VIA MEDICA

CASE REPORT

Jakub Marcin Ratajczak[1, 2], Adam Sukiennik[2], Marek Woźnicki[2], Jacek Kubica[2]

[1]Department of Cardiac Rehabilitation and Health Promotion, Nicolaus Copernicus University in Torun, Collegium Medicum in Bydgoszcz, Poland
[2]Department of Cardiology and Internal Medicine, Nicolaus Copernicus University in Torun, Collegium Medicum in Bydgoszcz, Poland

Percutaneous closure of the iatrogenic atrial septal defect following the transcatheter edge-to-edge mitral valve repair with MitraClip system led to instant improvement of hypoxemia — case report

Corresponding author:

Jakub Marcin Ratajczak
Department of Cardiac Rehabilitation and Health Promotion
Nicolaus Copernicus University in Torun, Collegium Medicum in Bydgoszcz, Poland;
e-mail: ratajczak.j.m@gmail.com

Medical Research Journal 2022; 10.5603/MRJ.a2022.0053

ISSN 2451-2591
e-ISSN 2451-4101

ABSTRACT

Transcatheter edge-to-edge mitral valve repair (TEER) is an established alternative for patients with severe, symptomatic mitral regurgitation (MR) at high surgical risk. The TEER procedure requires transseptal access, therefore might lead to the development of persistent iatrogenic atrial septal defect (iASD). The clinical significance of iASD and optimal management particularly from a long-term perspective is not clear. Herein, we described a case report of a 76-year-old female with prior left atrial appendage occlusion and severe MR that underwent a TEER procedure using MitraClip® (MC) system. After the MC implantation, she developed acute hypoxemia due to interatrial right-to-left shunt and required immediate iASD closure.

Key words: mitral regurgitation, transcatheter edge-to-edge mitral valve repair, MitraClip, iatrogenic atrial septal defect, iASD

Introduction

Mitral regurgitation (MR) is the second most common valvular disease following aortic stenosis [1, 2]. Cardiac surgery remains the first-line treatment option for most patients with severe MR. However, published in 2021 guidelines for the management of valvular heart disease underlined the role of transcatheter edge-to-edge repair (TEER), especially in patients at high surgical risk with symptomatic secondary MR despite adequate treatment (Class IIa recommendation) [3]. The TEER procedure could be performed using MitraClip® (MC) system (Abbott Vascular, Santa Clara, CA, USA) that had been introduced in 2003 and investigated in multiple randomized, controlled trials and retrospective, observational studies [4–9]. The TEER procedure requires transseptal access, therefore the development of an iatrogenic atrial septal defect (iASD) is inevitable. Nevertheless, previous studies showed a decreased rate of persistent iASD over time suggesting spontaneous closure in most of the patients [10]. The clinical importance of the persistence of iASD after a transseptal puncture is being increasingly discussed and up to date the optimal management in those patients remains not clear [11–13]. Still little is known regarding the haemodynamic and clinical consequences of persistent iASDs in the long-term perspective, therefore routine closure is not a common practice after the TEER procedure [13–15]. However, haemodynamic deterioration due to the right-to-left shunt after the transseptal puncture, although rare, is an undoubted indication to close iASD [13, 16]. Herein, a case report is presented of a patient that required immediate iASD closure following the MC procedure.

Case description

A 76-years old Caucasian female was admitted to the cardiology department to perform a TEER procedure. The patient had a history of chronic heart failure with reduced ejection fraction, persistent atrial fibrillation, hypertension, diabetes mellitus type 2, hyperlipidaemia, microcytic anaemia, iron deficiency, chronic cholecystitis, gastritis, peptic ulcer disease and hypothyroidism. She also underwent the percutaneous left atrial appendage occlusion (LAAO) procedure 6 months before the TEER procedure due to a high bleeding risk (HAS-BLED score 3 points) with a concomitant high risk of a thromboembolic event (CHA2DS2-VASc score 5 points). The patient suffered from dyspnoea and remained in the NYHA III functional class.

Table 1. Echocardiographic parameters of the patient

Echocardiographic parameter	Value
LVEDd [mm]	58
IVSd [mm]	12
LA [mm]	51
PWd [mm]	12
RVd [mm]	36
Aortic root diameter [mm]	35
RAa [cm^2]	27.7
LAa [cm^2]	33.3
Mitral valve regurgitation vena contracta [mm]	8
Mitral valve posterior leaflet length [mm]	11
Mitral valve anterior leaflet length [mm]	30
Mitral valve coaptation depth [mm]	10
Mitral valve coaptation height [mm]	5
RVSP [mmHg]	48
Tricuspid regurgitation Vmax [m/s]	3.1
AcT [ms]	85

AcT — acceleration time; IVSd — interventricular septum thickness; LA — left atrial diameter; LAa — left atrial area; LVEDd — Left ventricular end-diastolic diameter; PWd — posterior wall thickness; RAa — right atrial area; RVd — right ventricular diameter; RVSP — right ventricular systolic pressure

The echocardiography examination showed severe double-jet mitral regurgitation and severe tricuspid regurgitation. The mitral valve effective regurgitation orifice area (EROA) of the lateral and the medial jet was 0.22 cm^2 and 0.21 cm^2 respectively. All heart chambers were enlarged, and the ejection fraction (EF) was reduced to 35%. Detailed echocardiographic parameters are presented in Table 1.

The TEER procedure was performed using the MC Generation 4 system. The patient was anaesthetized and intubated. The transoesophageal echocardiography (TEE) probe was inserted. The right femoral access was used for the MitraClip Delivery System insertion. The place of previous interatrial septum punctuation made during the LAAO procedure was used to place a 22-Fr steerable guide catheter under the control of TEE. Afterwards, the severe MR (grade IV) was reduced to mild (grade I) after implantation of two clips (NTW and XT) and the mitral valve maximal gradient was 5 mmHg (Fig. 1). However, despite the successful clip delivery patient's state deteriorated. Severe hypoxemia with the O_2 saturation decreased to 84% was observed. The TEE revealed the presence of 7.3 mm iASD with reversed (right-to-left) interatrial blood flow (Fig. 2). The immediate decision was made to close the iASD. The shunt was successfully secured (Fig. 3) using the

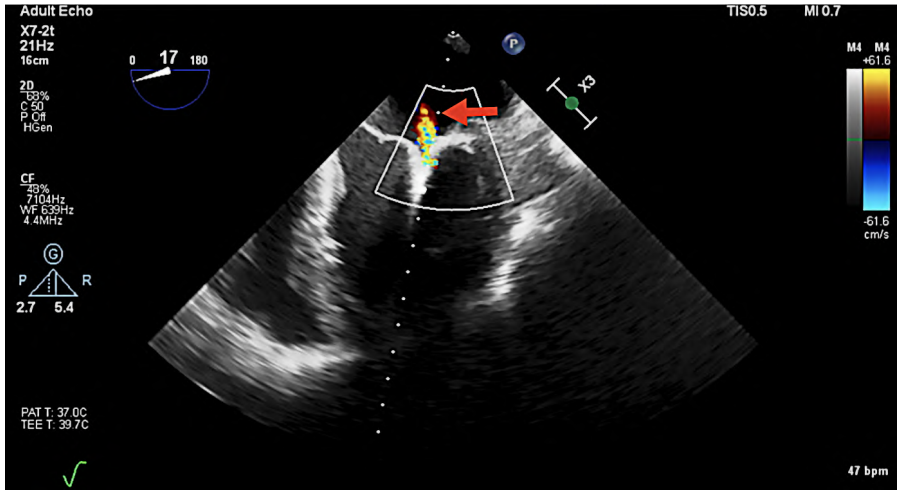

Figure 1. Reduction of mitral regurgitation to grade I after implantation of two MitraClip® devices (*red arrow* — residual mitral regurgitation jet)

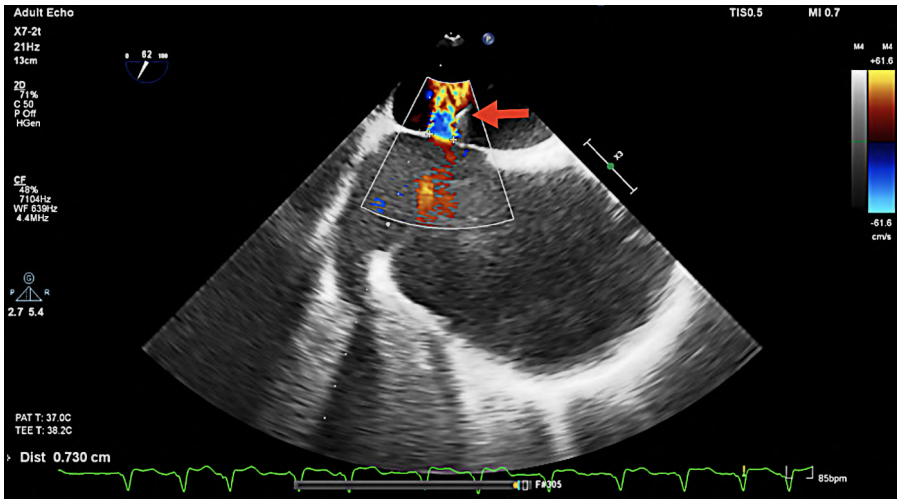

Figure 2. Modified bicaval view of a large iatrogenic atrial septal defect with right-to-left blood flow (*red arrow* — right-to-left shunt through interatrial septum)

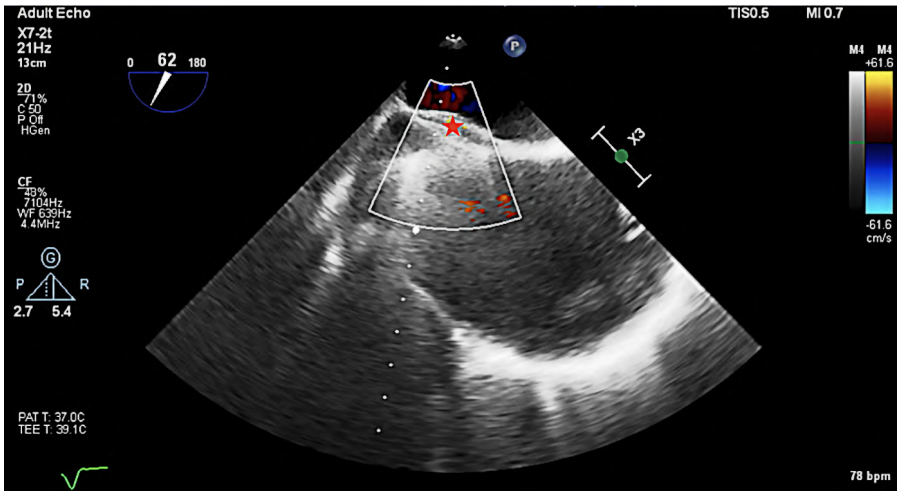

Figure 3. Modified bicaval view with no interatrial blood flow after the closure of the iatrogenic atrial defect (*red star* — atrial septal occluder)

Figulla Flex II PFO 23/25 mm (Occlutech GmbH, Jena, Germany) under the TEE control. After the occlusion the patient's condition stabilized instantaneously, the O_2 saturation increased and the extubation could be safely performed. The patient reported a slight reduction of dyspnoea after the procedure and was in the NYHA II/III functional class.

The transthoracic echocardiography performed at the end of the hospital stay showed moderate MR between two clips (*vena contracta* 6 mm). The mitral valve mean gradient and the maximal gradients were 4.5 mmHg and 9.3 mmHg respectively. The occluder was adequately placed within the interatrial septum with no blood flow. The patient's clinical state remained stable during the rest of the hospital stay and she was discharged 4 days after the procedure.

Discussion

The TEER procedure using the MC system was established as an alternative for the treatment of secondary, severe MR in patients with high surgical risk, particularly those who fulfil the COAPT-like criteria [3]. The MC technology significantly improved since its first use in 2003 and currently, the 4th generation of the MC device is in use. The technical development and increasing experience of the operators reflected in the reduction of complications related to the TEER procedure from 15% to less than 3.5% during the last 15 years [10]. Schnitzler et al. [10] identified two major groups of potential complications: procedure-related and device-related. The first group is mainly a result of the wide-lumen access and transseptal puncture

(e.g. vascular complications, thromboembolic complications or iASD) and the latter include functional or structural device failure (e.g. mitral stenosis, persistent MR or device detachment).

The prevalence of iASD varied in previous reports from 57–82% one month after the procedure and decreased over time to 50% after 6 months and 24–35% after 12 months of follow-up [17–21]. The optimal management of persistent iASD after the MC procedure is a subject of an ongoing debate. Immediate haemodynamic complications due to iASD undoubtedly need to be treated; nevertheless, this clinical situation is rather rare. In the large retrospective cohort study, Takaya et al. [22] reported that of the 2722 patients who were treated with the MC procedure in Japan only 30 (1%) required percutaneous iASD closure. Of those, the majority (n = 22, 73%) was performed within 24 hours after the MC device implantation. The most common indication for iASD closure, reported in 17 cases (57% of all performed procedures), was an acute deterioration of a patient due to hypoxemia with right-to-left blood flow, as described also in the presented manuscript [22]. Similar clinical scenarios were also described in other previously published case reports [12, 16, 23].

Residual iASD after the MC procedure and its clinical impact are still insufficiently explored. The iASD presence in some patients could potentially lead to a reduction of the expected beneficial effect of TEER due to fluid overload of the right ventricle. Schueler et al. investigated 66 patients who underwent the MC procedure of which 50% had persistent iASD 6 months after the procedure with a mean maximal diameter of 4.3 ± 1.7 mm [19]. The group without the iASD was less symptomatic and had a lower level of N-terminal pro-brain natriuretic peptide, lower right ventricle diameter, and lower death rate during 6 months of follow-up (16.6% *vs.* 3.3%; p = 0.05). In the cohort of 96 patients after the MC procedure investigated by Toyama et al., the occurrence of iASD at the 1-year follow-up was associated with right heart enlargement, worsening of the tricuspid regurgitation, and an increased rehospitalization rate due to heart failure [20]. Similarly, the group with persistent iASD at one-year follow-up in the study by Smith et al. [21] showed greater residual MR, worse tricuspid regurgitation and a trend toward higher LA volumes. Ikenaga et al. [17] investigated 131 patients who underwent the MC procedure and found that patients with residual iASD had worse MR and lower ejection fraction after 12 months of observation. Nevertheless, the authors found no association between iASD and the NYHA functional class or brain natriuretic peptide level.

On the contrary, some previous studies suggested that persistent iASD might lead to a reduction of the left atrium pressure and decreased left ventricle preload and thus improving the haemodynamic parameters of the patient [24]. Eden et al. [15] retrospectively investigated the haemodynamics of the iASD in 69 patients who underwent the TEER procedure. Besides the reduction of the mean LA pressure, the authors also reported decreased systemic and pulmonary vascular resistance, lower mean pulmonary capillary wedge pressure, and higher cardiac index after the device implantation. Furthermore, the iASD was not related to negative right ventricle remodelling 6 months after the procedure, regardless of the shunt volume.

The impact of iASD closure after a successful MC procedure was investigated in the MITHRAS trial [25]. Eighty patients with relevant iASD shunt (ratio of pulmonary to systemic blood flow ≥ 1.3) were randomized 1:1 to interventional closure procedure one month after the TEER or conservative treatment. After a 12-month follow-up, no differences were found in the combined endpoint of death or hospitalization due to heart failure between the groups. The authors also compared the MITHRAS cohort with a group of 235 patients without a relevant iASD (ratio of pulmonary to systemic blood flow < 1.3). The investigated clinical endpoint was more prevalent in patients with relevant iASD. The observed difference was mainly a result of a higher heart failure hospitalization rate [25].

The optimal long-term management of iASD after the TEER procedure is still not established and previous studies provided inconclusive results. Patients with large residual iASD and relevant shunt seem to be at higher risk of unfavourable outcomes in comparison to those without iASD. Large catheter size, longer duration of the procedure, higher left atrial pressure, left ventricular hypertrophy, and extensive manipulations of the intervascular sheaths were associated with the higher occurrence of the residual iASD [13]. Adequate qualification of patients for the TEER procedure could help reduce the complications and, in this context, also the assessment of pre-procedural pulmonary hypertension might be beneficial. Some of the authors recommend routine post-procedural imagining to determine the size, direction, and significance of the shunt [16]. The discussion regarding optimal strategy in patients with persistent iASD is ongoing and further studies are required in this field.

Conflicts of interests: *None.*

Funding: *None.*

References

1. Iung B, Delgado V, Rosenhek R, et al. EORP VHD II Investigators. Contemporary presentation and management of valvular heart disease: the eurobservational research programme valvular heart disease II survey. Circulation. 2019; 140(14): 1156–1169, doi: 10.1161/CIRCULATIONAHA.119.041080, indexed in Pubmed: 31510787.

2. Ratajczak J, Sukiennik A, Sielski S, et al. Successful reduction of severe mitral regurgitation after implantation of four MitraClip devices. Medical Research Journal. 2016; 3(4): 176–179, doi: 10.5603/fmc.2015.0014.
3. Vahanian A, Beyersdorf F, Praz F, et al. ESC/EACTS Scientific Document Group. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J. 2022; 43(7): 561–632, doi: 10.1093/eurheartj/ehab395, indexed in Pubmed: 34453165.
4. Feldman T, Wasserman H, Herrmann H, et al. Percutaneous mitral valve repair using the edge-to-edge technique. J Am Coll Cardiol. 2005; 46(11): 2134–2140, doi: 10.1016/j.jacc.2005.07.065, indexed in Pubmed: 16325053.
5. Feldman T, Kar S, Elmariah S, et al. Randomized comparison of percutaneous repair and surgery for mitral regurgitation. J Am Coll Cardiol. 2015; 66(25): 2844–2854, doi: 10.1016/j.jacc.2015.10.018, indexed in Pubmed: 26718672.
6. Sorajja P, Vemulapalli S, Feldman T, et al. Outcomes with transcatheter mitral valve repair in the united states: an STS/ACC TVT registry report. J Am Coll Cardiol. 2017; 70(19): 2315–2327, doi: 10.1016/j.jacc.2017.09.015, indexed in Pubmed: 29096801.
7. Stone GW, Lindenfeld J, Abraham WT, et al. COAPT Investigators. Transcatheter mitral-valve repair in patients with heart failure. N Engl J Med. 2018; 379(24): 2307–2318, doi: 10.1056/NEJMoa1806640, indexed in Pubmed: 30280640.
8. Puls M, Lubos E, Boekstegers P, et al. One-year outcomes and predictors of mortality after MitraClip therapy in contemporary clinical practice: results from the German transcatheter mitral valve interventions registry. Eur Heart J. 2016; 37(8): 703–712, doi: 10.1093/eurheartj/ehv627, indexed in Pubmed: 26614824.
9. Ratajczak J, Jaworska E, Tomczak M, et al. Treatment of severe mitral regurgitation with MitraClip system — a single-centre study. Medical Research Journal. 2016; 1(2): 81–87, doi: 10.5603/mrj.2016.0013.
10. Schnitzler K, Hell M, Geyer M, et al. Complications following MitraClip implantation. Curr Cardiol Rep. 2021; 23(9): 131, doi: 10.1007/s11886-021-01553-9, indexed in Pubmed: 34387748.
11. Alkhouli M, Sarraf M, Holmes DR. Iatrogenic atrial septal defect. Circ Cardiovasc Interv. 2016; 9(4): e003545, doi: 10.1161/CIRCINTERVENTIONS.116.003545, indexed in Pubmed: 27056767.
12. Shetty M, Lampert MB, Levisay J, et al. Iatrogenic atrial septal defect closure following mitral transcatheter edge-to-edge repair: when do you close? JACC Case Rep. 2020; 3(3): 357–360, doi: 10.1016/j.jaccas.2020.12.009, indexed in Pubmed: 34317536.
13. Kadado AJ, Islam A. Iatrogenic atrial septal defect following the MitraClip procedure: a state-of-the-art review. Catheter Cardiovasc Interv. 2021; 97(7): E1043–E1052, doi: 10.1002/ccd.29149, indexed in Pubmed: 32710470.
14. Blazek S, Unterhuber M, Rommel KP, et al. Biventricular physiology of iatrogenic atrial septal defects following transcatheter mitral valve edge-to-edge repair. JACC Cardiovasc Interv. 2021; 14(1): 54–66, doi: 10.1016/j.jcin.2020.10.032, indexed in Pubmed: 33413865.
15. Eden M, Leeb L, Frey N, et al. Haemodynamics of an iatrogenic atrial septal defect after MitraClip implantation. Eur J Clin Invest. 2020; 50(10): e13295, doi: 10.1111/eci.13295, indexed in Pubmed: 32474906.
16. Chandraprakasam S, Satpathy R. When to close iatrogenic atrial septal defect after percutaneous edge to edge repair of mitral valve regurgitation. Cardiovasc Revasc Med. 2016; 17(6): 421–423, doi: 10.1016/j.carrev.2016.04.005, indexed in Pubmed: 27162141.
17. Ikenaga H, Hayashi A, Nagaura T, et al. Left atrial pressure is associated with iatrogenic atrial septal defect after mitral valve clip. Heart. 2019; 105(11): 864–872, doi: 10.1136/heartjnl-2018-313839, indexed in Pubmed: 30482796.
18. Saitoh T, Izumo M, Furugen A, et al. Echocardiographic evaluation of iatrogenic atrial septal defect after catheter-based mitral valve clip insertion. Am J Cardiol. 2012; 109(12): 1787–1791, doi: 10.1016/j.amjcard.2012.02.023, indexed in Pubmed: 22475361.
19. Schueler R, Öztürk C, Wedekind JA, et al. Persistence of iatrogenic atrial septal defect after interventional mitral valve repair with the MitraClip system: a note of caution. JACC Cardiovasc Interv. 2015; 8(3): 450–459, doi: 10.1016/j.jcin.2014.10.024, indexed in Pubmed: 25703879.
20. Toyama K, Rader F, Kar S, et al. Iatrogenic atrial septal defect after percutaneous mitral valve repair with the mitraclip system. Am J Cardiol. 2018; 121(4): 475–479, doi: 10.1016/j.amjcard.2017.11.006, indexed in Pubmed: 29268934.
21. Smith T, McGinty P, Bommer W, et al. Prevalence and echocardiographic features of iatrogenic atrial septal defect after catheter-based mitral valve repair with the MitraClip system. Catheter Cardiovasc Interv. 2012; 80(4): 678–685, doi: 10.1002/ccd.23485, indexed in Pubmed: 22422577.
22. Takaya Y, Akagi T, Hara H, et al. Iatrogenic atrial septal defect requiring transcatheter closure following transcatheter mitral valve repair. Circ J. 2022; 86(11): 1740–1744, doi: 10.1253/circj.CJ-22-0048, indexed in Pubmed: 35387922.
23. Masumoto A, Yamamoto H, Takahashi N, et al. A large iatrogenic tearing of atrial septal defect after MitraClip implantation: a rare and cautionary complication during transcatheter edge-to-edge mitral valve repair. Eur Heart J Case Rep. 2022; 6(4): ytac119, doi: 10.1093/ehjcr/ytac119, indexed in Pubmed: 35434507.
24. Hoffmann R, Altiok E, Reith S, et al. Functional effect of new atrial septal defect after percutaneous mitral valve repair using the MitraClip device. Am J Cardiol. 2014; 113(7): 1228–1233, doi: 10.1016/j.amjcard.2013.12.035, indexed in Pubmed: 24513477.
25. Lurz P, Unterhuber M, Rommel KP, et al. Iatrogenic atrial septal defects following transcatheter mitral valve repair and implications of interventional closure. JACC Cardiovasc Interv. 2021; 14(24): 2685–2694, doi: 10.1016/j.jcin.2021.09.023, indexed in Pubmed: 34949392.