Impact of Prosthesis-Patient Mismatch on Hemodynamic and Symptomatic Status, Morbidity and Mortality after Aortic Valve Replacement with a Bioprosthetic Heart Valve

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Background and aims of the study: Previous studies have shown that the effective orifice area of an aortic prosthetic valve may be too small in relation to the patient's body surface area, resulting in abnormally high gradients. The consequences of this condition, termed prosthesis-patient mismatch, have not been fully studied. The study objective was to determine if the condition has a detrimental effect on symptomatic and hemodynamic status, morbidity and mortality of patients undergoing aortic valve replacement.

Methods: A cohort of 392 patients was prospectively followed for up to seven years after implantation of a Medtronic Intact bioprosthesis. Doppler echocardiography was performed annually in 72 patients. Based on previous studies, presence of mismatch was defined as an indexed valve area ≤0.85cm²/m².

Results: Mismatch was associated with less postoperative improvement of NYHA functional class (p <0.009) independently of other predictors, such as age and preoperative functional class, but had no significant impact on patient survival (mismatch: 75 ± 4%, no mismatch: 79 ± 3%; p = 0.59) and valve-related morbidity up to seven years. Cardiac index was similar in patients with and without mismatch up to three years after operation but decreased significantly thereafter only in patients with mismatch (-0.54 ± 0.32 versus -0.17 ± 0.49 l/min/m²; p = 0.04). Likewise, the mean transprosthetic gradient, which was higher at one year after operation in patients with mismatch (22 ± 8 versus 15 ± 7 mmHg), increased significantly (+6 ± 6 versus +1 ± 1 mmHg; p = 0.008) only in this group during follow up.

Conclusions: Patients with mismatch have less symptomatic improvement and worse hemodynamics that continue to deteriorate with time. However, medium-term prognosis (up to seven years) is relatively good. Further studies are necessary to determine the longer-term effects of mismatch on morbidity and mortality.

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The size of a prosthetic valve should be proportional to the size of the patient because minimal pressure gradient or no gradient across the prosthetic valve is one of the principal objectives of valve replacement. The existence of prosthesis-patient mismatch at the time of implantation can be defined from the effective orifice area (EOA) of the prosthesis indexed for body surface area (1-4). In patients with native valves, it is generally well accepted that aortic stenosis is clinically relevant if the indexed EOA (EOAI) is ≤0.9 cm²/m² (5). Consequently, the objective of aortic valve replacement should be to ensure that the postoperative EOAI of a prosthesis is above this critical level in order to avoid residual stenosis.

Previous studies (2,6) have shown that prosthesis-patient mismatch had important detrimental effects on the hemodynamic status of patients with an aortic stented bioprosthesis. However, it was not possible to determine the impact of mismatch on patient's well-being and prognosis. The primary objective of this study was therefore to determine if prosthesis-patient mismatch influences the patients' functional class as well as postoperative morbidity and mortality rates. Our secondary objective was to determine if there was more deterioration of bioprosthetic valve hemodynamics in patients with mismatch compared with patients without mismatch.

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Clinical material and methods

Patient selection

A cohort of 392 patients who underwent aortic valve replacement with a Medtronic Intact bioprosthetic valve (Medtronic Cardiac Surgery, Minneapolis, MN) between October 1986 and July 1995 at the Quebec Heart Institute were included in this study. These patients had been prospectively followed as part of a protocol designed to evaluate the clinical and hemodynamic performance of this bioprosthesis. Double valve replacements were excluded because of possible interactions between concomitant mismatch in the aortic and mitral positions. In total, 129 patients (33%) had significant coronary artery disease and underwent concurrent coronary artery bypass graft surgery. The mean time interval since prosthetic valve implantation was 6.0 ± 2.2 years (range: 1.9 to 10.0 years; median 5 years).

Clinical follow up

The study protocol was approved by the ethical committee of the Quebec Heart Institute. Informed consent permitting clinical and hemodynamic follow up was obtained from each patient before surgery. Before heart valve replacement, demographic data, NYHA functional class, coexistent cardiovascular diseases, hemodynamics and surgical data were collected. After aortic valve replacement, each patient underwent an annual follow up including determination of NYHA functional class, a physical examination, measurement of heart rate and systemic arterial blood pressure, and standard 12-lead electrocardiography. The investigator in charge of NYHA class determination was unaware of the prosthetic size or in vitro prosthetic valve BOA.

Evaluation of morbid and fatal events was conducted by direct communication with the patient and with attending physicians, family physicians and specialists. Adverse clinical events were recorded and classified as recommended by the Society of Thoracic Surgeons (7). The occurrence of congestive heart failure from any cause was also recorded. Congestive heart failure was defined as a new event in which the heart failed to meet the circulatory requirements of the body under differing physiological circumstances, and/or a state in which cardiac output was reduced relative to the metabolic demands of the body, assuming the evidence of adequate venous return. Early mortality was defined as death from any cause during or within 30 days of the operation if the patient was discharged, or within any interval if the patient was not discharged. The clinical follow up was complete for 384 (98%) of the 392 patients.

Doppler echocardiographic follow up

Doppler echocardiography was performed annually in a subgroup of 72 patients by the same technician (Hewlett-Packard Sonos 500, 1000 or 1500 ultrasound system; Hewlett Packard, Kirkland, Quebec, Canada). Results were subsequently reviewed by the same cardiologist.

As previously described (2), peak and mean transprosthetic gradients were obtained from continuous-wave Doppler recordings of the aortic jet velocities from apical and right parasternal windows and application of the modified Bernoulli equation; stroke volume was calculated from the left ventricular outflow tract. Cardiac index was equal to SV x HR/BSA, where SV is stroke volume, HR is heart rate and BSA is body surface area (in m²).

Effective orifice area was determined by the standard continuity equation as follows:

$$BOA = \frac{SV}{VTI}$$

where VTI is the velocity-time integral of the aortic jet Doppler signal.

Data analysis

Estimation of prosthesis-patient mismatch

Presence of prosthesis-patient mismatch was defined on the basis of the BOAS at the time of implantation calculated from the median value of the in vitro BOA of the prosthesis divided by the patient's BSA (2,3). The median in vitro values for BOA in the Intact valve are 0.91, 1.15, 1.50, 1.80 and 2.22 cm² for 19, 21, 23, 25, 27 and 29 mm prostheses, respectively (2). A previous study from this laboratory (2) has shown a good correlation between in vivo and in vitro BOAs in patients with an Intact bioprosthesis. This is further confirmed by the results of the present study where the correlation between in vitro and vivo BOAs one year after operation in the 72 patients who underwent serial echocardiography was also very good ($r = 0.84$, $SEE = ± 0.15$ cm², $BOA_{vivo} = 0.95$, $BOA_{vivo} = 0.03$; $p < 0.0001$). An BOA ≤0.85 cm²/m² was considered as an evidence of mismatch based on previous studies demonstrating that the hemodynamic impact of prosthesis-patient mismatch becomes more significant when the BOAI is ≤0.85-0.90 cm²/m² (2,3,6). These values are also consistent with the generally accepted criteria defining clinically relevant aortic stenosis in native valves (5).

Statistical analysis

Continuous data were expressed as mean ± SD and compared using an analysis of variance for repeated measurements in order to study the effect of time since prosthesis implantation and the effect of prosthesis-patient mismatch. Categorical data were given as a percentage and compared with a Fisher's exact test.
Table 1: Comparison of preoperative and operative data in patients with and without evidence of prosthesis-patient mismatch.

<table>
<thead>
<tr>
<th>Mismatch (n = 178)</th>
<th>No mismatch (n = 214)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>55 (32%)</td>
<td>56 (26%)</td>
</tr>
<tr>
<td>Male</td>
<td>123 (68%)</td>
<td>158 (74%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>70 ± 9</td>
<td>67 ± 9</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>1.80 ± 0.18</td>
<td>1.69 ± 0.19</td>
</tr>
<tr>
<td>Dominant valvular dysfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stenosis</td>
<td>155 (87%)</td>
<td>175 (82%)</td>
</tr>
<tr>
<td>Regurgitation</td>
<td>9 (5%)</td>
<td>33 (15%)</td>
</tr>
<tr>
<td>Mixed dysfunction</td>
<td>14 (8%)</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>Concurrent coronary artery bypass graft</td>
<td>59 (33%)</td>
<td>70 (33%)</td>
</tr>
<tr>
<td>Prosthesis size (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>3 (2%)</td>
<td>1 (0.5%)</td>
</tr>
<tr>
<td>21</td>
<td>25 (14%)</td>
<td>4 (2%)</td>
</tr>
<tr>
<td>23</td>
<td>77 (43%)</td>
<td>34 (16%)</td>
</tr>
<tr>
<td>25</td>
<td>67 (38%)</td>
<td>87 (40.5%)</td>
</tr>
<tr>
<td>27</td>
<td>6 (3%)</td>
<td>73 (34%)</td>
</tr>
<tr>
<td>29</td>
<td>0 (0%)</td>
<td>15 (7%)</td>
</tr>
</tbody>
</table>

NS: Non-significant.

Product-limit analyses were performed to examine the time-dependent cumulative probabilities of the outcomes. The plots of the negative log of the survival function versus time revealed that the exponential model was not appropriate for the survival data. Consequently, the log rank tests with associated chi-square were used to test the hypothesis that there was no difference in survival functions between groups. A multiple stepwise Cox regression model was used to examine the predictive value of preoperative and operative variables considered to have associations with outcome. A forward stepwise regression analysis was used when the outcome variable was continuous (postoperative transprosthetic gradient and cardiac index).

The preoperative and operative variables tested in the multivariate analysis were the following: patient's age, gender and BSA, dominant valvular dysfunction, coexisting cardiovascular diseases, cardiac rhythm, NYHA functional class, concomitant surgical procedures, year of operation, prosthetic size, and the degree of mismatch estimated by the EOAI (continuous variable). The preoperative coexisting cardiovascular diseases or abnormalities included angina, coronary artery disease, previous myocardial infarction, history of systemic hypertension, history of pulmonary hypertension, left atrial enlargement, left ventricular abnormalities including left ventricular dilatation, abnormal left ventricular wall motion and reduced ejection fraction (<50%). Concomitant surgical procedures included coronary artery bypass graft and ascending aortic resection.

For all variables, all reported p-values are two-tailed and are significant at the 0.05 level. The statistical package program SAS (SAS Institute Inc., Cary, N.C.) was used to perform these analyses.

Table 2: Comparison of NYHA functional class (FC) in patients with and without evidence of prosthesis-patient mismatch.

<table>
<thead>
<tr>
<th>Postoperative change in FC</th>
<th>Preoperative FC (n = 392)</th>
<th>1 Year (n = 299)</th>
<th>3 Years (n = 216)</th>
<th>5 Years (n = 92)</th>
<th>7 Years (n = 53)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mismatch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(EOAI &gt;0.85 cm²/m²)</td>
<td>3.1 ± 0.6</td>
<td>-1.8 ± 0.8*</td>
<td>-1.8 ± 0.8*</td>
<td>-1.9 ± 0.8*</td>
<td>-2.0 ± 0.8*</td>
<td>0.009</td>
</tr>
<tr>
<td>Mismatch</td>
<td>3.1 ± 0.5</td>
<td>-1.6 ± 0.8*</td>
<td>-1.5 ± 0.8*</td>
<td>-1.5 ± 0.8*</td>
<td>-1.6 ± 0.8*</td>
<td></td>
</tr>
</tbody>
</table>

Data are given as mean ± SD.

EOAI: Indexed effective orifice area at the time of implantation.

*Significant difference between groups; †significant difference compared with preoperative value.
Table III: Multivariate analysis of preoperative and operative determinants of patient New York Heart Association (NYHA) functional class after prosthesis implantation.

<table>
<thead>
<tr>
<th>Determinant</th>
<th>1 Year (n = 299)</th>
<th>3 Years (n = 216)</th>
<th>5 Years (n = 92)</th>
<th>7 Years (n = 53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age at implantation</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.001</td>
</tr>
<tr>
<td>Preoperative NYHA class</td>
<td>0.002</td>
<td>0.003</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Preoperative systemic hypertension</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.015</td>
</tr>
<tr>
<td>Preoperative left ventricular dilatation</td>
<td>0.007</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>EOAI</td>
<td>0.005</td>
<td>0.004</td>
<td>0.0007</td>
<td>NS</td>
</tr>
</tbody>
</table>

*p-values for preoperative or operative factors that were significant in the multivariate analysis.
EOAI: Indexed effective orifice area at the time of implantation (degree of mismatch).
NS: Non-significant at this time of the follow up.

Results

Among the 392 patients, the EOAI at the time of implantation was >1.05 cm²/m² in 36 patients (9.2%), 0.86-1.05 cm²/m² in 178 patients (45.4%), 0.66-0.85 cm²/m² in 167 patients (42.6%) and ≤0.65 cm²/m² in 11 patients (2.8%). Based on our definition (EOAI ≤0.85 cm²/m²), the overall prevalence of mismatch in this cohort was therefore 46%.

Preoperative determinants of mismatch

Table I shows preoperative and operative data in patients with and without evidence of mismatch. The only significant preoperative or operative determinants of mismatch in the multivariate analysis were patient's BSA (p = 0.012), age (p < 0.001) and prosthesis size (p <0.001).

Impact of mismatch on NYHA functional class

On average, NYHA functional class before surgery was similar in patients with and without evidence of mismatch (Table II). After surgery, however, functional class improved significantly (p < 0.001) in both groups, though there was significantly (p = 0.009) less improvement in patients with evidence of mismatch.

In the multivariate analysis (Table III), the only factors that independently influenced postoperative functional class were patient age at implantation, preoperative NYHA functional class, preoperative presence of systemic arterial hypertension (systolic arterial pressure ≥140 mmHg and/or diastolic arterial pressure ≥90 mmHg), preoperative left ventricular dilatation (left ventricular end-diastolic diameter ≥57 mm) and EOAI, i.e. degree of mismatch at implantation. The degree of mismatch had the most consistent influence with a sig-

Table IV: Comparison of postoperative Doppler echocardiographic data in patients with and without evidence of prosthesis-patient mismatch.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline 1 Year (n = 72)</th>
<th>Changes during follow up</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 Years (n = 45)</td>
<td>5 Years (n = 26)</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No mismatch (EOAI &gt;0.85)</td>
<td>15 ± 6*</td>
<td>+2 ± 4</td>
<td>+0 ± 5</td>
</tr>
<tr>
<td>Mismatch (EOAI ≤0.85)</td>
<td>22 ± 8*</td>
<td>+2 ± 9</td>
<td>-1 ± 9</td>
</tr>
<tr>
<td>Prosthetic EOA (cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Mismatch (EOAI &gt;0.85)</td>
<td>1.48 ± 0.29*</td>
<td>-0.14 ± 0.18*</td>
<td>-0.16 ± 0.30</td>
</tr>
<tr>
<td>Mismatch (EOAI ≤0.85)</td>
<td>1.24 ± 0.21*</td>
<td>-0.08 ± 0.16*</td>
<td>-0.16 ± 0.15*</td>
</tr>
<tr>
<td>Cardiac index (l/min/m²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No mismatch (EOAI &gt;0.85)</td>
<td>3.04 ± 0.45</td>
<td>-0.06 ± 0.53</td>
<td>-0.17 ± 0.49*</td>
</tr>
<tr>
<td>Mismatch (EOAI ≤0.85)</td>
<td>2.90 ± 0.68</td>
<td>-0.11 ± 0.80</td>
<td>-0.54 ± 0.32*</td>
</tr>
</tbody>
</table>

Data are given as mean ± SD.
EOAI: Effective orifice area; EOAI: indexed effective orifice area (cm²/m²) at the time of implantation.
*Significant difference between groups; †significant difference compared with baseline.
significant negative impact at all follow-up intervals except seven years, whereas preoperative functional class had such impact only at one and three years, and

patient age and preoperative systemic arterial hypertension only at seven years. The other factors tested in the multivariate analysis and found to have no independent influence on postoperative NYHA functional class were patient gender and BSA, dominant valvular dysfunction, other coexisting cardiovascular diseases, cardiac rhythm, concomitant surgical procedures, year of operation and prosthesis size.

Impact of mismatch on mortality and morbidity

The early (30-day) mortality rate was 2% in patients with mismatch compared with 3% in those with no evidence of mismatch. Late (seven-year) survival rates tended to be lower in patients with mismatch (75 ± 4% versus 79 ± 3%) but this difference was not statistically significant (Fig. 1). Also, no significant difference was observed for freedom from structural valve deterioration (p = 0.45), paravalvular leak (p = 0.25), thromboembolism (p = 0.44) and prosthetic valve endocarditis (p = 0.91). At seven years after surgery, freedom from valve-related reoperation was 93 ± 2% in patients with mismatch and 95 ± 2% in those without mismatch (p = 0.50).

Freedom from congestive heart failure due to any cause was lower (p = 0.05) in patients with evidence of mismatch (85 ± 3% versus 93 ± 2% at five years and 84 ± 3% versus 89 ± 3% at seven years). However, there was no independent predictor of heart failure when
mismatch was compared in the multivariate analysis with the following preoperative and operative factors: age, gender, BSA, preoperative presence of cardiovascular diseases and abnormalities, and concomitant surgical procedures.

Impact of mismatch on valve hemodynamic performance

Table IV provides hemodynamic data one year after surgery (baseline) and subsequent changes observed in the subgroup of 72 patients followed longitudinally using Doppler echocardiography. The prevalence of prosthesis-patient mismatch in this subgroup was similar (40%) to that of the principal cohort. As expected, the mean transprosthetic gradient at baseline was higher in patients with mismatch. During follow up, a significant increase in mean gradient was observed only in patients with mismatch. Further breakdown of gradients in relation to EO AI (Fig. 2) shows that the increase in gradient over time is greater in patients with the most severe mismatch.

Absolute values for EO AI at one year after operation were lower (1.24 ± 0.21 cm² versus 1.48 ± 0.29 cm², p <0.001) and BSA was larger (1.80 ± 0.18 m² versus 1.69 ± 0.19 m², p = 0.012) in patients with EO AI ≤ 0.85 cm²/m², suggesting that mismatch in this cohort was due to the combined effects of a larger BSA and a relatively smaller aortic annulus. EO AI decreased similarly over time in both groups.

Cardiac index was normal and did not change during the first years of follow up in either group, but decreased thereafter only in patients with mismatch. This decrease was more pronounced in patients with the most severe mismatch (Fig. 3). Furthermore, in the multivariate analysis, the EO AI was the only significant determinant (p = 0.04) of postoperative cardiac index.

Discussion

Preoperative determinants of prosthesis-patient mismatch

By definition, prosthesis-patient mismatch is due to a disproportion between prosthesis size and patient's size (too small a prosthesis for the patient's cardiac output requirement as estimated by their BSA), resulting in abnormally high transprosthetic gradients. The extent of mismatch can be estimated by calculating the EO AI, which has been shown to be the most potent predictor of postoperative transprosthetic gradients in patients with a normally functioning prosthesis (1,2,4). The results of this study confirm that mismatch is not necessarily a rare phenomenon in patients with a stented bioprosthesis valve since, by using a relatively conservative definition (EO AI ≤ 0.85 cm²/m²), it was observed in almost half of the patients in our cohort. The results in the subgroup of patients undergoing Doppler echocardiography also confirm that mismatch is associated with relatively high postoperative gradients. The long-term consequences of these gradients are unknown.

Impact of mismatch on NYHA functional class

An important result of this study is that mismatch has a negative impact on NYHA functional class improvement after operation. Multivariate analysis suggests that age, preoperative functional class, hypertension and left ventricular dilatation also have an influence, but it appears that mismatch has the most significant and consistent influence. The observation of a lower cardiac index and higher gradients in the subgroup of patients with mismatch and longitudinal echocardiographic follow up is also consistent with the lesser improvement in functional class in these patients.

Impact of mismatch on morbidity and mortality

Despite the adverse effects of mismatch on hemodynamics and postoperative functional class, the present study failed to demonstrate a clear negative impact of mismatch in medium-term (up to seven years) mortality and morbidity. This contrasts somewhat with the results of Kratz et al. (8) who reported that mortality 10 years after surgery was higher when a small (19 or 21 mm) St. Jude aortic prosthesis was implanted in patients with a BSA >1.9 m². Based on normal EO AI values reported for the St. Jude prosthesis, the EO AIs of 19- or 21-mm prostheses inserted in a patient with a BSA of 1.9 m² would be 0.64 cm²/m² and 0.95 cm²/m², respectively (9). It is, however, possible that mechanical prostheses have a more fixed EO AI and less potential for improvement during exercise, therefore resulting in more important increase in gradient with exercise.

A recent transversal study in 61 patients (6) showed that the occurrence of adverse clinical events not related to the valve was significantly higher in patients with an EO AI ≤ 0.85 cm²/m² (50% versus 21%; p = 0.02). The present study suggests that the long-term effect of mismatch could predispose to the development of heart failure whether or not it is related to the prosthetic valve. However, this result should be interpreted cautiously because the multivariate analysis did not reveal any significant predictor of postoperative heart failure. It is therefore difficult to be certain that the difference between the two groups was related to the presence of mismatch or to other undetermined factors.

Evaluation of prosthesis hemodynamics

The present longitudinal study provided new infor-
mation about the evolution of postoperative transprosthetic gradient and cardiac index as a function of the degree of mismatch and time interval since prosthesis implantation. The effect of mismatch on the transprosthetic gradient was already evident at one year after valve replacement (Table IV; Fig. 2). Thereafter, the gradient increased with time only in patients with evidence of mismatch, although there was a similar decrease in EOA and a higher decrease in cardiac index compared with patients without evidence of mismatch. In this context, it must be emphasized that the relation between the transvalvular pressure gradient and the EOA is exponential (1,2) and that, for an equivalent decrease in EOA, the increase in gradient is much more important in patients with a lower EOA, particularly if the EOA is ≤0.85 cm²/m². Hence, the greater increase in gradients observed in patients with mismatch is not necessarily due to more extensive degeneration of the prosthesis per se.

Clinical implications
To prevent prosthesis-patient mismatch, the surgical considerations include choosing a prosthesis with a large EOA, implanting the prosthesis in a supra-annular position and, if this is insufficient, enlarging the aortic annulus (10). Aortic valve replacement with a stentless bioprosthesis or a high-performance bileaflet or monostrut mechanical valve could be a good alternative to prevent mismatch. Recent advances in bileaflet valve design have considerably improved hemodynamic performance, especially in small sizes (11,12). Stentless bioprostheses show excellent hemodynamics due to their large internal diameter and high flexibility (13-16). Surgical alternatives such as supra-annular implantation and enlargement of the aortic root generally permit the insertion of a prosthesis that is one or two sizes larger than that normally implanted in a small aortic annulus (17-19).

At present, it is difficult to conclude that the benefit of avoiding prosthesis-patient mismatch would overcome the drawbacks associated with the enlargement of the aortic root, such as longer duration of cardiopulmonary bypass and higher postoperative blood loss. However, a recent study (20) suggested that long-term mortality and morbidity after aortic annular enlargement might be superior to those after standard aortic valve replacement with a small prosthesis.

Limitations of the study
The findings of this study are partly based on the subjective evaluation of NYHA functional class rather than on objective evaluation of functional capacity. This drawback is partially offset by the large number of patients included in this study, the fact that the clinician evaluating the patient was unaware of the presence or absence of mismatch, and that a highly significant statistical difference was found for this variable.

The absence of impact of mismatch on morbidity and mortality must be considered in the context that this is a medium-term study and that there were relatively few adverse events. In fact, there seems to be some tendency, although not yet significant, for mismatch adversely to affect mortality as well as the incidence of heart failure, and it is possible that these results might become significant in the longer term.

Given the extent of changes that were observed, longer-term studies will also be necessary to determine if the greater increase in transvalvular pressure gradient observed in patients with mismatch is due to a more important intrinsic deterioration of the prosthesis rather than simply to the fact that a similar decrease in EOA results in greater increase in gradient in patients with mismatch.

Residual left ventricular hypertrophy may adversely affect long-term outcome after aortic valve replacement. In our study, it was not possible to study the effect of mismatch on the regression of ventricular hypertrophy because preoperative or early postoperative baseline measurements of left ventricular mass were not available. However, a recent study demonstrated that the persistence of moderate pressure gradients (peak gradient 20 ± 1.5 mmHg) across stented bioprosthetic valves or mechanical valves results in significantly lesser regression of ventricular hypertrophy and lesser improvement of left ventricular function than occurs in aortic homografts (8 ± 1.2 mmHg) or stentless bioprosthetic valves (6 ± 1.0 mmHg) (15). In conclusion, the present study demonstrates that patients with evidence of prosthesis-patient mismatch have less symptomatic improvement and worse hemodynamics after aortic valve replacement. Furthermore, the hemodynamic status progressively deteriorates during follow up. Nonetheless, medium-term outcome with regard to postoperative morbidity and mortality seems relatively favorable in these patients. Longer-term studies are necessary to determine if the tendencies to higher morbidity and mortality and deterioration of hemodynamic performance will increase with time. Other studies are also necessary to determine if the hemodynamic and clinical impact of mismatch is different in patients with other types of valves such as mechanical valves or stentless bioprosthetic valves.

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References