Diagnosing cerebral aneurysms by computed tomographic angiography: meta-analysis

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CRD summary
This review concluded that computed tomography (CT) angiography had high accuracy in diagnosing cerebral aneurysms, specifically when using modern multidetector CT. Although there were some limitations to the review, such as the possibility of missing studies, these are unlikely to have changed the results greatly and the conclusions are likely to be reliable.

Authors' objectives
To determine the accuracy of noninvasive computed tomographic (CT) angiography for diagnosing intracranial aneurysms in symptomatic patients.

Searching
PubMed, Scopus, BIOSIS Previews and Web of Science were searched from 1995 to February 2010. There were no language restrictions. Search terms were reported and included a diagnostic filter. Reference lists of retrieved articles were screened.

Study selection
Studies that evaluated contrast enhanced helical CT angiography (index test) against digital subtraction angiography (DSA) (reference standard) for primary diagnosis of any type of cerebral aneurysm (target condition) in patients clinically suspected of having a cerebral aneurysm were eligible for inclusion. Studies had to report sufficient data to construct a 2x2 table of test performance on at least a per-patient basis, include at least five patients with and five patients without cerebral aneurysm and be prospective and report the time period for which patients were enrolled or enrol consecutive patients.

Studies used DSA (including rotational DSA in some studies) or a combination of DSA and intra-operative findings as the reference standard. Most studies used four-vessel DSA. Mean prevalence of non-traumatic subarachnoid haemorrhage was 86%. Mean prevalence of cerebral aneurysmal disease was 77%. Some studies were restricted to patients with non-traumatic subarachnoid haemorrhage. The proportion of women ranged from 40% to 77%. Mean/median age ranged from 45 to 62 years. CT angiography was performed with single-, four-, 16- or 64-detector CT. The volume of contrast medium ranged from 50 to 140mL. Iodine content ranged from 240 to 400mg/mL. Flow rate ranged from two to five ml/second. In slightly more than half of the studies CT angiography was interpreted by a single reader.

Two reviewers independently assessed studies for inclusion; disagreements were resolved through consensus.

Assessment of study quality
Study quality was assessed using the 14-item QUADAS tool. Studies were assigned a summary score based on the number of yes (1 point), unclear (0.5 points) and no (zero points) responses. Studies that scored less than 11 were considered to be of low quality.

It was unclear how many reviewers performed the quality assessment.

Data extraction
Two reviewers independently extracted data to populate 2x2 tables of test performance and used these data to calculate sensitivity and specificity. Data were extracted on a per-patient and per-lesion basis. Disagreements were resolved through consensus.

Methods of synthesis
Summary sensitivity and specificity together with 95% confidence intervals (CIs) were estimated using the bivariate random-effects model. Heterogeneity was assessed using the I^2 statistic. Subgroup analysis was conducted by extending the bivariate model to include covariates for intravenous contrast medium divided by the infected iodine volume and
the iodine flow rate. Additional analyses were performed with a binomial fixed-effect model for number of aneurysms per diseased patient, intracranial location of aneurysm, aneurysm size and CT scanner class. Publication bias was assessed using a funnel plot and bivariate meta-regression of the log diagnostic odds ratio against the effective sample size.

**Results of the review**

Forty-five studies (3,643 participants) were included. Studies were considered to be of high methodological quality: 43 scored at least 11 points on the QUADAS assessment.

Based on patient level data, CT angiography had a sensitivity of 97% (95% CI 96% to 98%) and a specificity of 98% (95% CI 96% to 99%) for the diagnosis of cerebral aneurysm. Results on a per-lesion basis were slightly lower. Heterogeneity was moderate (I^2=33% to 76%). The accuracy of multidetector CT angiography was significantly higher than that of single-detector CT, especially in detecting small aneurysms (<4mm diameter). Summary sensitivity was 99% (95% CI 97% to 100%) and specificity was 99% (95% CI 93% to 100%) for 64-row CT (eight studies). Data for other types of scanner were reported.

CT images with effective slice thickness of less than 1mm was significantly more accurate than thicker slices, sensitivity was greater with high intravenous iodine flow rate (p=0.010) and specificity was higher in studies restricted to patients with subarachnoid haemorrhage (p=0.016). There was no association between study quality score or other features assessed and sensitivity or specificity.

There was no evidence of publication bias (p=0.71).

**Authors’ conclusions**

CT angiography had a high accuracy in diagnosing cerebral aneurysms, specifically when using modern multidetector CT.

**CRD commentary**

The review addressed a focused question. Inclusion criteria were clearly defined. The literature search was adequate for published studies, although use of a diagnostic filter means that relevant studies may have been missed. It was unclear whether unpublished studies were eligible and so there was a risk of publication bias. Appropriate steps were taken to minimise bias and errors when assessing inclusion and extracting data; it was unclear whether similar steps were taken when assessing study quality. Study quality was assessed using appropriate criteria. The results of the assessment were presented using summary quality scores in the paper; full details were available as a web appendix.

The statistical analysis involved statistically robust methods of pooling accuracy data. Heterogeneity was investigated using appropriate subgroup analysis. It would have been helpful if the results of the heterogeneity assessments had been reported for each meta-analysis.

The authors’ conclusions are supported by the data and although there were some limitations to the review, such as the possibility of missing studies, these are unlikely to have changed the results greatly and these conclusions are likely to be reliable.

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

**Practice:** The authors stated that CT angiography may increasingly supplement or selectively replace DSA in patients suspected of having a cerebral aneurysm.

**Research:** The authors stated that research may show whether more advanced CT scanners further improved differential diagnosis in patients suspected of having a cerebral aneurysm.

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