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# Initial Slovenian experience with MitraClip therapy

## Careful selection of patients is crucial for optimal outcome

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**Summary**
*Background* MitraClip is a percutaneous mitral repair technology increasingly used for high surgical risk patients with primary or secondary mitral regurgitation. We describe initial Slovenian experience with MitraClip and discuss the importance of identifying the suitable candidates for this procedure.
*Methods* We retrospectively analyzed the first 10 patients (mean age 75.6 ± 6.9 years, logistic Euroscore 28.4 ± 10.9%) with severe and moderate to severe mitral regurgitation (8 secondary, 1 primary and 1 mixed etiology) who underwent a MitraClip procedure between January 2015 and February 2017.
*Results* Acute reduction of mitral regurgitation was achieved in all but one patient (90%). There were no periprocedural mortalities and at short to mid-term follow-up (median 12 months, interquartile range 3–15 months). In eight patients improvement of functional class was observed at discharge. No functional improvement was achieved in a patient with advanced ischemic cardiomyopathy, and in a patient with degenerative mitral disease in whom the MitraClip procedure had failed necessitating mitral valve surgery. One patient experienced late leaflet detachment and was effectively managed with a second MitraClip procedure. There were two vascular complications at the access site and one percutaneous closure of an iatrogenic atrial septal defect.
*Conclusion* Our initial experiences with a small number of patients indicate that percutaneous mitral repair with MitraClip is a feasible and safe method in high-risk patients. Special attention should be paid to careful patient selection including detailed echocardiographic evaluation of mitral valve anatomy, technical performance and final result, particularly at the beginning of the learning curve in order to reduce the rate of serious complications.

**Keywords** MitraClip · Mitral regurgitation · Percutaneous mitral valve repair · Echocardiography · Mitral anatomy

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## Introduction

Mitral regurgitation (MR) is the second most common valvular heart disease in the western world next to aortic stenosis with an increasing incidence through aging [1]. As the population ages, we are faced with new challenges on how to treat high-risk elderly patients with less invasive and yet effective procedures. Multiple percutaneous approaches have been developed in attempts to treat inoperable patients with MR. The MitraClip system (Abbott Laboratories, Abbott Park, IL, USA) is the most widely used and clinically applicable percutaneous technique for mitral valve repair. After its first use in 2003 over 45,000 patients have been treated with this method all over the world. In 2008 the MitraClip device obtained approval (Conformité Européenne) and in 2013 the U.S. Food and Drug Administration (FDA) approval for selected patients. Accordingly, the American and European guidelines have now included MitraClip therapy for patients with primary MR with a prohibitive operative risk and a life expectancy >1 year [2, 3]. The European guidelines state that MitraClip can be considered also for patients with secondary (functional) MR due to is-

chemic or non-ischemic dilated cardiomyopathy who remain symptomatic despite optimal medical therapy and cardiac resynchronization therapy when indicated [2].

The Everest II trial was the only randomized controlled study comparing mitral valve surgery and MitraClip [4]. This study included predominately patients with primary degenerative MR and demonstrated similar improvements in functional capacity but smaller reduction of MR in the MitraClip compared to the surgical group, with more needs for surgery at 1-year follow-up due to mitral valve dysfunction [4, 5]; however, the data from European registries and clinical trials [6, 7], reflecting the real world practice, showed that the majority of patients have dilated cardiomyopathy with secondary MR. Even in these very high-risk patients clinical outcomes demonstrate safety and efficacy of MitraClip in reduction of MR, reversed left ventricular remodelling, improved functional capacity and quality of life [6–8].

The objective of the present paper is to describe initial Slovenian experience with MitraClip and discuss the importance of selection of appropriate candidates for optimal outcome.

## Methods

### *Patient selection and procedure description*

We retrospectively analyzed the first 10 patients who underwent the MitraClip procedure between January 2015 and February 2017. Our heart team consisting of an interventional cardiologist, cardiac surgeon, cardiovascular imaging specialists and anesthesiologist, assessed the patient suitability for the MitraClip procedure. Patients needed to be at prohibitive risk for open heart surgery due to severe comorbidities (e.g. severe pulmonary, renal and/or liver disease, left and/or right ventricular dysfunction, severe pulmonary hypertension) or specific conditions (e.g. frailty, porcelain aorta, radiation damage to chest wall, previous cardiac operations). Conventional risk scores (logistic Euroscore, Euroscore II and Society of Thoracic Surgery score) were used to estimate procedural mortality risk. Anatomical and functional assessment of the mitral valve was done by transthoracic and transesophageal echocardiography. Indications for MitraClip procedure were moderate to severe or severe (3+ or 4+) MR, graded by an integrated approach with a cut-off value of effective regurgitant orifice area 0.4 $cm^2$ and 0.2 $cm^2$ for primary and secondary MR, respectively, according to the European guidelines for the management of valvular heart disease [2, 3]. Additionally, standard anatomical inclusion criteria based on the Everest trial were used: preferred central MR jet origin in the middle scallops of the anterior (A2) and posterior leaflets (P2), mitral valve area ≥4 $cm^2$, a coaptation length ≥2 mm and a coaptation depth ≤11 mm for patients with functional MR, and a flail gap <10 mm and flail width <15 mm for patients with degenerative MR [4].

The MitraClip procedure was entirely percutaneous via transfemoral venous route and transseptal puncture, with the patient under general anesthesia with echocardiographic and fluoroscopic guidance as previously described [4]. Immediately after clip implantation residual MR was assessed by transesophageal echocardiography with color Doppler, pulmonary venous flow, proximal isovelocity surface area (PISA) and vena contracta methods when feasible.

### *Follow-up*

At discharge the patients' functional capacity was evaluated by the New York Heart Association (NYHA) classification and residual MR was quantified by transthoracic echocardiography using an integrated multiparametric approach, as recommended in the European guidelines for the management of valvular heart disease [2]. During follow-up at 3, 6 and 12 months, the patients' NYHA functional class was assessed and N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels were measured. Follow-up transthoracic echocardiography was performed at 3 and 12 months.

## Results

### *Baseline characteristics*

Table 1 summarizes the clinical and echocardiographic data of the first 10 patients treated with the MitraClip system at the University Medical Center Ljubljana, Slovenia, from January 2015 to February 2017. All patients had symptomatic heart failure and were on optimal heart failure medication treatment. Of the patients eight had secondary (due to ischemic in four and non-ischemic cardiomyopathy in other four patients), one patient primary (degenerative) and one mixed etiology of MR.

### *Procedure and discharge*

Echocardiographic and clinical outcome after the MitraClip procedure are presented in Table 2. In six patients two clips were placed and one clip in the remaining five. There were no procedural deaths or deaths after 30 days. Acute procedural success, defined as successful implantation of one or more clips with a reduction of MR to equal or less than 2+, was achieved in all but one patient (90%; Fig. 1). In patient no. 8 the MitraClip procedure failed, which necessitated subsequent surgery. The patient had mixed MR etiology-mitral annular dilatation and degenerative disease (Figs. 2 and 3a–d). One clip was placed in a good position at the flail area of A2, but after deployment there was significant residual MR due to

**Table 1** Baseline patient and echocardiographic characteristics

| Patient, No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Age (years) | 65 | 72 | 71 | 79 | 75 | 78 | 69 | 84 | 88 | 75 |
| Gender | M | M | F | F | M | M | M | F | M | M |
| Logistic ES (%) | 16.4 | 29.7 | 29.7 | 32.1 | 28.4 | 15.1 | 53.7 | 19.5 | 30.5 | 28.4 |
| ES II (%) | 4.7 | 9.1 | 7.3 | 5.1 | 14.9 | 3.8 | 12.0 | 3.1 | 5.4 | 13.8 |
| NYHA class | III | IV | III | III | III | IV | III | IV | III | IV |
| *Comorbidities* | | | | | | | | | | |
| AF | – | + | + | + | + | + | – | + | – | + |
| DM | + | – | – | – | + | – | – | – | – | – |
| Chronic renal disease (eGFR <60 ml/min) | – | + | + | – | + | + | + | + | – | + |
| COPD | + | – | – | – | – | – | + | – | – | – |
| Prior MI | + | + | + | – | – | – | – | – | + | – |
| Prior CRT/PM | – | + | + | – | + | – | – | – | – | + |
| Prior PCI | + | + | + | – | + | – | – | + | – | – |
| Prior cardiac surgery | CABG | – | CABG | AVR | CABG | – | – | – | – | David |
| Porcelain aorta | – | – | – | + | – | – | + | + | – | – |
| *Echocardiographic characteristics* | | | | | | | | | | |
| LVEF (%) | 53 | 15 | 45 | 65 | 52 | 40 | 40 | 65 | 46 | 45 |
| LVEDD (cm) | 5.4 | 7.5 | 5.7 | 5.2 | 5.3 | 6.1 | 6.3 | 5.7 | 6.3 | 7.2 |
| LVEDV (ml) | 140 | 300 | 187 | 125 | 169 | 156 | 207 | 105 | 175 | 270 |
| LVEDVI (ml/m$^2$) | 78 | 150 | 98 | 80 | 84 | 82 | 109 | 60 | 107 | 139 |
| Type of MR | S | S | S | P | S | S | S | M | S | S |
| MR severity | 3+ | 3+ | 3+ | 4+ | 4+ | 4+ | 4+ | 4+ | 3+ | 4+ |
| EROA (cm$^2$) | 0.18 | 0.23 | 0.20 | 0.47 | 0.37 | 0.36 | 0.43 | 0.41 | 0.20 | 0.42 |
| PAPs (mm Hg) | 52 | 55 | 35 | 54 | 48 | 57 | 75 | 65 | 40 | 55 |

*M* male, *F* female, *ES* Euroscore, *NYHA* New York Heart Association, *AF* atrial fibrillation, *DM* diabetes mellitus, *eGFR* estimated glomerular filtration rate, *COPD* chronic obstructive pulmonary disease, *MI* myocardial infarction, *CRT* cardiac resynchronization therapy, *PM* pacemaker, *PCI* percutaneous coronary intervention, *CABG* coronary artery bypass grafting, *AVR* aortic valve replacement, *David* valve sparing aortic root replacement (David procedure), *LVEF* left ventricular ejection fraction, *LVEDD* left ventricular end-diastolic diameter, *LVEDV* left ventricular end-diastolic volume, *LVEDVI* left ventricular end-diastolic volume index, *MR* mitral regurgitation, *P* primary, *S* secondary, *M* mixed, *EROA* effective regurgitant orifice area, *PAPs* systolic pulmonary artery pressure

**Table 2** Echocardiographic and clinical outcomes after MitraClip procedure

| Patient, No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *MR severity* | | | | | | | | | | |
| After MC procedure | 1+ | 2+ | 1+ | 2+ | 1+ | 2+ | 2+ | 3+ | 1+ | 2+ |
| *NYHA class* | | | | | | | | | | |
| At discharge | I | IV | II | II | II | III | II | IV | II | II |
| At follow-up | I | IV | II | III | II | III | II | IV | II | II |
| *Clinical outcomes* | | | | | | | | | | |
| Inotropic support | – | + | – | – | – | – | – | – | – | – |
| Transfusion | – | – | – | + | – | – | – | – | – | – |
| Stroke and MI | – | – | – | – | – | – | – | – | – | – |
| Vascular complications | – | – | – | + | – | – | + | – | – | – |
| ASD closure | – | – | + | – | – | – | – | – | – | – |
| MC failure | – | – | – | – | – | – | – | + | – | – |
| Late leaflet detachment | – | – | – | + | – | – | – | – | – | – |
| Repeat MC procedure | – | – | – | + | – | – | – | – | – | – |
| Mitral surgery | – | – | – | – | – | – | – | + | – | – |

*MR* mitral regurgitation, *MC* MitraClip, *NYHA* New York Heart Association, *MI* myocardial infarction, *ASD* atrial septal defect

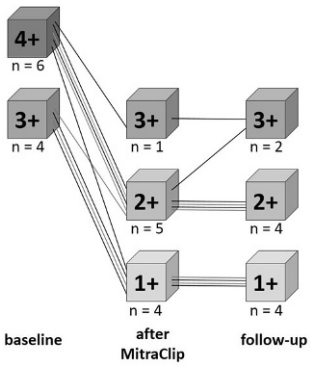


**Fig. 1** Change of mitral regurgitation grade after MitraClip procedure (immediately after procedure and at follow-up). *1+, 2+, 3+* and *4+* represent grading severity of mitral regurgitation

prolapse of the medial scallop of the posterior leaflet (P3; Fig. 3e, f), not suitable for placing another clip. The patient was readmitted 4 months after the MitraClip procedure severely symptomatic with significant MR predominately on the medial side of the clip and underwent surgery. Inspection of the valve demonstrated properly placed MitraClip at the middle scallops of both leaflets, but a tear was found at the medial side of the anterior leaflet with a large coaptation gap. Since other scallops of the valve were diseased as well, the patient underwent biological mitral valve replacement (Biointegral Surgical, Toronto, Canada) together with tricuspid annuloplasty (MC3 ring, Edwards Lifesciences, Irvine, CA, USA). Postoperatively the patient suffered from recurrent pleural effusions, but otherwise recovered well.

Periprocedural complications occurred in three patients, two had vascular complications at femoral access site (arteriovenous fistula and wound dehiscence) requiring surgical intervention and one patient had large iatrogenic atrial septal defect (ASD) with a diameter of 8 mm, which was closed with Amplatzer septal occluder (St. Jude Medical, Minneapolis, MN, USA). At discharge, improvement of NYHA functional class was noticed in eight patients. There was no functional improvement in patient no. 8 with failed MitraClip procedure and in patient no. 2 in spite of a reduction of MR after MitraClip procedure. This patient had advanced ischemic cardiomyopathy with severely depressed left and right ventricular function.

### *Long-term follow-up*

In our group of patients median follow-up was 12 months (interquartile range 3–15 months). No deaths were observed in this period. During follow-up functional improvement was sustained in seven patients (Table 2), which was also consistent with a decrease in NT-proBNP marker at the last follow-up ($p = 0.037$; Fig. 4). Worsening of MR was observed in one patient at follow-up. Patient no. 4 with a myxomatous mitral valve and flail of the lateral scallop of the posterior leaflet (P1) clinically deteriorated 8 months after MitraClip procedure. We noticed late leaflet detachment of the flailed segment from the clip with significant recurrent MR (Fig. 5a–f). Another MitraClip was successfully placed in the area of flail with no significant mitral valve gradient and only mild residual MR (Fig. 6).

## Discussion

In this paper we describe initial Slovenian experiences with the percutaneous treatment of MR with MitraClip system. Our data from 10 patients revealed that the method can be safely performed in high-risk patients and has good procedural results with acute reduction of MR even at the beginning of implementation of this new method. Based on our experience it is important to note that feasibility and efficacy of MitraClip therapy depend on appropriate selection of candidates from a clinical and anatomical point of view.

The MitraClip system can be an alternative in high-risk inoperable patients with primary MR. Otherwise in low risk patients with primary MR, surgical mitral valve repair or replacement is the gold standard therapy with excellent and predictive results. In contrast,

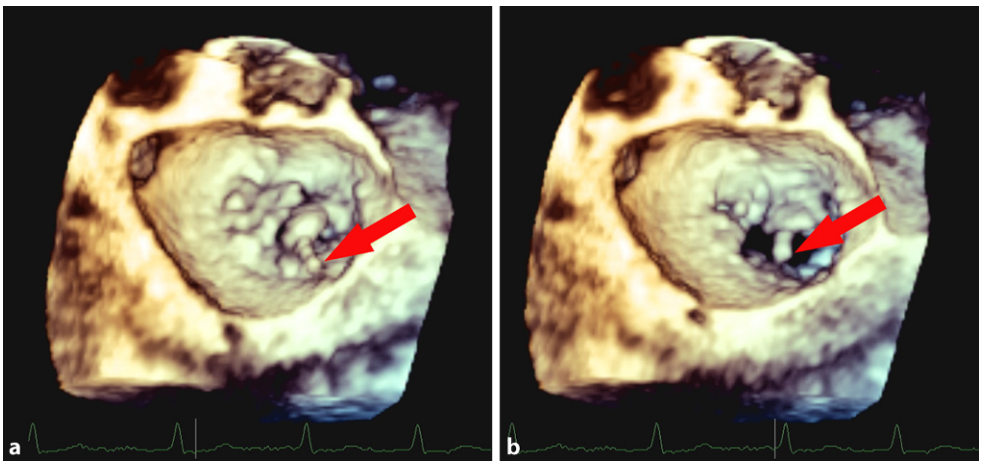


**Fig. 2** Three-dimensional transesophageal echocardiography image (surgeon's view) of the mitral valve in patient no. 8 showing widespread degenerative disease and flail of the middle scallop of the anterior leaflet-A2 (*arrow*; **a** in systole, **b** in diastole)

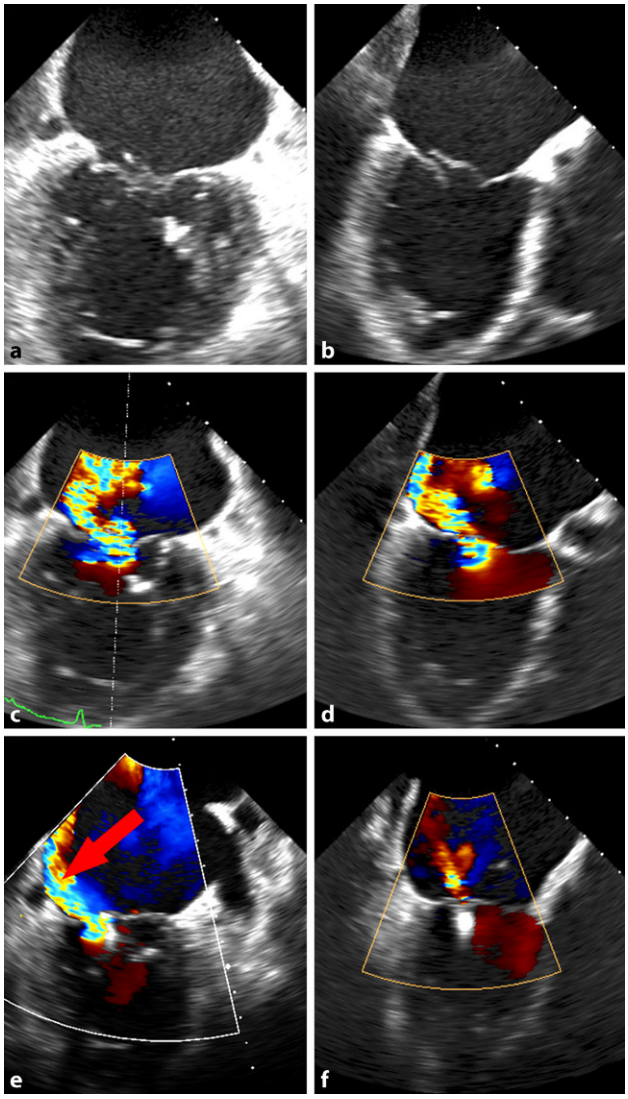


**Fig. 3** Transesophageal echocardiography in patient no. 8 with mixed mitral regurgitation, degenerative disease with a flail of the middle scallop of the anterior leaflet (A2) and annular dilatation due to long-standing atrial fibrillation, before MitraClip implantation (**a** intercommissural view, **b** long axis view, **c** intercommissural view with color Doppler flow, **d** long axis view with color Doppler flow) and immediately after MitraClip implantation with significant residual regurgitant jet medial to the clip (*arrow*; **e** intercommissural view with color Doppler flow, **f** long axis view with color Doppler flow)

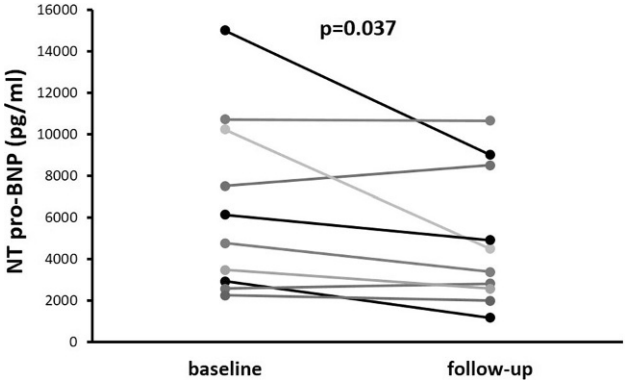


**Fig. 4** Change of N-terminal prohormone of brain natriuretic peptide values (NT-proBNP) from baseline to follow-up. Each dot corresponds to an individual patient

surgery for secondary MR yields conflicting results with no firm evidence of improving long-term prognosis [9, 10]. Surgery is considered only if a patient needs another open heart procedure, most commonly coronary artery bypass grafting but the most viable option for secondary MR is optimal medical therapy with individual consideration of novel upcoming percutaneous repair techniques [2, 3, 11]. Not surprisingly, the majority of patients treated nowadays with MitraClip are heart failure patients with advanced cardiomyopathy and secondary MR [4, 6]. The value of MitraClip in moderate to severe and severe secondary MR is currently being further evaluated in ongoing randomized controlled studies the results of which are eagerly awaited; COAPT is investigating the safety and efficacy of MitraClip versus optimal medical treatment in patients with secondary MR not eligible for mitral valve surgery, whereas RESHAPE-HF and MITRA-FR are comparing heart failure patients with secondary MR treated with MitraClip to optimal medical therapy and the primary outcome will be both heart failure hospitalization as well as all-cause mortality [12–14]. Additionally, the MATTERHORN trial is comparing MitraClip with reconstructive mitral valve surgery in high-risk patients with secondary MR [15].

Conventional risk scores for prediction of procedural mortality risk can help to make the decision for selecting patients for MitraClip, but have known limitations, not taking into account other important severe comorbidities that influence postprocedural mortality. Additionally, the heart team has to decide whether the patient's comorbidities would not preclude the expected benefit from reduction of the MR. Our patient no. 2 with very advanced ischemic cardiomyopathy and severely decreased left ventricular ejection fraction of 15% accompanied by depressed right ventricular function, remained equally symptomatic in spite of successful reduction of ischemic MR. He was a non-responder to cardiac resynchronization therapy as well. It can be expected that at a certain point the diseased left ventricle can no longer recover. Therefore, MitraClip therapy in such case would be futile. This assumption has been demonstrated in a recently published long-term observational study suggesting that advanced heart failure phenotype might not benefit from mitral valve repair [16]. In addition, in symptomatic heart failure patients it is often difficult to determine whether the patient's symptoms can be attributed mainly to MR or to ventricular dysfunction or even other concomitant diseases. Data regarding the predictors for adverse outcome after MitraClip procedure are controversial. Recent studies identified advanced heart failure (NYHA class IV), severely dilated ventricles,

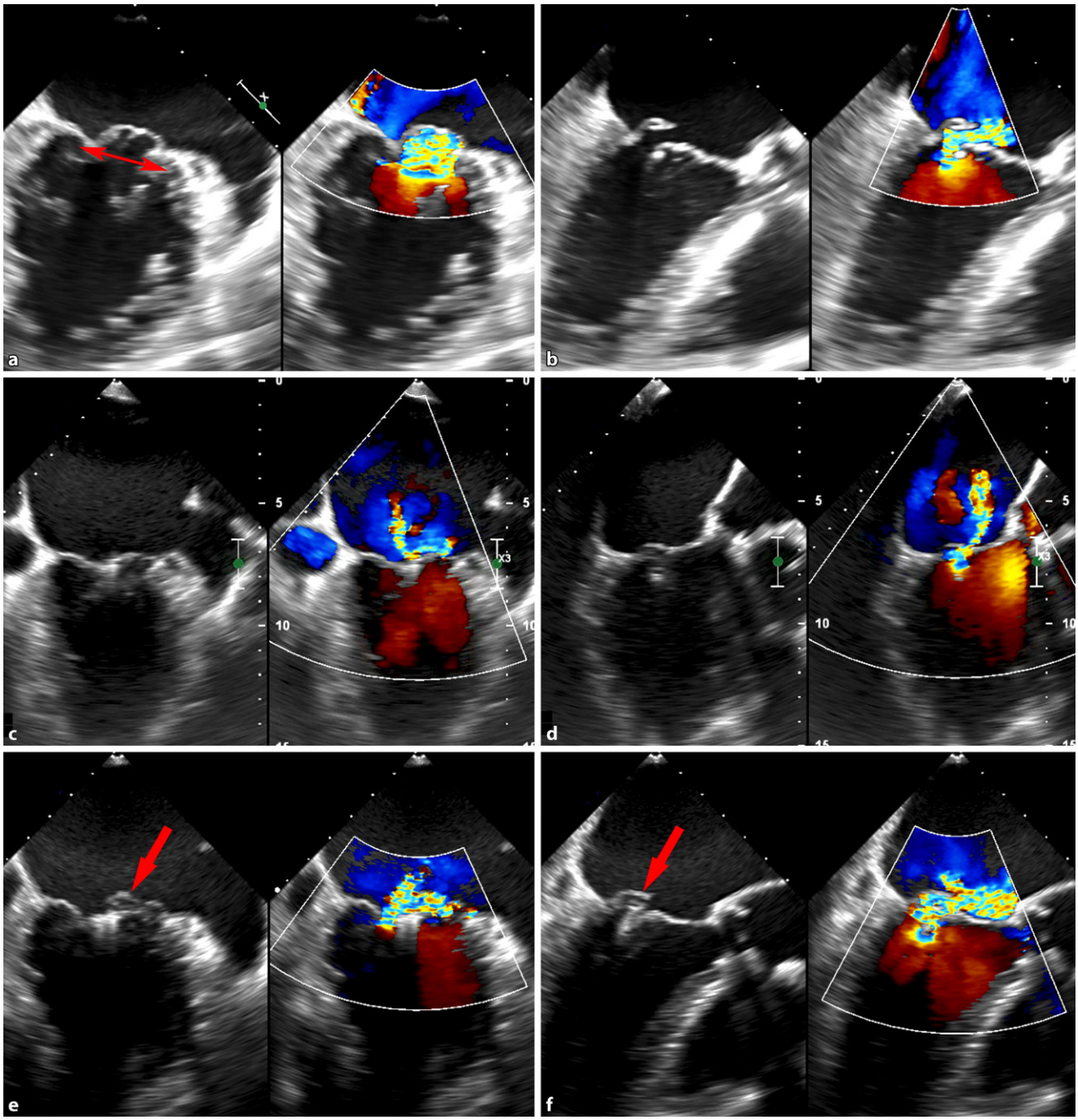


**Fig. 5** Transesophageal echocardiography in patient No. 4 with primary mitral regurgitation (myxomatous disease with a flail of the lateral scallop of the posterior leaflet [P1] and prolapse of adjacent scallops with a large coaptation width [*double arrow*]) before MitraClip implantation (**a** intercommissural view without and with color Doppler flow, **b** long axis view without and with color Doppler flow) and after implantation of two clips showing no evidence of flail, but residual regurgitant jet (**c** intercommissural view without and with color Doppler flow, **d** long axis view without and with color Doppler flow). Late leaflet detachment with recurrent flail of the posterior leaflet laterally to the clips (*arrow*) with significant mitral regurgitation (**e** intercommissural view without and with color Doppler flow, **f** long axis view without and with color Doppler flow)

ischemic etiology [17], elevated NT-proBNP levels, right ventricular failure [18] and renal and pulmonary dysfunction as predictors for adverse outcome [6]. Nevertheless, there are several data showing clinical improvement and reverse remodelling in patients with left ventricular ejection fraction <30% or even in critically ill patients on inotropes or in cardiogenic shock treated with MitraClip [19].

In recent years, the Everest anatomical criteria for MitraClip have been constantly expanded by increasing experiences and evolving technical solutions in a number of specialized high-volume centers. Any MR etiology is potentially suitable for MitraClip as

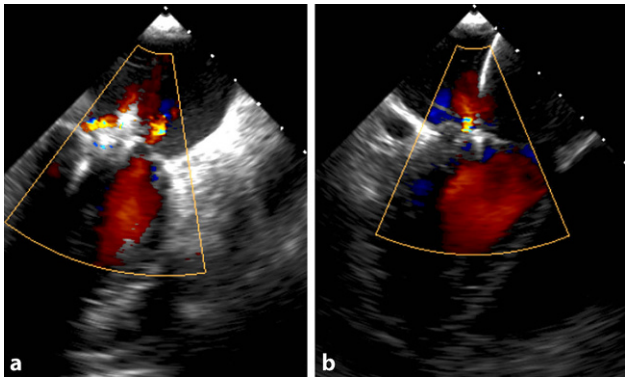

**Fig. 6** Transesophageal echocardiography with color Doppler flow of the final result after the second MitraClip procedure in patient no. 4 showing captured both mitral valve leaflets and trace residual mitral regurgitation (**a** intercommissural view, **b** long axis view)

long as there is enough leaflet tissue for attachment and the valve is not too small and too calcified in the landing zone; however, certain anatomical conditions might preclude a successful result. In primary MR, the central pathology is most suitable for MitraClip (localized prolapse or flail of A2 or P2). This pathology is also the most typical one in elderly patients with fibroelastic deficiency. On the other hand, patients with severely degenerative leaflets, wide flail segments, involvement of more leaflet segments, typical for Barlow disease or commissural regurgitation are technically challenging and have a higher failure rate [6]. Also in patient no. 8 the MitraClip procedure had failed, probably due to unfavorable anatomical situation as limited space with a risk for chordal damage precluded placing another clip in the medial area. The failure rate of MitraClip procedure is reported in about 4.8–9.5% of cases and may be due to unfavorable anatomy or technical problems [6]. The MR can also recur later after initially successful MitraClip procedure. Mitral valve repair after failed MitraClip procedure is challenging especially in extensive leaflet damage and increased number of implanted clips [20]. In such cases valve replacement is more reasonable. In our patient no. 8 MitraClip caused too extensive valve deterioration which excluded efficacious surgical repair. Possible cause for leaflet tear was substantial tension of the clipped leaflet area.

Patient no. 4 with myxomatous mitral valve disease fulfilled the proposed criteria of a flail gap less than 10 mm but the width of the flail P1 scallop and surrounding prolapse of P2 scallop was relatively large. We could successfully grasp the flail scallop and cover it by two clips, but 8 months later the patient's symptoms deteriorated considerably. We detected recurrent flail of P1 laterally to the clips with significant MR (Fig. 5a–e). Although the results of the index procedure initially showed reduction of MR, the clipping was obviously instable and increased leaflet mobility at the attachment site resulted in detachment of

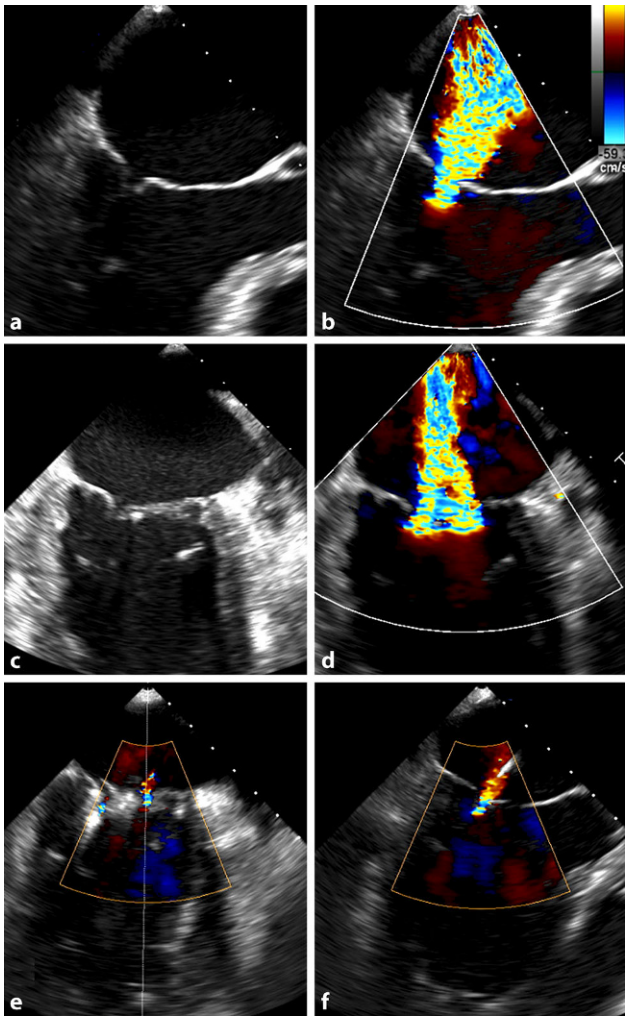

**Fig. 7** Transesophageal echocardiography in patient No. 1 with secondary (ischemic) mitral regurgitation and a favorable anatomy before (long axis view without (**a**) and with (**b**) color Doppler flow, intercommissural view without (**c**) and with color (**d**) Doppler flow) and immediately after MitraClip implantation with successful reduction of the regurgitant jet (**e** intercommisural view, **f** long axis view)

the flail segment from the clip. Most often described clip-specific complication is partial clip detachment where the clip remains attached to only one instead of two mitral valve leaflets. In the early Everest trial partial clip detachment was reported in 9% of patients at 2-year follow-up [4], but later data demonstrated lower rates of this complication, mostly occurring early after the procedure (1–2% at <30 days; [7, 21]). Repeat MitraClip intervention in cases of significant MR is a viable therapeutic option as long as there is no loss of leaflet insertion into the MitraClip (leaflet tear or perforation or partial clip detachment; [20]). The success rate of repeat MitraClip procedure, however, is lower that the index treatment.

In secondary MR the major technical concern can be very restricted posterior leaflet with not enough length available for grasping and severe coaptation failure. All of our patients with secondary MR had

suitable morphology and MitraClip was successfully implanted with no special technical adjustments (Fig. 7). In cases of severe coaptation failure some technical modifications have been proposed: the "zipping" technique placing one clip by another in sequential mode and simultaneous double clipping delivery guide strategy to promote grasping of the leaflets and for a better optimization of the final clip position [22, 23]. By introducing the new design MitraClip NT in 2016 with the capability of increasing the gripper drop angle, we can expect successful treatment of even more complex cases.

Assessment of residual MR after MitraClip implantation can be challenging [24]. Immediately after clip deployment, residual MR has to be assessed carefully. Qualitative evaluation by color Doppler is the easiest and fastest way. The PISA and vena contracta methods, which are mostly recommended for grading native MR, are usually not technically possible due to artefacts from the clip and presence of multiple and eccentric regurgitant jets. Qualitative Doppler using comparison of stroke volumes at the left ventricular outflow tract and mitral annular plane is a well-validated method; however, pulse wave sample volume positioned at the clip prosthesis as well as the measurement of the mitral annulus diameter can be misleading. Therefore, more reliable is comparison of stroke volume at the left ventricular outflow tract and left ventricular stroke volume, assessed by biplane Simpson's method. There is certainly a need for improved quantification of residual MR after percutaneous valve intervention. Direct measurement of the vena contracta area by 3D echocardiography shows potential for the quantification of MR, although no reference data are available yet [25]. It has been demonstrated that cardiac magnetic resonance imaging can be a useful technique with a good reproducibility in the quantification of residual regurgitation after MitraClip [26]. Although the technique has certain technical limitations, it can be valuable in some challenging cases.

One of the expected consequence of MitraClip procedure is iatrogenic ASD, as a large guiding catheter (24-F) is used for transseptal access. Approximately half of them close spontaneously in the next months, the remaining ones create a mostly small left to right shunt relieving the left atrium from chronic elevated pressure [27]. Although they are not supposed to be hemodynamically significant, there is not enough data concerning their long-term consequences and there is no recommendation for routine ASD closure. It has been reported that persistence of ASD is associated with more residual MR, larger left atrial volumes and even worse clinical outcome and increased mortality indicating advanced disease [28]. In our patient no. 3 we decided to percutaneously close a postprocedural large iatrogenic ASD as the patient already had depressed right ventricular function and significant tricuspid regurgitation. An ASD occluder was placed immediately after MitraClip implantation. This was an eminence-based decision founded on patient's right ventricular dysfunction and tricuspid regurgitation; however, we were aware that closure of ASD would prohibit a potential future redo MitraClip procedure. At present, there is no recommendation for routine ASD closure, but further studies are needed to identify patients in which closure may be beneficial.

According to our initial experiences, a safe and successful MitraClip procedure at a selected center necessitates specific operative training, a skilled echocardiographist with experience in 2D and 3D imaging for preprocedural screening and intraprocedural guidance, a good communication between echocardiographist and operator and a collaborative heart team discussing the best treatment option for individual patients.

## Limitations

The main limitations of our study are the small number of patients and single center experience. It is possible that higher complication rates in our group of patients might reflect the initial learning curve effect. In addition, primary MR was underrepresented in our set of patients, which is in concordance with current data showing that the majority of patients receiving MitraClip have secondary MR.

## Conclusion

Our initial experiences with percutaneous mitral valve repair in a small number of patients indicate that MitraClip procedure is a safe and efficacious therapy in high-risk and inoperable patients. With growing experiences worldwide, as well as improved grasping with recently introduced new MitraClip NT, indications for MitraClip will be extended towards anatomically more complex mitral pathologies and more advanced cardiomyopathies addressing secondary MR. Nevertheless, the indications for MitraClip should be carefully discussed within a heart team considering the clinical profile of the patient and morphology of the valve. Special caution is needed at the starting point of the learning curve in a certain center keeping in mind that when MitraClip fails, valve replacement will probably be necessary. In addition, upcoming percutaneous devices are going to challenge operators even further in terms of matching the individual patient and pathology to the optimal intervention.

### Compliance with ethical guidelines

**Conflict of interest** J. Ambrožič, M. Cvijič, M. Bervar, Š. Mušič, and M. Bunc declare that they have no competing interests.

**Ethical standards** This article does not contain any studies with human participants or animals performed by any of the authors. Informed consent was obtained from all patients

identifiable from images or other information within the manuscript.

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