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Original article

# Echocardiographic Categorization of Morphology of Mitral valve in Patients with Degenerative Mitral Alve Disease: Correlation with Clinical Features

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ABSTRACT

**Aims:** Due to differences in clinical history, prognosis, and surgical success, it is important to differentiate Barlow disease from fibroelastic deficiency. In the current study, we aim to distinguish these two identities using simple 2D transthoracic echocardiography criteria and correlate them with their clinical features. Methods: This study included patients with degenerative mitral valve disease who underwent evaluation using transthoracic 2D echocardiography. Prolapsing or fluttering leaflets were assessed using standard 2D echocardiographic criteria and classified into fibroelastic deficits, Barlow disease, and an intermediate group. Scallop involvement was assessed in the parasternal long axis, parasternal short axis, apical four-chamber view, and apical two-chamber view. Results: A total of 51.85% of the cases included in this study were reported to have fibroelastic deficiency, 14.81% suffered from Barlow disease and 33.33% belonged to the intermediate group. In the fibroelastic deficiency group, 50% were elderly and 57.85% were male. 64.29% of cases had a history of heart failure and 69.64% of cases had a duration of <1 year. The anterior mitral leaflet (AML) was involved in 19.64% of cases and the posterior mitral leaflet (PML) was involved in 80.36% of cases. In the Barlow disease group, 68.75% were <40 years old and 75% were female. 75% of cases had a positive family history and 81.25% of cases had a symptom duration of >1 year. AML was involved in 75% of cases and PML in 87.5% of cases. In the middle group, 47.22% of cases were <40 years old, 61.11% were female, and 55.56% of cases had a positive family history. AML was involved in 55.56% of cases and PML in 66.67% of cases. Conclusion: The long-term outcome of valve repair for degenerative mitral valve disease is poorly known due to a lack of etiologic classification. This study will help assess the long-term prognosis, recurrence rate, and need for reoperation in these patients.



## Introduction

Degenerative mitral valve disease is an important cause of cardiovascular morbidity and mortality [1]. It covers a wide spectrum of diseases in which infiltrative or dysplastic changes affect the mitral valve apparatus and impair its normal function. Although a common disease, differentiation into the specific degenerative process leading to mitral regurgitation has generally been less emphasized. However, differentiating degenerative mitral valve disease, particularly Barlow's disease, from fibroelastic deficiency is important because the clinical course,prognosis, surgical success, and recurrence rate after surgery depend on this distinction [2,3].

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These entities may be differentiated based on clinical features, echocardiographic assessment and surgical lesions. Patients with Barlow disease are typically young women who are asymptomatic at initial presentation. The etiology is generally unknown, although in some cases there is a genetic or familial component [4,5]. The pathologic hallmarks are myxoid infiltration that destroys the three-layered leaflet architecture and collagen changes noted on histologic examination [6]. The annulus is almost always present in patients with dilated Barlow disease. In contrast to Barlow disease, patients with fibroelastic deficiency are middle-aged or advanced in age and report a short history of shortness of breath or fatigue. Connective tissue deficiency is the most important pathological mechanism in fibroelastic deficiency. The 3-layer structure of the leaflet tissue is retained. Secondary pathologic changes in prolapsed segments may result in myxoid deposits with resultant thickening and expansion, but this process is usually limited to the prolapsed segment [7]. Annular enlargement, although present, is less pronounced than in Barlow disease. The average ring size in patients with fibroelastic deficiency is 32 mm [8]. Differentiation of degenerative diseases is useful to the reconstructive mitral surgeon

because the etiologic and resulting lesions help define the techniques required for successful repair. The lesions also affect the incision necessary for surgery [9,10]. For example, successful repair of a complex Barlow's lesion is less likely to be achieved with full access to the videoscope port, and in such a case it may be more reasonable to recommend a median sternotomy or a larger lateral thoracotomy, while a simple one P2 prolapse has been shown to be reliably repairable through a variety of minimally invasive approaches. The long-term outcomes of degenerative mitral valve repair remain poorly defined due to the lack of precise differentiation. Although available data suggest that patients with double wing prolapse have a higher rate of recurrence of moderate to severe mitral regurgitation and reoperation, 18 - 20 the results cannot be clearly differentiated based on etiology. The overall prevalence of DMVD is between 0.6 and 2.4%.21,22 In a study by Flameng et al., which included 348 patients, Barlow disease was diagnosed in 83 (24%) patients and Barlow disease in 285 (76%) %) were found to suffer from a fibroelastic deficiency. However, there are no Indian data on the prevalence of individual categories of degenerative mitral valve disease [11]. The current study was evaluated to investigate mitral valve morphology in patients with degenerative mitral valve disease (DMVD) and to etiologically classify degenerative mitral valve disease into Barlow's disease (BD) vs. fibroelastic deficiency (FED) or an intermediate group using 2D echocardiography. In addition, the correlation of these forms with the clinical characteristics of the patients was analysed.

**Methodology**

The study included 108 patients admitted or examined in the OPD who were found to have degenerative mitral regurgitation on echocardiography. The study was conducted between March 2015 and March 2017. The patients were personally asked for their consent. In addition, patients were informed of the purpose of the study and informed that their information would remain confidential and that each individual's content would only be evaluated by the researcher. All patients were evaluated using detailed clinical history, family history, physical examination, chest x-ray, ECG, and echocardiography. This study included patients over 18 years of age undergoing echocardiography and suffering from degenerative mitral regurgitation. Cases were excluded if there were cases with limited valve movement during systole or diastole, perforation or splitting of the leaflet, and unwillingness to consent. Patients were differentiated into Barlow disease or fibroelastic deficiency based on the echocardiographic criteria reported in Table 1.

**Table 1: Echocardiographic criteria**

| Differentiating characteristics | Barlow's Disease | Fibroelastic Deficiency |
|---|---|---|
| Leaflet involvement | Multisegmental | Unisegmental |
| Chordae tendenae | Chordal thickening | No chordal thickening |
| Annular dilatation | ≥ 36 mm | ≤ 32 mm |

The patient met all criteria. The three criteria mentioned for Barlow disease were summarized as Barlow disease. Patients who met all three criteria for fibroelastic deficiency were classified as having fibroelastic deficiency. Those patients who did not meet the criteria for either form was classified as having intermediate forms of the disease. In this work, 2D echocardiography devices and standard guidelines for functional analysis of MR46 were used. A comprehensive 2D transthoracic echocardiographic examination was performed in all patients. The degree of mitral regurgitation was graded on a standardized scale from 1 (minor) to 4 (severe). Prolapsing or beating leaflets were assessed according to standard criteria and described according to Carpentier's functional classification with precise localization of the involved bulges or segments according to four standardized imaging planesparasternal long axis, parasternal short axis, apical four-chamber, and apical two-chamber. Chamber view [12, 13]. Patients with degenerative mitral valve disease were differentiated into three different morphological forms and these were correlated with the clinical characteristics of the patients. This correlation may be useful in planning further treatment strategies for the patient as well as identifying the prognostic markers for such patients.

**Results**

Demographic variables in the study populationo f the 108 patients included in the study, 56 (51.85%) patients belonged to fibroelastic deficiency, 16 (14.81%) suffered from Barlow disease and 36 (33.33%) belonged to the intermediate group. Of the total 56 patients in the fibroelastic deficiency group, 28 (50%) patients were 60 years and older and 14 (25%) were younger than 40 years. 32 (57.14%) patients were male and 24 (42.86%) female, 32 (57.14%) patients had a history of hypertension while only 10 (17.86%) patients had a positive family history of fibroelastic deficiency had. 25 (44.64%) cases were in NYHA functional class II and 16 (28.57%) in NYHA functional class III, 4 (7.14%) cases in NYHA class IV and 36 (64.29%) cases were in NYHA functional class II %) Patients had a history of cardiac failure. The duration of symptoms was <1 year in 39 (69.64%) cases, but >1 year in 17 (30.36%) cases. Atrial fibrillation occurred in 11 (19.64%) patients, and enlargement of the left atrium occurred in 14 (25%) cases. On the other hand, the anterior mitral leaflet was affected in 11 (19.64%) patients and the posterior mitral leaflet was affected in 45 (80.36%) patients (Table 2).

**Table: 2- Demographic Variables in the study population**

| | Fibroelastic deficiency | Barlow's disease | Intermediate group | Total |
|---|---|---|---|---|
| Number of patients | 56 (51.85%) | 16 (14.81%) | 36 (33.33%) | 108 |
| Age | | | | |
| < 40 years | 14 (25%) | 11 (68.75%) | 17 (47.22%) | 42 (38.89%) |
| 40-50 years | 9 (16.07%) | 0 (0%) | 3 (8.33%) | 12 (11.11%) |
| 51-60 years | 5 (8.93%) | 2 (12.5%) | 8 (22.22%) | 15 (13.89%) |
| > 60 years | 28 (50%) | 3 (18.75%) | 8 (22.22%) | 39 (36.11%) |
| Sex | | | | |
| Male | 32 (57.14%) | 4 (25%) | 14 (38.89%) | 50 (46.30%) |
| Female | 24 (42.86%) | 12 (75%) | 22 (61.11%) | 58 (53.70%) |
| Hypertension | 32 (57.14%) | 4 (25%) | 14 (38.89%) | 50 (46.30%) |
| Family history | 10 (17.86%) | 12 (75%) | 20 (55.56%) | 42 (38.89%) |
| NYHA Class- I | 11 (19.64%) | 4 (25%) | 15 (41.56%) | 30 (27.78%) |
| II | 25 (44.64%) | 10 (62.5%) | 15 (41.56%) | 50 (46.30%) |
| III | 16 (28.57%) | 2 (12.5%) | 1 (2.78%) | 19 (17.59%) |
| IV | 4 (7.14%) | 0 (0%) | 0 (0%) | 4 (3.70%) |
| Duration of symptoms | | | | |
| < 1 years | 39 (69.64%) | 3 (18.75%) | 4 (11.11%) | 46(42.59%) |
| > 1 years | 17 (30.36%) | 13 (81.25%) | 32 (88.89%) | 62 (57.41%) |
| History of Heart Failure | 36 (64.29%) | 3 (18.75%) | 7 (19.44%) | 46 (42.59%) |
| H/O Infective Endocarditis | 2 (3.57%) | 0 (0%) | 0 (0%) | 2 (1.85%) |
| Atrial Fibrillation | 11 (19.64%) | 8(50%) | 18(50%) | 37(34.26%) |
| Left Atrial Enlargement | 14 (25%) | 9(56.25%) | 24(66.67%) | 47(43.52%) |
| Leaflet Involvement | | | | |
| Anterior | 11 (19.64%) | 12(75%) | 20(55.56%) | 43(39.81%) |
| Posterior | 45 (80.36%) | 14(87.5%) | 24(66.67%) | 83(76.85%) |

A total of 16 cases were included in the Barlow disease group, of which 11 (68.75%) patients were younger than 40 years and 12 (75%) patients were female. Four (25%) cases had a history of hypertension and 12 (75%) patients had a family history of Barlow disease.

Of the total 36 patients in the intermediate group, 17 (47.22%) patients were younger than 40 years and 22 (61.11%) were female (Table 2). 20 (55.56%) patients had a family history (Figure 5) and 14 (38.89%) patients had a known history of hypertension. 15 (41.56%) patients were in NYHA class II and 32 (88.89%) cases had symptoms for more than a year (Figure 2). 7 (19.44%) patients had a history of heart failure, 18 (50%) patients had atrial fibrillation, and 24 (66.67%) cases had left atrial enlargement. The anterior mitral leaflet was involved in 20 (55.56%) cases and the posterior mitral leaflet was involved in 24 (66.67%) cases.

**Segmental Analysis**

Of the total 648 A11 scallops in 108 patients, 126 (19.44%) scallops exhibited prolapse/flail. A1 turbinate was prolapsed/threshed in 7 (6.48%) cases, A2 turbinate in 43 (39.81%), A3 turbinate in 5 (4.62%), P1 turbinate in 11 (10,18 %), P2 scallop in 83 (76.85%) cases P3 scallop in 8 (7.40%). The anterior mitral leaflet was involved in 43 (39.81%) cases, the posterior mitral leaflet was involved in 83 (76.85%) cases, and both mitral leaflets were involved in 44 cases (Table 3).

**Table 3: Segmental analysis**

| Scallop/ segment | Number | Prolapse/flail | Prevalence |
|---|---|---|---|
| All | 648 | 126 | 19.44% |
| A1 | 108 | 7 | 6.48% |
| A2 | 108 | 43 | 39.81% |
| A3 | 108 | 5 | 4.62% |
| P1 | 108 | 11 | 10.18% |
| P2 | 108 | 83 | 76.85% |
| P3 | 108 | 8 | 7.40% |
| A | 108 | 43 | 39.81% |
| P | 108 | 83 | 76.85% |
| A+P | 216 | 44 | 20.37% |

**Discussion**

This study demonstrates the morphology of degenerative mitral valve disease clinically and echocardiographically. Degenerative mitral valve disease can result in tendon rupture with prolapse of a single segment into multiple segments in one or both valve leaflets. It accompanies excess tissue and marked annular dilatation [5]. Any lesion of the mitral valve can cause MI due to incomplete coaptation of the valve leaflets in systole. This study helps select an appropriate therapy plan. It also determines the chance of a successful valve repair. There are two different spectrums of degenerative mitral valve disease: - fibroelastic deficiency (FD) and Barlow disease (BD) [6]. Fibroelastic deficiency occurs most commonly in patients aged >60 years with a short history of mitral valve disease [8]. FD is associated with fibrillin protein deficiency, which can lead to weakness, elongation, and rupture of the chordae tendineae. It commonly affects the middle segment of the posterior leaflet17.

Tendon rupture is often associated with FD. The leaflets become thin, translucent and myxomatous. It is a major challenge to distinguish FD from BD using echocardiographic analysis of segments with prolapse. The ring size for FD18 is usually < 32 mm. Barlow disease (BD) generally occurs in people under 60 years of age with a long history. In BD, the valve leaflets present a more complex and diffuse lesion. Excess tissue is often found in the leaflets, leading to thickening, elongation, extensibility and even rupture of the chordae tendineae [14]. The ring size is >36 mm in BD. Calcifications can occur in both the annulus and the inferior valve apparatus [15].

Echocardiographic analysis of each scallop and segment helps to assess the valve structure, mechanism of mitral regurgitation, and localization of pathology. These determine the chance of a successful repair [12]. Our results suggest that the probability of successful repair is higher than that of Barlow syndrome (BD) in a tertiary health centre where 51.85% of patients suffer from fibroelastic deficiency (FD). This is in contrast to the study by Flameng et al., in which 76% of patients suffered from fibroelastic deficiency [11].

The reason for the low prevalence of FD in our study could be due to the different population characteristics. Furthermore, the study by Flameng et al. divided the patients into two different groups. In our study, a significant proportion of patients, namely 33.33%, could not be assigned to either group based on echocardiographic criteria and were therefore divided into a third group as an intermediate form. This is consistent with previous studies in which almost 20% of patients could not be specifically differentiated and had overlapping features.

Most patients (68.75%) with BD were under 40 years old, while those with FD were older. 50% of patients with FD were older than 60 years, which is consistent with the values of previous studies. Likewise, patients with BD were predominantly female, while males were common in the FD group. Family history was more common in patients with Barlow's disease and in the intermediate group than in patients with fibroelastic deficiency. The duration of symptoms was longer in the Barlow disease group than in the fibroelastic deficiency group.

Therefore, most demographic variables in both groups were similar to those of previous studies that included surgical or histological examination to confirm the echocardiographic diagnosis. However, the proportion of patients in the intermediate group was higher, which may be due to the use of very few (three) and simple echocardiographic criteria in this study. In addition, most patients in the intermediate group had clinical and epidemiological features similar to those with Barlow disease. Thus, these patients may represent an early form of Barlow's disease, which after some time may meet the criteria for Barlow's disease.

Distinguishing between FD and BD is an important step for a cardiac surgeon in selecting an appropriate surgical technique for successful valve repair or replacement. In general, FD is a simple lesion that can be repaired using minimally invasive techniques, while Barlow disease requires a more complex repair. This also increases the likelihood of successful repair rather than mitral valve replacement [16].

The long-term outcome of valve repair for degenerative mitral valve disease is poorly known due to a lack of etiologic classification. This study will help assess the long-term prognosis, recurrence rate and need for reoperation in these patients [17].

**Conclusion**

The use of clinical features and simple 2D transthoracic echocardiography may help distinguish fibroelastic deficiency from Barlow disease, even in a resource-limited setting. Most patients in the intermediate group had clinical features similar to Barlow disease. This may impact decision-making regarding referral to a cardiothoracic surgeon, surgical planning, and the prognosis and long-term outcomes of patients undergoing these procedures.

**Conflict of interest:** None

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