# Core Modality 1: Carotid Duplex Evidence

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# Protocol Document

#### Introduction and scope:

The presence and severity of disease of the extracranial arteries is assessed in order to plan therapy. Referral criteria are for patients with symptoms of cerebrovascular disease (stroke, transient ischaemic attacks or amaurosis fugax), carotid bruits, known risk of vascular disease, pre CABG or Tx workup.

#### Responsibilities:

Test staff: scientific or technical staff trained in vascular duplex scanning.

#### **Equipment:**

Duple

Duplex scanner with broadband linear array transducer.

#### Method:

Initial scanning is performed in a transverse plane in B-mode from the origin of the CCA (looking at the proximal subclavian where possible) to the bifurcation and distally, as far as the ICA and ECA can be followed. This is then repeated with colour flow imaging in transverse. Note any disease. In a longitudinal plane, flow waveforms of the CCA (mid-distal CCA), ECA and ICA (2-6cm beyond the bulb) are recorded and peak systolic and end diastolic velocities are measured in the CCA and ICA. Locate the vertebral artery and obtain a flow waveform. Note any abnormality in the direction or shape.

If disease is located, measure velocities pre stenosis and within stenosis. For lesions <50% B-mode with or without colour flow is used to measure the diameter reduction in the plane of greatest stenosis. When measuring velocities the Doppler angle should be 60 degrees or less and parallel with

the flow of blood. Identify plaque characteristics (smooth, irregular, homogeneous, heterogeneous, calcified). For lesions (>50%) in the ICA, use velocity measurements as a guide to the degree of stenosis where appropriate.

On patients with poor access, or who are moving excessively, it is acceptable to not record velocities if genuinely not possible, and describe any plaque on its colour and b-mode appearance.

When grading ICA stenosis use the Kings College Hospital velocity criteria, in table 1.. If suspicious that the velocity and ultrasound appearance of a stenosis do not match, also use the joint recommendation criteria, in table 2. If any of the ratios are used, the CCA measurements should be made within 2cm of the carotid bifurcation.

Table 1: Kings College Hospital Criteria

Diameter reduction % ECST	Peak systolic velocity (m/s)
>50%	>1.25 m/s
>60%	>1.8 m/s
>70%	>2.3 m/s
>80%	>3.0 m/s

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>60%	>1.8 m/s
>70%	>2.3 m/s
>80%	>3.0 m/s

>90%	>3.8 m/s

Table 2: Diameter reduction velocity criteria (Oates et al):

Percentage Stenosis	Internal carotid peak	Peak systolic velocity	St Mary's ratio
(NASCET)	systolic velocity cm/sec	ration ICApsv / CCApsv	ICArsy/CCArov
<50	<125*	<2ª	<8
50-59	>125ª	2-4°	8-10
60-69			11-13
70-79	>230°	>4ª	14-21
80-89			22-29
>90 but less than near occlusion	>400 <sup>b</sup>	>5 <sup>b</sup>	>30
Near occlusion	High, Low – string flow	Variable	Variable
Occlusion	No flow	Not applicable	Not applicable

- a Grant el al
- b Filis et al
- Nicolaides et al.

# Reporting:

The findings should be reported on the CRIS system. The findings should cover velocities, plaque stenosis percentage and image description.

Inform vascular surgeons of significant findings.

# Suggested images:

- Representative waveform and PSV and EDV measurements from CCA.
- Representative waveform and PSV and EDV measurements from ICA.
- Representative waveform from ECA.
- Representative waveforms from Vertebral artery.
- Images of other significant pathology reported on.

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# Inspection criteria:

Complete CRIS database patient tested/DNA/rebooked.

>90%	>3.8 m/s

# Table 2: Diameter reduction velocity criteria (Oates et al):

Percentage Stenosis	Internal carotid peak	Peak systolic velocity	St Mary's ratio <sup>c</sup>
(NASCET)	systolic velocity cm/sec	ration ICApsy / CCApsy	ICA <sub>PSV</sub> /CCA <sub>EDV</sub>
<50	<125*	<2*	<8
50-59	>125*	2-4°	8-10
60-69			11-13
70-79	>230°	>4*	14-21
80-89			22-29
>90 but less than near	>400b	>5 <sup>b</sup>	>30
occlusion			
Near occlusion	High, Low – string flow	Variable	Variable
Occlusion	No flow	Not applicable	Not applicable

a Grant el al

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- Representative waveform from ECA.
- Representative waveforms from Vertebral artery.
- Images of other significant pathology reported on.

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# Inspection criteria:

Complete CRIS database patient tested/DNA/rebooked.

#### References:

Bluth El et al.: Carotid duplex sonography; a multicenter recommendation for standardized imaging and Doppler criteria. Radoigraphics 6; 487-506 1988

Cole, S: Vascular Laboratory Practice: Part III. 1st edition. IPEM. York 2001.

Deane C: PgC Carotid vascular course notes. Kings College Hospital, 2001

Filis et al: Duplex ultrasound criteria for defining the severity of carotid stenosis. Ann Vasc Surg 2002; 16: 413-21

Grant et al: Carotid artery stenosis:grayscale and Doppler ultrasound diagnosis – society of radiologists in ultrasound consensus conference. Radiology 2003; 229:340-6

King=s College Hospital angiography and Duplex comparison studies.

Nicolaides et al: Angiographic and duplex grading of internal carotid stenosis: can we overcome confusion? J endovasc Surg 1996:3:15/-65

Oates et al: Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom. European Society for Vascular Surgery 2009; 37, 251-261

Zwiebel WJ: Introduction to Vascular Ultrasonography.

# Evidence – 25x Carotid Duplex Reports

Non								
				Waveform		Plaque Morphology		% Stenosi
CCA	PSV	0.70	m/s	NO	Normal	IR	Irregular plaque	10-19
	EDV	0.13	m/s					
Bulb						С	Calcified	30-39
ICA	PSV	1.03	m/s	NO	Normal	Н	Heterogeneous	20-29
	EDV	0.23	m/s					
ECA				I	Increased velocities	Н	Heterogeneous	>50
					A			
Vert		_		AN	Antegrade flow			
		-			Antegrade flow			
LEFT		_		Waveform		Plaque Morphology		
	PSV	_	m/s	Waveform		Plaque Morphology	Irregular plaque	
LEFT	PSV EDV			Waveform				
LEFT			m/s	Waveform				
LEFT CCA			m/s	<b>Waveform</b> NO	Normal	IR	Irregular plaque	10-19
LEFT CCA Bulb	EDV		m/s m/s	<b>Waveform</b> NO	Normal	IR C	Irregular plaque	10-19 30-39
LEFT CCA Bulb	EDV	1.07	m/s m/s	<b>Waveform</b> NO	Normal	IR C H	Irregular plaque	30-39 20-29

# Bilaterally:

Normal colour flow, waveforms and velocities in the CCA and ICA. Vertebral arteries are patent with antegrade flow.

Irregular heterogenous (predominately hyperechoic) plaque identified along both CCA's.

Moderate dense calcified plaque identified in the carotid bulbs; with mild-moderate plaque extending into the proximal ICA's. Raised velocities sampled at the right and left ECA origins, PSV 1.6 m/s and 2.4 m/s, respectively - suggestive of >50% stenoses.

Left CCA velocities not recorded due to technical error - however, flow observed was normal.

# Conclusion:

Mild-moderate plaque seen throughout

ECA origin >50% stenoses (L>R)

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.27	m/s	NO	Normal	-	]	0
	EDV	0.32	m/s					
Bulb						-		0
ICA	PSV	0.96	m/s	NO	Normal	-		0
	EDV	0.25	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
LEFT CCA	PSV	1.40	m/s		Normal	Plaque Morphology	]	% Stenosis
		1.40	m/s m/s		Normal	Plaque Morphology	1	
					Normal	Plaque Morphology	1	
CCA	EDV	0.34		NO	Normal Normal	Plaque Morphology	1	0
CCA Bulb	EDV	0.34	m/s	NO		Plaque Morphology	1	0
CCA Bulb	EDV PSV	0.34	m/s	NO		Plaque Morphology	1	0

Comments:

#### Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

No significant change to velocities or spectral waveforms identified in the proximal ICA or Vertebral arteries with head positioned to the left or right; not supportive of any underlying external vascular compression or eagle syndrome - if clinically indicated, alternative imaging is needed to rule out for certain.

#### Conclusion:



# Comments:

# **Bilaterally:**

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Only mild smooth heterogenous plague identified.

# Conclusion:

Carotid duplex	, _	

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.90	m/s	NO	Normal	-		0
	EDV	0.25	m/s					
Bulb						-		0
ICA	PSV	0.92	m/s	NO	Normal	-		0
	EDV	0.30	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.13	m/s	NO	Normal	-		0
	EDV	0.29	m/s					
Bulb						-	]	0
ICA	PSV	0.77	m/s	NO	Normal	-		0
	EDV	0.26	m/s					
ECA				NO	Normal			0
				140	Normal			0
Vert				AN	Antegrade flow			O

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# Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

# Conclusion:

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				Waveform		Plaque Morphology		% Stenosis
CA I	PSV	1.56	m/s	I	Increased velocities	-		-
1	EDV	0.36	m/s					
ılb						-		-
A I	PSV	1.32	m/s	I	Increased velocities	-		-
	EDV	0.49	m/s					
CA				NO	Normal	-		-
ert				AN	Antegrade flow			
FT				Waveform		Plaque Morphology		% Stenosis
	PSV	1.52	m/s		Increased velocities	Plaque Morphology	]	% Stenosis
CA I	PSV EDV		m/s m/s		Increased velocities	Plaque Morphology	]	% Stenosis
CA I					Increased velocities	Plaque Morphology	]	% Stenosis
CA I I Ilb		0.38		ı	Increased velocities	Plaque Morphology -	]	% Stenosis
CA F Ilb A F	EDV	0.38	m/s	ı		Plaque Morphology	]	% Stenosis
ilb CA I	edv PSV	0.38	m/s	ı		Plaque Morphology	]	% Stenosis

#### Comments:

# Right:

The ICA is tortuous with irregular diameters observed throughout (~4-6 mm), there are velocity increases in regions where the ICA is narrower (PSV ~1.7m/s).

There is no evidence of carotid dissection observed in the ICA.

The vertebral artery is patent with normal antegrade flow.

#### Left:

The ICA is tortuous with varying calibre. There is an irregular region at the mid ICA with raised velocities and localised dilatation measuring 6.5mm compared to 4.5 mm more proximally. There is no evidence of thrombus within the dilated region.

#### Conclusion:

No significant interval change compared with previous scan (14/09/22).

No evidence of haemodynamically significant plaque or thrombus.

Left side has raised velocities and a mild dilated segment at mid ICA.

Right side quite irregular appearance this might be suggestive of connective tissue disease, FMD? Ehlers-Danlos?

RIGHT				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.90	m/s	NO	Normal	MP	Minor plaque	10
	EDV	0.28	m/s					
Bulb						Н	Heterogeneous	10-19
ICA	PSV	0.77	m/s	NO	Normal	Н	Heterogeneous	10-19
	EDV	0.22	m/s					
ECA				NO	Normal	M	Minor plaque	10
Vert		_		AN	Antegrade flow			
Vert		_		AN	Antegrade flow			
LEFT		_		Waveform		Plaque Morphology		% Stenosis
	PSV	0.99	m/s		Antegrade flow	Plaque Morphology	Heterogeneous	<b>% Stenosis</b>
LEFT	PSV EDV		m/s	Waveform				
LEFT				Waveform				
LEFT CCA		0.31	m/s	Waveform		Н	Heterogeneous	10-19
LEFT CCA Bulb	EDV	0.31	m/s	<b>Waveform</b> NO	Normal	H MP	Heterogeneous Minor plaque	10-19
LEFT CCA Bulb	EDV	0.31	m/s	<b>Waveform</b> NO	Normal	H MP	Heterogeneous Minor plaque	10-19

#### Comments:

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# <u>Comments:</u>

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Only mild heterogenous plaque identified throughout the carotid arteries.

# Conclusion:

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Carotid duplex

				Waveform		Plaque Morphology	•	% Stenosis
CCA	PSV	1.34	m/s	NO	Normal	IT	Intimal thickening	<10
	EDV	0.30	m/s					
Bulb						-	]	0
ICA	PSV	0.95	m/s	NO	Normal	-		0
	EDV	0.23	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
		_						
LEFT				Waveform		Plaque Morphology		% Stenosis
LEFT CCA	PSV	1.47	m/s		Normal	Plaque Morphology	Intimal thickening	% Stenosis
		1.47	m/s m/s		Normal			
					Normal			
CCA	EDV	0.34		NO	Normal Normal		Intimal thickening	<10
CCA Bulb	EDV	0.34	m/s	NO			Intimal thickening	<10
CCA Bulb ICA	EDV	0.34	m/s	NO	Normal		Intimal thickening	<10
CCA Bulb	EDV	0.34	m/s	NO		- -	Intimal thickening	<10

Comments:

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### Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Intimal thickening identified along the CCA, bilaterally.

# CIMT:

Right - 1.0 mm Left - -1.2 mm



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#### Comments:

#### Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Mild/moderate heterogenous/calcified plaque detected throughout.

#### Conclusion:

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.99	m/s	NO	Normal	MP	Minor plaque	<10
	EDV	0.22	m/s					
Bulb						С	Calcified	10-19
ICA	PSV	0.45	m/s	NO	Normal	С	Calcified	10-19
	EDV	0.17	m/s					
ECA				NO	Normal	Н	Heterogeneous	30-39
				AN	Antegrade flow			
Vert				MIN	willedi ane ilom			
Vert				AIN	Antegrade now			
Vert				C) A	Antegrade now			
Vert LEFT				Waveform	Millegi aue now	Plaque Morphology		% Stenosis
	PSV	0.64	m/s	Waveform	Normal	Plaque Morphology	Minor plaque	% Stenosis
LEFT			m/s m/s	Waveform			Minor plaque	
LEFT				Waveform			Minor plaque Calcified	
LEFT CCA	EDV	0.18		<b>Waveform</b> NO		MP		<10
LEFT CCA Bulb	EDV PSV	0.18	m/s	<b>Waveform</b> NO	Normal	MP C	Calcified	<10
LEFT CCA Bulb	EDV PSV	0.18	m/s	<b>Waveform</b> NO	Normal	MP C	Calcified	<10

#### Comments:

# Right:

The carotid arteries are patent with normal velocities, waveforms and colourflow.

There is no evidence of haemodynamically significant carotid disease; just mild/moderate plaque.

The vertebral artery is patent with normal antegrade flow.

Of note, the origin of the CCA/brachiocephalic artery is tortuous.

#### Left:

The carotid arteries are patent with normal velocities, waveforms and colourflow.

There is no evidence of haemodynamically significant carotid disease; just mild/moderate plaque.

There is calcified plaque present in the origin of the ICA which is not haemodynamically significant, however it is difficult to estimate the plaque burden visually due to acoustic shadowing. The vertebral artery is patent with normal antegrade flow.

#### Conclusion:

There is no evidence of haemodynamically significant carotid disease; just mild/moderate plaque.

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				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.05	m/s	NO	Normal	MP	Minor plaque	10
	EDV	0.22	m/s					
Bulb						Н	Heterogeneous	10-19
ICA	PSV	0.76	m/s	NO	Normal	Н	Heterogeneous	10-19
	EDV	0.32	m/s					
ECA				NO	Normal	Н	Heterogeneous	10-19
				AN	Antegrade flow			
Vert				OIN	Tillogi duo Ilov			
		_			- Integrate not			N. Ohaanaia
Vert		_		Waveform	THROUGH THE THE	Plaque Morphology		% Stenosis
	PSV	1.23	m/s	Waveform	Normal	Plaque Morphology	Minor plaque	% Stenosis
LEFT	PSV EDV		m/s m/s	Waveform				
LEFT				Waveform				
LEFT CCA		0.24		<b>Waveform</b> NO		MP	Minor plaque	10
LEFT CCA Bulb	EDV	0.24	m/s	<b>Waveform</b> NO	Normal	MP	Minor plaque Heterogeneous	10-19
LEFT CCA Bulb	EDV	0.24	m/s	<b>Waveform</b> NO	Normal	MP	Minor plaque Heterogeneous Heterogeneous	10-19
LEFT CCA Bulb	EDV	0.24	m/s	Waveform NO	Normal Normal	MP H	Minor plaque Heterogeneous Heterogeneous	10-19

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#### Comments:

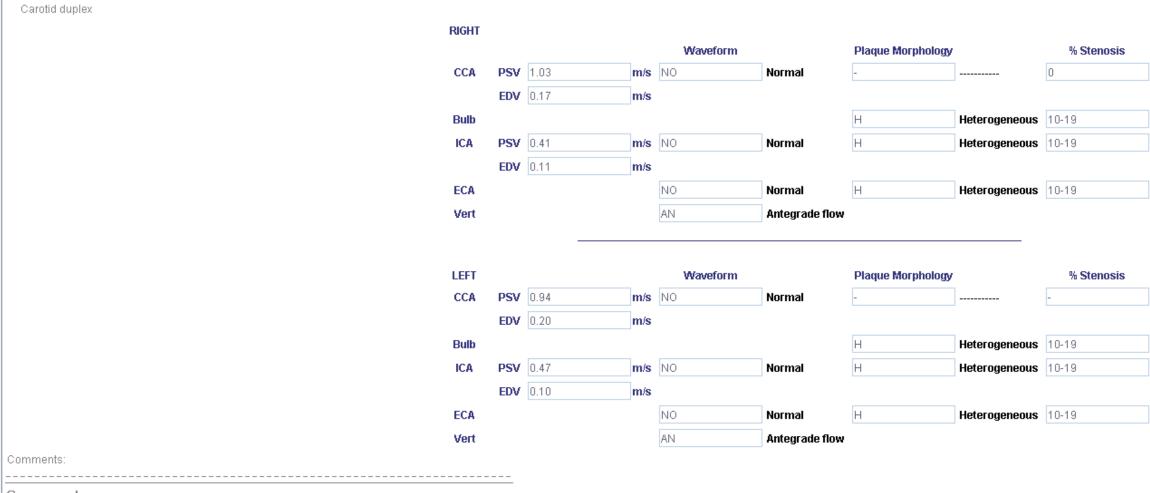
# Bilaterally:

Technically challenging scan - incomplete views of mid-distal ICA. Where seen:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Only mild heterogenous (predominately hyperechoic) plaque identified.

#### Conclusion:



# **Bilaterally:**

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Only mild heterogenous (predominately hyperechoic) plaque identified.

### Conclusion:

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RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.03	m/s	NO	Normal	-	]	0
	EDV	0.29	m/s					
Bulb						-		0
ICA	PSV	0.56	m/s	NO	Normal	-		0
	EDV	0.21	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			% Stanneis
LEFT				Waveform		Plaque Morphology		
	PSV	1.17	m/s	Waveform	Antegrade flow			% Stenosis
LEFT	PSV EDV		m/s m/s	Waveform				
LEFT				Waveform				
LEFT CCA		0.30		<b>Waveform</b> NO			]	0
LEFT CCA Bulb	EDV	0.30	m/s	<b>Waveform</b> NO	Normal		]	0
LEFT CCA Bulb	EDV	0.30	m/s	<b>Waveform</b> NO	Normal	Plaque Morphology -	]	0

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#### Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

#### Conclusion:

No evidence of haemodynamically significant stenosis.

Pt complains of periodic bouts of scalp tenderness, with additional visual disturbances, ?GCA - performed cursory investigation of superfical, parietal and frontal temporal arteries, bilaterally - all are vessels are patent and compressible, with no obvious evidence of halo sign detected. If detailed investigation still required, please make separate request.

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.97	m/s	NO	Normal	-		0
	EDV	0.19	m/s					
Bulb						-		0
ICA	PSV	0.74	m/s	NO	Normal	-		0
	EDV	0.16	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.04	m/s	NO	Normal			
					Normal	MP	Minor plaque	10
	EDV	0.23	m/s		Normal	MP	Minor plaque	10
Bulb	EDV	0.23	m/s		NUTHIA	MP H	Minor plaque Heterogeneous	
Bulb		0.23		NO	Normal			10-19
	PSV					Н	Heterogeneous	10-19
	PSV	0.83	m/s			Н	Heterogeneous	10-19
ICA	PSV	0.83	m/s		Normal	Н	Heterogeneous Heterogeneous	10-19

# <u>Comments:</u>

# Bilaterally:

Normal colour flow, waveforms and velocities sampled in the CCA and ICA. Vertebral arteries are patent with antegrade flow.

Mild heterogenous plaque sampled throughout left carotid arteries.

There is a moderate burden of homogenous hypoechoic plaque identified in the proximal ECA, causing raised velocities, PSV 2.8 m/s, suggestive of a >50% stenosis.

#### Conclusion:

Mild-moderate plaque identified in the left carotid arteries.

No evidence of haemodynamically significant stenosis in either CCA or ICA, bilaterally.

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.33	m/s	NO	Normal	Н	Heterogeneous	10-19
	EDV	0.08	m/s					
Bulb						С	Calcified	60-69
ICA	PSV	2.06	m/s	I	Increased velocities	С	Calcified	60-69
	EDV	0.57	m/s					
ECA				I	Increased velocities	С	Calcified	>50
Vert				AN	Antegrade flow			
LEFT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.47	m/s		Normal	Plaque Morphology	Heterogeneous	
		0.47	m/s		Normal			
CCA					Normal			
CCA		0.14		NO		С	Heterogeneous	10
CCA Bulb	EDV	0.14	m/s	NO		С	Heterogeneous Calcified	50-59
CCA Bulb	EDV	0.14	m/s	NO		H C C	Heterogeneous Calcified	50-59

#### Right:

Heavy burden of dense calcified disease identified at carotid bulb level (~1 cm in length), which extends into the proximal ICA and ECA; appears to be causing at least a 60-69% proximal ICA and >50% ECA stenosis. However, please note there is suboptimal views due to acoustic shadowing. Distal ICA waveforms and velocities appear relatively normal, albeit, patient appears to have ?arrhythmia, that also effects waveform morphology.

Vertebral artery is patent with antegrade flow.

#### Left:

Heavy burden of dense calcified disease identified at carotid bulb level (~2 cm in length), which extends into the proximal ICA and ECA; appears to be causing at least a 50-59% proximal ICA and >50% ECA stenosis. However, please note there is suboptimal views due to acoustic shadowing. Distal ICA waveforms and velocities appear relatively normal, albeit, patient appears to have ?arrhythmia, that also effects waveform morphology.

Vertebral artery is patent with antegrade flow.

#### Conclusion:

R 60-69% ICA stenosis L 50-59% ICA stenosis

R+L >50% ECA stenosis

Sent pt to head MRI and discussed result with vasc req.

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.76	m/s	NO	Normal	-	]	0
	EDV	0.18	m/s					
Bulb						Н	Heterogeneous	10-19
ICA	PSV	0.45	m/s	NO	Normal	-	]	0
	EDV	0.14	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
LEFT CCA	PSV	0.82	m/s		Normal	Plaque Morphology	]	% Stenosis
		0.82	m/s m/s		Normal	Plaque Morphology -	1	
					Normal	Plaque Morphology -	]	
CCA	EDV			NO	Normal Normal	-	]	0
CCA Bulb	EDV PSV	0.19	m/s	NO		-	]	10-19
CCA Bulb	EDV PSV	0.19	m/s	NO		-	]	10-19
CCA Bulb ICA	EDV PSV	0.19	m/s	NO	Normal	-	Heterogeneous	0 10-19 0

#### Comments:

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# Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Only mild heterogenous plaque identified at carotid bulb level.

# Conclusion:

	EDV	0.26	m/s					
Bulb						Н	Heterogeneous	10
ICA	PSV	0.90	m/s	NO	Normal	-		0
	EDV	0.40	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.01	m/s	NO	Normal	MP	Minor plaque	10
	EDV	0.30	m/s					
Bulb						Н	Heterogeneous	10
ICA	PSV	0.73	m/s	NO	Normal	-		0
		0.32	m/s					
ECA			m/s	NO	Normal	-		0

Normal

Plaque Morphology

% Stenosis

<10

Minor plaque

Waveform

m/s NO

#### Comments:

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# Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

RIGHT

CCA

PSV 0.88

Only minor heterogenous plaque identified.

# Conclusion:

Γ							
			Waveform		Plaque Morphology		% Stenosis
PSV	0.71	m/s	NO	Normal	Н	Heterogeneous	10-19
EDV	0.15	m/s					
					Н	Heterogeneous	20-29
PSV	0.62	m/s	NO	Normal	Н	Heterogeneous	20-29
EDV	0.04	m/s					
			NO	Normal	Н	Heterogeneous	10-19
			AN	Antegrade flow			
			AN Waveform	Antegrade flow	Plaque Morphology		% Stenosis
	0.60	m/s	Waveform	Antegrade flow	Plaque Morphology	Heterogeneous	% Stenosis
PSV	0.60	m/s	Waveform			1	
PSV EDV			Waveform			Heterogeneous	
PSV EDV			<b>Waveform</b> NO		Н	Heterogeneous	10-19
PSV EDV PSV	0.14	m/s	<b>Waveform</b> NO	Normal	Н	Heterogeneous Heterogeneous	10-19
PSV EDV PSV	2.06	m/s	<b>Waveform</b> NO	Normal	H H	Heterogeneous Heterogeneous	10-19 60-69 60-69

# Right:

The carotid arteries are patent with normal flow and velocities. No evidence of significant stenosis, but minor plaque present.

The vertebral arteries are patent with normal antegrade flow.

#### Left:

The carotid arteries are patent. A heavy burden of heterogenous (predominately hyperechoic) plaque identified at carotid bulb level; resulting in increased velocities in the bulb and proximal ICA/ECA suggestive of an upper limit 60-69% stenosis.

The vertebral arteries are patent with normal antegrade flow.

# **Conclusion:**

Left bulb/proximal ICA stenosis ~60-69%.

No significant interval change compared with previous scan (12/08/22).

CCA									
EDV   0.17   m/s   H   Heterogeneous   50-59     ICA   PSV   1.86   m/s   I   Increased velocities   H   Heterogeneous   60-69     EDV   0.81   m/s     Increased velocities   H   Heterogeneous   >50     Vert					Waveform		Plaque Morphology		% Stenosis
H	CCA	PSV	0.95	m/s	NO	Normal	Н	Heterogeneous	10-19
ICA PSV 1.86 m/s I Increased velocities H Heterogeneous 60-69  EDV 0.61 m/s  ECA I Increased velocities H Heterogeneous >50  Vert Vert Vaveform Plaque Morphology % Stenosis  CCA PSV 0.94 m/s NO Normal H Heterogeneous 20-29  EDV 0.26 m/s  Bulb H Heterogeneous 50-59  ICA PSV 1.29 m/s I Increased velocities H Heterogeneous 50-59  EDV 0.43 m/s  ECA Increased velocities H Heterogeneous >50-59  EDV 0.43 m/s		EDV	0.17	m/s					
ECA	Bulb						Н	Heterogeneous	50-59
Increased velocities	ICA	PSV	1.86	m/s	I	Increased velocities	Н	Heterogeneous	60-69
Increased velocities		EDV	0.61	m/s					
LEFT	ECA				I	Increased velocities	Н	Heterogeneous	>50
CCA         PSV         0.94         m/s         NO         Normal         H         Heterogeneous         20-29           EDV         0.26         m/s         H         Heterogeneous         50-59           Bulb         H         Heterogeneous         50-59           ICA         PSV         1.29         m/s         I         Increased velocities         H         Heterogeneous         50-59           ECA         I         Increased velocities         H         Heterogeneous         >50	Vert				I	Increased velocities			
CCA         PSV         0.94         m/s         NO         Normal         H         Heterogeneous         20-29           EDV         0.26         m/s         H         Heterogeneous         50-59           Bulb         H         Heterogeneous         50-59           ICA         PSV         1.29         m/s         I         Increased velocities         H         Heterogeneous         50-59           ECA         I         Increased velocities         H         Heterogeneous         >50									
CCA         PSV         0.94         m/s         NO         Normal         H         Heterogeneous         20-29           EDV         0.26         m/s         H         Heterogeneous         50-59           Bulb         H         Heterogeneous         50-59           ICA         PSV         1.29         m/s         I         Increased velocities         H         Heterogeneous         50-59           ECA         I         Increased velocities         H         Heterogeneous         >50									
EDV 0.26 m/s  Bulb									
Bulb  ICA PSV 1.29 m/s I Increased velocities H Heterogeneous 50-59  EDV 0.43 m/s  I Increased velocities H Heterogeneous >50  Heterogeneous >50  Heterogeneous >50  Heterogeneous >50	LEFT				Waveform		Plaque Morphology		% Stenosis
ICA PSV 1.29 m/s I Increased velocities H Heterogeneous 50-59  EDV 0.43 m/s  I Increased velocities H Heterogeneous >50		PSV	0.94	m/s		Normal		1	
EDV 0.43 m/s    I   Increased velocities   H   Heterogeneous   >50						Normal		1	
ECA Increased velocities H Heterogeneous >50	CCA					Normal	Н	Heterogeneous	20-29
	CCA Bulb	EDV	0.26	m/s	NO		Н	Heterogeneous Heterogeneous	20-29
Vert DF Damped flow	CCA Bulb	EDV	0.26	m/s	NO		Н	Heterogeneous Heterogeneous	20-29
	CCA Bulb ICA	EDV	0.26	m/s	NO	Increased velocities	Н	Heterogeneous Heterogeneous	20-29 50-59 50-59

Comments.

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# Comments:

# Right:

There remains significant stenoses at the ICA and ECA origins; raised velocities at ICA origin suggestive of worsening stenosis compared with previous scan (07/09/22), today velocities are more suggestive of a 60-69%. Raised velocities also sampled in the ECA origin (PSV 1.9 m/s), suggestive of >50% stenosis.

Increased velocities (PSV 4.8m/s) at the VertA origin indicative of tight stenosis (>75%). Also there are raised velocities at mid vertebral, suggestive of a further >50% stenosis. Distally the VertA is patent with dampened flow (PSV 0.4 m/s).

#### Left:

There remains an 50-59% stenosis in the ICA and >50% stenosis in the ECA.

Origin of the VertA appears occluded. Flow appears to recanalise at mid neck level with dampened waveforms.

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	1.08	m/s	NO	Normal	MP	Minor plaque	<10
	EDV	0.32	m/s					
Bulb						MP	Minor plaque	10-19
ICA	PSV	0.77	m/s	NO	Normal	-		0
	EDV	0.22	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
LEFT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.87	m/s		Normal	Plaque Morphology MP		
CCA		0.87	m/s m/s		Normal			
CCA Bulb					Normal		Minor plaque	<10
		0.25		NO	Normal Normal	MP	Minor plaque	<10
Bulb	EDV	0.25	m/s	NO		MP	Minor plaque	<10
Bulb	EDV	0.25	m/s	NO		MP	Minor plaque	<10
Bulb	EDV	0.25	m/s	NO	Normal	MP	Minor plaque	<10

#### Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Minor plaque identified along the CCA and at carotid bulb level.

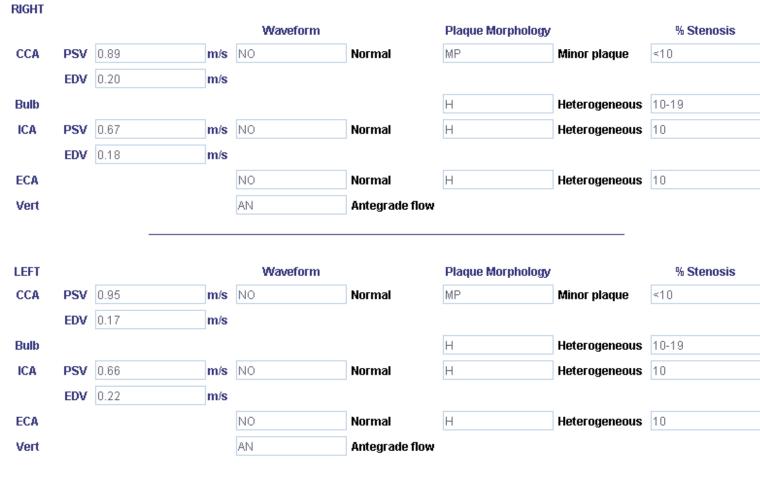
Both ICA's appear tortuous (R>L), however, no significant velocities increase identified.

#### Conclusion:

No evidence of haemodynamically significant stenosis.

# Spot check of Abdominal Aorta:

Generally poor views due to bowel gas. However, where seen, the distal abdominal aorta is patent and of normal calibre, maximal diameter measured 1.1 cm, AP.



Comments:

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# Comments:

# **Bilaterally:**

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Mild smooth heterogenous (predominately hyperechoic) plaque identified throughout the carotid arteries.

### Conclusion:

RIGHT								
				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.61	m/s	NO	Normal	-		0
	EDV	0.18	m/s					
Bulb						-		0
	PSV	0.79	m/s	NO	Normal	_		0
					]			-
	LDV	0.51		NO				0
ECA				NU	Normai	-		U
Vert				AN	Antegrade flow			
LEFT				Waveform		Plaque Morphology		% Stenosis
CCA	PSV	0.70	m/s	NO	Normal	-		0
	EDV	0.20	m/s					
						-		0
	DSV	0.71	mís	NO	Normal	_		
				NO	Horman			0
	EDA	0.30	m/s					
ECA				NO	Normal	-		0
Vert				AN	Antegrade flow			
	CCA  Bulb ICA  ECA Vert  LEFT CCA  Bulb ICA	CCA PSV EDV Bulb ICA PSV EDV ECA Vert  LEFT CCA PSV EDV Bulb ICA PSV EDV EDV	CCA PSV 0.61 EDV 0.18  Bulb ICA PSV 0.79 EDV 0.31  ECA Vert  LEFT CCA PSV 0.70 EDV 0.20  Bulb ICA PSV 0.71 EDV 0.30  ECA	CCA PSV 0.61 m/s EDV 0.18 m/s  Bulb ICA PSV 0.79 m/s EDV 0.31 m/s  ECA Vert  LEFT CCA PSV 0.70 m/s EDV 0.20 m/s  Bulb ICA PSV 0.71 m/s EDV 0.30 m/s  ECA	Waveform   CCA	Waveform   CCA   PSV   0.61   m/s   NO   Normal	Waveform   Plaque Morphology	Waveform   Plaque Morphology   CCA   PSV   0.61   m/s   NO   Normal   -

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# Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

# Conclusion:

-	 -	 	1-	

			Waveform		Plaque Morphology		% Stenosis	
PSV	1.08	m/s	NO	Normal	-	]	0	
EDV	0.32	m/s						
					-		0	
PSV	0.63	m/s	NO	Normal			0	
EDV	0.26	m/s						
			NO	Normal	-		0	
			AN	Antegrade flow				
			Old	Antegrate now				
			OLA	Antegrade now				
			Old	Antegrade now				
			Waveform	Aintegraue now	Plaque Morphology		% Stenosis	
PSV	0.76	m/s		Normal	Plaque Morphology	]	% Stenosis	
PSV EDV		m/s m/s	Waveform		Plaque Morphology	1		
			Waveform		Plaque Morphology -	1		
EDV	0.24		<b>Waveform</b> NO		Plaque Morphology -	1	0	
EDV	0.24	m/s	<b>Waveform</b> NO	Normal	Plaque Morphology -	1	0	
EDV	0.24	m/s	<b>Waveform</b> NO	Normal	Plaque Morphology	1	0	
	EDV	PSV   1.08   EDV   0.32   PSV   0.63   EDV   0.26	EDV 0.32 m/s  PSV 0.63 m/s	PSV 1.08 m/s NO  EDV 0.32 m/s  PSV 0.63 m/s NO  EDV 0.26 m/s	PSV 1.08	PSV 1.08 m/s NO Normal -  EDV 0.32 m/s  -  PSV 0.63 m/s NO Normal  EDV 0.26 m/s  NO Normal -	PSV 1.08 m/s NO Normal  EDV 0.32 m/s   PSV 0.63 m/s NO Normal  EDV 0.26 m/s  NO Normal	PSV 1.08

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#### Comments:

#### Bilaterally:

Technically challenging scan due to vessel tortuosity, high carotid bifurcation and thick neck/body habitus. Where seen:

Normal colour flow, waveforms and velocities in the carotid arteries - poor views of distal ICA's, however, normal waveforms and velocities sampled proximally, not suggestive of significant distal stenosis; however, can not rule out the possibility minor narrowing.

Vertebral arteries are patent with antegrade flow.

#### Conclusion:

Carotid duplex RIGHT Plaque Morphology Waveform % Stenosis CCA **PSV** 1.25 m/s NO Normal EDV 0.15 m/s Bulb Heterogeneous 10-19 m/s NO **PSV** 1.10 Normal Heterogeneous 10-19 ICA **EDV** 0.17 m/s Heterogeneous 10-19 **ECA** NO Normal AN Antegrade flow Vert LEFT Waveform Plaque Morphology % Stenosis **PSV** 1.71 m/s NO CCA Normal -----**EDV** 0.17 m/s Heterogeneous 10-19 Bulb **PSV** 0.87 m/s NO Heterogeneous 10-19 ICA Normal **EDV** 0.16 m/s Heterogeneous 10-19 **ECA** NO Normal

AN

Antegrade flow

Comments:

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# Comments:

# Bilaterally:

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Vert

Mild heterogenous plaque identified in the carotid bulbs; extending into the proximal ICA/ECA.

### Conclusion:

RIGHT								
				Waveform		Plaque Morphology		% Stenosi
CCA	PSV	0.88	m/s	NO	Normal	Н	Heterogeneous	20-29
	EDV	0.21	m/s					
Bulb						Н	Heterogeneous	20-29
ICA	PSV	0.51	m/s	NO	Normal	Н	Heterogeneous	20-29
	EDV	0.15	m/s					
ECA				NO	Normal	Н	Heterogeneous	<50
		_		AN AN	Normal  Antegrade flow		Heterogeneous	<50
ECA Vert		_						
Vert	PSV	0.71	m/s	AN Waveform		,		
Vert LEFT	PSV EDV		m/s m/s	AN Waveform	Antegrade flow	Plaque Morphology		% Stenosi
Vert LEFT				AN Waveform	Antegrade flow	Plaque Morphology		% Stenosi
Vert LEFT CCA		0.20		Waveform NO	Antegrade flow	Plaque Morphology H	Heterogeneous	% <b>Stenos</b> i 20-29
Vert  LEFT  CCA  Bulb	EDV	0.20	m/s	Waveform NO	Antegrade flow	Plaque Morphology H	Heterogeneous Heterogeneous	<b>% Stenos</b> i 20-29 20-29
Vert  LEFT  CCA  Bulb	EDV PSV	0.20	m/s	Waveform NO	Antegrade flow	Plaque Morphology H	Heterogeneous Heterogeneous	<b>% Stenosi</b> 20-29 20-29

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# <u>Comments:</u>

#### Bilaterally:

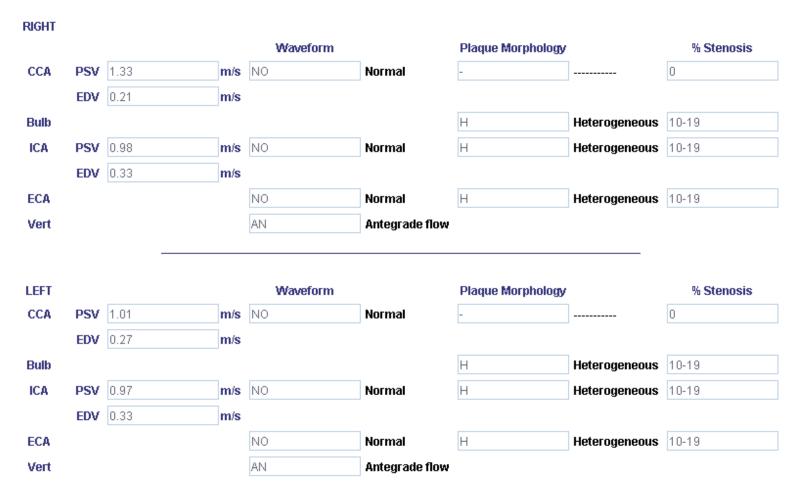
Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Mild-to-moderate smooth heterogenous (predominately hypoechoic) plaque identified throughout (20-29%).

Previous CT imaging (09/05/23) describes a 65% left carotid bulb/ICA stenosis; this was not seen in today scan - no raised velocities sampled and visually appears to be closer to a 20-29% narrowing.

### Conclusion:

Mild-to-moderate disease seen throughout the carotid arteries (~20-29%).



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# Comments:

# **Bilaterally:**

Normal colour flow, waveforms and velocities in the carotid arteries. Vertebral arteries are patent with antegrade flow.

Mild heterogenous (predominately hyperechoic) plaque identified in the carotid bulbs extending into the proximal ICA/ECA.

# Conclusion: