

Clinical Protocol

CAROTID DUPLEX

SETTING	Vascular Science Unit
FOR STAFF	Clinical Vascular Scientists
PATIENTS	Patients referred for a Carotid Duplex

INTRODUCTION

Carotid Duplex ultrasound examinations are carried out to assess for the presence of disease and the haemodynamic status of the common carotid artery (CCA), internal carotid artery (ICA) external carotid artery (ECA), vertebral artery (VA) and subclavian artery (SUBA).

The most common type of carotid artery pathophysiology is atherosclerosis. Atherosclerotic lesions can lead to a carotid artery stenosis or occlusion which can cause a Transient Ischemic Attack (TIA) or cerebrovascular accident (CVA). Other carotid artery pathophysiology includes thrombus/embolus, dissection, aneurysm and arteritis.

Every patient with a suspected TIA who after specialist assessment is considered as a candidate for carotid endarterectomy should have urgent carotid imaging, one form of which is Ultrasound Duplex imaging [1].

This protocol should be read in combination with the Vascular Science generic protocol which covers preparation, patient communication, environment, equipment, workforce, health & safety, infection control and equality & diversity.

NICE GUIDELINES

In relation to assessment of people with a suspected TIA and carotid artery duplex Nice guideline NG128 and NICE Clinical Knowledge Summaries state [1, 2]:

- If the person has had a suspected TIA within the last week:
 - Arrange urgent assessment (within 24 hours) by a specialist stroke physician [2]
- If the person has had a suspected TIA which occurred more than a week previously:
 - Refer for specialist assessment as soon as possible within 7 days. [2]
- Every patient with a suspected TIA *who after specialist assessment* is considered as a candidate for carotid endarterectomy should have urgent carotid imaging [1]

- Ensure that people with stable neurological symptoms from acute non-disabling stroke or TIA who have symptomatic carotid stenosis of 50 to 99% according to the NASCET (North American Symptomatic Carotid Endarterectomy Trial) criteria are assessed and referred urgently for carotid endarterectomy to a service following current national standard. [1]

REFERRAL PATHWAY

There are three main reasons for a carotid duplex referral:

1. Referral from doctors/consultants when there is clinical suspicion of TIA or CVA (see clinical indication section below)
2. Referral from a cardiac specialist nurse or doctor as a pre-operative assessment
3. Referral from eye hospital doctors/consultants when there is suspicion of carotid artery involvement in an eye pathology

All referrals are received through the ICE referral system. With the exception of Weston General Hospital (WGH) TIA/stroke consultants who refer via email with the 'WGH Urgent Carotid Duplex Referral Form'.

Referrals are triaged by a senior or junior vascular scientist. Prioritisation of patients is based on the clinical information presented on the referral. If there is insufficient information on the referral it should be sent rejected or discussed with the referring clinician.

ACUTE pathway

All outpatients with a suspected acute TIA must be referred via the BRI or WGH TIA clinic where an urgent carotid duplex can be arranged in timely manner. If the patient is not referred via the TIA clinic the referring clinician must agree to take responsibility and act on any urgent findings before the request is accepted.

All inpatients with a suspected acute TIA or stroke can be referred by the ICE system and an urgent carotid duplex can be arranged in a timely manner.

ROUTINE pathway

Routine outpatient carotid referrals can be accepted without going via the TIA clinic and booked via the VSU routine pathway. The exception to this is cardiac pre-operative assessments which, where possible, are arranged as a one-stop scan.

CLINICAL INDICATION

Common indications for a carotid artery duplex are:

- Unilateral weakness or sensory loss
- Dysphasia
- Ataxia, vertigo, or incoordination

- Syncope
- Sudden transient loss of vision in one eye (amaurosis fugax)
- Homonymous hemianopia
- Cranial nerve defects
- Pulsatile neck masses
- 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)
- Evaluation of suspected subclavian steal syndrome

CONTRAINDICATIONS

There are no known major contraindications for a carotid duplex ultrasound.

LIMITATIONS

- Patients with short, thick or muscular necks
- Patients with a high BMI
- Patients who have had recent surgery, ultrasound visualisation may be limited due to oedema, haematoma, surgical staples, dressings etc.
- Calcified plaque may cause acoustic shadowing limiting Doppler and B-mode image assessment
- Examination performed with the patient in a chair/upright position due to immobility or existing co-morbidities e.g. chronic obstructive pulmonary disease (COPD)
- Patients who are unable to cooperate due to reduced cognitive functions e.g. Alzheimer's or dementia and through involuntary movements
- Examinations undertaken portably at the patient's bedside maybe limited due to equipment and room dimensions

EQUIPMENT SPECIFICATION

For accessory equipment, maintenance, QA, calibration and ultrasound safety please refer to the generic vascular Science protocol.

GE Logic 9 ultrasound machines are used for carotid duplex. The 5-9MHz linear array transducer is routinely used, the curvilinear array transducer, phased array or hockey stick transducer are used when necessary. The carotid pre-set should be used as standard.

All equipment has regularly safety checks and maintenance.

PREPARATION

For test preparation applicable to all assessments please refer to the generic vascular Science protocol.

PATIENT COMMUNICATION

For patient arrival and waiting time and introduction, information and consent please refer to the generic vascular Science protocol.

Clinical history and presenting Symptoms

The written referral for the investigation should contain a relevant clinical history. This should be confirmed and clarified with the patient prior to starting the examination. A relevant carotid duplex clinical history should be taken including:

- Presenting symptoms – character, onset, duration, frequency, severity and progression
- Investigation into any other typical TIA/stroke symptoms that is/are not the primary presenting symptoms
- Previous history of TIA/Stroke

Relevant risk factors

Assess the patient's relevant risk factors to include:

- Smoking history
- Hypertension
- Ischemic heart disease
- Diabetes and diabetes control if applicable (insulin, tablet or diet)
- Rheumatic Fever

STANDARD OPERATING PROCEDURE

Please see the Carotid Duplex SOP

REPORTING

The carotid duplex is reported on CRIS and the vascular science database. The standardised CRIS report (appendix 1), reporting phrases (appendix 2) and conclusions (appendix 3) should be used wherever possible. Additional comments can be added when necessary.

All reports should include:

- Type of scan 'CAROTID DUPLEX'
- Symptoms and relevant clinical history (as stated above)
- Relevant risk factors (as stated above)
- Clinical report – see below

- Name of Vascular Scientist performing scan
- VSU end of report statement – including that Vascular Science use NASCET criteria
- VSU contact phone number

Clinical report

Following the criteria set out in table 1, the absence of disease or, if present, the type of disease with reporting comments, the peak systolic velocity (PSV) and the end diastolic velocity (EDV) for each of the following arteries should be reported:

- Common carotid artery (CCA)
- Internal carotid artery (ICA)
- External carotid artery (ECA)
- Vertebral artery (VA)
- Subclavian artery (SubA)

Table 1. Reporting criteria

Type of disease	Reporting comments (see appendix 2 for reporting comments in full)
No disease	<ul style="list-style-type: none"> • Normal
Atherosclerotic disease, but <50% stenosis	<ul style="list-style-type: none"> • Nature of disease <ul style="list-style-type: none"> ○ Mild /moderate ○ Irregular/smooth ○ Calcified/echolucent/homogenous ○ Large/small ○ <50% plaque
Atherosclerotic disease, but >50% stenosis	<ul style="list-style-type: none"> • Nature of disease <ul style="list-style-type: none"> ○ Irregular/smooth ○ Calcified/echolucent/homogenous • Distance of stenosis from origin (if applicable)/location of stenosis • Length of stenosis (if applicable) • PSV and EDV • Percent of stenosis according to NASCET method (see table 2) • R1 and R2 ratios (see table 2) • If not all of the ratios agree state '2 out of 3 criteria agree' • If nil agreement between the PSV and ratios, an explanation is essential • Presence/absence of atheroma distally • Position of the bifurcation
Occlusion	<ul style="list-style-type: none"> • Proximal to distal extent • Acute or chronic (if able) • Presence of collateral vessels
Aneurysm	<ul style="list-style-type: none"> • Maximum inner-to-inner transverse and longitudinal anterior-posterior diameter measurement (to 1 decimal

	place)
Dissection	<ul style="list-style-type: none"> • Proximal to distal extent
Subclavian steal syndrome (applicable to vertebral arteries)	<ul style="list-style-type: none"> • Direction/description of flow in vertebral arteries • Description of flow or presence of stenosis in subclavian artery
Poor views/unable to visualise	<ul style="list-style-type: none"> • Reason for poor views/unable to visualise
Not assessed	<ul style="list-style-type: none"> • Reason for not assessing

- Any incidental findings should be documented, reported and acted upon appropriately, for example:
 - Fluid collection
 - Vascularised thyroid
 - Irregular/abnormal heart rate
- Any limitations or low confidence measurements should be clearly stated in the reported
- A summary of the right and left side should be included at the end of the report – see appendix 3 for the standard summary phrases.

Table 2 Carotid artery stenosis grading criteria [3]

Adapted from the 'Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom' (Oates C et al., 2009), all measurements and comparisons will use the **NASCET method**

SVT/VS Internal Carotid Artery Grading Recommendations			
Grading Criteria	ICA _{PSV}	ICA _{PSV} : CCA _{PSV}	ICA _{PSV} : CCA _{EDV}
<50% stenosis	< 124cm/s	< 2	< 8
50-69% stenosis	125 to 229cm/s	2-4	8-13
70-89% stenosis	230 to 399cm/s	> 4	14-29
>90% stenosis	> 400cm/s	> 5	> 30
Trickle flow	Threadlike flow visible, either >> 400cm/s or severely damped low velocity flow		
Occluded	No flow		

Urgent findings

For patients referred by the stroke team (TIA clinic or patient on the stroke ward) significant stenosis or other urgent findings will be reviewed by a stroke clinician.

For a patient from any other referral source (eg pre op cardiac surgery, GP referral, eye hospital or other inpatient ward) any significant stenosis or urgent findings should be followed up with a phone call or email to the referring clinician.

RELATED DOCUMENTS AND PAGES

Carotid Standard Operating Procedure
Vascular Science generic protocol

Table A

REFERENCES	<p>1) NICE Guideline NG128]. Stroke and transient ischaemic attack in over 16s: diagnosis and initial management (May 2019)</p> <p>2) NICE CKS: Stroke and TIA (March 2017)</p> <p>3) Oates CP et al., Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom, Eur J Vasc Endovasc Surg (2008)</p>
RELATED DOCUMENTS AND PAGES	<p>Carotid Standard Operating procedure</p> <p>Vascular Science generic protocol</p>
AUTHORISING BODY	Vascular Science Unit
SAFETY	Please refer to the Vascular Science Health and Safety policy
QUERIES AND CONTACT	<p>Vascular Science Unit A225 Bristol Royal Infirmary Upper Maudlin Street Bristol, BS2 8HW</p> <p>Tel: 0117 342 7530 Email: VSU@UH Bristol.nhs.uk or uhb-tr.vascular-science@nhs.net</p>

APPENDIX 1 – Report Template

<p>Phrase: UCARON (normal)</p>	<p>CAROTID DUPLEX: SYMPTOMS: RISK FACTORS:</p>
<p>Phrase: UCAROM (mild)</p>	<p>RIGHT SIDE Common carotid artery (RCCA) cm/s Carotid bifurcation (RBif) Internal carotid artery (RICA) (cm/s R1 and R2) External carotid artery (RECA) cm/s</p> <p>Vertebral artery (RVert) cm/s Subclavian artery (RSubc) cm/s Brachiocephalic artery (BCA)</p> <p>LEFT SIDE Common carotid artery (LCCA) cm/s Carotid bifurcation (LBif): Internal carotid artery (LICA): (cm/s R1 and R2) External carotid artery (LECA) cm/s</p> <p>Vertebral artery (LVert) cm/s Subclavian artery (LSub) cm/s</p> <p>SUMMARY RIGHT SIDE: SUMMARY LEFT SIDE:</p> <p>Scanned by:</p> <p>Maximum peak systolic velocity (PSV) and end diastolic velocity (EDV) measurements, along with ICAPsv/CCAPsv (R1) and ICAPsv/CCAedv (R2) ratio calculations, are obtained to categorise the % stenosis in accordance with SVT/VS grading recommendations and NASCET criteria.</p> <p>Any queries please contact Vascular Science on 0117 34 27530.</p>

APPENDIX 2 – Standard reporting phrases

<p><50% Phrase: UCAROP50</p>	<p>Mild/Moderate/severe small irregular calcified plaque at origin <50% (cm/s R1 <2 and R2<8) small irregular heterogeneous plaque at origin <50% (cm/s R1 <2 and R2<8) small smooth homogenous plaque at origin <50% (cm/s R1 <2 and R2<8)</p>
<p>50-69% Phrase: UCAROP69</p>	<p>Large irregular calcified plaque at origin 50-69% (cm/s R1 2-4 and R2 8-13). Distally free from atheroma. large irregular heterogeneous plaque at origin 50-69% (cm/s R1 2-4 and R2 8-13). Distally free from atheroma. large smooth homogenous plaque at origin 50-69% (cm/s R1 2-4 and R2 8-13). Distally free from atheroma.</p>
<p>70-89% Phrase: UCAROP89</p>	<p>large irregular calcified plaque at origin 70-89% (cm/s R1 >4 and R2 14-35). Distally free from atheroma. large irregular heterogeneous plaque at origin 70-89% (cm/s R1 >4 and R2 14-35). Distally free from atheroma. large smooth homogenous plaque at origin 70-89% (cm/s R1 >4 and R2 14-35). Distally free from atheroma.</p>
<p>>90% Phrase: UCAROP90</p>	<p>large irregular calcified plaque at origin >90% (cm/s R1 >5 and R2 >35). Distally free from atheroma. large irregular heterogeneous plaque at origin >90% (cm/s R1 >5 and R2 >35). Distally free from atheroma. large smooth homogenous plaque at origin >90% (cm/s R1 >5 and R2 >35). Distally free from atheroma.</p>
<p>Vertebral phrases Phrase: UCAROVF</p>	<p>Normal stenosis at origin PS cm/s antegrade flow however the Doppler signals displayed peak systolic pull-down indicating a subclavian stenosis antegrade flow rest but this changed to RETROGRADE FLOW on release of a hyperaemic occlusive arm cuff indicating a subclavian stenosis oscillatory flow at rest (with RETROGRADE FLOW during systole and antegrade flow during diastole) indicating a subclavian stenosis. permanent RETROGRADE FLOW in the vertebral artery indicating a subclavian occlusion or high grade subclavian stenosis occluded Not visualised</p>

APPENDIX 3 – Standard summary phrases

Summary Phrases
Normal extra cranial carotid arteries
Mild atheroma in the extra cranial carotid arteries
<50% stenosis of the internal carotid artery
50-69% STENOSIS IN THE INTERNAL CAROTID ARTERY. Normally positioned bifurcation
70-89% STENOSIS IN THE INTERNAL CAROTID ARTERY. Normally positioned bifurcation
>90% STENOSIS IN THE INTERNAL CAROTID ARTERY. Normally positioned bifurcation
OCCLUDED INTERNAL CAROTID ARTERY

