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Original Research Paper

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A STUDY OF CLINICAL APPLICATION OF THREE DIMENSIONAL ECHOCARDIOGRAPHY IN BALLOON MITRAL VALVULOPLASTY

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ABSTRACT

Background: Mitral Stenosis (MS) in an obstruction to blood flow between the left atrium and left ventricle, is caused by abnormal valve function. Our aim is with use of the recent 3D echocardiography (RT3DE) to evaluate, the mitral valve and its relation to neighbouring structures in mitral stenosis, combined with Quantitative analysis software during BMV.

Methods: This is a prospective, Cross-sectional hospital based study design on utilizing real time Three dimensional Transthoracic echocardiography (RT3DE) for comprehensive assessment of cardiac anatomy in patients with rheumatic mitral stenosis who underwent Balloon mitral valvotomy (BMV)

Results: Our study group comprised thirty consecutive patients with rheumatic mitral valve stenosis. There were eighteen male and twelve female with mean age of 32.3 ± 8.6 years. (range 22 to 42 years). The real time 3D Echocardiogram showed well delineated commissural splitting and atrial puncture site. After Balloon mitral valvotomy, the functional capacity improved to NYHA class I and mitral valve orifice increased to 1.45 ± 0.24 cm2.

Conclusion: Three dimension echocardiogram reconstruction of the mitral valve obtained by Transthoracic echocardiography during BMV is a new, non invasive imaging technique that can be accurately visualize the mechanism of successful BMV as well as some of its complications.

KEYWORDS : Mitral stenois (MS), Real time 3D Echo Cardiogram (RT3DE), Balloon mitral Valvotomy (BMV), Percuteneous Transvenous Mitral Valve Commissurotomy (PTMC)

Introduction

The mitral valve consist of six major anatomic components: The posterior left atrial wall, annulus, leaflet, chordae tendinae, papillary muscles and left ventricular free wall. The circumference of the normal valve ranges from 8 to 10.5 cm (Mean 9.4).

Mitral valve consists of two leaflets. The anterior leaflet has a much longer base to margin of closure width (2.3 cm) than posterior leaflet (1.2cm), but the circumference (6cm) of the posterior leaflet (annular attachment) is about twice that of the anterior leaflet (3cm). The anterior leaflet is large and semicircular and it partially separates the ventricular inflow and outflow tracts. However, unlike its right-sided counterpart, it also forms part of the outflow tract. The posterior mitral leaflet is rectangular and is usually divided into three Scallops[1,2]. The middle scallop is the largest of the three in more than 90 percent of normal hearts. Occasionally, however, either the anterolateral or the posteromedial scallop is larger, and rarely there are accessory scallops. Posterior mitral leaflet prolapse usually involves the middle scallop and may be associated with chordal rupture. Both mitral leaflets are normally similar in area. The anterior leaflet is twice the height of the posterior leaflet but has half its annular length[3]. With advanced age, the mitral leaflet thicken somewhat, particularly along their closing edges[4].

The commissures are cleft like splits in the leaflet tissue that represents the sites of separation of the leaflets. Beneath the two mitral commissures lie the anterolateral and posteromedial papillary muscles, which arise from the left ventricular free wall. Commissural chords arise from each papillary muscle and extend in a fan-like array to insert into the free edge of both leaflets adjacent to the commisures (major commissures)[5] or into two adjacent scallops of the posterior leaflet (minor commissures). The attachments of commissural chords precisely demarcate the commissure.

The anterolateral papillary muscle is commonly single and usually has a dual blood supply from the left coronary circulation[6]. In contrast, the posteromedial papillary muscle usually has multiple heads and is most commonly supplied only by the right coronary artery. Small left atrial branches supply the most basal aspects of the mitral leaflets. Papillary muscle contraction pulls the two leaflets toward one another and thereby promotes valve closure.

The chordate tendineae anchor and support the leaflets and, by doing so, prevent leaflet prolapsed during ventricular systole. Two particularly prominent rough zone chords, referred to as strut chordate, insert along each half of the ventricular surface of the anterior mitral leaflet and tend to calcify with age. Unlike the tricuspid valve, the normal mitral leaflets have no chordal insertions into the ventricular septum.

Mitral stenosis (MS) an obstruction to blood flow between the left atrium and left ventricle is caused by abnormal mitral valve function. In virtually all adult patients, the cause of MS is previous rheumatic carditis. Rheumatic fever results in four forms of fusion of mitral valve apparatus leading to stenosis: 1.Commissural. 2.Cuspal 3.Chordal and 4.combined. The typical M-mode and 2D echocardiographic features of rheumatic mitral stenosis include the following.

1. Thickened and calcified mitral leaflet and subvalvular apparatus. 2. Decreased E-F slope. 3. 'Hockey- Stick' appearance of anterior mitral leaflet in diastole. 4. Immobility of the posterior mitral leaflet.5.Fish mouth orifice in the short axis view. 6. Increased LA size.

The mitral valve area can be measured by

1. Planimetry
2. Preesure –half time
3. Continously equation.
4. PISA (Proximal Isovelocity Surface Area)

The following categories the severity of mitral stenosis according to mitral valve area.

Normal	4 to 6 cm^2
Mild.	1.6 to 2.0 cm^2
Moderate	1.1 to 1.5 cm^2
Severe	1.0 cm^2 or smaller

Mitral stenosis is considered severe when the

1. Resting mean pressure gradient is ≥10mmHg
2. Mitral valve area is ≤ 1.0 cm^2

3. Pressure half time is ≥ 220 milliseconds

Management of mitral stenosis includes 1. Medical. 2.Surgical. and 3. Interventional therapies. The interventional therapy is usually performed in patients with severe MS and occasionally in patients with moderate MS. In patients undergoing balloon mitral valvuloplasty (BMV) an echocardiographic score based on valve thickness, calcification, mobility and subvalvular thickening can be used to predict the outcome of the procedure. The patients with an echogardiographic score of 8 or less have a more favourable result form BMV than those with a higher score, but a score higher than 8 does not preclude the option of valvuloplasty. Commissural calcification or fusion is another important determination of poor outcome after percutaneous valvuloplasty or valvotomy. With the recent introduction of a novel. high speed, volumetric scanner system, realtime, 3D echocardiography (RT3DE) could be used to display the mitral valve and its relation to neighboring structures in real time. It has great potential in assessing morphological characteristics of the mitral valve apparatus and to determining the valve orifice are, combined with quantitative analysis software during BMV.

AIM OF THE STUDY

This study aims at utilizing real time three dimensional transthoracic echocardiography (RT3DE) technique for comprehensive assessment of
- cardiac anatomy
- cardiac pathophysiology
- pathomorphology

in patients with rheumatic mitral stenosis who underwent Balloon mitral valvotomy (BMV)

METHODS AND MATERIALS

This study was conducted in the department of cardiology Govt. Mohan Kumaramangalam Medical College Hospital, Salem during the year of 2015-2018.

STUDY INDICATION

Study indication was for the comprehensive assessment of cardiac anatomy and pathomorphology of rheumatic mitral stenosis who undergoes balloon mitral valvotomy.

STUDY GROUP SELECTION

Study groups are those who were refereed and admitted for the management of rheumatic mitral stenosis. Candiates for balloon mitral valvotomy were carefully evaluated by history taking, physical examination and laboratory tests, including electrocardiography chest radiographs and echocardiography. Color Doppler-two-dimentional echocardiography is essential to evaluate mitral valve morphologies and assess the degree of mitral regurgitation. Transesophogeal echocardiography is performed to verify the presence or absence of left atrial thrombi.

EXCLUSION CREITERIA

1. Mitral regurgitation- moderate and more
2. Moderate and more calcification of mitral valves
3. Fresh left atrial thrombus
4. Thrombus on atrial septum
5. Mobile thrombus

STUDY POPULATION

The study group consisted of 30 rheumatic mitral stenosis (severe) patients consisting 18 males and 12 females (Mean age =32.3 ± 8.6 years, range =22 to 42 years). The purpose and methodology were explained to the study subject in detail and informed consent was obtained.

All the patients were subjected to clinical examinations, ECG, X-ray chest, TTE and 3D Echocardiogram prior and post to balloon mitral valvotomy. TEE was done in selected individual to rule out LA clot. (n=4)

CLINICAL EVALUATION

The patients were either in class II (16 out of 30, 53%) or in class III (14 out of 20,47%) of the New York Heart association functional classification. All patients underwent thorough clinical evaluation before the study. None of the study patients were on anticoagulant or antithrombotic drug therapy, and all were on mild oral diurectic, oral penicillin's and potassium chloride syrups. Complete haemogram and basic blood biochemical analysis were normal in all the subjects. All the baseline clinical characteristics and investigate parameters of the study population are listed in the Table (1) & (2).

Table-1 Basline and 2D echocardiographic characters of patients pressure data of BMV (mmHg)

Age	22-42 years
NYHA	II-III
Left atrial size (mm)	4.4 ± 3.1
MVO planimetry (cm2)	0.7 ± 19
MVO PHT (msec)	325 ± 60
Wilkins Score	3± 2
Pulmonary artery Pressure (mmHg)	59.8 ± 18.6/ 39.0 ± 13.5
Mitral	PG 25 ± 8.15 MG15.8 ± 5.36

Table-2 Baseline haemodynamic characters of patients.

Aorta	108/76/52
LV	118/10
PA	90/62/42
RV	92/14
LA	42/27/19
	(a) (mean) (v)

TRANSTHORACIC ECHOCARDIOGRAPHY

All the subjects in the study population underwent both transthoracic 2D and 3D echocardiographic examination prior and post to Balloon mitral valvotomy. Transthoracic M-mode, Two-dimentional, colour flow Doppler, pulsed and continuous wave Doppler and RT3DE (real time 3D echocardiogram) were performed in all the subjects, with Philips i.E33 ultrasound machine using X3-1 phased array transducer.

With the subject in left lateral decubitus position, continuous heart rate and single lead ECG on-line monitoring was done, and a complete TTE and RT3DE examination was performed following conventional criteria in multiple views. M-mode, 2D, Doppler and colour flow imaging of the mitral valve and related parameters were analyzed. Evaluation of LA size was done by M-mode and two-dimensional echocardiography. According to the American society of echocardiography criteria. LA dimension in M-mode by TTE represents the distance between the leading edge of the posterior aortic wall echo and leading edge of posterior LA wall echo at the level of aortic valve at end-systole. To determine the MVA by continuity equation left ventricular outflow tract diameter (LVOT) time velocity integrals (TVI) of LVOT and mitral valve measured. This equation was not used in aortic and mitral regurgitation.

To determine the MVO area by proximal isovelocity surface area (PISA) the following steps were used. 1.Zoom the area of the mitral valve from apical four chamber view. 2. Use color flow imaging of the mitral stenosis jet and upward shift of zero baseline for color map (30 to 40 cm/sec aliasing velocity). 3.Freeze color flow images in a cine loop and identify an optional frame to measure radius ® of PIZA in the left atrium. 4. Determine the angle (α) between two mitral leaflets at the atrial surface and the PIZA formula used.

REAL TIME THREE DIMENSIONAL ECHOCARDIOGRAPHY

In each patient, RT3DE is performed immediately after 2D study using a Philips iE.33 ultrasound machine with an X3-1 probe. This probe is unique as it contains 3000 elements arranged in a rectangular format. Each transducer element is less than the size of the human hair. The foot point of the RT3DE probe is almost the same size as that of the 2D echocardiography probe.

RT3DE examination is performed from the same windows that are used for 2D echocardiography, namely parasternal long axis, parasternal short axis, apical subcostal &suprasternal views. Hence the plane of examination and the views are exactly similar to that of 2D echocardiography. Initially parasternal long axis view of mitral valve is obtained with routine 2D echo. Then one can switch over form 2DE to 3DE so that 15^{0} x 90^{0} sector of the heart structures can be obtained. In case of mitral valve, apart from showing the anterior mitral leaflet and posterior mitral leaflet, its ventricular and atrial surface, the subchordal structure and papillary muscles can be clearly visualized by the 3D Echocardiography. In the parasternal short axis view, apart from visualizing the fish mouth narrowed mitral valve orifice, one can rotate the picture and visualize the extent of commissural fusion, presence and extent of commissural splitting (medical, lateral or both commissures) can be analyzed post operatively. Any tear in the commissure can be visualized, as extension of splitting,perpendicular or oblique to the commissure line.

The RT3DE examination can also be done in the zoom mode to visualize the mitral valve or any other region of interest. In the zoom mode a 30^{0} x 60^{0} sector of the heart is visualized. This live 3DE can be performed from the standard echocardiography window using the standard 2DE windows as starting point. The entire heart and surrounding structure can be interrogated and we can obtain a pyramidal shape datas set. The narrows portion of pyramid being nearer to the transducer and the widest portion is in other end of transducer. The pyramid is about 80^{0} x 90^{0} in size. The 80^{0} view is obtained as four datas set of 20^{0} each from four cardiac cycles and the datas set are merged to get full pyramid. During full volume acquisition mode the patient should hold the breath during expiration and the datas are collected from four cardiac cycle.

The full volume data can be analyzed later by cutting it from different direction and also by slicing. The entire mitral valve, the orifice and the surface of mitral valve can be analyzed from the left artial side or left ventricular side by post processing. This again helps us to obtain an enface view or surgeon's view of the mitral valve. The mitral valve orifice can be measured and the splitting of mitral valve, extension of commissural splitting and any tear in the leaflet can be visualized. The full volume acquisition can also be performed in the color Doppler mode. The size of pyramid is 60^{0} x 90^{0} and it is obtained from seven cardiac cycles with the patient holding the breath in expiration. The full volume datas set can be post processed and we can clearly visualize the stenotic or regurgitation jets. In case of mitral regurgitation, the area of the mitral regurgitation can be directly measured from the narrowest portion of the color Doppler jet.

RESULTS

Our study group comprised thirty consecutive patients with rheumatic mitral valve stenosis. There were eighteen male and twelve female patients with the mean age of 32.3 ± 8.6 years (range 22 to 42 years). Mitral stenosis was the predominant valvular lesion in all patients. In the pre-BMV period, fourteen patients had associated mild mitral regurgitation, whereas two patients had associated mild aortic regurgitation. None of the patients showed aortic stenosis. Regarding the analysis of the tricuspid valve, none of the patients showed tricuspid stenosis, but 23 showed tricuspid regurgitation. Systolic and diastolic left ventricular diameters from the parasternal approach were 42 ± 6 and 32 ± 6mm. All patients were in normal sinus rhythm.

Regarding the BMV procedure, the size of the balloon was selected according to the body surface index. The mean body surface was 1.72 ± 0.16, the body mass surface index 27.28 ± 5.09 and accordingly the mean INOUE balloon used was 28.1 ± 1.20. No deep anesthesia was used for the BMV.

Their functional capacities were ranged between class II - class III according to New York Heart Association classification (NYHA). Left atrium diameter was 44.8 ± 3.1 mm. Mitral valve orifice areas were 0.7 ± 0.17 cm^{2}. Mitral valve pressure halftime varied between 325 ± 60ms. Mitral valve peak transvalvular gradient 24 ± 9.01 mmHg. Mitral valve mean transvalvular gradient 15.9 ± 5.21 mmHg.

EF slope ranged 21.8 ± 2.24 mm/sec. LVOT diameter was 1.9 ± 1 cm. Right ventricular diastolic diameter was 24 ± 2 mm. Aortic end systolic diameter 26 ± 3mm. The pulmonary artery systolic pressure 50.2 ± 19.04 mmHg. Mean Pulmonary artery pressure 38 ± 14.21 mmHg. Left atrial mean pressure 23.9 ± 4.96 mmHg. Right ventricle systolic pressure was 59.6 ± 17.98 mmHg. Right atrial mean pressure 7.2 ± 1.2 mmHg. Twenty one patients were noted to have mild mitral regurgitation. The Wilkins Score was 3 ± 2.

After the Balloon mitral valvotomy their functional capacity improved to NYHA class I. Left artial diameter decreased to 39.4 ± 2.6 mm. Mitral valve orifice increased to 1.45 ±0.21 cm^{2}. MVPHT decreased to 150 ± 20 ms. Mitral valve peak gradient decreased to 11.6 ± 2.86 mmHg. Mitral valve mean gradient reduced to 7.1 ± 2.4 mmHg. RV diastolic diameter was reduced in size 15 ± 2 mm. The mean pulmonary artery pressure decreased to 22.9 ± 9.6 mmHg. The right ventricular systolic pressure decreased to 35.0 ± 10.9 mmHg.

The Real Time 3D Echocardiogram showed well delineated commissural splitting and atrial puncture site. It also clearly visualized rupture of anterior mitral leaflet. Out of thirty patients, eight patients had bilateral commissural splitting. Fourteen patients showed unilateral splitting of commissure. RT3DE was able to identify asymmetrical splitting of commissures in five patients who had mild to moderate mitral regurgitation. Three patients had rupture of anterior mitral leaflet in addition to asymmetrical splitting of commissure which transthoracic. Echocardiogram had failed to visualize. One patient had two atrial septal puncture sites which were clearly visualized by RT3DE.

Table 3: Echocardiogaphic and haemodynamic characters in pre and post BMV

Parameters	Pre-BMV	Post-BMV	P-Value
NYHA	Class II- III	Class I	< 0.05
Left atrium diameter (mm)	44.8 ± 3.1	39.4 ± 2.6	< 0.05
Mitral valve orifice (cm^{2})	0.7 ± 0.17	1.45 ± 0.21	< 0.05
Mitral valve peak gradient (mmHg)	24.0 ± 9.01	11.6 ± 2.86	< 0.05
Mitral valve mean gradient (mmHg)	15.9 ± 5.21	7.1 ± 2.4	< 0.05
Pulmonary artery systolic pressure (mmHg)	59.2 ± 19.04	35.0 ± 10.9	< 0.05
Mean Pulmonary artery pressure (mmHg)	38.0 ± 14.21	22.9 ± 9.6	< 0.05
Left atrial mean pressure (mmHg)	23.9 ± 4.96	10.2 ± 2.82	< 0.05
RA mean pressure (mmHg)	7.2 ± 1.2	6.4 ± 0.96	< 0.05
RV systolic pressure (mmHg)	59.6 ± 17.98	35.2 ± 10.91	< 0.05
MVO Continuity equation (cm^{2})	0.65 ± 0.19	1.6 ± 0.18	< 0.05
MVO (cm^{2}) RT3DE	0.7 ± 0.17	1.45 ± 0.21	< 0.05

DISCUSSION

Percutaneous BMV is a safe, effective, less invasive alternative to surgery for selected patients with mitral stenosis. It has been shown to convey a similar improvement in hemodyanmics, valve area and symptoms for up to 2 years after the procedure as compared with open surgical commissurotomy[8]. It is, however, not without morbidity, the most serious being cardiac perforation, systemic emboli and the development regurgitation[9]. These potentially lethal complications can be minimized with the use of echocardiography. Doppler echocardiography has a clear and well-established role in evaluating patients with mitral stenosis who undergo BMV.

Transthoracic echocardiography is a standard screening tool that is used to assess the mitral valve and submitted apparatus in patients who are potential candidates for this procedure[10]. It has also been

used to monitor patients during BMV. Immediately before BMV, Tranthoracic echocardiography used to clearly visualize the left atrium, left atrial appendage and interatrial septum for the presence of thrombi, which are a potential source for systomic embolization during the procedure.

During valvuloplasty Tranthoracic echocardiography has been shown to be an invaluable aid in guiding the transseptal puncture by visualizing the 'Tenting' of the interatrial septum by the Brockendbrough needle.

Tranthoracic echocardiography is also useful in guiding the balloon catheter across the mitral valve and obtaining a quick and accurate assessment of the mitral valve area and the amount of mitral regurgitation. After valvuloplasy Tranthoracic echocardiography can assess the adequacy of the procedure and identify the presence, exact location and size of iatrogenic atrial septal defects. In this study we have shown the advantages of obtaining three-dimensional echocardiograpic reconstruction during BMV. This technique offers the ability to view the mitral valve from any cut-plane of the three-dimensional data set. By viewing the mitral valve from the perspective of looking up from the left ventricle, the mitral leaflets, commissures and mitral annulus were easily visualized en-face.

The two dimensional Tranthoracic echocardiography can accurately visualize a larger mitral valve orifice or an increase in the amount of mitral regurgitation. However it is often difficult and potentially inaccurate to mentally reconstruct a three-dimensional image from the two-dimensional echocardiographic images. Therefore, by comparing the initial three-dimensional reconstruction to the one obtained after the procedure, the extent of commissural splitting was easily evaluated and was shown to be related to the extent of improvement in mitral valve area with BMV. When the development of worsening of mitral insufficiency complicated BMV, leaflet tears were visualized in one patient. What three-dimensional reconstruction provides that is not obtainable from two-dimensonal echocardiography is the mechanism by which valve area increases, as well as the detection of leaflet tear.

The three-dimensional echocardiographic reconstructions correlate well with what is seen on pathologic specimens and direct visual inspection of the valves of patients who underwent. MV.Hogan et al [11]. analyzed pathologic specimens of mitral valves in 11 patients who underwent BMV and found that fracture of the commissural fusion was the fundamental mechanism for the success of the procedure. This was also described by Inoue et al[14]. Who where the first to describe the anatomic mechanism of successful BMV in patients undergoing open commissurotomy. Tears of the mitral valve leaflet were shown to be responsible for the development of mitral regurgitation secondary to balloon valvoplasty in three-fifths of mitral valves studied pathologically. BMV has become the procedure of choice in symptomatic patients when the stenotic mitral valve is not heavily calcified and mitral regurgitation is not significant because it is cost effective and safe. This technique may also be used in patients with less favourable anatomic feacturs, particualry in patients who are considered to be at high surgicla risk[15], such as pergnant women[16], very elderly patients with renal or malignant diseases. The results of BMV are equivalent to those of surgical, open commissurotomy and both give better results than closed commissurotomy[18].

Patients with Rheumatic mitral valve stenosis who require an intervention can be easily identified using non-invasive techniques and the results can be predicted by a careful pre-BMV Doppler echocardiographic evaluation. Before the BMV, the pressure gradient, the valvular area, and the severity of valvular regurgitation, can be used to ecaluate patients reliably. Prior to BMV ,Doppler echocardiographic estimation of MVA correlates well with invasive estimation[19]. Immediately following BMV, the PHT method has been shown to have a poor agrement with invasive data[20]. There are various reasons for this inaccuracy including; (1) the development of an atrial septal defect in many patients after BMV[20], and (2) the PHT method assumes that the left atrial and left ventricualr compliances remain stable[34]; this assumption is not valid in the immediate period following BMV because rapid changes in the left atrial pressure and left ventricular filling occur in this setting, affecting the compliance of both the left atrium and ventricle.

Compared to the PHT method, planimetry (2D or 3D) is not as dependent on haemodynamic variables (heart rate, cardiac index, cardiac rhythm, left ventricular systolic and diastoloic dysfunction, left ventricular and atrium compliance,left ventricular hypertrophy and concomitant valvular disease)[20] . Accrodingly, planimetry of MVA should be more accurate in the setting of PMV. Planimetry of mitral valve orifice using 2D echo is a valid method but has its own set of limitations, especially following vavuloplasty, when the mitral orifice becomes irregular and technically difficult to trace, particularly if calcium is present.

3D echo allows a different and superior evaluation of the mitral valve apparatus, improving the ability to obtain an accurate measurement of the MVA[20] . Restriction of the tips and chordae, during the evolution of the rheumatic mitral valve disease, effectively converts the mitral valve apparatus into a funnel with its restrictive mitral valve orifice being at the tips of the leaflets. Due to the variable geometry of the stenotic mitral valve orifice, correct plane orientation frequently becomes difficult.

Minor changes in depth and angle of the ultrasound beam leads to an overestimation of the MVA by anywhere from 63 % to 88%[17]. 3D echo has already been shown to be useful to optimise the result s and prevent the development of significnt mitral regurgitation during balloon mitral valuloplasty [18] . The use of the new transthoracic 3D matrix array probe that allows on-line 3D rendering, allows fast visualization of the mitral valve apparatus and the acquisition of en face views of the mitral valve from which the accurate measurements of the mitral valve area can be made.This image modality should be routinely used to both monitor the mitral BMV and obtain accurate MVA measurements.

In this study, RT3D was the most accurate echocardiographic technique for measuring MVA. Compared with PHT and 2D echo planimetry , RT3D echo had the best agreement when compared to the invasively derived MVA. Not only did this occur in the per-BMV period but also in the post –BMV period. Thus, our results show that RT3D is an accurate and practical non-invasive tool for measuring MV A in allclinical situations, including the immediate post-BMV period. Importantly, since manipulation of the RT3D echo probe is similar to other clinically used transthoracic 2D probes, sonographers do not need a long training period to be versatile with RTED image acqusiton [19]. We need to know, that although 3D echo provides a more accurate evaluation of the anatomy of the mitral vales, as with 2D echo, it is importantly influenced by the quality of the acoustic window . Needless to say that although the new equipment provides better resolution and image quality, a bad acoustic window will lead to a poor analysis of the patient.

CONCLUSIONS

Form the above study, We concluded that three-dimensional echocardiographic reconsturction of the mitral valve obtained by transthoracic echocardiography during BMV is the best , mostly acceptable noninvasive imaging technique that can more accurately visualize the mechanisms of successful BMV,as well as some of its complications. This can potentially be used to further guide and optimize the results of BMV by visualizing the extent of commissural splitting so that a maximal mitral valve area can be obtained safely. It may also help to prevent the development of significant mitral regurgitation during the procedure. Visualizing a small tear of the mitral valve leaflet associated with only minimal valvular regurgitation may prevent another balloon inflation that may worsen the tear and create more significant mitral regurgitation. Transthoracic RT3DE is a feasible and accurate technique for measuring MVA in patients with Rheumatic mitral

valve stenosis compared to the PHT method and 2D echo planimetry. RT3DE results have the best agreement with the invasively determined MVA, particularly in the immediate post- BMV period, where PHT is inaccurate.

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