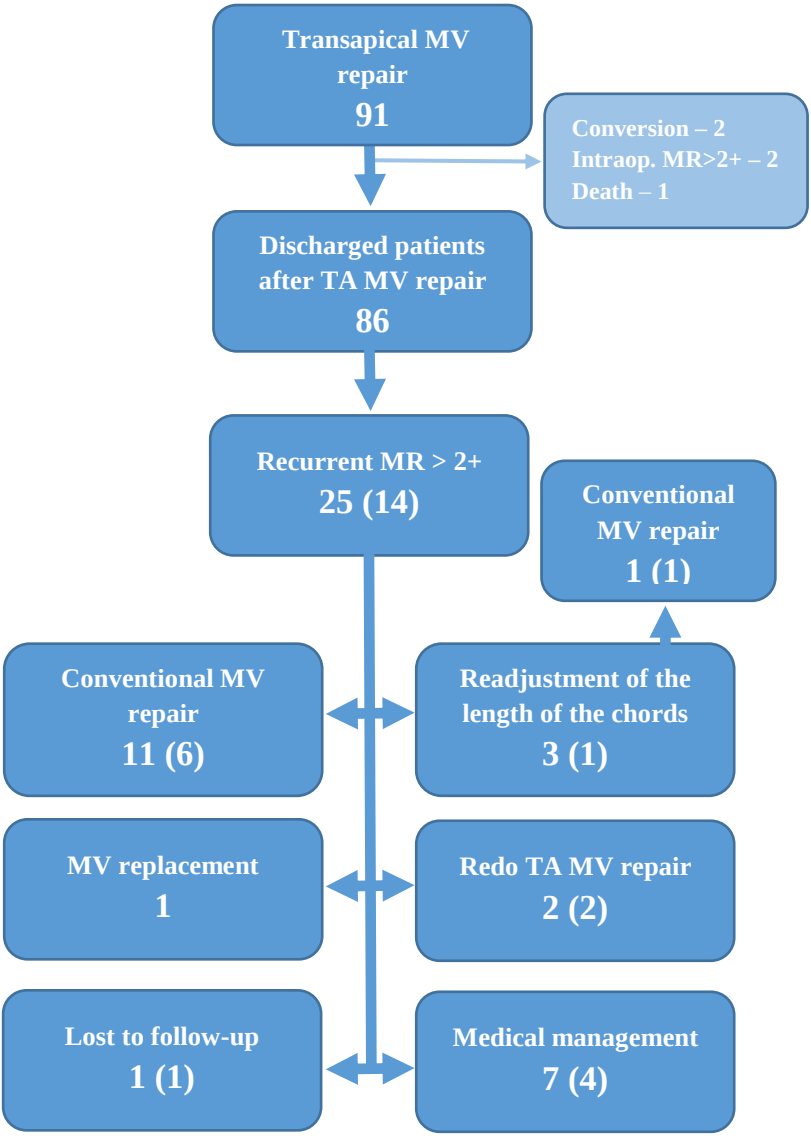


Diagram 3. *Management of the recurrent MR in the TA group (number of type A and B patients is shown in brackets).*

Eleven patients in the TA group underwent conventional MV repair for severe recurrent MR. Also, one patient had MV replaced with a prosthetic valve. The length of the artificial chords was readjusted in 3 patients and redo transapical repair was performed in two patients. One of the patients who underwent length readjustment of the chords developed severe recurrent MR again and underwent conventional MV repair later. Seven patients were managed medically. One patient was lost to follow-up; therefore, the further course of his treatment is unknown.

The diagrams above show that not all patients with a recurrent MR were re-operated upon. Repeat surgery was performed on 4 out of 7 patients with recurrent MR in the CS group and in 17 out of 25 patients in the TA group. Nine out of 14 patients of type A and B in the TA group were re-operated upon. Figures 18 and 19 show the results of the CS and TA group (combined type A and B): the green curve shows freedom from severe MR, and red – freedom from reoperations. This difference was not statistically significant in either

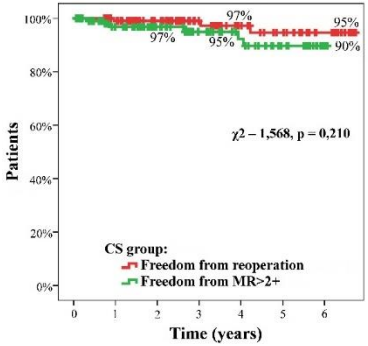


Figure 18. *Long-term durability of the repair and reoperations: CS group*

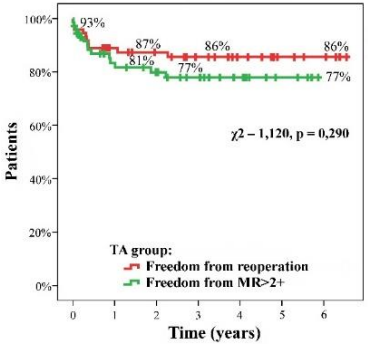


Figure 19. *Long-term durability of the repair and reoperations: TA group (Type A and B)*

the CS ($\chi 2$ – 1.568, p=0.210) or in the TA group ($\chi 2$ – 1.120, p=0.290).

Causes of the MR recurrence

MR recurrence in the CS group was caused by mitral prolapse due to a new rupture of the native chords. This diagnosis was confirmed mostly by echocardiography because there was only one patient who underwent a repeat surgery in this group.

The main causes of the MR recurrence in the TA group are listed in Table 13. Although sometimes recurrent MR was caused by a combination of factors, few main groups of causes can be identified:

- Relative elongation of the artificial chords. This most likely happens due to the reverse remodelling of the LV. There were 3 patients in the TA group who underwent readjustment of the length of the chords.
- Rupture of the native chords. Rupture of the AMVP chords was the most common in the TA group. The rupture could be spontaneous or induced by mechanical interactions with artificial chords.
- Rupture of the artificial chords. Artificial chord ruptures in the TA group happened both in the middle part and at the level of the apex of the ventricle. This was most likely caused by mechanical damage of the chord during the implantation.
- Leaflet restriction caused a recurrent MR in one patient.
- Dehiscence of the artificial chords from the edge of the leaflet occurred in 2 patients. However, rupture of the native chords was also diagnosed in both patients and it remains unclear which of the MR causes was the primary one.

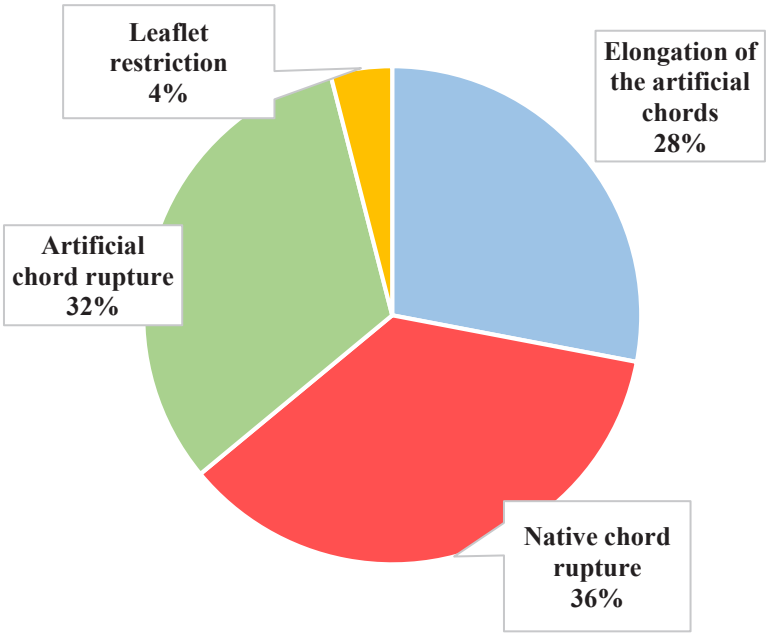


Figure 20. *Causes of the MR recurrence in the TA group*

Table 13. *Recurrent MR causes in the TA group*

Patient	Type	MR mechanism	Re-intervention
1	C	Relative elongation of the artificial chords	Conventional MV repair
2	C	Rupture of the native chords (P1)	Conventional MV repair
3	C	Relative elongation of the artificial chords	Conventional MV repair
4	B	Relative elongation of the artificial chords	None
5	C	Relative elongation of the artificial chords	Length readjustment
6	C	Leaflet restriction	None
7	C	Rupture of the artificial chords.	Conventional MV repair
8	B	Rupture of the native chords (AMVL) Dehiscence of the artificial chords	Conventional MV repair
9	B	Rupture of the artificial chords.	None
10	B	Rupture of the artificial chords.	Conventional MV repair
11	B	Relative elongation of the artificial chords	Length readjustment. Later – conv. MV repair
12	B	Rupture of the artificial chords.	Conventional MV repair
13	C	Relative elongation of the artificial chords	Length readjustment
14	C	Rupture of the artificial chords.	MV replacement
15	D	Relative elongation of the artificial chords	None
16	C	Rupture of the native chords (AMVL)	Conventional MV repair
17	B	Rupture of the native chords (AMVL)	None
18	B	Rupture of the artificial chords.	Conventional MV repair
19	A	Rupture of the native chords (AMVL)	Transapical MV repair
20	B	Rupture of the native chords (AMVL)	Lost to follow-up
21	B	Rupture of the native chords (AMVL)	Conventional MV repair
22	B	Rupture of the native chords (AMVL)	Transapical MV repair
23	A	Rupture of the artificial chords.	None
24	C	Rupture of the artificial chords.	None
25	A	Rupture of the native chords (AMVL)	Conventional MV repair

Mortality and causes of death

No patients died in the CS group postoperatively.

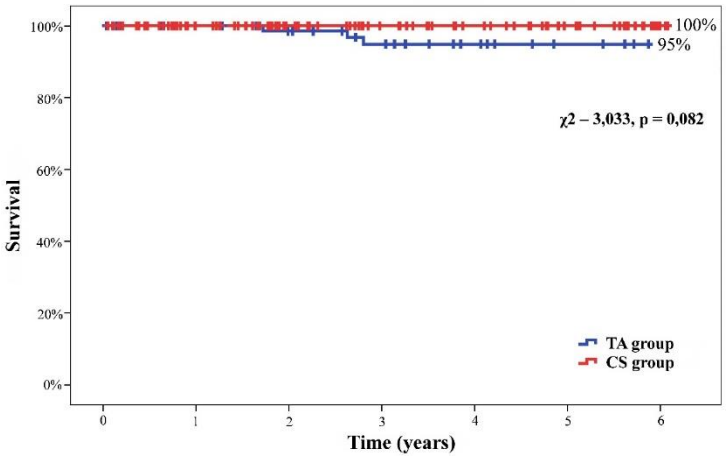


Figure 21. *Survival: CS and TA groups*

There were 3 late deaths in the TA group:

- A 50-year-old patient died 32 months after TA repair. His initial mitral pathology was classified as anatomical type A. The patient had liver cirrhosis and died from hepatic failure. According to the latest echocardiography, his MR was <1+.
- A 64-year-old female died 34 months after the procedure. She was known to have type C mitral pathology. A recurrent MR was diagnosed 2.5 years after the transapical repair; for that reason, she underwent conventional MV repair, however, she died of sepsis and multiple organ failure 4 weeks later.
- A 72-year-old male died 20 months after the procedure. He was stratified as anatomical type C patient and had a successful transapical repair, however, a severe recurrent MR was revealed 1 month later. For that reason, he underwent MV

replacement with a tissue valve 14 months later. After 4 months, he was readmitted to the hospital with an infective endocarditis of the prosthetic valve. Also, spontaneous intracerebral haemorrhage was also diagnosed. The patient was managed medically and died 1 month later.

The first death was classified as non-cardiac, and the other two were cardiac related. The survival of patients in the CS and TA groups is presented in Figure 21. The difference between survival in both groups was not statistically significant ($\chi 2 - 3.033$, $p = 0.082$).

The survival in the CS and TA group (combined types A and B only) after 6 years was 100% and 98%, respectively (Figure 22).

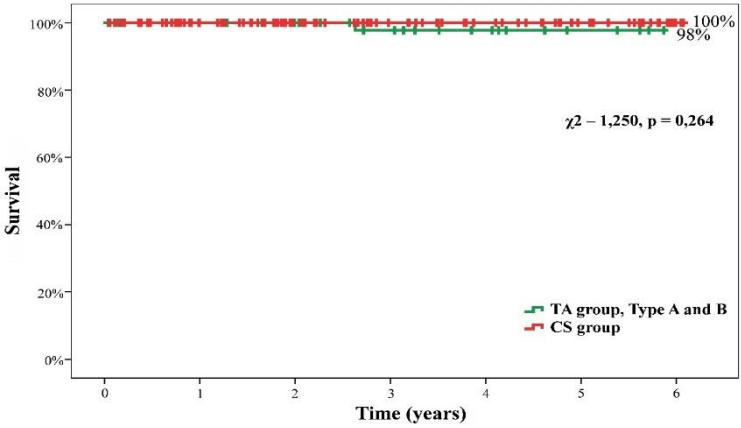


Figure 22. *Survival: CS and TA (Type A and B) groups*

14. TRANSAPICAL MV REPAIR FOLLOWING PREVIOUS CARDIAC SURGERY

The TA group included one patient who had a history of previous cardiac surgery – aortic valve replacement with a 21mm tissue valve 9 years ago. Eight years later, severe MR due to the rupture of P2 native chords was revealed. Mitral pathology was stratified as anatomical type A. The patient underwent successful transapical implantation of two artificial chords to the prolapsing P2 segment and 4 months later echocardiography showed MR 1+.

Severe MR recurred in 7 patients after conventional MV repair. Four of them underwent repeat surgical procedures: conventional repair was performed in one patient and 3 patients had transapical repair. The last three patients formed a small group which was separated from the main TA group, because these patients had previous MV reconstruction and had an annuloplasty ring implanted. A brief overview of the management of these patients is presented below:

1. A 35-year-old female underwent conventional MV repair for the myxomatous mitral degeneration five years ago: P2 and A2 segments were re-suspended with four artificial chordae and a 36mm annuloplasty ring was implanted. Despite the patient remaining asymptomatic a recurrence of severe mitral regurgitation (MR) was diagnosed at routine follow-up four years later. Echocardiography revealed A3 segment native chordae rupture. The patient underwent a successful transapical off-pump implantation of 3 neochordae into the A3 segment with a residual mild MR seen on intraoperative TEE. Although the patient had 1 unit of red blood cells transfused due to anaemia, her further postoperative course was rather uneventful and she was discharged on the 7th postoperative day. At the 10-month follow-up, transthoracic echocardiography showed no change in residual MR.

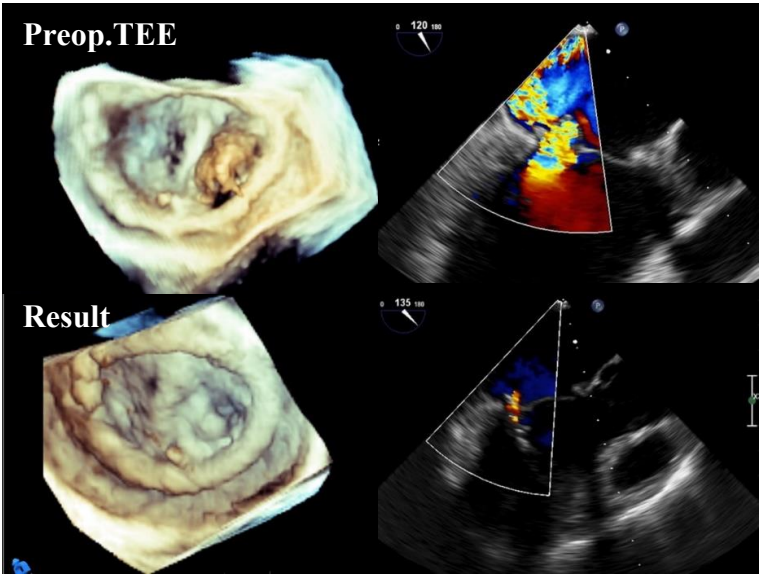


Figure 23. *Transapical MV repair following failure of conventional MV repair (1st patient)*

2. A 35-year-old male underwent conventional MV repair for the bi-leaflet prolapse of myxomatous valve 3 years ago: segments A1-A3, P2 and P3 were re-suspended with six artificial chordae and 40mm annuloplasty ring was implanted. Two years later a severe MR due to new P2 (lateral) prolapse was revealed on follow-up TTE. The patient underwent successful transapical off-pump implantation of 2 neochordae into the prolapsing segment resulting residual trivial MR. The patient underwent re-exploration for bleeding postoperatively and had a fresh frozen plasma transfusion. His further postoperative course was uneventful and he was discharged from the hospital on the 9th postoperative day. At the 1-month follow-up, transthoracic echocardiography showed trivial residual MR.

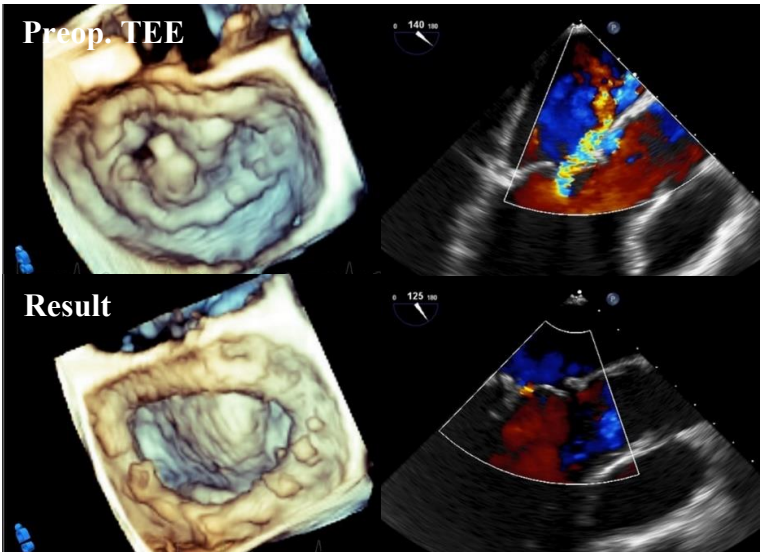


Figure 24. *Transapical MV repair following failure of conventional MV repair (2nd patient)*

3. A 59-year-old male underwent conventional MV repair for the P2 prolapse caused by chordal rupture 3 years ago: the P2 segment was re-suspended with three artificial chordae and a 36 mm annuloplasty ring was implanted. Two years later the patient started to complain of shortness of breath and ecochardiography showed severe recurrent MR due to the prolapse of the middle of the P2 segment. A successful transapical repair was performed: two artificial chords were deployed into the prolapsing segment and a trivial MR was achieved. The patient underwent re-exploration for postoperative bleeding on day 2. The further course of treatment was uneventful and the patient was discharged on day 12. At the 4-month follow-up, transthoracic echocardiography showed mild MR.

DISCUSSION

This study presents and compares the intraoperative, early and late postoperative results of conventional and transapical MV repair.

Conventional MV repair is a standard method to treat degenerative mitral regurgitation. Since the 1980s, the use of ePTFE artificial chords has become a standard tool in modern cardiac surgery and is one of the most commonly used components of the repair. MV repair, performed using artificial chords, is associated with good long-term durability and good haemodynamic parameters of the reconstructed valve.

In order to reduce the invasiveness of the procedure and number of CPB-related adverse events, a concept of transapical MV repair was developed. There are many publications presenting the late outcomes of the conventional MV repair, but the majority of publications about transapical repair present only intraoperative and early postoperative results. The longest long-term results were reported by Colli et al. (2018): the publication presents European experience of the transapical mitral repair with 12 months postoperative follow-up. This dissertation presents a much longer follow-up duration of the TA group – 39 months, which is important for proper assessment of the long-term durability of the repair. In addition, there are no publications comparing the outcomes of conventional and transapical MV repair. It is announced that a randomised study RECHORD has been launched aiming to compare the results of these two techniques, but no data have been published to date.

Intraoperative results of the transapical MV repair published by Colli et al. (2018) are similar to those presented in this study: the duration of the procedure is about 120 minutes, three or four artificial chords were implanted in two thirds of the patients, about 2% of patients underwent a conversion to conventional MV repair; the procedure was successful in about 96% of patients. There were no

intraoperative deaths in either the group of Colli et al. or in the TA group of this study. This shows that transapical MV repair is a short, effective and safe procedure. However, this study showed that intraoperative residual MR<1+ was achieved more often in the CS group: 76.8% vs. 62.1% (p=0.025). This most likely occurred due to the wider choice of components in the conventional repair, like annuloplasty rings, paracomissural stitches, closure of the leaflet fissures and others. In the majority of patients in the CS group, the tricuspid valve was repaired as well.

It is important to note that in the evaluation of MV repair effect, this study followed the recommendations of the MVARC, according to which the intraoperative result is considered acceptable if the MR is reduced by at least one grade and postoperative MR does not exceed 2+. However, in practice, such a result after conventional MV repair is generally considered unacceptable, and further valve reconstruction or valve replacement is performed.

One of the most relevant variables of the early postoperative period is postoperative bleeding and the incidence of blood product transfusions. The postoperative drainage in the TA group was significantly lower comparing to the CS group (200 ml vs. 350 ml (p<0.001)), and most of the patients in the TA group were classified as type 2 according to the BARC classification. Red blood cell transfusion was required in only 4.6% of the patients, and this figure is almost twice as low as that given in the article of Colli et al. (2018) - 8%. Red blood cell transfusion was much more common in the CS group, with 43.5% of patients, while the most commonly reported incidence is about 50% after conventional MV repair and about 40% after minimally invasive MV surgery.

Recent publications show that surgical re-exploration for postoperative bleeding following minimally invasive MV surgery is necessary in 3.5-7% cases and the rate is similar to that of conventional MV repair. The reported rate of re-explorations after transapical MV repair is lower – 1.4% of patients. In this study, re-

exploration for bleeding was performed in 2.3% of patients in the TA group and slightly more often (2.8%) in the CS group. Low postoperative drainage, and a low rate of transfusions and re-explorations indicate that the risk of postoperative bleeding after transapical MV repair is low.

This study also confirms that one of the positive facts associated with the transapical repair is a lower rate of postoperative atrial fibrillation: 17.4% vs. 37% in the CS group. Colli et al. (2018) reported an incidence of this adverse event of 22.5% in his group of patients, while the rate reported by Samalavicius et al. (2017) was lower - 12%. Permanent pacemakers were also much less frequently implanted in the TA group: 2.3% vs. 12%. Both pacemakers in the TA group were implanted for preoperatively known sick sinus syndrome.

The lower incidence of PPM implantation in the TA group could be explained by the fact that all manipulations are carried out further away from the locations at which the heart conductive system could be damaged. Similarly, Colli et al. reported only one patient who had a postoperative myocardial infarction and none of the patients in this study had this complication, because manipulations are carried out further away from major coronary arteries, so the risk of damaging them is low.

The incidence of postoperative renal failure was almost 4 times higher in the CS group, with 2.8% of the patients requiring haemofiltration postoperatively. Recent publications report rate of the latter adverse event following mitral surgery to be less than 3% (131,132). None of the patients in the TA group needed haemofiltration.

One of the most commonly reported CPB-related adverse events is stroke. Various authors report the rate of neurological complications ranging from 1% to 2.8%. In this study, this complication occurred in 1.9% of the patients in the CS group. One patient had a transitory speech disorder following transapical MV

repair, but the patient completely recovered before he was discharged from the hospital.

Publications reporting the outcomes of transapical MV repair often emphasise that this is a minimally invasive procedure, which significantly reduces the duration of postoperative mechanical ventilation, length of stay at the intensive care unit and the length of postoperative in-hospital stay. Kavakli et al. (2016) reports these indicators to be 2.6 hours, 19.8 hours and 5 days, respectively, while Samalavicius et al. (2017) reported 4 hours, 22 hours and 8 days, respectively, and Colli et al. (2018) reported 3 hours and 8 days (duration of stay in the intensive care unit is not provided). This study showed similar results: 4 hours, 22 hours and 8 days, and it was much shorter compared to the CS group: 7 hours, 67 hours and 12 days.

In summary, most of the early postoperative results in the TA group are better and adverse events following transapical repair are rare, which shows safety of this treatment method. Patients recover from the operation faster and they leave the hospital earlier. This method is effective: acceptable intraoperative results were achieved in almost all patients. However, analysis of the late outcomes shows that long-term durability of the repair is better in the CS group, even when compared only with the results of the two best anatomical types of the TA group: freedom from severe MR was 90% after 5 years in the CS group, 85% for the type A patients and 74% for the type B patients in the TA group. The long-term durability was very poor in type C patients: it is only 23% after 2 years. Therefore, transapical MV repair should not be performed in type C patients.

Initial mitral valve anatomy was different in both groups. There were more type C patients in the CS group, while the majority of patients in the TA group were classified as types A and B. However, long-term durability was very similar in different anatomical types of the CS group, which shows that anatomical type is not relevant for the conventional repair. For this reason, the results were compared

between the entire CS group and different anatomical types of the TA group. The statistical reliability of a direct comparison between the anatomical types in different patient groups would be much lower due to the significantly lower number of patients.

It should also be noted that cases of MR recurrence in the CS group are evenly distributed throughout the postoperative follow-up period. Meanwhile, the majority of MR recurrence events in the TA group are concentrated within the first 6 months after the procedure. Then, the incidence of repair failure becomes much lower and a "plateau" phase can be seen after 6 months in group A and after 24 months in group B when new events of failure no longer occur.

This study shows the safety and efficacy of transapical MV repair in the early postoperative period. Although this treatment method is associated with a lower incidence of transfusions and arrhythmias compared to conventional techniques, it also has a higher rate of failure of the repair, especially during the first 24 months.

Transapical MV repair is a completely new approach, which has been refined both technically, for example by changing the location of ventriculotomy in the TACT study, and theoretically, developing patient selection criteria and categorising patients into anatomical types. The main difference between conventional and transapical repair is that MV annuloplasty is not performed in the latter approach. Therefore, combining transapical procedures with endovascular or other minimally invasive annuloplasty could in theory improve the long-term durability of this repair. Currently, the thorough selection of patients based on characteristics of the mitral anatomy remains crucial for improving the long-term results of transapical mitral repair.

FINDINGS

1. Transapical MV repair is an effective and safe method of treatment of degenerative mitral regurgitation characterised by the lower incidence of postoperative adverse events in the early postoperative period compared to conventional MV repair.
2. The long-term durability of transapical MV repair is statistically significantly poorer compared to the results of conventional MV repair (long-term durability of transapical MV repair (types A and B) was 77%, while durability of conventional MV repair – 90%).
3. The long-term durability of the conventional MV repair does not depend on the anatomical type of mitral pathology. The best long-term durability of transapical MV repair is achieved in patients with isolated P2 segment prolapse or pathology of the P2 segment and adjacent areas. Patients with MV pathology not limited to the P2 segment and adjacent areas should not undergo transapical MV repair due to poor long-term outcomes.
4. The recurrence of mitral regurgitation after transapical MV repair is usually caused by artificial and native chord rupture, as well as the relative elongation of artificial chords. The main cause of recurrent mitral regurgitation after conventional MV repair is the new rupture of native chords.

PRACTICAL RECOMMENDATIONS

1. Transapical MV repair can only be performed in patients with a mitral valve pathology of anatomical type A or B.
2. Patients with MV pathology not limited to the P2 segment and adjacent areas should undergo conventional MV repair.
3. In order to improve the long-term durability of transapical MV repair, a thorough preoperative selection of patients based on echocardiographic data and anatomical characteristics of mitral valve is necessary.

LIST OF PUBLICATIONS

1. Samalavicius RS, Norkiene I, Drasutiene A, **Lipnevicius A**, Janusauskas V, Urbonas K, Zakarkaite D, Aidietis A, Rucinskas K. Anesthetic Management and Procedural Outcomes of Patients Undergoing Off-Pump Transapical Implantation of Artificial Chordae to Correct Mitral Regurgitation: Case Series of 76 Patients. Anesth Analg. 2018 Mar;126(3):776–784. doi: 10.1213/ANE.0000000000002767.

2. Colli A, Manzan E, Aidietis A, Rucinskas K, Bizzotto E, Besola L, Pradegan N, Pittarello D, Janusauskas V, Zakarkaite D, Drasutiene A, **Lipnevicius A**, Danner BC, Sievert H, Vaskelyte L, Schnelle N, Salizzoni S, Marro M, Rinaldi M, Kurnicka K, Wrobel K, Ceffarelli M, Savini C, Pacini D, Gerosa G. An early European experience with transapical off-pump mitral valve repair with NeoChord implantation. Eur J Cardiothorac Surg. 2018 Sep 1;54(3):460–466. doi: 10.1093/ejcts/ezy064.

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Congenital cardiac surgery
Minimally invasive cardiac surgery
Mitral valve surgery

SUMMARY IN LITHUANIAN

Santrauka

ĮVADAS

15. TIRIAMOJI PROBLEMA, DARBO AKTUALUMAS IR REIKŠMĖ

Degeneracinės kilmės mitralinio vožtuvo nesandarumas (MVN) yra labiausiai paplitusi širdies vožtuvų patologija išsivysčiusiose šalyse ir yra nustatomas 2–3 % populiacijos. Pagrindinis nesandarumo mechanizmas yra mitralinio vožtuvo (MV) burių ir povožtuvinio aparato morfologiniai pakitimai ir dėl to atsirandantis burių prolapsas. Negydomas MVN ilgainiui tampa širdies ritmo sutrikimų bei širdies nepakankamumo priežastimi, reikšmingai pablogėja ligonio gyvenimo kokybė.

Plačiausiai naudojamas ir efektyviausiu pripažintas degeneracinės kilmės MVN gydymo metodas šiuo metu yra MV atkuriamosios operacijos, kitaip dar vadinamos MV plastika. Šio gydymo tikslas – atlikti anatominę pažeisto MV rekonstrukciją ir sugrąžinti jo funkciją. Palyginti su MV protezavimu, MV plastika yra susijusi su geresniais pooperaciniais rezultatais, ilgesniu išgyvenamumu ir geresne kairiojo skilvelio funkcija, atkuria normalią gyvenimo kokybę bei trukmę, turi mažesnę infekcinio endokardito ir trombembolinių komplikacijų riziką.

Populiariausias MV plastikos metodas yra klasikinė MV plastika per vidurinę sternotomiją. Tokios operacijos visada atliekamos naudojant dirbtinę kraujo apytaką (DKA) ir kardioplegiją, t. y. operacija vyksta neplakančios širdies sąlygomis. Tokioms operacijoms yra būdingos komplikacijos, susijusios su DKA ir kardioplegija, t. y. insultas, sisteminis uždegiminis atsakas,

pooperacinis širdies ir sisteminės kraujotakos nepakankamumas, širdies ritmo sutrikimai, inkstų ir kitų organų funkcijos nepakankamumas, infekcija, didesnis pooperacinis kraujavimas.

Nuo 1980-jų metų atliekant MV plastiką pradėtos naudoti ePTFE dirbtinės chordos. Jos yra implantuojamos į prolabuojančio burės segmento kraštą ir fiksuojamos papiliniuose raumenyse. Tokiu būdu šis segmentas yra nuleidžiamas iki neprolabuojančių segmentų aukščio ir grąžinamas vožtuvo sandarumas. Per kelis dešimtmečius dirbtinės chordos labai išpopuliarėjo ir dabar plačiai naudojamos atliekant MV plastiką.

Per pastaruosius 20 metų atsirado keletas mažiau invazinių MV plastikos metodų. Jie buvo sukurti siekiant sumažinti chirurginės procedūros traumą, tačiau išlaikant priimtiną saugumo ir korekcijos kokybės lygį. Nors šios operacijos neabejotinai turi tam tikrų privalumų, tačiau jas atliekant visgi išlieka rizika, susijusi su DKA naudojimu.

Tobulėjant technologijoms pasaulinėje praktikoje vis labiau jaučiama tendencija tobulinti mažiau invazines procedūras. Šį faktą nulemia tai, kad nuolat siekiama trumpinti hospitalizacijos ir nedarbingumo laikotarpį, be to, senstant populiacijai didėja ir MVN paplitimas tarp senyvo amžiaus žmonių. Tai skatina kurti naujus, mažiau invazinius metodus, kurie būtų saugesni ir sukeltų mažesnę pooperacinę traumą. Jie leistų darbingo amžiaus žmonėms greičiau pasveikti ir sugrįžti į darbą, be to, būtų tinkamesni senyviems pacientams, turintiems didesnę klasikinės chirurgijos riziką.

Vienas iš tokių naujoviškų alternatyvių gydymo metodų yra transapikalinė MV plastika naudojant „NeoChord DS1000^{TM}“ sistemą. Ši sistema yra unikalus chirurginis instrumentas, leidžiantis implantuoti dirbtines ePTFE chordas į prolabuojantį burės segmentą bei atkurti normalią vožtuvo funkciją. Ši procedūra yra atliekama per mažą pjūvį ir be DKA, todėl leidžia išvengti su DKA susijusių komplikacijų. Nuo 2011 m. tokios transapikalinės MV plastikos operacijos yra atliekamos Vilniaus universiteto ligoninėje Santaros

klinikose (VULSK). Tuo pačiu laikotarpiu toliau buvo atliekamos klasikinės MV plastikos.

Transapikalinė MV plastika yra nauja procedūra, kuri nėra paplitusi pasaulyje ir atliekama tik pavieniuose širdies chirurgijos centruose, todėl duomenų apie šį gydymo metodą bei publikacijų, aprašančių pooperacinius rezultatus, yra labai mažai. Tik vienoje publikacijoje pateikiami vėlyvieji (12 mėn.) 213 ligonių rezultatai bei duomenys apie ilgalaikį plastikos efektyvumą. Todėl nauji ankstyvieji bei vėlyvieji rezultatai yra ypač aktualūs ir įdomūs, nes nuo to priklauso tolesnis šios technologijos naudojimas ir tobulinimas.

Nepavyko rasti nė vienos publikacijos, kurioje būtų palyginami klasikinės bei transapikalinės plastikos rezultatai, o tai yra labai svarbu siekiant įvertinti šio naujo gydymo metodo saugumą bei efektyvumą.

16. TYRIMO TIKSLAS

Įvertinti ir palyginti klasikinės ir transapikalinės mitralinio vožtuvo plastikos efektyvumą, ankstyvuosius bei vėlyvuosius pooperacinius rezultatus.

17. TYRIMO UŽDAVINIAI

1. Įvertinti transapikalinės MV plastikos efektyvumą ir saugumą (komplikacijų skaičių ankstyvuoju pooperaciniu laikotarpiu) ir palyginti su klasikinės MV plastikos rezultatais.
2. Įvertinti transapikalinės MV plastikos ilgalaikį efektyvumą ir jį palyginti su klasikinės MV plastikos rezultatais.
3. Nustatyti ryšį tarp MV anatominio tipo ir ilgalaikio MV plastikos efektyvumo.

4. Išanalizuoti priežastis, lėmusias MVN atsinaujinimą po transapikalinės ir klasikinės MV plastikos.

18. DARBO NAUJUMAS

Šiuo metu yra tik viena publikacija, kurioje pateikiami 213 ligonių transapikalinės MV plastikos vėlyvieji (12 mėn.) pooperacinės stebėsenos rezultatai. Vilniaus universiteto ligoninėje Santaros klinikose transapikalinė MV plastika atliekama nuo 2011 metų ir į šį tyrimą įtrauktų ligonių pooperacinės stebėsenos mediana yra 39 mėn. (IKP 20–51 mėn.). Šioje disertacijoje pateikiami vėlyvieji transapikalinės MV plastikos rezultatai, analizuojamas ilgalaikis šios plastikos efektyvumas bei jo priklausomybė nuo MV anatominio tipo, taip pat aptariamos priežastys, sukėlusios MVN atsinaujinimą po transapikalinės ir klasikinės MV plastikos.

Nė vienoje iš publikacijų transapikalinės MV plastikos rezultatai nebuvo palyginti su klasikinės MV plastikos rezultatais. Abu šie gydymo metodai yra naudojami degeneracinei MV ligai gydyti, tačiau transapikalinė MV plastika yra visiškai naujas, o klasikinė chirurginė MV plastika – seniai ir plačiai taikomas metodas, kuris pripažintas saugiu ir efektyviu. Disertacijoje yra palyginami šių dviejų gydymo metodų ankstyvieji ir vėlyvieji rezultatai.

19. PRAKTINĖ DARBO REIKŠMĖ

Šiame darbe buvo ištirtas ilgalaikis transapikalinės MV plastikos efektyvumas ir jo ryšys su pradine MV anatomija. Nustatyta, kad geriausias ilgalaikis transapikalinės MV plastikos efektyvumas pasiekiamas ligoniams, kuriems MVN sukėlė izoliuotas P2 segmento prolapsas.

Taip pat nustatyta, kad nors ankstyvuoju pooperaciniu laikotarpiu komplikacijų skaičius po transapikalinės MV plastikos buvo

mažesnis, ilgalaikis klasikinės MV plastikos efektyvumas yra geresnis ir nepriklauso nuo MV anatomijos.

TIRIAMIEJI IR TYRIMO METODAI

Tyrimas atliktas 2014–2018 m. Vilniaus universiteto ligoninėje Santaros klinikose (VULSK). Tyrimui atlikti gautas Vilniaus regioninio biomedicininių tyrimų etikos komiteto pritarimas Nr. 158200-16-829-345.

Tai retrospektyvusis kohortinis stebėsenos tyrimas. Į tyrimą buvo įtraukti 202 ligoniai, kuriems nuo 2011 m. gruodžio 1 d. iki 2018 m. sausio 1 d. VULSK buvo atlikta klasikinė chirurginė MV plastika arba transapikalinė MV plastika dėl degeneracinės kilmės MVN. Duomenys rinkti iš medicininės dokumentacijos.

Į šį tyrimą įtraukti ligoniai, kurie buvo operuoti dėl degeneracinės kilmės MVN: vienos arba abiejų burių prolapso (taip pat ir plevėsuojančios burės), su chordos plyšimu arba be jo. Visi ligoniai, kurių MVN buvo sukeltas burių restrikcijos (reumatas, kardiomiopatija), išeminės širdies ligos, arba MV infekcinio pažeidimo, taip pat ligoniai, kuriems buvo centrinė MVN srovė, į šį tyrimą neįtraukti.

Remiantis gautais echokardiografijos duomenimis buvo atrenkami ligoniai, tinkami klasikinei arba transapikalinei MV plastikai. Transapikalinė MV plastika buvo atlikta ligoniams (n = 94), kurių MV anatomija buvo palanki šiam gydymo metodui ir kurie sutiko šiai procedūrai. Kitiems ligoniams buvo atlikta klasikinė MV plastika (n = 108).

Transapikalinė MV plastika buvo atlikta 3 ligoniams, kuriems anksčiau buvo atlikta klasikinė MV plastika ir implantuotas anuloplastikos žiedas. Šie ligoniai buvo atskirti nuo pagrindinės ligonių grupės ir jų gydymo eiga buvo aprašyta atskirai.

Tokiu būdu buvo suformuotos dvi ligonių grupės:

1. Klasikinės chirurginės mitralinio vožtuvo plastikos (KC) grupė – 108 ligoniai.
2. Transapikalinės mitralinio vožtuvo plastikos (TA) grupė – 91 ligonis.

Tyrime buvo analizuojami duomenys, gauti atliekant klinikinį ištyrimą, instrumentinius bei laboratorinius tyrimus:

1. prieš procedūrą (pradinė būklė);
2. prieš išrašant iš ligoninės;
3. per stebėjimo apsilankymus praėjus 1 mėn., 6 mėn. ir 12 mėn. po operacijos, o vėliau – kas 12 mėn.

20. STATISTINĖ ANALIZĖ

Statistinė duomenų analizė atlikta naudojant duomenų kaupimo ir analizės programos paketą „SPSS 22.0“ (IBM Corp., Armonk, NY, USA). Kiekybinių tolydžiųjų duomenų normalumui patikrinti naudotos histogramos, stačiakampės diagramos, Sapiro ir Vilko (angl. *Shapiro–Wilk*) kriterijus ($p > 0,05$). Kiekybiniai pagal normalųjį skirstinį pasiskirstę duomenys išreikšti vidurkiu ± standartiniu nuokrypiu. Šių duomenų vidurkio palyginimui naudotas Stjudento t kriterijus nepriklausomoms imtims. Vidurkiams tarp daugiau negu dviejų grupių palyginti naudota vieno faktoriaus dispersinė analizė (ANOVA). Kiekybiniai tolydieji duomenys, pasiskirstę ne pagal normalųjį skirstinį, išreikšti mediana ir kvartilių intervalu. Šiems duomenims palyginti naudotas Mano, Vitnio ir Vilkoksono kriterijus (angl. *Mann–Whitney–Wilcoxon*). Kategoriniai duomenys išreikšti procentais. Kategoriniai kintamieji buvo palyginti χ^2 arba Fišerio (Fisher) tiksliuoju kriterijumi. Ligonių KC bei TA grupės vertintos Kaplano ir Mejerio (angl. *Kaplan–Meier*) metodu, o tarpusavyje ligonių grupės buvo palygintos taikant logranginį testą (angl. *Log Rank test*). Cenzūruoti duomenys – ligoniai, kurių stebėjimas baigtas. Dydžiai $p < 0,05$ buvo vertinami kaip statistiškai reikšmingi, o $0,05 < p \leq 0,1$ buvo laikomi tendencija.

REZULTATAI

TA grupės ligoniai buvo kiek vyresni nei KC grupės – atitinkamai 61 m. ir 56 m. ($p = 0,008$). Taip pat TA grupės ligoniai turėjo šiek tiek didesnį kūno masės indeksą. Tiek KC, tiek TA grupės ligonių priešoperacinė rizika vertinama kaip maža: 0,44 % ir 0,48 % pagal STS, 0,84 % ir 0,8 % pagal EuroSCORE II, reikšmingo skirtumo tarp ligonių grupių nebuvo.

KC grupėje buvo daugiau ligonių, turinčių paroksizminį ir lėtinį prieširdžių virpėjimą – atitinkamai 21 % ir 19 %, o TA grupėje tokie ligoniai sudarė 2 % ir 3 % ($p < 0,001$). Dažniausia abiejų grupių ligonių gretutinė liga buvo pirminė arterinė hipertenzija, kiek dažnesnė ji buvo TA grupėje (39 % ir 54 %). Statistiškai reikšmingo skirtumo tarp sergamumo vainikinių arterijų liga, diabetu, lėtine obstrukcine plaučių liga bei insultu nenustatyta.

Visiems tyrimo dalyviams prieš operaciją buvo nustatytas ryškus MV nesandarumas: apie ¾ ligonių – MVN 3+ ir ¼ ligonių – MVN 4+ abiejose grupėse. KC grupėje reikšmingas (≥2+) triburio vožtuvo nesandarumas buvo dažnesnis: 13 % vs 4 % ($p=0,036$).

Pagal patologinio segmento lokalizaciją visi ligoniai buvo suskirstyti į keturis anatominius tipus:

A – izoliuotas P2 segmento prolapsas. TA grupėje tokių ligonių buvo 22 (24 %), o KC grupėje – 15 (14 %);

B – P2 segmento ir greta esančių sričių prolapsas. Šio tipo MV patologiją turėjo 48 (53 %) TA grupės ligoniai ir 20 (19 %) KC grupės ligonių;

C – vienos arba abiejų burių prolapsas, kai prolabuoja ir parakomisūriniai segmentai. Šie ligoniai sudarė daugumą KC grupėje – 70 (65 %). TA grupėje tokių ligonių buvo 16 (18 %);

D – izoliuotas A2 segmento prolapsas. TA grupėje tokių ligonių buvo 5 (5 %), o KC grupėje – 3 (3 %).

Dauguma klasikinių MV plastikos operacijų buvo atlikta per vidurinę sternotomiją – 91,7 %, anuloplastikos žiedas buvo

implantuotas 96,3 % ligonių, o dirbtinės ePTFE chordos – 83,3 % ligonių.

Dviem trečdaliams TA grupės ligonių buvo implantuotos 3 arba 4 chordos.

TA grupėje buvo 4 (4,4 %) ligoniai, kuriems procedūra laikoma nesėkminga: dviem ligoniams buvo atlikta intraoperacinė konversija į klasikinę MV plastiką ir 2 ligoniams pasiektas MVN buvo didesnis nei 2+.

MV buvo visiškai sandarus arba turėjo minimalų nesandarumą 62,1 % ligonių, kuriems buvo sėkmingai atlikta transapikalinė MV plastika. KC grupėje tokių ligonių buvo 76,8 % ($p = 0,025$). Penkiems ligoniams po TA plastikos išliko MVN 2+.

Pooperacinis kraujavimas buvo daug mažesnis TA grupėje – 200 ml, KC grupėje – 350 ml. TA grupėje kraujo produktų transfuzijų dažnis buvo daug mažesnis – 5,8 % vs 43,5 % ($p < 0,001$). Naujas prieširdžių virpėjimas TA grupėje išsivystydavo rečiau: 37 % vs 17,4 %. Pooperacinis kreatinino koncentracijos padidėjimas >150 % buvo nustatytas tik 3,6 % TA grupės ligonių, o KC grupėje tokių ligonių buvo 15,7 %. Hemofiltracijos TA grupės ligoniams neprireikė.

Ligoniai po TA plastikos būdavo ekstubuojami gerokai anksčiau – po 4 val. vs 7 val., be to, intensyviosios terapijos skyriuje jie buvo gydomi trumpiau – 22 val. vs 67 val. Pooperacinės hospitalizacijos trukmė buvo taip pat mažesnė: 8 d. vs 12 d.

Pooperacinės stebėsenos trukmės mediana KC grupėje buvo 34 mėn., TA grupėje – 39 mėn.

Ilgalaikis klasikinės MV plastikos efektas buvo daug geresnis nei TA MV plastikos: praėjus 72 mėnesiams po operacijos MVN neviršijo 2+ 90 % ligonių. TA grupės ligonių šis rodiklis buvo 68 %.

Suskirsčius KC grupės rezultatus pagal anatominius tipus, didesnio skirtumo tarp grupių negauta ($\chi 2 – 0,106$, $p = 0,991$), todėl toliau KC grupės rezultatai buvo vertinami kartu, neskirstant į grupes.

Palygintas plastikos efektyvumas tarp KC grupės ir TA grupės, pastarąją suskirsčius į anatominius A, B, C ir D tipus. Geriausi rezultatai buvo gauti A anatominėje grupėje – per pirmuosius 6 mėn. ligonių, kuriems išliko geras plastikos efektas, sumažėjo iki 85 %, o vėliau šis skaičius nesikeitė. Kiek prastesnis ilgalaikis efektyvumas buvo B grupėje: po 6 mėn. MVN ≤2+ išliko 87 % ligonių, po metų – 80 %, o nuo 24 mėn. iki stebėjimo pabaigos – 74 % ligonių. C grupės rezultatai buvo prasčiausi. Jau po pusės metų ryškus MVN atsinaujino maždaug pusei ligonių, o nuo 24 mėn. geras plastikos efektas išlieka tik 23 % ligonių.

Sudėjus A ir B anatominių grupių rezultatus, MVN ≤2+ išliko 81 % ligonių po 12 mėn. ir 77 % po 28 mėn. Toliau rezultatas nesikeičia iki stebėjimo pabaigos.

Po transapikalinės MV plastikos iš ligoninės išvyko 86 ligoniai, iš jų 25 (29 %) ligoniams MVN >2+ atsinaujino. Trys ligoniai buvo priskirti A anatominiam tipui, 11 – B tipui, 10 – C tipui ir 1 – D tipui.

Visais atvejais, kai atsinaujindavo MV nesandarumas KC grupėje, buvo diagnozuojamas naujas chordų plyšimas. Pagrindinės priežastys, sukėlusios MVN atsinaujinimą TA grupėje, buvo reliatyvus dirbtinių chordų pailgėjimas, natyvinių ir dirbtinių chordų plyšimas.

IŠVADOS

1. Transapikalinė MV plastika yra efektyvus ir saugus degeneracinės kilmės MV nesandarumo gydymo metodas, pasižymintis mažesniu pooperacinių komplikacijų skaičiumi ankstyvuoju pooperaciniu laikotarpiu lyginant su klasikine MV plastika.
2. Ilgalaikis transapikalinės MV plastikos efektyvumas yra statistiškai patikimai prastesnis nei klasikinės chirurginės MV

plastikos (A ir B anatominių tipų transapikalinės MV plastikos efektyvumas yra 77%, o klasikinės MV plastikos – 90%).

3. Klasikinės MV plastikos ilgalaikis efektyvumas nepriklauso nuo MV anatominio tipo. Geriausias ilgalaikis transapikalinės MV plastikos efektyvumas pasiekiamas ligoniams, turintiems izoliuotą P2 segmento prolapsą arba P2 segmento ir gretimų sričių patologiją, o ligoniams, kurių MV patologija neapsiriboja P2 segmento ir gretimų sričių prolapsu, transapikalinė MV plastika neturi būti atliekama dėl prastų vėlyvų rezultatų.
4. MVN atsinaujinimą po transapikalinės MV plastikos dažniausiai sukelia dirbtinių bei natyvinių chordų plyšimas, taip pat reliatyvus dirbtinių chordų pailgėjimas. Pagrindinė MVN atsinaujinimo po klasikinės MV plastikos priežastis – naujas natyvinių chordų plyšimas.

PRAKTINĖS REKOMENDACIJOS

1. Transapikalinė MV plastika gali būti atliekama tik tiems ligoniams, kurių mitralinio vožtuvo patologija yra A ar B anatominio tipo.
2. Ligoniams, kurių MV patologija neapsiriboja P2 segmento ir gretimų sričių prolapsu, turi būti atliekama klasikinė chirurginė MV plastika.
3. Siekiant pagerinti ilgalaikį transapikalinės MV plastikos efektyvumą, būtina griežta priešoperacinė ligonių atranka remiantis echokardiografijos duomenimis ir MV anatomijos ypatumais.

DISERTACIJOS TEMA PASKELBTŲ DARBŲ SĄRAŠAS

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