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Transcatheter mitral valve repair in patients with acute myocardial infarction: insights from the European Registry of MitraClip in Acute Mitral Regurgitation following an acute myocardial infarction (EREMMI)

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Introduction

Acute mitral regurgitation (MR) may develop in the setting of an acute myocardial infarction (AMI) as a result of papillary muscle dysfunction or rupture. Acute ischaemic MR without papillary muscular rupture may induce severe MR due to leaflet tethering produced by the sudden onset of regional or global left ventricular dysfunction. This can lead to pulmonary oedema or cardiogenic shock during the acute or subacute phase of the MI[1]. Although previous experience with the MitraClip® (Abbott Vascular, Santa Clara, CA, USA) for correcting MR following AMI has been reported[2], data on consecutive patients treated for this condition are lacking and the issue remains understudied. The aim of this registry was to collect the largest experience of acute MR following AMI treated with the MitraClip in Europe.

Methods

This is a prospective registry of all consecutive patients with severe MR which developed early after an acute transmural myocardial infarction who underwent percutaneous mitral valve repair (PMVR) at 11 centres across Europe between January 2016 and December 2018. The main exclusion criterion was low probability of success with the device. Clinical condition did not contraindicate the procedure. Detailed inclusion and exclusion criteria and more information regarding methods are shown in **Supplementary Appendix 1**.

Results

Between January 2016 and December 2018, 883 cases were treated with the MitraClip in the recruiting centres. Among them, 44 (5%) patients (63.6% male, mean age 70.0±10.8 years) were included in the study. Median time from MI to treatment was 18 days (13-36.8 days) and from diagnosis of MR to treatment 12.5 days (4.5-18 days).

BASELINE CHARACTERISTICS

The baseline characteristics of the entire population are presented in **Table 1**. Surgical risk was extremely high, with a median

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Table 1. Baseline clinical characteristics.

Characteristics		Total n=44
Age, years		70.0±10.8
Diabetes		22 (50.0)
Hypertension		30 (68.2)
Smoker		15 (34.1)
NYHA functional class	I	1 (2.3)
	II	6 (13.6)
	III	9 (20.5)
	IV	28 (63.6)
Dyslipidaemia		26 (59.1)
Extracardiac arteriopathy		8 (18.2)
Atrial fibrillation		11 (25.0)
Chronic obstructive pulmonary disease		6 (13.6)
Permanent pacemaker		2 (4.5)
Previous CABG		4 (9.1)
EuroSCORE II		15.1 (6.2-23.2)
Primary angioplasty		30 (68.2)
Infarct location	Anterior	10 (22.7)
	Inferior	17 (38.6)
	Lateral	10 (22.7)
	Undetermined	2 (4.5)
Culprit vessel	LAD	12 (27.3)
	LCX	16 (36.4)
	RAC	8 (18.2)
	Undetermined	8 (18.2)
Multivessel disease		24 (54.5)
Complete vascularisation		23 (52.3)
LV assistance devices	VA ECMO	2 (4.5)
	IABP	14 (31.8)
Inotropes		24 (54.5)

ECMO: extracorporeal membrane oxygenation; IABP: intra-aortic balloon pump; LA: left atrium; LAD: left anterior descending; LCX: left circumflex; LV: left ventricle; NYHA: New York Heart Association; RCA: right coronary artery; VA: veno-arterial

EuroSCORE II of 15.1 (6.2-23.2). Baseline echo characteristics are shown in **Supplementary Table 1**.

PROCEDURE AND 30-DAY FOLLOW-UP

Technical success was obtained in 86.6% of cases with a median of two clips per case (range 1-2). The median gradient post clip was 3 mmHg (2-4) and the median length of stay of patients after the procedure was 16 (8-27) days. Clinical events at 30 days are shown in **Table 2**. None of the extracorporeal membrane oxygenation (ECMO) patients died during hospitalisation.

SIX-MONTH FOLLOW-UP

MR grade ≤2+ and New York Heart Association (NYHA) functional class are shown in **Figure 1**. Clinical events at six months

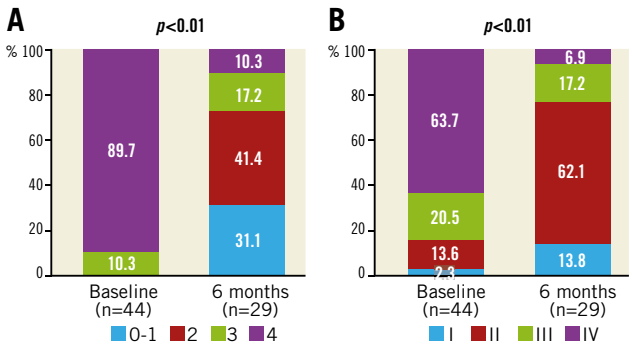

Figure 1. *MR reduction and NYHA functional class improvement from baseline to six-month follow-up. A) MR reduction. B) NYHA functional class improvement.*

are shown in **Table 2**. Median follow-up was 4.0 (1-7) months. Kaplan-Meier survival curves of freedom from mortality and major adverse events (MAE) are shown in **Figure 2**.

Table 2. Clinical events.

Events	30 days	6 months
Death, n (%)	4 (9.1)	8 (18.2)
Re-admission due to HF, n (%)	0	8 (18.2)
Cardiac surgery, n (%)	1 (2.3)	3 (6.8)
MAE, n (%)	5 (11.4)	16 (36.4)

HF: heart failure; MAE: major adverse events

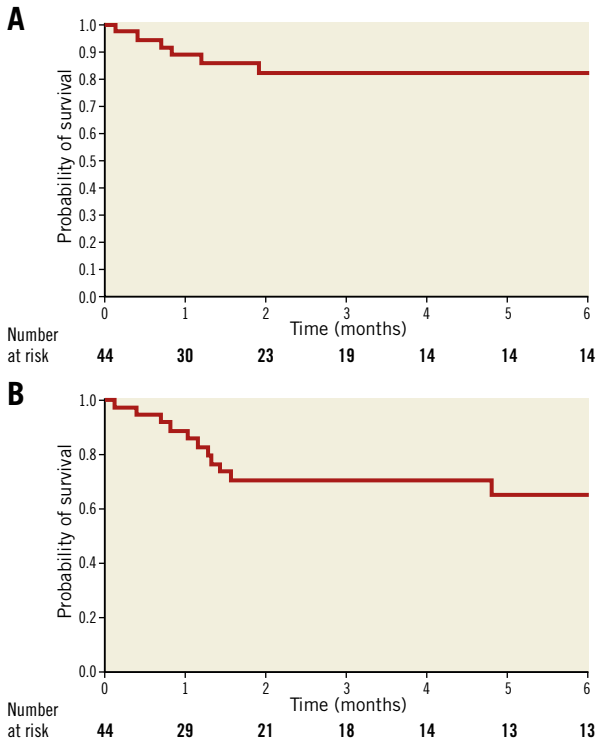

Figure 2. *Kaplan-Meier probability of survival free from mortality (A) and major adverse events (MAE) (B).*

Discussion

Acute MR after MI is a serious complication that may occur in roughly 3% of cases. Regarding the treatment of this condition (excluding complete papillary muscle rupture), it has been reported that revascularisation by means of primary percutaneous coronary intervention (PCI) can significantly improve the degree of MR and should therefore be the first line of treatment[3]. However, even after successful percutaneous revascularisation, the degree of MR may worsen, and further treatment may be required. Until recently, cardiac surgery was the only option available for the treatment of such a condition. In a recent review of all published series, the pooled 30-day mortality was 19%, with some of them showing mortalities of around 39%[4].

Notwithstanding, in recent years, PMVR has been extensively developed and the MitraClip is the device with the largest experience so far. There are several potential advantages to this therapy. First, there is the rapid decrease in left ventricular (LV), left atrial and pulmonary artery pressures and the increase in cardiac output observed after a successful correction of the MR[5] that may lead to a fast recovery. Second is the avoidance of the LV damage induced by the systemic inflammatory response, free radical injury and myocardial oxidative stress associated with cardiopulmonary bypass[6]. Moreover, the MitraClip may also avert the restraint of the mitral annular motion caused by mitral rings or prosthesis and the development of abnormal septal motion that may negatively impact on LV performance. In addition, acute MR usually develops in a previously normal mitral valve, which usually translates into optimal leaflet tissue and coaptation for device therapy. Furthermore, use of the MitraClip does not preclude delayed cardiac surgery in case the device fails.

Limitations

First, the sample size was small and our results should be interpreted with caution. Second, echo follow-up was not complete. However, our aim was to prove effectiveness in the clinical setting, not to show the positive effects on LV parameters. Third, the procedures were performed at very experienced centres.

Conclusion

In selected patients with acute mitral regurgitation following myocardial infarction, edge-to-edge mitral valve repair with the MitraClip is feasible. Further investigation in this setting may be warranted.

Impact on daily practice

Acute mitral regurgitation after myocardial infarction is associated with high mortality and morbidity. Treatment with the MitraClip is associated with MR reduction and low 30-day mortality. This represents a valid alternative for selected patients.

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Conflict of interest statement

R. Estévez-Loureiro, D. Arzamendi, P. Denti, X. Freixa, B. Melica, and L. Nombela-Franco are consultants for Abbott. The other authors have no conflicts of interest to declare.

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Supplementary data

Supplementary Appendix 1. Methods.

Supplementary Table 1. Baseline echo parameters.

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Supplementary data

Supplementary Appendix 1. Methods

The indication for PMVR was discussed by an interdisciplinary Heart Team. Likewise, the decision to perform coronary angiography and subsequent revascularisation was left to the discretion of the attending physicians.

Patient population

Inclusion criteria

- Patient ≥18 years old.
- Transmural myocardial infarction in the previous four weeks.
- Symptomatic severe mitral regurgitation was diagnosed by left ventriculography, transthoracic echo or transoesophageal echo.
- Considered by the Heart Team as being at high risk for conventional surgery.

Exclusion criteria

- Anatomy not suitable for MitraClip implantation.
- Patient is a candidate for emergent heart transplant.
- Uncontrolled infection.

Study endpoints

Procedural and clinical adverse events during follow-up were defined according to MVARC. Our main objectives were to assess the safety and effectiveness of MitraClip implantation in reducing MR in this setting and the clinical events (total mortality, admission due to HF and cardiac surgery during admission or follow-up) during

hospitalisation and follow-up up to six months. The combination of these variables was considered to be the major adverse events (MAE).

Statistical analyses

Continuous variables were summarised as mean±standard deviation (SD) or as medians and interquartile range (IQR). Categorical variables were described as percentages and compared using the chi-square test or Fisher's exact test according to the expected frequency above or below 5, respectively. Survival curves for time-to-event were constructed on the basis of all the available follow-up data using Kaplan-Meier estimates. Statistical analyses were performed using SPSS, Version 25.0 (IBM Corp., Armonk, NY, USA).

Supplementary Table 1. Baseline echo parameters.

Baseline echo parameters	
Mitral regurgitation severity 3 4	 4 (10.3) 35 (89.7)
MR jet location A1-P1: lateral A2-P2: central A3-P3: medial	 3 (7.5) 36 (90.0) 6 (15.0)
LVEDD (mm)	55.5 (48.2-59.5)
LVEDV (ml)	136 (102-163)
LVESV (ml)	76 (54-87.8)
LA volume (ml)	59.5 (52-65.0)
LVEF (%)	35 (26-44)
Tricuspid regurgitation	1 (1-2)
SPAP (mmHg)	52.5 (25-77.5)
TAPSE (mm)	16.5 (16-20.3)

LA: left atrium; LVEDD: left ventricular end-diastolic diameter; LVEDV: left ventricular end-diastolic volume; LVEF: left ventricular ejection fraction; LVESV: left ventricular end-systolic volume; SPAP: systolic pulmonary artery pressure; TAPSE: tricuspid annular plane systolic excursion