EDITORIAL

Prevention of Moderate Prosthesis-Patient Mismatch: Individualization Versus Generalization

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In this issue of Revista Española de Cardiología, Urso et al[1] analyze the impact of moderate prosthesis-patient mismatch (PPM) on 30-day mortality following aortic valve replacement (AVR) in 272 patients aged 66 to 76 years (median age, 72 years). In the opinion of the authors, justification for the study is based on the fact that there is still some uncertainty as to whether moderate PPM independently influences survival and should thus be a consideration when operating on these patients given that, in this situation, the main conundrum faced by the surgeon is either to carry out an annular enlargement procedure, which may increase surgical risk, or to carry out the operation with the prosthesis as initially chosen and accept the consequences of moderate PPM. Having indeed found no difference between patients with and without moderate PPM, they imply in their conclusion that the importance of moderate PPM may have been overemphasized in the past and that it may not be an important consideration after all.

Our spontaneous reaction after reading this paper is 2-fold. First, we are impressed by the fact that none of the patients in this series had severe PPM. This finding is confirmation that the prevalence of severe PPM has decreased substantially over the last decade due to: *a)* generalized recognition and awareness that, notwithstanding associated conditions, severe PPM is definitely associated with adverse outcomes and that it should thus be avoided in all patients undergoing AVR; *b)* widespread implementation of the preventive strategy utilized to calculate the projected indexed effective orifice area of the prosthesis to be implanted so that alternative strategies may be adopted if severe PPM is anticipated; and *c)* improved design and hemodynamic performance of newer generation prostheses. On the other hand, we are somewhat surprised that such findings and the conclusion are being reported by this particular group. Indeed, Urso et al[1] have previously published 2 papers on the same topic[2,3] and their conclusions and implications appear to be significantly different from the present ones. Hence, in a series of 163 patients over 75 years old, they reported that moderate PPM did not have a negative impact on mid-term mortality but was associated with a significant reduction of the quality of life[2] and we agreed at the time that these findings could become a justification for avoiding moderate PPM in patients with a good functional class if this could be accomplished at an acceptable risk/benefit ratio.[4] As well, in another study based on an extensive review of the literature, they concluded that severe PPM was generally associated with poor outcomes and should ideally be avoided in all cases, whereas moderate PPM could be an independent risk factor of early and mid-term overall survival in the subgroup of patients with associated left ventricular (LV) dysfunction.[3] From the latter 2 papers, one could logically have surmised that there are definite advantages to avoiding moderate PPM in certain circumstances and that the decision in this regard should be individualized depending on the patient's underlying condition and the risk-benefit ratio of altering the originally planned operative strategy. Surprisingly, the present paper seems to backtrack from this more sophisticated approach and rather presents a generalization that can easily be interpreted as implying that moderate PPM is not an important consideration in the operative strategy of patients undergoing AVR and can thus almost be ignored in all cases.

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Influence of Prosthesis-Patient Mismatch on Outcomes

The impact of PPM on outcomes is highly dependent on its degree of severity.[2,5] Hence, it is generally accepted that severe PPM, representing an obstruction akin to severe aortic stenosis, may

have detrimental effects regardless of the patient's preoperative characteristics and should thus be avoided in all cases. Fortunately, and as mentioned above, its prevalence is significantly decreasing. On the other hand, the impact of moderate PPM on outcomes is more pronounced in younger patients and in patients with LV dysfunction and/or severe LV hypertrophy, whereas it is generally well tolerated and has less impact in elderly sedentary patients with normal LV function. As a whole and from the pathophysiological standpoint, these findings are consistent with the fact that the occurrence of adverse outcomes in such situations is most likely related to an imbalance between cardiac reserve and the increased load with which the ventricle must cope. Hence, the increased hemodynamic burden imposed by moderate PPM is likely to be less well tolerated by a poorly functioning ventricle than by a normal ventricle. Likewise, the fact that the impact of PPM is more pronounced in young patients than in older ones is probably related to the fact that younger patients have higher cardiac output requirements and are exposed to the risk of PPM for a longer period of time. Finally, for an equivalent degree of PPM, overall LV hemodynamic load will be higher in patients with decreased arterial compliance and/or concomitant hypertension due to ventricular-arterial coupling; likewise, such patients are likely to have more severe concentric LV hypertrophy and a paradoxical decrease in cardiac output due to a restrictive physiology.[6] In this context, the findings of Urso et al[1] are the other side of the coin in that they show that the concept of moderate PPM and adverse outcomes cannot be generalized to fit the whole population. However, the practical implications are very limited since there are many other factors that need to be taken into account when considering the influence of moderate PPM in the individual patient. In fact, as presented, the conclusion may easily lead to a risky misinterpretation, i.e. that, regardless of patient characteristics including age, degree of physical activity, LV function, presence of decreased arterial compliance, etc., moderate PPM should never be a concern in patients undergoing AVR and can be ignored altogether.

Individualization Versus Generalization for the Prosthesis-Patient Mismatch Preventive Strategy

The aforementioned considerations draw attention to the importance of individualizing the PPM preventive strategy according to: *a)* the baseline characteristics of the patient; *b)* the anticipated severity of PPM; and *c)* the estimated risk/benefit ratio of the alternative procedure that is contemplated to prevent PPM or reduce its severity. As reiterated by Urso et al[1] in their discussion, it is widely accepted that it is possible to predict the occurrence and severity of postoperative PPM by calculating, at the time of the operation, the projected indexed effective orifice area of the prosthesis to be implanted, and we indeed believe that, given its simplicity and rapidity, this exercise should be performed in every patient undergoing AVR. Depending on the result, if moderate PPM is anticipated in a patient with certain characteristics (eg, depressed LV function and/or severe LV hypertrophy, young age, athletic lifestyle, and, as previously demonstrated by Urso et al,[2] an elderly patient seeking enhanced quality of life) or a severe PPM in any given patient, the following strategies can be considered: *a)* the implantation of a prosthesis with a better hemodynamic performance (eg, a newer generation of stented bioprosthesis or bileaflet mechanical valves implanted in a complete supra-annular position or a stentless bioprosthesis); or *b)* the performance of an aortic root enlargement, allowing the implantation of a larger size of the same type of prosthesis. Unfortunately, the leitmotiv used to justify recent papers[1,7] on moderate PPM has been based on the false premise that the first-line strategy, if not the only option, for avoiding PPM is aortic root enlargement, which may carry an increased operative mortality, particularly in the elderly. In reality, given the significant improvements in design leading to the availability of a newer generation of mechanical or biological prostheses, contemporary prevention of PPM can largely be accomplished by the implantation of prosthetic models providing a better hemodynamic performance. Indeed, several recent studies have shown that PPM can be successfully avoided, or its severity reduced, by using such a strategy, and Table 1 is an obvious illustration of the fact that, for a given patient annulus size, the effective orifice area and, thus, the resulting hemodynamic performance can vary widely from one prosthesis type to the other. Hence, it should be reiterated that aortic root enlargement should be considered not as the first option but as the last resort, i.e. only when PPM, and, particularly, severe PPM, cannot be avoided by using a prosthesis with a better hemodynamic performance, and when the risk/benefit ratio of carrying out such a procedure is considered advantageous given the patient's overall situation.

An important pitfall with regard to the interpretation of the present study would thus be to attempt to find implications that can be applied in general to the entire population with moderate PPM. Indeed, the data published in the literature shows us that it is wrong to state that PPM has a detrimental impact in all patients, as it is also wrong to conclude that PPM is benign in all patients,

TABLE 1. **Normal Reference Values of Effective Orifice Areas for Aortic Valve Prostheses**

Prosthetic Valve Size, mm	19	21	23	25	27	29
Stented aortic bioprostheses						
Mosaic, mean (SD)	1.1 (0.2)	1.2 (0.3)	1.4 (0.3)	1.7 (0.4)	1.8 (0.4)	2.0 (0.4)
Hancock II, mean (SD)	–	1.2 (0.1)	1.3 (0.2)	1.5 (0.2)	1.6 (0.2)	1.6 (0.2)
Carpentier-Edwards Perimount, mean (SD)	1.1 (0.3)	1.3 (0.4)	1.50 (0.4)	1.80 (0.4)	2.1 (0.4)	2.2 (0.4)
Carpentier-Edwards Magna, mean (SD)	1.3 (0.3)	1.7 (0.3)	2.1 (0.4)	2.3 (0.5)	–	–
Biocor (Epic), mean (SD)	–	1.3 (0.3)	1.6 (0.3)	1.8 (0.4)	–	–
Mitroflow, mean (SD)	1.1 (0.1)	1.3 (0.1)	1.5 (0.2)	1.8 (0.2)	–	–
Stentless aortic bioprostheses						
Medtronic Freestyle, mean (SD)	1.2 (0.2)	1.4 (0.2)	1.5 (0.3)	2.0 (0.4)	2.3 (0.5)	–
St. Jude Medical Toronto SPV, mean (SD)	–	1.3 (0.3)	1.5 (0.5)	1.7 (0.8)	2.1 (0.7)	2.7 (1.0)
Mechanical aortic prostheses						
Medtronic-Hall, mean (SD)	1.2 (0.2)	1.3 (0.2)	–	–	–	–
Medtronic Advantage, mean (SD)	–	1.7 (0.2)	2.2 (0.3)	2.8 (0.6)	3.3 (0.7)	3.9 (0.7)
St. Jude Medical Standard, mean (SD)	1.0 (0.2)	1.4 (0.2)	1.5 (0.5)	2.1 (0.4)	2.7 (0.6)	3.2 (0.3)
St. Jude Medical Regent, mean (SD)	1.6 (0.4)	2.0 (0.7)	2.2 (0.9)	2.5 (0.9)	3.6 (1.3)	4.4 (0.6)
MCRI On-X, mean (SD)	1.5 (0.2)	1.7 (0.4)	2.0 (0.6)	2.4 (0.8)	3.2 (0.6)	3.2 (0.6)
Carbomedics Standard, mean (SD)	1.0 (0.4)	1.5 (0.3)	1.7 (0.3)	2.0 (0.4)	2.5 (0.4)	2.6 (0.4)

Table adapted from Pibarot et al.[5]

and especially in all elderly patients. This again underscores the need to individualize the PPM preventive strategy with regards to the particularities of each case. Hence, it may be reasonable to accept moderate PPM in elderly sedentary patients with good LV function and in whom the strategy to avoid PPM is deemed to represent added risk. On the other hand, for patients in whom moderate PPM is perceived to be potentially detrimental (see the aforementioned conditions), the risk/benefit ratio of adopting an alternative strategy should be taken into consideration.

Conclusion

In light of previous studies reported by these authors[2,3] and others, the present study by Urso et al[1] indirectly provides further confirmation that no generalization can be made with regard to the prevention of moderate PPM. Hence, it would be a major error, in our opinion, to extrapolate the findings of the present study to fit all patients presenting with this entity.

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