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The number of patients with prosthetic valves is steadily increasing, in particular because of the epidemic of aortic stenosis in the elderly. In Germany alone, more than 24,000 patients undergo valve replacement per year. In addition to the patient’s history and physical examination, echocardiography is the key element in the follow-up of individuals with a prosthetic valve (Box 1).

The examination of the patient with a prosthetic cardiac valve, however, is one of the most challenging tasks in echocardiography. For several reasons echocardiography in these patients is more difficult than in others:

- Due to the valvular heart disease present before valve replacement, these hearts are never normal, even with a perfectly functioning valve replacement.
- The prosthesis itself, especially in the case of a mechanical prosthetic, invariably generates artefacts and often is not well visualised. For example, in aortic mechanical prostheses it is often difficult or impossible to delineate precisely the extent of occluder motion.
- Even normally functioning valve prostheses present a variable degree of obstruction and regurgitation.

Box 1 The following questions should be systematically answered when examining a prosthesis by echocardiography

- Does the history or clinical presentation of the patient suggest a prosthesis related disorder (for example, new onset of severe dyspnoea, fever, etc)?
- Is the prosthesis firmly implanted as a whole (absence of rocking)?
- In a bioprosthesis, are there morphologic signs of degeneration (thickened, immobile or pathologically mobile leaflets or leaflet segments)? In a mechanical prosthesis, do the occluder discs move normally?
- How much regurgitation is there, and is it transprosthetic or paraprosthetic?
- What are the mean and maximal transprosthetic gradients, are they in the normal range, and have they changed substantially from baseline?
- Are there fixed or mobile mass lesions attached to the prosthesis (thrombus, vegetation, pannus)?
- Are there other signs of endocarditis, in particular abscess formation at the prosthetic ring, fistulae, or a pericardial effusion?

The first routine postoperative assessment is particularly important, since it serves as baseline for later comparison, especially with regard to transprosthetic gradients, prosthetic regurgitation, right ventricular peak pressure, left ventricular function, and other aspects.

This article provides an overview of procedures, the problems that can arise, and recommendations on how to deal with them.

TYPES OF VALVE PROSTHESSES

Mechanical valves are the oldest and most durable replacements for native cardiac valves. They mainly differ by the mechanism by which the occlusion of the valve is achieved. Currently, mostly bileaflet prostheses are implanted, but single disc valves (tilting disc) such as the Medtronic-Hall or the Björk-Shiley valves exist in substantial numbers, while the earliest type, the “ball-in-cage”, has become a rarity. Biological prostheses span a range from porcine or bovine trileaflet valves in a rigid ring to stentless bioprostheses and finally homografts, which are processed human cadaveric valves. In addition, the Ross procedure uses an “autograft”, the patient’s own pulmonary valve to replace a diseased aortic valve, while the pulmonary valve is replaced by an ordinary bioprosthesis. Mechanical prostheses are the most difficult to image, since reverberations and artefacts from the non-biological material mostly preclude detailed morphologic assessment (Fig 1A). However, in the mitral (or tricuspid) position, the occluders (leaflets or tilting discs) can often be seen quite well, particularly by transoesophageal echocardiography (TOE) (Fig 2–4). Mechanical prostheses often release echocardiographically detectable small gas bubbles, apparently caused by cavitation in blood due to the fast movement of the occluder. This unique phenomenon should be considered normal. Characteristically, Doppler recordings from mechanical valves display the opening and closing clicks as bright (high intensity), vertical lines enclosing the transprosthetic forward flow profile (Fig 1B). Minor changes in the opening amplitude of occluding discs, which may occur with partial thrombosis or other obstruction, necessitate fluoroscopy to exclude or document with certainty. Stented bioprostheses are easier to image (Fig 5), and stentless bioprostheses, homografts, and autografts are often indistinguishable morphologically or by transvalvular flow velocities from native valves, except for minor echodensities at the valvular circumference, where the prostheses has been sewn in. The newly introduced three dimensional TOE probe is able to generate “en face” views of prostheses, resembling visual inspection.
which allow a more intuitive assessment of prosthetic occluders and rings (fig 6). Recently, interventionally deployable aortic prostheses have been introduced. The CoreValve prosthesis is a porcine pericardial trileaflet bio-prosthesis mounted into a self-expanding nitinol frame. The Edwards-Sapien valve is a bovine pericardial trileaflet valve mounted in a balloon expandable steel stent. Thus, these prostheses neither have a typical ring nor are they stentless. After deployment, these prostheses frequently have paraprosthetic leaks and also may leak centrally (fig 7). Details on peri-interventional echocardiography can be found elsewhere.

ECHOCARDIOGRAPHIC CHARACTERISTICS OF SPECIFIC PROSTHETIC IMPLANTATION SITES

Aortic valve prostheses

Aortic prostheses should be examined in all cross sections containing the aortic valve, in particular the parasternal long and short axis. Zoom images are helpful. Special attention should be paid to the para-aortic tissue in order to rule out a para-aortic abscess. While the discs of mechanical prostheses are often insufficiently viewed, even by TOE, bioprostheses or homografts pose no unusual problems in imaging and should be examined by trans-thoracic echocardiography or TOE, if necessary, with regard to opening motion, thickening, calcification, mobile components, masses, and other abnormalities. In the parasternal long and short axis views and the apical long axis view, paraprosthetic (arising outside the prosthetic ring) and transprosthetic (arising inside the prosthetic ring) regurgitation can be detected by colour Doppler. Differentiation of the two types of regurgitation may be difficult, especially between a small paraprosthetic leak and the eccentric, but transprosthetic, normal regurgitation of bileaflet prostheses.

Peak and mean gradients across prosthetic aortic valves should be measured by continuous wave Doppler in long axis views (fig 1B). Care should be taken not to mistake a post-premature beat ejection or the ejection after a long filling period in atrial fibrillation as representative, since in these instances the velocities will be atypically high. Substantial aortic regurgitation or a high output state, as in sepsis, also increase gradients. Normal values vary drastically depending on type and size of prosthesis (table 1).

In patients who underwent replacement of the aortic valve together with the ascending aorta by a valved graft (Bentall procedure), typically due to annulo-aortic dilatation or to dissection or aneurysm of the ascending aorta, transoesophageal echocardiography is advantageous to assess the whole thoracic aorta including the graft. Pseudoaneurysm formation at the site of re-implantation of the coronaries has been described, and the morphology of persistent dissection in the arch and descending aorta may be assessed.

The interpretation of transprosthetic aortic gradients in mechanical prostheses is complicated by the occurrence of significant pressure recovery effects due to the design, especially of the bileaflet prostheses. Pressure recovery also exists in other prostheses (and, for that matter, in native aortic stenosis), but usually to a minor degree. The presence of localised high gradients, in particular between the medial orifice of normally functioning bileaflet valves, precludes the usual grading of stenosis severity. For example, mean (SD) peak velocities of 2.9 (0.5) m/s and attending peak gradients up to 35 (11) mm Hg are found routinely by continuous wave Doppler in St Jude Medical.

**Figure 1** (A) Mechanical bileaflet prosthesis in the aortic position. Parasternal long axis view. The prosthesis (solid arrow) is obscured by typical artefacts and reverberations extending into the left atrium (dotted arrow). Asc, ascending aorta; LV, left ventricle. (B) Corresponding continuous wave Doppler recording of aortic transprosthetic gradient. Maximal velocity of 3.4 m/s, corresponding to a peak gradient of 46 mm Hg. Note clicks (vertical lines) at the beginning and end of ejection.

**Figure 2** Mechanical bileaflet prosthesis in the mitral position, diastolic apical four chamber view. The leaflets are in the open, parallel position (arrows). The small image on the right shows the systolic, closed position (arrow), where the leaflets are not individually discernible. LA, left atrium; LV, left ventricle.
bileaflet number 19 prostheses without evidence of dysfunction, with corresponding effective orifice areas by continuity of only 1.0 (0.2) cm². Moreover, because malfunction of such a valve may lead to a breakdown of such localised gradients, a partially stenotic bileaflet valve may show only a minor or no increase in velocities and gradients. Calculation of the effective valve orifice area by the continuity equation does not circumvent the problem, because it utilises the maximal transprosthetic velocity which is not representative for the whole prosthetic orifice(s); the area calculated will therefore be much lower than the expected orifice area or the orifice area provided by the manufacturer, even if there is no malfunction. The use of alternative measures of obstruction is not routinely recommended.

Therefore, interpreting these findings correctly requires at least one of the following additional pieces of information:

- A baseline continuous wave Doppler study providing values for comparison from a time in which the prosthesis was presumably working well.
- Fluoroscopy of the valve allowing exact visualisation of the maximal opening angle of each disc. Finding the optimal projection (often a cranially tilted left anterior oblique projection) may be cumbersome.
- Reconstruction of functional datasets of a non-contrast enhanced multi-detector cardiac computed tomography, which allows very precise analysis of the discs’ motion.

Assessing the degree of more than mild mechanical prosthetic aortic regurgitation is extremely difficult (even with TOE) and requires utmost caution. Short of detecting a visibly large para-prosthetic leak, a rocking, dehiscent prosthesis, or torrential regurgitation filling the entire outflow tract during diastole, secondary signs of severe

Figure 3  Mitral mechanical bileaflet prosthesis in the transoesophageal four chamber view in diastole. The leaflets are in the open, parallel position (arrows). The small image on the right shows the leaflets during systole in a tent-like, closed configuration. LA, left atrium; LV, left ventricle.

Figure 4  Mitral tilting disc prosthesis (Medtronic-Hall) in the transoesophageal four chamber view. (A) Two dimensional (2D) image in systole with disc in closed position. Arrow points at central strut. (B) 2D image in diastole with disc in open position. (C) Systolic colour Doppler image of normal central regurgitation around central strut. LA, left atrium.
regurgitation should be sought, such as a short (<250 ms) pressure half time of the continuous wave Doppler signal of aortic regurgitation, or holodiastolic backward flow in the descending aorta by pulsed wave Doppler from the suprasternal notch. It remains sometimes impossible, however, to be confident about whether an aortic prosthetic regurgitation is moderate or severe.

Another sign of haemodynamic improvement after aortic valve replacement is regression of left ventricular mass and improvement in function. Wall thickness decreases and ejection fraction and tissue Doppler parameters of myocardial function improve after replacement of a stenotic aortic valve, with functional improvement beginning as soon as 24 h after the procedure. After replacement for aortic regurgitation, left ventricular diameters, volumes, and mass decrease and ejection fraction usually improves.8,9

EXAMINATION OF MITRAL VALVE PROSTHESSES

Compared to aortic prostheses, the larger size of mitral prostheses and the presence of large blood filled heart chambers on both sides of the prosthesis make echocardiographic assessment easier. The left atrial side of the prostheses and the left atrium are obscured by mechanical mitral prostheses when viewed from the apex (compare fig 2). Therefore, examination should include especially subcostal views which often visualise the left atrium well. The most important functional parameter is the mean diastolic Doppler gradient by continuous wave Doppler (table 1). It should be kept in mind that this gradient is very sensitive to heart rate and may be substantially elevated in spite of a perfectly normal prosthesis during atrial fibrillation with a rapid ventricular response. The pressure half-time (PHT, in ms) depends heavily on prosthesis type and the formula 220/PHT for native mitral valve orifice area in cm² cannot be used for prostheses; however, intra-individual serial comparisons can be performed using the PHT. Furthermore, when searching for paraprosthetic regurgitation special attention should be paid to the presence of proximal convergence zones on the ventricular side of the mitral prosthetic ring; in fact, the presence of a reproducible, well formed proximal convergence zone by itself signals substantial paraprosthetic regurgitation.7 TOE affords excellent visualisation of mitral prostheses and the left atrium, including occluder mobility, but the ventricular side of mechanical prostheses is obscured (figs 3 and 4).

A secondary sign of haemodynamic improvement after mitral valve replacement is postoperative reduction in systolic right ventricular pressures, estimated by maximal tricuspid regurgitant velocity.

TRICUSPID POSITION

Replacement of the tricuspid valve is avoided whenever possible in favour of reconstructive surgery, typically with a ring. Because of the relatively slow right atrial and trans-tricuspid flow velocities, tricuspid prostheses are at a particularly high risk of thrombosis. Imaging is performed in the typical cross sections for the tricuspid valve (parasternal right ventricular inflow view, parasternal short axis view of aortic valve, apical and subcostal four chamber views). TOE is helpful by supplying additional transgastric (for example, right ventricular long axis views) and transoesophageal images (four chamber, aortic valve short axis, and others). Functional performance is evaluated by continuous wave Doppler measurement of mean transtricuspid gradient8 (table 1).
Obstruction

Flow velocities across a prosthetic valve should be assessed by continuous wave Doppler as in a native valve and peak and mean gradients calculated. The use of PHT in mitral or tricuspid prostheses is hampered by the fact that the classic formula for mitral orifice area $A = 220/PHT$ does not hold. However, serial changes in PHT may be useful to detect obstruction if the pressure half-time increases substantially in a given valve. Transprosthetic velocities are always elevated in comparison to the native valve. They are particularly high in small bileaflet prostheses in the aortic position, where localised high pressure gradients may exist which exceed the net pressure difference between the left ventricle and the ascending aorta. These localised pressure gradients are recorded by continuous wave Doppler and are indistinguishable from gradients generated by true prosthetic obstruction. Therefore, correct motion of the leaflets/occluder should be ascertained. This is best achieved by fluoroscopy; a systematic comparison between fluoroscopy, transthoracic and transoesophageal echocardiography showed that occluding disc angles of mitral prostheses could be ascertained.

Table 1 Selection of published ranges of mean transprosthetic Doppler gradients ($\pm$ range of standard deviations) in normally functioning prostheses

<table>
<thead>
<tr>
<th>Prosthetic Position</th>
<th>Mean transprosthetic Doppler gradients mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aortic position</strong> (prosthesis sizes 19–25):</td>
<td></td>
</tr>
<tr>
<td>Mechanical bileaflet prostheses</td>
<td>$10 \pm 19$ (2–6)</td>
</tr>
<tr>
<td>Stented bioprostheses</td>
<td>$16 \pm 24$ (5–9)</td>
</tr>
<tr>
<td><strong>Mitrail position:</strong></td>
<td></td>
</tr>
<tr>
<td>Mechanical bileaflet prostheses</td>
<td>$4 \pm 5$ (1–2)</td>
</tr>
<tr>
<td>Mechanical tilting disc prostheses</td>
<td>$3 \pm 6$ (1–2)</td>
</tr>
<tr>
<td>Stented bioprostheses</td>
<td>$3 \pm 5$ (1–2)</td>
</tr>
<tr>
<td><strong>Tricuspid position:</strong></td>
<td></td>
</tr>
<tr>
<td>All types</td>
<td>$3 (1)$</td>
</tr>
</tbody>
</table>

*For further detail according to type and size of prosthesis, see Rosenhek et al* and Connolly et al.*
transthoracically and by TOE in 85% and 100%, respectively, but that aortic prostheses were not sufficiently assessed.\textsuperscript{11} It is also helpful to compare with transvalvular gradients from the postoperative period, when the valve was presumably functioning normally. Therefore, it is important to record such gradients or velocities early after surgery in order to have these baseline values ready for later comparison. This problem does not arise in mitral prostheses (mainly because of different “receiving chamber” morphology). Normal values for transprosthetic gradients have been published and depend on valve position, type, and size (table 1), but the normal ranges are wide and, as mentioned above, especially in the aortic position, high gradients can be both “by design” and thus normal or due to malfunction. By exercise or dobutamine stress echocardiography, the range of transprosthetic pressure gradients occurring in real life can be further estimated, but there is no universally accepted indication for stress echocardiography to assess prosthetic function.

True obstruction in a mechanical prosthesis is caused by impaired occluder opening due to thrombosis or pannus (tissue ingrowth), both of which may or may not be directly visible on TOE (fig 8). While thrombus is often associated with dense surrounding spontaneous echo contrast, a history of suboptimal anticoagulation, and occurs more often on mitral than aortic prostheses due to higher flow velocities across the latter,\textsuperscript{12} pannus tends to be more echodense than thrombus, arises from the prosthetic ring suture line, and only rarely occurs early postoperatively.\textsuperscript{13} Nevertheless, both pathologies may coexist and often cannot be differentiated with confidence.

The management options for prosthetic thrombosis have been studied in a number of observational studies.\textsuperscript{14} It seems that small, asymptomatic thrombi not causing embolism or haemodynamic instability can be treated conservatively by ensuring adequate anticoagulation. Laplace \textit{et al}, using routine postoperative transoesophageal echocardiography, have observed an incidence of 9.4% of thrombi early postoperatively in 680 mechanical mitral valve replacements.\textsuperscript{15} Except for two obstructive thrombi treated surgically, all non-obstructive thrombi were treated medically in a non-standardised fashion by re-initiation of heparin, re-adjustment of oral anticoagulation, or addition of aspirin. If patients were stratified by thrombus size, 22% of patients with thrombi \(\geq 5\) mm experienced complications (including neurologic ischaemic events) over the next month, but only one patient (3.4%) with a thrombus \(<5\) mm.

Elaborate management algorithms have been recommended for the choices between anticoagulation, thrombolysis, and reoperation, depending on the presence of obstruction, embolism, or haemodynamic compromise.\textsuperscript{11, 12, 15, 16} Bioprosthetic ageing leads to degenerative changes which manifest as leaflet thickening and reduced mobility, with the consequence of functional obstruction (fig 9).

\textbf{Figure 9}

(A) Degenerative stenosis in a mitral bioprosthesis. Transoesophageal view. Note reduced opening of the thickened leaflets. LA, left atrium; LV, left ventricle.

(B) Corresponding transprosthetic continuous wave Doppler recording, showing notably elevated mean diastolic gradient of 15 mm Hg.
Patient–prosthesis mismatch

If the size of a prosthesis is too small for the size of the patient ("a mosquito valve in the heart of a whale"), it will cause functional obstruction despite mechanically functioning well. This concept, originating from Rahimtoola, has received attention especially in aortic valve prostheses, but is also applicable to mitral prostheses. Crucial for mismatch considerations is the effective orifice area of the prosthesis, which is indexed by body surface area to yield the "indexed effective orifice area" in an individual patient. This effective orifice area is not to be confused with the manufacturer’s "internal geometric area", which, like the valve ring size, has only a loose relationship to effective orifice area. For example, for a bileaflet Sorin Bicarbon mechanical prosthesis size 21, the effective orifice area is only 1.66 cm², less than half the number calculated by assuming a circle of 21 mm diameter (which would come to 3.46 cm²). For aortic prostheses, an area of 0.85 cm²/m² body surface area is an accepted cut-off value below which patient–prosthesis mismatch is assumed, and a cut-off of 0.65 cm²/m² has been proposed for severe mismatch. Mild mismatch has been found in one third to one half of aortic valve replacements, and severe mismatch (indexed orifice area <0.65 cm²/m²) is present in <10% of patients. Moreover, the estimation of effective orifice area is difficult, at least in vivo, since it may not be flow independent and the calculation of effective orifice area, especially in bileaflet mechanical prostheses, is unreliable due to localised pressure gradients, as discussed in the section on obstruction. Effective orifice areas calculated by the continuity equation therefore are likely to underestimate true effective orifice area substantially.

Importantly, in a mechanical aortic prosthesis it is not possible to distinguish from Doppler data alone (that is, without additional baseline data and/or direct imaging of occluding disc motion):

1. High gradients due to localised pressure gradients in a normally functioning and not mismatched prosthesis
2. High gradients due to mechanical obstruction (thrombus, pannus)
3. High gradients due to patient–prosthesis mismatch, with a normally functioning valve, or
4. Any combination of 1–3.

Regurgitation

Regurgitation in a prosthetic valve is often difficult to assess. Mitral prostheses, especially mechanical ones, create acoustic shadowing of the left atrium...
when interrogated from the apical window, often precluding colour Doppler assessment of the left atrium. The parasternal and subcostal views should be used with particular care to look for a regurgitant jet in this situation. Moreover, more than mild regurgitation often is detectable by the proximal convergence zone on the ventricular, and thus unobstructed, side of a mitral prosthesis, and such convergence zones should be sought in all apical views. TOE is of particular value to assess mitral prosthetic regurgitation.

All currently implanted mechanical prostheses are designed to allow a minor amount of transvalvular leakage, which in the most common bileaflet valves is supposed to prevent stasis and thrombus formation at the leaflet hinges. This leakage is detectable throughout the interval in which the prosthesis is in the closed position, and thus is different from the “closure leakage” occurring early when the leaflets move to the closure position. Typically, the inbuilt prosthetic leakage creates characteristic jet patterns detectable on colour Doppler, especially by TOE, which arise at the hinge points in bileaflet valves or centrally—for example, in the Medtronic-Hall tilting disc valve. These jets are strictly transvalvular—that is, they occur within the sewing ring. They also are often too small to display a clearly aliased turbulence zone.

Regurgitant jets arising outside the sewing ring are due to paraprosthetic leaks, which can occur in any size and position along the prosthetic circumference (figs 10 and 11). Large paraprosthetic leaks lead to prosthetic dehiscence, which is a term used if the whole of the prosthesis develops a rocking motion due to insufficient support. Small paraprosthetic...
leaks observed intraoperatively after valve replacement may close over the next hours or days. Observation of a new paraprosthetic leak in a prosthesis is very suspicious of infective endocarditis. Finally, in rare instances, there may be massive transprosthetic regurgitation due to loss of structural integrity of the prosthesis—notoriously this occurred in a series of tilting disc valves that suffered from strut fractures, with subsequent disc embolisation and catastrophic regurgitation. Massive regurgitation can also occur if mechanical obstruction by thrombus or pannus freezes the occluder in a semi-open position. In bioprostheses, minor regurgitation is frequent and may increase in severity if degenerative changes (restricted leaflet motion or leaflet tears) ensue. Endocarditis is always a concern in a newly detected prosthetic regurgitation. Grading of severity of regurgitation follows the general principles for native valves.

Infective endocarditis
Cardiac valve prostheses carry a high risk of infective endocarditis. During the first year after implantation, the rate has been estimated to be 3%, and approximately 0.5%/year thereafter. Especially in mechanical prostheses, identifying small vegetations is very difficult. In bioprostheses, on the other hand, the presence of degenerative leaflet changes with thickening and increased echogenicity often makes it difficult or impossible to exclude incipient endocarditis with confidence. Moreover, an unsatisfactory sensitivity for the detection of paraprosthetic abscesses has been noted, which has not decreased substantially in spite of today’s higher image quality. Therefore, the clinical suspicion of endocarditis in a patient with a prosthetic valve should regularly lead to a transoesophageal examination, as recommended by the European guidelines. Much higher diagnostic accuracy for vegetations and in particular for abscess detection (fig 12) has been well documented for TOE.

Echocardiography follow-up after valve replacement: key points

- Echocardiography is the crucial and usually sufficient imaging technique in the follow-up of patients with valvular prostheses. Whenever prosthetic dysfunction or endocarditis is suspected, transoesophageal echocardiography (TOE) due to its higher diagnostic yield should be harnessed. Especially in aortic mechanical prostheses, occluder motion is often not well seen even by TOE and may necessitate fluoroscopy for precise assessment. Even normally functioning prostheses, except homografts and autografts, create some degree of obstruction to flow, and most exhibit some degree of regurgitation. Therefore, baseline echocardiographic assessment early postoperatively, when normal prosthetic function can be assumed, is extremely valuable for later comparison. This is of particular importance in the assessment of aortic transprosthetic gradients, which have a wide range of normalcy.
- Echocardiography, if necessary including TOE, should be promptly performed in newly symptomatic patients with valvular prostheses. Routine yearly echocardiographic examination is recommended after the fifth year in patients with a bioprosthesis.

FOLLOW-UP: WHEN AND HOW?
It is crucial that each patient who has received a valve replacement should receive a “baseline” echo
after the operation to be able to compare with subsequent findings. The examination should be performed at a time when the patient is haemodynamically stable, off ventilator or circulatory support and mobilised, with special attention to transprosthetic gradients and the presence of regurgitation; within 12 weeks after operation is the current recommendation, although it seems reasonable to perform this earlier—for example, before discharge from hospital. TOE is not routinely required if the prosthesis appears to function normally. Recently, the routine postoperative performance of TOE in patients with mitral mechanical prostheses has been advocated based on findings of clinically silent, postoperative thrombi in 10%, which predicted a higher adverse event rate during follow-up. However, it remains to be proven whether such a strategy would entail significant and beneficial changes in patient management.

Further regular follow-up should be planned. The intervals are largely arbitrary; current European guidelines stipulate yearly clinical examinations and transthoracic echocardiography should be performed if any new symptoms occur after valve replacement or if complications are suspected. Yearly echocardiographic examination is recommended after the fifth year in patients with bioprosthesis.

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Provenance and peer review: Commissioned; internally peer reviewed.

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5. Extension of the previous work, with important clinical consequences: a high transprosthetic gradient in an aortic prosthesis.
6. Usefulness for normal transprosthetic gradients in the tricuspid position.
7. Useful reference for normal transprosthetic gradients in the tricuspid position.
8. Important overview of detection and management of prosthetic thrombosis.
9. This study assessed how often mechanical occluder motion in aortic or mitral prostheses can be accurately evaluated by transthoracic or transesophageal echocardiography, against a standard of fluoroscopy.
10. Important large study with systematic postoperative TOE, finding a surprisingly high rate (almost 10%) of postoperative thrombus formation in mitral prostheses.

► The current, detailed, and authoritative recommendations for the management of valvular heart disease and prosthetic valves, from the European Society of Cardiology.


► Analysis of 1266 aortic valve replacements with regard to the implications of prosthesis size relative to patient size on short term prognosis.


► With a longer follow-up than the previous study, this paper describes functional and clinical implications of patient–prosthesis mismatch in the aortic position.


► Although mitral patient–prosthesis mismatch is a less common problem, in this study it was found to influence the postoperative course and prognosis.


► In over 1100 patients with aortic valve replacement, these authors did not see clear prognostic effects of patient–prosthesis mismatch.


► Another paper calling into question the clinical relevance of patient–prosthesis mismatch.


► Good editorial sketching the positions in the debate on the clinical relevance of patient–prosthesis mismatch.


► This study evaluated in vitro the colour Doppler patterns of regurgitant jets in normally functioning mechanical prostheses, establishing typical configurations of normal regurgitation in these prostheses.


► Excellent overview and recommendation paper on how to assess valvular regurgitation by echocardiography. The basis for looking at the more difficult evaluation of prosthetic regurgitation.


► Current recommendations on clinical management of endocarditis by the European Society of Cardiology; look out for the update.