NOVEL TECHNIQUE FOR THE QUANTITATIVE ANALYSIS OF WALL COVERAGE OF DEPLOYED STENTS: COMPARISON OF FIVE STENTS

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Background: Adequate wall coverage in stenting procedures is obtained through a uniform stent strut distribution and minimal openings between the individual struts. This is important for optimal drug delivery, reduced tissue prolapse and minimal balloon-artery contact zones (known to introduce vascular injury). Therefore, the aim of this study was to investigate and compare the wall coverage of five different stents using an innovative virtual bench testing approach.

Methods: Five coronary balloon-expandable 3 mm stents were included in this study: the Taxus Liberté stent (Boston Scientific), the Cypher stent (Cordis, Johnson & Johnson), the Coroflex stent (BBraun), the Endeavor stent (Medtronic) and the Promus stent (Boston Scientific). Two micro-CT scans were performed on each crimped stent to acquire accurate geometrical information: a scan at lower resolution (7 micron voxel pitch) to obtain the entire stent geometry, followed by a high resolution scan (1 micron voxel pitch) to obtain more detailed information on the strut dimensions. These micro-CT data were then used to generate stent models and the corresponding high quality hexahedral meshes using the open source pyFormex software. A displacement driven radial expansion simulation strategy was used to virtually expand the stents up to 3.5 mm inner diameter. This expansion strategy has been validated by comparing the virtual stent deformations with in-vitro bench testing results. Wall coverage was quantified by the diameter of the maximum inscribed circle (D_{max}) for the deformed stent cells. Large maximum inscribed circles correspond with large gaps between the struts and thus with a low wall coverage. D_{max} was calculated at different stent expansion diameters, allowing to assess the impact of under- or overexpansion on the wall coverage.

Results: At a stent diameter of 3 mm, D_{max} ranged from 0.65 (Taxus Liberté) to 1.23 (Cypher) mm, demonstrating considerable differences in wall coverage between the investigated stents. Overexpansion leads for all stents to a reduced wall coverage (i.e. larger D_{max}), as the individual struts tend to move away from each other.

Conclusion: Wall coverage is an important stent design parameter which affects drug delivery, tissue scaffolding and balloon-artery interaction. A quantification of the wall coverage of different stents, using novel computer simulation methodologies, showed important differences between the investigated stents. The proposed analysis technique can also be used during the design process of new stents.

Two abstract themes:
Theme 1: Stents and endografts
Theme 2: Atherosclerosis: Coronaries and Peripheries

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