Changes in P-Wave After Percutaneous Mitral Valvuloplasty in Patients With Mitral Stenosis and Left Atrial Enlargement

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Objective

To investigate potential clinical, echocardiographic and/or hemodynamic predictors of the regression of electrocardiographic (ECG) signs of left atrial enlargement (LAE) after successful percutaneous mitral valvuloplasty (PMV).

Methods

We studied 24 patients (75% female, mean age =37.1 ± 11.9 years) with moderate to severe mitral stenosis (MS), sinus rhythm (SR) and ECG signs of LAE who underwent successful PMV between 2002 and 2004. At least 6 months after the procedure (388.2 ± 192.9 days), the patients returned for clinical, ECG and echocardiographic follow-up. They were then divided in 2 groups: patients of group 1 (n = 8; 33.3%) still had ECG signs of LAE, and patients of group 2 (n = 16; 66.6%), had normal P wave. A multivariate analysis of clinical, ECG, echocardiographic and hemodynamic variables was performed.

Results

The mitral valve area (MVA) increased from 1.12 ± 0.15 cm^2 to 1.9 ± 0.35 cm^2 immediately after the procedure ($p < 0.0001$) and decreased to 1.89 ± 0.41 cm^2 at follow-up (p = NS). Left atrium diameter decreased from 48 ± 2.9mm pre-procedure to 43 ± 4.8mm at follow-up (p = 0.0001). P-wave duration decreased from 0.12 ± 0.01 sec pre-PMV to 0.09 ± 0.02 sec at follow-up (p = 0.0001). An MVA ≥ 1.7 cm^2 at follow-up was the only independent predictor of a normal P-wave after PMV (p=0.02).

Conclusion

ECG changes suggestive of LAE regress in the majority of patients with MS and sinus rhythm that undergo a successful PMV. An MVA≥1.7 cm^2 at late follow-up was found to be an independent predictor of such normalization.

Key words

Percutaneous mitral valvuloplasty, left atrial enlargement, mitral stenosis.

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Electrocardiographic signs of left atrial enlargement are frequently found in patients with mitral stenosis and sinus rhythm which normally regress after a successful mitral valvuloplasty.

The changes in the left atrium can be verified indirectly in a practical and easy manner through the analysis of an electrocardiogram, by analyzing the criteria for diagnosing left atrial enlargement, as mentioned in the paper by Hazen et al., where the authors associate changes in P-wave morphology in the electrocardiogram to a high specificity (90%) for left atrium enlargement[1]. Another paper associates changes in P-wave morphology to elevated pressure levels in the pulmonary artery[2].

Percutaneous mitral valvuloplasty, first performed by Inoue et al, in 1982, is the procedure of choice for symptomatic cases (Functional Class above II-NYHA), valve area $\leq$ 1.5 cm^2 and valve morphology that is favorable to percutaneous intervention, in the absence of thrombus in the left atrium or in the absence of moderate or severe failure[3]. A low rate of complication with significant clinical and hemodynamic improvement is expected in the short and long term[4]. In successful procedures, the mitral valve area usually doubles, and the transvalvular gradient decreases by 50% to 60% immediately after the procedure[3,5]. An increase in the velocity of flow in the left atrial appendage that has a correlation with the decrease and disappearance of the left atrium spontaneous contrast is observed. This finding suggests a beneficial effect of the procedure on blood stasis and on the causes of thromboembolism[6,7]. Other authors mention the significant decrease in left atrium pressure after the procedure[8].

Although there are numerous predictors of late events following the procedure – age, functional class IV, previous surgical commissurotomy, moderate to severe mitral deficit, echo score > 8, severe mitral deficit following dilatation and increased pressure in the pulmonary artery after dilatation, small valve area after the procedure ($\leq$ 1.5 cm^2), non-sinus rhythm, valve calcification on fluoroscopy, increased LA pressure, increased transvalvular gradient[9-15] ; there are no details in the literature about changes of P wave in the electrocardiogram performed after the mitral valvuloplasty in patients with mitral stenosis and left atrial enlargement, and there is even less understanding about the meaning of these changes at late follow-up after the percutaneous intervention.

This study was carried out to investigate potential clinical, echocardiographic and hemodynamic predictors of regression of electrocardiographic signs of left atrial enlargement following successful mitral valvuloplasty.

Methods

This is a retrospective study of 24 patients submitted to successful mitral valvuloplasty between the years 2002 and 2004. The patients presented sinus rhythm and left atrial enlargement on electrocardiogram pre-procedure.

The patients' complete history was taken before the intervention and at late follow-up as well, with special emphasis on their functional class based on NYHA criteria. On auscultation, the murmurs in the mitral area were classified according to their intensity (+ to ++++) and to the phase of the cardiac cycle (systolic and diastolic). The patients underwent percutaneous mitral valvuloplasty using the technique described by Inoue et al[16].

The electrocardiograms were performed prior to the procedure, immediately after and late after the procedure on a Dixtal device, where the usual 12 leads and long DII were obtained. The cardiac rhythm was observed and one or more of the following criteria of left atrial enlargement were verified: a P wave longer than 0.10 seconds on the bipolar leads, j.deflections separated by more than 0.03 seconds (especially in D1 and D2), deviation of the electric axis of P's mean vector to the left, predominance of the negative phase in V1 and presence of the Morris Index[17]. The record was obtained at a velocity of 25 mm/s, analyzed using a ruler; the average bipolar leads was also calculated. Care was taken to ensure that the diagnosis of left atrial enlargement was agreed upon by two experienced independent cardiologists.

An echocardiographic study was carried out prior to the procedure, early after the procedure (48 hours post procedure) and late after the procedure, always by the same experienced practitioner. All the tests were performed on an Apogee 800 plus, manufactured by ATL (Advanced Technologies Laboratories) and on an AU3 Partner, manufactured by Esaote, with multifrequency convex transducers with emission frequency of 2.5-3.5 MHz. The images have been captured in the transverse parasternal view for analysis of the mitral commissure and planimetry of the valve. The morphological aspects of the mitral valve were quantified according to the Wilkins echocardiographic score[18]. The parameters of flow were obtained in the apical four chamber view using pulsating, continuous wave and color Doppler.

After a minimum of six months after the percutaneous mitral valvuloplasty the patients were contacted by phone or mail and asked to come back to the Hemodynamics Department for clinical and echocardiographic follow-up. They underwent a second medical history, physical examination, and follow-up electrocardiogram and echocardiogram.

As to the statistical analysis, the between-group comparison was performed using Fisher's exact test, the binomial test and Mann-Whitney's non-parametric test. The evolution of the variables was studied pre and post-procedure and late post-procedure using the binomial test, Friedman's non-parametric test and Wilcoxon's non-parametric test. For multivariate analysis, due to the small number of cases, those variables whose p value in the univariate analysis was smaller than 0.50 were

included. For these variables, the cut-off values have been stipulated by adjusting a Logistics Regression Model and obtaining the results here informed.

Results

The 24 patients (75% female, mean age 37.13 ± 11.91 years) submitted to percutaneous mitral valvuloplasty, who, in the pre-procedure electrocardiogram, presented sinus rhythm with left atrial enlargement, presented the clinical, echocardiographic and hemodynamic characteristics in the pre and post-procedure period as mentioned in Table 1.

According to the follow-up electrocardiogram, obtained at follow-up at an average of 388.2 ± 192.9 days, patients were divided into two groups: Group 1 (n = 8; 33.3%) still with electrocardiographic signs of left atrial enlargement at late follow up, and Group 2 (n = 16; 66.6%), with normal P wave. There was no difference between the groups as to the variables studied. The main clinical, electrocardiographic and echocardiographic characteristics of the two groups are on Table 2.

The clinical and electrocardiographic variables of left atrial enlargement obtained at late follow-up in both groups and their statistical differences are listed on Table 3.

In the search for independent predictors of P wave evolutive regression a multivariate analysis was performed including all clinical, echocardiographic and hemodynamic variables studied. The only independent predictor of the regression of electrocardiographic signs that diagnose left atrial enlargement was a mitral valve area ≥ 1.7 cm^2 at late follow-up (p = 0.02).

Table 1 – Main clinical, echocardiographic and hemodynamic characteristics of the population studied

	Pre-PMV	Early Post-PMV	Late Post-PMV	p
FCII/III(NYHA)	23 (95.8%)		2 (8.33%)	<0.0001
DM++/+++	18 (75%)		3 (12.5%)	0.0001
MVA planimetry (cm^2)	1.17 ± 0.15	2.03 ± 0.34	1.96 ± 0.44	<0.0001
MVA Doppler (cm^2)	1.12 ± 0.15	1.9 ± 0.35	1.89 ± 0.41	<0.0001
Left atrium (cm)	4.8 ± 0.29	4.34 ± 0.49	4.28 ± 0.48	0.0001
Pulmonary trunk pressure (mmHg)	34.71 ± 22.4	28.27 ± 11.69		0.0074
DP2LV (mmHg)	8.57 ± 3.57	10.19 ± 3.28		0.0025
ECHO Gradient (mmHg)	11.09 ± 4.21	6.41 ± 3.09	6.77 ± 2.97	0.0004
P Duration (seg)	0.12 ± 0.01	0.12 ± 0.01	0.09 ± 0.02	0.0001

FC - functional class; DM - diastolic murmur; MVA - mitral valve area ; DP2LV - final diastolic pressure in left ventricle; ECHO - echocardiogram.

Table 2 – Main clinical, echocardiographic and hemodynamic characteristics of the groups obtained

	Group 1	Group 2	p
n = 24	8 (33.3%)	16 (66.6%)	
Female	5 (71.4%)	11 (73.3%)	1.0
Age	42.5 ± 11.9	34.44 ± 11.28	0.10
Pre-PMV FC II/III (NYHA)	8 (100%)	14 (87.5%)	0.53
Pre-PMV MVA Doppler (cm^2)	1.13 ± 0.13	1.11 ± 0.16	0.78
Pre-PMV LA (cm)	4.93 ± 0.34	4.77 ± 0.26	0.41
Pre-PMV Echo gradient (mmHg)	11.25 ± 4.13	11.01± 4.39	0.88
Echo score	7.25 ± 2.49	7.06 ± 1.28	0.92
Pre-PMV Pulmonary trunk pressure (mmHg)	28.88 ± 23	37.63 ± 22.3	0.21
Pre-PMV Gradient (mmHg)	11.38 ± 6.04	18.13 ± 9.93	0.07
P Duration pre-PMV (sec)	0.12 ± 0.005	0.12 ± 0.01	0.88
P Amplitude pre-PMV (mm)	1.92 ± 0.44	1.88 ± 0.35	0.69
j.deflection pre-PMV	4 (50%)	10 (62.5%)	1.0
Early post-PMV Pulmonary trunk pressure (mmHg)	27 ± 13.3	28.87 ± 11.31	0.73
Early post-PMV gradient (mmHg)	2.4 ± 1.85	2.23 ± 2.38	0.83
Early post-PMV MVA Doppler (cm^2)	1.92 ± 0.31	1.86 ± 0.37	0.56
Early post-PMV LA (cm)	4.31 ± 0.61	4.36 ± 0.45	0.92

FC - functional class; MVA - mitral valve area; LA - left atrium; ECHO - echocardiogram.

Table 3 – Clinical, echocardiographic and electrocardiographic variables obtained at late follow-up

n = 24	Group 1(n = 8)	Group 2(n = 16)	p
P duration at late follow-up (sec)	0.11 ± 0.009	0.08 ± 0.01	<0.0001
P amplitude at late follow-up (mm)	1.81 ± 0.37	1.73 ± 0.37	0.63
P j.deflection at late follow- up	4 (50%)	3 (18.75%)	0.16
FC II/III (NYHA) at late follow-up	1 (12.5%)	1 (6.25%)	1.0
MVA at late follow-up Doppler (cm^2)	1.76 ± 0.47	1.95 ± 0.37	0.29
LA (cm) at late follow-up	4.34 ± 0.64	4.26 ± 0.40	0.92
Echo gradient (mmHg) at late follow-up	8.11 ± 3.27	6.05 ± 2.62	0.21

FC - functional class; MVA - mitral valve area; LA - left atrium.

Discussion

We observed a high rate of patients whose electrocardiograms presented regression in the signs of left atrial enlargement at late follow-up – 66.6% of patients did not present this alteration after the mitral valvuloplasty.

There are few studies in the medical literature which make a correlation between percutaneous mitral valvuloplasty and the related electrocardiographic changes. There are even less studies which mention specific changes in the P wave of electrocardiograms or long term improvement of left atrial enlargement after the procedure. Chandrasekar et al.[19] demonstrated that acute hemodynamic changes following mitral valvuloplasty with a balloon produce changes in the electrocardiogram, indicative of an important hemodynamic benefit resulting from the procedure. In this study patients who had changes in the P-wave patterns had a significant decrease in the left atrium average pressure, smaller residual transmitral gradient and a higher percentage in the opening of the mitral valve. However, the assessment was restricted to the first 72 hours post procedure[19]. Turhan et al[20] associated a significant decrease in P-wave dispersion (a new electrocardiographic marker associated with changes in the propagation of the sinus impulse that is the difference between the maximum and the minimum P-wave duration) following mitral valvuloplasty in both the short and the long term.

The findings of this paper in a way support those mentioned before, since they relate the disappearance of the left atrium enlargement on electrocardiography to the presence of larger valve areas at late follow-up.

To conclude, we point out that the changes in the P-wave which suggest left atrial enlargement regress in most patients with mitral stenosis and sinus rhythm submitted to a successful percutaneous mitral valvuloplasty. The finding of a mitral valve area ≥ 1.7 cm^2 at late follow-up was considered an independent predictor of such normalization.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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