Magnetic resonance angiography for the diagnosis of renal artery stenosis: a meta-analysis

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Authors' objectives
To determine the accuracy of magnetic resonance angiography (MRA) with and without gadolinium enhancement for the diagnosis of renal artery stenosis (RAS), with catheter angiography as the reference.

Searching
MEDLINE (via PubMed) was searched from 1985 to 2001 for English language studies; the keywords were stated. The reference lists of identified studies were also checked for additional relevant articles. Abstracts and unpublished data were excluded.

Study selection
Study designs of evaluations included in the review
Diagnostic accuracy studies with a blinded comparison of the index test and reference standard were eligible for inclusion. The time between the index and reference standard had to be less than 3 months.

Specific interventions included in the review
Studies that investigated MRA for the diagnosis of RAS, and that had clear descriptions of imaging techniques, were eligible for inclusion. The tests included in the non-enhanced MRA studies were two-dimensional (2D) time-of-flight (TOM), 2D phase contrast with 2D TOM, three-dimensional (3D) TOM, 2D TOM breath hold, 3D phase contrast, 3D TOM with phase contrast, 3D tilted optimised non-saturating excitation, breath-hold gradient echo, selective inversion recovery, rapid gradient echo, and phase contrast cine. Gadolinium-enhanced MRA techniques included 3D spoiled gradient echo (SPGR), fast SPGR, 3D SPGR breath-hold, 3D MRA breath-hold, 3D fast imaging with low angle shot (FLASH), 3D FLASH breath-hold, and gradient echo. The diagnostic cut-off point was detection of greater than 50% stenosis.

Reference standard test against which the new test was compared
The authors stated that studies comparing MRA with catheter arteriography, using intra-aortic injection with at least two projections, were eligible for inclusion. However, in the included studies, intravenous digital subtraction angiography was used as the reference standard in 21 patients, and surgical findings were used in 4 patients; catheter arteriography was used in all other patients. The diagnostic threshold was the detection of greater than 50% stenosis.

Participants included in the review
Studies of patients with suspected RAS were eligible for inclusion. The included studies were required to state the indication for arteriography. All of the patients in the included studies were investigated for suspected RAS. Some had symptoms of peripheral vascular disease, and eight were being investigated prior to renal donation. The mean ages of the patients in the gadolinium-enhanced and non-enhanced groups were 62 and 59 years, respectively.

Outcomes assessed in the review
The authors did not state any inclusion or exclusion criteria relating to the outcomes. 2x2 Data were reported for the included studies.

How were decisions on the relevance of primary studies made?
Two investigators independently assessed studies for inclusion. Consensus was reached, based on the predetermined inclusion and exclusion criteria.

Assessment of study quality
The authors did not state that they assessed validity.
Data extraction
The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

The data extracted for both MRA and catheter arteriography were the numbers of arteries with greater than 50% stenosis and less than or equal to 50% stenosis, the number of main and accessory renal arteries visualised, and the number of occluded main arteries. The mean age of the participants, indications for imaging and imaging failures were also extracted.

Methods of synthesis
How were the studies combined?
The number of false positives, false negatives, true positives and true negatives for each study that used non-enhanced MRA were added to calculate a total number of false positives, false negatives, true positives and true negatives for that group. The same was done for the group of studies that used gadolinium-enhanced MRA. It seems that these totals were then used to calculate overall specificity, sensitivity, positive predictive values and negative predictive values for each of the two groups.

How were differences between studies investigated?
Heterogeneity was assessed using Breslow and Day's test. The chi-squared test was used to assess differences between non-enhanced and gadolinium-enhanced groups. A subgroup analysis, which separated studies that used consecutive patient recruitment from those that did not, was performed and the total sensitivity, specificity, and positive and negative predictive values were calculated for each of the subgroups.

Results of the review
Twenty-five diagnostic accuracy studies, with a total of 923 patients, were included in the review.

Non-enhanced MRA detected 49% of the accessory arteries demonstrated by angiography. The sensitivity and specificity of non-enhanced MRA were 94% (95% confidence interval, CI: 90, 97) and 85% (95% CI: 82, 87), respectively.

Gadolinium-enhanced MRA detected 82% of the accessory arteries demonstrated by angiography. The sensitivity and specificity of gadolinium-enhanced MRA were 97% (95% CI: 93, 98) and 93% (95% CI: 91, 95), respectively.

Gadolinium-enhanced MRA showed a significantly higher specificity and positive predictive value than non-enhanced MRA (P<0.001). There was no significant difference in sensitivity between the groups. There was significant heterogeneity between studies in both the non-enhanced (P<0.0001) and gadolinium-enhanced (P<0.043) groups. A subgroup analysis of only those studies that recruited patients consecutively accounted for some of the heterogeneity. However, for both the enhanced and non-enhanced MRA groups, after removing studies that did not recruit patients consecutively, no significant differences were found.

Authors' conclusions
Gadolinium-enhanced MRA is preferred over non-enhanced MRA as the diagnostic test for suspected RAS. Gadolinium-enhanced MRA may replace catheter arteriography for many patients with suspected RAS, and it has advantages in that it is noninvasive and it avoids the use of ionising radiation or a nephrotoxic contrast agent.

CRD commentary
The review had a clear aim, and the inclusion criteria were defined in terms of the participants, index test and reference standard. Limiting the search to just one database and studies written in English means that relevant articles might have been missed. In addition, the exclusion of abstracts and unpublished data might have introduced publication bias, although this was not assessed. The decision to include or exclude studies was made by two independent reviewers, which helps to reduce bias. An appropriate maximum length of time was specified between the index test and reference
standard, which limits the likelihood of disease progression bias. The authors did not report that they assessed the validity of the included studies, although restricting studies to those with blinded comparisons might have helped to reduce bias.

Some details of the studies, in terms of imaging methods and results, were provided. However, a lack of information about the participants’ characteristics, the setting, and the order in which the patients received the two tests means that the extent to which these results can be generalised to other patients is unknown. Clinical heterogeneity between the studies was evident in the patients, sample sizes and imaging methods used. Statistical heterogeneity was assessed, but the impact of potential sources was only investigated in terms of whether studies had used consecutive recruitment or not, which could only partially account for study differences. The pooling of data was poorly described and appeared inappropriate, particularly given the clinical and statistical heterogeneity.

The authors acknowledged that the diagnostic accuracy might have been overestimated because the majority of the included studies were based in centres where MRA was performed by specialised MR radiologists, and in patients who were thought to be at higher risk of having renal stenosis. The authors’ conclusions are broadly supported by the evidence presented. However, given the lack of a validity assessment and the inappropriate pooling of the study results, the review should be interpreted with caution.

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

**Practice:** The authors stated that gadolinium-enhanced MRA should be preferred over non-enhanced MRA for the investigation of patients with possible RAS. Gadolinium-enhanced MRA may replace catheter arteriography for many patients with suspected RAS. It has advantages in that it is noninvasive and it avoids the use of ionising radiation or a nephrotoxic contrast agent.

**Research:** The authors did not state any implications for further research.

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