Carotid artery stenting versus carotid endarterectomy: systematic review and meta-analysis

CRD summary
The review concluded that carotid endarterectomy was equal to carotid artery stenting in patients with carotid stenosis in terms of incidence of stroke and death. Each mode of therapy can be optimised with careful patient selections. The authors' conclusions appeared appropriate based on the evidence presented, but should be viewed with some caution given potential for language and publication biases.

Authors' objectives
To evaluate the complications of carotid endarterectomy and carotid artery stenting in patients with carotid stenosis.

Searching
PubMed, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), DARE and ACP Journal Club databases were searched for studies published in English between 1995 and 2008. Search terms were reported. Reference lists of retrieved studies were reviewed for additional articles.

Study selection
Prospective, randomised or controlled clinical trials in patients treated for carotid angioplasty, carotid stent and carotid endarterectomy were eligible for inclusion. Studies had to involve use of an emboli-protection device in the carotid artery stenting procedure and where patients were symptomatic or asymptomatic of carotid stenosis before treatment.

Studies with poor reporting of patient characteristics and lack of relevant outcome data were excluded from the review.

The interventions in the included studies were carotid angioplasty and stenting and carotid endarterectomy. Endovascular techniques and surgical techniques varied between studies. Participants in included studies had a mean age in the range 42 years to 70 years. Five studies reported all participants were symptomatic of internal carotid artery stenosis. One study reported more than 80% of participants as asymptomatic of internal carotid artery stenosis. Eligibility was determined by angiography, ultrasound, magnetic resonance angiography (MRA) or computed tomography angiography (CTA). Most studies reported various proportions of participants with a history of stroke, transient ischaemic attack, hypertension, diabetes mellitus or hyperlipidaemia. Outcomes reported included stroke, mortality, myocardial infarction, pulmonary embolus, bradycardia or hypotension, cervical or groin haematomas, cervical or peripheral nerve injury, ipsilateral intracerebral bleeding and restenosis rate.

Two reviewers independently selected studies for inclusion. Methods used to resolve disagreements were not reported.

Assessment of study quality
Validity was assessed using the Jadad scale and graded from 1 to 4. Two reviewers independently assessed quality. Methods used to resolve disagreements were not reported.

Data extraction
Data on endovascular and surgical techniques, follow-up and occurrence of adverse events were extracted. Data on occurrence of adverse events were used to calculate relative risks (RR) with corresponding 95% confidence intervals (CIs).

Two reviewers extracted data. Methods used to resolve disagreements were not reported.

Methods of synthesis
Data were pooled in a meta-analysis using a fixed-effect model. Where there was evidence of significant heterogeneity, a random-effects model was applied. Heterogeneity was assessed using the $X^2$ and I$^2$ tests. Publication
bias was assessed using funnel plots.

Results of the review
Eight randomised controlled trials (RCTs) were included in the review (n=2,942). One study scored 4 points on the quality score, five studies scored 3 points and two studies scored 1 point.

There were no statistically significant differences between carotid endarterectomy and carotid artery stenting for incidence of stroke or death within 30 days (RR 0.69, 95% CI 0.45 to 1.07; eight studies) or one year after the procedure (RR 0.88, 95% CI 0.43 to 1.79; three studies). There was evidence of statistical heterogeneity for the one year analysis (p=0.02, I^2=74.8%). Carotid artery stenting was associated with a higher incidence of stroke and death within 30 days among previously symptomatic patients (RR 0.53, 95% CI 0.30 to 0.95; five studies).

There were no statistically significant differences between carotid endarterectomy and carotid artery stenting for: rates of mortality within 30 days (six studies); incidence of disabling stroke within 30 days (seven studies); and incidence of non-disabling stroke within 30 days (seven studies). Use of embolic protection devices in carotid artery stenting procedures did not provide any significant improvements compared to carotid endarterectomy procedures in the occurrence of disabling stroke (three studies) or death (five studies) within 30 days. There was no evidence of statistical heterogeneity for these analyses.

For participants who underwent carotid endarterectomy, the risk was significantly higher for myocardial infarction within 30 days (RR 3.69, 95% CI 1.28 to 10.67) and within one year (RR 3.16, 95% CI 1.04 to 9.58) and for cervical or peripheral nerve injury within 30 days (RR 12.70, 95% CI 4.48 to 33.48). Participants who underwent carotid artery stenting had a higher risk of bradycardia or hypotension within 30 days (RR 0.08, 95% CI 0.03 to 0.22) and one year restenosis rate (RR 0.28, 95% CI 0.28 to 0.63).

There were no statistically significant differences between groups for pulmonary embolus, cervical or groin haematoma and ipsilateral intracerebral bleeding within 30 days.

Evidence of publication bias was reported for some outcomes (funnel plots not reported). Results remained similar for sensitivity analyses, although there was a significantly higher risk reported for non-disabling stroke within 30 days of carotid artery stenting when one study was excluded (data not reported).

Authors’ conclusions
Carotid artery stenting was equal to carotid endarterectomy with regard to incidence of stroke and death. These procedures may be considered complementary rather than competing modes of therapy, each of which can be optimised with careful patient selections. Carotid artery stenting with an embolic protection device may be appropriate in certain patients. In general, carotid artery stenting should be considered cautiously in symptomatic patients.

CRD commentary
Inclusion criteria were explicitly stated for intervention, participants and study design, but not for outcomes. Several relevant sources were searched, although inclusion only of studies published in English may have meant that some relevant data was missed. No attempts were made to reduce the risk of publication bias; formal assessment reported some evidence of publication bias. Appropriate methods were used to reduce error and bias in the selection of studies, assessment of validity and extraction of data. Validity was assessed using the Jadad score, but it was unclear whether results of the validity assessment were used to inform the analysis. Studies were appropriately combined in a meta-analysis and the potential for statistical heterogeneity was assessed. Although analyses identified evidence of statistical heterogeneity, no efforts were made to adjust for this. The authors’ conclusions appeared appropriate based on the evidence presented, but should be viewed with some caution given the potential for language and publication biases.

Implications of the review for practice and research
Practice: The authors stated that carotid artery stenting with embolic protection devices may be appropriate in some patients. In general, carotid artery stenting should be considered cautiously in symptomatic patients.

Research: The authors stated that further rigorous large RCTs and results from ongoing trials were needed to determine the safety and durability of carotid artery stenting.
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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.