Atherosclerotic disease of the extracranial internal carotid artery (ICA) is one of the common causes of ischemic stroke, along with embolism from the heart and penetrating brain arteriolar disease causing small, deep, lacunar brain infarcts. Extracranial carotid stenosis is nearly always located at or just beyond the common carotid artery bifurcation in the neck. Unstable plaques with endothelial ulceration or intraplaque hemorrhage can throw embolic material into the cerebral circulation, causing transient neurological deficits if the embolus fragments and allows reperfusion (transient ischemic attacks [TIAs]) or fixed deficits when the vessel does not reopen. TIAs are followed by stroke in up to 30% of patients, most occurring within several months. Warning TIAs precede about one-third of strokes resulting from carotid stenosis.

Asymptomatic carotid stenosis is detected by Doppler ultrasonography ordered to investigate a neck bruit, an episode of neurological symptoms not referable to the carotid distribution (such as syncope or dizziness), or simply performed as part of a cerebrovascular system work-up.

TIAs

Hemispheric TIAs are usually in the territory of the largest branch of the intracranial ICA receiving the majority of its blood flow, the middle cerebral artery (MCA), which supplies primary sensory and motor cortex and in the dominant hemisphere, speech areas. Given that face and hand control have a large amount of cortical representation, as does language, carotid distribution TIAs usually present as episodes of contralateral face and hand weakness, combined with dysphasia when the speech-dominant (usually left) hemisphere is affected (Table 1). TIAs last minutes and incomplete resolution after several hours usually signals an infarct in evolution rather than reversible ischemia. A second type of TIA is ocular and ipsilateral to the proximal carotid disease, where emboli pass via the ophthalmic artery into the

John’s case

John is a 69-year-old smoker who visits his doctor irregularly. He is taken to the hospital by ambulance after his wife finds him in his home workshop seemingly confused with right-sided face, arm and hand weakness. He has hypertension which has been treated with ramipril and elevated cholesterol in the past which has gone untreated. According to his wife, he has no history of neurological disease or symptoms.

On examination, John is in sinus rhythm and his BP is 160/100 mmHg. He is able to converse, but has difficulty in finding certain words. Although much of his weakness has resolved at this point, several hours from the onset of his illness, he still has persistent right face weakness, a right pronator drift and word-finding difficulties.

What is the probable diagnosis and what immediate treatment and investigations does John require?

For the correct answer, see page 14.
retina causing transient whole or partial monocular blindness (amaurosis fugax). This is characteristically described as a curtain being drawn down or across the vision of the affected eye, followed by gradual clearing.

When multiple, TIAs tend to be stereotypical and they can increase in intensity as well as duration (“crescendo TIAs”) or terminate as a fixed deficit, indicative of a stroke. Patients with relatively minor deficits not causing significant functional disability are treated in the same way as patients with TIAs, but more severe deficits managed by a stroke team within three hours of stroke onset are assessed for treatment with IV thrombolysis using recombinant tissue plasminogen activator (rt-PA). 1

**Recent symptoms of hemispheric ischemia are the most important signal of impending cerebral infarction resulting from carotid stenosis.**

### Risk factors for stroke

Recent symptoms of hemispheric ischemia are the most important signal of impending cerebral infarction resulting from carotid stenosis. 4 The higher the risk of stroke in any individual patient with symptomatic carotid stenosis, the greater the need for carotid repair.

In asymptomatic patients with carotid stenosis, higher, long-term stroke risk is with higher degrees of stenosis or documented stenosis worsening over time, plaque ulceration and male gender. In addition, younger and otherwise relatively healthy, asymptomatic patients stand to benefit more from carotid repair in the long term. 2

#### Investigation of suspected carotid stenosis

Following neurological and CV examinations, all patients presenting with suspected TIAs or minor stroke should undergo immediate CT scanning to rule out brain hemorrhage as well as mass lesions such as chronic subdural hematomas and brain tumours, both of which can sometimes present in a stroke-like fashion (Table 2). Electrocardiography rules out atrial fibrillation and the patient’s coagulation status should be checked in addition to routine blood investigations. If carotid stenosis is the most likely underlying cause of symptoms at this point then carotid ultrasonography is indicated and it should be performed as soon as possible, preferably within 24 hours. If symptomatic carotid...
artery stenosis is the provisional diagnosis after sudden-onset carotid distribution neurological deficits, patients should remain in hospital until investigations are complete.

It is unclear if patients with carotid bruits or indeed any asymptomatic patient should undergo carotid artery screening, including those patients scheduled for major vascular operations such as aortocoronary artery bypass. Persons with some combination of atherosclerotic risk factors, cervical bruit and noncarotid neurological symptoms comprise the majority of asymptomatic patients referred for carotid repair.

Significant carotid stenosis detected by Doppler ultrasonography is usually confirmed by more direct vascular imaging—the modality of choice presently being computed tomographic angiography (CTA). Less invasive and expensive than catheter angiography, CTA also provides more anatomical information than magnetic resonance angiography, including:
• precise stenosis location and severity,
• plaque surface characteristics and
• the presence of plaque calcification.

How useful is the finding of a carotid bruit on physical examination?
While a carotid bruit is a marker for cerebrovascular disease, only about one-half of neck bruits are due to a significant internal carotid artery stenosis and only about one-half of significant ICA stenoses cause an audible cervical bruit. A carotid bruit is not a reliable indicator of underlying carotid stenosis.

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with moderate symptomatic stenosis between 50% and 70%. The stroke risk reduction is not as great for this range, but remains significant. In this moderate range, higher degree and ulcerated stenosis, male gender and minor strokes (as opposed to TIAs) are among a list of features correlating with a greater benefit from carotid repair. For maximum benefit, CEA should be carried out as soon as possible.

Severe asymptomatic carotid stenosis is a reasonable indication for CEA in selected patients. When performed with a low perioperative stroke risk, it can halve the five-year stroke risk from roughly 12% to 6%, a statistically significant reduction. Careful patient selection ensures maximum benefit from surgery, targeting those who are younger with high-grade stenosis.

Except for specific and fairly uncommon clinical circumstances, such as carotid stenosis difficult to repair surgically (e.g., anatomically high, radiation-induced or recurrent carotid stenosis) and patients at high risk of surgery due to unstable cardiac disease, carotid angioplasty and stenting (CAS) remains a procedure still under investigation. Completed randomized trials comparing CAS

### FAQ

**What factors are associated with a higher stroke risk from a carotid stenosis?**

- Recent symptoms of ischemia
- Male gender
- Age > 75
- Motor (hemispheric) vs. ocular (amaurosis fugax) symptoms
- Multiple and longer TIA events
- Lingering signs of ischemia on examination indicative of a minor stroke as opposed to TIA
- Contralateral carotid occlusion
- Presence of plaque ulceration
- Presence of intracranial atherosclerosis

**Recent symptoms of hemispheric ischemia are the most important signal of impending cerebral infarction resulting from carotid stenosis.**

### FAQ

**Should patients with carotid stenosis be referred for carotid angioplasty and stenting (CAS)?**

Selected patients with anatomically difficult stenosis may be more safely treated with CAS than with Carotid endarterectomy (CEA), but for the majority of patients CAS is unproven and CEA remains the treatment of choice.
Carotid Stenosis Repair

More on John...

Three hours after the onset of his “brain attack,” John still has some evidence of neurological deficit and therefore might be experiencing a minor stroke rather than a “TIA” of his left cerebral hemisphere. An ECG shows sinus rhythm and a brain CT scan rules out hemorrhage and a mass lesion such as subdural hematoma or brain tumour presenting in a “stroke-like” fashion. John has mild weakness rather than paralysis so his neurological condition is not severe enough to warrant consideration of IV thrombolytic treatment. Since carotid artery to artery thromboembolism is suspected, he is given ASA and a carotid Doppler ultrasound is ordered for the same day. An IV is started and John’s neurological and vital signs are checked hourly.

The carotid Doppler indicates a 70% to 90% left ICA stenosis and John remains stable.

Discussion

John has suffered a minor, improving ischemic stroke due to a severe left ICA stenosis, now confirmed by CTA done following his abnormal Doppler ultrasound (Figure 1). A small hypodensity is now seen in the left frontal lobe, indicating a small infarct. ASA treatment has been started.

A carotid surgeon should be consulted to discuss early CEA with John.

Take-home message

• The best candidates for carotid repair have suffered either a carotid TIA or minor stroke due to significant carotid artery stenosis confirmed by CTA, are otherwise medically stable and have accepted the risks of the procedure.

• Asymptomatic patients should be very carefully selected for surgical consideration, with men <70 years-of-age who are otherwise healthy, but with severe or ulcerated stenosis benefiting most.

• CEA remains the proven and first choice for carotid repair in the majority of patients.

References