Comparative accuracy of renal duplex sonographic parameters in the diagnosis of renal artery stenosis: paired and unpaired analysis

CRD summary
This review assessed the relative accuracy of duplex ultrasound parameters, compared with intra-arterial angiography, for the diagnosis of renal artery stenosis. The authors concluded that sonography is a moderately accurate screening tool and that measurement of peak systolic velocity gives the best performance. The review was methodologically sound and well reported, and its conclusions are likely to be reliable.

Authors’ objectives
To evaluate the performance of duplex ultrasound, in comparison with intra-arterial angiography, for the diagnosis of renal artery stenosis (RAS).

Searching
MEDLINE (1966 to March 2005) and EMBASE (1988 to March 2005) were searched for relevant articles. The bibliographies of review articles and studies selected for inclusion were screened for additional articles, and investigators were also contacted. Detailed search strategies were reported in an appendix to the article.

Study selection
Studies that compared duplex ultrasound (without the use of echo-enhancing agents) with renal angiography for the diagnosis of RAS in patients with hypertension were eligible for inclusion. The included studies were required to report sufficient data for the construction of 2x2 contingency tables for the calculation of sensitivity and specificity. The majority of included studies (75 out of 88) were of hypertensive patients; other clinical characteristics recorded were peripheral arterial disease, chronic kidney disease and renal transplant. The participants in the included studies crossed a wide spectrum of ages (1 to 92 years), and the prevalence of RAS ranged from 5.8 to 89.5%. The ultrasound parameters evaluated included peak systolic velocity (PSV), renal-aortic ratio (RAR), acceleration time (AT), acceleration index (AI), and combinations with and without PSV. Threshold values for PSV ranged from 100 to 200 cm/second, the threshold for RAR ranged from 1.8 to 3.5, AT threshold values were >0.1 to >0.7 m/second, and AI threshold values were 3 to 4.5 m/second. RAS severity was defined by appearance on angiography (most commonly 50 or 60%).

Two authors assessed studies for inclusion.

Assessment of study quality
Items relating to the clinical spectrum and recruitment of participants, study design (prospective or retrospective), description of ultrasound and angiographic methods, handling of data on unsuccessful tests and occluded arteries, and blinding of angiography and ultrasound operators to the results of the other test and to clinical information, were assessed. Most items were treated as binary data (coded 'yes' or 'no'); some items, e.g. percentage of unsuccessful tests, were treated as continuous variables.

Two reviewers independently extracted the data, with any disagreements resolved by a third reviewer. The reviewers were not blinded to authorship.

Data extraction
For each study, data to populate 2x2 contingency tables were extracted and the sensitivity, specificity and diagnostic odds ratio (DOR) calculated. Data were extracted per artery, as only 28 of the 88 articles reported data per patient. Where included studies reported data for more than one threshold per ultrasound parameter, data for the threshold most commonly used in other studies were extracted.
Two reviewers independently extracted the data, with any disagreements resolved by a third reviewer. The reviewers were not blinded to authorship.

**Methods of synthesis**
Where at least 5 studies assessed the same ultrasound parameter, summary receiver operating characteristic (SROC) curves were constructed. Preliminary analyses were conducted, using the method of Moses et al., to identify outliers and potentially influential studies. A hierarchical SROC model was then constructed; details of the model were reported in an appendix to the article. Covariates were added to the model to assess whether test performance, diagnostic threshold, or the shape of the SROC curve varied with population and study design characteristics. Statistical significance was set at 5% and only results which were robust to the removal of influential studies were reported.

**Results of the review**
Eighty-eight studies, with data on 9,974 arteries, were included in the review. Fifty-one articles contributed no data to the meta-analyses since they reported on parameters used in fewer than 5 studies.

Both SROC methods gave similar results; results for the hierarchical model were reported.

The estimated summary DOR values for each ultrasound parameter, in decreasing order of overall accuracy, were: PSV 60.9 (95% confidence interval, CI: 28.3, 131.2; 21 studies, 2,785 arteries), RAR 29.3 (95% CI: 12.7, 67.7; 13 studies, 1,347 arteries), AT 28.9 (95% CI: 7.1, 117.2; 13 studies, 1,927 arteries), AI 16.0 (95% CI: 5.1, 50.0; 13 studies, 1,299 arteries). Summary estimates for sensitivity, specificity, and positive and negative likelihood ratios were reported.

For the 9 studies in which PSV and RAR were directly compared, PSV performed better (relative DOR 1.8, p=0.03). Analysis of the 9 studies that assessed both AT and AI showed no significant difference in DOR. Analysis of the 5 studies that assessed both AI and PSV showed PSV to be more accurate (relative DOR 5.3, p<0.001). Analysis of the 7 studies in which PSV alone was compared with PSV in combination with other parameters showed only weak evidence for an improvement in accuracy when tests are used in combination (relative DOR 1.6, p=0.09).

Frequency data for population and study design characteristics were reported. For PSV, the treatment of data on failed sonographic examinations was associated with diagnostic threshold, but not with test accuracy. For AI, test accuracy increased as the diagnostic threshold increased. Other characteristics had no significant effect on test performance.

**Authors’ conclusions**
Ultrasound examination is moderately accurate for the detection of RAS. PSV is the best performing parameter, with an expected sensitivity and specificity of 85% and 92%, respectively; additional parameters do not increase accuracy.

**CRD commentary**
The review addressed a clearly stated research question that had been defined by appropriate inclusion criteria. The review methodology was robust and clear; advanced meta-analytic techniques were used and full descriptions provided. Relevant population and study design characteristics of the included studies were assessed and incorporated in the meta-analyses. The reporting of results was limited to summary data; the inclusion of the results of individual included studies might have been useful, particularly in relation to those not included in the meta-analyses. Overall, the conclusions of the review are likely to be reliable.

**Implications of the review for practice and research**
Practice: Noninvasive, duplex ultrasound is a moderately accurate screening test for RAS in patients with hypertension, and PSV is the best performing parameter. Operator expertise and patient spectrum may be important considerations when using PSV as a triage test for RAS.

Research: High-quality research is needed to provide further data on individual ultrasound parameters and specified combinations, and direct comparative data on PSV versus AT. To facilitate exploration of the relationship between operator experience and test performance, authors of future studies should report the experience of test operators.
Funding
National Health and Medical Research Council Program grant number 211205 (Australia).

Bibliographic details

PubMedID
17312071

DOI
10.2214/AJR.06.0355

Indexing Status
Subject indexing assigned by NLM

MeSH
Cohort Studies; Humans; Renal Artery Obstruction /epidemiology /ultrasonography; Reproducibility of Results; Sensitivity and Specificity; Ultrasonography, Doppler, Duplex /statistics & numerical data

AccessionNumber
12007000996

Date bibliographic record published
10/03/2008

Date abstract record published
03/11/2008

Record Status
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.