REVIEW

Management of the Near Total Internal Carotid Artery Occlusion

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Objectives. The risk of stroke in patients with near total internal carotid artery (ICA) occlusion is perceived to be high as stroke risk increases with severity of the stenosis. The management of this entity has not been addressed specifically in the existing randomised trials and thus it remains controversial.

Methods. Systematic review of the relevant literature.

Results. The management of patients with near total ICA occlusion remains controversial: some favour intervention whereas others have condemned it as dangerous or of no benefit. A prospective multicentre randomised trial regarding intervention versus best medical treatment for patients with symptomatic near total ICA occlusion seems difficult because of the large number of patients required to power the study. Nevertheless, it appears hard to decline surgery based on the current evidence.

Conclusions. Because of the current controversy over the best management of the near total ICA occlusion, prospective observational studies are needed to demonstrate its prevalence in the symptomatic and asymptomatic population and any associated excess stroke risk. Based on the current evidence, surgery is the treatment of choice in most centres but its validity over best medical treatment remains untested.

Keywords: Internal carotid artery; Critical stenosis; Near total occlusion; Sub-occlusion; Pre-occlusive disease; Management.

Introduction

The results of the randomised multicentre trials published over the last decade have significantly influenced the management of extracranial carotid artery disease (symptomatic or asymptomatic) by providing evidence about the benefits and risks of surgery in addition to best medical treatment available at the time of the trials.1–5 All these studies have identified the degree of carotid stenosis as being associated with an increased risk of ipsilateral hemispheric events in both the symptomatic and asymptomatic setting. However, some reviews suggest the risk of distal embolisation of a critical asymptomatic stenosis greater than 90% is low,6 and in recently symptomatic patients upon occlusion of a critical stenosis the risk for ipsilateral stroke is also low7 raising concern about the appropriate management of near total occlusion (95–99% stenosis) of the internal carotid artery (ICA).

Morgenstern et al.,8 using the NASCET design and methods in their study of 106 symptomatic patients with near total occlusion of ICA concluded that carotid endarterectomy is beneficial and not more dangerous than in patients with 70–94% stenosis, provided that the procedure is performed by experienced surgeons with low complication rate. In contrast, a recent report after reanalysis of the final results of the ECST trial
concluded that surgery was of little benefit in symptomatic patients with near total occlusion. However, this was a retrospective analysis of a small subset of patients using data from a trial that was not designed to answer that specific question.

Given the contradicting results it is not surprising that some clinicians favour in both symptomatic and asymptomatic patients surgical treatment whereas others have condemned it as potentially harmful or of no benefit.

**Methods**

A MEDLINE search from 1970 until 2004 (National Library of Medicine and OVID) and an extensive manual search were carried out using references from relevant published reports.

The main terms for inclusion were ICA critical stenosis, near total occlusion of ICA, ICA sub-occlusion, ICA pre-occlusive disease, pseudo-occlusion of the ICA, carotid string or slim sign, management of symptomatic and asymptomatic carotid artery disease. Other search terms relevant to this topic included non-invasive imaging and diagnosis or detection of near total occlusion or pseudo-occlusion of ICA, angiographic evaluation of near total occlusion or pseudo-occlusion of ICA, cerebral microembolism in symptomatic and asymptomatic high grade ICA stenosis, cerebral blood flow and brain collateral circulation. Case reports and very small series (n<10 patients) were excluded. Papers were chosen by their cohesion and relevance of data. The data were analysed in respect to the prevalence, diagnosis, pathophysiology, and decision making for treatment of the near total occlusion of ICA.

There is no prospective randomised trial specifically designed for the management of near total occlusion of the ICA. Most of the prospective data regarding the outcome of this entity comes from the medical arm of the randomised control trials in the management of symptomatic and asymptomatic significant carotid artery disease. In addition, there were several reports of retrospective nature relevant to diagnosis, pathophysiology, and management of near total occlusion of the ICA, some of which included mixed population with symptomatic and asymptomatic carotid disease.

Because of these limitations, the authors considered that pooled analysis and statistical manipulation of the data would not be appropriate. Therefore, the presentation and analysis was descriptive from selected reports on various relevant topics regarding the near total occlusion of the ICA.

The prevalence of near total occlusion of the internal carotid artery

The prevalence of near total occlusion is uncertain and it has been estimated in the range of 0.5–10% of all cases either undergoing carotid endarterectomy or recruited in the relevant prospective trials. However, it is possible many of those patients diagnosed with an ‘occluded’ ICA and continuing ipsilateral hemispheric events, attributed to be the so-called ‘carotid stump syndrome’, may actually have near total occlusion.

The problem in identifying the true prevalence of near total ICA occlusion is partly due to the lack of diagnostic criteria and standardised imaging techniques.

Diagnosis of near total internal carotid artery occlusion

Selective intra-arterial angiography has been considered the ‘gold standard’ in the differentiation of near total from total occlusion of the ICA, but it carries certain risks. Diagnosis of near total occlusion using this investigation is made when the ICA lumen is smaller at its widest diameter than the ipsilateral internal maxillary artery and/or demonstration of delayed ICA filling relative to the ipsilateral external carotid artery with cross filling of intracranial collaterals. The angiographic appearance may be affected by the presence of a coexistent tight stenosis in the contralateral ICA, the vertebral arteries, or the proximal ipsilateral common carotid artery and occlusion or tight stenosis of the brachiocephalic or left subclavian arteries.

Some retrospective studies have suggested that colour duplex imaging may detect near total occlusion with sensitivities ranging from 78 to 100%, but others questioned whether ultrasonography can distinguish total occlusion from severe stenosis and this may require further evaluation. Although with this degree of stenosis the blood flow velocity across the lesion might be assumed to be low, on selective angiography 11 out of 13 ICAs proved to be near total occlusions, and had velocities that would have placed them between 70 and 90% stenosis. In the same study, even power Doppler, which is superior to colour duplex imaging, misdiagnosed two patent ICAs as completely occluded.

A prospective study testing the validity of ultrasonography versus magnetic resonance angiography, using arteriography as the gold standard, showed that advanced ultrasonographic techniques such as echo-enhanced colour duplex or power flow imaging
can reliably identify near occlusions whereas non-enhanced ultrasonic imaging and time-of-flight (TOF) magnetic resonance angiography (MRA) could not. The authors suggested that because it is non-invasive and accurate echo-enhanced duplex or power flow imaging should be the first line investigation in the diagnosis of near total occlusion.

Total occlusion diagnosed by ultrasonography can be confirmed using MRA and no further imaging is necessary, although in this study Gadolinium-enhanced MRA performed better than ultrasonography in the identification of near total occlusion.

In respect to the identification of a patent ICA distal to the near total occlusion of the ICA, conventional catheter angiography remains the diagnostic tool of choice. Multi-slice CT angiography correlates well with findings on catheter angiography in diagnosing total versus near total ICA occlusion. However, no information can be gained about blood flow velocity and directionality. Thus, when such information is required CT angiography should be used with other imaging modalities including duplex scanning, catheter, and MR angiography.

The lumen of the ICA can be followed from the cervical region to the skull base with MR angiography only on the basis of source images. However, MR angiography has a limited ability to help differentiate between vessels with distal focal high grade stenoses and those with diffuse disease.

The ability of colour duplex imaging to depict lesions distally to the available sonographic window in the neck is not well documented. Low velocity flow with a high resistance pattern when measured in a patent cervical ICA may be suggestive of a distal lesion or dissection. Nevertheless, therapeutic decisions in these cases might be better made by using conventional catheter angiography.

Reduced diameter of internal carotid artery distal to high-grade stenosis

The diameter of the distal ICA decreases when the severity of stenosis exceeds 60% luminal reduction. This has important implications on the calculation of the severity of ICA stenosis using arteriography as NASCET criteria employ distal ‘normal’ ICA to calculate the percentage stenosis. The NASCET authors proposed that if the ICA diameter distal to the stenosis is smaller than the contralateral ICA diameter then the calculation of the degree of stenosis should be based on the latter. Diffuse distal ICA disease may also mimic poststenotic narrowing as a consequence of dissection, post-irradiation changes, sub-acute partial thrombosis, and chronic subtotal thrombosis.

Poststenotic narrowing of the ICA may be associated with a low risk of stroke. Rothwell and Warlow showed that in patients with 70–99% stenosis, those randomised to best medical treatment had a 5-year actuarial risk of ipsilateral stroke of 8% when there was poststenotic ICA narrowing and 25% in the absence of such narrowing. The 1-year stroke risk was 11% in patients with near total ICA occlusion compared with 35% when ICA stenosis was 90–94%. Similar results were reported in an ultrasound based study in which a reduced risk of ipsilateral hemispheric ischaemic events was noted in those with very severe or ‘critical’ ICA stenosis.

This low risk of ipsilateral hemispheric ischaemic events can probably be attributed to the low flow conditions across the stenosis that reduces the risk of dislodgement of emboli from the plaque surface or the transfer of large particles to the brain.

Echostructure of the carotid plaque

There is good evidence that, apart from the severity of ICA stenosis the ultrasonic structural appearance of carotid atheroma, particularly the presence of soft or echolucent plaques, may be an additional factor for development of ipsilateral symptomatic disease. Asymptomatic embolisation in patients with ICA stenosis is an independent factor for future stroke in both asymptomatic and symptomatic carotid disease. Emboli detected by means of transcranial Doppler are more frequent in the presence of an ipsilateral echolucent carotid atheroma, although in the presence of high degree of carotid stenosis the number of emboli detected is very low, and it might be expected that an echolucent plaque causing a near total occlusion would have a high risk of stroke due to a combined risk of embolisation and hypoperfusion.

There is no available data regarding the echostructure of the carotid plaque in near total occlusions. Plaques producing near total ICA occlusion result in low velocity flow that may reduce the risk of plaque rupture and distal embolisation regardless of echostructure.

Collateral brain circulation

With increasing severity of ICA stenosis a compensatory collateral circulation develops, and has been demonstrated by methods including positron emission tomography (PET), single photon emission tomography.
tomography (SPECT), magnetic resonance studies, middle cerebral reactivity with transcranial Doppler (TCD), and cerebral angiography.

In NASCET the 2-year risk of transient ischemic attacks, hemispheric stroke, and disabling or fatal strokes was reduced in the presence of collaterals on cerebral angiography in medically treated patients from 36 to 19%, from 28 to 11%, and from 13 to 6%, respectively.51

A severely reduced middle cerebral artery reactivity on TCD in patients with ICA occlusion or asymptomatic stenosis was found to be an independent predictor of ipsilateral ischemic events, particularly in patients with a tight ICA stenosis or occlusion.52 Blaser et al., 53 reported that in patients with recently symptomatic high-grade stenosis and ipsilateral hemodynamic compromise on TCD the incidence of stroke in those with low reactivity was 27% per month compared to 5% in those with normal reactivity.

The contribution of tight stenosis or occlusion of the contralateral ICA or the vertebral arteries is unknown.

Future Perspectives

The nomenclature associated with near total ICA occlusion all need to be known for future trials. Terms, such as ‘pseudo-occlusion’, ‘sub-occlusion’, ‘critical stenosis’, ‘pre-occlusive stenosis’, and ‘string sign’, have been used to describe the same entity. Whatever definition is chosen, it appears that the clinical behaviour of near total ICA occlusion may differ from lesser degrees of severe (greater than 70%) stenosis, and the term ‘near total occlusion’ of the internal carotid artery is best suited.

A more accurate method of calculating the degree of stenosis that is less affected by postenotic narrowing, using the dimensions of the contralateral normal distal ICA51 or the ipsilateral CCA,54 will be required and the identification of near total ICA occlusion may require the use of more than one diagnostic modality.

The natural history of near total ICA occlusion is unknown, as there is lack of prospective observational or natural history studies. Variables that might affect natural history include the impact of poststenotic narrowing of the ICA, the collateral circulation and the type of carotid atheroma echostructure.

In all previous randomised trials of surgical intervention plus ‘best’ medical treatment versus best medical treatment alone,1–5 the only antiplatelet regime used was aspirin. However, in recent years the introduction of new antiplatelet agents and wider use of cholesterol and blood pressure lowering drugs might have a significant impact in favour of medical treatment alone, although it appears difficult to render carotid endarterectomy obsolete.55,56

Endovascular intervention is under evaluation57,58 although currently it is not known whether this carries higher risk of peri-procedural ipsilateral stroke and neurological events. Some information on the feasibility of carotid stenting and complications in patients with near total occlusion may be available from ongoing trials.

Prospective observational studies are needed to demonstrate the prevalence of near total occlusion in the symptomatic population and any associated excess stroke risk from which the size of any future randomised trial can be calculated. The size of the population needed will be large and the observation time required will be long. Thus, such a natural history study appears a difficult undertaking. In addition, even if a prospective observational study demonstrates that near total ICA occlusion is associated with an excess risk of ipsilateral stroke, a prospective multicentre randomised study, which is needed to demonstrate the potential benefit of the addition of carotid endarterectomy or endovascular intervention to existing best medical treatment, would probably be impossible. This is because large number of patients is required, even if asymptomatic patients were included.

Based on the current evidence surgery is the treatment of choice in most centres but its validity over best medical treatment remains untested. Patients with near-occlusion should be considered for endarterectomy but should be advised that the benefit will be limited.55 For ethical reasons they must also be told that medical treatment risks loss of the opportunity to undertake surgery later if the ICA occludes, even though this may not be associated with any clinical event.

References


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