How to perform a temporary balloon test occlusion

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Introduction

A temporary balloon test occlusion is performed prior to endovascular occlusion of carotid or vertebral arteries. It may also be performed preoperatively when vascular sacrifice is intended or possibly during surgical therapy for tumours of the cervical region or skull base.[1] The indications for parent artery vessel occlusion include certain giant aneurysms, pseudoaneurysms and carotid cavernous fistulae which cannot be treated with preservation of the parent vessel.[1]

Tests used to predict tolerance to permanent occlusion

A temporary balloon test occlusion is performed to predict the ability of the patient to tolerate permanent occlusion. The risks of ipsilateral hemispheric ischaemia or infarction largely depend on the adequacy of collateral circulation. Various tests have been used to assess tolerance during temporary occlusion.

Assessment of neurological status (motor, sensory, speech and level of alertness) during trial occlusion is used in all patients unless it is not possible, or desirable to perform the procedure under local anaesthesia. It does not however, identify all patients at risk for post occlusion infarction. This is probably because there is a group of patients with marginal cerebral blood flow reserves who are able to tolerate temporary occlusion, but who are at risk for developing flow related infarction during episodes of hypotension, anaemia, hypoxaemia or hypoglycaemia.

Various other tests have been used in combination with clinical testing during trial occlusion. Stump pressure is not an accurate predictor of stroke risk.[2] Angiographic evidence of cross filling via collaterals is a poor indicator of whether the patient will tolerate permanent occlusion. The venous phases of an angiogram are a better predictor of tolerance to permanent occlusion.[3] If there is less than a 1.5 second delay in the appearance of the venous phase, following an injection

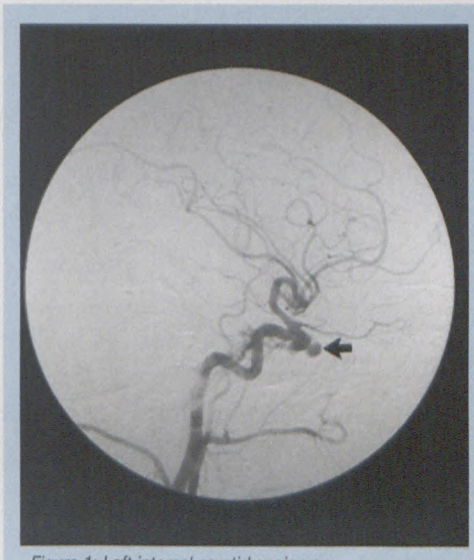

Figure 1: Left internal carotid angiogram. Pseudoaneurysm with CCF arising from the carotid syphon

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into the opposite carotid or vertebral artery, permanent occlusion is probably safe.[3] Transcranial Doppler has not been used extensively. The disadvantage of using transcranial Doppler is that only flow in major vessels is assessed. Permanent occlusion is considered to be relatively safe if the peak systolic velocity in the middle cerebral artery decreases by no more than 65%.[4]

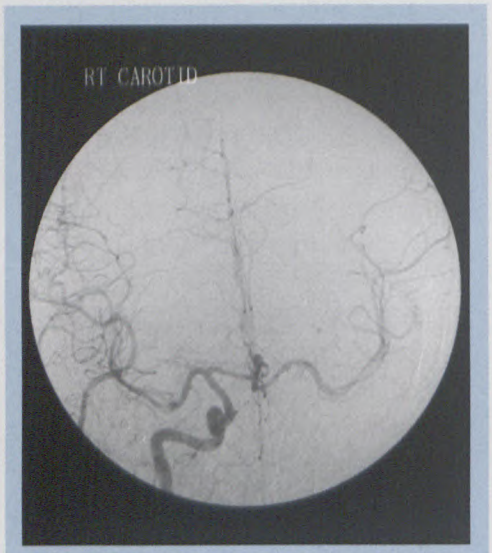

Figure 2: Trial occlusion test. Arterial phase of the right internal carotid angiogram with balloon inflated in the left internal carotid artery

Several tests have been used in an attempt to identify patients with marginal CBF reserves - SPECT, PET, Xenon CT CBF and tolerance to induced hypotension during trial occlusion.[5] Single-photon emission CT (SPECT) and stable Xenon CT CBF take direct intracranial measurements of parameters linked to CBF to assess CBF reserves. Although PET scanning has been used to assess cerebral blood flow quantitatively during balloon occlusion, the technology is not widely available.[6] Xenon CT CBF is performed by placing and inflating the balloon in the angiography suite and performing a trial occlusion with neurological monitoring. If the patient experiences no deficit, the balloon is deflated and the patient transferred to the CT scanner where the balloon is reinflated (without fluoroscopic guidance) and the Xenon CBF study performed. Quantitative information can be obtained using regions of interest. It is considered safe to proceed with permanent occlusion if the cerebral blood flow is greater than 30 ml/100 g/min. Ten to fifteen per cent of patients will pass the clinical occlusion test, but will have a CBF of less than 30 ml/100 g/min and this group of patients is thought to be at moderate risk for infarction after permanent occlusion. Patients with a CBF of less than 23 ml/100 g/min are at high risk for ischaemia during balloon occlusion.[7] To perform a SPECT scan, 99mTcHMPAO (hexamethyl propyleneamine oxime) is injected intravenously during temporary occlusion. The balloon is then deflated and the SPECT scan performed. A baseline study can be performed prior to the test occlusion, or in patients showing hypoperfusion, 24 hrs later. Areas of asymmetric hypoperfusion not present on the baseline study are considered to be abnormal and place the patient in a high risk category for cerebral infarction following permanent occlusion.[8] Induced hypotension, where the systolic blood pressure is decreased by 30% for a period during trial occlusion has also been used to assess tolerance to parent vessel occlusion.[5]

Balloons used for trial occlusion test

Several methods have been described for performing trial occlusions. One uses a detachable balloon which is detached in the same position, without deflation, if the patient passes the occlusion test. This has the advantage of simulating the effect of permanent occlusion most closely as the balloon is inflated in its detachment position. There is however a risk of premature detachment. The second method uses a non-detachable balloon. This is more time consuming and necessitates deflating the balloon and reinflating the detachable balloon if the patient passes the trial occlusion test. A double lumen balloon catheter, which allows perfusion of the distal stump with heparinised saline has also been used. Although the double lumen balloon catheter has the theoretical advantage of preventing thrombus formation in the distal stump, it seems unnecessary in practice.[9] There are proponents of each of these methods.

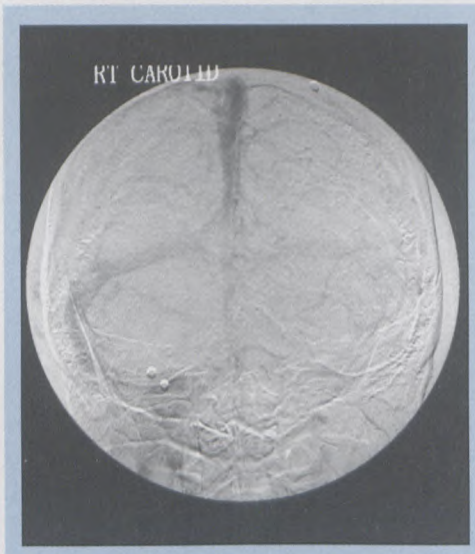

Figure 3: Trial occlusion test. Venous phase of the right internal carotid angiogram with balloon inflated in the left internal carotid artery. The venous phase of the left cerebral hemisphere appeared about 1.5 seconds after the venous phase of the right cerebral hemisphere

Complications

Trial occlusion has a complication rate of about 3%. Some of the complications are asymptomatic (dissections, pseudoaneurysm and embolus) and the remainder ischaemic (although usually transient).[1] The incidence of stroke following permanent occlusion in patients who have passed the temporary balloon occlusion test is reported to be

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between 10 and 20%.[10] About 4% of ischaemic events are permanent and 10% are transient.[5] They may be due to thromboembolism or secondary to decreased flow. Hypoperfusion is a particular problem in the elderly, whose blood pressure and cardiac output may be less stable than in younger patients.

Procedure

Many different techniques are utilised in performing a trial occlusion test. The following is the technique used by the author.

The patient is fully conscious for the trial occlusion test. Bilateral femoral artery punctures are performed. A 5Fr sheath is placed in the left femoral artery. A sheath to match the chosen guiding catheter is placed in the right femoral artery. A diagnostic angiogram is then performed.

The patient is heparinised. A loading dose of 5000 iu is given. The ACT (activated clotting time) is maintained above 300 seconds for the duration of the procedure by giving additional boluses of heparin during the procedure. The diagnostic catheter is positioned in the artery on which the trial occlusion test is to be performed. This is exchanged over a 260 cm exchange wire for the chosen guiding catheter. The guiding catheter selected will depend on the balloon size. It is important to keep the tip of the wire below the skull base, and stationary during the exchange to prevent spasm. The guiding catheter is connected to a rotating haemostat valve (RHV) and continuously flushed with heparinised saline (3000 iu in 1L N/S). The diagnostic catheter is then placed in the contralateral internal carotid artery.

If a permanent occlusion is going to be performed after a successful trial occlusion test, a detachable balloon is used to perform the trial occlusion test. Only if it seems unlikely that the patient will pass the trial occlusion test, or if a permanent occlusion is not planned, is a non-detachable balloon used. The detachable balloon is filled with iso-osmolar solution of contrast and sterile water. It is inflated and checked for a leak. The RHV is disconnected from the guiding catheter and the delivery catheter advanced through the RHV. The balloon is then mounted on the tip of the delivery catheter. It is inflated and air purged from the system. It is then deflated. It is important to perform this step to be certain that it is properly mounted and that the balloon will in fact deflate (if the tip of the delivery catheter does not extend beyond the valve it will not deflate).

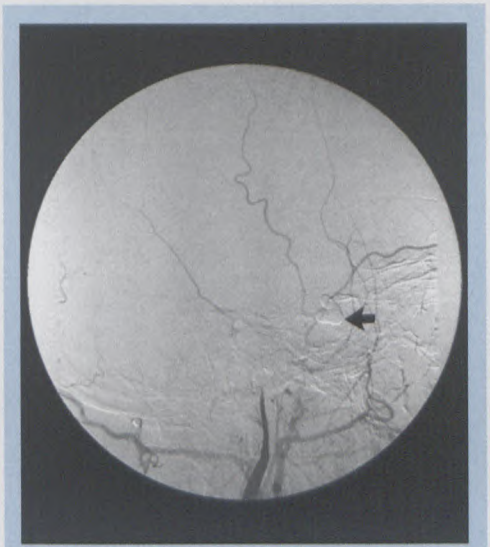

Figure 4: Left carotid angiogram post detachment of the balloon and post detachment of a second balloon

The RHV is reconnected to the guiding catheter and the balloon is advanced beyond the tip of the guiding catheter under fluoroscopic control. Ideally this should be done using a roadmap image (subtracted fluoroscopy). The balloon is positioned at the site of the anticipated permanent occlusion. The author uses transcranial Doppler as part of the assessment and a baseline velocity in the middle cerebral artery is obtained. The ACT is checked immediately prior to inflation of the balloon.

The balloon is progressively inflated until it completely occludes the artery. A check angiogram through the guiding catheter is done to confirm occlusion. The velocity in the middle cerebral artery is checked. A check angiogram is performed from the opposite side and the timing of the venous phase of the angiogram in the two cerebral hemispheres compared. A neurological assessment is performed. If no deficit has developed, the middle cerebral artery velocity has decreased by no more then 50% and the venous phases are separated by less than 2 seconds, the test is continued for 30 minutes. The above parameters are checked intermittently during this period. If a neurological deficit develops, the test is immediately terminated. If the patient passes the test, the balloon is detached and a second 'safety' balloon placed proximally. Patients often experience headache and retro-orbital pain during the procedure which can be treated with opioid analgesia.

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