

Modeling of Valve-in-Valve Transcatheter Aortic Valve Implantation after Aortic Root Replacement Using 3-Dimensional Artificial Intelligence Algorithm

Objective: Aortic root replacement requires reimplantation of coronary arteries and the construction of the composite valve graft, which may involve an angled supra-coronary aortic anastomosis. This study aimed to assess the feasibility of valve-in-valve transcatheter aortic valve implantation after bioprosthetic root replacement.

Methods: A retrospective review was conducted on 74 consecutive patients who underwent root replacement at a single institution from October 10, 2019 to October 19, 2021. Forty patients underwent bioprosthetic root replacement and had postoperative computed tomographic angiography scans. Computational simulations of transcatheter valve deployment were performed using both balloon and self-expanding valves. This dynamic, computational model assessing post deployment anatomy was then compared to traditional, manually measured valve-to-coronary distances from computed tomography scans to determine safety and feasibility of deployment.

Results: For the right coronary artery, the mean model and manual coronary distances were 14.09 mm and 4.86 mm for the balloon-expanding valve and 14.2 mm 6.85 mm for the self-expanding valve. For the left coronary artery, the mean distances were 10.6 mm and 5.06 mm for the balloon-expanding valve and 12.0 mm and 7.30 mm for the self-expanding valve. Per the model, one patient was at risk for right coronary obstruction using a balloon-expandable valve. No patients were at risk of coronary obstruction with a self-expanding valve (Figure A). Five patients (5/40) had simulated valve stent deformation with a self-expanding valve (Figure B). Overall, 98% (39/40) of patients were candidates for balloon-expanding valves and 88% (35/40) of patients were candidates for self-expanding valves.

Conclusions: Following aortic root replacement, all patients are candidates for valve-in-valve using one or both types of transcatheter heart valves. Self-expanding valves may be at higher risk for stent frame deformation at graft anastomotic lines, and balloon-expandable valves may be at higher risk of coronary obstruction. Surgeons can optimize for transcatheter aortic reinterventions with high coronary reimplantation and avoidance of an angled aortic graft anastomosis.

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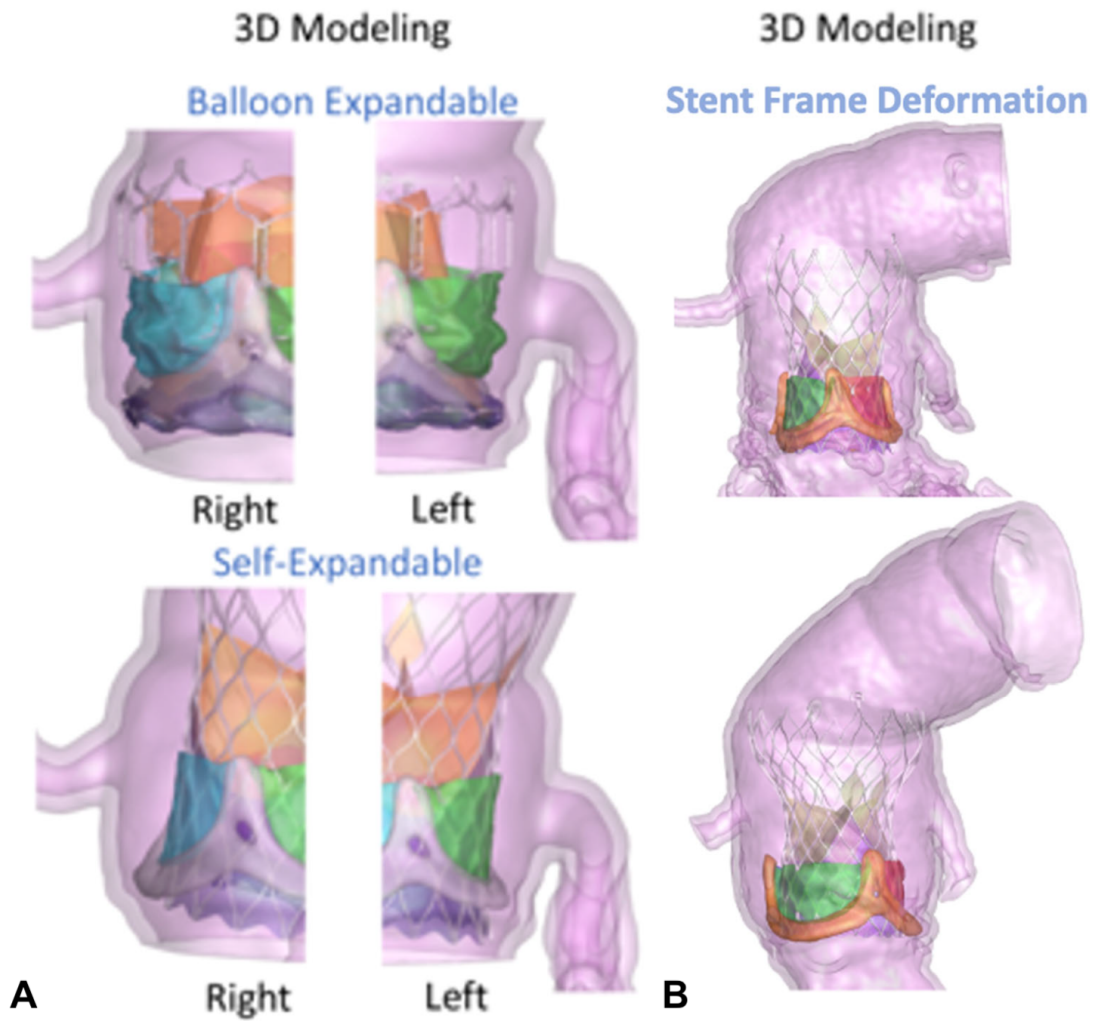


Figure. Three-dimensional modeling of valve-in-valve transcatheter aortic valve implantation after bioprosthetic root replacement. A) Valve deployment modeling risk of coronary obstruction. B, Valve deployment modeling risk of stent frame deformation.