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**Vascular Lab – Dudley Group NHS Foundation Trust.**

**Colour duplex of the Extracranial Carotid Arteries**

**Reviewed January 2019.**

**Purpose:**

Extracranial cerebrovascular duplex ultrasound examinations are carried out to assess for the presence of pathology and the haemodynamic status of the common carotid artery (CCA), internal carotid artery (ICA) external carotid artery (ECA) and vertebral artery.

**Equipment:**

Colour duplex scanner: Philips EPIQ 5G.

Service and quality control test are carried out by supplier and Medical Physics Department, New Cross Hospital – Wolverhampton.

Consumables: Ultrasound gel, tissues, paper roll for the couch.

**Common Indications:**

* Transient ischemic attacks (TIA)
* Amaurosis fugax
* Carotid bruit
* Cerebrovascular Accident (CVA)
* Follow-up of known carotid stenosis
* Post intervention follow-up e.g. carotid endarterectomy, stent or bypass
* Trauma in the distribution of the carotid artery e.g. suspected dissection, arteriovenous fistula or pseudoaneurysm
* Pre-operative assessment for high risk patients e.g. coronary artery bypass surgery (CABG)
* Pulsatile neck masses
* Evaluation of suspected subclavian steal syndrome

**Procedure:**

The vascular sonographer should introduce themselves and correctly identify the patient using date of birth, address and unique hospital number.

An explanation of the procedure should be given, verbal consent obtained and any relevant medical history should be sought.

A 9-4 MHz linear array transducer is used with optimal settings for a carotid duplex scan.

The patient should be examined in a supine position with the head tilted and rotated away from the side being examined, in order to maximise exposure of the patient’s neck.

Survey the proximal common carotid artery (CCA) in B-mode followed by colour-flow in a longitudinal plane, scanning distally to the bifurcation where the internal and external carotid arteries (ICA & ECA) can usually be located (with the internal situated postero-laterally, and external antero-medially - although this is NOT ALWAYS the case).

Using spectral doppler, create an angle that is suitably parallel to the flow direction and is at an angle of 60° or less.  Always ensure that the transmitting frequency, angle, sample volume size, PRF, colour box size and direction, focus, and gain settings are correct.

Measure the peak systolic and end diastolic velocities (PSV &EDV) of the CCA approximately 2cm proximal to the bifurcation and the ICA approximately 1-2cm distal to the bifurcation or where the highest velocity is detected.  Measure the PSV of the ECA in a similar way.

Measurements should always be taken in the centre of the lumen in the longitudinal plane, where velocity of flow is uniform.

With all settings correct, turbulent flow, incomplete colour filling or high velocities suggests presence of a lesion.

If there is plaque present, the plaque morphology, distance from bifurcation and length should be recorded.

The CCA, ICA and ECA should then be examined in transverse plane in B-mode and colour Doppler.

In the presence of reversed or partially reversed flow the subclavian artery should be examined.

**Vertebral Arteries:**

Due to the position of the vertebral arteries, a full study cannot be performed.  Short segments of the vertebral artery can be visualised if the transducer is angled posteriorly.  The flow direction is checked using colour Doppler, but more importantly using spectral Doppler.

**Subclavian Arteries:**

Subclavian Steal Syndrome (SSS)  
The main objective in assessing the subclavian artery is to identify the presence of a proximal stenosis occlusion of the proximal subclavian artery and establish a diagnosis of subclavian steal syndrome (SSS).

This phenomenon occurs where there is significant stenosis or occlusion of the subclavian artery proximal to the origin of the ipsilateral vertebral artery.  The pressure distal to the disease is reduced compared to that at the junction of the vertebral artery resulting in retrograde flow down the vertebral artery on the side of the stenosis to supply the upper extremity and subclavian branches.

Due to the presence of the lesion in the subclavian artery, spectral Doppler waveform of the subclavian artery is abnormal.  
In a transverse plane, the CCA is traced proximally towards the clavicle and the transducer is angled beneath the clavicle until the subclavian artery is viewed in a longitudinal section.  High velocities or turbulence detected on spectral Doppler in the subclavian artery or abnormal waveform characteristics should be noted on the report.

**Reporting:**                                    
  
B-mode:

* The following points must be noted regarding CCA, ICA, and ECA.
* Patency as seen by the outward compliance movement of the walls and movement of the red cell aggregates in the lumen.
* Anatomical variation in calibre, anatomy and/or course of vessels.
* Presence of intimal thickening or plaque.
* Site, extent and severity of plaque.
* Type of plaque.

Plaque morphology:

In B-mode, plaque morphology should be examined and noted.

Grading:

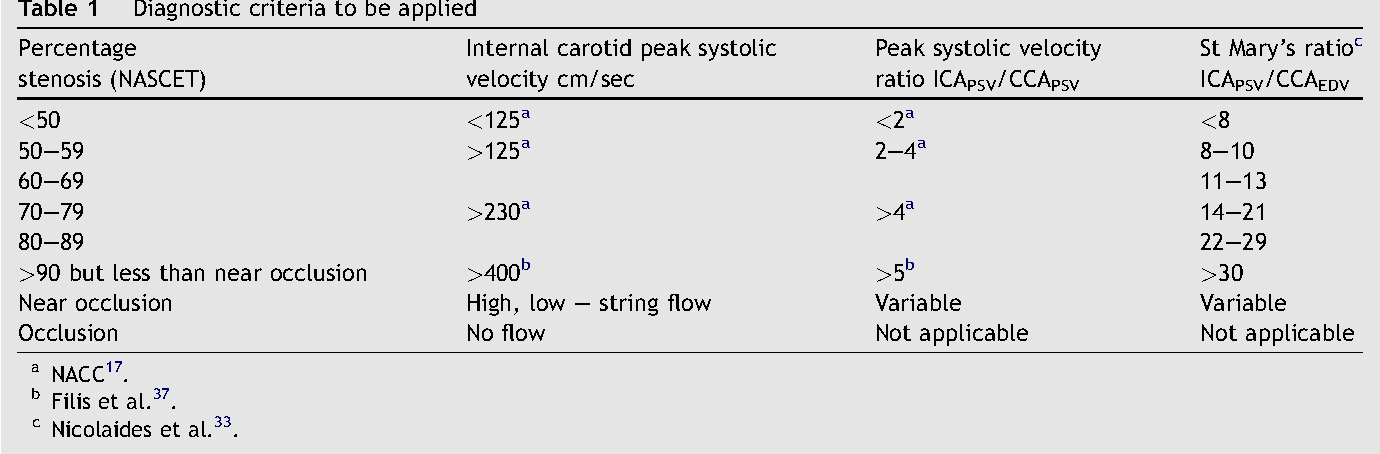
* Soft: echo lucent plaque with similar echogenicity to that of blood.
* Mixed: variable echogenicity, some areas echogenic and some echo lucent
* Calcified: acoustic shadowing cast from the plaque
* Ulcerative: area of mixed plaque forming a ‘crater’ filled with either soft plaque (seen in transverse plane as a ‘hook’ of mixed plaque surrounding soft plaque), or with blood visibly swirling within the crater.

Image storage: An appropriate number of annotated images should be saved in order to represent the entire examination, which will then be stored onto the PACS system.

**Doppler:**

The interpretation of a carotid examination relies upon the accurate and methodical collection of Doppler information that is confirmed (or modified) by the appearance of the B-mode image and the colour filling.

Velocity criteria for ICA stenosis (this should be used as a guide only)



**Pitfalls:**

* Colour Duplex cannot always distinguish between an occlusion and sub-occlusion of a vessel, therefore on reporting it must only be suggested that the vessel is occluded, and give the reasons that back up the statement; i.e. no flow detected using spectral Doppler, reverse component in the CCA Doppler signal, no flow detected with the power Doppler.
* Compensatory flow caused by an occlusion of an ICA.  In the ipsilateral ECA and contralateral CCA, ICA and ECA, the compensatory flow is in the form of enhanced velocities but not usually disturbed flow.  However, if atheroma is present in the contralateral carotid artery, it can be difficult to distinguish between enhanced velocities due to compensational and those due to stenosis and is probably one of the main causes for over grading stenosis. Grade stenosis as accurately as possible always commenting that there may be a degree of over estimation and reasons why.

**Other factors to consider when grading the disease:**

* Proximal occlusion e.g. innominate artery disease or occlusion could cause under estimation of disease present.
* Distal occlusion of the ICA may be missed, the proximal ICA may be patent but with an abnormal waveform present.
* Poor cardiac output/ mitral valve disorder may cause under estimation of disease present in carotid arteries. Any abnormal flow in the CCA must be commented on and suggestions of cause of abnormality documented on report.  
    
  Aliasing is another problem that occurs when using colour-flow.  Aliasing occurs when the true Doppler shift exceeds one half the pulse repetition frequency.

Aliasing can be reduced by:

* Increasing the PRF (scale)
* Altering Doppler angle
* Lowering baseline shift
* Reducing operating frequency

Images are also affected by biological variability e.g. depth of vessels, tortuosity of vessels, high bifurcation and calcification. Always comment on report any difficulties encountered when performing scan. If unable to conclude or be accurate, report as an inconclusive scan, state the reasons and suggest another imaging modality.  
  
The skill and bias of the observer can also alter the results obtained.

**Referrals:**

TIA clinic: Patient will be sent up to Vascular Lab and the scan will be reported on CRIS and the patient referred back to Stroke Consultant. Any urgent findings to be phoned through to the Stroke Consultant so they are made aware.

GPs: Requests will be vetted by Dr. Randhawa, Dr Latif or Dr Ajayi. If a GP patient is booked and there are significant findings then the GP needs to be contacted and the report faxed through. They can then make an appropriate referral to a Stroke/Vascular Consultant if required.

Inpatients: Any significant findings to be phoned through to the Doctor on the stroke ward C8 and report available immediately on the CRIS system.