Diagnostic accuracy of magnetic resonance angiography for internal carotid artery disease: a systematic review and meta-analysis

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CRD summary
This review concluded that time-of-flight and contrast-enhanced magnetic resonance angiography showed high accuracy for detecting high grade internal coronary artery stenosis and occlusions, but not moderately severe stenosis. Given that most studies were small and retrospective, potential for error and bias during the review process and some uncertainties regarding the analysis, the results should be interpreted with caution.

Authors' objectives
To determine the diagnostic accuracy of time-of-flight (TOF) magnetic resonance angiography (MRA) and contrast-enhanced MRA (CE-MRA) for the detection of internal carotid artery disease.

Searching
PubMed, EMBASE, SCOPUS and Cochrane Central Register of Controlled Trials (CENTRAL) were searched from inception to November 2006; search terms were reported. Bibliographies of selected articles and contents of relevant journals were searched. Only English-language publications were included.

Study selection
Studies of any design that assessed accuracy of 2D or 3D time-of-flight MRA or CE-MRA for the diagnosis of internal carotid artery stenosis, with intra-arterial angiography as the reference standard, were eligible for inclusion. Sufficient data to construct a 2x2 outcome table needed to be presented. The authors stated that studies had to be reported according to the STARD guidelines. Included studies evaluated 2D and/or 3D time-of-flight MRA or CE-MRA. The definition of high-grade stenosis varied across studies (>50% to >80%). Most studies recruited patients with symptoms or prescreened with ultrasound.

Studies were selected by independent reviewers; disagreements were resolved by discussion.

Assessment of study quality
Study quality was assessed in relation to delay between imaging procedures, study design and setting, sample recruitment, size and mix, andblinding. The authors stated that 11 of the 14 criteria of the QUADAS tool were used as a guide for inclusion (criteria not used were those for the representative patient spectrum, availability of clinical data to interpreters of the tests and reporting of uninterpretable results were not used). The interpreters of the test images had to be blinded for the study to be included.

The authors did not state how many reviewers performed the quality assessment.

Data extraction
Data were extracted to produce 2x2 tables for different grades of stenosis (50% to 69%, 70% to 99%, occlusion). From these, sensitivity, specificity and positive and negative likelihood ratios (LR+/-) were calculated. Study authors were contacted where data were not sufficient to produce a 2x2 table.

The authors did not state how many reviewers performed the data extraction.

Methods of synthesis
Summary estimates of sensitivity, specificity and the likelihood ratios were calculated using a fixed-effect meta-analysis, weighted on the number of arteries analysed. Separate analyses were conducted for stenosis (50% to 69% and 70% to 99%) and occlusion. Heterogeneity was assessed using the Cochran Q and I² statistics. Summary receiver
operating characteristic (SROC) curves were produced and the area under the curve (AUC) calculated. Studies that recruited only symptomatic patients were analysed as a separate subgroup.

**Results of the review**

Fifty three studies met the inclusion criteria (n=2,526, range 19 to 203). Twenty five of the 42 that reported on data collection were prospective. Thirty seven of the 40 studies that reported patient selection recruited a consecutive sample. Where reported, delay between tests varied from less than 24 hours to three months.

**Time-of-flight MRA:**

For occlusion (29 studies, n=1,341), pooled sensitivity was 95% (95% CI 91% to 97%) and specificity 99% (95% CI 99% to 100%).

For detection of 70% to 99% stenosis (32 studies, n=1,422), pooled sensitivity was 91% (95% CI 89% to 93%) and specificity 88% (95% CI 87% to 90%).

For detection of 50% to 69% stenosis (seven studies, n=415) pooled sensitivity was 38% (95% CI 29% to 47%) and specificity 92% (95% CI 90% to 94%).

**CE-MRA:**

For occlusion (18 studies, n=923), pooled sensitivity was 99.4% (95% CI 96.8% to 100%) and specificity 99.6% (95% CI 99% to 100%).

For detection of 70% to 99% stenosis (19 studies, n=990), pooled sensitivity was 95% (95% CI 92% to 96%) and specificity 92% (95% CI 90% to 93%).

For detection of 50% to 69% stenosis (eight studies, n=454) pooled sensitivity was 65.9% (95% CI 57% to 74%) and specificity 93.5% (95% CI 91.3% to 95.3%).

When time-of-flight MRA and CE-MRA were used for the detection of high grade stenosis in the same patients (five studies, n=172), CE-MRA was more sensitive (96%, 95% CI 91% to 99% versus 90%, 95% CI 82% to 95%); there was no difference in specificity.

Three of the eight analyses that reported results for tests of heterogeneity were not statistically significant (sensitivity of CE-MRA to detect 70% to 99% stenosis and sensitivity and specificity of time-of-flight MRA to detect 50% to 99% stenosis).

Results for subgroup analyses were reported, none of which altered the results of the main analyses.

**Authors’ conclusions**

Time-of-flight MRA and CE-MRA showed high accuracy for detection of high grade internal coronary artery stenosis and occlusions; CE-MRA had the edge over time-of-flight MRA. The sensitivity of the tests was poor to fair for the detection of moderately severe stenosis.

**CRD commentary**

The review addressed a clear research question with well defined inclusion criteria. Several relevant sources were searched. Only English-language publications were included, so there was potential for language and publication biases. Study selection was conducted in duplicate; it was unclear whether similar methods to reduce error and bias were employed during data extraction and quality assessment. Studies had to be reported in accordance with the STARD statement statement to be included. Several of the included studies were published prior to this statement being introduced; it was unclear whether studies were excluded based on this criterion. Most of the included studies were small and a large number were retrospective. The proportion of uninterpretable results in the included studies did not appear to be considered; if these results were excluded, the summary estimates of diagnostic accuracy may be overestimated. There were limited investigations into the potential causes of heterogeneity, for example the impact of...
the use of 2D and/or 3D time-of-flight MRA was not investigated; results for the test for heterogeneity were not reported for each analysis. Given the mentioned limitations, the results of the review should be viewed with caution.

**Implications of the review for practice and research**

**Practice:** The authors stated that the change in use of MRA to detect high-grade internal coronary artery stenosis was justified given the superiority of CE-MRA. The authors recommend use of a second non-invasive study to confirm the grade of stenosis before treatment decisions were made, because of the lack of accuracy of MRA for detecting moderate stenosis. A complimentary diagnostic test was considered by the authors to be necessary for decisions regarding potential endarterectomy or stenting.

**Research:** The authors stated that larger studies that recruited symptomatic and asymptomatic patients, with varying severity of disease were required. Prospective blinded studies were required to confirm the superiority of CE-MRA over time-of-flight MRA.

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