CRD summary
This well-conducted review assessed Duplex ultrasound (DUS), magnetic resonance angiography (MRA) and computed tomography angiography (CTA) against a reference standard of intra-arterial angiography for the diagnosis of vertebral artery stenosis. The authors concluded that contrast-enhanced MRA and possibly CTA may be more sensitive than DUS, but further research is required. This conclusion is likely to be reliable.

Authors' objectives
To assess the accuracy of Duplex ultrasound (DUS) magnetic resonance angiography (MRA) and computed tomography angiography (CTA) compared with intra-arterial angiography (IAA) in the detection of severe vertebral artery stenosis.

Searching
MEDLINE, PubMed and EMBASE were searched up to July 2006; the search terms were reported. Only articles reported in English were eligible for inclusion in the review. In addition, the references of studies that met the primary inclusion criteria were checked.

Study selection
Diagnostic accuracy studies that assessed DUS, MRA or CTA in comparison with the reference standard of IAA were eligible for inclusion. The included studies assessed DUS with and without colour, MRA with and without contrast enhancement, and CTA. Case series with fewer than 5 patients were excluded from the review. Eligible studies examined the vertebral artery for stenosis or occlusion in patients aged at least 18 years. The patients in the included studies were aged from 18 to 77 years. Studies that merged vertebral artery data with data on other vessels were excluded from the review. Studies were required to categorise stenosis into degrees and only studies that provided sufficient data for the construction of 2x2 contingency tables were eligible for inclusion. Where data were available for only a subset of patients, this subset was included in the review. The definitions of stenosis varied in the included studies.

Two reviewers independently assessed studies for inclusion in the review.

Assessment of study quality
Validity was assessed using criteria such as whether the study was prospective, blinding of the assessors and the recruitment of consecutive patients. Where such information was not stated, the study was assumed to be retrospective, unblinded and non-consecutive.

Two reviewers independently assessed the validity of the studies. Any disagreements were resolved through consensus or consultation with a third reviewer.

Data extraction
Data on sensitivity and specificity were extracted using a 2x2 diagnostic table for several different categories of stenosis, which were based in part on the definitions employed in the included studies. Diagnostic odds ratios (DORs) with 95% confidence intervals (CIs) were calculated for all stenosis groups. Where values were 100%, 0.5 was added to all cells. Authors were contacted for further information in some instances.

Two reviewers independently performed the data extraction.

Methods of synthesis
The DORs were pooled in a fixed-effect meta-analysis. Subgroup analyses were performed based on the different
imaging techniques and different degrees of stenosis. Heterogeneity was assessed using the $\chi^2$ test. DOR plots were also scrutinised for evidence of outliers.

**Results of the review**
Thirteen studies were included in the review. Five studies assessed DUS (n at least 271; 694 arteries), of which two used colour (n=164; 322 arteries); 7 studies assessed MRA (n=285; at least 560 arteries), of which five used contrast-enhanced MRA (n=185; at least 319 arteries); and one study assessed CTA (n=24). The number of patients was not reported for one study and the number of arteries was unclear in another study.

Only 3 studies were prospective and consecutive and, of these, two employed blinded assessment for both the index and reference tests. Eleven studies presented data on 50 to 99% stenosis.

**DUS.**

The 3 studies that used ultrasound without colour had a pooled sensitivity of 70.2% (95% CI: 56.6, 81.6), a pooled specificity of 93.4% (95% CI: 89.2, 96.3) and a pooled DOR of 37 (95% CI: 16, 83) for diagnosis of 50 to 99% stenosis versus <50% stenosis or 100% occlusion. For diagnosis of occlusion, the sensitivity was 98.8% (95% CI: 89.4, 100), the specificity was 90.8% (95% CI: 87.2, 93.7) and the DOR was 211 (95% CI: 38, 1,172). For the 2 studies using colour DUS, the pooled sensitivity was 70.2% (95% CI: 54.2, 83.3), the pooled specificity was 97.7% (95% CI: 95.2, 99.1) and the pooled DOR was 75 (95% CI: 24, 234) for diagnosis of 50 to 99% stenosis versus <50% stenosis or 100% occlusion. For diagnosis of occlusion, the sensitivity was 83.3% (95% CI: 51.6, 97.9), the specificity was 100% (95% CI: 98.8, 100) and the DOR was 2,557.8 (95% CI: 115.4, 56,671).

**MRA.**

The 2 non-contrast MRA studies showed significant statistical heterogeneity for all outcomes for diagnosis of 50 to 99% stenosis (p-value between 0.015 and 0.007) and were not pooled. One study showed very high sensitivity and specificity (100% and 97.4%, respectively), whilst the other showed poor sensitivity and specificity (53.8% and 88%, respectively). For diagnosis of occlusion, the sensitivity was 100% (95% CI: 75.3, 100), the specificity was 100% (95% CI: 97.5, 100) and the DOR was 8,019 (95% CI: 153, 420,402).

Four of the 5 studies using contrast-enhanced MRA assessed 50 to 99% stenosis. Statistically significant heterogeneity was detected for specificity of diagnosis. The pooled sensitivity was 93.9% (95% CI: 79.8, 99.3), the pooled specificity was 94.8% (95% CI: 91.1, 97.3) and the pooled DOR was 179 (95% CI: 42, 765). For diagnosis of occlusion, the sensitivity was 89.5% (95% CI: 66.9, 98.7), the specificity was 99.6% (95% CI: 97.9, 100) and the DOR was 429.7 (95% CI: 73.9, 2,498.6).

**CTA.**

The one study that assessed the diagnostic accuracy of CTA found a sensitivity of 100% (95% CI: 15.8, 100), a specificity of 95.2% (95% CI: 83.8, 99.4) and a DOR of 81 (95% CI: 3, 2,183.3) for diagnosis of 50 to 99% stenosis. Detection of the one occluded artery in the study was unclear.

Results for 50 to 69 or 70% and 70 to 99% stenosis were also reported in the paper, although data for these outcomes were scarce.

**Authors' conclusions**
Contrast-enhanced MRA and possibly CTA may be more sensitive in diagnosing vertebral artery stenosis than DUS, but the data are limited and further high-quality studies are required.

**CRD commentary**
The review question and the inclusion criteria, including the reference standard, were clear. The authors searched some relevant databases but excluded non-English language reports. They also did not report searching for unpublished studies. Both of these facts might have increased the possibility that some relevant studies were not included in the review. The authors used appropriate methods to minimise bias and error in the selection of studies for the review, the
extraction of data and the assessment of study validity. The validity assessment used appropriate criteria. The decision to combine the studies statistically where there was no clear evidence of statistically significant heterogeneity appears appropriate. This was a well-conducted review and the cautious conclusions are likely to be reliable.

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

Practice: The authors did not state any implications for practice.

Research: The authors stated that studies comparing DUS, contrast-enhanced MRA and CTA against IAA in the same cohort of patients are required to determine optimum imaging protocols. CTA also requires validation.

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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.