Anaesthesia for carotid surgery

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Abstract

Carotid endarterectomy (CEA) is a surgical procedure to prevent strokes in patients with atheromatous disease at the carotid bifurcation. The effectiveness of CEA has been established in large clinical trials. Patients should have surgery performed within 2 weeks from the onset of symptoms. This time frame presents challenges to the anaesthetist and surgeon in terms of risk stratification and optimization of patients. Optimization includes blood pressure control and use of antiplatelet and lipid-lowering therapy. CEA can be carried out under general anaesthesia or regional anaesthesia with the advantages and disadvantages of both techniques discussed. Understanding surgical technique and the implications for anaesthesia is important, specifically the use of carotid shunting, eversion technique and patch angioplasty. Cerebral perfusion monitoring can be used during CEA to reduce neurological morbidity and mortality. The gold standard for monitoring remains an awake patient where sensory, motor and higher mental functions can be assessed continuously. Intraoperative and postoperative management may involve haemodynamic and neurological complications such as stroke, cerebral hyperperfusion syndrome, heart failure and myocardial infarction. Compromise to the airway can occur as a result of oedema or haematoma and the latter may require exploration in theatre.

Keywords Anaesthesia; carotid endarterectomy; general; regional; stroke; vascular

Royal College of Anaesthetists CPD Matrix: 3A05

Learning objectives

After reading this article, you should be able to:

- describe the preoperative assessment for carotid surgery
- explain the advantages of both general and regional anaesthesia in this patient group
- describe methods of monitoring cerebral perfusion
- describe the management of cardiovascular and neurological problems in the intraoperative and postoperative period

Introduction

Stroke is the fourth largest cause of adult death and the largest cause of disability in the UK. Carotid endarterectomy (CEA) is a preventative surgical procedure performed to reduce the incidence of embolic or thrombotic strokes. The NHS carries out approximately 4200 CEA procedures annually. Current best evidence recommends early surgical revascularization, which poses challenges for the anaesthetist. The latest NICE guideline[1] recommends CEA within 14 days of a non-disabling stroke or TIA for patients with symptomatic carotid artery stenosis (Figure 1) while the Getting It Right First Time (GIRFT) Report for Vascular Surgery recommends reducing the time from presentation to surgery for patients in need of a CEA to 7 days. The National Stroke Strategy suggests CEA be performed within 2 days of symptoms, although this is associated with a higher perioperative risk compared to surgery performed after 3 days.[3] Therefore based on current recommendations, 3–14 days seems to be the optimal window and maximal benefit is seen in patients with a high-grade carotid artery stenosis (70–99%). The NASCET trial demonstrated a 5-year absolute risk reduction of 17% for an ischaemic stroke following CEA.[4] These recommendations apply only to patients with a low-moderate cardiac risk. Patients at high risk of cardiac events have a less clear pathway and should be managed on an individual basis. Early referral and medical optimization is essential as the risk of a fatal or disabling stroke is highest within the first few days after a TIA.

Preoperative assessment

CEA carries significant morbidity and mortality, with the NASCET study[5] reporting a combined stroke and death rate of 6.5% for CEA. Preoperative assessment should optimize any existing coronary artery disease, hypertension, diabetes mellitus, chronic renal disease and respiratory disease, which are common in this group of patients.[6]

All patients presenting with an ischaemic stroke or a TIA should be prescribed a loading dose of an antiplatelet agent for secondary prevention. This is usually followed by clopidogrel 75 mg once daily, though aspirin 75 mg and modified-release dipyridamole 200 mg twice daily may be used if clopidogrel is not tolerated. There is no significant increase in intraoperative bleeding risk by continuing antiplatelet medication perioperatively. Statin therapy in symptomatic patients undergoing CEA is associated with a reduction in hospital stroke and mortality rates, even when started 1 week before CEA.

Untreated preoperative hypertension is associated with postoperative hypertension, which can lead to wound haematoma with airway obstruction, cerebral hyper-perfusion syndrome and may exacerbate pre-existing cardiac disease. Conversely, overtreatment or a rapid reduction in BP can cause cerebral hypoperfusion resulting in an ischaemic stroke. As the optimal preoperative BP targets remain unclear due to the paucity of clinical data, a systolic BP of <180 mmHg before CEA is acceptable by most surgeons and anaesthetists.

Surgical technique

CEA is performed via a neck incision along the anterior border of sternocleidomastoid muscle. The common (CCA), internal (ICA)

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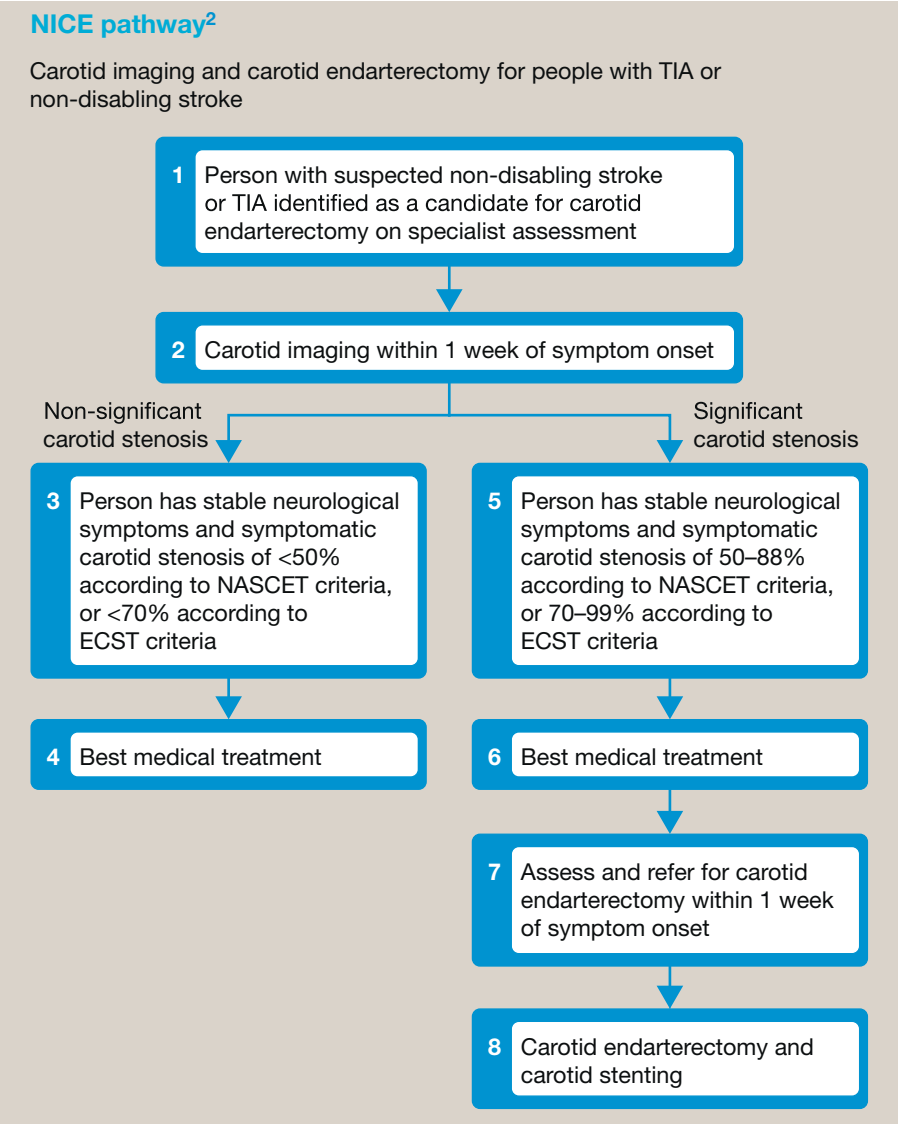

Figure 1 NICE pathway[2]

and external carotid arteries (ECA) are exposed and usually the hypoglossal nerve is visualized. The ICA is clamped first to prevent embolization and an arteriotomy is performed. Carotid cross clamping causes a physiological increase in the BP from baseline which reverses upon its removal (Figure 2). This effect is obtunded in patients having a general anaesthetia (GA). There are two surgical techniques, namely a standard CEA or an eversion CEA and most studies demonstrate no significant difference in clinical outcome between the two techniques.

Prior to clamping of the vessels, a bolus of 3000−5000 units of heparin is given. There is no evidence that a weight-based dose is safer. A shunt can be used during the clamping phase of CEA to maintain blood flow from the CCA to ICA. A shunt is generally used in CEA patients under GA and approximately 10% of patients under regional anaesthesia (RA). Shunts are thought to be useful in patients with contralateral carotid stenosis or a compromized Circle of Willis. Complications include air or plaque embolization, intimal tears and carotid dissection. Following the endarterectomy, the vessel can be closed primarily but more often is patched with either synthetic material or autologous vein.

Anaesthetic technique

CEA can be performed under GA or RA (Table 1), though there is no convincing evidence on which method is superior. The GALA trial[7] compared both, with the primary outcome being proportion of patients with myocardial infarction (MI), stroke or death between randomization and 30 days after surgery. The combined primary outcome was 4.5% in the RA group and 4.8% in the GA group. There was no difference in secondary outcomes that included MI, stroke, death at 1 year and length of hospital stay. A meta-analysis the following year showed that the odds ratio for 30-day stroke or death was similar, but RA is associated with a significant reduction in postoperative haemorrhage.[8]

GA involves tracheal intubation and controlled ventilation to maintain a normal carbon dioxide tension. Minimum monitoring

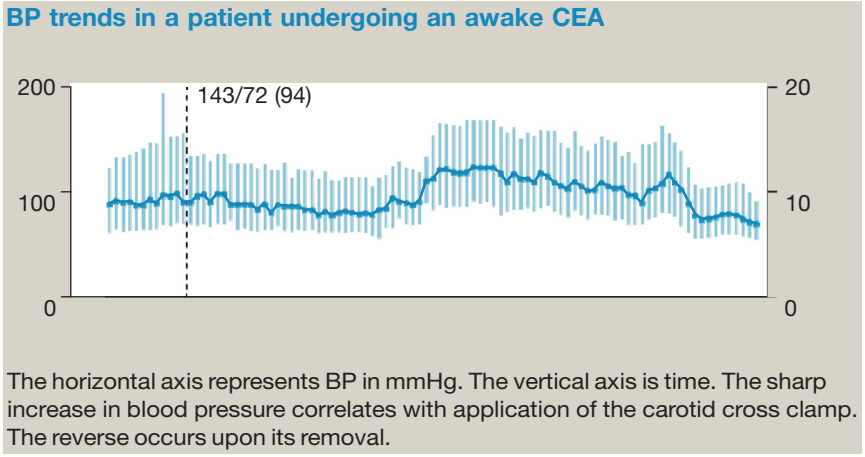

Figure 2

Comparison of general and regional anaesthesia

Technique	Advantages	Disadvantages
General Anaesthesia	• Controlled ventilation and normocarbia • Airway control • Immobility	• Reduction in sympathetic and baroreceptor activity resulting in a dose dependent decrease in cardiac output and BP • Intraoperative hypotension and need for vasopressors • Postoperative hypertension
Regional Anaesthesia	• Direct monitor of cerebral perfusion • Maintains cerebral autoregulation • Lower requirement for shunt (10%)	• Requires immobile and cooperative patient • Limited access to patient's airway • Complications of block — subarachnoid/epidural/intravascular injection, phrenic nerve palsy

Table 1

includes five-lead ECG, invasive and non-invasive BP, pulse oximetry and capnography. Maintenance can be with a volatile or intravenous anaesthetic agent and a short-acting opioid such as remifentanil. This combination allows for rapid emergence and early assessment of the patient's neurological function. Nitrous oxide should be avoided due to its effects of increasing cerebral metabolic rate and oxygen consumption and is associated with an increase in myocardial ischaemia. Irrespective of the agent used, there is a reduction in sympathetic and baroreceptor activity resulting in a dose dependent decrease in cardiac output and BP. At the time of carotid cross clamping the BP should be augmented by 20% from the patient's baseline. This is crucial to avoid cerebral hypoperfusion and a vasopressor infusion such as metaraminol or phenylephrine together with fluid boluses can be used. Augmenting the BP is not without risks as it can cause myocardial ischaemia, intracerebral haemorrhage and wound haematoma. Once the carotid cross clamp is released post endarterectomy and blood flow restored on the ipsilateral side, the BP can be returned to baseline. Postoperative analgesia can be with intravenous paracetamol, local infiltration and titrated small doses of intravenous morphine (2.5–10 mg). Non-steroidal anti-inflammatory drugs are best avoided due to the associated increased risk of adverse cardiovascular events and an elevation of blood pressure.

The technical description of RA techniques for CEA is beyond the scope of this article but it is conventionally performed with a superficial cervical plexus block, a deep cervical plexus block or a combination of both. Ultrasound-guided cervical plexus blocks have gained popularity in recent years and offer the advantage of being able to visualize the anatomical structures. The deep cervical block has been associated with a higher complication rate compared with the superficial plexus block, but there has been no formal evidence from studies to demonstrate the increased risk. RA can be supplemented by local anaesthetic infiltration by the surgeon as a rescue technique for less than adequate blocks or if the patient complains of pain. Propofol and/or remifentanil target-controlled infusion can be used to maintain conscious sedation however it should not impair assessment of neurological function intraoperatively.

Cerebral monitoring

Cerebral monitoring during carotid cross clamping aims to reduce the neurological morbidity of CEA. There is no consensus as to which cerebral monitor should be used as all these techniques have a poor specificity and sensitivity for detecting cerebral ischaemia (Table 2). The gold standard remains clinical assessment of mental status, speech and motor function in an awake patient.

Postoperative care and complications

Two-thirds of patients will develop hypertension postoperatively with 40% requiring therapeutic intervention. Hypertension may be linked to cerebral hyperperfusion syndrome, which occurs in 1–3% of CEA patients and usually presents 2–7 days post

Cerebral monitoring

Cerebral Monitor	Advantages	Disadvantages
Electroencephalography (EEG)	• Detect cortical ischaemia	• Operator dependent • Requires trained neurophysiologist • Poor sensitivity • Unreliable in detecting ischaemia of deeper structures
Carotid Stump Pressure	• Easy technique to perform	• Poor sensitivity in detecting clinically significant ischaemia
Transcranial Doppler	• Allows assessment of flow in MCA • Detect microemboli during dissection (>50 per hour correlates with increased incidence of postoperative neurological dysfunction)	• Inadequate view in 10% patients • Poor sensitivity
Somatosensory Evoked Potentials	• Theoretical advantage of monitoring cortical and deeper structures • May be useful in patients with difficult EEG to interpret owing to previous stroke	• Signal amplitude reduced by volatile anaesthetic agents • Specialized equipment/training
Near Infrared Spectroscopy (NIRS)	• High negative predictive value (97%)	• Poor positive predictive value (33%)

Table 2

procedure. It is related to normal or elevated perfusion pressure within the previously hypoperfused ipsilateral hemisphere resulting in cerebral oedema and intracranial haemorrhage. Clinical features include headaches and focal seizures. Intracranial haemorrhage occurs in 0.6% of patients who develop hyperperfusion syndrome. Prompt treatment is essential to reduce the systolic BP to <170 mmHg or within 20% of preoperative values. Intravenous drugs used include labetalol (20 mg bolus every 2 minutes, up to 100 mg), hydralazine (2 mg bolus every 5 minutes, up to 10 mg) and glyceryl trinitrate infusion (1 mg/ml titrated to response). Hypotension can also be a problem in the recovery period and should be treated with fluid boluses and vasopressors. A cardiac event and bleeding should be excluded.

The incidence of wound haematoma was reported to be 3–8% in the NASCET trial. This, coupled with airway oedema caused by CEA, can lead to rapid airway obstruction and surgical re-exploration may be required.

Postoperative care should be in an acute care area where invasive BP monitoring, ECG and frequent neurological examination can be carried out. There are widespread variations in the United Kingdom as to postoperative discharge. Our practice is to keep patients for 2–4 hours in recovery, and in the absence of complications they are discharged to a vascular ward. ◆

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