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Two D Echocardiographic Evaluation of Left Ventricular Diastolic Function After Closed Mitral Valvotomy in Rheumatic Mitral Stenosis

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Abstract

Aims: The aim of this study is 2D Echocardiographic evaluation of left ventricular diastolic function after closed mitral valvotomy in rheumatic mitral stenosis. *Settings and Design:* This was a single centre one-year comparative study consisting of twenty nine patients of rheumatic severe mitral stenosis. *Methods and Material:* We analyzed preoperative and post operative transthoracic 2D echocardiographic parameters of diastolic function and compared both data to evaluate improvement of diastolic function in all patients who underwent closed mitral valvotomy. *Statistical analysis used:* The statistical analyses were performed on SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. Categorical groups were compared by chi-square (x^2) test. A two-sided (α=2) p value less than 0.05 ($p<0.05$) was considered statistically significant. *Results:* All the twenty nine patients underwent successful surgeries. In perioperative and follow up, there was no incidence of Mitral regurgitation and thromboembolic incident. There was no mortality. *Conclusions:* Surgical closed mitral valvotomy produces excellent and comparable early hemodynamic improvement, significant improvement in clinical stage of disease and improvement in diastolic function.

Key-words: Two Dechocardiography; Rheumatic Mitral Stenosis; Diastolic Function; Closed Mitral Valvotomy (CMV)**.**

Key Messages: *Closed mitral valvotomy remains a simple, safe, and effective means of treating mitral stenosis in regions where socioeconomic changes have not yet reduced the incidence of rheumatic heart disease and where resources for its treatment are limited there is still a place for this procedure.*

Introduction

Rheumatic mitral stenosis continues to be a major public health problem in developing countries. Isolated mitral stenosis occurs in 40% of all patients presenting with rheumatic heart disease, and 60% of patients with mitral stenosis give a history of rheumatic fever [1]. Patients with a mitral valve area of less than 1.5 cm^2 and NYHA functional Class III-IV symptoms should be referred for surgery [2]. Diastolic dysfunction occurs when the left atrium (LA) is unable to fill the left ventricle (LV) at normal LA pressures due to impaired relaxation, impaired compliance, or both. The assessment of left ventricular (LV) diastolic function and filling pressures is of paramount clinical importance to assess prognosis, and to identify underlying cardiac disease and its treatment [3]. Two D Echocardiography has played a central role in evaluation of LV diastolic function over the past two decades and can detect diastolic dysfunction with excellent sensitivity and minimal risk to the patient when compared to the gold standard of invasive pressure-volume measurements over time [4]. We analyzed preoperative and post operative transthoracic 2D echocardiographic parameters for assessment of diastolic function and compared both data to evaluate the improvement of diastolic function

in all patients who underwent closed mitral valvotomy (CMV) at one month follow up.

Subjects and Methods

This comparative study included all consecutive patients undergoing closed mitral valvotomy, admitted for rheumatic severe mitral stenosis and operated from October 2013 till September 2014. Trans-oesophageal echocardiography done in patients with atrial fibrillation. Patients with left atrium (LA) / left atrial appendage (LAA) clot and mitral regurgitation >2 were excluded. Four methods of assessment for diastolic dysfunction are transmitral inflow, pulmonary venous flow, mitral annulus tissue Doppler, and color M-mode Doppler (propagation velocity, Vp). In our study, Mitral Valve Orifice Area (MVA), Ejection fraction (EF), Deceleration time (DT), E / A-wave, E / E'-wave, TIE index (IVCT+IVRT / ET), Mitral inflow propagation velocity (Vp) were included for 2D-Echocardiographic assessment of diastolic function. All patients had their baseline investigations done and were operated on only when these were within the normal range. Surgery performed by standard anterolateral thoracotomy with left atrial appendage purse string and TUBB'S transventricular dilator used for dilatation of stenotic mitral valve and follow up transthoracic 2D-echocardiography done at one month. The postoperative management in the intensive care unit (ICU) consisted in maintaining a good perfusion of organs and tissues and ionotropic support was provided as and when required. Demographic data in terms of patient characteristics, pre and post operative laboratory investigations, and ICU data were obtained. Detailed 2D Echocardiography data, Including Mitral Valve Orifice Area (MVA), Ejection fraction (EF), Deceleration time (DT), E / A-wave, E / E'-wave, Tie index (IVCT+IVRT / ET) and Mitral inflow propagation velocity (Vp) were recorded preoperatively and at one month follow up. The statistical analyses were performed on SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The data were summarized as Mean ± SD (standard deviation). The pre and post operative groups were compared by paired t test. Categorical groups were compared by chi-square (x^2) test. A two-sided (α=2) p value less than 0.05 ($p<0.05$) was considered statistically significant.

Results

A total of 29 symptomatic patients were included . The outcome measures of the study were MVA, EF, DT, EW / AW ratio, E / E' ratio, TEI score, MIPV and Grade. The outcome measures were observed preoperatively and 1 month follow-up. The mean values of the haematological and biochemical parameters for all patients were within the normal ranges in this study. The demographic characteristics age, sex, height, weight and body mass index (BMI) of patients are summarized in Table 1. Twenty nine patients underwent successful closed mitral valvotomy (CMV). Pre operative maximum patients were in NYHA grade 3 (69.0%) and post operative maximum patients were in NYHA grade 1 (48.3%) and rest of patients were in NYHA grade 2 (41.4%). Four patients were in AF. Wilkins score ranged from 6 to 10. MVA increased from 0.77 ± 0.13 to 2.32 ± 0.26, EF increased from 61.38 ± 4.61 to 64.79 ± 3.22, DT (ms) decreased from 231.55 ± 49.31 to 168.28 ± 14.30, E / A ratio reverted to 1.70 ± 0.54 from 0.89 ± 0.39, E / E' ratio decreased from 14.59 ± 3.34 to 8.86 ± 3.03, TEI index improved from 0.50 ± 0.03 to 0.39 ± 0.06, MIPV (cm / sec) increased from 47.28 ± 3.71 to 57.86 ± 3.19 (Table.2). In peri-operative and follow up, there was no incidence of severe mitral regurgitation (MR). There was no thromboembolic incident and no mortality.

Discussion

Rheumatic mitral stenosis remains a common health problem in developing countries, and mostly affects the poorer sections of the population. In mitral stenosis, the hemodynamic changes seen are due to the obstruction of left ventricular filling, and this in turn leads to an elevation of the left atrial pressure, and the pulmonary venous and capillary pressures, as a result reduced LV filling during diastole, causing diastolic dysfunction. In the developing countries, CMV may be the surgery of choice to treat mitral stenosis. Indeed, Farhat and colleagues[5] showed that open commissurotomy improved hemodynamic values to a much greater extent than did closed commissurotomy, and as a consequence closed mitral commissurotomy is no longer performed in developed, industrialized countries. Mitral valve area (MVA) increased from 0.77 ± 0.13 to 2.32 ± 0.26. Ufuk Tütün and colleagues [6] investigated the long-term efficacy of closed mitral valvotomy (CMV), and observed that preoperatively, the mean MVA was 0.9 ± 0.3 cm^2. The mean MVA was 2.04 ± 0.5 cm^2 after closed mitral valvotomy (CMV). E.V. Ussiri and colleagues [7] observed that patients presenting with severe mitral stenosis revealed a significant mean dilatation of mitral valve area from 0.69 ±0.17 cm^2 before closed mitral valvotomy (CMV) group to 1.75± 0.48cm^2 post closed mitral valvotomy group. Clinically, they found

that dilatation of mitral orifice (valvotomy) of >1.5cm^2 has a remarkable improvement in the outcomes in terms of clinical and diastolic function. Zoltan G. Turi and colleagues [8] found that mitral valve area was 1.6±0.6 cm^2 in the balloon commissurotomy group and it was 1.8±0.6 cm^2 in the surgical closed valvotomy group after 8 months follow up. In our study, comparing the mean MVA levels at pre CMV and post CMV, t test revealed significantly different and higher (66.8%), MVA at post mitral valvotomy as compared to pre mitral valvotomy. Ejection fraction (EF) increased from 61.38 ± 4.61 to 64.79 ± 3.22. The mean ejection fraction level after surgery increased comparatively as compared to before surgery. Fawzy ME observed [9] that baseline LV ejection fraction was < 50%. LV ejection fraction increased from 57±7% to 62±6% immediately after mitral valvotomy and 71± 8% later. On the basis of their study they concluded that the LV ejection performance improved after successful mitral valvotomy. Mayer I V and colleagues [10] showed that global LV ejection fraction (EF) was significantly increased from 57% before mitral valvuloplasty to 63% after valvuloplasty and normalized thereafter. In our study, comparing the mean ejection fraction (EF) levels before closed mitral valvotomy and after closed mitral valvotomy, t test revealed significantly different and higher (5.3%) ejection fraction (EF). Deceleration time DT (ms) decreased from 231.55 ± 49.31 to 168.28 ± 14.30. The mean DT level after closed mitral valvotomy decreased comparatively as compared to before closed mitral valvotomy. Nurcan Arat and colleagues [11] found that E wave deceleration time (DT) was 96.6±62.3 before mitral valvuloplasty, 95.5±31.1 after 48 hrs of valvuloplasty and 109.7±30.0 three months after valvuloplasty. In our study the mean DT level at post mitral valvotomy decreased comparatively as compared to pre mitral valvotomy, thus showing improvement in diastolic function following CMV. Comparing the mean DT levels at pre CMV and post CMV, t- test revealed significantly different and lower (29.9%). E / A ratio reverted to 1.70 ± 0.54 from 0.89 ± 0.39. The mean EW / AW ratio at post CMV increased comparatively as compared to pre CMV. Ragab A. Mahfouz and colleagues[12] found that before the closed mitral valvotomy E / A ratio was 1.12 ± 0.14 and in follow up after the procedure it was 1.54 ± 0.17. Their study showed increase in E / A ratio thus, indicating improvement in left ventricular diastolic function. Nurcan Arat and collegues [11] observed that E / A ratio was 0.9±0.5 before mitral valvuloplasty, it was 1.3±0.7 after 48 hours of mitral valvuloplasty and 1.4±0.7 after three months of mitral valvuloplasty. They studied several parameters of diastolic function and found that there was significant improvement in diastolic function following mitral valvuloplasty. Thus, Comparing the mean EW / AW ratio at pre CMV and post CMV, t test revealed significantly different and higher (47.9%) EW / AW ratio at post CMV as compared to pre CMV. The E/E' ratio of patients before closed mitral valvotomy 14.59 ± 3.34 while post surgery it was 8.86 ± 3.03. The mean E/E' ratio at post valvotomy decreased comparatively as compared to pre valvotomy. Maged Z. and colleagues [13] showed statistically significant higher peak mitral annular E' velocity from septal, anterior, inferior and lateral portions of the mitral annulus in the mitral stenosis group compared with controls. The ratio of early diastolic mitral inflow velocity to mitral annular velocities (E/E') from all recorded sites was statistically significantly higher in the mitral stenosis compared with controls. So we observed that by comparing the mean E/E' ratio before closed mitral valvotomy and post valvotomy, t test revealed significantly different and lower (39.3%) E/E' ratio. TEI index improved from 0.50 ± 0.03 before valvotomy to 0.39 ± 0.06 after valvotomy. The mean TEI score at post valvotomy decreased comparatively as compared to pre valvotomy. Nurcan Arat and colleagues [11] observed that TIE index was 0.70±0.30 before mitral valvuloplasty, 0.50±0.20 after 48 hrs of mitral valvuloplasty and 0.30±0.10 three months after mitral valvuloplasty. A significant correlation was found between EF and the TEI index. Amdadul Haque and colleagues [14] showed that TEI index significantly increased after surgery in patients with AS (0.38 to 0.49), aortic regurgitation (0.60 to 0.70) and decreased in mitral stenosis (0.39 to 0.33) and decreased significantly in mitral regurgitation (0.50 to 0.44). In their study decrease in TEI index was significant in mitral valvular lesion as compared to aortic valve lesion. Comparing the mean TEI score at pre CMV and post CMV, t test revealed significantly different and lower (21.5%) TEI score at post CMV as compared to pre CMV. The mitral inflow propagation velocity, Vp (cm / sec) increased from 47.28 ± 3.71 to 57.86 ± 3.19 The mean MIPV level at post increased comparatively as compared to pre CMV. Wierzbowska K and colleagues [15] compared Propagation velocities between groups with normal and pseudo normal mitral inflow profiles and Sensitivity, specificity and accuracy for the detection of pseudo normal mitral inflow pattern for early wave propagation were 87%, 96% and 94%. On the basis of their study they found that decreased value of mitral inflow early wave propagation velocity (Vp) offers high sensitivity and specificity for the diagnosis of mitral inflow pseudo-normalisation (Diastolic dysfunction). Licker and colleagues [16] concluded that, LV diastolic dysfunction characterized by Vp

d" 40 cm / sec best identifies patients at higher risk of LV dysfunction after cardio pulmonary bypass (CPB) and was associated with more frequent cardiac complications in the ICU. In our study, comparing the mean MIPV level before CMV and after CMV, t test revealed significantly different and higher (18.3%) MIPV. Thus, we conclude that closed mitral valvotomy (CMV) produce excellent and comparable early hemodynamic improvement, significant improvement in clinical stage of the disease and improvement in diastolic function and are associated with a lower rate of residual stenosis. Closed mitral valvotomy remains a simple, safe, and effective means of treating mitral stenosis in regions where socioeconomic changes have not yet reduced the incidence of rheumatic heart disease and where resources for its treatment are limited there is still a place for this procedure.

Table 1: Demographic characteristics (Mean ± SD) of patients (n=29)

Demographic characteristics	Statistic
Age (yrs):	
Mean ± SD	34.97 ± 9.74
Range (min to max)	(13 to 55)
Sex:	
Male	11 (37.9%)
Female	18 (62.1%)
Height (cm):	
Mean ± SD	158.03 ± 10.29
Range (min to max)	139 to 186
Weight (kg):	
Mean ± SD	45.21 ± 9.88
Range (min to max)	28 to 70
BMI (kg/m^2):	
Mean ± SD	18.05 ± 3.33
Range (min to max)	12 to 25

BMI- Body mass index

Table 2: Pre CMV and post CMV diastolic function parameter levels (Mean ± SD) of patients

Diastolic function parameters	Pre CMV (n=29)	Post CMV (n=29)	Mean change (Post-Pre)	t value (DF=28)	p value
MVA (cm^2)	0.77 ± 0.13 (0.5 to 1.0)	2.32 ± 0.26 (1.6 to 2.7)	1.55 ± 0.27 (0.8 to 2.0)	31.26	<0.001
EF (%)	61.38 ± 4.61 (52.0 to 69.0)	64.79 ± 3.22 (58.0 to 71.0)	3.41 ± 2.01 (0.0 to 8.0)	9.15	<0.001
DT (m/sec)	231.55 ± 49.31 (160.0 to 310.0)	168.28 ± 14.30 (140.0 to 200.0)	-69.28 ± 52.83 (-160.0 to -6.0)	7.06	<0.001
EW/AW	0.89 ± 0.39 (0.5 to 2.0)	1.70 ± 0.54 (0.8 to 2.4)	0.81 ± 0.54 (0.1 to 1.7)	7.85	<0.001
E/E'	14.59 ± 3.34 (10.0 to 22.0)	8.86 ± 3.03 (0.8 to 14.0)	-5.73 ± 3.79 (-14.0 to 1.0)	8.14	<0.001
TIE Index	0.50 ± 0.03 (0.5 to 0.6)	0.39 ± 0.06 (0.3 to 0.6)	-0.11 ± 0.05 (-0.2 to 0.0)	12.30	<0.001
MIPV (cm/sec)	47.28 ± 3.71 (40.0 to 55.0)	57.86 ± 3.19 (52.0 to 66.0)	10.59 ± 4.73 (0.0 to 22.0)	12.05	<0.001

***p<0.001- as compared to Pre

MVA- Mitral valve area, EF- Ejection fraction, DT- Deceleration time, EW/AW- E wave/A wave, E/E'- E wave/E' wave, TIE index- Total isovolumic ejection, MIPV- Mitral inflow propagation velocity.

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