NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of laser-assisted cerebral vascular anastomosis without temporary arterial occlusion

Arteries in the head may need to be bypassed as part of an operation for cancer, or because of 'ballooning' or blockage of arteries. This procedure aims to create a bypass without the need to interrupt the blood flow in the artery, using a graft taken from another part of the circulation.

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) in making recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in June 2007.

Procedure name

- **Laser-assisted cerebral vascular anastomosis without temporary arterial occlusion**

Specialty societies

- Society of British Neurological Surgeons
- The Vascular Society

Description

Indications

Intra-cranial artery bypass

A number of conditions may require the establishment of a high-flow cerebral vascular bypass, which may be either an internal-to-external bypass or an

internal-to-internal bypass. These conditions include giant cerebral aneurysms, large tumours of the skull base that impinge on the carotid artery, and surgical revascularisation following ischaemic stroke.

Current treatment and alternatives

Conventional treatments for intracerebral vascular disease, such as clipping or coiling of aneurysms, aim to preserve normal blood flow. This is not always possible, however, and arterial ligation or endovascular balloon occlusion may be required to treat the abnormality. Collateral blood supply through the circle of Willis often permits limited blood supply without clinical consequence but where collateral supply to a sensitive area of brain is deficient, bypass may be required. Conventional bypass requires open surgery to create a direct superficial bypass for the temporal artery to the middle cerebral artery, or an interposition saphenous vein or radial artery graft is used. Both techniques require temporary occlusion of the blood supply while the anastomosis is formed, risking ischaemic events.

What the procedure involves

The laser-assisted non-occlusive anastomosis technique aims to produce high-flow bypass to and from cerebral vessels without the temporary occlusion of the blood supply required for conventional anastomosis techniques which starves the blood supply to the brain.

The procedure is undertaken under general anaesthesia. The proximal connection of the graft is performed using a standard end-to-end or end-to-side anastomosis. The anastomosis site is prepared by stitching a platinum ring onto the wall of the distal (recipient) vessel. The bypass graft vessel is stitched end-to-side to the recipient vessel around the ring as guide. A combined laser–vacuum-suction catheter is introduced through the bypass graft into the platinum ring onto the wall of the recipient vessel. Using vacuum suction and laser pulses, a disc-shaped area is resected in the wall of the recipient vessel. This punched-out disc is withdrawn with the catheter, completing the non-occlusive anastomosis. The end of the graft is temporarily clipped to prevent backflow.

Efficacy

Clinical outcomes

In two case series of 77[1] and 34[2] patients with intracranial aneurysms undergoing laser-assisted cerebral vascular anastomosis without temporary arterial occlusion, 68% (52/77) of patients were independent (using the Rankin scale) at 2–4 months' follow-up, and 79% (27/34) were independent at 3.3 years' follow-up. In one of these studies functional health improved in 14% (11/77) of patients, was unchanged in 65% (50/77) and had decreased in 21% (16/77) at 2–4 months' follow-up.[1] In the other study, Rankin score had improved in 71% (24/34) of patients at discharge and 74% (25/34) at 3.3 years' follow-up.[2] In this same study, pre-existing cranial nerve compression resolved in 30% of 27 patients who had this condition at baseline.

One case series of 15 patients with carotid artery occlusion and recurrent ischaemic symptoms reported that the annual rate of disabling stroke or vascular death following laser-assisted cerebral vascular anastomosis without temporary arterial occlusion was 15.4% (95% confidence interval [CI] 4.2 to 39.4%).[3] In this series, median carbon dioxide reactivity (which measures blood distribution to the hemispheres of the brain) improved significantly from 6% at baseline to 22% following the procedure (p = 0.005). A patent bypass was identified on Doppler ultrasound examination in 91% (10/11) of the patients who survived to 6 months' follow-up.

Operative characteristics

In one case series of 34 patients with intracranial artery aneurysms, the mean operative time for the procedure was 443 minutes, and length of hospital stay was 24 days.[2] In one case report of a patient with a giant basilar artery aneurysm the operative time was 15 hours.[4]

Safety

Mortality rates (up to 30 days' follow-up) following laser-assisted cerebral vascular anastomosis without temporary arterial occlusion of 0% (0/1),[5] 4% (3/77),[1] 6% (2/34)[2] and 7% (1/15)[3] have been reported, although the indication for the procedure varied between studies.

One case series of 77 patients with intracranial artery aneurysms treated with the procedure reported that haemorrhage causing persistent deficit occurred in 5% (4/77) of patients, ischaemia causing persistent deficit occurred in 21% (16/77) and other intracranial events causing persistent deficit occurred in 3% (2/77).[1] Procedure-related complications resulting in a Rankin score of 3–5 occurred in 9% (7/77) of patients.[1]

One case series of 34 patients with intracranial artery aneurysms treated with laser-assisted cerebral vascular anastomosis without temporary arterial occlusion reported ischaemic complication with subarachnoid haemorrhage in 3% (1/34) of patients, aneurysm bleed in 3% (1/34), cranial nerve deficit in 6% (2/34) and postoperative ischaemic complications in 9% (3/34).[2]

A case report of 15 patients with carotid artery occlusion who underwent the procedure reported that ischaemic stroke occurred in 20% (3/15) of patients, and dysphasia with right-sided weakness in 13% (2/15)[3]. Long-term outcomes (median follow-up 14 months) included death from sudden coma in 14% (2/14) and death from brainstem infarct in 7% (1/14).[3]

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to laser-assisted cerebral vascular anastomosis without temporary arterial occlusion. Searches were conducted via the following databases, covering the period from their commencement to 26th June 2007: Medline, PreMedline,

EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches. (See Appendix C for details of search strategy.)

The following selection criteria (Table 1) were applied to the abstracts identified by the literature search. Where these criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good-quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial or laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising methodology.
Patient	Patients with damaged occluded or impinged carotid arteries requiring bypass
Intervention/test	Laser-assisted cerebral vascular anastomosis without temporary arterial occlusion
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the overview

This overview is based on three case series[1–3] and two case reports.[4,5]

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (Table 2) are listed in Appendix A.

Existing reviews on this procedure

No published systematic reviews with meta-analysis or evidence-based guidelines were identified at the time of the literature search.

Related NICE guidance

Below is a list of NICE guidance related to this procedure. Appendix B details the recommendations made in each piece of guidance listed below.

Interventional procedures

'High-flow interposition extracranial to intracranial bypass' NICE interventional procedures guidance 73 (2004). Available from http://guidance.nice.org.uk/IPG73

Technology appraisals

None

Clinical guidelines

None

Public health

None

Table 2 Summary of key efficacy and safety findings on laser-assisted cerebral vascular anastomosis without temporary arterial occlusion

Abbreviations used: CI, confidence interval; EC, extracranial; ELANA, Excimer laser-assisted non-occlusive anastomosis; IC, intracranial; ICA, intracranial artery; WFNS, World Federation of Neurological Societies [grading scale]

Study details	Key efficacy findings	Key safety findings	Comments
Brilstra EH (2002)[1] **Case series** Holland Study period: 1990 to 2000 **n = 77 with intracranial aneurysms** Population: age = 52 years; male = 29%. Aneurysm size 0–10 mm = 15%; 11–25 mm = 18%: > 25 mm = 67%. Aneurysm ruptured = 31%. Good condition (WFNS grade I–III) 16%; poor (grade IV or V) = 1%. Independent = 68%; dependent = 16%. Indications: Intracranial aneurysm; prolonged temporary occlusion during clip application anticipated (n = 13), or before permanent closure of the parent vessel (n = 64). Technique: Anastomosis using the Excimer laser for EC–IC bypass, or Excimer laser for the proximal anastomosis and conventional anastomosis at the distal end for an IC–IC bypass. . **Follow-up: 2.5 months (median)** Conflict of interest: Not stated.	**Clinical outcomes** Clinical outcomes were evaluated at 2–4 months' follow-up and categorised as independent (Rankin 0–2), dependent (3–5) or death. **Status** **n = 77** Independent 68% (52/77) Dependent 22% (17/77) Deceased 10% (8/77) **Functional health** Decreased 21% (16/77) Unchanged 65% (50/77) Improved 14% (11/77) **Risk factors associated with a poor outcome** Multiple logistic regression evaluated the following factors: patient age, clinical condition at baseline, history of cardiovascular events, aneurysm type / size / location, indication for bypass operation, EC–IC or IC–IC bypass, and year of procedure. Only clinical condition at baseline had a significant prognostic value with regard to poor outcome (odds ratio 4.0 95% CI 1.3 to 11.9). The year of procedure was not related to poor outcome, suggesting no obvious learning curve. **Surgical success** Laser anastomosis failed in 2 patients because the excised section of the targeted artery wall did not attach to the laser tip on withdrawal. In 97% (75/77) of patients a high-flow bypass was successfully established. A second procedure was required in 8 patients, usually because a thrombus filled the bypass after the operation.	**Complications** **Outcome** **Rate** Death (procedure related) 4% (3/77) Haemorrhage Persistent deficit 5% (4/77) Transient deficit 4% (3/77) Ischaemia Persistent deficit 21% (16/77) Transient deficit 10% (8/77) Other intracranial event Persistent deficit 3% (2/77) Transient deficit 1% (1/77) Rankin score 3–5 (procedure related) 9% (7/77) Cerebral ischaemia developed in 2 patients > 24 hours after the procedure.	Some of the same patients may also be reported in Van Doormaal (2006), although study periods overlap by only 1 year. Method of case selection for the ELANA procedure not defined. Retrospective data collection Clinical condition at baseline assessed using the WFNS grading scale ranging from grade 1: 'mild headache with or without meningeal irritation', to grade 5: 'patient either posturing or comatose', for those who had suffered haemorrhage > 30 days before the procedure. The Rankin scale was used for unruptured aneurysms or rupture > 30 days before surgery; ranges from grade 0: 'no symptoms' to grade 7: 'dead'. Both of these scores were dichotomised into 'good' and 'poor' groups. Clinical outcomes were evaluated at 2–4 months' follow-up and categorised as independent (Rankin 0–2), dependent (3–5) or death.

Abbreviations used: CI, confidence interval; EC, extracranial; ELANA, Excimer laser-assisted non-occlusive anastomosis; IC, intracranial; ICA, intracranial artery; WFNS, World Federation of Neurological Societies [grading scale]

Study details	Key efficacy findings	Key safety findings	Comments
Van Doormaal TPC (2006)[2] **Case series** Holland Study period: 1999 to 2004 **n = 34** Population: age = 53 years; male = 26%. Aneurysm lumen = 20 mm; intersection = 30 mm. Symptoms of cranial nerve compression = 65%; history of subarachnoid haemorrhage = 26%; no objective symptoms = 9%. Indications: Patients with non-coilable, non-clippable intracranial aneurysms of the ICA proximal to its bifurcation, thought to be at risk of ICA occlusion. Technique: Anastomosis using the Excimer laser for the proximal part of the EC–IC bypass, and conventional end-to-end anastomosis to the external carotid artery, using the saphenous vein as a graft. **Follow-up: 3.3 years (mean)** Conflict of interest: One author is supported by a grant from a national institution.	**Surgical success** The mean operative time was 443 minutes (range 300–750 minutes). Mean length of hospital stay was 24 days (range 8–59 days). During the procedure the recipient artery was never occluded during the bypass procedure. A patent high-flow bypass was successfully established In 97% (33/34) of patients. A second attempt was required in 18% (6/34) of patients. The artery wall flap was not retrieved successfully in 15% (5/34) of patients. After ligation of the ICA (n = 9) intraoperative bypass flow was 102 ml/min. Where the ICA was occluded after surgery and angiograph bypass flow measurement performed (n = 9) the mean flow was 138 ml/min was recorded. **Clinical outcomes** Clinical outcomes were evaluated at discharge and at 3.3 years' follow-up by means of a questionnaire using a modified Rankin scale and categorising patients with a score > 2 as dependent. Favourable outcomes were classified as an improvement of at least 1 point on the modified Rankin scale. **Independent Rankin status** **Baseline** 85% (29/34) **Discharge** 74% (25/34) **3.3 years** 79% (27/34) **Improved Rankin score** **Discharge** 71% (24/34) **3.3 years** 74% (25/34) Cranial-nerve compression was resolved following EC–IC bypass in 30% (10/27) of patients who had this condition pre-operatively. These are the figures reported in the study, but they do not resolve.	**Complications** **Outcome** / **Rate** Fatal complication 6% (2/34) Air embolus from a central line at 1 day follow up in 1 patient ICA rupture at 2 days' follow-up in 1 patient (ICA not ligated intraoperatively) Non fatal complications 21% (7/34) Ischaemic complication and subarachnoid haemorrhage at 2 days' follow-up in 1 patient (treated with second procedure to ligate the ICA) Aneurysm bleed at 14 days' follow-up in 1 patient (clipped to stop flow inversion through the aneurysm). Postoperative ischaemic complication in 3 patients Cranial nerve deficit in 2 patients	May include some of the same patients reported in Brilstra (2002), although study periods overlap by only 1 year. One clinician undertook all the procedures. The ICA was ligated if there was acute danger of the aneurysm bleeding. Not clear whether patients who died during follow-up were censored from outcome assessment. Authors state that ELANA procedure negates the use of brain protection measures such as hypothermia, circulatory arrest or barbiturate protection. Authors state that controlled trials are necessary, as comparison with natural history is problematic.

Abbreviations used: CI, confidence interval; EC, extracranial; ELANA, Excimer laser-assisted non-occlusive anastomosis; IC, intracranial; ICA, intracranial artery; WFNS, World Federation of Neurological Societies [grading scale]

Study details	Key efficacy findings	Key safety findings	Comments
Klijn C J M (2002)[3] **Case series** Holland Study period: Sept 1995 to Jul 1998 **n = 15** Population: age = 58 years; male = 80% Indications: Patients with internal carotid artery occlusion leading to recurrent ischaemic symptoms that were transient or, at most, moderately disabling. Technique: Anastomosis using the Excimer laser for the proximal part of the EC–IC bypass, and conventional end-to-side anastomosis to the superficial temporal artery, using saphenous vein or radial artery grafts. Antithrombotic medication given; other risk factors 'rigorously managed'. **Follow-up: 27 months** Conflict of interest: One author is supported by a grant from a national institution.	**Clinical outcomes** Annual rate of disabling stroke (Rankin grade 4 or 5), or vascular death = 15.4% (95% CI 4.2 to 39.4%). Annual rate of any stroke or vascular death = 22.2% (95% CI 8.2 to 48.4%). **Surgical success** Transcranial Doppler ultrasound on 11 of the patients who survived to 6 months showed that a patent bypass was established in 91% (10/11) of patients. Carbon dioxide reactivity (a measurement of blood distribution in the brain) improved significantly from a median of 6% (upper and lower quartiles −7% to 12%) at baseline, to 22% (upper and lower quartiles 8% to 39%) following the procedure (p = 0.005).	**Complications** All events occurring within 30 days of surgery were considered a complication of the procedure. **Outcome** — **Rate** Death (myocardial infarction) — 7% (1/15) Ipsilateral ischaemic stroke — 20% (3/15) Dysphasia and right-sided weakness — 13% (2/15) Repeat surgery — 13% (2/15) *Complications without permanent sequelae* Cerebrospinal fluid leak — 27% (4/15) Bone flap infection (2 months) — 7% (1/15) Wound infection — 7% (1/15) Urinary tract infection — 7% (1/15) Pneumonia — 7% (1/15) Transient delirium — 20% (3/15) No clinically silent infarcts on MRI scan at 6 months (survivors only) — 100% (14/14) *Late follow-up (median 14 months)* **Outcome** — **Rate** Death (sudden coma) — 14% (2/14) Death (brainstem infarct) — 7% (1/14) Brainstem infarct not affecting Rankin score — 7% (1/14)	Prospective case series. The 15 patients were selected for the procedure from 103 consecutive patients, using predefined clinical criteria. Operator experience not stated.

Abbreviations used: CI, confidence interval; EC, extracranial; ELANA, Excimer laser-assisted non-occlusive anastomosis; IC, intracranial; ICA, intracranial artery; WFNS, World Federation of Neurological Societies [grading scale]

Study details	Key efficacy findings	Key safety findings	Comments
Streefkerk HJN (2004)[4] **Case report** Norway Study period: Not stated **n = 1** Population: age = 36 years; male Indication: Patient with partially thrombosed giant basilar artery aneurysm. Devastating headache and brainstem compression. Patient not suitable for endovascular treatment or a clipping procedure. Technique: Anastomosis using the Excimer laser for the proximal part of bypass from ICA to superior cerebellar artery bypass; conventional end-to-side anastomosis at the distal end. **Follow-up: Not stated** Conflict of interest: Not stated.	**Surgical success** Perioperative evaluation demonstrated a stable flow of 40–41 ml/min throughout the bypass. Operative time was 15 hours. Angiogram at 1 day follow-up showed normal filling of the bypass and the superior part of the posterior circulation. The patient did not regain consciousness from anaesthesia and died at 2 days' follow-up.	**Complications** The patient did not regain consciousness from anaesthesia and died at 2 days' follow-up.	Different clinical indication to the other patients with aneurysms included in this overview. Procedure selected because the patient was not suitable for endovascular treatment and if left untreated quality of life was unacceptably poor and life expectancy short. Experience of team in carrying out the procedure is not stated. Authors state that the procedure requires expertise involving a multidisciplinary stroke team specialised in the treatment of complex cerebrovascular lesions.

Abbreviations used: CI, confidence interval; EC, extracranial; ELANA, Excimer laser-assisted non-occlusive anastomosis; IC, intracranial; ICA, intracranial artery; WFNS, World Federation of Neurological Societies [grading scale]

Study details	Key efficacy findings	Key safety findings	Comments
Reinert M (2006)[5] **Case Report** Switzerland Study period: 2004 **n = 1** Population: Age = 57 years; male Indications: Patient with a giant aneurysm of the left intracranial segment of the ICA. Technique: IC– IC bypass. Anastomosis using the Excimer laser for bypass from ICA to middle cerebral artery using saphenous vein graft. Aspirin given during postoperative period. **Follow-up: 2 months** Conflict of interest: supported by manufacturer and national foundation.	**Surgical success** Angiogram immediately after the procedure and at 2 months showed that the bypass had taken over the complete blood flow and a complete thrombosis of the aneurysm. A later angiogram demonstrated a recurrent perfusion of the aneurysm and occlusion of the bypass.	**Complications** The patient developed transient ischaemic attacks with motor aphasia (not clear when this outcome began). A secondary procedure was required to create an EC–IC bypass.	Not clear whether the secondary bypass procedure was undertaken using the ELANA technique. Follow-up period of outcomes not well reported.

Validity and generalisability of the studies

- Operative technique varied between and within studies. Some patients received IC–IC bypass and some EC–IC bypass.
- In all studies conventional anastomosis was used at the proximal end of the bypass, requiring temporary occlusion.
- Clinical indications for bypass varied between studies; these can be expected to have variable prognosis and natural history.
- No comparative data are available to demonstrate reduction in ischaemic events associated with surgery, compared with other anastomotic techniques.
- The reduction in occlusion time compared with conventional surgery is not presented.

Specialist advisers' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College.

Mr R Kerr (Society of British Neurological Surgeons), Prof. A Mendelow (Society of British Neurological Surgeons), Prof. A Strong (Society of British Neurological Surgeons)

- Two Specialist Advisers considered this procedure to be novel and of uncertain safety and efficacy, while a third categorised it as an established procedure and no longer new.
- Theoretical adverse events associated with the procedure may include laser damage to the bypass vessel wall and leakage or late stenosis of the anastomosis.
- A lab training session is required to carry out this procedure (no further details provided).
- This procedure is likely to have a very slow trajectory; it would have only a minor impact on the NHS, with fewer than 10 specialist centres taking it up.
- The key efficacy outcomes identified by the Specialist Advisers are: graft patency (including angiographic assessment) without further stenosis and lack of haemorrhage during the procedure.
- The key safety outcomes highlighted were vascular damage, stroke and death.

Issues for consideration by IPAC

- A very high proportion of the cases presented in the overview were undertaken at one centre.
- Only a single CE marked device / system is currently available for this procedure.
- Neither of the Specialist Advisers has undertaken the procedure.

References

1 Brilstra EH, Rinkel GJ, Klijn CJ et al. (2002) Excimer laser-assisted bypass in aneurysm treatment: short-term outcomes. *Journal of Neurosurgery* 97: 1029–1035.

2 Van Doormaal TPC, Van Der ZA, Verweij BH et al. (2006) Treatment of giant and large internal carotid artery aneurysms with a high-flow replacement bypass using the excimer laser-assisted nonocclusive anastomosis technique. *Neurosurgery* 59: 328–334.

3 Klijn CJ, Kappelle LJ, Van Der ZA et al. (2002) Excimer laser-assisted high-flow extracranial/intracranial bypass in patients with symptomatic carotid artery occlusion at high risk of recurrent cerebral ischemia: safety and long-term outcome. *Stroke* 33: 2451–2458.

4 Streefkerk HJN, Wolfs JFC, Sorteberg W et al. (2004) The ELANA technique: Constructing a high flow bypass using a non-occlusive anastomosis on the ICA and a conventional anastomosis on the SCA in the treatment of a fusiform giant basilar trunk aneurysm. *Acta Neurochirurgica* 146: 1009–1019.

5 Reinert M, Barth A, Schroth G et al. (2006) Repeated laser-assisted high-flow bypass for recurrent giant intracranial aneurysm. *Swiss Medical Weekly* 136: 353–356.

Appendix A: Additional papers on laser-assisted cerebral vascular anastomosis without temporary arterial occlusion not included in summary Table 2

The following table outlines studies considered potentially relevant to the overview not included in the main data extraction table (Table 2). It is by no means an exhaustive list of potentially relevant studies.

Article title	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in Table 2
No additional studies were identified.			

Appendix B: Related published NICE guidance for laser-assisted cerebral vascular anastomosis without temporary arterial occlusion

Guidance programme	Recommendation
Interventional procedures	IPG 73 High-flow interposition extracranial to intracranial bypass 1.1 Current evidence on the safety and efficacy of high-flow interposition extracranial to intracranial bypass does not appear adequate for this procedure to be used without special arrangements for consent and for audit or research. 1.2 This decision relates to the procedure when used for the treatment of diseases of the carotid artery, such as atherosclerosis. No judgement is made regarding its use as one part of a larger operation, such as bypassing an internal carotid artery that has been surgically occluded during resection of a tumour. 1.3 Clinicians wishing to undertake high-flow interposition extracranial to intracranial bypass should take the following actions: • Inform the clinical governance leads in their Trusts. • Ensure that patients understand the uncertainty about the procedure's safety and efficacy and provide them with clear written information. Use of the Institute's Information for the Public is recommended. • Audit and review clinical outcomes of all patients having high-flow interposition extracranial to intracranial bypass. 1.4 Publication of safety and efficacy outcomes will be useful in reducing the current uncertainty. The Institute may review the procedure upon publication of further evidence.
Technology appraisals	None applicable
Clinical guidelines	None applicable
Public health	None applicable

Appendix C: Literature search for laser-assisted cerebral vascular anastomosis without temporary arterial occlusion

IP: 411 laser-assisted cerebral vascular anastomosis without temporary arterial occlusion		
Database	**Date searched**	**Version searched**
Cochrane Library	26/06/2007	Issue 2, 2007
CRD databases (DARE & HTA)	26/07/2007	Issue 2, 2007
Embase	26/07/2007	1996 to 2007 Week 20
Medline	26/07/2007	1950 to April Week 4 2007
PreMedline	26/07/2007	May 21, 2007
CINAHL	26/07/2007	1982 to May Week 1 2007
British Library Inside Conferences	27/07/2007	–
NRR	26/07/2007	2007 – Issue 2
Controlled Trials Registry	26/07/2007	–

The following search strategy was used to identify papers in Medline. A similar strategy was used to identify papers in other databases.

1 Brain Ischaemia/
2 Cerebrovascular Disorders/
3 exp Cerebral Infarction/
4 Ischaemia/
5 Ischem$.tw.
6 (Brain adj3 ischem$).tw.
7 Intracranial Aneurysm/
8 Intracranial Hemorrhages/
9 Cerebral Hemorrhage/
10 (Cereb$ adj3 (disord$ or infract$ or aneury$ or Hemorr$ or accident$)).tw.
11 (Intracran$ adj3 (Ischem$ or Hemorrh$ or Embol$ or throm$)).tw.
12 "Intracranial Embolism and Thrombosis"/
13 Cerebrovascular Accident/

14 Intracranial Arteriosclerosis/
15 (Cerebrovascul$ adj3 Accid$).tw.
16 Stroke$.tw.
17 Apoplex$.tw.
18 Brain Neoplasms/
19 (Brain$ adj3 (cance$ or neoplasm$ or tumor$ or carcinog$)).tw.
20 (Cereb$ adj3 (cance$ or neoplasm$ or tumor$ or carcing$)).tw.
21 or/1-20
22 Anastomosis, Surgical/
23 Anastom$.tw.
24 Cerebral Revascularization/
25 (Cereb$ adj3 revascul$).tw.
26 Bypass$.tw.
27 (cereb$ adj3 bypas$).tw.
28 or/22-27
29 exp Keratectomy, Photorefractive, Excimer Laser/
30 Laser Surgery/
31 Laser Coagulation/
32 (Laser adj3 (surg$ or coag$ or knife$ or excim$ or scalp$)).tw.
33 ELANA$.tw.
34 (Lase$ adj3 (assist$ or non occlus$ anastom$)).tw.
35 or/29-34
36 21 and 28 and 35
37 Animals/
38 Humans/
39 37 not (37 and 38)
40 36 not 39 (109)
41 from 40 keep 1-109