CONDUCTION DISTURBANCES ASSOCIATED WITH
MITRAL ANULAR CALCIFICATION

BY
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ABSTRACT

To investigate the apparent association of mitral anular calcification (MAC) and electrocardiographic abnormalities, the relation between the location of two-dimensional (2D) echo-quantified MAC and conduction disturbances was studied in 140 patients with MAC (MAC group) and 135 age- and sex-matched patients without MAC (control group). The MAC group was subclassified regarding the site and severity of calcium in the mitral anulus. The site of MAC was defined as Type I of MAC near the conduction system and Type II of MAC away from the conduction system. The severity of MAC was graded on 2D echocardiography as mild (localized within 1 segment) and moderate to severe (more than 1 segment).

Seven patients with MAC, and only one control subject, had pacemakers in place. Conduction disturbances were present in 44 (31%) of 140 patients with MAC and in 37 (27%) of the 135 control patients (no significant difference). But there were more conduction disturbances in the patients with Type I MAC (53%) than in those with Type II MAC (25%) (p<0.01). Specifically, complete left bundle branch block and intraventricular conduction delay were more prevalent when MAC was near the conduction system. Intraventricular conduction delay also was more prevalent in the patients with Type I MAC than in the control group (Type I: 12% vs control: 4%; p<0.05). These data suggest that moderate to severe degrees of MAC located near the conduction system are associated with conduction disturbances, especially intraventricular conduction delay.

Key words: Mitral Anular Calcification, Conduction Disturbance, Two-Dimensional Echocardiography.

INTRODUCTION

Mitral anular calcification (MAC) is a degenerative lesion with calcium deposition which may involve the area of the conduction system. In 1908, the first reported observation of atioventricular muscular fibrosis was made by Bönninger (1) in autopsy studies of two elderly patients with complete heart block. Since then, the relationship between calcified lesion of the mitral anulus and conduction disturbances has been studied by the pathologists for many years (2–4). Recently, echocardiography has been widely applied for the diagnosis of MAC. Several articles (5–8) have demonstrated the usefulness of echocardiography in detecting MAC, and also have referred to the associated lesions such as heart murmurs, mitral valve disease, left ventricular dysfunction and conduction disturbances. However, whether MAC and conduction disturbances have a cause and effect relationship remains controversial. Thus, in our serial investigations including our recent work (9), we extended this paper to a large population study regarding the association of conduction disturbances with echo-quantified MAC. We also focused on the context of other studies.

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relevant to this clinical problem (10–12).

**Method**

*Patient selection:* One hundred forty patients with echoquantified MAC (MAC group) and 137 patients who were age- and sex-matched but without MAC (control group) were studied. There were 90 women and 50 men in the MAC group with a mean age of 70±13 years (±S. D.), and 86 women and 69 men with a mean age of 69±11 years in the control group. All of the patients studied were identified from the echocardiographic records in the computerized patient data bank, so the control group was typical for a cardiology referral practice. We excluded patients with either recent myocardial infarction or prosthetic mitral valve. Conduction disturbance in the setting of infarction is a special consideration, and patients with prosthetic mitral valve were excluded because of the difficulties in distinguishing the dense echoes of MAC from the reverberation echoes of the valve ring or stents. Recognition of the associated heart disease of the two groups was obtained from the patient’s clinical record containing aortic valvular disease, coronary artery disease, dilated cardiomyopathy, rheumatic mitral valve disease, aortic regurgitation, hypertrophic cardiomyopathy, mitral valve prolapse and congenital heart disease. Most patients referred to echocardiographic examination had a heart disease of some type, but the patient’s background was not significantly different between the MAC and non-MAC groups.

*The criteria for MAC:* The criteria for MAC by M-mode echocardiography consist of dense echoes, more than 3 mm in thickness, behind the posterior mitral

![Image of M-mode echocardiogram](image_url)

**Fig. 1.** On the M-mode echocardiogram, mitral anular calcification (MAC) is noted as a thick band (>3mm in thickness) of echoes between the posterior mitral valve leaflet (pml) and left ventricular posterior wall (1vpw). Note the parallel motion of echoes of MAC with the left ventricular posterior wall.
leaflets and anterior to the left ventricular endocardium, moving parallel to the posterior ventricular wall (Fig. 1). The 2D echocardiographic criteria for MAC include: intense echoes (usually more bright echoes than those of pericardium) located at the junction of the atrioventricular groove and posterior mitral valve leaflet on the parasternal long axis view; and an echo-dense structure posterior to the posterior mitral leaflet on the short axis view (Fig. 2).

The location and/or extent of MAC was assessed by 2D echocardiography guided by a diagram of the mitral annulus (Fig. 3). The mitral annulus was divided into four portions, which were referenced to the postero-medial, central and antero-lateral portions of the posterior mitral annulus, and extension of dense echoes onto the basal portion of the anterior mitral valve leaflet (anterior mitral anulus). To examine the incidence of conduction disturbances related to the extension of MAC, the patients with MAC were subclassified into two types. Type I was defined as medial location of MAC near the conduction system; MAC located in the medial segments and/or extending onto the anterior mitral valve leaflet, and type II was defined as central and/or lateral location of MAC away from the conduction system (Fig. 3). In addition, the degree of severity of MAC was determined by both M-mode and 2D echocardiography using the criteria of echo thickness and number of involved segments as shown in Figure 4.

Electrocardiographic studies: The standard
12-lead electrocardiogram recorded within two weeks of the echocardiographic examination was analyzed. Conduction disturbances included atrioventricular block, right or left bundle branch block and intraventricular conduction delay. Intraventricular conduction delay was diagnosed in the presence of a QRS duration of more than 120ms when the pattern was not typical of either right or left bundle branch block.

**RESULTS**

*Electrocardiographic (ECG) abnormalities in patients with MAC and without MAC*

The incidence of ECG abnormalities found in the two groups is presented in Figure 5. There were no statistically signifcant differences, either for type of conduction disturbance or arrhythmia, between the two groups overall. However, seven patients in the MAC group had previously implanted pacemakers, versus only one in the control group. In the MAC group, the ECG findings before pacemaker implantation were sick sinus syndrome (2 cases), atrial fibrillation with intermittent heart block (1 case), and complete atrioventricular heart block (5 cases). Complete heart block was the reason for the pacemaker placement in the one control patient without MAC.

*Conduction disturbances related to severity of MAC*

The severity of MAC by 2D echocardiography was mild in 88 of 140 cases

**SITE OF MITRAL ANULAR CALCIFICATION**

**ON LEFT VENTRICULAR SHORT AXIS VIEW**

Fig. 3. The patients with MAC were classified into two types. Type I was defined as medial location of calcium located either only at the medial portion of the posterior mitral annulus or also extending to the anterior mitral valve leaflet, which was the area adjacent to the conduction system. Type II was defined as central and/or lateral location of MAC which was the area far from the conduction system.
(63%), moderate in 28 of 140 cases (20%), and severe in 24 of 140 cases (17%). All the severe cases had calcium involving the medial Type I MAC distribution, and most of the mild cases were Type II MAC. Conduction disturbances were found in 27 of 88 patients (31%) with mild MAC and in 23 of 52 (44%) patients with moderate to severe MAC (p=NS). There were no statistically significant differences in the incidence of aggregate conduction disturbances, comparing the mild group to the moderate and severe MAC groups. However, both complete left bundle branch block and intraventricular conduction delay were more frequently seen in moderate to severe cases when compared with the mild cases (both p<0.05). Only intraventricular conduction delay occurred with a much higher incidence in the moderate to severe MAC group compared with the control group (p<0.05).

The severity of MAC by M-mode echocardiography was compared to the 2D echocardiographic evaluation. Eighty-six of 130 cases (66%) had the same grade of severity evaluated by M-mode and 2D echocardiography. The remaining 44 of 130 cases (34%) were graded differently by the two echo methods. This discrepancy may be explained by the two qualitatively different criteria for the two methods employed in this study: thickness of an echo on M-mode versus extension of echoes circumferentially by 2D imaging. M-mode echocardiography seems quite

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**Fig. 4.** The M-mode and two-dimensional echocardiographic criteria for the severity of MAC. The M-mode criterion was based on the thickness of the calcified mitral annulus echoes, and two-dimensional echocardiographic criterion was based on the number of involved segments.
sensitive in diagnosing MAC, but has the disadvantage of evaluating the extension of MAC.

Conduction disturbances related to the location of MAC

We segregated the MAC patients with calcium near the conduction system for a special note, as opposed to either the rest of the MAC group or the controls. We found 51 cases of Type I MAC (medial type of MAC) and 89 cases of Type II MAC. Conduction disturbances occurred with a higher incidence in Type I MAC than in Type II MAC (53% vs 26%; p<0.01) (Table 1). Specifically, complete left bundle branch block and intraventricular conduction delay were noted with a significantly higher incidence in Type I MAC. The incidence of intraventricular conduction delay and all conduction disturbances also were higher in Type I MAC compared with the control group.

<table>
<thead>
<tr>
<th>ECG Abnormalities in MAC and Control Groups</th>
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<tbody>
<tr>
<td><strong>ECG findings</strong></td>
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<tr>
<td></td>
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<tr>
<td>Normal ECG cases</td>
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<tr>
<td>Total CD cases</td>
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<tr>
<td>LAH/LPH</td>
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<tr>
<td>CRBBB+LAH/LPH</td>
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<tr>
<td>CRBBB/CLBBB</td>
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<tr>
<td>IVCD</td>
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<tr>
<td>PR int. &gt; 0.20sec</td>
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<tr>
<td>II/III AV Block</td>
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<tr>
<td>Implanted pacemakers</td>
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<td>Total arrhythmias</td>
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![Fig. 5. All electrocardiographic abnormalities seen in the MAC group and the control group. There were no statistically significant differences between the two groups either in types of conduction disturbances or arrhythmias.](image-url)
Table 1. Incidence of Conduction Disturbances in Type I and Type II Mitral Anular Calcification

<table>
<thead>
<tr>
<th></th>
<th>Type I (medial)</th>
<th>Type II (other)</th>
<th>Control (group)</th>
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</thead>
<tbody>
<tr>
<td>Total cases</td>
<td>51 (31%)</td>
<td>89 (57%)</td>
<td>135</td>
</tr>
<tr>
<td>Birnak ECG cases</td>
<td>16 (1%)</td>
<td>51 (57%)</td>
<td>68 (50%)</td>
</tr>
<tr>
<td>Total CD cases</td>
<td>27 (53%)</td>
<td>23 (26%)</td>
<td>38 (28%)</td>
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<tr>
<td>CLBBB</td>
<td>7 (14%)</td>
<td>2 (2%)</td>
<td>9 (7%)</td>
</tr>
<tr>
<td>IVCD</td>
<td>6 (12%)</td>
<td>2 (2%)</td>
<td>5 (4%)</td>
</tr>
<tr>
<td>LAH, LPH, BFB, CRBBB</td>
<td></td>
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<td>P=NS</td>
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<tr>
<td>Prolonged PR int.</td>
<td></td>
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<tr>
<td>II/III AV block</td>
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+, *: p<0.05, +, **: p<0.01.
CD=conduction disturbance, CLBBB=complete left bundle branch block, IVCD=intraventricular conduction delay, LAH=left anterior hemiblock, LPH=left posterior hemiblock, BFB=bifascicular block, CRBBB=complete right bundle branch block, AV block=atrioventricular block, NS=not significant.

in comparison with chest roentgenography of fluoroscopy (13).

Relationships between conduction disturbances and MAC

The previous investigators reported a higher incidence of conduction disturbances in patients with MAC; the incidence has varied from 26–70% (10, 11). In contrast, Savage et al. (12) found a lack of significant association of MAC conduction abnormalities in the very large and well characterized Framingham epidemiologic study population. Our study presented no difference in the incidence of conduction disturbances in the overall MAC group compared to the non-MAC control group. However, there was an apparently high incidence of conduction disturbances in the medial location of MAC or moderate to severe MAC in comparison to the central or lateral location of MAC or mild MAC group. These data may suggest that MAC specifically involving the area adjacent to the bundle of His and its primary branch could be etiologically related to conduction disturbances.

Clinical implication

MAC may frequently be observed in elderly patients with hypertension, cardiomyopathy, valvular heart disease, renal dysfunction and connective tissue disorders. Our study may have established part of the answer to the clinical questions of whether MAC is a finding suggestive of future conduction disturbances. The finding of MAC deserves special clinical notation when it is moderate to severe and it is located near the conduction system. Although, we currently have no data on the natural history of such patients, a long term follow-up study focused in this way may clarify the possible causal nature of this relationship.
REFERENCES


