Contrast-enhanced MR angiography for carotid disease: review of source images using a semi-automated vessel-tracking algorithm may improve diagnostic specificity.

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Purpose: Contrast-enhanced MR angiography (CEMRA) is increasingly used in the pre-operative evaluation of carotid disease. In a similar manner to conventional digital subtraction angiography (DSA), stenosis on CEMRA is often determined from Maximum Intensity Projection (MIP) images. Such a 2-D display does not make use of the 3D nature of CEMRA, which is particularly important in cases of non-circular lumens. Review of CEMRA source images may circumvent such issues and increase diagnostic accuracy but measuring from current display techniques is impractical and time-consuming. We aim to clinically evaluate a semi-automated vessel-tracking algorithm by comparison with manual measurements of stenosis on CEMRA MIP images and DSA.

Methods: 83 symptomatic patients (100 abnormal arteries), with screening Doppler ultrasound showing $\geq$ 50% stenosis in one or more arteries, prospectively underwent both CEMRA and four-view DSA. DSA and MIP were independently reviewed according to NASCET criteria by three blinded attending neuroradiologists. The CEMRA protocol used a bolus-timed high-resolution (0.6 x 0.8 x 0.9 mm) elliptic-centric acquisition. Source images were then reviewed using Advanced Vessel Analysis (AVA) software (GE Medical Systems, Buc, France). This software requires the user to manually input tracking points from which the vessel center-line is automatically determined. The vessel diameter at each location is quantified and graphically displayed, allowing determination of minimum stenotic diameter and mean diameter of the normal internal carotid artery for calculation of NASCET stenosis (Figure1).

Results: Measurements on AVA correlated well with both MIP and DSA (Pearson coefficient 0.92 and 0.85 respectively). With DSA as the gold standard, sensitivity and specificity of AVA for detection of severe stenosis (70-99%) was 85% and 85% respectively. Similar values for MIP measurements were 85% and 75% respectively. AVA overestimated 10 cases of moderate stenosis on DSA as severe but this may be actual underestimation by DSA due to the limited number of projections. Analysis of a random subgroup of 20 cases by a second reader indicates good inter-observer agreement (kappa 0.79) for AVA, comparable to that of DSA itself (average kappa 0.81).

Conclusions: AVA is a practical and potentially useful clinical tool to review CEMRA source images for measurement of carotid stenosis. This may improve specificity compared to manual MIP measurements.

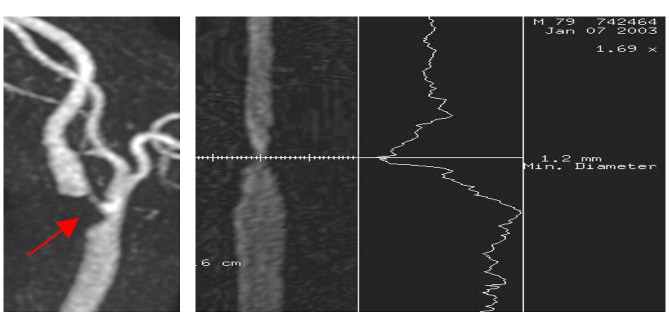

Figure 1: CEMRA (left) illustrating a tight stenosis of the internal carotid artery (ICA) and use of AVA software (right) which facilitates review of source data. The vessel diameter at each location is quantified from axial source data and graphically displayed, allowing determination of maximal narrowing and diameter of the distal normal ICA as per NASCET criteria.