Relative importance of the components of stent geometry to stretch induced in-stent neointima formation

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RESULTS

Ninety nine stented artery sections containing 1000 struts were available for analysis. The number of strut elements in each cross section was 10.1 (0.3); strut depth was 0.149 (0.001) mm; strut width was 0.349 (0.007) mm; metal coverage was 40 (2)%; inter-strut distance was 0.53 (0.01) mm; strut protrusion was 0.293 (0.007) mm; angular burden was 106.4 (0.9) degrees; medial bowing was 0.004 (0.002) mm; and oblateness was 1.077 (0.007). The cross sectional area of the lumen was 4.5 (0.1) mm² and of the neointima 1.34 (0.08) mm². The thickness of the neointima at each strut was 0.17 (0.01) mm.

Per strut analysis revealed five predictors of neointimal thickness. In order of significance, they were strut protrusion (p < 0.001), inter-strut distance (p < 0.001), medial bowing (p < 0.001), strut depth (p < 0.001), and angular burden (p < 0.001). Strut thickness was not a significant predictor.

Per section analysis revealed that lumen area correlated negatively with mean medial bowing (p < 0.001) and...
positively with mean angular burden (p < 0.001), major axis (p = 0.002), minor axis (p = 0.022), and maximum angular burden (p = 0.036). Neointimal area correlated positively with major axis (p < 0.001), mean medial bowing (p < 0.001), mean angular burden (p = 0.001), and negatively with mean protrusion (p = 0.021).

DISCUSSION
We have shown that stent induced stretch of coronary arteries results in a neointima whose magnitude is directly related to a number of simple parameters of stent geometry. In particular, neointimal thickness at a strut is related to strut protrusion, inter-strut distance, medial bowing, strut depth, and angular burden. Neointimal area is related to major axis, mean medial bowing, mean angular burden, and mean strut protrusion. While other authors have examined individual parameters, such as strut number, strut thickness, and angular burden, this is the first study to investigate all potential factors together, and to assign a relative importance to each.

It has been suggested that stent design is unimportant to restenosis. We have shown this to be incorrect. While novel stent designs are directed by industrial ingenuity towards enhancing deliverability, conformability, and radial strength (all highly desirable attributes), control of the biological response may also be possible through careful manipulation of stent design, to enhance the beneficial effect of stent coatings and drugs.

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Conflict of interest: Dr Gunn has performed paid consultancy work for Abbott Vascular Devices and Biocompatibles (current and previous manufacturers of the BiodivYsio stent). Those companies have also supported several of his research projects.

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REFERENCES

IMAGES IN CARDIOLOGY
The invisible stent: imaging of an absorbable metal stent with multislice spiral computed tomography

A 60 year old man was admitted for recurrent stress dependant episodes of chest pain radiating toward the left shoulder for three months. Laboratory tests showed normal troponin I concentrations. During exercise testing the ECG documented significant ST segment depression >1 mm in V1–V3. Informed consent was obtained and coronary angiography was performed. Examination revealed a single segmental stenosis of the mid left anterior descending coronary artery (LAD) (segment 7, 65% diameter stenosis).

Successful placement of a single absorbable metal stent (AMS) (Biotronik, Bulach, Switzerland) was accomplished in the catheterisation laboratory under fluoroscopic and intravascular ultrasound (IVUS) guidance. After stent placement a contrast enhanced multislice spiral computed tomography (MSCT) (Somatom Sensation 16, Siemens, Forchheim, Germany) scan was performed using a 500 ms rotation time and 0.75 mm slice thickness during a 30 second breathhold. MSCT demonstrated adequate perfusion throughout the entire LAD without signs of stenosis in the stented area (panel B).

The AMS therefore overcomes the imaging problems of conventional metallic stents (panel A) and enables reliable direct visualisation of coronary arteries. Thus, non-invasive follow up with MSCT of patients treated with AMS might be feasible for the first time because of adequate differentiation between stent patency, in-stent stenosis, and stent occlusion.

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