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Review Article

Echocardiographic Features in Patient Rheumatic Mitral Stenosis

Nur Kaputrin Dwigustiningrum[1*], Anna Fuji Rahimah[2], Wella Karolina[2], Heny Martini[2]

[1]Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.
[2]Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.

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ABSTRACT

Rheumatic mitral stenosis (RMS) is a progressive valvular heart disease that can lead to significant morbidity and mortality, especially in developing countries. Echocardiography plays a crucial role in the diagnosis, assessment, and management of patients with RMS. This study aims to review the utility echocardiography feature in patient RMS. We discuss the key echocardiographic parameters used for assessment and severity of RMS, and associated valvular abnormalities. Additionally, we explore the role of multimodality imaging, such as transesophageal echocardiography in enhancing the diagnostic accuracy and therapeutic decision-making in RMS. A thorough understanding of echocardiographic findings in RMS is essential for clinicians involved in the care of these patients, as it aids in risk stratification, treatment planning, and monitoring of disease progression. Integrating echocardiography is a widely used non-invasive method for comprehensive assessment, monitoring disease progression and evaluating treatment efficacy, ensuring optimal management for patient with RMS.

1. Introduction

Rheumatic mitral stenosis is a cardiovascular condition characterized by the narrowing of the mitral valve opening due to rheumatic fever. It is a prevalent cause of heart disease in many developing countries. Echocardiography, a non-invasive imaging technique, plays a crucial role in assessing and screening patients with rheumatic mitral stenosis.[1] Echocardiography assessment allows healthcare professionals to evaluate the severity of mitral stenosis, assess associated complications, and determine the most appropriate management strategies. By utilizing ultrasound waves, echocardiography provides detailed information about the structure and function of the heart, enabling accurate diagnosis and effective treatment planning.[2]

Echocardiography various parameters are evaluated, including valve morphology, valve area, pressure gradients, and left atrial size. These measurements aid in determining the severity of mitral stenosis and assist in making informed decisions regarding treatment options, such as medical therapy, balloon valvuloplasty, or surgical intervention.[3] These findings aid in risk stratification and guide the management of patients with rheumatic mitral stenosis.[4] Additionally, Furthermore, echocardiographic follow-up allows for monitoring disease progression and evaluating treatment efficacy, ensuring optimal patient care.[5] The advantage during an echocardiographic examination real-time imaging, allowing healthcare providers to visualize blood flow across the mitral valve and detect any abnormalities, such as regurgitation or thrombus formation.

Echocardiography plays a vital role in the assessment and management of patients with rheumatic mitral stenosis. This non-invasive imaging modality provides valuable information regarding the severity of the condition, associated complications, and treatment options. By utilizing echocardiography, healthcare professionals can effectively manage patients with rheumatic mitral stenosis, leading to improved patient outcomes and quality of life.[6]

2. Discussion

Definition of Rheumatic Mitral Stenosis

Rheumatic heart disease (RHD) occurs as a consequence of acute rheumatic fever (ARF), which develops when the body's immune system reacts to an infection caused by Streptococcus pyogenes (group A Streptococcus bacteria), commonly known as a throat infection.[7] The mitral valve is the most frequently affected valve, followed by the aortic valve, tricuspid valve (TV), and rarely the pulmonary valve. Scarred or damaged mitral valves due to RHD undergo alterations in the endothelial cells, making them more susceptible to colonization by circulating bacteria on the valve surface. The survival of these adherent bacteria eventually leads to the formation of infected vegetation.[8]

The development of RHD after ARF episodes is not universal and depends on factors such as the presence, type, or severity of valvular disease. When RHD involves the mitral valve, it can lead to congestive heart failure due to mitral stenosis (MS) and mitral regurgitation (MR).

* Corresponding author at: Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.
E-mail address: kaputrin@gmail.com (N.K. Dwigustiningrum).

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In some cases, the aortic valve may also be affected.[7] MS is characterized by a narrowing of the valve orifice, leading to obstruction of blood flow to the left ventricle, and it is most commonly caused by rheumatic fever.[8]

Epidemiology of Rheumatic Mitral Stenosis

Rheumatic Mitral Stenosis presents a significant global health burden, affecting approximately 33 million people worldwide, with the majority of cases (80%) found in low- and middle-income countries (LMICs). It is responsible for about 275,000 deaths annually, with 95% occurring in LMICs. Among the complications associated with Rheumatic Mitral Stenosis, Atrial Fibrillation (AF) stands out as a major cause of morbidity and mortality in affected patients.[9]

The results of a recent meta-analysis by Noubiap et al showed that the prevalence of AF in rheumatic mitral stenosis was 32.8%, with the most severe valve abnormality rate being the mitral valve compared to the aortic valve (30.4% vs 6.3%). The frequency of AF is higher in mixed mitral valve disease than isolated stenosis or isolated regurgitation.[9] In Indonesia, there is still no definite prevalence data. Although it is estimated that the number of mitral stenosis is still large, data at Moehammad Hoesin Hospital Palembang for five years (1990-1994) shows that 13.94% of cases are related to heart valve disease. Rheumatic mitral stenosis appears to be more common in women, with the majority of cases at Dr. M. Djamil Padang in 2012-2016 occurred in women (72.3%).[4]

Anatomic and Pathophysiology of Mitral Valve

The mitral complex, which consists of the mitral annulus, mitral leaflets, chordae tendineae, and the LV wall with papillary muscles, [4] plays a crucial role in the left side of the cardiac system, from the left atrium to the left ventricle. The main hemodynamic abnormality in mitral stenosis is the obstruction of left ventricular inflow at the level of the mitral valve level due to limited mitral valve opening caused by abnormal mitral valve apparatus. This leads to increase pressure of left atrial, LA remodeling, and elevated pressure of pulmonary venous, resulting in symptoms like dyspnea and hemoptysis, as well as elevation pressure of pulmonary artery pressure elevation. In severe cases, pulmonary edema may occur when pulmonary venous pressure exceeds plasma oncotic pressure. Chronic pulmonary arterial hypertension may develop due to changes in the pulmonary arterioles, leading to dysfunction of right ventricular and congestive heart failure.[10]

The commissures, cusps, chordae, or a mix of these structures are only a few of the mitral valve apparatus components that might be abnormally affected by mitral stenosis. The rheumatic process causes commissural thickening and fusion, which limits leaflet movement and causes the mitral opening to become narrowing in shape. The subvalvular apparatus is frequently involved, and the mitral chordae can fuse, shorten, fibrosis, and calcify, which can cause mitral regurgitation. Streptococcal M proteins share epitopes with myosin and valve endothelium, and this molecular mimicry is thought to have a role in the development of rheumatic carditis. Cross-reactive antibodies that result cause the valve to be damaged, and turbulant blood flow via the stenotic valve adds to its thickening and calcification.[10]

Rheumatic carditis affects the mitral and other heart valves as well as the myocardium. Isolated mitral stenosis occurs in about a quarter to forty percent of patients, with as many as forty percent experiencing mitral stenosis and mitral regurgitation. The aortic and tricuspid valves may be involved in up to twenty-five percent of patients with rheumatic carditis, and left ventricular dysfunction may occur due to myocardial involvement directly or valvular dysfunction.[10]

Clinical Presentation and Diagnostic Challenges

An accurate and comprehensive examination involved the patient's medical history, symptoms, and physical examination (including auscultation) is essential in diagnosing rheumatic mitral stenosis (RMS). Typically, exertional dyspnea is the initial symptom, which progressively worsens as the valve damage advances. Heart failure symptoms develop over time as the valve lesions progress. Due to the gradual nature of the disease, some patients may not recognize their symptoms, especially in endemic regions where advanced valve damage can occur at a younger age. While some patients may be diagnosed after experiencing an episode of acute rheumatic fever (ARF), others, particularly in low- and middle-income countries (LMICs), may present without any prior symptoms or memory of ARF. The diagnosis of RMS is often made during clinical examination, where pathological heart murmurs are detected. In some cases, the first signs of RMS may appear during pregnancy or after complications like acute heart failure, atrial arrhythmia, embolic events, or infective endocarditis (IE). Most patients exhibit heart failure symptoms at the time of diagnosis, often detected through pathological heart murmurs during auscultation.[2]

Electrocardiography and chest radiographs are valuable initial assessment tools, revealing signs of left atrial or left ventricular enlargement and ventricular strain. More severe cases may show atrial fibrillation. Chest radiographs may also indicate an enlarged left atrium or left ventricle and signs of pulmonary venous congestion in advanced stages.[2]

Echocardiography plays a significant role in evaluating valve anatomy and hemodynamic consequences in RMS patients, eliminating the need for invasive catheterization procedures. Various echocardiographic screening methods can determine the severity of MS, guiding further management decisions, including medical therapy or the timing and type of intervention, based on prognostic factors and clinical findings.[4]

Echocardiographic Assessment of Rheumatic Mitral Stenosis

Table 1A. Anatomic/Morphological Parameters in the Echocardiographic Assessment of Mitral Stenosis.[3]

Valvular Findings	Associated Finding
• Extent and pattern of commissural fusion	• Left atrial size
• Degree and extent of valve thickening and calcification	• Presence of thrombi and/or spontaneous echo contrast (“smoke”) in the left atrium and/or appendage
• Degree of subvalvular abnormalities	• Right ventricular and atrial size
• Severity of valve narrowing (valve area and transvalvular gradient)	• Other co-existent abnormalities (e.g. multivalvular disease)

Table 1B. Classification of Mitral Stenosis Severity.[3]

	Progressive		
	Mild	Moderate	Severe
Valve area (cm²)	>2.5	2.5-1.6	≤1.5
Pressure half-time (miliseconds)	<100	100-149	≥150
Mean gradient (mmHg)	<5	5-9	≥10
Systolic pulmonary artery pressure (mmHg)	<30	30-49	≥50

As an initial assessment of somebody with known or suspected RMS, a thorough Transthoracic Echocardiogram (TTE) with 2-dimensional (2D) imaging and Doppler interrogation is the standard diagnostic procedure. The TTE offers important supplementary information, such as an evaluation of other valve lesions and the effect of the valve obstruction on heart chambers and extraordinary vessels.

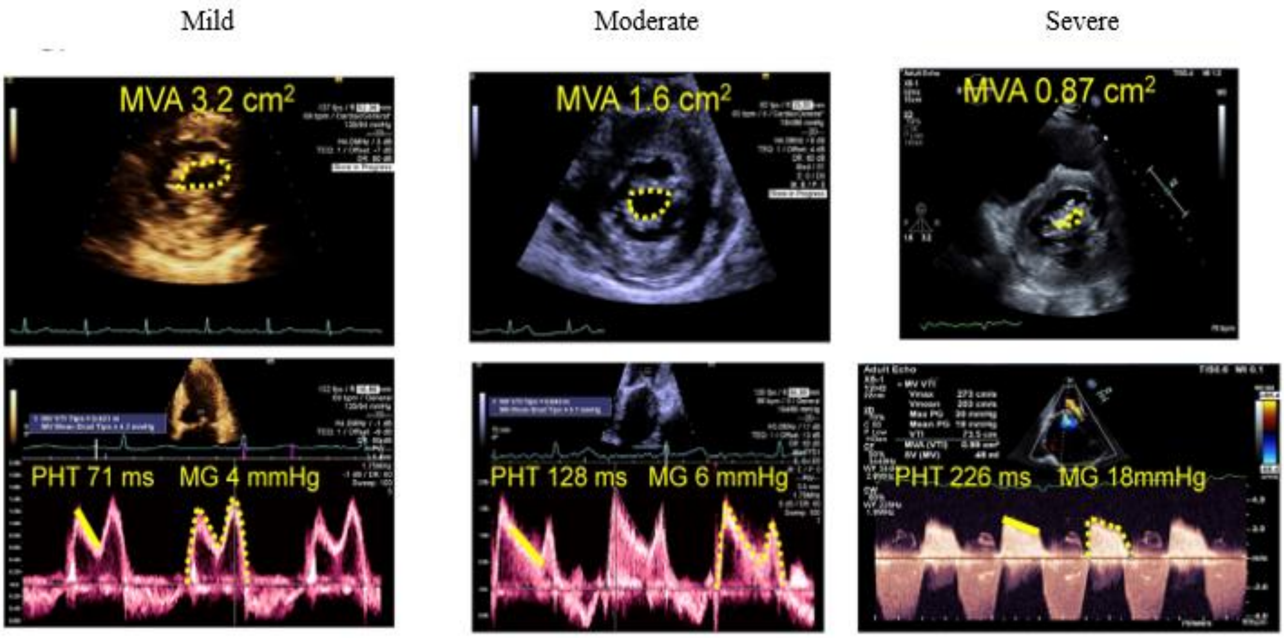

Figure 1. Stages of mitral stenosis by echocardiographic parameters. MVA, Mitral Valve Area; PHT, Pressure Half-Time; MG, Mean Gradient

Through TTE, it is possible to accurately assess the anatomy, etiology, co-occurring valve illness, and related anomalies including aortic dilatation. Due to the intrinsic measurement variability for these parameters, which is present in the linear dimensions, 2D and 3D volumes, and ejection fraction (LVEF) of the left ventricle (LV), it is crucial to take successive studies into account for sound conclusions. Doppler echocardiography provides a painless and precise.[8]

A comprehensive evaluation of valve morphology and related anomalies is necessary for anatomic evaluation of MS (Table 1A). The anterior mitral leaflet develops a distinctive "hockey-stick" or "doming" appearance during diastole as a result of the rheumatic involvement of the MV, which also manifests specific morphological features such as commissural fusion, leaflet thickening (with or without calcification), restricted leaflet motion, and chordal thickening and shortening. (Figure 2).[3]

Two-dimensional (2D) and three-dimensional (3D) echocardiography can be used from different view to assess the thickness and calcification of the mitral leaflets. While the restricted motion of the posterior mitral leaflet and commissural fusion, the primary obstruction mechanism, are best understood in short-axis orientations, showing a small central oval orifice with a distinctive "fish-mouth" appearance, diastolic doming of the anterior leaflet is best seen in long-axis views.[3]

Due to MV thickening and commissural fusion, the mitral valve area (MVA) is gradually decreasing. A common symptom of chronic severe mitral stenosis (MS) is calcification of the annulus and valve. MVA is a significant indicator of severity, with values greater than 2.5 cm^2 indicating asymptomatic patients, MVA between 1.5 and 2.5 cm^2 suggesting mild symptoms, and MVA less than 1.5 cm^2 indicating severe MS (table 1B). However, due to the progressive nature of MS, no single index value should be used to determine the severity of the disease. To take into consideration the anatomic and hemodynamic effects of MS, a thorough assessment of MS severity should use a multi-parametric approach that takes into account valve area, pressure half-time (PHT), transmitral mean pressure gradient, and pulmonary pressures.[3]

If a rheumatic process can be established in cases where the diagnosis of rheumatic MS is unclear by verifying commissural fusion in the parasternal short-axis view. Commissural fusion is a distinctive hallmark of rheumatic MS. It's crucial to distinguish between annular calcification and rheumatic MS since the former rarely results in considerable stenosis unless the calcification extensively affects the leaflets' basal regions, whilst the latter mostly affects the leaflets' tips and margins. It is advised to average at least five measurements for individuals with atrial fibrillation (AF) and irregular heartbeats in order to precisely determine pressure gradients and valve area while avoiding severe cycle lengths.[3]

Echocardiography-Guided Therapeutic Decision-Making

Echocardiography plays a crucial role in the evaluation of mitral valve (MV) anatomy, helping to identify the most suitable treatment option for patients. It allows for the assessment of various morphological features, including leaflet mobility, thickness, calcification, subvalvular fusion, and commissural fusion. Different scoring systems are utilized to describe the extent of MV disease, evaluate eligibility for balloon mitral valvuloplasty (BMV), and predict the success and potential complications following the procedure. While no individual scoring system has proven to be superior to others, the Wilkins score, also known as the "splitability score," is widely used and validated. This score assesses parameters such as leaflet thickness, leaflet calcification, leaflet mobility, and subvalvular apparatus involvement on a 1 to 4 scale, with a maximum total score of 16. An inverse relationship exists between the total splitability score and BMV success, with a cutoff of <8 indicating better short and long-term results.[11] This indicates that a mitral valve with a sufficiently pliable score is more likely to respond well to balloon dilatation.[14] While the The Wilkins score has been widely used because of its simplicity and predictability of patients with a successful versus unsuccessful outcome based on increased valve area, but it has limitations. Assessment of individual components remains semi-quantitative and adjusts for observer subjectivity, making it less reliable in classifying patients with scores in the middle range. Moreover, the Wilkins score does not assess commissure morphology, and consequently, is not successful for evaluating postprocedural mitral regurgitation (MR), which is an important predictor of long-term outcome. [12]

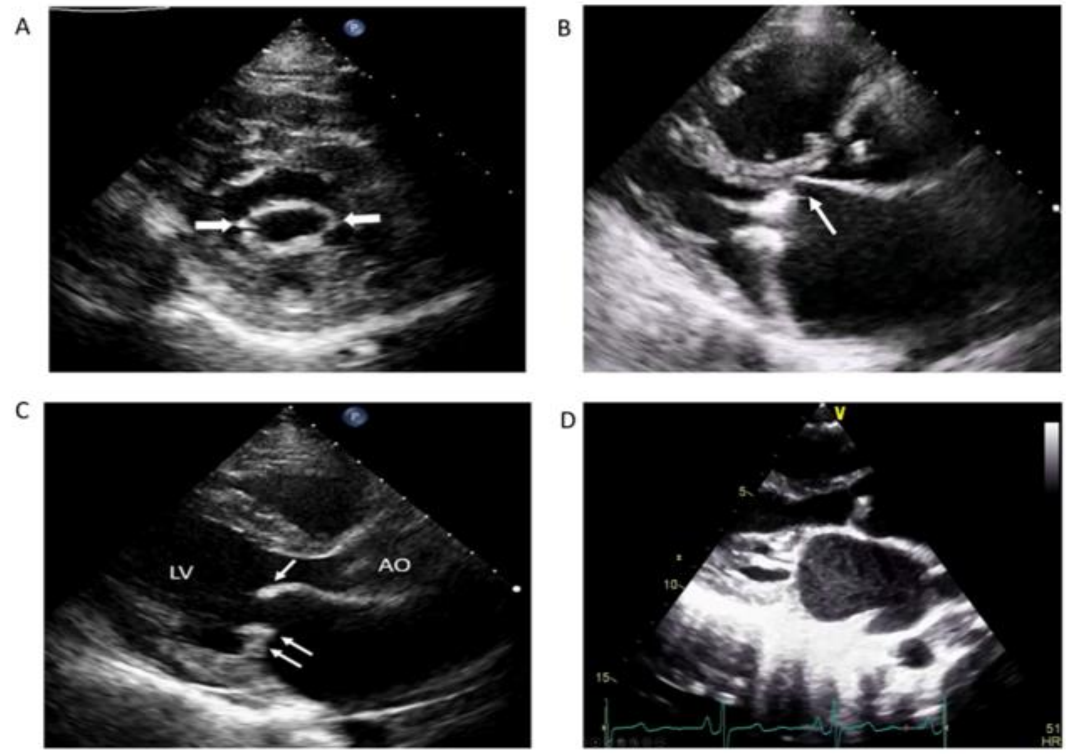

Figure 2. 2D echocardiography findings of MS. (A) Bi-comissural fusion (arrows) of a rheumatic valve in parasternak short-axis view. (B) Thickened and calcified mitral valve leaflets seen in parasternal long-axis view, with diastolic doming of the anterior leaflet (arrow). (C) Thickenend and doming mitrala nterior leaflet (single white arrow) and restricted motion odf posterior leaflet (double arrows) in parasternal long-axis view. (D) Chordal thickening and calcification seen in parasternal long-axis view.

Commissural calcification has been found to be a strong indicator of unfavorable results and severe MR after BMV. In order to predict patient outcomes after BMV, it is advised to employ a commissure score based on commissural morphology as a supplement to the Wilkins score. In contrast to calcified commissures that are resistant to splitting, highly fused, non-calcified commissures are more likely to split when given a high score. Echocardiography also enables the assessment of other valves and the determination of hemodynamic severity in coexisting lesions. BMV is not contraindicated in the presence of aortic regurgitation (AR) grade 2 or less and haemodynamically insignificant aortic stenosis (AS).

Similar to considerable tricuspid valve regurgitation (TR), which is often attributable to right ventricular and tricuspid annular dilatation brought on by chronic pulmonary hypertension (PH), severe TR is frequently seen in patients with severe MS. Although the existence of such a functional TR is not a contraindication for BMV, it is a crucial technical factor, especially in situations where the RA is dilated.[11]

The management of rheumatic mitral stenosis is shown in Figure 3. Echocardiographic imaging plays a crucial role in excluding contraindications to balloon mitral valvuloplasty (BMV).[11] Aortic valve disease, severe combined tricuspid stenosis and regurgitation requiring surgery, left atrial thrombus, more than mild mitral regurgitation (MR), severe or bi-commissural calcification, absence of commissural fusion, and significant concomitant aortic valve disease may all contraindicate BMV. Concomitant coronary artery disease (CAD) may also require bypass surgery.[13]

Table 2. Assessment of mitral valve anatomy according to the Wilkins score.[12]

Grade	Mobility	Thickening	Calcification	Subvalvular thickening
1	Highly mobile valve with only leaflet tips restricted	Leaflet near normal in thickness (4-5 mm)	A single area of increased echo brightness	Minimal thickening just below the mitral leaflets
2	Leaflet mid and base	Midleaflets normal, considerable thickening of margins (5-8 mm)	Scattered areas of brightness confined to leaflet margins	Thickening of chordal structures extending to one-third of the chordal length
3	Valve continues to move forward in diastole, mainly from the base	Thickening extending through the entire leaflet (5-8 mm)	Brightness extending into the mid-portions of the leaflets	Thinckening extended to distal third of the chords
4	No or minimal forward movement of the leaflets in diastole	Considerable thickening of all leaflet leaflet tissue (>8-10 mm)	Extensive brightness throughout much of the leaflet tissue	Extensive thickening and shortening of all chordal structures extending down to the papillary muscles

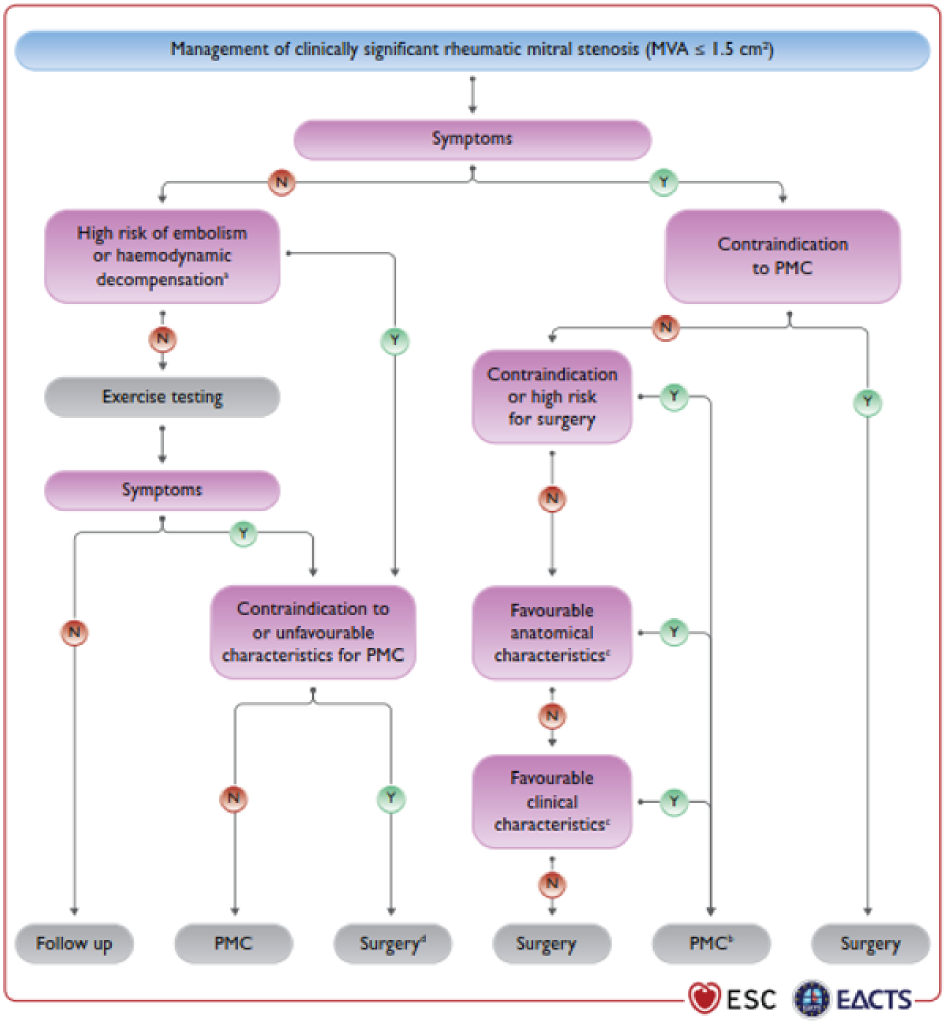

Figure 3. Management of clinically significant rheumatic mitral stenosis (MVA ≤1.5 cm^2). AF = atrial fibrillation; LA = left atrium/left atrial; MVA = mitral valve area; NCS = non-cardiac surgery; PMC = Percutaneus mitral commissurotomy. [a]High thromboembolic risk: history of systemic embolism, dense spontaneus contrast in the LA, new-onset AF. High-risk of haemodynamic decompensation: systolic pulmonary pressure > 50 mmHg at rest, need for major NCS, desire for pregnancy. [b]Surgical commisurotomy may be considered by experienced surgical teams in patients with contraindications to PMC. [c]See recommendation on indications for PMC and mitral valve surgery in clinically significant mitral stenosis. [d]Surgery if symptoms occur for a low level of exercise and operative risk is low

Echocardiographic Guidance during Percutaneous Balloon Mitral Valvuloplasty (PBMV)

PBMV is considered a safe and effective treatment option for selected symptomatic patients with RMS. The pathogenesis of RMS, caused by rheumatic fever, leads to commissural fusion of the mitral valve, resulting in narrowing of the valve orifice and obstruction. To be effective, requires the presence of commissural fusion.[14] The procedure is typically guided by fluoroscopy and angiography; however, these imaging techniques have limitations, such as radiation exposure, two-dimensional projection of a three-dimensional organ, lack of accurate tissue differentiation, and the use of radiographic contrast agents. In contrast, echocardiography offers unique characteristics that make it an ideal technique for guiding percutaneous catheter-based procedures.[15]

Echocardiography's portability, real-time imaging, and accurate assessment of the target structure's anatomy and physiology make it well-suited for PBMV. Three-dimensional echocardiography is also used to provide accurate procedural guidance, early detection of problems, and close post-procedure patient follow-up, all of which contribute to a positive outcome.[15] The role of transesophageal echocardiography (TEE) in patients undergoing PBMV has expanded beyond its initial evaluation of left atrial thrombus to serve as an additional guiding tool during the procedure. TEE assists with septal puncture, early result evaluation, and complication detection, ultimately reducing the rate of complications resulting from transseptal catheterization and balloon valvuloplasty, as well as procedure and fluoroscopy times. Seong-Hoon Park et al reported transesophageal echocardiography (TEE) can be used effectively during balloon mitral valvuloplasty, and it may help to reduce the rate of complications resulting from transseptal catheterization and balloon valvuloplasty and to reduce procedure time and fluoroscopy time.[16] Yao Liu et al reported that PBMV could be successfully performed under only echocardiography guidance and appeared safe and effective while avoiding radiation and contrast agent use.[17] In some cases, interventionalists may find the multiple imaging planes of two-dimensional TEE unfamiliar, leading to potential misinterpretation. Three-dimensional images obtained with real-time three-dimensional TEE can resolve these misunderstandings due to their similarity to real anatomy, making them easier for interventional cardiologists to recognize.[15] Research has shown that three-dimensional echocardiography provides better accuracy and agreement with invasively determined mitral valve area (MVA) compared to conventional two-dimensional planimetry and is superior in assessing commissural opening.[14]

Transseptal (TS) puncture of the interatrial septum (IAS) is a common first step in several left-side percutaneous procedures, including PBMV. In patients with dilated atria or atypical IAS morphology, TEE or intracardiac echo guidance is especially beneficial. The optimal TS puncture site is in the posterior, more inferior portion of the fossa ovalis. The mid-esophageal short axis view at the level of the aortic valve (30°–60°) and the bicaval view (90°–110°) are the TEE views that are advised.[15] Particularly for patients with dilated atria or unusual interatrial septum (IAS) morphology, like a large atrial septal aneurysm, past IAS surgery, distortion from scoliosis, or previous pneumectomy, TEE or intracardiac echo guidance may be helpful. On TEE, a tent-like depression of the IAS can be used to identify the needle tip used for transseptal (TS) puncture. The anterior-posterior orientation is achieved with a short-axis view at the base (30°-45°), the superior-inferior orientation is observed on a long-axis view (90°-100°), and the height above the valve is best visualized in the 4-chamber view (0°). By simultaneously displaying anterior-posterior and superior-inferior orientations, X-plane imaging makes TS piercing easier. The PMBV catheter and balloon are placed across the mitral valve leaflets following TS puncture.[14]

It is important to evaluate potential complications including pericardial effusion and left-to-right shunt through the artificial atrial septal defect (ASD) caused by the TS puncture. Due to factors such atrial compliance, the existence of a newly generated ASD, and changes in hemodynamics affecting this measurement, the pressure half-time method for determining MVA becomes unreliable after PBMV.[14]

Successful PBMV is typically defined as an MVA of 1.5 cm^2 or more, or 1.0 cm^2 or more with MR (mitral regurgitation) 2+ or less, and the absence of complications. Several clinical, morphological, and hemodynamic parameters have been identified as predictors of outcome after PMBV. Predictors of outcome after PMBV are listed in Table 3, encompassing various clinical, morphological, and hemodynamic parameters. The peri-interventional role of echocardiography is summarized in Table 3.[14]

Table 3. Role of Echocardiography during Percutaneous Balloon Mitral Valve

Reassessment of mitral valve pathology before the procesure (MS and MR) and identification of contraindication
Guidance of transseptal puncture
Optimazation of transseptal puncture
Assessment of residual MS after PBMV
Assessment of MR severity after PBMV
Assessment of complication

Echocardiographic for Long-term Monitoring and Follow-up Strategies

Asymptomatic patient with RMS

Transthoracic echocardiography (TTE) and regular exams are essential monitoring of asymptomatic patients with rheumatic mitral stenosis (RMS). The purpose of follow-up is to prevent the severe RMS's irreversible effects, which can impact the ventricles and pulmonary circulation in particularly, which can develop without apparent symptoms. These individuals should have history and physical exams at least once a year. The type and severity of the valve lesion, the known pace of progression of the particular valve lesion, and its effects on the affected ventricle all affect how frequently 2D and Doppler echocardiography is repeated. For individuals with mild regurgitation who exhibit no changes during a 10- to 15-year period, the interval between follow-ups may be extended. The beginning of symptoms or any changes noticed during the physical examination should raise concerns about the cardiac response to the valve lesion in addition to routine periodic imaging, prompting a repeat TTE for additional investigation.[18]

Table 4. Frequency of Echocardiograms in Asymptomatic Patients with VHD and Normal LV Function.[11]

Stage	Mitral Stenosis
Progressive (Stage B)	Every 3-5y (MV are >1.5 cm^2)
Severe symptomatic (Stage C)	Every 1-2y (MV area 1.0-1.5 cm^2) Every year (MV area <1.0 cm^2)

Patients after underwent BMV

The most important parameter for predicting the success of balloon mitral valvuloplasty procedure is the improvement in mitral valve area. Various surrogate echocardiographic parameters have been proposed and validated against mitral valve area to assess the severity of mitral stenosis. The mitral valve area can be measured using planimetry, pressure half-time, continuity equation, and proximal isovelocity surface area methods. Several echocardiographic parameters are available to predict successful of BMV.[19]

After the procedure, mean Doppler gradients and planimetry are used in two-dimensional (2D) echocardiography to evaluate the post-procedure mitral valve area. MR severity and location are assessed by three-dimensional (3D) echocardiography, if it is available, to assess commissural opening. Echocardiography is also performed to find any residual atrial level shunts. Periodic checking of pulmonary artery pressures is essential after successful BMV, particularly in younger individuals, as it leads to a significant regression of pulmonary hypertension. BMV is a palliative treatment, and that all patients should have an echocardiogram within a year or earlier (if the findings are less than optimum). This follow-up is intended to keep an eye on any changes to the hemodynamics of the valves, the progression of lesions in other valves, the regression of pulmonary hypertension and tricuspid regurgitation, and mitral regurgitation (MR).[11]

Real-time 3D echocardiography has shown superior accuracy and agreement with invasively determined mitral valve area (MVA) compared to conventional 2D planimetry. Furthermore, real-time 3D echocardiography offers clearly view of the commissural opening, a strong predictor of long-term outcomes, linked to a larger MVA, lower gradients, and better functional outcomes. It is important to consider that measures of MVA and gradients made immediately following a procedure might be different from those made later, after left atrial remodeling and changes in left atrial wall compliance. Mitral gradients are also affected by changes in heart rate, thus it's important to carefully interpret comparative findings with this in mind. Left atrial pressure, mean mitral gradient, and pulmonary artery systolic pressure all markedly drop after percutaneous balloon mitral valvuloplasty (PBMV), and mitral valve area increases in line with these changes.[11]

Multimodality Imaging of Rheumatic Mitral Stenosis

Role of Transesophageal Echocardiography (TEE)

When patients have inadequate transthoracic acoustic windows, transesophageal echocardiography (TEE) is an essential tool for assessing mitral stenosis (MS). It is especially helpful to rule out thrombi in the left atrium (LA) and/or LA appendage and to evaluate the morphology of the mitral valve (MV) before to PBMV. Transthoracic echocardiography (TEE), with or without 3D capability, offers better visualization of morphological abnormalities. 3D TEE is especially valuable for evaluating commissural fusion and MV area by planimetry. By displaying the complete delineation of the LA appendage and the anatomy of the interatrial septum, it aids in the planning of PBMV. Because of the young age and higher number of female patients who may have late diagnosis during pregnancy, using 3D TEE during PBMV promotes safe trans-septal puncture, appropriate balloon orientation, and minimizes or eliminates the requirement for radiation exposure.[20]

Role of Stress Echocardiography

When imaging results and symptoms do not correlate, stress echocardiography, utilizing exercise or dobutamine, is helpful to determine the hemodynamic severity of MS.[2] It is recommended for asymptomatic people with severe MS seen on echocardiography or for symptomatic patients with mild or moderate MS found on echocardiography. It enables medical professionals to assess the true hemodynamic load of MS.[20] The increase in heart rate and cardiac output brought on by stress allows us to assess the hemodynamic behavior of the valvular blockage and its effects on the pulmonary circulation. By identifying any differences between resting echocardiographic data and symptoms, it also helps with risk classification in patients with moderate stenosis. Transmitral gradient, stroke volume, MVA, pulmonary artery systolic pressure (PASP), left ventricular (LV) and right ventricular (RV) function, and any changes in mitral regurgitation (MR) are a few of the echocardiographic measurements that need to be made during a stress test. Exertional dyspnea caused by the hemodynamic effects of MS may be explained by a rise in transmitral mean gradient of >15 mmHg with exercise or >18 mmHg with dobutamine infusion. This can help identify high-risk patients who might benefit from intervention. Another indicator of hemodynamically significant MS has been thought to be a stress-induced PASP >60 mmHg, although this indicator should be interpreted in the context of age and other diagnostic indices. Prognostic implications could also result from an early rise in PASP greater than 90% higher than its resting value.[2]

The measurement of pulmonary artery pressure during stress echocardiography (dobutamine or exercise) aids in determining the best course of treatment or additional measures. For determining MS severity and hemodynamic burden, exercise stress echocardiography, preferably performed while supine, is favored over pharmaceutical stress echocardiography. Exercise-induced symptom detection in asymptomatic patients with moderate-to-severe MS is one of its key applications. For individuals who are unable to exercise, dobutamine stress echocardiography is an option. Patients who have MV morphology that is favorable for PBMV and who are symptom-free but who have considerable objective limits on exercise may be candidates for PBMV. An MV area bigger than 1.5 cm2 with a transmitral mean gradient of more than 15 mm Hg and a pulmonary artery wedge pressure less than 25 mm Hg, or the pulmonary artery systolic pressure is greater than 60 mm Hg during exercise are requirements for considering PBMV.[20]

Cardiac Magnetic Resonance

If transthoracic echocardiography (TEE) is unfavorable or inconclusive, or if TEE is otherwise contraindicated, cardiac magnetic resonance (CMR) may be a helpful option. Restricted MV leaflets can be clearly seen on CMR, especially in the left ventricular outflow tract image. Strong correlation exists between the pressure half-time approach and direct planimetric assessment of the stenotic orifice area by CMR. On the basis of intrinsic tissue properties and anatomic appearance, CMR also provides observation of the morphology and thrombus of the LA appendage. Using phase-contrast imaging, one may determine MVA, pressure half-time, and velocities. Due to the low temporal precision of CMR, which could result in an underestimation of peak velocities, it does, however, require careful performance. Measurement of RV and LA remodeling as well as LA fibrosis detection are both possible with CMR. If both echocardiography and multi-detector computed tomography (MDCT) are inconclusive, CMR is considered the third-choice imaging modality.[20]

Invasive Assessment

When there is a mismatch between clinical complaints and echocardiographic findings, or as part of a planned catheter intervention, invasive examination may be required. In addition to information acquired from non-invasive testing, catheterization gives precise estimates of left atrial pressures (measured as pulmonary capillary wedge pressure), ventricular filling pressures, and cardiac output that can be used to help create a treatment plan. Patients with severe RMS and adequate valve morphology most frequently undergo PBMV, which has substantial advantages for them.[8]

Management Patient with RMS

Medical Management

When evaluating patients with Rheumatic Mitral Stenosis, it is crucial not to neglect standard guideline-directed medical therapy (GDMT) for cardiac risk factors such as hypertension, diabetes mellitus, and hyperlipidemia. Patients with Rheumatic Mitral Stenosis should adhere to heart-healthy lifestyle factors, which include regular exercise, a healthy diet, avoiding smoking, and maintaining a normal body weight, similar to the general population. If it is not possible or declined, the patient should continue with GDMT (Guideline-Directed Medical Therapy) for left ventricular systolic dysfunction. This includes medications like diuretics, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), beta-blockers, aldosterone antagonists, and/or sacubitril/valsartan. Biventricular pacing should also be considered as indicated in heart failure guidelines. Avoid abruptly reducing blood pressure when there are stenotic valve lesions. Additionally, appropriate patient groups should receive prophylaxis for rheumatic fever and infective endocarditis (IE). Maintaining optimal oral health is of utmost importance in preventing IE. Patients with valvular heart disease should also follow standard recommendations for influenza and pneumococcal vaccinations.[18]

Since medicine therapy has not been proven to be effective in slowing the disease's progression, the main goal of treatment is to cure underlying heart failure and left ventricular dysfunction in order to reduce symptoms. Patients with rheumatic heart disease frequently have atrial fibrillation (AF), which is a substantial source of morbidity and mortality. For AF patients, anticoagulation is advised to lower their risk of cardioembolic events. Although oral Vitamin K antagonists are the recommended treatment, both patients and healthcare professionals must deal with a number of difficulties with them.[21]

Interventional Management

Evidence on balloon mitral valvuloplasty (BMV) for Rheumatic Heart Disease continues to grow, and indications have expanded considerably over the past decade, now encompassing challenging and unfavorable mitral valve involvement. Percutaneous valve interventions are continuously evolving worldwide, with transcatheter aortic valve implantation being a notable example for aortic stenosis treatment. This success has sparked interest in using percutaneous valve interventions as a viable treatment option for both aortic and mitral diseases, including repeated interventions, which are common in Rheumatic Heart Disease.[21]

Patients with severe valvular heart disease (VHD) are typically the only ones who can benefit from surgical and transcatheter treatments. However, for patients at risk of Rheumatic Mitral Stenosis (RMS) or those with mild to moderate valve dysfunction, other essential aspects of management are equally important. These include accurate diagnosis, patient education, regular observation, and medical treatment. The presence of symptoms, the severity of RMS, the response of the left ventricle (LV) and/or right ventricle (RV) to volume or pressure overload caused by RMS, and the impact on the pulmonary or systemic circulation all play a role in the decision to intervene and the frequency of monitoring. Improved symptoms, longer survival, and reduced risk of consequences from RMS, including irreversible ventricular dysfunction, pulmonary hypertension, stroke, and atrial fibrillation (AF), are the ultimate goals of valvular intervention. Regular monitoring and early intervention when necessary can have a significant impact on the long-term outcomes and quality of life for patients with Rheumatic Mitral Stenosis.[18]

3. Conclusion

Rheumatic mitral stenosis is a condition where the mitral valve becomes narrowed due to scarring and fusion of the valve leaflets, resulting from rheumatic fever. Echocardiography assessment plays a crucial role in patients with rheumatic mitral stenosis. Echocardiography, specifically transthoracic echocardiography (TTE), is a non-invasive imaging technique that provides detailed information about the structure of anatomic and hemodynamic of the affected valve lesion including the assessment and severity of rheumatic mitral valve stenosis. Echocardiography can also guided therapeutic decision-making, intraprocedural echocardiographic guidance during catheter-based and long-term monitoring and follow up strategies. Many echocardiographic parameters for predicting successful of BMV are available. By combining these echocardiographic findings, clinicians can determine the severity of mitral stenosis, guide treatment decisions, and monitor disease progression. Echocardiography is a valuable tool in the diagnosis, and management of patients with rheumatic mitral stenosis, providing essential information for appropriate patient care and intervention.

4. Declaration

4.1 Ethics Approval and Consent to participate
Not applicable.

4.2. Consent for publication
Not applicable.

4.3 Availibility of data and materials
Data used in our study were presented in the main text.

4.4 Competing interests
Not applicable.

4.5 Funding Source
Not applicable.

4.6 Authors contributions
Idea/concept: NKD. Design: NKD. Control/supervision: AF, WK, HM. Data collection/processing: NKD. Analysis/interpretation: NKD, AF. Literature review: NKD. Writing the article: NKD. Critical review: AF, WK, HM. All authors have critically reviewed and approved the final draft and are possible for the content and similarity index of the manuscript.

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