THEMATIC REVIEW

EDUCATIONAL SERIES ON THE SPECIALIST VALVE CLINIC

How to run a specialist valve clinic: the history, examination and exercise test

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Abstract

Echocardiography is the key to the detection and initial assessment of valve disease. The examination helps differentiate severe from moderate disease if this is unclear from the echocardiogram, but is less useful than echocardiography for surveillance. However, the history is extremely important because symptoms are an indication for surgery in all types of valve disease. In aortic stenosis, the mortality rises soon after the onset of exertional breathlessness or chest tightness. Exercise testing is an extension of the history and may reveal symptoms in apparently asymptomatic patients. This article discusses the history, examination and exercise testing in patients either newly referred or under routine follow-up in a specialist valve clinic.

Key Words
▶ clinical assessment
▶ valve clinic
▶ valve disease

Introduction

Echocardiography is the key to the detection and initial assessment of valve disease. A murmur leading to echocardiography is a common path to a valve clinic. Beyond this the examination is of relatively minor importance. However the history, the other bulwark of traditional clinical practice, remains of extreme importance although it is difficult to take well. Furthermore patients judged asymptomatic after the most careful history may still experience symptoms on exercise testing. A formal exercise test should therefore be seen as an extension of the history. This article discusses the history, examination and exercise test in patients either newly referred or under routine follow-up in a specialist valve clinic.

History

Symptoms are a class I indication for surgery in all types of valve disease (1, 2, 3). In severe aortic stenosis the history is critical and may be life-saving (4) since the mortality in the first 3 months after the onset of symptoms is 3 or 4% even in carefully supervised research studies (5, 6). Furthermore mortality is approximately doubled when surgery is performed for severe compared with mild symptoms (7). Symptoms in patients followed in a specialist valve clinic are less severe and of shorter duration than those followed in non-specialist clinics (8).

The history should focus on exercise capacity (Box 1) since most patients slow down to avoid experiencing overt chest pain or breathlessness. In Otto's study (9) of aortic stenosis, 38% of patients requiring

Box 1 Helpful questions to ask

Do you ever have to stop because of chest heaviness or pain or breathless?

Do you ever get dizzy when you walk?

Can you manage stairs or hills easily?

How many stairs can you climb easily without stopping or slowing?

Have you noticed any change in exercise ability since last year?

Can you do the shopping, gardening, house-work etc as normal?

Is there anything you have had to stop doing in the last 6 months e.g. swimming or climbing hills?

Can you keep up with your friends/spouse/partner?

What is the most exertion you've done in the last 1 month?

Is this less than 6 months ago

surgery had a reduction in exercise capacity rather than an overt symptom. Therefore the clinician should ask whether the patient can climb stairs or hills normally and can manage all the activities they expect to do like shopping or gardening. The most important feature is change. What is the most significant exertion the patient has done recently and is this less than they could do 6 months ago? Is there an activity, for example, swimming, that the patient has had to stop? It is also important to ask an accompanying friend or relative who will often notice a change before the patient does.

Breathlessness is the most common symptom in all types of valve disease and almost always starts on exertion. Occasionally acute decompensation can occur as a result of a new arrhythmia or mitral chordal rupture. A chest sensation, tightness or heaviness, occurs on exertion in aortic or pulmonary stenosis but may not be recognised as overt pain on a symptom enquiry. Exertional chest tightness, usually mild, can occasionally occur in any other left-sided valve disease. Dizziness or syncope can occur on exertion in aortic stenosis but is far less common than breathlessness or chest tightness. Symptoms at rest are not expected in valve disease. Chest pain at rest may be caused by chest muscle cramp and dizziness or syncope by conduction tissue disease. On occasion, abnormal conduction can be caused by calcium related to the aortic annulus impinging on the AV node or bundles. As the natural history progresses and decompensation occurs the patient may need to sleep propped up (orthopnoea), but it is important to check that this is a change and caused by breathlessness and not some other cause like COPD,

gastro-oesophageal reflux or arthritis of the neck. Chronic fluid load may lead to ankle swelling as for any cause of heart failure.

In new patients who have a prior cardiac history, it is useful to start with this and to see whether there was improvement after any intervention (Table 1). For example initial improvement after aortic valve replacement followed by decompensation suggests structural valve deterioration if it occurs at the known durability of the valve or some other pathology if earlier. Failure to improve suggests uncorrected pathology like LV dysfunction or patient prosthesis mismatch. The non-cardiac past history and general symptom enquiry may reveal conditions causing similar symptoms to valve disease e.g. lung disease (wheeze, chronic cough, chest infections during winter). The family history may be relevant for example bicuspid aortic valve or aortic dissection. It is important to ask about conditions affecting risk from potential surgery (e.g. renal failure, lung disease, peripheral vascular disease, stroke) or which might limit the benefit of potential surgery (e.g. malignancy, dementia).

An important purpose of a valve clinic is to build up a relationship with a patient which helps to understand their philosophy of life and their needs and requirements. If the encounter needs to lead quickly to an intervention you will have to ask directly about their attitude to risk and to intervention. Hospital phobia, distressing medical experiences with close relatives or friends and psychiatric diagnoses are all considerations when planning interventions. If the patient is a Jehovah's Witness you need to establish what types of blood conserving measures or rescue products would be tolerated. A life plan including when a break from work is most easily feasible or when holidays have been booked may also affect the timing of elective surgery for example prophylactic mitral valve repair. Unsurprisingly patients usually prefer to make a decision about the type of replacement valve to be

Table 1 Elements of the history.

Symptoms: Breathlessness, exertional chest sensations (Box 1). Approximate duration
Cardiac past history: valve surgery, myocardial infarction, corontary angioplasty or bypass grafting
General past history: (1) conditions that may mimic symptoms from valve disease (e.g. COPD/asthma, anaemia, morbid obesity); (2) conditions that may affect the risk of a cardiac intervention (e.g. renal failure, hepatic cirrhosis); (3) conditions that may affect type of valve (e.g. need to avoid anticoagulation with liver disease, alcoholism, haemophilia)
Family history: aortic valve surgery, bicuspid aortic valve, Marfan syndrome
Medication

implanted jointly with their specialist (10). This leads to better outcomes after surgery (11).

Examination

The finding of a murmur on auscultation is non-specific (12). We showed (13) that one half of patients referred for echocardiography did not have murmurs still apparent when seen in a murmur clinic. No patient with normal auscultation and a normal point-of-care study had an abnormal transthoracic study (13). Auscultation is also insensitive (14). The yield of valve disease is approximately doubled by performing echocardiography in patients not only with a murmur but also with breathlessness, atrial fibrillation, a cardiac history or age ≥75 years (15).

In the valve clinic the examination is of some use in the initial assessment to corroborate the findings on echocardiography and particularly to help differentiate more moderate from severe lesions when the echocardiogram has features of both. For example a loud pan-systolic murmur suggests that mitral regurgitation is severe (Table 2) rather than moderate; a late systolic crescendo murmur that the regurgitation is mild or moderate (16). A well-heard second sound suggests more moderate than severe aortic stenosis. The second sound is the key to auscultation since it guides grading in aortic stenosis, mitral stenosis and mitral regurgitation (Table 2).

The examination is also of use on clinical follow-up to trigger echocardiography if not routinely indicated. For example, finding clinically obvious new tricuspid regurgitation late after implantation of a replacement mitral valve indicates the need for echocardiography. The blood pressure and the heart rate and rhythm are always needed but there is little clinical value in repeat auscultation in a valve clinic if the patient is having an echocardiogram. It is still useful as part of the ritual of the encounter which is valued by patients (17) and not to be belittled. The chest examination may also show evidence of lung disease as a non-cardiac cause of breathlessness – crackles, wheeze, reduced peak expiratory flow rate.

Many traditional signs are of limited use (14) having been described when valve disease was rheumatic in origin and occurred in younger people. These signs may no longer be relevant to our more elderly patient with comorbidities like hypertension or coronary disease and who may be taking haemodynamically active medication. The blood pressure in severe aortic stenosis is said to be low with a narrow pulse pressure but systemic hypertension is now a risk factor for calcific aortic valve disease and up to 40% with severe AS have a systolic blood pressure >130 mmHg (18, 19). A narrow pulse pressure was found in only 7% of patients requiring aortic valve surgery for aortic stenosis (18). The carotid upstroke may be shortened by stiff arteries in an older person or delayed by the use of a beta-blocker. In one study (20), a slow carotid upstroke was found in 53% with severe but also in 33% with moderate aortic stenosis.

Some commonly used manoeuvres are also unhelpful. If a murmur can be heard easily, it is almost always systolic and it is therefore not necessary to time it against the pulse. Using the radial artery is particularly misleading because of the delay between the aortic valve and the pulse wave reaching the radial artery. Similarly a sharp pulse at the wrist is common in patients with stiff arteries and is not a useful sign of severe aortic regurgitation. The carotid artery better reflects central events and the timing of systole.

Exercise test

The exercise test extends and complements the history. In our valve clinic we do a treadmill exercise test in patients with all types of valve disease if they are asymptomatic on the history and provided that the risk of early surgery is low. We also exercise patients with high-end moderate aortic stenosis (Vmax >3.5 m/s) on first referral,

Table 2 Signs suggesting severe disease.

	Murmur	Second sound	Blood pressure	Other
Aortic stenosis	Harsh and long	Soft or absent	–	Slow carotid
Aortic regurgitation	–	–	Wide pulse pressure, diastolic pressure <70 mmHg	Sharp carotid upstroke Mid-diastolic sound Displaced apex beat
Mitral stenosis	Long diastolic on long cycles	Wide-split (late P2)	–	
Mitral regurgitation	Loud pan-systolic	Wide-split (early A2)	–	Displaced apex beat 3rd sound

Box 2 How to conduct an exercise test

A treadmill is most commonly used in the UK while a bicycle may be more usual in other parts of Europe. Patients with asymptomatic severe aortic or mitral regurgitation are not at risk and can have exercise using a standard Bruce protocol with the same number of exercise physiologists as for a test for ischaemic heart disease. Patients with aortic or mitral stenosis are more likely to be elderly and may also have a markedly limited exercise capacity so should usually have a Bruce protocol modified by two warm-up stages and supervision from a trained senior nurse or cardiologist. They will ask the patient about symptoms and look for signs of distress. The test should be stopped for chest tightness or anything more than physiological breathlessness (which is often associated with facial pallor, cold hands or forehead, a drop in blood pressure or ventricular ectopy). Dizziness is uncommon. A fall in blood pressure by 20 mmHg from the previous stage should be rechecked if the patient looks well but if there is a progressive fall then the test should be stopped. ST segment depression is non-specific in view of LV hypertrophy. Although ST depression >5 mm is a conventional criterion for stopping, this is almost never seen. There should be a 1 min cool down at the end of exercise before the patient sits because of a theoretical risk of pulmonary oedema from increased venous return in the context of exercise induced raised LV filling pressures. A test conducted in this way is safe with no medical adverse events (21).

and when the grade crosses from moderate to severe. We repeat the test every 1–2 years for most severe disease under surveillance but aim for every year for severe aortic stenosis because of the major effect on prognosis of

new-onset symptoms. Patients are well known to slow down to avoid overt symptoms or may dismiss a symptom as a normal effect of ageing. Others may forget or not be aware of symptoms. In our series (20), some patients with a fall in systolic blood pressure and dizziness as a reason for stopping the test still denied that they were experiencing symptoms. We do not do a test if the patient has comorbidities making interpretation impossible or if surgery will only be done for severe symptoms (e.g. in an elderly person with comorbidities)

The test is also useful in patients with equivocal symptoms since direct observation gives insight; sometimes perceived breathlessness is within normal limits and a patient can still talk easily. However, objective observation of definite pathological breathlessness is a clear indication for surgery. In one series (7), 18% who had AVR for severe symptoms had no or only mild symptoms 1 month before and their surgical mortality was 17% compared with only 5% in those with mild symptoms at surgery. Sometimes an exercise test is useful for demonstrating the need for surgery to a patient and relative.

For aortic and mitral regurgitation a normal Bruce protocol is used and there does not have to be supervision. The method of conducting a treadmill exercise test for aortic stenosis is given in Box 2. Symptoms are revealed in 38% with apparently asymptomatic severe aortic stenosis and 24% with moderate aortic stenosis (21). The test may be positive in moderate aortic stenosis because the grade may be underestimated or because of coexistent coronary disease or LV disease of another aetiology for example hypertension. Revealed symptoms are as valid as spontaneous symptoms on the history as an indication for surgery (1, 2, 3) and presage events (22). Patients with revealed symptoms have a progressive fall in stroke volume on exercise (23) quite different from the increase
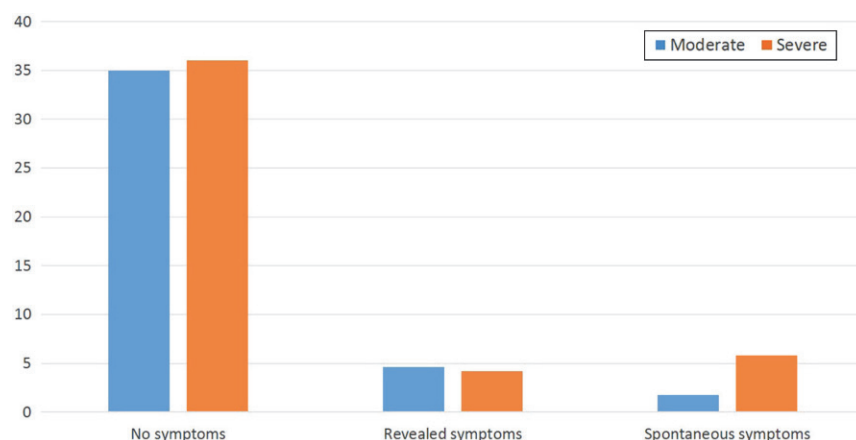
Figure 1
Change in indexed stroke volume in aortic stenosis by grade and symptomatic status. Patients who were asymptomatic on the history were exercised on a treadmill allowing subdivision into those with revealed symptoms and those who remained asymptomatic. All patients then had stress echocardiography. There were three main findings: (1) patients with revealed symptoms had a similar haemodynamic response to those with spontaneous symptoms; (2) patients with no symptoms had a larger increase in stroke volume index than the other groups and (3) patients with moderate stenosis had a similar haemodynamic response to those with severe aortic stenosis. Data from (25, 26).

in those without symptoms. We have shown (24) that the onset of symptoms later in the test is presaged by a rapid rate of rise in the heart rate to the 85% target or by >50% within the first 6 min of a modified Bruce protocol. We have also shown that the physiological response to exercise is similar with spontaneous as with revealed symptoms (Fig. 1).

In the EuroHeart survey (27), only 6% of patients with aortic stenosis in whom it was indicated actually received a test. This may be because of logistic difficulties. In our valve clinic an exercise physiologist is on duty so that we can offer a one-stop service but resources are often more limited. Safety may be of concern but we have had no medical events in 797 tests to date (21).

Conclusion

Echocardiography is the key to the detection and initial assessment of valve disease. The history is crucial since symptoms are a class I indication for surgery in all types of valve disease. A reduced exercise capacity is often the earliest symptom and this is hard to detect even with a careful history. An exercise test is therefore a necessary extension of the history in patients who appear asymptomatic and who are not at high risk at surgery.

References

1 Baumgartner H, Falk V, Bax JJ, De Bonis M, Hamm C, Holm PH, Iung B, Lancellotti P, Lansac E, Muñoz DRB, *et al.* 2017 ESC/EACTS guidelines for the management of valvular heart disease. *European Heart Journal* 2017 **38** 2739–2791. (https://doi.org/10.1093/eurheartj/ehx391)

2 Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara P, Ruiz CE, Skubas NJ, Sorajje P, *et al.* 2014 AHA/ACC Guideline for the management of patients with valvular heart disease. *Circulation* 2014 **129** 2440–2492. (https://doi.org/10.1161/CIR.0000000000000029)

3 Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Fleisher LA, Jneid H, Mack MJ, McLeod CJ & O'Gara PT. 2017 AHA/ACC focused update of the 2014 AHA/ACC guideline for the management of patients with valvular heart disease. *Circulation* 2017 **135** e1159–e1195. (https://doi.org/10.1161/CIR.0000000000000503)

4 Chambers JB. Avoiding needless deaths in aortic stenosis. *British Journal of Cardiology* 2019 **26** [epub]. (https://doi.org/10.5837/bjc.2019.015)

5 Pellika PA, Nishimura RA, Bailey KR & Tajik AJ. The natural history of adults with asymptomatic, hemodynamically significant aortic stenosis. *Journal of the American College of Cardiology* 1990 **15** 1012–1017. (https://doi.org/10.1016/0735-1097(90)90234-G)

6 Kelly TA, Rothbart RM, Cooper CM, Kaiser D, Sonneker ML & Gibson RS. Comparison of outcome of asymptomatic to symptomatic patients older than 20 years of age with valvular aortic stenosis. *American Journal of Cardiology* 1988 **16** 123–130. (https://doi.org/10.1016/0002-9149(88)91317-3)

7 Pierard S, de Meester C, Seldrum S, Pasquet A, Gerber B, Vancraeynest D, Robert A, El Khoury G, Noirhomme P & Vanoverschelde JL. Impact of preoperative symptoms on postoperative survival in severe aortic stenosis: implications for the timing of surgery. *Annals of Thoracic Surgery* 2014 **97** 803–809. (https://doi.org/10.1016/j.athoracsur.2013.08.059)

8 Zilbersac R, Lancellotti P, Gilon D, Gabriel H, Schemper M, Maurer G, Massetti M & Rosenhek R. Role of a heart valve clinic programme in the management of patients with aortic stenosis. *European Heart Journal Cardiovascular Imaging* 2017 **18** 138–144. (https://doi.org/10.1093/ehjci/jew133)

9 Otto CM, Burwash IG, Legget ME, Munt BI, Fujioka M, Healy NL, Kraft CD, Miyake-Hull CY & Schwaegler RG. Prospective study of asymptomatic valvular aortic stenosis. Clinical, echocardiographic, and exercise predictors of outcome. *Circulation* 1997 **95** 2262–2270. (https://doi.org/10.1161/01.CIR.95.9.2262)

10 Korteland NM, Bras FJ, van Hout FMA, Kluin J, Klautz RJM, Bogers AJJC & Takkenberg JJM. Prosthetic aortic valve selection: current patient experience, preference and knowledge. *Open Heart* 2015 **2** e000237. (https://doi.org/10.1136/openhrt-2015-000237)

11 Rimington HM, Weinman J & Chambers JB. Predicting outcome after valve replacement. *Heart* 2010 **96** 118–123. (https://doi.org/10.1136/hrt.2008.160010)

12 Gardezi SKM, Myerson SG, Chambers J, Coffey S, d'Arcy J, Hobbs FDR, Holt J, Kennedy A, Loudon M, Prendergast A, *et al.* Cardiac auscultation poorly predicts the presence of valvular heart disease in asymptomatic primary care patients. *Heart* 2018 **104** 1832–1835. (https://doi.org/10.1136/heartjnl-2018-313082)

13 Draper J, Subbiah S, Bailey R & Chambers JB. Murmur clinic: validation of a new model for detecting heart valve disease. *Heart* 2019 **105** 56–59. (https://doi.org/10.1136/heartjnl-2018-313393)

14 Das P, Pocock C & Chambers J. The patient with a systolic murmur: severe aortic stenosis may be missed during cardiovascular examination. *QJM* 2000 **93** 685–688. (https://doi.org/10.1093/qjmed/93.10.685)

15 Chambers JB, Kabir S & Cajeat E. Detection of heart disease by open access echocardiography: a retrospective analysis. *British Journal of General Practice* 2014 **64** 86–87. (doi:10.3399/bjgp14X677167)

16 Leatham A. *Auscultation of the Heart and Phonocardiography*, 2nd ed. Edinburgh, London and New York: Churchill Livingstone, 1975.

17 Gaede L, Di Bartolomeo R, van der Kley F, Elsässer A, Iung B & Möllmann H. Aortic valve stenosis: what do people know? A heart valve awareness survey of over 8,800 people aged 60 or over. *EuroIntervention* 2016 **12** 883–889. (https://doi.org/10.4244/EIJY16M06_02)

18 Lombard JT & Seltzer A. Valvular aortic stenosis. A clinical and haemodynamic profile of patients. *Annals of Internal Medicine* 1987 **106** 292–298. (https://doi.org/10.7326/0003-4819-106-2-292)

19 Mautner GC, Mautner SL, Cannon RO, Hunsberger SA & Roberts WC. Clinical factors used in predicting aortic valve structure in patients >40 years of age with isolated valvular aortic stenosis.

American Journal of Cardiology 1993 **72** 194–198. (https://doi.org/10.1016/0002-9149(93)90159-A)

20 Aaranow WS & Kronzon I. Prevalence and severity of valvular aortic stenosis determined by Doppler echocardiography and its association with echocardiographic and electrocardiographic left ventricular hypertrophy and physical signs of aortic stenosis in elderly patients. *American Journal of Cardiology* 1991 **67** 776–777. (https://doi.org/10.1016/0002-9149(91)90542-S)

21 Saeed S, Rajani R, Parkin D & Chambers JB. Exercise testing in patients with asymptomatic moderate or severe aortic stenosis. *Heart* 2018 **104** 1836–1842. (https://doi.org/10.1136/heartjnl-2018-312939)

22 Das P, Rimington H & Chambers J. Exercise testing to stratify risk in aortic stenosis. *European Heart Journal* 2005 **26** 1309–1313. (https://doi.org/10.1093/eurheartj/ehi250)

23 Rajani R, Rimington H & Chambers JB. Treadmill exercise in apparently asymptrsma E omatic patients with moderate or severe aortic stenosis: relationship between cardiac index and revealed symptoms. *Heart* 2010 **96** 689–695. (https://doi.org/10.1136/hrt.2009.181644)

24 Chambers JB, Rajani R, Parkin D & Saeed S. Rapid early rise in heart rate on treadmill exercise in patients with asymptomatic moderate or severe aortic stenosis: a new prognostic marker? *Open Heart* 2019 **6** e000950. (https://doi.org/10.1136/openhrt-2018-000950)

25 Lumley MFM. The dynamic interaction of coronary circulation, left ventricle and aortic valve during exercise. PhD Thesis. Supervisors Perera SD, Chambers JB. King's College London, 2016.

26 Lumley M, Williams R, Asrress KN, Arri S, Briceno N, Ellis H, Rajani R, Siebes M, Piek JJ, Clapp B, *et al.* Coronary physiology during exercise and vasodilatation in the healthy heart and severe aortic stenosis. *Journal of the American College of Cardiology* 2016 **68** 688–697. (https://doi.org/10.1016/j.jacc.2016.05.071)

27 Iung B, Baron G, Butchart EG, Delahaye F, Gohlke-Bärwolf C, Levang OW, Tornos P, Vanaoverschelde J-L, Vermeer F, Boersma E, *et al.* A prospective survey of patients with valvular heart disease in Europe: the Euro Heart Survey on valvular heart disease. *European Heart Journal* 2003 **24** 1231–1243. (https://doi.org/10.1016/s0195-668x(03)00201-x)