Treatment of brain arteriovenous malformations: a systematic review and meta-analysis

CRD summary
The authors of this review noted a decrease in mortality over time, but stated that treatment of brain arteriovenous malformations remained associated with considerable risks and incomplete efficacy. They recommended that randomised controlled trials should be conducted to compare different treatments for the condition. This recommendation appears appropriate given that the review located only observational studies (which cannot determine causality).

Authors' objectives
To assess rates of mortality, long-term risk of haemorrhage, complications and successful obliteration of brain arteriovenous malformations (AVM) after intervention and to assess determinants of these outcomes

Searching
PubMed and EMBASE were searched up to March 2011 using search terms documented in the report. Six relevant journals were handsearched from January 2000 to March 2011.

Study selection
Eligible studies needed to report on at least 15 consecutive patients of any age who underwent brain AVM treatment. Follow-up duration needed to be noted as did death and intracranial haemorrhage after treatment. Articles in languages other than English, French, German, Italian and Spanish were excluded. Studies that described other intracranial vascular malformations were excluded. Studies where 20% or more of patients were lost to follow-up and studies where 5% or more were not treated were excluded.

The three treatments investigated were microsurgery, stereotactic radiosurgery (SRS) and embolisation. The primary outcome was all-cause case fatality during treatment and follow-up. The secondary outcome was intracranial haemorrhage beyond 30 days of treatment. Tertiary outcomes were treatment complications and successful obliteration of brain AVMs.

Two authors were involved in the selection of studies for the review. Discrepancies were resolved by consensus.

Assessment of study quality
High-quality studies were defined as those with either a prospective study design or an independent outcome measure.

Two reviewers were involved in the assessment. Disagreements were resolved by consensus.

Data extraction
Where multiple publications were produced from the same cohort, the authors included the largest cohort.

Two authors extracted data for the review. Discrepancies were resolved by consensus.

Methods of synthesis
The authors calculated case fatality and haemorrhage rates per 100 person-years for all cohorts and for each treatment modality separately with the number of outcomes and the number of person-years for each study as parameters in regression models. Sensitivity analyses were conducted to investigate the impact of study quality on overall case fatality and haemorrhage rates. Statistical heterogeneity was assessed for case fatality and haemorrhage rates in all cohorts and in the three treatment modalities separately. Regression analysis was used to investigate the associations of study characteristics on the occurrence of complications and on the proportion of patients in whom successful obliteration was achieved after each of the three treatment modalities.
Results of the review

One hundred and thirty-seven studies with 142 cohorts were included in the review (13,698 participants and 46,314 patient-years of follow-up). None of the studies were in the form of a randomised controlled trial (RCT). All were observational in design.

Case fatality was 1.1 (95% CI 0.87 to 1.3) per 100 person-years after microsurgery, 0.50 (95% CI 0.43 to 0.58) after stereotactic radiosurgery and 0.96 (95% CI 0.67 to 1.4) after embolisation. Internal haemorrhage rates were 0.18 (95% CI 0.10 to 0.30) per 100 person-years after microsurgery, 1.7 (95% CI 1.5 to 1.8) after stereotactic radiosurgery and 1.7 (95% CI 1.3 to 2.3) after embolisation.

Complications that led to permanent neurological deficits or death occurred in a median of 7.4% (range 0% to 40%) after microsurgery, 5.1% (range 0% to 21%) after stereotactic radiosurgery and 6.6% (range 0% to 28%) after embolisation.

Obliteration was achieved in 96% (range 0% to 100%) of patients after microsurgery, 38% (range 0% to 75%) after stereotactic radiosurgery and 13% (range 0% to 94%) after embolisation.

Further results of determinants of these outcomes and sensitivity analyses are detailed in the report.

Authors' conclusions

Although case fatality after treatment has decreased over time, treatment of brain AVM remains associated with considerable risks and incomplete efficacy. RCTs comparing different treatment modalities appear justified.

CRD commentary

The review was underpinned by broadly defined inclusion criteria for participants, interventions, outcomes and study design. Searching was based on two databases and handsearches of selected journals. It was possible that studies were missed from the search. Inclusion of unpublished studies was unclear. Two reviewers selected studies, extracted data and assessed study quality in order to minimise bias. Quality was assessed using only two basic criteria. Synthesis appeared to be appropriate. Results of statistical heterogeneity testing were not reported in full.

The authors' recommendation for RCTs to compare different treatment modalities appears appropriate given that the review located only observational studies.

Implications of the review for practice and research

Practice: The authors stated that standardised international prospective registrations of conservative or interventional management of brain AVMs may provide more information for individual risk prediction.

Research: The authors stated that RCTs were needed to evaluate the safety and effectiveness of different treatment modalities in brain AVM subgroups.

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