Doppler echocardiography in elderly patients with ejection systolic murmurs

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Summary: Thirty-nine elderly patients, mean age 77 years (range 65 to 96), with ejection systolic murmurs were studied to evaluate the functional significance of these murmurs. Subjects were evaluated clinically, by 2-D echocardiography, and by a full Doppler echocardiography study. Good quality Doppler signals were obtained in 35 subjects. Mitral regurgitation was found to be the only significant valvular lesion in 6 patients (17%). Doppler gradients in systole across the aortic valve were less than 30 mmHg in 28 subjects (80%) and were considered not significant. Gradients of greater than 30 mmHg representing significant aortic stenosis were found in 7 subjects (20%). The clinical sensitivity in detecting significant aortic stenosis was 44% and specificity was 81%. Doppler evidence of significant aortic stenosis was found in a substantial proportion of these elderly subjects. Neither clinical assessment nor 2-D echocardiography can be relied on to exclude this condition.

Introduction

Aortic systolic murmurs are found in approximately 50% of elderly patients.^{1,2} Establishing the aetiology of these murmurs and differentiating between significant aortic stenosis and the debated diagnosis of aortic sclerosis is difficult on clinical and electrocardiographic grounds alone. The introduction of echocardiography, both M-mode and real time, helped to evaluate this problem but relies on indirect measures including left ventricular internal diameter, wall thickness and aortic valve calcification. Measurements of valvular gradients and their precise anatomical localization, hitherto only possible with invasive procedures, are now possible to assess using Doppler echocardiography.

The aims of this study were: to determine the significance of ejection systolic murmurs in the elderly; to appraise the sensitivity and specificity of clinical assessment in detecting significant disease; and to relate clinical and electrocardiographic findings to aortic valve function as gauged by Doppler echocardiography.

Methods

Thirty-nine elderly subjects, mean age 77 years (range 65 to 96 years), were studied. Recruitment

was from among both general medical and geriatric inpatients and outpatients and from attenders at a geriatric day hospital. Consecutive subjects with ejection systolic murmurs of any grade as judged by attending medical staff were recruited regardless of cardiac symptoms. Patients with overt cardiac failure were excluded as were those unable to cooperate with echocardiography.

Patients were assessed by a cardiologist and by a geriatrician. Grade of murmur, quality of the aortic second sound (reduced, normal, or increased), the presence or absence of aortic regurgitation, and finally a verdict on the presence or absence of significant aortic stenosis were recorded independently by the two clinicians, along with blood pressure and pulse pressure.

A 12 lead electrocardiogram (ECG) was recorded and analysed for voltage criteria of left ventricular hypertrophy,³ electrical axis and evidence of conduction defects. 2-D and Doppler (continuous wave) echocardiography were recorded using a Hewlett Packard phased array 90° sector scanner (3.5 MHz transducer). Echocardiograms were recorded on VHS videotape and analysed later for valvular abnormalities (aortic stenosis or aortic regurgitation), aortic valve calcification and cusp separation on 2-D and aortic valve gradient in systole and the presence of aortic regurgitation on Doppler. All echocardiographic and Doppler data was averaged over 3 cardiac cycles.

Adequate quality echocardiograms were obtained in 35 subjects with full clinical and ECG data

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in 31. Doppler gradients across the aortic valve in excess of 30 mmHg were regarded as representing significant stenosis and those under 20 mmHg as not significant. Sensitivity and specificity of clinical detection of aortic stenosis by the two clinicians was evaluated.

Analysis of ECG and Doppler echocardiography data was performed using correlation coefficients and Wilcoxon's rank sum test.

Results

Of the 35 subjects with full echocardiographic data, 6 were found to have mitral regurgitation as the only significant valvular pathology. Of the 29 remaining, 22 had gradients of less than 20 mmHg and 7 had gradients in excess of 30 mmHg with no subject between these values (Table I).

The clinical sensitivity in detecting significant stenosis was 44% and the specificity was 81%. There was no significant association between the presence of stenosis as defined by Doppler gradients and either the grade of the murmur or the quality of the aortic second sound. Median pulse pressure was significantly lower in those with stenosis at 45 mmHg (range 15–80) than those without at 65 mmHg (range 35–100) ($P < 0.05$).

There was a weak correlation between voltage measurements from ECG and the Doppler gradient ($r = 0.4$, $P < 0.05$). ECG criteria of left ventricular hypertrophy, however, were of little value in predicting the presence of significant stenosis with a sensitivity of only 37.5%. Neither cusp separation or the presence of valve calcification on 2-D echocardiography showed significant correlation with Doppler gradients.

Discussion

Real time Doppler echocardiography is a non-invasive method of evaluating valvular abnormalities and is now available in most teaching and in many district general hospitals. There is good correlation between aortic valve gradients measured at cardiac catheterization and those measured simultaneously by Doppler echocardiography.^{4,5} It was therefore felt justifiable to use the measured Doppler gradient as a 'gold standard' in this non-invasive study for evaluating ejection systolic murmurs in the elderly. Recourse to cardiac catheterization would be hard to justify on ethical grounds.

The gradient across the aortic valve which should be considered evidence of 'significant' stenosis is difficult to define and no universally agreed level exists. Even with left heart catheterization, where gradients may be peak-to-peak or

Table I Doppler gradients (excluding 6 subjects with mitral regurgitation)

	Number	Range (mmHg)	Median
Total	29	4–164	10
Non-significant (gradient < 20 mmHg)	22	4–18	8
Significant (gradient > 30 mmHg)	7	38–164	56

instantaneous, there is no universally agreed gradient which represents significant stenosis. It is known that the gradient at rest depends on both left ventricular function and the level of patient anxiety, and may underestimate values during exercise. There is an intermediate level of velocity/gradient between normal flow and definite stenotic/high velocity flow. For the purposes of this study, 20 mmHg was selected as representing stenosis. In practice, all 7 subjects considered to have stenosis had gradients in excess of 30 mmHg and this would be accepted by most authorities as indicating significant disease. Maximum Doppler gradients ranging from 31 mmHg to 111 mmHg have been reported in subjects with critical stenosis (aortic valve area ≤ 0.75 cm²).⁶

The significance of a finding of aortic stenosis in these patients is not clear. We believe we are the first to report on the prevalence of aortic stenosis in unselected patients with aortic murmurs, most of whom were not suspected clinically of having significant disease. Prior to the introduction of Doppler echocardiography there was no method of non-invasively screening for or accurately assessing the severity of aortic stenosis. Accordingly investigation has been limited to those in whom aortic stenosis was suspected clinically and who would be candidates for surgical intervention. Currently available information on disease progression and the need for intervention is based on experience with this highly selected group of patients and may not be applicable to the type of patients identified in this study. The prognosis and need for follow up of these patients requires further study.

This study confirms the unreliability of clinical assessment of aortic systolic murmurs in elderly patients.⁷ Further evidence of this is the fact that 17% of subjects considered to have ejection systolic murmurs had mitral regurgitation as the only significant finding. No significant associations between clinical or ECG parameters and the presence of stenosis were found indicating that, even with the addition of ECG evidence, clinical evaluation is insufficiently accurate. Pulse pressure was the only measurement showing a significant

difference between those with and without stenosis. There is a large degree of overlap between the two groups, however, and the usefulness of this as a predictor of stenosis is limited. 2-D echocardiography evidence (cusp separation and presence of valve calcification) also showed no correlation with significant stenosis indicating that the indirect measurements of valvular dysfunction provided by this technique are not reliable.

One of the problems with Doppler assessment of aortic valve gradient is that the actual measurement made is of velocity of blood flow which is converted into a gradient. This is the standard technique on all Doppler equipment and in practice involves marking the peak velocity on the display screen electronically. An automatic analysis is then performed using the Bernoulli equation to derive the gradient.⁸ When cardiac output is low, the

ejection fraction is lower resulting in a decreased velocity of flow over the valve. This may result in the gradient across the valve being underestimated. In this study this was not found to be a problem as no subject had a fractional shortening of less than 25%.

In summary, this study shows a high prevalence of significant aortic valve disease in elderly subjects with ejection systolic murmurs. The evaluation of these patients is difficult. A substantial number of patients have, in fact, mitral valve disease. In those with aortic murmurs neither clinical assessment, ECG evidence or 2-D echocardiography are sufficiently accurate to be useful. Reliable information on the presence or absence of significant aortic stenosis in these patients can be obtained non-invasively only by Doppler echocardiography.

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