Letters to the Editor

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Small aortic annulus: The hydrodynamic performances of 5 commercially available tissue valves *To the Editor:*

We are writing to comment on the study by Gerosa and associates¹ published in a recent issue of the *Journal*.

This highly interesting report compared geometric dimensions and hemodynamic performance of 5 different stented tissue valves for aortic valve replacement. Three pericardial bioprostheses (Carpentier-Edwards Perimount Magna [Edwards Lifesciences, Irvine, Calif], Sorin Soprano, and Sorin Mitroflow [Sorin Biomedica Spa, Saluggio, Italy]) and 2 porcine bioprostheses (Medtronic Mosaic [Medtronic, Inc, Minneapolis, Minn] and St Jude Medical Epic Supra [St Jude Medical, Inc, St Paul, Minn]) were tested at cardiac outputs of 2, 4, 5, and 7 L/min. So that a meaningful comparison could be made, prostheses that could be fitted in a 21-mm pulse duplicator ring were used, regardless of industry-labeled valve size. This addresses a very important issue that we try to solve for in vivo comparisons of different valve types by calculating the “effective orifice fraction,” which is the ratio of the intraoperatively measured aortic annulus area and the echocardiographically obtained effective orifice area of the prosthesis.^{2,3}

In our opinion, one of the most striking results of the study by Gerosa’s group was the finding that even some of the geometric dimensions given by the manufacturers could not be reproduced by direct measurements, such as the internal or the tissue annulus diameter of certain bioprostheses.

The authors state that there are some discrepant findings compared with in vivo results published by our group: We found that in some patients the implantation of a Medtronic Mosaic valve labeled one size bigger than the Carpentier-Edwards Perimount valve was possible because of the smaller geometric dimensions of this valve.⁴ In the described in vitro setting, upsizing of the Medtronic Mosaic compared with the Carpentier-Edwards Peri-

mount Magna was not possible. This corresponds to our in vivo findings, because the Carpentier-Edwards Perimount Magna has a 3-mm smaller sewing ring diameter than the Carpentier-Edwards Perimount for the identical labeled valve size. Thus, the hemodynamic benefit of the Carpentier-Edwards Perimount Magna valve results from the possibility of upsizing.⁵

The second cited manuscript from our group³ is a prospective, nonrandomized comparison of 3 completely supra-annular prostheses (Carpentier-Edwards Perimount Magna, Medtronic Mosaic, and Sorin Soprano) with one intrasupra-annular valve (Carpentier-Edwards Perimount). These again were in vivo comparisons in which the sewing ring dimensions and the aortic root anatomy played a decisive role in the selection of a certain valve size. The basic findings of this work were that in patients with an aortic annulus of 18 to 20 mm in diameter (intraoperative direct measurements with a Hegar dilator), no significant hemodynamic differences between the investigated prostheses were present, whereas in patients with an annulus diameter between 21 and 23 mm, the Carpentier-Edwards Perimount Magna showed superior hemodynamic results compared with the other prostheses because of the beneficial ratio of sewing ring and internal orifice diameters. We disagree with the statement of Gerosa’s group that these conclusions would clash with their in vitro data. In our opinion, the decision that leads to the selection of a certain valve size in a complex anatomic structure, such as the aortic annulus in combination with prosthesis dimensions including stent height, sewing ring diameter, complete supra-annular position, and anatomic relation to the coronary ostia, is responsible for the different findings (Figure 1).

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Figure 1. The schematic drawing shows two aortic root anatomies with an identical tissue annulus diameter (TAD). The *right figure* shows a more bulbous-shaped root. This is the ideal situation for complete supra-annular placement, in which the TAD corresponds to the internal orifice diameter (IOD) of the prosthesis (TAD = IOD). The *left figure* shows a narrow aortic root. Despite the same TAD, a completely supra-annular valve of the same size (gray) would not fit in. Thus a smaller valve (white) has to be chosen with the consequence that, despite implanting a completely supra-annular prosthesis, stent and sewing ring material impair the bloodstream. Thus the shape of the aortic root does not allow the implantation of a valve large enough to ensure that the IOD corresponds to the TAD. This illustrates the hypothesis that hemodynamic benefit cannot be achieved in every aortic root because of a completely supra-annular placement of the prosthesis. ESRD, External sewing ring diameter.

Walter Eichinger reports lecture fees from Edwards Lifesciences and St Jude Medical. Ruediger Lange reports lecture fees from Edwards Lifesciences and the Sorin Group.

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Reply to the Editor:

We appreciate the comments of Eichinger, Hettich, and Lange on our recent article reporting on in vitro performances of 5 different aortic tissue valves designed for supra-annular implantation.¹

We agree that the complex aortic root anatomy is responsible for different findings and different prosthesis fittings, because larger sewing rings and higher profiles may play a crucial role in terms of encumbrance in the sinus portion of the aorta. We selected the largest prostheses of each model that could be fitted in a 21-mm valve holder regardless of the manufacturer's size. We observed that the valves with the more advantageous ratio between internal orifice versus tissue annulus-sewing ring diameters were the Sorin Mitroflow (Sorin Biomedica Spa, Saluggia, Italy) and the Carpentier-Edwards Magna bioprostheses (Edwards Lifesciences, Irvine, Calif). Unfortunately, the Mitroflow valve has not been studied by Eichinger, Hettich, and

Lange. Nevertheless, comparing the hydrodynamic performances of the Sorin Soprano versus the Carpentier-Edwards Magna, we did not observe significant differences between the two valves, such as those observed by this group in vivo.² Eichinger's group highlights the beneficial ratio between internal and sewing ring diameters as well as the hemodynamic performances of the Carpentier-Edwards Magna valve. In vivo, the beneficial effect was observed only when comparing patients with a larger tissue annulus diameter (between 21 and 23 mm); surprisingly, this benefit disappeared for the smaller diameters (18-20 mm). We believe that the beneficial ratio between internal orifice diameter and sewing ring diameter is valid also for 19- or 21-mm prostheses and not only for the larger prosthesis sizes. Moreover, since the upsizing of the Medtronic Mosaic (Medtronic, Inc, Minneapolis, Minn) versus the Carpentier-Edwards Magna prosthesis was not possible in our in vitro study, we maintain that the hemodynamic benefit, observed in vivo with the Carpentier-Edwards prosthesis in comparison with the Medtronic Mosaic by Eichinger and coauthors,³ results mostly from the different internal orifice diameters and tissue annulus diameters rather than from the prosthesis up-