Cost-effectiveness of magnetic resonance angiography

The cost-effectiveness of magnetic resonance angiography for carotid artery stenosis and peripheral vascular disease: a systematic review

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Executive summary

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Executive summary

Background

The principal manifestations of carotid and peripheral atherosclerosis, respectively, include transient ischaemic attack and stroke, and lower limb arterio-occlusive disease resulting in intermittent claudication (pain on walking), ischaemic rest pain, ulceration or gangrene. The total costs to the NHS of arterial and venous disease, in hospital and primary care, exceed £350 million; the total costs of stroke have been estimated as substantially higher, at 5.8% of total expenditure.

Clinical decision-making relies on evaluation of the vessels in terms of the degree of stenosis, or narrowing. Magnetic resonance angiography (MRA) is a technique for imaging blood vessels that contain flowing blood. It can be performed on most magnetic resonance scanners installed in hospitals today, and represents an alternative to conventional angiographic techniques using X-rays (digital subtraction angiography (DSA)), or more recent imaging developments, including ultrasound. In this review the use of contrast-enhanced MRA and two-dimensional (2D) and three-dimensional (3D) time-of-flight (TOF) MRA for presurgical assessment in carotid artery disease and in peripheral vascular disease is considered.

Objectives

- To identify the literature on MRA that is relevant to the use of MRA for presurgical assessment in carotid artery disease and in peripheral vascular disease.
- To synthesise published evidence about the diagnostic performance of MRA, compared with DSA, in carotid artery disease and in peripheral vascular disease at surgical decision thresholds.
- To use this evidence, together with other information about costs and outcomes, to model the cost-effectiveness of MRA compared with conventional angiography in carotid artery disease and in peripheral vascular disease.

Methods

Data sources

- Electronic searches of MEDLINE, EMBASE, HealthSTAR, Science Citation Index, Index to Scientific and Technical Proceedings, the Cochrane Library, Inside from the British Library, EconLIT, HEED, the NHS EED and the Online Computer Library Centre, 1990–1999.
- A limited Internet search for reviews, 1990–1999.
- A handsearch of ten key journals and the Department of Health databases (Hospital Episode Statistics and Health Related Resource Groups), 1990–1999.

Study selection

Studies of the diagnostic performance of MRA in the relevant clinical conditions and performed on humans were included with two provisos: that sufficient data were reported for the construction of a 2 × 2 contingency table, and that application-specific inclusion criteria were satisfied. Non-English-language studies were included. Studies reporting cost data were included, providing resource use and costs for the UK setting were reported separately, and providing the study did not use expert opinion or charge data to estimate costs.

Data extraction

Checklists that covered study design, patient characteristics, technical details and potential biases in study execution were completed independently by two reviewers. Consensus was reached on any disagreements. One reviewer, who worked with another where difficulty arose, extracted results on diagnostic performance. Summaries were written to describe each article. Cost data were extracted and summarised by two team members.

Data synthesis

Summary receiver operating characteristic methods were used to combine the results of diagnostic performance studies, grouped by MRA technique and diagnostic threshold. The thresholds used were:

- For carotid artery disease, using the North American Symptomatic Carotid Endarterectomy Trial (NASCET) protocol:
  - 0–69% or 100% versus 70–99%
  - 0–49% or 100% versus 50–99%
  - 0–99% versus 100%.
- For peripheral vascular disease:
  - 0–49% versus 50–100%
  - 0–49% or 100% versus 50–99%
  - 0–99% versus 100%.

Study validity was investigated using a multiple linear regression analysis. Overall event rates were calculated by pooling patient results from the included studies. A decision analytic model was used to combine information from the literature and cost estimates, in order to determine the relative cost-effectiveness of MRA and DSA in the two clinical applications. The analysis was performed from the perspectives of the healthcare purchaser and clinician. Sensitivity analysis was performed.

Results

Ten articles on carotid artery stenosis satisfied all the inclusion criteria and a further 24 satisfied at least four inclusion criteria. There were too few articles on the latest contrast-enhanced techniques for quantitative synthesis, but the results appear better than those for 2D and 3D TOF methods. The TOF methods are highly accurate for detecting occlusion and 70–99% stenoses, but are less accurate for 50–99% stenoses. The decision analytic model showed that over 10 years following its use, MRA is expected to cost £194 less than DSA, with no difference in expected quality-adjusted life-years (QALYs). Providing the equipment is used at more than 10% of capacity, MRA is associated with lower expected costs than DSA.

Twenty articles on peripheral vascular disease satisfied all the inclusion criteria. Both 2D TOF and contrast-enhanced MRA are highly accurate for distinguishing 0–49% from 50–100% stenoses. The contrast-enhanced techniques show a non-significant trend for improved performance over 2D TOF MRA. The decision analytic model showed that there is no difference in expected QALYs for MRA and DSA. If the equipment is used at under 100% of capacity, 2D TOF MRA is associated with higher expected costs than DSA, but contrast-enhanced MRA has lower expected costs.

Conclusions

Implications for healthcare

In carotid artery disease, 2D and 3D TOF MRA techniques are accurate for identifying both occlusions and 70–99% stenoses as defined by conventional angiography. The evidence does not support their use for identifying 50–99% stenoses. If the utilisation rate for an MRA system to evaluate all patients (with and without carotid artery disease) is greater than 10%, then MRA is likely to be a cost-effective option.

In peripheral vascular disease the evidence supports the use of 2D TOF and contrast-enhanced MRA techniques for identifying occlusions and 50–100% stenoses. If both DSA and MRA are already available in the local setting, then MRA is more cost-effective than DSA, especially if contrast-enhanced MRA is available.

The conclusions about cost-effectiveness are valid only for high-quality diagnostic studies. Such examinations can only be performed following training and adequate experience. Consequently, there is a case for guidelines, training and accreditation schemes to be established by the relevant professional bodies.

Recommendations for further research

- The establishment of a multicentre tracker study to determine the accuracy of contrast-enhanced MRA, duplex ultrasound and computed tomography (CT) angiography (singly or in combination) for the investigation of peripheral vascular disease.
- The establishment of a multicentre tracker study to determine the accuracy of MRA, duplex ultrasound and CT angiography (singly or in combination) for the investigation of carotid artery disease.
- Support for data from primary studies to be held on web servers is recommended, as it would facilitate future modelling activity.
- A rapid, structured review focused on contrast-enhanced MRA in 2002.
- The compilation of general guidelines for designing and presenting trials of diagnostic and imaging technologies.
- A methodological investigation of publication bias specifically focused on diagnostic literature.
- Studies on patient preferences for the diagnostic process and expected impact on

their health status and health-related quality of life.
- Monitoring of expert opinion to ensure that trials of new non-invasive MRA techniques are implemented in a timely way.
- Updating of the peripheral vascular disease model in 2005.

Publication

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The NHS R&D Health Technology Assessment (HTA) Programme was set up in 1993 to ensure that high-quality research information on the costs, effectiveness and broader impact of health technologies is produced in the most efficient way for those who use, manage and provide care in the NHS.

Initially, six HTA panels (pharmaceuticals, acute sector, primary and community care, diagnostics and imaging, population screening, methodology) helped to set the research priorities for the HTA Programme. However, during the past few years there have been a number of changes in and around NHS R&D, such as the establishment of the National Institute for Clinical Excellence (NICE) and the creation of three new research programmes: Service Delivery and Organisation (SDO); New and Emerging Applications of Technology (NEAT); and the Methodology Programme.

This has meant that the HTA panels can now focus more explicitly on health technologies ('health technologies' are broadly defined to include all interventions used to promote health, prevent and treat disease, and improve rehabilitation and long-term care) rather than settings of care. Therefore the panel structure has been redefined and replaced by three new panels: Pharmaceuticals; Therapeutic Procedures (including devices and operations); and Diagnostic Technologies and Screening.

The HTA Programme will continue to commission both primary and secondary research. The HTA Commissioning Board, supported by the National Coordinating Centre for Health Technology Assessment (NCCHTA), will consider and advise the Programme Director on the best research projects to pursue in order to address the research priorities identified by the three HTA panels.

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