Acute Changes in Left Atrial Pressure After MitraClip Are Associated With Improvement in 6-Minute Walk Distance

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Background—Data on the clinical use of left atrial (LA) hemodynamic monitoring during MitraClip procedure are limited. This study evaluated the association between intraprocedural changes in LA pressure after MitraClip and improvement in exercise capacity as documented by 6-minute walk test (6MWT).

Methods and Results—Study population included 50 patients who underwent MitraClip at the Mayo Clinic (Rochester, MN), between June 2014 and July 2016 and completed both baseline and 30-day follow-up 6MWT. Primary outcome for the current analysis was defined as 6MWT improvement above the median. Mean age of the study population was 79±10 years, and 34 (68%) were men. Baseline preprocedural 6MWT distance was 308 m (interquartile range [IQR], 234–394 m). Acute, intraprocedural change in LA pressure after MitraClip was 3 mm Hg (IQR, 1–6 mm Hg), and change in V wave was 11 mm Hg (IQR, 6–19 mm Hg). Median 6MWT improvement was 25 m (IQR, 19–47 m). Univariate analysis showed that patients with ≤ mild postprocedural mitral regurgitation were 4-fold more likely to experience an improvement in 6MWT (*P*=0.02). Multivariate model demonstrated that each 5 mm Hg decrease in V wave was associated with 49% increased likelihood for improvement in 6-minute walk (*P*=0.04). Similar model with V-wave change as a dichotomous variable showed that patients with a V-wave decrease of ≥11 mm Hg were 3.8× more likely to improve their 6MWT (*P*=0.05).

Conclusions—Acute changes in LA pressure after MitraClip procedure are associated with clinical improvement as measured by 6MWT. Continuous LA pressure monitoring may be a useful tool for procedural guidance during transcatheter mitral repair. **(*Circ Cardiovasc Interv*. 2017;10:e004856. DOI: 10.1161/CIRCINTERVENTIONS.116.004856.)**

Key Words: atrial pressure ■ echocardiography ■ exercise ■ mitral valve ■ walk test

Transcatheter mitral valve repair (TMVR) has been shown to reduce symptoms, severity of mitral regurgitation (MR), left ventricular dimensions, need for surgery, and hospitalizations in patients with symptomatic primary MR at high risk for surgery.[1] However, intraprocedural decision-making can be challenging, particularly when deciding whether to accept device position or attempt repositioning and whether to place a second clip during the same procedure. Intraprocedural color Doppler transesophageal echocardiography (TEE) is primarily used to guide decision-making, but may be limited, particularly in the case of eccentric jets and acoustic shadowing by the MitraClip device.[2] These factors can make procedural guidance solely by color flow Doppler problematic.

Left atrial pressure (LAP) may be elevated in a variety of disease states, including mitral valve disease, and abnormalities of left atrium (LA) and left ventricular function.[3,4] In MR, the LA V wave reflects the regurgitant volume and its interaction with LA compliance.[4,5] In the EVEREST II trial (Endovascular Valve Edge-to-Edge Repair Study), the degree of MR reduction was associated with clinical benefit from TMVR.[1] A complementary tool for assessment of immediate hemodynamic response to TMVR such as LAP measurement may provide valuable information to aid in intraprocedural decision-making and predict the degree of clinical benefit. Although the currently available MitraClip system only allows for measurement of LAP through the steerable sheath before and after the device has already been released, we recently developed a simple method to measure continuous LAP to allow for integration into real-time procedural decision-making.[6] We hypothesized that the magnitude of mean LAP and V-wave reduction would predict the degree of clinical improvement after TMVR. Accordingly, we systematically measured LAP and determined its relation to subsequent improvement in exercise capacity as measured by 6-minute walk test (6MWT).

Methods

Patient Population

This prospective study was approved by the Mayo Clinic Institutional Review Board. From June 2014 through July 2016, patients underwent percutaneous TMVR with MitraClip (Abbott Vascular, Santa Clara, CA) with LAP measurement before, during, and after clip deployment.

Received December 8, 2016; accepted March 6, 2017.

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WHAT IS KNOWN

- Transcatheter mitral valve repair (TMVR) has been shown to reduce symptoms in patients with mitral regurgitation at high risk for surgery.
- Intraprocedural decision-making during TMVR can be challenging, because of limitations of transesophageal echocardiography, such as eccentric jets and acoustic shadowing.
- No studies have specifically examined the relationship between intraprocedural hemodynamic data and long-term clinical response to MitraClip.

WHAT THE STUDY ADDS

- The principle finding of this study is that acute changes in left atrial pressures during TMVR were associated with clinical improvement at 30-day follow-up.
- Continuous left atrial pressure monitoring during TMVR provides simple to obtain, yet valuable prognostic hemodynamic data.

Patients were considered candidates for the procedure if they had primary MR and comorbid conditions that would preclude sternotomy and valve repair or replacement. In addition, patients with secondary MR who were candidates for the COAPT trial (Clinical Outcomes Assessment of the Mitraclip Percutaneous Therapy) and randomized to TMVR were also included in this analysis. Consultation with a cardiac surgeon with expertise in mitral valve surgery occurred before proceeding with percutaneous TMVR. Society of Thoracic Surgeons risk score was calculated for the mitral valve patients using the mitral valve repair algorithm. Alternatives, including open surgery and medical therapy, were carefully discussed using a Heart Team approach. All procedures were performed electively. Transthoracic echocardiography was performed according to recommended guidelines before and at 30 days postprocedure. TEE was performed before and during the TMVR procedure.

TMVR Procedure

TMVR was performed using the MitraClip device in the cardiac catheterization laboratory in all patients. Patients were placed under general endotracheal anesthesia. Intraprocedural imaging was performed with TEE. Two Perclose ProGlide devices (Abbott Vascular) were deployed in a preclose fashion in the right common femoral vein. Transseptal puncture was performed using standard techniques in a posterior and mid- to-superior location on the interatrial septum using *x*-plane TEE guidance after confirmation of adequate distance from puncture location to the mitral annular plane. The atrial septum was sequentially dilated with a 14F dilator over a J-tip Amplatz Super Stiff Wire in the left superior pulmonary vein. The MitraClip steerable sheath was then advanced into the LA under fluoroscopic and TEE guidance. Unfractionated heparin (200 U/kg) was administered to ensure adequate systemic anticoagulation, and the activated clotting time was monitored regularly to maintain a level above 300 s. The MitraClip delivery system was steered through the LA under TEE guidance to the appropriate position above the mitral valve. After confirming adequate clip arm orientation, angle, and location relative to the regurgitant jet, the clip was advanced across the valve. Using TEE guidance, the clip was brought under the mitral valve leaflets and grippers lowered to grasp the leaflets. Although the clip arms were closed, the color Doppler jet and LAP were assessed. After satisfactory leaflet insertion, MR reduction, and LA V-wave reduction, the clip was released. If there was moderate or more residual MR or a persistently elevated LA V wave after first device deployment, consideration was given to place an additional MitraClip device.

LA Pressure Measurement

We have recently described a simple method for continuous LA pressure measurement during TMVR.[6] After transseptal access has been obtained, 2 stiff J-tip wires (one 0.032 Amplatz Extra Stiff and one 0.035 Amplatz Super Stiff) are advanced into the left superior pulmonary vein through an 8F Mullins sheath. After dilatation of the LA septum, a 4F multipurpose catheter is advanced over the extrastiff wire into the left superior pulmonary vein. The MitraClip steerable sheath is then advanced into the LA over the other wire (Amplatz Super Stiff) alongside the multipurpose catheter, after which the multipurpose catheter is pulled into the LA and connected for continuous fluid-filled pressure monitoring throughout the procedure. This method was used in the majority of patients in this study; with the remainder of patients having LAP measurement before and after each clip was released through the 22F steerable MitraClip sheath. We defined significant reduction in LAP based on examination of the distribution of each parameter (mean LAP as ≥3 mm Hg decrease and LA V-wave reduction ≥11 mm Hg decrease). End-diastolic LAP was also measured to estimate the contribution of left ventricular diastolic dysfunction to LAP post-TMVR.

Echocardiography

Intraprocedural TEE was performed with commercially available equipment (Phillips Healthcare, Andover, MA) according to the established guidelines.[7] Grading of residual MR by TEE was based on integrated analysis of color flow Doppler. Thirty-day follow-up transthoracic echocardiography was performed according to established guidelines.[8]

Definitions and Study End Point

Change in 6MWT distance between baseline and follow-up was documented for all participants. Primary end point of the current analysis was improvement in 6MWT distance above the median (25 m). Secondary end point included New York Heart Association class I heart failure symptoms at 30-day follow-up. Device success was defined as absence of procedural mortality or need for emergency surgery, correct positioning at least 1 MitraClip device, and reduction in MR to moderate or less moderate severity with no significant mitral stenosis. MR was graded as absent, trace, mild, moderate, or severe. Complications, including single leaflet device attachment, complete device detachment, conversion to open surgery, myocardial infarction, stroke, emergency surgery, bleeding, and vascular complications, were reported according to the Valve Academic Research Consortium criteria.[9]

Follow-Up

In-hospital and postdischarge adverse events, including recurrent heart failure symptoms, heart failure hospitalization, need for repeat mitral valve procedure, and mortality, were prospectively recorded for all participants. Follow-up medical evaluations were performed at our institution. All participants completed a 6MWT during their follow-up visit. Thirty-day transthoracic echocardiogram data were collected. Only participants with follow-up visit data were included in this study.

Data Analysis

Continuous variables were expressed as mean±SD if normally distributed or median with interquartile range if skewed. Paired *t* tests were used to compare pre- and postprocedure variables within patients. Univariate and multivariate binary logistic regression analysis was performed to evaluate the role of LAP in identifying which patient will have improvement in their 6MWT. Mean LAP and V wave were evaluated as a continuous variable (for each 5 mm Hg increase) and dichotomous variables (above versus below the median). Age, sex, baseline LA volume index, and residual MR were used as prespecified covariates in the multivariate model. Statistical significance was accepted for 2-sided $P<0.05$. The statistical analyses were performed with IBS SPSS version 20.0 (Chicago, IL).

Results

Patient Characteristics

A total of 114 patients underwent the MitraClip procedure between June 2014 and July 2016. The current analysis includes 50 patients who completed both baseline and follow-up 6MWT. Mean age of the study population was 79±10 years, 34 (68%) were men, and mean Society of Thoracic Surgeons score was 8.8±5.5%. Baseline characteristics of the study population are summarized in Table 1. Primary degenerative MR was present in 37 (74%) patients, mixed cause MR in 8 (16%, both primary and secondary components) and secondary functional MR was present in 5 (10%). The LA was severely enlarged in 46 (92%) patients. Baseline echocardiographic characteristics of the study population are summarized in Table 2.

Procedural Characteristics

Successful TMVR was achieved in 47 (94%) patients. One clip was implanted in 28 (56%) patients, 2 clips in 20 (40%) patients, and 3 clips in 1 (2%) patient; in 1 patient, the TMVR procedure included the implantation of 1 clip and 1 Amplatzer Vascular Plug (AVP)-II plug. Mean fluoroscopy time was 55±23 minutes, and mean fluoroscopic dose area product was 131±106 Gy·cm². After TMVR, 4 (8%) patients had trivial MR, 22 (44%) patients had mild residual MR, 21 (42%) patients had moderate residual MR, 2 (45) had moderate to severe MR, and 1 (2%) patients had severe residual MR. There were no intraprocedural deaths. Mean hemoglobin decreased by 1.2 mg/dL (12.04 versus 10.88; P<0.001). No patients required emergency open heart surgery or cardiopulmonary bypass. Procedural complications included bleeding requiring transfusion in 4 (8%) patients, single leaflet device attachment in 1 (2%) patient, and hemothorax in 1 (2%) patient. No strokes or acute kidney injury occurred. Mean hospital stay was 2.9±3.4 days.

Table 1. Baseline Characteristics of Study Population

Variable	n (%), Mean±SD or Median (Interquartile Range)
Male	34 (68%)
Age, y	80 (74–85)
White race	49 (98%)
Underlying cause	
Primary mitral regurgitation	37 (74%)
Secondary mitral regurgitation	5 (10%)
Mixed cause	8 (16%)
Hypertension	42 (84%)
Diabetes mellitus	11 (22%)
Obesity	16 (32%)
Atrial fibrillation	36 (72%)
Coronary artery disease	23 (46%)
Ischemic cardiomyopathy	17 (34%)
COPD	16 (32%)
History of bypass surgery	21 (42%)
Cerebrovascular disease	7 (14%)
STS score (%)	8.5 (4.6–10.5)
Body mass index, kg/m²	27 (23–31)
Body surface area, m²	1.93 (1.72–2.23)
Hemoglobin	12±2
Creatinine	1.2 (1–1.6)
Estimated GFR, mL/min	54±20
Chronic kidney disease (GFR<30)	6 (12%)
Baseline 6-min walk, m	308 (234–394)
Baseline 6-min walk (% of expected)	72 (55–92)

COPD indicates chronic obstructive pulmonary disease; GFR, glomerular filtration rate; and STS, Society for Thoracic Surgeons.

Table 2. Baseline Echocardiographic Parameters of Study Population

Variable	n (%), Mean±SD or Median (Interquartile Range)
Systolic blood pressure, mm Hg	120±17
Diastolic blood pressure, mm Hg	67±12
Heart rate, bpm	71±13
Mitral regurgitation severity	
Severe	44 (88%)
Moderate to severe	6 (12%)
Anatomy	
Flail scallop	21 (42%)
Prolapse	21 (42%)
Cleft	7 (14%)
Pure A2 P2 defect	23 (48%)
LV ejection fraction (%)	55 (45–62)
Ejection fraction <40%	7 (14%)
LV end-systolic dimension, cm	4 (3.4–5.0)
LV end-diastolic dimension, cm	5.8 (5.4–6.1)
LA volume index, mL/m²	65 (49–76)
LA volume index >40 mL/m²	46 (92%)
Cardiac index	2.75 (2.43–3.05)
PISA measurements	
Regurgitant flow, mL/s	222±88
EROA, cm²	0.45±0.18
Regurgitant volume, mL	70±24
Estimated RVSP, mm Hg	51 (44–65)
≥Mild tricuspid regurgitation	31 (62%)

EROA indicates estimated regurgitant orifice area; LA, left atrial; LV, left ventricular; PISA, proximal isovelocity surface area; and RVSP, right ventricular systolic pressure.

LA Pressure During TMVR

At baseline, the median LAP in the overall group was elevated at 22 mm Hg (interquartile range [IQR], 18–26 mm Hg) with a

Table 3. Follow-Up Echocardiography

Variable	n (%), Mean±SD or Median (Interquartile Range)
Systolic blood pressure, mm Hg	120±17
Diastolic blood pressure, mm Hg	64±10
Heart rate, bpm	68±12
Mitral regurgitation severity	
Severe	1 (2%)
Moderate to severe	2 (3%)
Moderate	21 (42%)
Mild or trivial	26 (52%)
Mitral valve gradient, mm Hg	4 (3–5)
Mitral valve gradient ≥7 mm Hg	5 (10%)
LV ejection fraction (%)	53 (41–64)
Ejection fraction <40%	8 (16%)
LV end-systolic dimension, cm	3.8 (3.3–4.7)
LV end-diastolic dimension, cm	5.4 (4.9–6)
LA volume index, mL/m^2	60 (46–87)
LA volume index >40 mL/m^2	28 (88%)
Cardiac index	2.84 (2.56–3.28)
PISA	
Regurgitant flow, mL/s	138±66
EROA, cm^2	0.49±1.3
Regurgitant volume, mL	45±22
Estimated RVSP, mm Hg	44 (41–56)
≥Mild tricuspid regurgitation	29 (58%)

EROA indicates estimated regurgitant orifice area; LA, left atrial; LV, left ventricular; PISA, proximal isovelocity surface area; and RVSP, right ventricular systolic pressure.

median LA V wave of 40 mm Hg (IQR, 30–46 mm Hg). After TMVR, the mean LAP decreased to a median of 18.5 mm Hg (IQR, 14.8–24 mm Hg) and median V wave decreased to 28 (IQR, 20–35 mm Hg). The median change of LAP and V-wave height was 3 mm Hg and 11 mm Hg, respectively (*P*<0.001 for both). Univariate analysis showed that none of the baseline clinical or echocardiographic characteristics were associated with decrease in V wave above the median (data not shown), with the exception of baseline hypertension (decrease in V wave was less common among hypertensive patients [39% versus 89%; *P*=0.007]). The distribution of LA pressure reduction was similar in patients with mild or less mild post procedural MR or more: median V-wave reduction was 10 mm Hg (IQR, 7–19; n=20) in patients with mild or less mild postprocedural MR, compared with 12 mm Hg (IQR, 4–19; n=30) among patients with more than mild MR. Median LA pressure reduction was 3 mm Hg (IQR, 0–6; n=24) in patients with mild or less MR, compared with 3 mm Hg (IQR, 1–4; n=26) among patients with moderate or more MR.

Echocardiographic and Clinical Outcomes

Median time to follow-up echocardiography was 39 days (IQR, 33–46 days). The results are summarized in Table 3. Compared with baseline echocardiography, follow-up echocardiography demonstrated significant decrease in mitral valve regurgitant volume by PISA (70±24 versus 45±22; *P*<0.001) and in the estimated right ventricular systolic pressure (56±16 versus 48±14; *P*<0.001). There was a decrease in LA volume index at follow-up. (71±27 versus 66±24; *P*=0.063). New York Heart Association functional class improved significantly: 5 (10%) patients had class III symptoms, 3 patients had class II–III symptoms, 18 (36%) reported class II symptoms, and 24 (48%) patients had no heart failure symptoms. There were no statistically significant differences in left ventricular dimensions or function. During a median follow-up of 330 days (IQR, 150–558 days), 8 (16%) patients died.

Six-Minute Walk Test

All patients completed baseline and follow-up 6MWT. Median time from baseline 6MWT and the TMVR procedure was 5 days (IQR, 2–19 days). Median distance was 308 m (IQR, 234–394 m), which was 72% of the predicted distance for age and sex (IQR, 55%–92%). Median time from TMVR procedure and follow-up 6MWT was 39 days (IQR, 33–44 days). Median distance at follow-up was 344 m (IQR, 246–398 m), which was 76% of predicted (IQR, 61%–97%). The median improvement in 6MWT distance was 25 m (IQR, 19–47 m). Univariate model did not show a significant association between baseline clinical characteristics and improvement in 6MWT (data not shown), although there was a trend toward a significant increased likelihood of 6MWT improvement among men versus women (odds ratio, 3.14; *P*=0.075). Echocardiographic evidence of residual MR of more than mild was associated with a 4-fold increased likelihood of improvement in 6 MWT (odds ratio, 4.02; 95% confidence interval, 1.20–13.53; *P*=0.020).

LAP and Improvement in 6MWT

Univariate binary logistic regression showed a trend toward a significant association between changes in LA pressures during TMVR and improvement in 6MWT (Figures 1 and 2;

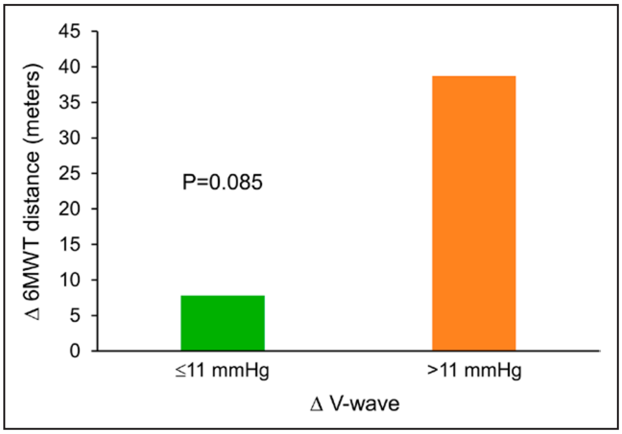

Figure 1. Improvement in 6-min walk distant among patients with a V-wave decrease ≤11 and >11 mm Hg. The mean improvement in the first group was 7 m, with a median improvement of 6 m and interquartile range of −32 to 43 m. The mean improvement in the second group was 39 m, with a median improvement of 43 m and interquartile range of −14 to 64 m. Six-minute walk test (6MWT) improvement was larger in the second group (*P*=0.085).

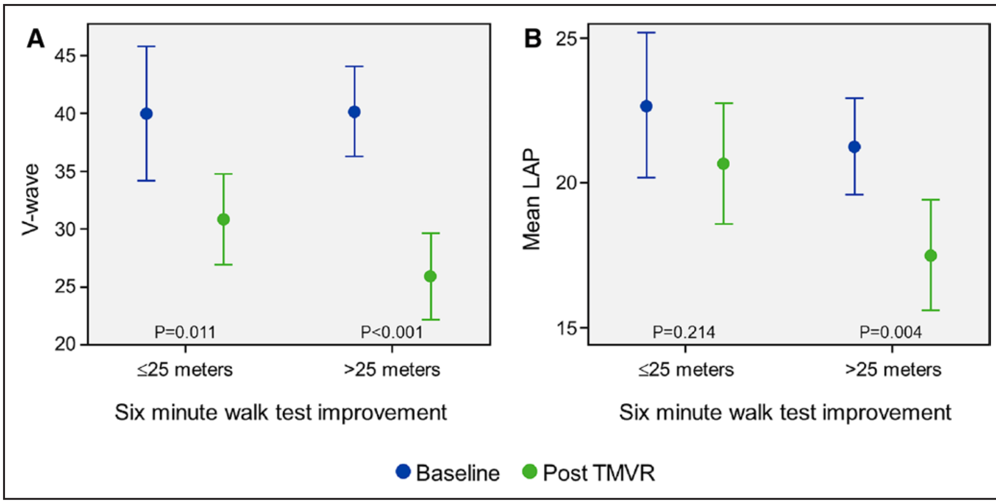

Figure 2. A, Acute changes in V wave in patients with improvement in 6-min walk test (6MWT) above and below the median. Although changes in V wave were statistically significant in both groups, the change was larger in patients with higher 6MWT improvement. **B**, Acute changes in mean left atrial pressures in patients with improvement in 6MWT above and below the median. Acute changes in mean left atrial pressure were statistically significant only among patient who improved their 6MWT distance above the median. LAP indicates left atrial pressure; and TMVR, transcatheter mitral valve repair.

Table 4), such that each 5 mm Hg decrease in V-wave height was associated with 37% increased likelihood of improvement in 6MWT (95% confidence interval, 0.99–1.90; *P*=0.060), and that each 5 mm Hg decrease in LAP was associated with a 2-fold increased likelihood of improvement in 6MWT (95% confidence interval, 0.88–4.91; *P*=0.097). Consistently, the same model showed that patients with a reduction in V wave above the median (11 mm Hg) were 2.7-fold more likely to improve their 6MWT (95% confidence interval, 0.85–8.37; *P*=0.093). A multivariate binary logistic regression model demonstrated an independent association between change in V wave and improvement in 6MWT such that each 5 mm Hg decrease in V wave was associated with a 49% increased likelihood of 6MWT improvement (*P*=0.043; Table 5). Similar multivariate model with V-wave change as a dichotomous variable showed a strong trend toward a significant improvement in 6MWT distance among patients with a V-wave reduction of 11 mm Hg or more (odds ratio, 3.8; *P*=0.051; Table 6).

Table 4. Univariate Binary Logistic Regression Model

Independent Variable	Odds Ratio	95% CI	*P* Value
Baseline LA pressure*	0.95	0.85–1.06	0.34
Delta LA pressure*	1.16	0.97–1.38	0.10
LA reduction > median (3 mm Hg)	1.38	0.45–1.38	0.57
Final LA pressure*	0.87	0.77–0.99	0.03
Baseline V-wave pressure*	1.00	0.96–1.05	0.95
Delta V-wave pressure*	1.07	1.00–1.14	0.06
V-wave reduction > median (11 mm Hg)	2.67	0.85–8.37	0.09
Final V-wave pressure*	0.94	0.88–1.01	0.07
Primary vs secondary MR cause	0.22	0.02–2.11	0.19
Left ventricle ejection fraction (continuous)	1.02	0.97–1.06	0.52

Improvement in 6-min walk test above the median (25 m) was used as the outcome in this model. CI indicates confidence interval; LA, left atrium; and MR, mitral regurgitation.

*Units are mm Hg.

At 30-day follow-up, 24 (48%) patients reported New York Heart Association class I heart failure symptoms (Figure 3). Compared with patients with heart failure symptoms, New York Heart Association class I patients had greater reduction in both V wave and mean LA pressures: 14±11 versus 10±8 and 4±4 versus 2±3 (*P*=0.053 and 0.112, respectively). Multivariate binary logistic regression model with adjustment for age, sex, and residual MR showed an association between clinical improvement in heart failure symptoms and reduction in LA pressure, such that each 1 mm Hg reduction in mean LA pressure was associated with 19% increase likelihood of class I symptoms (*P*=0.059). A similar model using the same covariates showed that each 5 mm Hg reduction in V wave was associated with 32% increase likelihood of class I symptoms (*P*=0.105).

Discussion

The principle finding of this study is that changes in LAP during TMVR for patients with symptomatic primary MR were associated with clinical improvement at 30-day follow-up as measured by 6MWT. Specifically, each 5 mm Hg decrease in LAP V-wave height during TMVR was associated with a 49% increase in the likelihood of improvement in 6MWT distance. These results suggest that routine measurement of continuous LA pressure during MitraClip procedures may be a useful aid for intraprocedural decision-making. The simple method of continuous LAP monitoring described in this study represents a novel tool to aid clinical decision-making during TMVR and provide predictive data that can be used for procedural guidance and subsequent management. These data suggest that LAP analysis during TMVR can provide insight into both the

Table 5. Multivariate Binary Logistic Regression Model (Continuous)

Independent Variable	OR	95% CI	*P* Value
Age (continuous)	0.98	0.93–1.07	0.93
Male sex	2.83	0.67–11.97	0.16
LA volume index (continuous)	0.99	0.97–1.02	0.73
Residual MR (≤mild vs >mild)	3.49	0.86–14.10	0.80
Decrease in V wave (each 5 mm Hg)	1.49	1.01–2.18	0.04

Improvement in 6-min walk test above the median (25 m) was used as the outcome in this model. CI indicates confidence interval; LA, left atrium; MR, mitral regurgitation; and OR, odds ratio.

contribution of MR to symptoms and to determine the adequacy of MR reduction for a specific clip grasping site.

Although TMVR is primarily a TEE-guided procedure that relies heavily on detailed and rigorous 2-dimensional (2D), 3D, and Doppler imaging, quantification of MR after MitraClip device implantation can be challenging because of eccentric jets, distortion of the leaflet anatomy, and acoustic shadowing by the device. In cases where Doppler assessment of MR reduction by MitraClip is equivocal, the availability of real-time LAP based on our experience is invaluable to determine whether a clip grasping site should be kept and released, moved to another location, or whether an additional device may be required. In addition, the predictive use of the LA V-wave height suggests that pulsed wave Doppler assessment of pulmonary vein systolic flow reversal should also be a standard part of the echocardiographic assessment in these patients.

Previous studies of acute hemodynamic effects of TMVR have demonstrated increases in cardiac output and stroke volume along with reduction in systemic vascular resistance.[10] Furthermore, acute reductions in left ventricular end-diastolic pressure and volume occur after MitraClip. LAP reduction has also been demonstrated (mean LAP reducing from 16 to 12 and V wave reducing from 27±14 to 18±10 [P=0.01 for both]).[11] Recently, Horstkotte et al[12] reported that continuous LAP monitoring was associated with superior intraprocedural results translating into improved MR reduction at the end of the hospital stay. However, no studies have specifically examined the relationship between hemodynamic data and long-term clinical response to MitraClip, particularly in a population of

Table 6. Multivariate Binary Logistic Regression Model (Dichotomous)

Independent Variable	OR	95% CI	*P* Value
Age (continuous)	0.99	0.93–1.07	0.90
Male sex	2.51	0.60–10.42	0.21
LA volume index (continuous)	0.99	0.97–1.02	0.67
Residual MR (≤mild vs >mild)	4.00	0.97–16.64	0.06
Decrease in V wave >11 mm Hg	3.80	0.97–14.51	0.05

Improvement in 6-min walk test above the median (25 m) was used as the outcome in this model. CI indicates confidence interval; LA, left atrium; MR, mitral regurgitation; and OR, odds ratio.

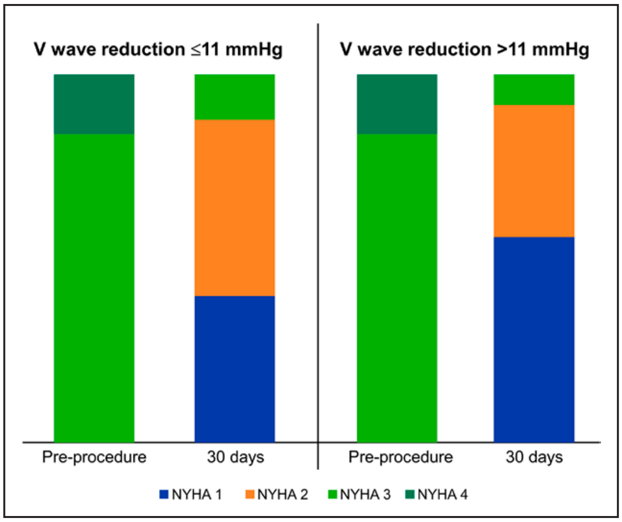

Figure 3. Improvement in heart failure symptoms. **Left**, New York Heart Association (NYHA) function class heart failure symptoms before and after MitraClip procedure among patients with V-wave reduction below the median (≤11 mm Hg). In this group, 10 (40%) and 12 (28%) patients were in NYHA function class I and II, respectively. Similarly, (**right**) NYHA function class heart failure symptoms among patients with V-wave reduction above the median (>11 mm Hg). In this group, 14 (56%) and 9 (36%) patients were in NYHA function class I and II, respectively.

primary MR, which is the group for which TMVR is recommended in the most recent American College of Cardiology/American Heart Association (ACC/AHA) guidelines.[13] Continuous LAP monitoring during TMVR seems to provide simple to obtain, yet valuable prognostic hemodynamic data without the requirement for performing routine right heart catheterization, thus obviating the need for additional venous access and added procedural time.

Limitations

This study is limited by its observational design and relatively small number of patients with short-term clinical follow-up. Because of the risk of overfitting, important covariates were not included in the multivariate model. In addition, LAP and V-wave measurements vary because of fluid volume status and loading conditions associated with general anesthesia. However, the systematic measurement of continuous LAP used for procedural guidance and observed relationship with objective outcome of 6MWT distance has important implications for clinical practice. Further prospective studies with larger numbers and greater follow-up duration are necessary to determine the long-term prognostic significance of LAP response to TMVR.

Conclusions

Continuous LAP monitoring is a useful tool for procedural guidance during TMVR. Acute changes in LA pressure during TMVR with MitraClip are associated with clinical improvement as measured by 6MWT. This study supports the use of continuous LA pressure monitoring for procedural guidance during TMVR.

Acknowledgments

We thank Tom Michnowski for his assistance in data collection.

Disclosures

None.

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Circulation
Cardiovascular Interventions

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Circ Cardiovasc Interv. 2017;10:
doi: 10.1161/CIRCINTERVENTIONS.116.004856
Circulation: Cardiovascular Interventions is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 1941-7640. Online ISSN: 1941-7632