December 2019 - Annual Report

Numerical Models of Transcatheter Aortic Valve-in-Valve Implantation and Their Post-procedural Function

Gil Marom[1] and Ariel Finkelstein[2]
[1]School of Mechanical Engineering, Tel Aviv University and [2]Division of Cardiology, Tel Aviv Medical Center

Coronary artery obstruction (CAO) is a fatal complication of transcatheter aortic valve implantation (TAVI) that is more common after implantation in failed bioprosthetic valves (Valve-in-Valve; ViV). It was recently proposed to lacerate one or two leaflets of the failed bioprosthesis to prevent CAO with a technique known as BASILICA. Engineering studies also demonstrated that this technique may decrease the risk of leaflet thrombosis.

While there is an increased evidence that the BASILICA technique improves the hemodynamics, we hypothesize that it may harm the tension in the surgical valve, leading to a weaker support and anchoring of the TAVI device. This study aimed to compare the anchorage post-ViV implantations, with and without lacerated leaflets, by finite element analysis. Therefore, this study may aid interventional cardiologists to choose an appropriate TAVI device for the BASILICA technique and may aid in designing future devices that ensures adequate anchorage with lacerated leaflets.

Deployments of the latest generation of TAVI devices (Medtronic Evolut PRO and Edwards SAPIEN 3) inside a surgical bioprosthetic valve (Sorin Mitroflow) were compared and the influence of lacerations on the anchorage was evaluated. The results show that each laceration reduces the contact area of the TAVI stent with its landing zone and that the anchorage contact force weakens. The BASILICA technique has lesser effect on the anchorage contact area and forces in the SAPIEN than in the Evolut cases, because the balloon inflation is less sensitive to the deployment region. TAVI stent migration was not found in any of the models. In addition, our study suggests that larger TAVI devices should be used after BASILICA to compensate for the lack of contact with stronger anchoring forces. Finally, we are currently using the results of the results of the finite element models as the anatomies for computational fluid dynamics modeling of the hemodynamics post BASILICA. Our aim is to evaluate the thrombogenic risk, and the potential location of the leaflet thrombosis, based on these models of several BASILICA cases.

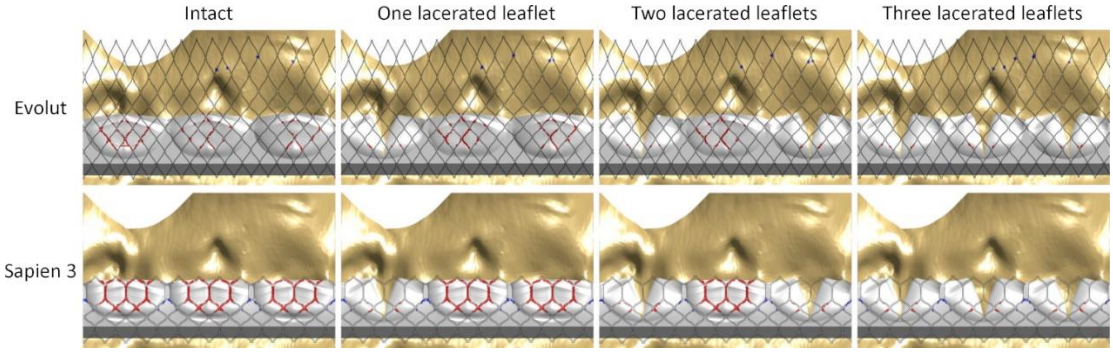

Figure 1: Comparison of the contact regions between the TAVI stents and the different parts for the eight models at the end of the recoil phase. The aortic root is shown in a spread-view manner with the angular coordinate increasing horizontally. Contact with the leaflets of the Mitroflow valve is marked in red and the contact with the remaining parts is in blue.