THE MITRAL VALVE PROLAPSE SYNDROME was described clinically by Barlow et al.\textsuperscript{1, 2} as a mid-systolic click and/or late systolic murmur. The clinical spectrum of mitral valve prolapse ranges from normal mitral anatomy and function to severe distortion of leaflet and chordal anatomy with severe mitral regurgitation.

Multiple etiological factors contribute to mitral valve prolapse, as indicated by its association with Marfan's syndrome, thoracic skeletal deformities, connective tissue disorders, rheumatic heart disease, decreased left ventricular dimensions as seen in secundum atrial septal defect and aging, hypercontractile states of the ventricle, and coronary artery disease with papillary muscle dysfunction.\textsuperscript{3-8} Mitral prolapse also occurs in the absence of these related disorders and may be either sporadic or familial.

A prevalence figure for mitral valve prolapse in the general population has been difficult to determine, since prevalence depends, in part, on the age, sex, and associated disease processes in the study population. The prevalence figures reported include 1.4\% of black South African school children,\textsuperscript{9} 5\% in routine autopsies of patients over 40 years of age,\textsuperscript{6, 7} and 6-10\% of presumably normal young women studied by echocardiography.\textsuperscript{8-10} In this study we assessed the prevalence of mitral valve prolapse in a group of young healthy adult males.

**Methods**

The study population comprised 107 male house staff and medical students of the Emory University School of Medicine stationed at the Atlanta Veteran's Administration Hospital over a 3-month period.

These persons were randomly selected, since their rotation schedules alone determined their participation in the study. Each participant completed a questionnaire which characterized his clinical status with regard to dyspnea, chest discomfort, palpitations, known arrhythmias, fatigability and syncope. Each participant was examined on two occasions, in the supine, sitting, and standing positions before and after a Valsalva maneuver. Thoracic bony abnormalities such as "straight back" syndrome, pectus excavatum and scoliosis were noted. Only persons in whom both auscultators independently described a click or murmur were designated as positive.

Echocardiograms were performed using an Ekoline E-20A diagnostic ultrasonoscope (Smith, Kline Instruments, Inc, Palo Alto, California) with an SKI Model C-12 transducer (2.25 mHz, 3\%-inch diameter, unfocused). Permanent echocardiograms were recorded on a Honeywell 1865A Visicorder oscillograph (Honeywell Test Instruments Division, Denver, Colorado) using Kodak linagraph direct print paper (Type 2295, Eastman Kodak Co, Rochester, New York). Subjects were examined in the supine position with the transducer held perpendicular to the chest wall, intersecting the mitral leaflets and the left atrium. When necessary, the mitral apparatus was scanned. We searched for two characteristic echocardiographic patterns — typical abrupt mid-systolic posterior displacement of the posterior leaflet or both mitral leaflets and hammocking with increased excursion of the mitral valve leaflets during systole. Echocardiograms were done at rest and after amyl nitrite inhalation and were interpreted by two echocardiographers who were unaware of the auscultatory findings.

**Results**

**Auscultation**

Eleven subjects had a mid-systolic click that moved toward the first heart sound after standing. In four of these 11, there was no accompanying systolic murmur. Three of the four underwent phonocardiographic ex-
amination which confirmed the presence of a mid-
systolic click (fig. 1). In the seven subjects with both a
click and a murmur, maneuvers that diminished left
ventricular volume caused the click to occur earlier in
systole and the murmur to occupy a greater part of
systole. The remaining 96 subjects had a normal
auscultatory examination and no evidence of cardiac
disease by history.

Echocardiography

One hundred one of the 107 echocardiograms were
of sufficient quality to evaluate the presence or

\[\text{FIGURE 1. Phonocardiogram of one of the seven subjects with mitral valve prolapse}
\text{showing two systolic clicks at the apex. There is also an unrelated systolic flow mur-
\text{mur at the second left intercostal space. Abbreviations: } S_1 = \text{first heart sound; } S_2 = \text{second heart sound; } C = \text{click; SM = systolic}
\text{murmur; } 2\text{LICS = second left intercostal space.}}\]

\[\text{FIGURE 2. Echocardiograms of the mitral valve in the seven subjects with an}
\text{auscultatory click-murmur and echocardiographic prolapse of one or both leaflets of}
\text{the mitral valve. Arrow indicates systolic prolapse. Subject D was spontaneously}
\text{symptomatic with three episodes of syncope and one brief episode of atrial fibrillation.}\]
absence of mitral valve prolapse. Echocardiograms were of poor quality in six of the 107 subjects and were therefore eliminated from the final analysis, since auscultatory data could not be confirmed. Seven of the remaining 101 echocardiograms showed unequivocal mitral valve prolapse (fig. 2). After these results were recorded, the echocardiograms were correlated with the auscultatory data. The seven subjects with mitral valve prolapse documented by echocardiography were the same persons in whom both a click and a murmur were heard. None of the four subjects with isolated clicks showed mitral valve prolapse by echocardiography. No evidence of prolapse was found by echocardiography in the 90 subjects who did not have a click or murmur (table 1).

Clinical Data

Five of the seven subjects with mitral valve prolapse documented by echocardiography denied having any cardiovascular symptoms. One of the remaining two subjects experienced a syncopal episode after accidental inhalation of amyl nitrite. The spontaneously symptomatic subject reported three episodes of syncope, two associated with micturition and one with acute, transient atrial fibrillation. None of the 90 subjects with a normal echocardiogram and cardiovascular examination had syncope, palpitations or dyspnea, although five complained of episodic, nonexertional chest pain. Clinically, all seven persons with mitral valve prolapse had either pectus excavatum or straight back (fig. 3). Only two of the 94 with normal echocardiograms had pectus excavatum.

Discussion

This study documents a surprisingly high prevalence of the mitral valve prolapse syndrome (defined as a characteristic mid-systolic click, late systolic murmur, and echocardiographic evidence of posterior mitral leaflet prolapse into the left atrium) compared with a similar study reporting 4% prevalence of this syndrome in presumably healthy young males. However, our results are consistent with the previously reported prevalence of mitral valve prolapse in a similar age-matched population of females. If these surveys are correct, the mitral valve prolapse syndrome may be the most common valvular abnormality. These data suggest that mitral valve prolapse is not a function of sex-related differences in left ventricular geometry (i.e., the relationship of the major and minor axes to the mitral valve apparatus), as has been speculated elsewhere. Since only 1.4% of black South African school children have been found to have the typical auscultatory findings, one might also suggest that mitral valve prolapse becomes more evident with age, or has a different racial distribution. However, a recent study by Cohen et al. reassessed the prevalence in black school children to be 17.9%. Our study emphasizes the relationship between thoracic skeletal abnormalities and mitral valve prolapse. Comparison with a previous report on this relationship suggests a closer association in the young male subgroup.

Only one of the seven subjects with mitral valve prolapse in our random, prospective study was spontaneously symptomatic. This is in contrast to nonrandom studies which have reported that as many as 50% of patients with mitral valve prolapse were symptomatic (palpitations, chest pain or dyspnea). The mean age of the population in those studies (mean 41 years) was older than in our study (mean 28 years),

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<td>Click-murmur</td>
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Figure 3. Posteroanterior and lateral chest roentgenogram of one of the seven subjects with mitral valve prolapse showing straight back (lack of normal dorsal kyphosis).
suggesting that asymptomatic patients with mitral valve prolapse may become symptomatic as they become older. Of course, other common, age-related cardiac disorders, such as coronary atherosclerotic heart disease, may have a role in the appearance of symptoms. The possibility that the auscultatory-echocardiographic complex seen in these patients is a normal variant rather than a true anatomic abnormality has not been determined. This is particularly relevant in presumably healthy young females, as studied by Markiewicz et al., where seven of 17 subjects with click-murmur had no echocardiographic evidence of prolapse. We found no echocardiographic evidence of prolapse without also noting both a click and a murmur, although Markiewicz et al. found 11 of 21 subjects with a positive echocardiogram, but no click or murmur.

The high prevalence of mitral valve prolapse documented by this and other studies has serious implications for infective endocarditis prophylaxis. If 6–10% of all healthy young adults are at risk for developing infective endocarditis during the bacteremic phase of dental procedures, considerable cost and a certain number of allergic reactions to penicillin could result from treating all persons. Long-term follow-up of patients with asymptomatic mitral valve prolapse is needed to determine more specific indications for endocarditis prophylaxis. However, Procacci et al. have suggested that infective endocarditis is rare in patients with mitral valve prolapse, and Cohen et al. recommend that only patients who have evidence of constant mitral regurgitation receive prophylaxis. It has not been determined whether any therapy can prevent the occurrence of symptoms or the progression of mitral regurgitation. The expense of prophylactic \( \beta \)-blocker therapy for everyone with mitral valve prolapse is probably great; therefore, a method for determining subjects at risk of progression is very important.

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References

Prevalence of mitral valve prolapse in presumably healthy young men.
J R Darsee, J R Mikolich, N B Nicoloff and L E Lesser

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