Proposal for computer tomography-based valve sizing and prosthesis simulation in endoscopic aortic valve surgery

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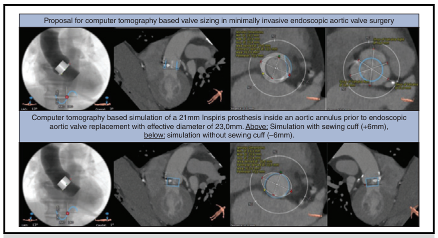

Digital simulation of surgical bioprostheses inside aortic annuli.

CENTRAL MESSAGE

In endoscopic aortic valve replacement, direct sizing is not practical. We propose digital simulation of surgical prostheses into computed tomography-based aortic valve reconstructions.

In transcatheter aortic valve replacement (AVR), computed tomography- (CT) based annular sizing is standard of care.[1] The most commonly used application is 3mensio (3mensio Medical Imaging BV). CT-based annular sizing and correlation with direct intraoperative sizing has been investigated.[2-4] However, due to the possibility of direct intraoperative sizing in open aortic valve replacement (AVR), CT-based annular sizing is not common. In endoscopic aortic valve replacement (Endo-AVR) via right anterior minithoracotomy, surgical incisions have become so small that direct intraoperative sizing is unpractical. Also, preoperative CTs are routinely performed. We created digital phantoms of surgical prostheses using company-given details of the prostheses (Table 1) and created STL files that can be imported into 3mensio and be used as digital phantoms (Figure 1). Due to the flexibility of the cuff, 2 different phantoms are used for each prosthesis, 1 with—and 1 without—a sewing cuff. The sewing cuff may formally add 6 to 7 mm but due to its flexibility it may not use this amount of space. For example, a 21-mm Inspiris (Edwards Lifesciences) fits into an aortic annulus with an area-derived diameter of 23.0 mm (Figure 2). In these examples, we simulated the phantom retrospectively (Figure 3). Whereas echocardiography images may give us an average diameter, we cannot simulate digital phantoms of surgical bioprostheses and CT images give us a much better idea of annular anatomy. It not only shows annular size, but also anomalies of coronary ostia, shallow aortic sinuses (important for later valve-in-valve), left ventricular outflow tract area, and aortic/annular degree of calcifications. We propose routine use of digital simulation before Endo-AVR as a substitute for direct intraoperative sizing; however, further studies are needed as to the diameter of the sewing cuff. This technique eases procedural steps for endoscopic surgeons.

TABLE 1. Examples of company-given diameters used for the creation of STL files

Label size	Valve model	Stent internal diameter, mm	Stent outer diameter, mm	External sewing ring diameter, mm	Profile height
21	Magna Ease*	20	21	26	14
	Inspiris Resilia*	20	21	27	14
	Avalus†	19.5	21	29	14
	Hancock II Ultra†	18.5	21	26	15
23	Magna Ease	22	23	28	15
	Inspiris Resilia	22	23	29	15
	Avalus	21.5	23	31	15
	Hancock II Ultra	20.5	23	28	16
25	Magna Ease	24	25	30	16
	Inspiris Resilia	24	25	32	16
	Avalus	23.5	25	33	16
	Hancock II Ultra	22.5	25	30	17.5
27	Magna Ease	26	27	32	17
	Inspiris Resilia	26	27	34	17
	Avalus	25.5	27	36	17
	Hancock II Ultra	24	27	32	18.5

*Edwards Lifesciences. †Medtronic.

Conflict of Interest Statement

The authors report no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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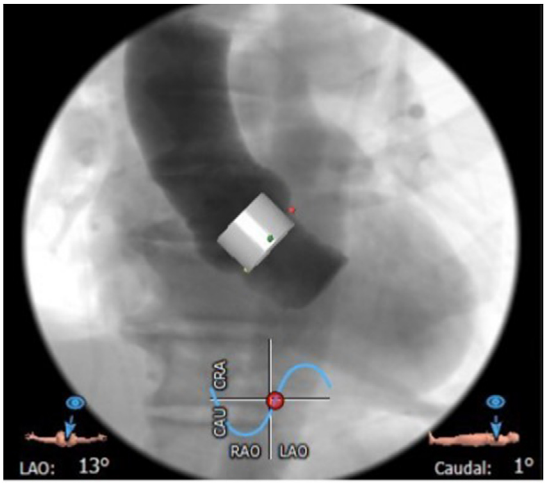

FIGURE 1. Digital phantom of a surgical bioprosthesis (21-mm Inspiris; Edwards Lifesciences) using STL Files and the 3mensio software (3mensio Medical Imaging BV).

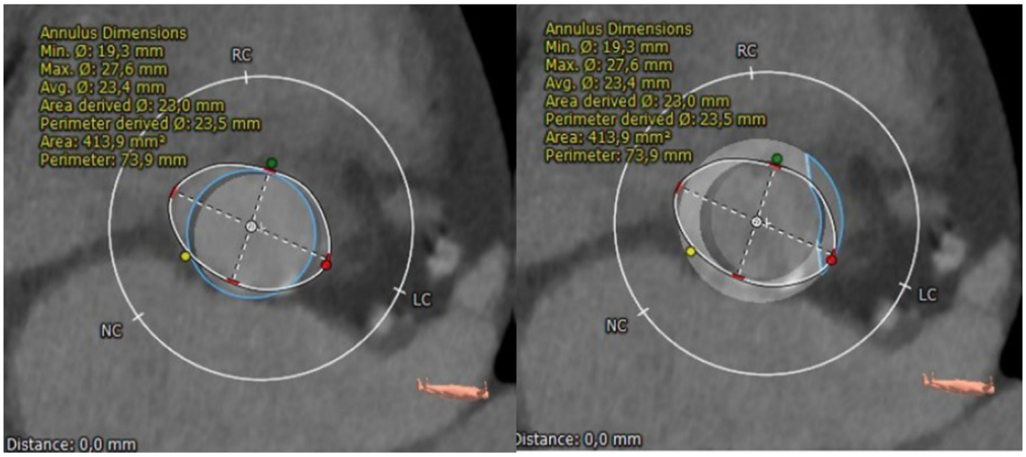

FIGURE 2. Difference of digital phantoms using diameters with and without the sewing cuff (±6 mm; transverse view).

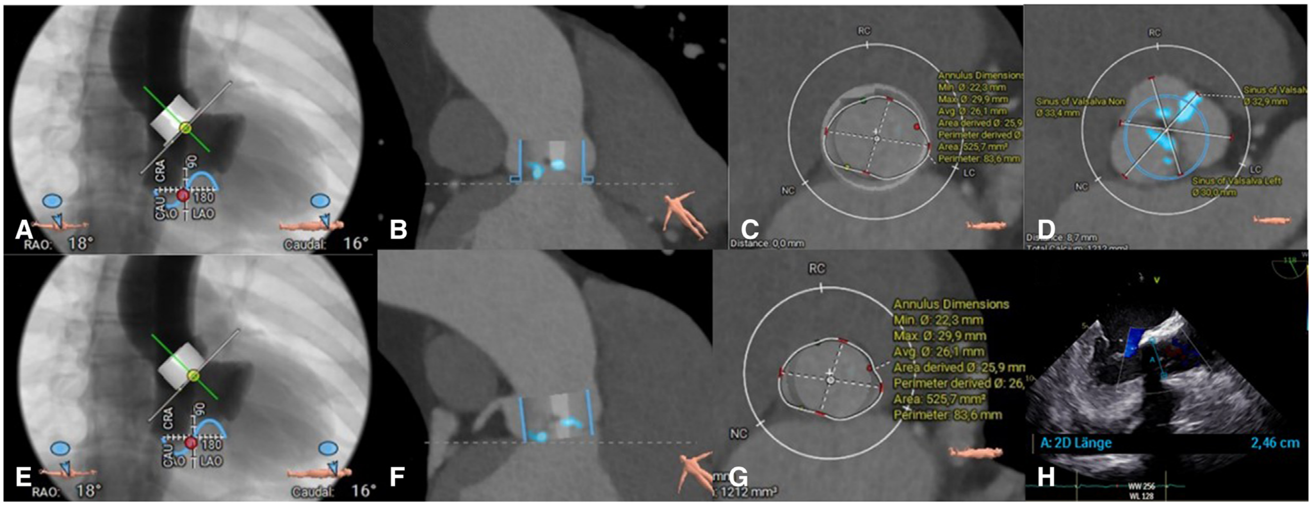

FIGURE 3. Computer tomography based simulation of a 25-mm Inspiris prosthesis (Edwards Lifesciences) inside an aortic annulus with effective diameter of 25.9 mm before endoscopic aortic valve replacement. A-D, Simulation with sewing cuff (+7 mm). E-G, Simulation without cuff (−7 mm). H, Intraoperative echocardiography measurement. This patient received a 25-mm Inspiris prosthesis during endoscopic aortic valve replacement.