

Calcific Aortic Stenosis

C. WREN, MB, MRCP(UK), *Registrar*

M. C. PETCH, MD, FRCP, FACC, *Consultant Cardiologist*

Regional Cardiac Unit, Papworth Hospital, Papworth Everard, Cambridge

The clinical features of aortic stenosis have been well described and are familiar to all practising physicians [1-9]. Despite this, the diagnosis is often delayed [10], especially in the elderly [11]. In order to determine the possible reasons for this delay we analysed the records of 115 consecutive patients undergoing valve replacement for calcific aortic stenosis in Papworth Hospital.

Patients and Methods

All patients with calcific aortic stenosis who were undergoing aortic valve replacement in Papworth Hospital in 1979-80 were studied, in part retrospectively and in part prospectively. Those with dominant aortic regurgitation or additional rheumatic mitral valve disease and those undergoing a second operation were excluded.

It is our policy to refer all patients with symptomatic aortic stenosis for surgery unless there is some contraindication such as another mortal illness or limiting physical disability. In practice we know of only four such patients during the years 1979-80 but we recognise that there must have been others who were not referred to our Unit because a family doctor or physician had already decided that further assessment was unwarranted. Also excluded from our study were those patients with 'mild' aortic stenosis. These generally had measured gradients of 30 mm Hg or less and no symptoms. It is not possible to define rigid criteria for surgical referral in a clinical study of this nature since so much depends upon the interpretation of the patient's symptoms, his wishes, the attitude of his doctor, and so on.

Details of the history and mode of presentation were recorded and those in whom the diagnosis or referral had been delayed were identified where possible. The presence and duration of angina pectoris, dyspnoea and syncope were noted, as were details of previous rheumatic fever and hypertension. The following signs were recorded: blood pressure, clinical left ventricular hypertrophy (LVH), cardiac rhythm, heart murmurs, and the presence of third or fourth heart sounds. Heart failure was considered to be present when there was peripheral oedema, elevation of venous pulse, signs of pulmonary congestion on the chest X-ray and a history of orthopnoea or nocturnal dyspnoea. Although we pay great attention to the carotid pulse waveform, this was not included in our study as it is a difficult and subjective sign even for experienced cardiologists [12] and may be unreliable in the elderly [13].

The radiographic features included the transverse cardiac diameter and the presence of aortic valve calcification on the lateral film. The ECG features included heart rate, rhythm, the presence of LVH, using the Estes' scoring system [14], and bundle branch block or other conduction disturbances. Echocardiograms were available for most patients and it was sometimes this investigation that had led to the true diagnosis being suspected. All showed abnormal echoes from the aortic root and non-rheumatic mitral valves. The quality of the tracings was often not good enough to allow analysis of the left ventricular dimensions or wall thickness and this investigation was, therefore, omitted from our study.

Ninety-one patients underwent cardiac catheterisation by the brachial route while the remainder were referred for surgery without invasive investigation. According to our policy, coronary arteriography was performed on all those with chest pain, even if it was not typical of angina. Coronary artery disease was considered to be present if there was a stenosis of 50 per cent or more in one or more vessels. In six patients the aortic valve could not be crossed; the peak systolic aortic valve gradient and the left ventricular end diastolic pressure (LVEDP) (recorded after the 'a' wave, where present, and with the zero at mid-thorax) were measured in the remainder.

Intracardiac pressure measurements made at the time of operation were also available for most patients. The surgeon's description of the aortic valve was recorded, together with the details of any additional procedures performed, such as mitral valve replacement or coronary artery bypass grafting. The pathologist's report on the excised valve was noted, with special reference to possible rheumatic aetiology and past infective endocarditis.

Finally, we asked all the pathologists undertaking autopsies in our region how many patients had presented to their departments with a primary diagnosis of calcific aortic stenosis.

Results

The 115 patients comprised 87 men and 28 women. Their mean age was 60.5 ± 10.4 years (mean \pm standard deviation); for the men it was 60.0 ± 9.9 years and for the women 62.5 ± 11.4 years. As shown in Fig. 1, calcific aortic stenosis is predominantly a disease of elderly men, 67 per cent of all patients being men over the age of fifty.

Dyspnoea was the commonest presenting symptom (Table 1) although it often accompanied exertional chest

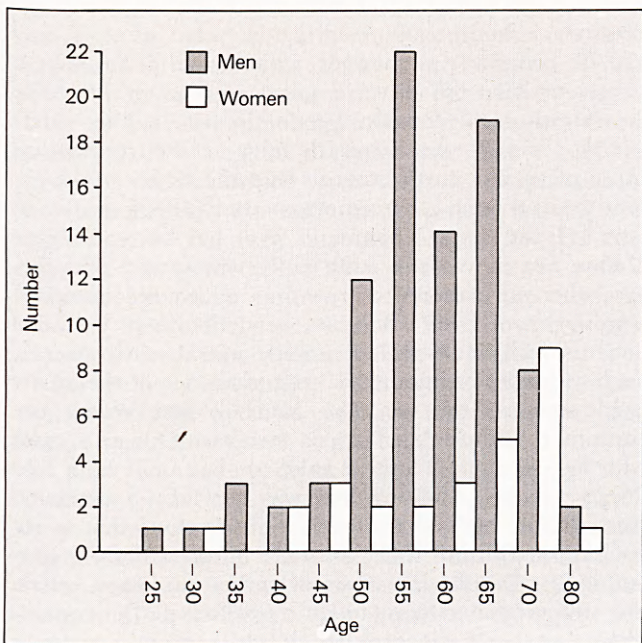


Fig. 1. Age distribution of patients with calcific aortic stenosis.

Table 1. Prevalence and duration of symptoms.

Symptom	No.	%	Mean duration (months)
Angina	67	58	31.8
Dyspnoea	90	78	22.5
Syncope	18	16	26.6
+ presyncope	28	24	
Failure	36	31	2.7
Asymptomatic	6	5	

pain. Angina occurred in more than half the patients, syncope, presyncope and heart failure being less frequent. Table 1 also shows the mean duration of symptoms at the time of operation. Seventeen patients (15 per cent) had a history of rheumatic fever and 13 (11 per cent) were receiving treatment for high blood pressure. Seven (6 per cent) had had infective endocarditis and, of these, two had no diastolic murmurs; one of these seven patients underwent aortic valve replacement during treatment of his endocarditis. One patient had previously had repair of a coarctation of the aorta.

All patients had a systolic murmur. Clinical LVH was present in 102 patients (89 per cent), and 63 (54 per cent) had a diastolic murmur. A third or fourth heart sound was detected in 29 (25 per cent).

Pre-operative chest X-ray and ECG findings are shown in Table 2. Of the seven patients with normal X-rays two also had normal ECGs; both were symptomatic and had a peak systolic aortic valve gradient of 60 mm Hg. The peak valve gradient in patients with normal ECGs averaged 74 mm Hg (range of 50-100). Atrial fibrillation was seen on the ECG in 10 patients; eight of these presented in heart failure. Using Estes' criteria[14], a score of 4 indicates probable LVH, while 5 or more is definite LVH. A score cannot be made in left bundle branch block

Table 2. Pre-operative chest X-ray and ECG results.

SR = sinus rhythm. AF = atrial fibrillation. CHB = complete heart block. HB = heart block. RBBB = right bundle branch block. LBBB = left bundle branch block. LAHB = left anterior hemi-block.

Results	No. of patients	%
Chest X-ray		
Cardiomegaly (>15.5 cm)	58/115	50
Calcification on lateral film	95/104	91
Normal	7/115	6
ECG		
Normal Rhythm	7	6
SR	101	88
AF	10	9
CHB	1	
1°HB	2	
Paced	1	
RBBB	7	
RBBB + LAHB	1	9
LBBB	2	
Estes' score		
≥4	88	77
≤3	23	20

or in some patients with right bundle branch block. Those patients with a score of 3 mainly had T wave inversion of the 'left ventricular strain' type.

In the 85 patients undergoing successful cardiac catheterisation the mean peak systolic aortic valve gradient was 88 ± 30 mm Hg. The LVEDP was raised in 46 cases and of these 14 had evidence of heart failure. Coronary arteriography was performed in 71 patients. Fifteen (21 per cent) had significant coronary stenoses—five in one vessel, six in two vessels and four in three vessels; the aortic valve gradient in these patients was not significantly different from the whole group. Interestingly, all those with coronary artery disease were men.

Only one patient had a permanent pacemaker before investigation; it had been implanted three years previously for symptomatic complete heart block (CHB). A further patient was found to be in CHB shortly before operation. Five patients had permanent pacemakers implanted post-operatively; four in the immediate post-operative period for CHB (between two and 14 days later) and one 19 months later for Stokes-Adams attacks. None of the pacemaker patients had a history of syncope, although two had right bundle branch block and one had left bundle branch block pre-operatively. Nine patients had pre-operative bundle branch block of some kind but only three of these had experienced syncope.

At operation, 57 of 106 patients (54 per cent) were considered by the surgeon to have a congenital bicuspid valve and 49 (46 per cent) had a tricuspid valve; in the remaining nine cases either the surgeon made no comment on the valve or the valve was so heavily calcified and disorganised that it was not possible to assess the original number of valve leaflets. The aortic valve systolic gradient at the time of operation averaged 71 ± 32 mm Hg compared with a mean catheter gradient of 88 ± 30 mm

Hg. Figure 2 shows the relationship of the gradients as measured at catheterisation and at surgery.

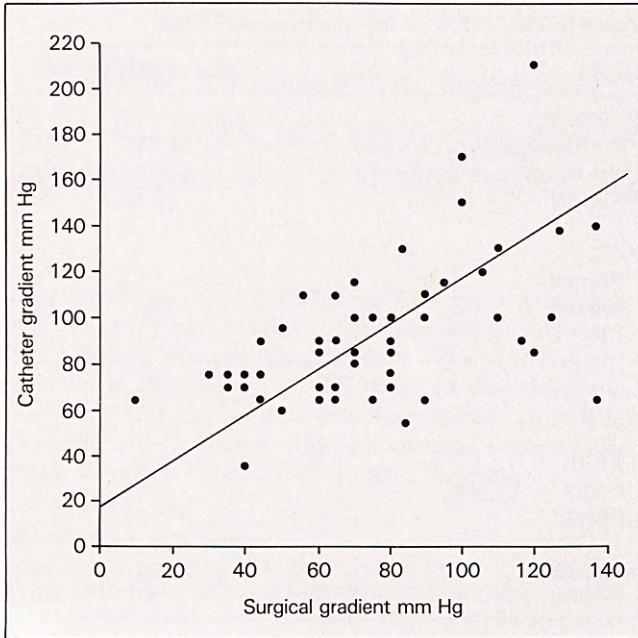


Fig. 2. Surgical and catheter gradient in patients with aortic stenosis.

Intra-operative measurements of peak LV pressure were lower than those at catheterisation by 27 ± 38 mm Hg; the systemic pressure was also lower by 12 ± 3 mm Hg.

Two patients underwent double valve replacement; both had floppy mitral valves. Their aortic valve gradients were 70 and 65 mm Hg. Coronary artery bypass grafting was an additional procedure in six patients; two had single, three had double and one patient needed triple coronary artery bypass grafting.

Pathological examination of the excised valves showed all to be calcified and, in some, cartilage formation and ossification was seen. In eight cases histological appearances suggested a rheumatic aetiology but none of these had any evidence of mitral valve disease. There was no correlation between pathological evidence of rheumatic disease and history of rheumatic fever.

As a result of the pathologists' enquiry we learned of a further 103 patients with calcific aortic stenosis who died during 1979 and 1980. Their age range and sex distribution were similar to those patients in our study, with elderly men predominating. Clinical details of these patients were scanty but the diagnosis of aortic stenosis had not usually been appreciated in life.

Discussion

When the features of aortic stenosis were described more than two decades ago, clinicians thought that the cause was previous rheumatic infection. Mitchell and his colleagues[4] concluded that the 'vast majority' were rheumatic in origin and Wood[7] suggested a figure of 80 per cent. Nowadays we recognise that this is not so[15-18].

Previous inflammation resulting in valve stenosis may still be common in younger patients; in older men a congenital bicuspid valve is most common, while senile degenerative calcification predominates in the elderly[18]. Overall, the bicuspid valve is the commonest cause of calcific aortic stenosis and the figure of 43 per cent derived from a post-mortem study[18] is similar to ours (54 per cent). Rheumatic fever has become a rare disease but it was still sufficiently widespread 50 years ago, when our patients were young, to have accounted for a minority of cases. Because we deliberately excluded patients with additional rheumatic mitral valve disease, we have under-estimated the true incidence of rheumatic aortic stenosis but we, like Mitchell and Wood, are concerned with isolated aortic stenosis. Our two cases who had additional mitral valve replacement both had floppy valves—a finding that was not fully appreciated from the pre-operative investigations but one that might be expected from time to time in an elderly population[19]. Despite the views of earlier clinicians, which are still propounded in today's textbooks[20], it seems likely that rheumatic fever has always been an uncommon cause of isolated aortic stenosis. The incidence, presentation, clinical features and natural history should have changed little over the decades.

Although sudden death is a well-recognised complication of aortic stenosis, we were surprised that so many cases presented directly to the pathologists in our region. Our survey indicates that clinicians are no better at diagnosing this condition than they were when Lewes reported that the correct diagnosis had only been made in 52 per cent of his series[21]. In so far as we were able to judge, the diagnosis had not usually been suspected in life. While it would be unwise to draw any firm conclusions about the incidence of aortic stenosis in East Anglia, our Unit serves a population of approximately two million and, as the numbers presenting to the pathologists and to ourselves are about equal, a figure of one new case per 10,000 p.a. would be a conservative estimate. What we can conclude with more certainty is that the diagnosis is often missed. In this we agree with Tunstall-Pedoe[22], who found that 22 per cent of cases with isolated aortic valve disease were first detected at necropsy; in his survey only 57 per cent had received treatment in life, implying that the diagnosis may not have been recognised in 43 per cent.

Our experience also suggests that the diagnosis of aortic stenosis is frequently delayed. The classical symptoms of angina pectoris, dyspnoea and syncope were present in 58 per cent, 78 per cent, and 16 per cent respectively. These figures are not very different from those of others, for example Wood's of 70 per cent, 45 per cent and 'one-third' respectively. However, cardiac failure (which was found in 31 per cent of our patients as compared with 15 per cent of Wood's) and dyspnoea were more common in our series. This might imply that the diagnosis was suspected only when the heart began to fail. This notion is also supported by the fact that patients with heart failure were referred relatively quickly whereas those whose only symptom was angina waited, on average, 32 months for definitive treatment. At the time of

our study the waiting list for surgery for this condition was less than two months and for a cardiologist's opinion less than one month. Among the possible reasons for the delay in diagnosis might have been the uncomplaining nature of East Anglian patients, but undoubtedly the greatest delay was caused by the difficulty in appreciating the valve stenosis, especially in patients presenting with angina alone. In discussing the reasons for this it is important to remember that we are dealing with a selected population of survivors. We have no means of knowing how many patients died suddenly with a short history, perhaps before visiting their doctors.

Our patients presenting with angina pectoris were usually thought to have coronary artery disease. The angina was quite typical in most respects but sometimes the pain was less predictable and longer-lasting than usual, as others have observed[3]. The first real clue to the diagnosis should have been the systolic murmur that was always present. However, the murmur was often unimpressive (as is usual when the force of left ventricular contraction is reduced), best heard at the apex and without radiation. Moreover, the quiet first and second heart sounds characteristic of aortic stenosis meant that the murmur was often attributed to mitral regurgitation and papillary muscle dysfunction. These traps have been well described[23] but are easily overlooked in a busy clinic. We have already alluded to the difficulty in appreciating the quality of the arterial pulse but the co-existence of systemic hypertension deserves emphasis. Of our patients, 11 per cent were receiving treatment for high blood pressure. Others had raised systolic pressures reflecting their sclerotic vasculature so that a normal pulse pressure was common. Layton *et al.*[24] noticed that 34 per cent of patients developed hypertension following aortic valve replacement and although this may have resulted from off-loading the left ventricle, their observation, coupled with ours, may indicate that systemic hypertension accelerates the wear and tear on the aortic valve, especially a bicuspid one, so that the valve becomes stenotic. Clinical LVH might have been another clue to the diagnosis but this was often difficult to appreciate until the patient was examined in the lateral position.

Wood found that the electrocardiogram was never normal in severe cases, but it was normal in 6 per cent of our patients. These patients, and the 20 per cent with 'probable' LVH by Estes' criteria did not differ significantly from the other patients with 'definite' LVH. The ST segment and T wave changes of LVH were easily ascribed to cardiac ischaemia. The antero-posterior chest X-ray film is usually said to be normal in uncomplicated aortic stenosis but 50 per cent of our patients had cardiomegaly which reflected their relatively advanced disease. The most useful clue to the diagnosis was the presence of calcification in the lateral chest X-ray. Unfortunately, this view was often omitted before referral. Six of our patients had an entirely normal chest X-ray. It is a salutary lesson that severe aortic stenosis can occur with both a normal chest X-ray and electrocardiogram. The other useful screening test was echocardiography, which invariably revealed abnormal echoes from the aortic root.

Our policy is to undertake cardiac catheterisation in

patients with aortic stenosis if there is a history of chest pain or uncertainty about the diagnosis. In all our patients the presence of aortic stenosis was confirmed; the measured gradient was 18 mm Hg higher than that recorded during surgery, presumably reflecting the lower cardiac output during cardiac surgery. Although 58 per cent of our patients had angina, only 21 per cent of those studied had coronary artery disease and in only 5 per cent was it deemed sufficiently severe to merit bypass grafting. We were unable to discern any features that reliably predicted the presence of coronary artery disease, although none of the women undergoing cardiac catheterisation had coronary artery disease.

The prognosis of patients with symptomatic aortic stenosis is poor. The average length of survival of those with angina is 2-3 years and it is less following the onset of cardiac failure[5,6,9,25,26]. The results of surgery are good. There were seven deaths within 30 days of operation in our 115 patients (6 per cent), and a low late morbidity and mortality. It is not our intention to discuss these results here but merely to point out that once the correct diagnosis has been established the symptoms can be alleviated and the prognosis improved.

We conclude that the diagnosis of aortic stenosis remains difficult even though aetiology and presentation have changed little over the past few decades. The diagnosis should be considered in any patient presenting with a cardiac murmur and angina pectoris or heart failure. A lateral chest X-ray and, when available, echocardiography are the best screening tests.

References

1. McGinn, S. and White, P. D. (1934) *American Journal of the Medical Sciences*, **188**, 1.
2. Dry, T. J. and Willins, F. A. (1939) *American Heart Journal*, **17**, 138.
3. Kumpke, C. W. and Bean, W. B. (1948) *Medicine*, **27**, 139.
4. Mitchell, A. M., Sackett, S. H., Hunzicker, W. J. and Levine, S. (1954) *American Heart Journal*, **48**, 684.
5. Bergeron, J., Abelmann, W. H., Vazquez-Milan, H. and Ellis, L. V. (1954) *Archives of Internal Medicine*, **94**, 911.
6. Matthews, M. B., Medd, W. E. and Gorlin, R. (1955) *British Medical Journal*, **2**, 759.
7. Wood, P. (1958) *American Journal of Cardiology*, **1**, 553.
8. Baker, C. and Somerville, J. (1959) *Guy's Hospital Reports*, **108**, 101.
9. Ross, J. Jr. and Braunwald, E. (1968) *Circulation*, **37**, 61.
10. Morgan, D. J. R. and Hall, R. J. C. (1979) *Brit. Med. J.*, **1**, 784.
11. Roberts, W. C., Perloff, J. K. and Costantino, T. (1971) *American Journal of Cardiology*, **27**, 497.
12. Spodick, D. H., Sugiura, T., Doi, Y. *et al.* (1982) *ibid.*, **49**, 159.
13. Flohr, K. H., Weir, E. K. and Chesler, E. (1981) *British Heart Journal*, **45**, 577.
14. Romhilt, D. W. and Estes, E. H. (1968) *Amer. Heart J.*, **75**, 752.
15. Bacon, A. P. C. and Matthews, M. B. (1959) *Quarterly Journal of Medicine*, **28**, 545.
16. Edwards, J. E. (1962) *Circulation*, **26**, 817.
17. Roberts, W. C. (1970) *American Journal of Medicine*, **49**, 151.
18. Pomerance, A. (1972) *British Heart Journal*, **34**, 569.
19. Pomerance, A. (1965) *ibid.*, **27**, 697.
20. Oram, S. (1981) *Clinical Heart Disease*. London: Heinemann.
21. Lewes, D. (1951) *British Medical Journal*, **1**, 211.
22. Tunstall-Pedoe, H. (1982) *ibid.*, **47**, 200.
23. Burch, G. E. and Phillips, J. H. (1963) *Amer. Heart J.*, **66**, 439.
24. Layton, C., Brigden, W., McDonald, L. *et al.* (1973) *Lancet*, **2**, 1343.
25. Frank, S., Johnson, A. and Ross, J. Jr. (1973) *British Heart Journal*, **35**, 41.
26. Rapaport, E. (1975) *American Journal of Cardiology*, **35**, 221.