

## Characterization of Heart Valves in Rheumatic Heart Disease Patient Using Echocardiography

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## Abstract

## Original Research Article

We aimed to evaluate the valves of the heart and the severity of valvular lesion in rheumatic heart disease patients using echocardiography to help patients treat the disease. A retrospective descriptive and analytic study including 60 consecutive patients (44 males and 16 females, with a mean age of 40 years) was conducted by evaluating a total of 60 echocardiography examinations of the heart. Tests were performed with a direct adhesion technology with convex and sector transducers with frequency ranges between 2 to 4 MH. The results show a high frequency of degenerative valve diseases like mixed valve disease, isolated mitral stenosis, isolated aortic regurgitation, and aortic stenosis. This study concluded that the valvular changes in Rheumatic heart disease are detectable by conventional ultrasound only in very advanced stages of the disease. The study recommended using echocardiography routinely in the diagnosis and treatment units of rheumatic heart disease and follow-up patients with rheumatic heart disease. It also suggested that the research could constitute a base for further research in this field.

**Keywords:** Rheumatic, Echocardiography, Heart valves.

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### 1.1. INTRODUCTION

Rheumatic heart disease is cardiac inflammation and scarring triggered by an autoimmune reaction to infection with group A streptococci [1]. This condition consists of pericarditis in the acute stage, involving inflammation of the myocardium, endocardium, and epicardium. Chronic disease is manifested by valvular fibrosis, resulting in stenosis and insufficiency [1].

Rheumatic fever is rare before age five and after 25 years; it is most frequently observed in children and adolescents. The highest incidence is observed in children aged 5-15 years and in underdeveloped or developing countries where antibiotics are not routinely dispensed for pharyngitis and low compliance [1]. The average annual incidence of acute rheumatic fever in children aged 5-15 years is 15.2 cases per 100,000 populations in Fiji [12] compared with 3.4 cases per 100,000 populations in New Zealand, [2] it less than 1 case per 100,000 populations in the United States. Although rheumatic fever was previously the most common cause of heart valve replacement or repair, this disease is currently relatively uncommon, trailing

behind the incidence of aortic stenosis due to degenerative calcific disease, bicuspid aortic valve disease, and mitral valve prolapse [2].

Etiology and Pathophysiology; rheumatic fever is a late inflammatory, non-suppurative complication of pharyngitis that is caused by group A-hemolytic streptococci. Rheumatic fever results from humoral and cellular-mediated immune responses occurring 1-3 weeks after the onset of streptococcal pharyngitis. Streptococcal proteins display molecular mimicry recognized by the immune system, especially bacterial M-proteins and human cardiac antigens such as myosin and valvular endothelium. Antimyosin antibody recognizes laminin; an extracellular matrix alpha-helix coiled protein, part of the valve basement membrane structure [3].

The valves most affected by rheumatic fever, in order, are the mitral, aortic, tricuspid, and pulmonary valves. In most cases, the mitral valve is involved with one or more of the other 3. In acute disease, small thrombi form along the lines of valve closure. In chronic illness, there is thickening and fibrosis of the

valve resulting in stenosis, or less commonly, regurgitation [4].

The acute involvement of the heart in rheumatic fever gives rise to pericarditis, with inflammation of the myocardium, pericardium, and endocardium. Carditis occurs in approximately 40-50% of patients on the first attack; however, the severity of acute carditis has been questioned. Pericarditis occurs in 5-10% of patients with rheumatic fever; isolated myocarditis is rare[5].

Genetic factors; familial studies of rheumatic heart disease suggest a vulnerable population with increased risk. Relationships between the development of rheumatic fever and human leukocyte antigen (HLA)-DR subtypes have been found[6, 7].

Clinical Features; acute rheumatic fever is a multisystem disease characterized by involvement of the heart, joints, central nervous system (CNS), subcutaneous tissues, and skin. Except for the heart, most of these organs are only mildly and transiently affected. The clinical diagnosis depends on criteria involving these systems as well as laboratory findings indicative of recent streptococcal infection, the so-called Jones criteria.<sup>[8]</sup> Rheumatic heart disease is the predominant cause of mitral stenosis. A history of rheumatic fever can be elicited from approximately 60% of patients presenting with pure mitral stenosis. (There is a 2:1 female-to-male incidence. In developed countries, the disease has a latent period of 20-40 years, with another period of almost a decade before symptoms require surgical intervention[8].

One significant limiting symptoms occur, there is a 0-15% 10-year survival rate without treatment. Severe pulmonary hypertension is a bad prognostic sign. The mean age of presentation in North America is in the fifth to sixth decade, and more than one-third of patients undergoing valve repair or replacement is older than 65 years[9]

Approximately one-fifth of patients with post rheumatic heart disease have pure insufficiency: 46% of patients have stenosis with insufficiency; 34%, pure stenosis; and 20%, pure insufficiency. Mitral insufficiency is more likely caused by floppy mitral valve, with ischemia and endocarditis other important causes [10].

Rheumatic heart disease usually results from cumulative damage from recurrent episodes of acute rheumatic fever. It has been reported that after the first episode of carditis, cardiac auscultation becomes unremarkable in one-third of children, but even these children may progress to significant rheumatic valve disease in later life, as confirmed by echocardiography. Thus early detection of “subclinical” rheumatic valve disease is vital, as it presents an opportunity for case

detection at a time when prophylactic penicillin – to prevent recurrent episodes – can prevent progression to important valve disease in young adult life [11]. Echocardiography is used to diagnose cardiovascular diseases. In fact, it is one of the most widely used diagnostic tests for heart disease. It can provide a wealth of helpful information, including the size and shape of the heart, its pumping capacity, and the location and extent of any damage to its tissues. It is especially useful for assessing diseases of the heart valves. It not only allows doctors to evaluate the heart valves, but it can detect abnormalities in the pattern of blood flow, such as the backward flow of blood through partly closed heart valves, known as regurgitation. By assessing the motion of the heart wall, echocardiography can help detect the presence and assess the severity of any wall ischemia that may be associated with coronary artery disease. Echocardiography also helps determine whether any chest pain or associated symptoms are related to heart disease. Echocardiography can also help detect any cardiomyopathy, such as well as others. The biggest advantage to echocardiography is that it is noninvasive (doesn't involve breaking the skin or entering body cavities) the Transthoracic echocardiogram. A standard echocardiogram is also known as a transthoracic echocardiogram (TTE), or cardiac ultrasound. In this case, the echocardiography transducer (or probe) is placed on the chest wall (or thorax) of the subject, and images are taken through the chest wall. This is a non-invasive, highly accurate, and quick assessment of the overall health of the heart [11].

Echocardiography has been shown to be helpful in detecting rheumatic heart disease in its early stages. Its use as screening provides the opportunity to initiate secondary antibiotic prophylaxis in case of “significant lesions,” as currently recommended by the World Health Organization expert committee. The follow-up of children with sub-clinical rheumatic heart disease should be instrumental in assessing the best strategy for prevention[11].

This study will provide an evaluation of the valves of the heart and the severity of valvular lesion in rheumatic heart disease patients using echocardiography to help patients in the treatment of the disease.

## 1.2. MATERIALS AND METHODS

Between October 2013 and April 2014, a retrospective study including 60 consecutive patients (44 males and 16 females with mean age of 40 years) was conducted by evaluating a total of 60 echocardiography examinations in the Ribat university hospital echocardiography department. The patients were screened and segregated into three groups according to the duration of RHD. Duration of < 5 years constituted group A and had 30 patients, group B duration was between 6-10 years and had 16 patients,

rest belonged to group C with duration > 15 years. The parameters which had been studied and compared were (1) patients highest and shape, (2) sonographically detected (a) mitral valve (Stenosis, Regurgitation, Atresia and Normal) and (b) tricuspid valve (Stenosis, Regurgitation, Atresia and Normal) (c) pulmonary valve (Stenosis, Regurgitation, Atresia and Normal) (d) aortic valve (Stenosis, Regurgitation, Atresia and Normal).

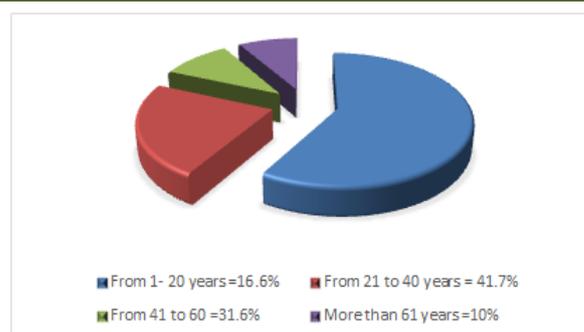
A cardiologist with five years of experience and a researcher in echocardiography departments completed the evaluation and recorded consensus findings. The patient who came to the echocardiography departments in several stages of RHD during the availability of the investigator to perform the examinations were included in the study. The examination was performed with both 2 and 4 MHz ultrasound units (Shimadzu SDU 2300, Toshiba vision-200, General Electric, and Siemens with, ) with a curved linear probe, in the left lateral decubitus position, with the left arm extended behind the head. For the subcostal view, the patient was placed in the recumbent position.

**Long Axis Parasternal:** The heart sits obliquely in the left chest with the apex pointing toward the left hip. To obtain the long parasternal view, the probe has been passing across the parasternal area in the third and fourth intercostal space.

**Short Axis Parasternal:** The short axis is in-plane ninety degrees from the long axis and points the probe toward 8 o'clock (mark on left) or the left shoulder. The short axis focuses on obtaining an image of the LV in a circular pattern and then angling through the various positions to interrogate the respective wall segments. Subxiphoid: A common approach to critically image the heart is the subxiphoid view. Unlike other cardiac views, this view is dependent on the left lobe of the liver as an acoustic window in the near field. Apical: On physical exam, the point of maximal intensity on the chest wall demarcates the cardiac apex. An ultrasound probe was placed lateral to the nipple line there and rotated between the three apical views (Apical four-chamber, apical two chambers, and apical long).

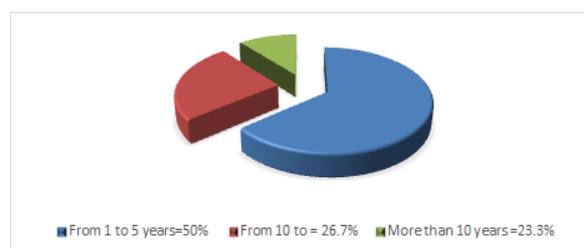
### 1.3. RESULTS AND DISCUSSION

Rheumatic heart disease does not impact everyone equally. Out of 60 cases, 44;72.8% were male, and 16;27.2% were female. This may be because gender compounds other aspects of inequality. There was some evidence to suggest that women were less likely to receive routine surveillance checks for the long-term complications of Rheumatic heart disease. This was disagreeing with Essien *et al.* [12] because they found that the female was more affected than male by Rheumatic heart disease.



**Fig-1: Distribution of age**

In our study, the age of the patients was ranging from 20 years to 81 years old. We notice that the age group ranged from 21 to 40 years more affected (Figure 1), this result was a slight difference when compared it with Chockalingam *et al.* [13] because they found that the mitral valve regurgitation was more common in age less than 18 years, while mitral stenosis and isolated aortic valve disease was more common in age more than 18 years.



**Fig-2: Distribution of onset of RHD**

The onset of Rheumatic heart disease was grouped into group A. The onset of Rheumatic heart disease ranged from 1 year up to 5 years the percentage was (50%) they were 30 patients, group B the onset of Rheumatic heart disease ranged from 6 up to 10 years the percentage was (26.7%) they were 16 patients, group C the onset of Rheumatic heart disease more than ten years the incidence was (23.3%) (Figure 2). This compatible with Hwang JJ (14); they found that out of 213 patients, 147 had predominant mitral stenosis, and 66 patients had significant mitral regurgitation. Twenty-eight patients had LA thrombi by TEE criteria. These findings were all confirmed at surgicopathologic studies (specificity 100%). Regarding metabolic syndrome distribution, out of 60 cases, one patient had only diabetes. The percentage was (1.6%), and 11 patients had both diabetes and hypertension; the percentage was (18%) (Table 1).

Most of the patients who had the diabetic disease were developed hypertension or vice versa; both of them were metabolic disorder diseases and responding to some factors such as (obesity, high cholesterol levels, lack of physical activities, and smoking.)

**Table-1: Distribution of hypertension and diabetes subjects**

	Frequency	Percent
Hypertension	13	21.6%
Diabetes	1	1.7%
Both Hypertension and Diabetes	11	18.9%
Normal	35	58.3%
Total	60	100%

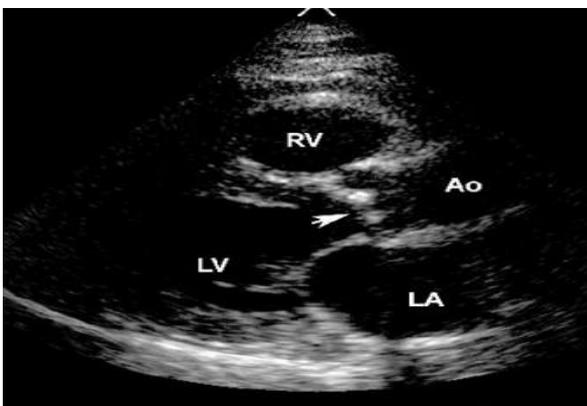
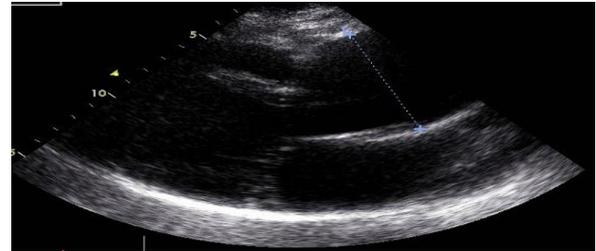
Regarding patient's shape and height distribution, it was analyzed into three groups, those who were short including 25;41.7% patients, were the medium including 8;13.3% patients, and taller including 27;45% patients, the majority of patients diagnosed with rheumatic heart disease were categorized under the taller population.

Regarding our results about the aortic valve abnormalities, the patients were categorized into four groups, Group one included the patients who had isolated aortic valve stenosis, group two included the patients who had isolated aortic valve regurgitation, group three included the patients who had atresia and the last group included the patient without any abnormalities in aortic valve (Table 2).

**Table-2: Distribution of aortic valve echocardiography Findings**

	Frequency	Percent
Isolated Stenosis	10	16.7%
Isolated Regurgitation	35	58.3%
Mixed disease	1	1.7%
Normal	14	23.3%
Total	60	100

The incidence rate of aortic valve abnormalities in the current study was 76.7% (Table 2), which is higher than the rate (33.3%) reported by Shogade TT *et al.*[12]. This might be due to the fact that our sample size is smaller than the population they investigated.

**Image-1: Echocardiography of 82 years old male patients shows critical aortic stenosis****Image-2: Echocardiography of 60 years old female patients shows Aortic root and ascending aorta dilatation**

When further exploring pulmonary valve, we categorized the patients in two groups; group one includes the subject with pulmonary valve regurgitation, and group two include the subject with normal pulmonary valve as presented in Table 3.

**Table-3: Distribution of pulmonary valve echocardiography findings**

	Frequency	Percent
Regurgitation	7	11.7%
Normal	53	88.3%
Total	60	100.0

The incidence of the pulmonary valve abnormalities in our study was 11.7% (Table 3), which is similar to the incidence rate of 9.3% reported by Shogade TT *et al.*[12].

To our knowledge, any abnormalities that affect the mitral valve can increase the pressure and distention of the pulmonary veins and capillaries can lead to pulmonary edema [15].

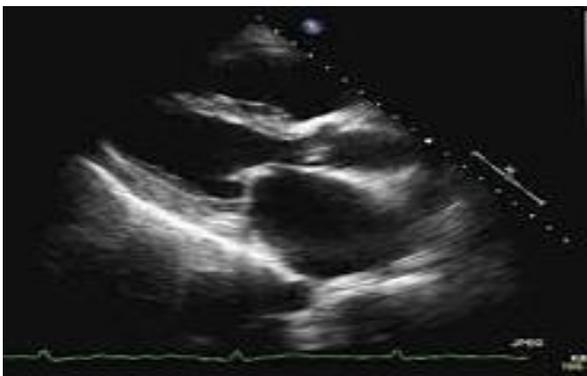
In the current study, the subjects were distributed into four groups; the first group includes subjects who had isolated mitral valve stenosis, the second group include t subjects who had normal mitral valve, the third group subjects who had isolated mitral valve regurgitation, and the fourth group subjects who had more than mitral valve disease (Table 4).

**Table-4: Distribution of Mitral valve echocardiography Findings**

	Frequency	Percent
Isolated stenosis	9	15.0%
Isolated regurgitation	41	68.3%
mixed disease	2	2.4%
Normal	8	13.3%
Total	60	100.0

The incidence of mitral valve stenosis with regurgitation was common mitral valve abnormalities in our study, as presented in Table 2. Such findings could be compared to a Prospective study of 9463 pregnancies patients that reviewed, where the incidence of both the mitral and the aortic valve was observed in 49.8% of the patients and was more common in men as compared to women (52.7 versus 47.8%; P=0.047) [16]. In addition, another study carried out by Talluto *et al*. [17] found that mitral valve stenosis with regurgitation associate with severe aortic stenosis were common abnormalities that affect the aortic valve.

The incidence of aortic valve abnormalities in our study group, which is in contrast to the results reported by Talluto *et al*. [17] and Shrestha *et al*. [16].



**Image-1:** Echocardiography of 48 years old male patients shows mitral valve stenosis



**Image-3:** Echocardiography of 67 years old female patients shows mitral regurgitation.

Furthermore, regarding our results about tricuspid valve findings, the patients were categorized into two groups (normal and regurgitation subjects), out of 60 subjects, 23; 38.3% diagnosed with tricuspid valve regurgitation, while the normal subjects in our study were 37; 61.7% as presented in Table 5. Our findings on the tricuspid valve were compatible with the results of Chockalingam *et al*. [13], where they found incidence rates of tricuspid valve regurgitation was 38.9%.

**Table-5: Distribution of tricuspid valve echocardiography Findings**

	Frequency	Percent
Regurgitation	23	38.3%
Normal	37	61.7%
Total	60	100.0



**Image-4:** Echocardiography of 48 years old male patients shows tricuspid valve regurgitation

Overall echocardiography findings regarding heart valve abnormalities were concluded in Table 5. Regarding this table, the patients were categorized into seven groups; group one include all subject with abnormalities in all heart valves, while group two include the subject who had abnormalities in three valves; group three, four, and five include the subjects who had findings in two valves such as aortic and mitral valves or aortic and tricuspid valves or tricuspid and mitral valves), group six and seven include the subject with findings in one valve such as mitral or aortic valves.

**Table-6: Distribution of final echocardiography Findings**

	Frequency	Percent
All valve disease	3	5%
Three valve disease	18	30%
Two valve disease ( aortic +mitral)	18	30%
Two valve disease ( aortic +tricuspid)	3	5%
Two valve disease (tricuspid +mitral)	3	5%
One valve disease (Mitral)	10	16.7%
One valve disease (Aortic)	5	8.3%
Total	60	100.0

Our results demonstrate that rheumatic heart disease can affect more than one valves, as presented in Table 1. The majority of these findings were detected in

more than two valves, and a small percentage were affected by less than two valves.

## 1.4. CONCLUSION

In a nationally representative sample of US adults, the prevalence of Rheumatic heart disease increases with increasing weight classes. Because Rheumatic heart disease has now high incidence proportion in Sudan, endangering not just the lives of its victims but also the social and economic fabric of society, therefore it is recommended that our society should raise the medical awareness campaign about the disease itself and mode of protection and the health effect issue. These medical awareness campaigns should be in schools, universities, media, hospitals, etc. Also, there should be more well-prepared and equipped centers to deal with Rheumatic heart disease with more intensive and continuous Rheumatic heart disease concerning programs covering whole Sudan. Once society becomes fully aware of this slow-killing disease, they will tend to be more careful in implementing preventive measures. Valvular changes in Rheumatic heart disease are detectable by conventional ultrasound only in very advanced stages of the disease. Pathologic resistive indices, however, may be detected in the earlier stages.

Even later in life, combined lifestyle factors are associated with a markedly lower incidence of new-onset Rheumatic heart disease.

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