Diagnostic tests for renal artery stenosis in patients suspected of having renovascular hypertension: a meta-analysis


Authors' objectives
To summarise and compare the validity of computed tomography angiography (CTA), magnetic resonance angiography (MRA), ultrasonography, captopril renal scintigraphy and the captopril test, for the diagnosis of renal artery stenosis in patients suspected of having renovascular hypertension.

Searching
MEDLINE, EMBASE and the Cochrane Library were searched from database inception until August 2000 using the following keywords: 'magnetic resonance imaging', 'tomography', 'x-ray', 'computed', 'ultrasonography', 'captopril', 'angiography', 'renal artery' and 'hypertension, renovascular'. The bibliographies of selected articles were examined for potentially relevant references. Only studies published in English, German or French were eligible for inclusion. In the case of duplicate reports of the same study, the most recent report was included.

Study selection
Diagnostic accuracy studies were included.

Specific interventions included in the review
The intervention were CTA, MRA (gadolinium-enhanced and 2-dimensional time-of-flight), ultrasonography, captopril renal scintigraphy and the captopril test.

Reference standard test against which the new test was compared
Studies had to use intra-arterial X-ray angiography as the reference standard to be included in the review. Studies in which verification bias was a possibility, i.e. when only some of the patients who had the index test were referred for the reference test, were excluded.

Participants included in the review
Patients referred because they were suspected clinically of having renovascular hypertension. Studies that included patients who had received renal transplants were excluded.

Outcomes assessed in the review
The studies had to report sufficient data to construct a 2x2 table of test performance. The criteria and cut-off values for a positive result for each test had to be explicitly defined.

How were decisions on the relevance of primary studies made?
Two investigators screened the full text of potentially relevant studies using the inclusion criteria.

Assessment of study quality
No formal method for assessing validity was reported. However, only studies which included a specific reference standard, reported the criteria for a positive test result, and avoided verification bias, were eligible for inclusion. In addition, data were extracted on whether the test results were reviewed blind, and if there were any missing observations.

Data extraction
The data were extracted using a standard form. In some instances, more than one estimate of sensitivity and specificity was reported because of the different approaches used to analyse the data. In such cases, the estimates based on the
inclusion of accessory renal arteries, on patients as the unit of analysis, or on the inclusion of missing observations in the analysis, were preferred. Data were extracted on: study details; index test; the number of patients; the definition of haemodynamically significant stenosis; unit of analysis; the numbers of true positives, true negatives, false positives and false negatives; sensitivity and specificity; and the area under the receiver operating characteristic (ROC) curve.

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

**Methods of synthesis**

**How were the studies combined?**

In studies where more than one diagnostic technique was evaluated, each modality was considered separately. Summary ROC curves were calculated. The areas under the summary ROC curves were used as a measure of the diagnostic accuracy.

Diagnostic odds ratios were calculated on the basis of the 2x2 data reported in each study, and then derived areas under the ROC curves for each study. Linear regression analysis was used to compare the diagnostic tests. Indicator variables represented the tests and the presence or absence of specific study characteristics. The coefficients resulting from the model were translated into areas under the summary ROC curves, differences between areas under the summary ROC curves, and 95% confidence intervals for these differences.

**How were differences between studies investigated?**

No formal test for heterogeneity was performed. However, a multivariate regression analysis was performed to investigate the effects of various study characteristics on test performance; the area under the summary ROC curve was used as the dependent variable.

**Results of the review**

A total of 55 studies (n=4,220) were included: 25 of CTA, 16 of MRA, 24 of ultrasonography, 14 of captopril renal scintigraphy, and 4 of the captopril test. Ten studies reported more than one imaging test.

The areas under the summary ROC curves were 0.99 for CTA, 0.99 for gadolinium-enhanced MRA, 0.97 for non-gadolinium-enhanced MRA, 0.93 for ultrasonography, 0.92 for captopril renal scintigraphy, and 0.72 for the captopril test.

The areas under the summary ROC curves were compared using a multivariate regression model. The results showed that both CTA and gadolinium-enhanced MRA were significantly better than all the other tests studied (p<0.05), while CTA and gadolinium-enhanced MRA had similar diagnostic performance (p>0.20). Non-gadolinium-enhanced MRA was significantly better than captopril renal scintigraphy (p=0.022) and the captopril test (p<0.001), while ultrasonography (p=0.01) and captopril renal scintigraphy (p=0.017) were better than the captopril test. Ultrasonography and captopril renal scintigraphy did not differ significantly in diagnostic performance (p>0.20). An additional analysis comparing the performance of various different types of non-gadolinium-enhanced MRA found no differences between the different methods.

The effect of study characteristics on test performance was also investigated using multivariate regression models. Studies that included more than 50 patients showed a statistically better diagnostic performance than those that included 50 or fewer patients. Other study characteristics that were poor predictors of diagnostic performance included the stringent definition of haemodynamically significant stenosis, the inclusion of missing observations in the analysis, the inclusion of accessory renal arteries in the analysis, and the publication year.

**Authors’ conclusions**

CTA and gadolinium-enhanced MRA seem to be preferred in patients referred for evaluation of renovascular hypertension. However, because few studies of these tests have been published, further research is recommended.

**CRD commentary**
This was a good review of the area. An appropriate literature search was carried out, although a broader search may have identified further relevant studies. Only studies in English, French and German were included and no attempts were made to locate unpublished studies. Thus, it is possible that some relevant studies may have been missed. The inclusion criteria were clearly reported and were relevant to the review's objective. Details of how the studies were assessed for inclusion were also reported. Although no formal quality assessment was performed, the inclusion criteria and extracted data did cover some relevant quality criteria. However, the review would have benefited from a more formal quality assessment.

Details of the data extraction were provided, although the authors did not report how many of the reviewers were involved in this process. Relevant study details were clearly summarised in tabular format. The methods used to pool the studies were appropriate. However, no formal test for heterogeneity was performed, although regression models were used to investigate the differences between studies.

The authors' conclusion are supported by the results presented.

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

Practice: The authors state that CTA and gadolinium-enhanced MRA are superior to the other studied diagnostic tests for the detection of renal artery stenosis. Careful selection, based on clinical evaluation, is a prerequisite for the cost-effective use of these tests in the work-up strategy for patients with possible renovascular hypertension.

Research: The authors state that because only a limited number of published studies on CTA and gadolinium-enhanced MRA could be included in the meta-analysis, further research is recommended.

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**Other publications of related interest**

This additional published commentary may also be of interest. Weise WJ, Jaffery JB. Review: CT angiography and magnetic resonance imaging are the best less invasive tests for renal artery stenosis. Evid Based Med 2002;7:58.

**Indexing Status**

Subject indexing assigned by NLM

**MeSH**

Angiotensin-Converting Enzyme Inhibitors; Captopril; Gadolinium; Humans; Hypertension, Renovascular /complications /diagnosis; Linear Models; Magnetic Resonance Angiography /methods; ROC Curve; Radioisotopes; Renal Artery Obstruction /diagnosis /etiology /radionuclide imaging /ultrasonography; Reproducibility of Results; Tomography, X-Ray Computed

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Database of Abstracts of Reviews of Effects (DARE)
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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.