

Supplementary Material

Carotid Stenosis

Planar measurements of stenosis do not correspond to cross-sectional measurements of luminal narrowing. This is exemplified by the standard use of ultrasound to assess carotid disease. One of the main criteria for grading stenosis on duplex ultrasound is by detection of increased flow velocities across stenoses. This haemodynamic disturbance of flow is essentially a function of reduction in cross-sectional area and the lack of direct correspondence between diameter and cross-sectional area reduction helps explain a lack of correlation between ultrasound and angiographic measures. Additionally, the morphology of a lesion will have a bearing on the correlation between diameter and area reduction with at one extreme a fully eccentric '50% stenosis' diameter reduction equating to a 50% reduction in cross sectional area while a truly concentric '50% stenosis' diameter reduction equates to a 75% reduction in cross sectional area, which is haemodynamically much more significant in terms of flow limitation and volume of atheroma (see *Figures 1 and 2*). All measures of stenosis are surrogate markers for plaque volume/burden which more closely follows cross-sectional area stenosis measurements.

Figure 1. Drawings illustrate how projection images (*a, b*) and a cross-sectional image (*c*) are used to measure the diameter of an eccentric arterial stenosis. In *a*, the minimum luminal diameter (D_a) is depicted at the optimal projection angle. In *b*, the degree of stenosis is underestimated because the minimum luminal diameter (D_b) is depicted at a suboptimal projection angle, making it larger than D_a . The cross-sectional image is oriented perpendicular to the vessel and accurately depicts lumen morphology, making the minimum luminal diameter easy to measure. D_a and D_b in *c* correspond to the diameters measured in *a* and *b*.

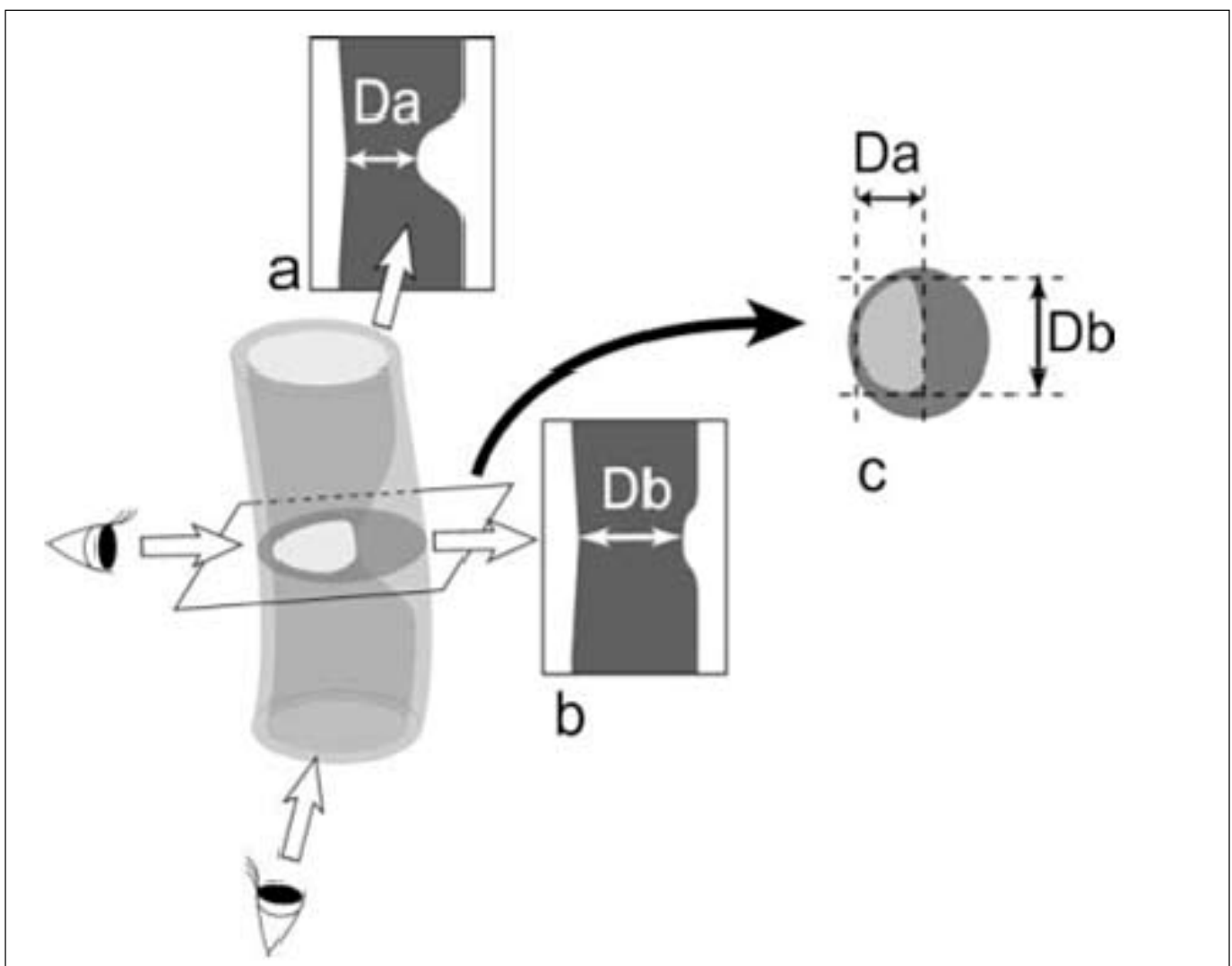
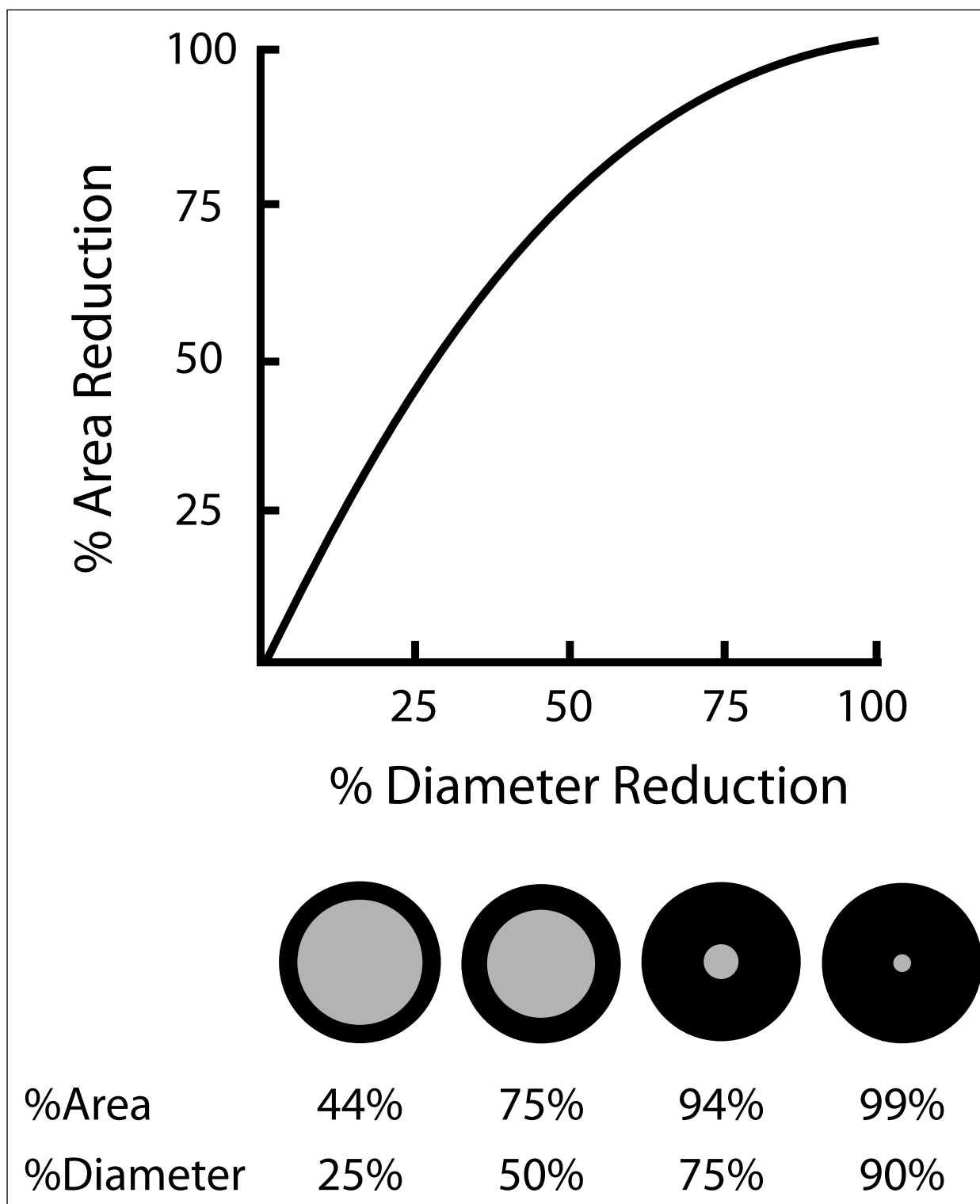


Figure 2. Graph (top). Illustrates the relationship between area reduction and diameter reduction in a completely concentric stenosis. The relationship is described by the equation $A = D \times (2 - [D/100])$, where A = percentage of area reduction and D = percentage of diameter reduction. Drawings at bottom illustrate cross-sectional views of lumina at various percentages of area and diameter stenosis.



None of these assessments of stenosis take into consideration lesion morphology such as ulceration, which confers significantly increased risk at all grades of stenosis or plaque composition, which is also known to correlate with propensity for atheroembolism. Nor do these morphological criteria necessarily relate to biological plaque activity.

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