

A simple and effective approach for carotid plaque risk assessment in clinical practice

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Background Multi-contrast high-resolution magnetic resonance imaging (MRI) is a most promising modality for visualizing and quantitatively analyzing the carotid atherosclerotic plaque. Carotid Atherosclerosis Score (CAS)¹ is a noninvasive imaging approach to assess carotid plaque severity, which aim to predict the presence of two most critical features for the plaque instability -- intraplaque hemorrhage (IPH) and fibrous cap rupture (FCR). However, CAS calculation requires the whole artery fully reviewed, which always takes a relatively long time. Therefore, the application of CAS in the clinic circumstance was limited. Morphology-enhanced probabilistic plaque segmentation (MEPPS)² is an automatic segmentation method of in vivo carotid MRI, which has been histological validated.

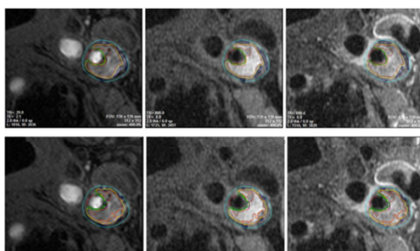
Purpose The purpose of this study was to test the hypothesis that MEPPS is able to calculate CAS the same way as human reviewers, which potentially would be a simple and fast approach for the risk assessment of carotid atherosclerotic plaque in clinical practice.

Methods Totally 334 subjects from 4 different centers are recruited in this study. All subjects have been fully analyzed by human reviewers. MEPPS plaque components analysis performed in all subjects. The CAS score of all subjects calculated based on manual results and MEPPS results, respectively. Then the agreement were calculated. With a subgroup with MRA data, the predict capability of CAS by MEPPS were analyzed.

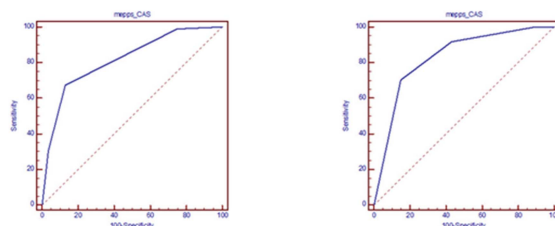
Results The agreement of MEPPS and manual in CAS calculation was good (kappa value : 0.72), and the 4-tier CAS was a strong classifier of both IPH (AUC=0.82) and FCR (AUC=0.83). In a subcohort of individuals with CE-MRA (n=116), CAS calculated by MEPPS was a stronger classifier than stenosis for both IPH (AUC= 0.79 versus 0.57, respectively) and FCR (AUC= 0.77 versus 0.67, respectively).

Discussion Generally, MEPPS can accurately assess CAS score, and it provide a simple, fast approach to stratify carotid plaques. However, there are some differences between manual and MEPPS results, therefore, an optimal MEPPS-based CAS system need to be considered. What's more, currently, manual defined lumen and outer boundaries are still required before performing MEPPS, assuming only several specific locations, rather than the whole artery, need to define lumen and outer boundaries before MEPPS perform, the process will be more faster and effective.

Conclusion MEPPS can calculate CAS the same way as human reviewers, and it is a simple, efficient carotid plaque risk assessment tool, which is potentially can be used in clinic practice extensively.



Plaque composition analysis, example of a high risk subject with IPH (CAS=4), sequence TOF, T1W, T2W; top: human reviewer result, bottom: same subject analyzed by MEPPS



ROC analysis of CAS by MEPPS, left : IPH (AUC= 0.81); right: FCR (AUC= 0.83)

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