

**ascular Laboratories**

**Carotid Artery Duplex Protocol**

**Date updated: October 2019   
Date for review: October 2020**

**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.

**Pre procedure**

**Patient preparation**

* Identify patient
* The patient should be identified by at least two means e.g. name, date of birth, address
* For administrative purposes the referral should also include MRN number which can be used to check for previous relevant imaging
* Be aware of special circumstances such as the need for an interpreter or chaperone
* Explain procedure
* The vascular scientist should introduce her/himself and anyone else in the room, explain the procedure to the patient including time frame, what clothing they will need to remove and use of cold gel; why it is being performed, how long it will take and what will happen with the results afterwards
* Obtain consent
* Verbal consent is suitable for this examination, if a trainee is carrying out the procedure, the patient must be aware of this.
* If consent is withheld or the patient lacks capacity a note to that effect should be made on the referral and the referring consultant informed
* The patient’s consent should be sought if the scan is also being used for teaching/research purposes
* Prepare patient
* Ask patient to remove clothing and jewellery appropriate to the procedure, assisting if necessary
* The patient should be positioned on the examination couch in a manner commensurate with the procedure being undertaken

Throughout the procedure the patient’s privacy, dignity and security should be observed.

The vascular scientist should recognise and adapt to ethnic, medical and demographic variables.

This protocol is available to the patient.

**Relevant medical history**

A medical history relevant to carotid artery pathology should be taken prior to the scan. This should include presenting symptoms, their timescales and frequency, and medication. This also provides opportunity to verify that the requested procedure correlates with the patient’s clinical presentation.

Common indications for performing a carotid scan;

* Transient ischaemic attacks (TIA)
* Cerebrovascular Accident (CVA)
* Amaurosis fugax
* Follow-up of carotid stent or known carotid stenosis
* Pre-operative assessment for patients undergoing AAA repair or CABG
* Peri or post op patency checks
* Symptoms of Vertebrobasilar disease
* Ocular ischaemic syndrome
* Other symptoms or indications of rare conditions (e.g. dissection/arteritis/Carotid body tumours)

**Equipment**

The examination is performed using a medium to high frequency (between 3-9MHz) flat linear transducer. The ultrasound machine should be regularly safety checked and maintained according to local Quality Assurance protocols.

The examination couch should be height adjustable and the vascular scientist’s chair should be height adjustable to minimise occurrence of work related musculo-skeletal disorders.

The examination room should be temperature controlled with adjustable lighting suitable for examination.

Cleaning materials should be available in line with local and manufactures guidelines.

**Procedure**

**Carotid artery interrogation**

The patient can be positioned either seated, upright with the head resting on a pillow or supine on the bed, depending on operator preference and patient habitus. In either position the neck should be extended and free from clothing and jewellery.

The carotid optimised preset is selected at the start of the examination. The patient name/operator ID should be entered for image capture.

A lateral approach is usually adequate to image the carotid tree, but more anterior and posterior approaches may be appropriate.

Starting in B mode and transverse orientation, a preliminary scan of the carotid tree may be made to ascertain the anatomy and presence/character of atheroma. This includes a brief assessment of the proximal subclavian arteries and brachiocephalic artery.

The following techniques should be used to evaluate the carotid tree:

* B-mode in longitudinal and transverse section to image the artery and assess for aneurysmal dilation and vessel contents e.g. atheromatous plaque
* Colour Doppler in longitudinal and transverse section to assess for presence/absence of flow and aid the position of Spectral Doppler when quantifying stenoses
* Spectral Doppler in longitudinal section to determine direction of flow, blood flow velocities and absence of flow

Throughout the duplex scan the machine controls (e.g. scale, gain, angle, depth, gate etc.) are adjusted to optimise the image/colour filling/spectral trace.

Care should be taken to ensure the Doppler insonation angle is ≤60° and the angle correction cursor is angled correctly in the direction of flow.

Evaluation of the following arteries on both sides of the neck should be included;

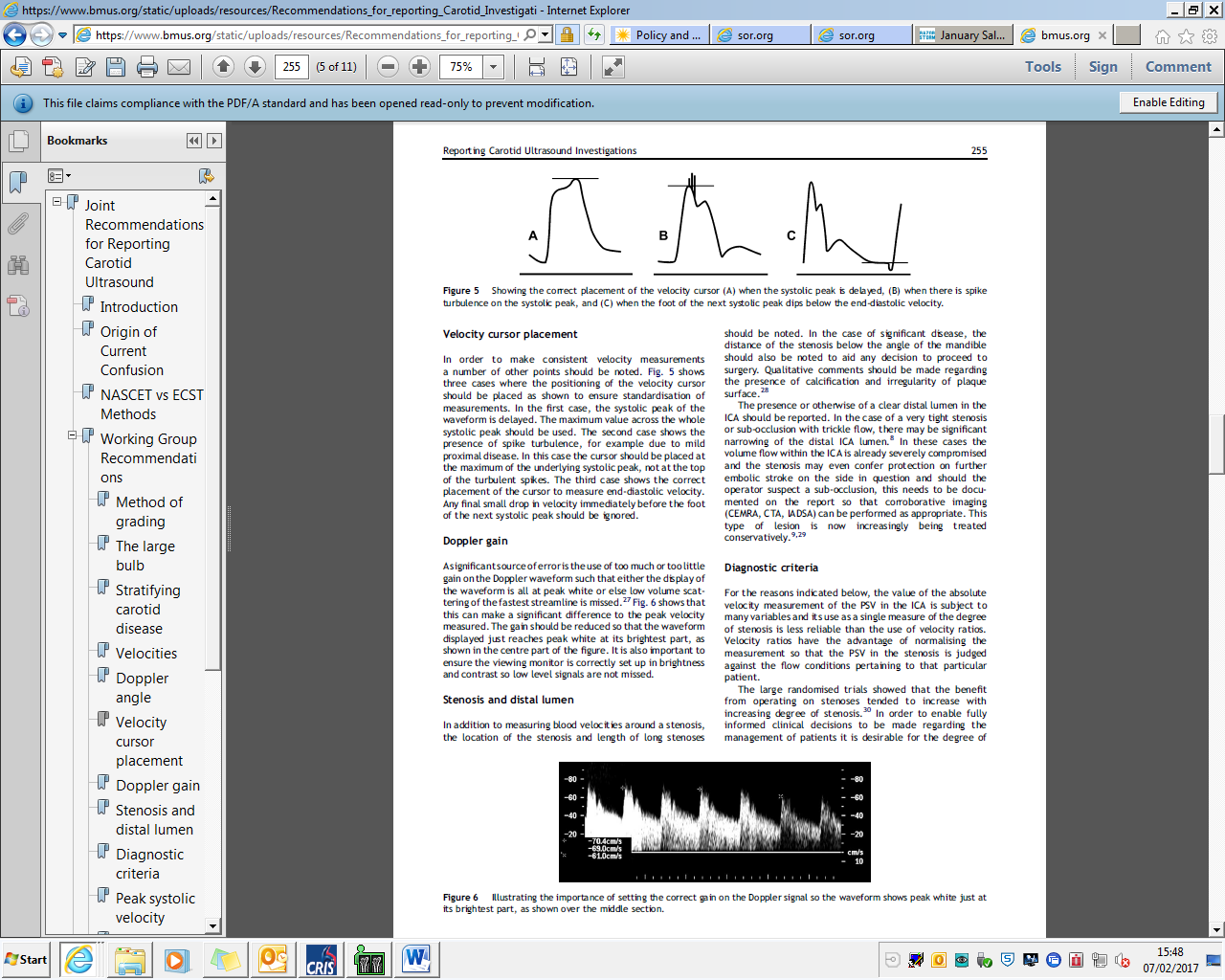
* Common Carotid Artery (CCA)
* External Carotid Artery (ECA) (identified via combination of waveform, temporal tap, observation of branches, size and position)
* Internal Carotid Artery (ICA) (identified via combination of waveform, size and position, presence of bulb, lack of temporal tap and lack of branches)
* Vertebral Artery (VA)

Each artery is examined at regular intervals along its length, paying close attention to areas of turbulence, colour aliasing or any other abnormal pathology.

The location and nature (size, echogenicity etc) of any atheromatous plaque, the presence of intimal thickening, occlusions, and any abnormal Doppler readings or waveforms, are noted and evaluated. Factors such as tortuosity, vessel size, cardiac output and contra-lateral disease are also considered.

Peak systolic (PSV) and end diastolic velocity (EDV) measurements are taken within the distal CCA. In the ICA, PSV and EDV are taken at the point of highest velocity. The highest ICA PSV will be seen either at the point of tightest stenosis or, if normal, distal to the ICA bulb (flow separation due to atypical geometry). The PSV is also measured in the ECA. All velocity measurements should be made with the vessel imaged in longitudinal section with the longest length possible shown with both anterior and posterior vessel walls visible. The sample volume should be placed in the centre of the vessel, occupying roughly one third of the vessel, with the gate angle set to represent the direction of flow. In the case of an eccentric jet within a stenosis the angle cursor would be aligned to the jet, which may not always represent the curvature of the vessel walls.

The figure below shows examples of cursor placement in different situations.



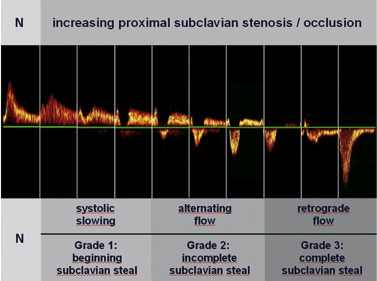
In the presence of disease these velocity measurements are used to grade the degree of stenosis using the criteria below. Special consideration should be made for factors that can cause variation in ICA velocity, namely variations in the geometry of the vessel, collateral flow effects from contralateral disease and irregular heart rhythms (in this case PSV should be taken on the second or subsequent cardiac cycle of a string of regular cycles).

On occasion the B-mode image and Doppler reading give conflicting results. The discrepancy must be highlighted in the report.

**Vertebral artery interrogation**

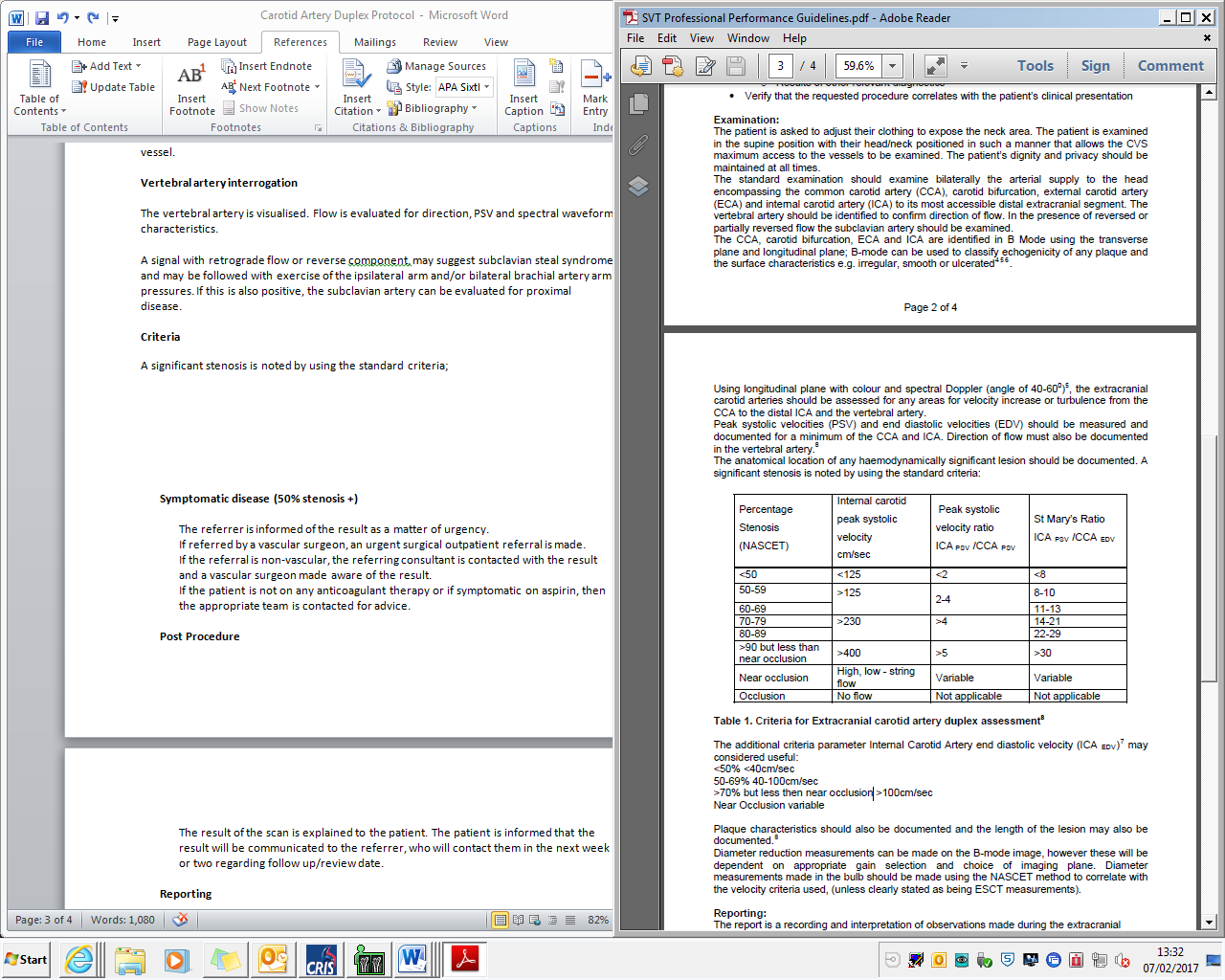
The vertebral artery is visualised. Flow is evaluated for direction, PSV and spectral waveform characteristics.

A signal with complete, partial or transient retrograde flow may suggest subclavian steal syndrome and may be followed bilateral brachial artery arm pressures, and investigation of relevant symptoms by hand exercise to elicit a positive hyperaemic response. If this is also positive, the subclavian artery can be evaluated for proximal disease.

[](http://www.sciencedirect.com/science/article/pii/S2211968X12000940#mmc1)

**Criteria**

A significant stenosis is noted by using the standard criteria from the 'Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom' Oates C.P.et al. European Journal of Vascular and Endovascular Surgery (2009) 37, 251-261.



Stenoses under 50 % are estimated visually. Plaque characteristics (smooth/irregular, homogeneous/heterogeneous or echolucent/calcified) should also be documented as well as the length of the lesion and length of distant patent vessel to the jawline should be documented. Other information useful to surgery may include deep, tortuous or particularly small vessels.

If diameter measurements are made in the bulb, these should be made with caution, using the appropriate gain selection and imaging plane, with measurements taken using the NASCET method.

Contralateral disease, inflow and outflow problems, and tortuosity may have significant effect on the readings produced and must be taken into account when providing diagnostic judgements.

ECA Stenosis - ECA stenosis will not normally be clinically relevant unless associated with ICA occlusion and possible collateral pathway – any ECA stenosis should be determined with a combination of visual estimation and velocity measurements.

**Report**

The report should include correct patient demographics, date of examination, examination type and status of vascular scientist.

The report should include;

* CCA - PSV and EDV 1-2cm below the bifurcation
* ICA - PSV and EDV at the point of highest velocity
* ECA - PSV
* Vertebral Arteries - PSV and direction of flow
* Plaque - qualitative nature e.g. calcified, echolucent, irregular, smooth etc. and length and anatomical position
* Stenosis - % degree using NASCET criteria as above
* Limitations
* Any incidental/abnormal findings/comments
* Annotated images if appropriate to the examination and in accordance with SVT Image Storage Guidelines

The report is then signed and copied to PACS, with the original report sent to the referrer with the referral attached.

**Post procedure**

The result of the scan is explained to the patient. The patient is informed that the result will be communicated to the referrer who will arrange appropriate follow up.

In the case of significant, symptomatic disease (>50%) the referrer should be informed as a matter of urgency. If the patient is an outpatient and is not being seen directly by a consultant of the referring team the patient should remain within the department until advice from the referring physician has been sought. This should be documented.

All inpatient reports are filed in hospital notes. If significant symptomatic disease is detected the referrer is informed with a note that the vascular team need to review the patient.

All outpatient reports are sent back to the referrer. If significant symptomatic disease is detected, the on call vascular surgeon is notified.

**References**

Clinical Imagine Board (Collaboration between RCR, I. a. (n.d.). *Patient Identification: guidance and advice.* Retrieved from <http://www.sor.org/sites/default/files/document-versions/patient_id_guidance.pdf>

IPEM/SVT Vascular Laboratory Practice, Part I and II

Mansour MA, Labropoulos N, Elsivier Saunders 2005, Vascular Diagnosis.

Oates CP, Naylor AR, Hartshorne T, Charles SM, Fail T, Humphries K, Aslam M, Khodabakhsh P. Joint Recommendations for Reporting Ultrasound in the United Kingdom. *J Vasc Endovasc Surg* 2009; **37**:251-261.

SCoR and BMUS. (n.d.). *Guidelines for Professional Ultrasound Practice.* Retrieved from <http://www.sor.org/sites/default/files/document-versions/bmus_scor_ultrasound_guidelines.pdf>

SVT Professional Standards Committee April 2012: Guidance on image storage and use, for vascular ultrasound scans.

Strandness DE Jr. Lippincott Williams & Wilkins, third edition, Duplex Scanning in Vascular Disorders.

Thrush A, Hartshorne T. Harcourt Publishers Ltd. 1999, Peripheral Vascular Ultrasound, How,Why and When.

Zwiebel WJ, WB Saunders Co Third Edition, Introduction to Vascular Ultrasonography.

‘Pitfall of vertebral artery insonation: Bidirectional flow without subclavian artery pathology’.

Susanne Johnsen, Stephan J Schreiber et al. Perspectives in Medicine (2012) 1, 449 – 451.

‘Analysis of Doppler blood flow waveforms of cerebral arteries and common abnormal findings’.

Shu-Yi Chen, Hung-Ti Hsu. Journal of Medical Ultrasound (2014) 22, 3 – 6.