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Carotid endarterectomy

Aims and intended learning outcomes

The aim of this article is to provide an overview of carotid artery disease and its management. After reading this article you should be able to:

- Describe the basic anatomy and pathology relating to atherosclerotic carotid disease.
- Explain the common symptoms of carotid disease.
- Discuss the risk factors associated with the development of atherosclerosis.
- Give a basic description of the surgical procedure and discuss possible variations.
- Rationalise in detail the nursing care of a patient undergoing carotid endarterectomy.

Introduction

According to Warlow (1993), stroke is the third most common cause of death after coronary disease and cancer, and is the main cause of neurological disability in the western world. More than 100,000 people suffer a cerebrovascular accident (CVA), or stroke, in the UK each year, and 70,000 of these will die from it (Bryan 1998). There is a massive cost to the individual and his or her family in terms of disability and reduced quality of life, and to society in terms of financial cost.

One of the specific aims in The National Service Framework for Care of Older People (DoH 2001) is to reduce the incidence of stroke. However, although the risk generally increases with age, stroke also affects younger people: each year in the UK, 10,000 people under 55 years and 1,000 people under 30 years have a stroke (DoH 2001).

Carotid artery stenosis (narrowing) is the cause of 15 to 25 per cent of strokes (Timsit et al 1992). Carotid endarterectomy (CEA) is a surgical procedure performed with the aim of preventing stroke, and hence reducing the ensuing disability and dependence on others, which stroke so often causes. It is the most common arterial procedure performed in the US and also in many of the large vascular units in the UK (Thomas and Wolfe 1992).

Anatomy

The right common carotid artery arises from the brachiocephalic artery and passes upwards in the right side of the neck. At the level of the upper part of the larynx, it divides into the right external and right internal carotid arteries (Fig. 1). The left common carotid artery is the second branch of the aortic arch and follows a similar path in the left side of the neck. The structures supplied with blood by these arteries are shown in Box 1.

Inside the skull, at the base of the brain, the internal carotid arteries join the basilar artery to form an ‘arterial roundabout’ called the Circle of Willis (Fig. 2). The arteries supplying most of the brain arise from the Circle of Willis (Tortora and Anagnostakos 1990).

Cerebrovascular accident (stroke)

A stroke is characterised by a relatively abrupt onset of neurological symptoms, persisting for longer than 24 hours, because of an infarction (death of tissue due to failure of its blood supply) of brain tissue. This might be caused by cerebral ischaemia (a decreased blood supply to the brain), or an intracerebral haemorrhage, from spontaneous rupture of a blood vessel in the brain. About 80 per cent of all strokes are ischaemic.
causes the smooth muscle cells that make up the middle layer of the arterial wall to proliferate, and the macrophages and muscle cells begin to accumulate cholesterol from the circulating blood. The mound of tissue that is formed is called an atherosclerotic plaque – it gradually enlarges, protruding into the arterial lumen and creating a rough, irregular surface which encourages the formation of thrombus. In addition, cracks or fissures can occur in the plaque, allowing the thrombotic contents to come into direct contact with the circulating blood. Calcium is laid down in the plaque, which reduces the natural elasticity of the vessel – hence the colloquial term, ‘hardening of the arteries’.

Patients with symptoms of atherosclerotic disease should also be encouraged to reduce the fat content in their diet, particularly saturated (animal) fats. These increase circulating low-density lipoproteins (LDL) – the type of cholesterol that is instrumental in the atherosclerotic process. Those patients found to have raised blood cholesterol levels might be prescribed lipid-lowering drugs (statins or fibrates). Hypertension and diabetes mellitus are also related to atherosclerotic disease (Baker 2000). Hypertension might be reduced by lifestyle changes – the major contributors being obesity, high salt or alcohol intake, excessive stress and lack of regular exercise. However, early hypertension is often asymptomatic; therefore, regular monitoring of blood pressure is an essential aspect of health promotion concerned with stroke prevention. Nurses also have a role to play in ensuring that patients appreciate the importance of taking any anti-hypertensive drugs prescribed for them. Orme (1988) found that reducing systolic blood pressure by 5mmHg reduces the risk of stroke by 35 per cent.

Donnelly et al (2000) state that the risk of stroke is two to three times higher in patients with diabetes. They also suggest that patients with diabetes are more prone to irreversible ischaemic brain damage. Also, patients with diabetes who suffer a stroke have a higher death rate, and a poorer neurological outcome with more severe disability. Patients with diabetes, therefore, need to understand the importance of maintaining a stable blood sugar level, within ‘normal’ limits, by dietary control and taking their insulin or hypoglycaemic drugs, and thus preventing complications as far as possible.

Early detection of diabetes is essential and regular monitoring of blood and urine glucose levels, and HbA1c (glycosylated haemoglobin blood test) is needed to ensure timely advice and intervention when necessary. Up to half of non-insulin dependent diabetics have vascular complications at diagnosis (Donnelly et al 2000).

To complete optimisation of all risk factors, patients with carotid disease will also usually be prescribed antiplatelet therapy to prevent thrombus formation. Aspirin is usually the drug of choice, providing the patient does not have any history of gastric ulceration, asthma or bleeding disorders. It has been shown that antiplatelet therapy with aspirin reduces the long-term risk of stroke by 25 per cent (ATC 1988). In patients with contraindications to aspirin, other anti-platelet agents are prescribed – for example, clopidrogel or dipyridamole.

**TIME OUT 1**

The above is a basic description of atherosclerosis. Read a more detailed explanation in a textbook. Is it a degenerative or inflammatory process? Think about how you would explain this to a patient with atherosclerosis.

**Risk factors**

Atherosclerosis is usually a systemic disease, so patients with intermittent claudication or ischaemic heart disease are also likely to have a degree of carotid artery disease. Thus the specific risk factors for ischaemic stroke are identical to those for any atherosclerotic disease (for example, ischaemic heart disease or peripheral vascular disease).

Smoking is the most significant single factor contributing to the development and progression of atherosclerosis (Campbell 1999). In a study of more than 10,000 people, over three years, the Atherosclerosis Risk in Communities (ARIC) study found that the atheroma in carotid arteries was 50 per cent greater in smokers than non-smokers (Howard et al 1998). Nurses are in an ideal position to encourage and support patients through smoking cessation, following the Smoking Cessation Guidelines for Health Professionals (Raw et al 1998).

**TIME OUT 2**

Nurses frequently say they do not have time to encourage patients to give up smoking. Read the Smoking Cessation Guidelines for Health Professionals (Raw et al 1998). Think about whether you are able to implement them into your own nursing practice.
Box 3 lists aspects of the maximal medical therapy that should be addressed for patients with atherosclerotic disease.

### History of carotid endarterectomy

The first report linking stroke to atherosclerosis of the extracranial vessels was by Savory (1856), and the first successful carotid endarterectomy (CEA) was performed in 1954 (Eastcott et al 1954). However, by the 1980s, a paradox was evident: the operation aiming to prevent stroke was actually causing perioperative stroke in some patients.

In the 1990s, two large trials were carried out to find out if CEA and appropriate medical treatment of all risk factors was more beneficial for patients with different degrees of carotid stenosis than medical treatment alone: the North American Symptomatic Carotid Endarterectomy Trial (NASCET 1998) and the European Carotid Surgery Trial (ECST 1998).

Both trials found that for patients with a 70 to 99 per cent stenosis (that is, in which 70 to 99 per cent of the diameter of the artery is occluded), CEA and medical treatment of all risk factors provided a 48 per cent relative reduction in stroke risk compared with medical treatment alone (Cina et al 2001). The reduction in stroke risk was smaller for patients with less severe stenosis (ECST 1998), so CEA is usually only undertaken on those patients with 70-99 per cent stenosis.

If the carotid artery is found to be completely occluded on investigation, surgery is not appropriate, as there is no blood flow to carry emboli up into the intracerebral arteries, and cerebral perfusion will continue via the other arteries feeding into the Circle of Willis.

### One-stop carotid clinic

The risk of major stroke is highest in the first three months after a TIA (or amaurosis fugax) (Dennis et al 1990), so GPs are encouraged to refer patients after the first focal neurological event (sign of a neurological problem). To maximise the benefit, the timing of surgery after the first symptoms appear is crucial (Bhatti et al 1999). To prevent delay from the time of referral to surgery, vascular consultants at the author's hospital offer a one-stop carotid clinic service. This includes the patient consultation with the vascular surgeon, when risk factors are assessed and treated, and an ultrasound duplex scan is performed, which determines the presence, position and degree of a carotid stenosis. Duplex scanning is completely non-invasive and so involves no risk, unlike the more traditional investigation – angiography. It is, therefore, possible to decide promptly whether the patient might benefit from carotid surgery and if this is the case, arrangements are made at this stage for further investigations as necessary, and the patient's name is placed on the waiting list for hospital admission.

The pre-operative investigations that are usually needed are shown in Box 4. In addition, patients are cross-matched for two units of blood, although this is not often required. Patients are usually admitted to hospital the day before surgery, but they might be admitted on the day of surgery by utilising a pre-operative assessment clinic. A repeat duplex scan is carried out before surgery, to provide a current assessment of the carotid plaque, confirming the side, level and extent of the stenosis.

### Pre-operative nursing care

Patients are routinely prepared for theatre as though they will be undergoing general anaesthesia, although some surgeons will undertake CEA under local anaesthetic. However, any antihypertensive or cardiac medication usually taken by the patient should be given as normal, even though the patient is taking nil by mouth.

It is particularly important to assess and document any neurological deficits that the patient might have pre-operatively, such as limb or facial weakness, altered speech, or visual disturbance. Nurses should try to allay patient anxiety, particularly if surgery is to be performed under local

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**Box 3. Medical therapy for patients with atherosclerotic disease**

- Smoking cessation
- Antiplatelet therapy
- Control and monitoring of: Blood pressure, Blood lipid levels, Diabetes mellitus, Blood glucose
Cardiovascular disorders

anaesthetic, by ensuring the patient is given an explanation of the procedure. In particular, it should be made clear that the operation will be performed on the opposite side to any weakness or numbness they have experienced. If the patient is to be admitted to an intensive care or high dependency area post-operatively, a visit to the area should be offered.

An incision is made on the side of the patient’s neck and the tissues carefully dissected to free the carotid artery, without damaging veins or nerves or dislodging unstable plaques in the artery. Following systemic heparinisation, the common carotid artery and internal and external carotid arteries are clamped beyond the stenosis. Cerebral blood flow continues via the Circle of Willis, but might be reduced by carotid clamping to a level insufficient for adequate cerebral perfusion. This could cause a hypoperfusion stroke. A longitudinal incision is made into the common carotid artery extending into the internal carotid artery. Some surgeons measure the backflow pressure (stump pressure) in the internal carotid artery, and if this is considered too low to maintain adequate cerebral perfusion throughout the procedure, a shunt will be used (a temporary bypass allowing blood to flow to the brain around the clamped artery). Alternative ways of measuring the adequacy of cerebral perfusion include transcranial Doppler monitoring (TCD) and NIRS (near infra-red spectroscopy). The atherosclerotic plaque and any associated thrombus are peeled out of the inside of the artery (Fig. 3). The arteriotomy is then closed by either primary suturing or patching. A Redivac drain is usually inserted and the wound closed with sutures or clips.

The patient’s cardiovascular status is monitored continuously throughout the procedure. In addition, TCD monitoring is performed to assess cerebral blood flow and detect circulating emboli (Ghali et al 1997). Three aspects of surgery are frequently dependent on the surgeon’s preference: the choice of anaesthetic, whether to place a shunt and the use of a patch to close the arteriotomy.

**Local or general anaesthetic?** The main advantage of local anaesthesia is that it allows neurological assessment of the awake patient during surgery. Cerebral ischaemia might be detected clinically as confusion, loss of consciousness, altered speech, or reduced limb strength (O’Hare and Bodenham 1999). This assists the surgeon in the decision about whether to use a shunt – if the patient becomes symptomatic during initial clamping of the carotid artery, the cerebral perfusion is inadequate. In addition, the awake patient is more easily monitored for chest pain indicating cardiac ischaemia. However, the patient has to remain relatively still for between one and two hours and swallowing might make the fine dissection more difficult. Also, for the occasional patient needing general anaesthetic, urgent intubation is significantly more difficult (Beard and Gaines 1998). Patient anxiety might also be a problem; again, pre-operative explanation of the procedure and reassurance will help to relieve this.

In contrast, surgeons favouring general anaesthetic feel it provides better operating conditions and improved surgical access. When the patient is

### Time Out 3

Note down what you currently understand about the surgical procedure itself. Then compare it with the following text.

### Box 4. Pre-operative investigations

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>Detect any abnormality</td>
</tr>
<tr>
<td>Blood screen: full blood count, urea and electrolytes, glucose, lipids, clotting, liver function tests</td>
<td></td>
</tr>
<tr>
<td>ECG (electrocardiogram)</td>
<td>Detect abnormal heart rhythm Assess heart function Detect abnormality</td>
</tr>
<tr>
<td>LVEF (left ventricular ejection fraction)</td>
<td></td>
</tr>
<tr>
<td>CXR (chest X-ray)</td>
<td>Only occasionally, if ultrasound duplex scan has not shown detail required</td>
</tr>
<tr>
<td>Selected patients</td>
<td></td>
</tr>
<tr>
<td>Carotid angiogram</td>
<td></td>
</tr>
<tr>
<td>CT scan</td>
<td></td>
</tr>
<tr>
<td>MRI scan</td>
<td></td>
</tr>
</tbody>
</table>
Box 5. Potential peri-operative complications

- Stroke
- Hypertension/hypotension
- Bradycardia
- Haemorrhage/haematoma
- Myocardial infarction
- Cranial nerve injury

not co-operative, general anaesthesia is preferable. It is also argued that it is less stressful for the patient, which might benefit those with limited cardiovascular reserve (O’Hare and Bodenham 1999). Cerebral metabolic requirements are reduced under general anaesthetic, so reducing the risk involved with lowered cerebral perfusion on clamping the carotid artery.

Shunt needed? Surgeons who support intra-operative shunting argue that its routine use allows more time, enables training and ensures familiarity with shunt insertion, whereas those who prefer not to use a shunt claim there is increased risk of damaging the arterial wall and embolisation, and the shunt physically interferes with the procedure (Beard and Gaines 1998). Many surgeons, therefore, tend to use a shunt only for those patients who are at significant risk of intra-operative cerebral ischaemia, as indicated by neurological symptoms, low stump pressure or TCD measurements.

Patch or primary closure? The rationale for closing the arteriotomy with a patch is to prevent narrowing of the vessel. Patches are either synthetic or vein tissue, usually from the long saphenous leg vein. It is claimed that suturing a patch in place takes longer, and so increases the length of time for which the artery is clamped. Other criticisms involve susceptibility of vein patches to rupture and synthetic patches to infection (Beard and Gaines 1998).

Potential peri-operative complications

Potential complications of the operation are listed in Box 5. Sandison et al (2000) state the most common complications are stroke, bleeding and hypohypertension; these usually manifest within two hours of the operation.

The three primary mechanisms which might cause peri-operative stroke are embolisation, thrombosis occluding the carotid artery and haemorrhage (O’Brien and Ricotta 1994). Embolisation is a warning sign of imminent thrombosis and is detectable by transcranial Doppler monitoring. Cerebral haemorrhage can occur due to an increase in the intracerebral pressure.

Bradycardia can also occur post-operatively. The baroreceptors in the carotid sinus monitor the blood pressure in the carotid artery. They are part of the autonomic nervous system; they detect any increase in pressure in the carotid artery and pass this information to the vasomotor centre in the brain, which reacts by slowing the patient’s heart rate to compensate. Drugs such as ephedrine, glyceryl trinitrate and glycopyrronium might be prescribed to correct fluctuations of blood pressure and heart rate which exceed the desired parameters.

Post-operative nursing care

At Walsgrave hospital, patients are transferred from theatre to the high dependency unit (HDU) following CEA. However, patients in other centres might be admitted to intensive care, or have an extended stay in the theatre recovery area and return to the surgical ward, according to the surgeon’s preference and availability of resources. Close monitoring of the patient’s condition is necessary for 24 hours post-operatively – early detection of any problems will enable action to be taken to prevent more serious complications.

Continual monitoring and hourly recording of the patient’s heart rate, blood pressure (via an arterial cannula in a radial artery), respirations and oxygen saturation is undertaken. Most patients are given supplementary oxygen at 2litres/min for the first 24 hours to ensure good oxygen saturation levels. Close observation for any signs of neurological deterioration is needed – monitoring limb movement and strength, level of consciousness and speech. This monitoring continues throughout the first night post-operatively, so the nurse needs to explain that he or she will be disturbing the patient on an hourly basis for this reason. The surgeon is informed at the first sign of a neurological problem, as it might be necessary to return the patient to theatre for evacuation of thrombus from the carotid lumen. Haemorrhage and formation of a haematoma at the surgical site has the potential of causing airway compromise and the nurse should observe the wound for ooze and swelling, and have either a stitch cutter or clip remover at the bedside as appropriate. Redivac drainage should be monitored and recorded. If bleeding at the wound site is evident, firm pressure should be applied and the surgeon informed; preparations should be made for the patient to return to theatre urgently.

TCD monitoring has been shown to predict formation of carotid thrombus and ensuing stroke. To reduce this risk, the vascular technicians undertake post-operative TCD monitoring when the patient has been settled into HDU. This assesses the number of cerebral emboli over a set time period, which determines whether an intravenous infusion of dextran (an anticoagulant) is required. The nurse should assess and record any pain the patient experiences, along with his or her sedation level, and give analgesia if needed. The patient remains nil by mouth, in case urgent return to theatre is necessary, with hydration being maintained by an intravenous infusion.
Normal micturition should have occurred within 12 hours of surgery – if not, the cause should be investigated. The patient’s temperature is monitored and recorded on a two-hourly basis; prophylactic antibiotic cover is usually given.

The patient remains on bed rest until the next morning, when he or she will also be able to eat and drink normally – the intravenous fluid infusion will be discontinued. The Redivac drain and arterial cannula will be removed and the patient is transferred to the step-down unit (SDU) or surgical ward. Gentle mobilisation is encouraged on the first post-operative day, and the nurse continues to observe the patient for any sign of neurological deterioration or cardiovascular instability.

Over the next 24 hours, a rapid return to independence is encouraged, and the patient is usually discharged on the second post-operative day. The primary care nurse will remove sutures or clips and the patient will return for a routine outpatient follow-up appointment after six weeks.

**Conclusion**

Carotid endarterectomy is specialised surgery, and as such should only be performed in hospitals where appropriate resources are available and team members have the understanding and skills necessary to complement each other in the patient’s care. The nurse’s role is of paramount importance, for efficient observation and appropriate action is necessary to ensure a successful outcome.

Stroke can be devastating for individuals and their families and has high cost implications for health service resources. There is no doubt that the best treatment lies in its prevention. In the symptomatic patient, surgery has been shown to be beneficial over maximal medical therapy alone in a number of studies.

**TIME OUT 5**

Now that you have completed the article, you might like to think about writing a practice profile. Guidelines to help you are on page 55.