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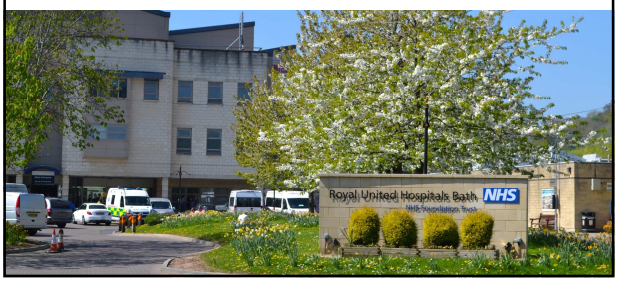
Introduction to Vascular Disease

Christopher Curd, Clinical Vascular Scientist



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Lecture Content

- Blood Vessels
- Haemodynamics
- Arterial disease
  - Carotid Disease
  - Peripheral Vascular Disease (PVD)
- Venous Disease
  - Deep Vein Thrombosis (DVT)
  - Venous incompetence/insufficiency

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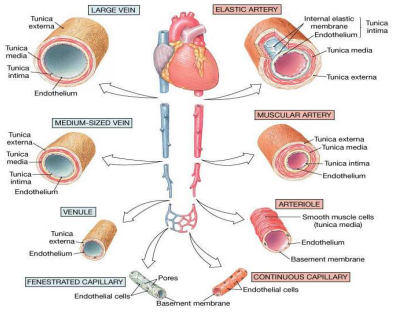
Blood Vessels



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Blood Vessel Walls

- Consists of 3 layers
  - Tunica intima (inner layer)
    - A layer of smooth endothelium one cell thick
    - Provides a waterproof lining
  - Tunica media (middle layer)
    - A combination of smooth muscle, elastic and white fibrous (connective) tissue
    - Relatively thick layer. Expansion and contraction helps maintain blood flow and pressure
  - Tunica externa/adventitia (outer layer)
    - Very strong, white fibrous tissue
    - Holds vessels in place
    - Contains the Vasa Vasorum.

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Veins vs Arteries

- Adventitia is considerably thinner and weaker in veins than arteries.
- Media in veins is also thinner and weaker, and contains far less elastic tissue
- Folds in the intima of veins for valves. No valves present in arteries.
- Arteries act a pressure reservoir, Veins act as fluid reservoir.

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Arterioles

- "Little artery" <0.5mm in diameter
- Transition of 3 to 2 layers – Media and intima. Eventually no adventitia.
- Arterioles play a key role in flow regulation
  - Capable of dramatic dilation (up 50%) and contraction.
  - Play major role in resistance to blood flow
  - Resistance to flow can be controlled
    - Adjusts arterial blood pressure
    - Variation in distribution of arterial blood flow (e.g. in sympathetic and parasympathetic responses)

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Venules

- "Little veins"
- More numerous and of a greater diameter than arterioles at the same level of the vascular network.
- Starts off with no smooth muscle but this becomes more evident as venules get bigger.
- Transition of 2 to 3 layers – Starts with Adventitia and intima. Eventually develops a media.

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Capillary Network

- Consist of two type of vessels:
  - Preferential channels (metarteriole).
  - Capillaries *(lat* "hairlike")
    - Layer of endothelium with a basement membrane
    - 0.01mm diameter
- Supply O^2 and nutrients
- Removes CO^2 and waste products

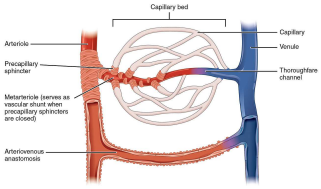

Image taken from - https://en.wikipedia.org/wiki/Metarteriole#/media/File:2105_Capillary_Bed.jpg

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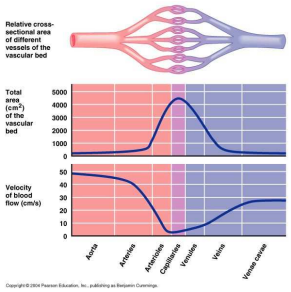
Cross sectional area vs velocity



- Arteries -> Capillaries
  - Individual x sectional area decreases
  - Overall x sectional area increases
  - Blood flow velocity decreases
- Capillaries -> Veins
  - Individual x sectional area increases
  - Overall x sectional area decreases
  - Blood flow velocity increases

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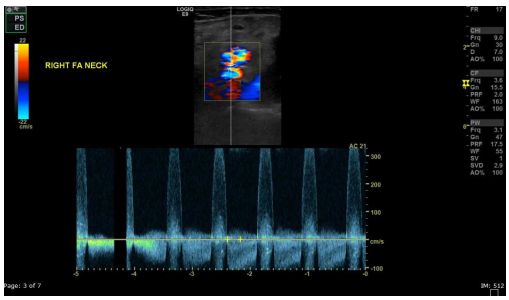
Haemodynamics



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Bernoulli Principle

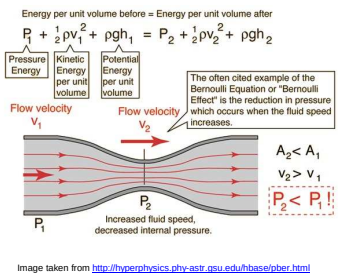

Image taken from http://hyperphysics.phy-astr.gsu.edu/hbase/pber.html

- $A_1V_1=A_2V_2$
- Works for a perfect system with no energy losses
- Pressure drop across stenosis may play a role in embolisation

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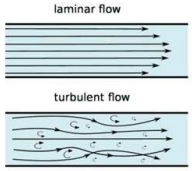
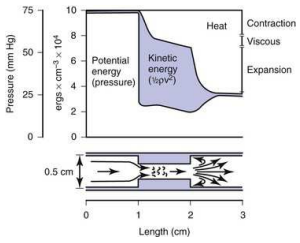
Turbulence and the Reynolds number





- Reynolds Number
- Re = Dρv/μ
- D diameter, ρ fluid density, μ viscosity, v velocity

Images taken from https://aviation.stackexchange.com/questions/52379/how-to-calculate-reynolds-number and https://clinicalgate.com/arterial-physiology/

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Poiseuille Principle

$$Q = \frac{\Delta P \pi r^4}{8 \mu L}$$

- Q, flow
- P, pressure
- R, radius
- μ, viscosity
- L, length

- Flow is proportion to 4th power of the radius.
- If radius is halved, flow is reduced to 1/16th of what it was.
- Really important in peripheral arterial disease.

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Duplex/Triplex Ultrasound

Grey Scale/B Mode | Colour Doppler/Flow | Spectral/Pulse Doppler

- Duplex = Two ultrasound modes operating at once
- Triplex = Three ultrasound modes operating at once

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Arterial Disease

- Arteriosclerosis – the arteries in the body become thickened and stiff, ultimately restricting blood flow.
  - Atherosclerosis is a specific type of arteriosclerosis, where fats, cholesterol and other substances build up in and on your artery walls (plaque), which can restrict blood flow
  - This can lead to stenosis/occlusion
  - Arterial calcification – common in diabetics
- Aneurysmal – most common in aorta, iliacs and popliteals
- Embolic – from an aneurysm or the heart
- Thrombotic – thrombus forms over a plaque (often post rupture), restricting blood flow. Acute on chronic disease.

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Arterial disease continued

- Vasculitis
  - Giant cell/temporal arteritis
  - Takayasu's arteritis
- Dissection
- Extrinsic compression
  - Thoracic outlet syndrome
  - Popliteal Entrapment
- Fibromuscular dysplasia

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Use of Ultrasound in Arterial Disease

- Identification of type, site, severity and extent of disease.
- Can measure
  - Peak Systolic Velocity (PSV)
  - Mean velocity – inc Time Averaged Mean Velocity (TAMV), used in determining volume flow.
  - Resistance and pulsatile indices
  - Turbulence/spectral broadening

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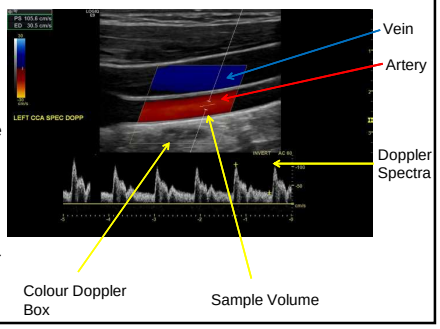
Measuring Velocities in Arteries

- Colour box placed over region of interest
- Sample volume placed in centre of artery/region of highest velocities
- PSV obtained by measuring peak of Doppler spectra



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Activity 1 – 5 minutes

- Match up the vascular disease facts and figures

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Cerebro-vascular disease

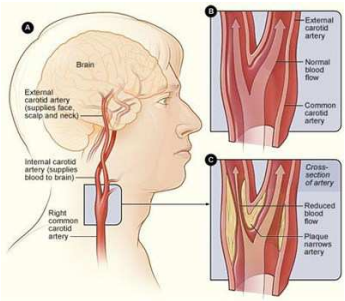

Image taken from https://mft.nhs.uk/rmi/services/vascular-surgery/vascular-laboratory/ultrasound/scan-of-the-carotid-arteries/

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Stroke and TIA

- A stroke is a serious life-threatening medical condition that occurs when the blood supply to part of the brain is cut off. This can cause permanent damage.
- A transient ischaemic attack (TIA) or "mini stroke" is caused by a temporary disruption in the blood supply to part of the brain. Resolves within 24 hours.

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Stats

- >100,000 stroke every year in the UK
- 1.2 million stroke survivors in the UK
- 4th biggest killer in the UK
- Almost 2/3rds of stroke survivors leave hospital with a disability.
- 1 in 12 people with a TIA will go on to have a stroke within a week.
- About 20/100 strokes are caused by carotid artery disease.

Taken from State of the Nation, Stroke Statistics, February 2018 and https://www.bhf.org.uk/informationsupport/heart-matters-magazine/medical/stroke-and-carotid-artery-disease

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Symptoms

- Hemiparesis – unilateral weakness
- Dysphasia – speech disturbance
- Dysarthria – slurred speech
- Amaurosis fugax ("Fleeting Dark") – temporally loss of vision in one eye.
- Homonymous Hemianopia – loss of one side of vision field in both eyes.
- Dizziness

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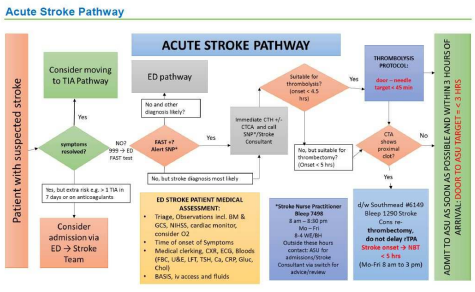
Acute Stroke Pathway - RUH



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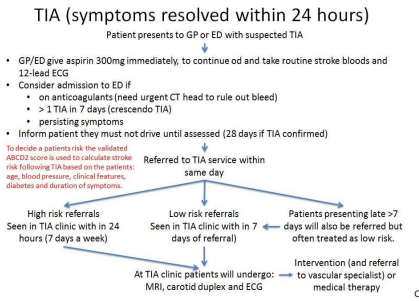
TIA Pathway - RUH



Courtesy of I. Softley, STP Trainee

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ABCD² Score

- A seven-point, risk-stratification tool to identify patients at high risk of stroke following a TIA.
- Validated for stroke risk 2, 7, 30 and 90 days post TIA
- "Validation and refinement of scores to predict very early stroke risk after transient ischaemic attack" Johnston et al 2007

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ABCD² Score Criteria

Symbol	Clinical feature	Criterion	Point
A	Age	>= 60	1
B	Blood pressure	>= 140/90 mmHg	1
C	Clinical features of the TIA	unilateral weakness	2
		speech disturbance without weakness	1
D1	Duration of symptoms	>= 60 min	2
		10-59 min	1
		<10 min	0
D2	Diabetes	known diabetes	1

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ABCD² Score and Stroke Risk

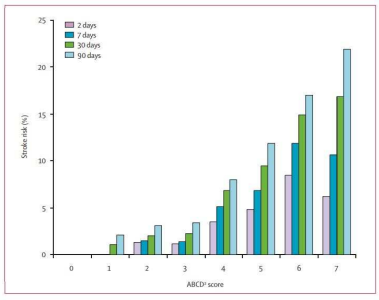

Figure: Short-term risk of stroke by ABCD² score in six groups combined (n=4799)

- Higher ABCD² score associated with greater risk of stroke.
- Patients with a score of 4 or more are considered high risk and should be seen in clinic within 24 hours of the onset of symptoms.

Taken from "Validation and refinement of scores to predict very early stroke risk after transient ischaemic attack" Johnston et al 2007

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Investigations

- Routine Blood Tests (FBC, electrolytes, LFTS, calcium, cholesterol, glucose).
- Electrocardiogram (ECG)
- Chest X-ray
- Brain imaging – MRI or CT
- Carotid imaging
- Transthoracic Echocardiography (TTE)
- Ambulatory cardiac recording – 24/48 hour tape
- Specialised blood tests – for younger patients
- Bubble Contrast Echocardiography

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Classifying Carotid Disease

- Quantitative
  - Percentage stenosis
  - Length of stenosis
- Qualitative
  - Plaque morphology
  - Description of waveforms

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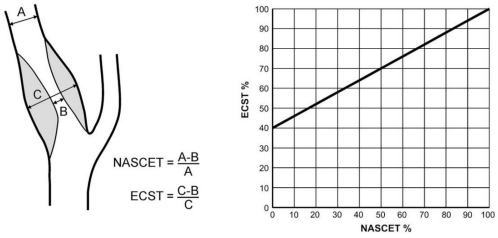
Grading Stenoses



Taken from Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom

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Grading Stenoses - Doppler

Table 1 Diagnostic criteria to be applied

Percentage stenosis (NASCET)	Internal carotid peak systolic velocity cm/sec	Peak systolic velocity ratio ICA_{PSV}/CCA_{PSV}	St Mary's ratio[c] ICA_{PSV}/CCA_{EDV}
<50	<125[a]	<2[a]	<8
50–59	>125[a]	2–4[a]	8–10
60–69			11–13
70–79	>230[a]	>4[a]	14–21
80–89			22–29
>90 but less than near occlusion	>400[b]	>5[b]	>30
Near occlusion	High, low – string flow	Variable	Variable
Occlusion	No flow	Not applicable	Not applicable

[a] NACC[17].
[b] Filis et al.[37].
[c] Nicolaides et al.[33].

Taken from Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom

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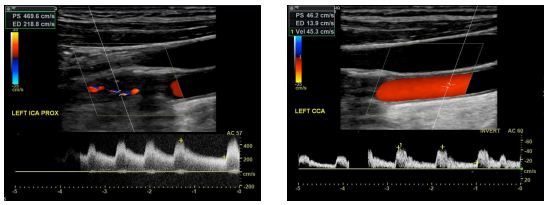
A Significant Carotid Artery Stenosis



CCA PSV = 45cm/s

ICA PSV = 470cm/s

ICA/CCA PSV ratio = 10.4 = >90% stenosis

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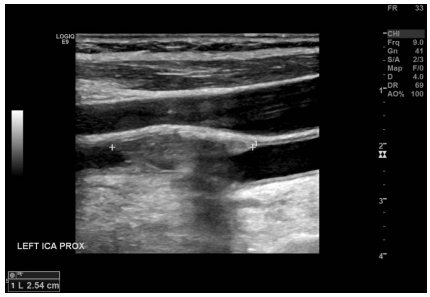
A Significant Carotid Artery Plaque



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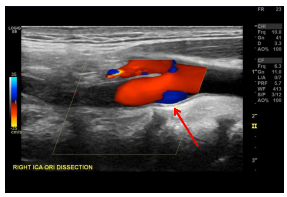
Carotid Artery Dissection

- Intima comes away from the other two layers of arterial wall



- Usually caused by trauma eg car crash, beauty parlour syndrome.

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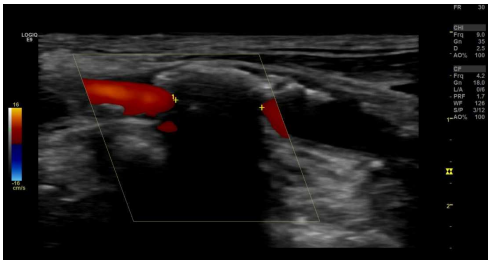
Acoustic Shadowing



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Outcomes from Carotid Duplex Scan

- <50% internal carotid artery stenosis
  - Best medial therapy
- >50% stenosis
  - Asymptomatic
    - Best medical therapy
  - Symptomatic
    - For vascular review as may be candidate for carotid endarterectomy

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From Carotid Duplex to Surgery

- Secondary Imaging
  - CT Angiogram aortic arch and carotid
  - Some centres have repeat duplex with another operator.
- Surgical Review
  - Review in vascular clinic to determine suitability for endarterectomy.
- CAR Score

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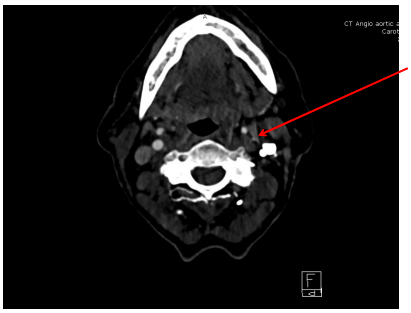
CT Angiogram of aortic arch and carotids



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The CAR Score

- Carotid Artery Risk Score
- Estimates the 5 year ipsilateral stroke rate in a recently symptomatic patient with a carotid stenosis of >50% treated with modern optimised medical treatment (OMT)
- Yet to be validated by ECST-2 (European Carotid Surgery Trial 2)

THE 2nd EUROPEAN
ECST-2
CAROTID SURGERY TRIAL

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Carotid Endarterectomy (CEA)

- Should be performed within two weeks of onset of symptoms for patients identified with a significant, symptomatic stenosis.
- Involves removal of atherosclerotic plaque from artery

Image taken from https://en.wikipedia.org/wiki/Atheroma

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The Procedure

- Can be under local or general anaesthetic
- Incision is made along the anterior border of the sternocleidomastoid muscle
- The common carotid and the internal carotid (above the disease) are clamped.
- Shunt can be used if necessary (to maintain blood flow to the brain).
- The artery is opened up longitudinally and the atherosclerotic plaque removed.
- The artery either has primary closure or closure with a patch (either vein or prosthetic)

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The Procedure

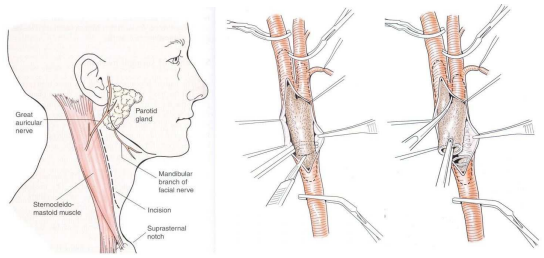

Image taken from Carotid Endarterectomy, Shikham and Scott

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Complications of CEA

- 2% risk of stroke
- 1% risk of death
- 1% risk of wound infection – treated with antibiotics
- 4% risk of nerve damage - can cause a hoarse voice and weakness or numbness on the side of your face
- 2-4% risk of restenosis – may require further surgery

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Carotid Artery Stenting

- Makes up <5% of carotid revascularisation procedures in England.
- Interventional radiology procedure – less invasive
- Catheter inserted into common femora artery and up into carotid artery under x-ray guidance.
- Angioplasty performed - balloon inflated in to open up the artery.
- Compressed stent inserted using a catheter and is then expanded to keep the artery open.

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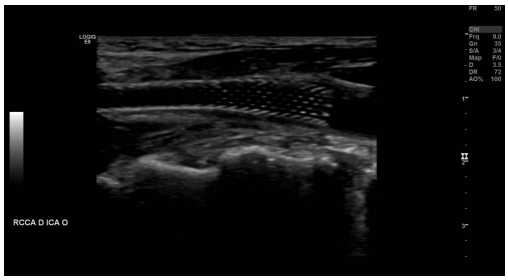
Carotid Artery Stent US



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Medical Management

- Antiplatelet – Loading dose of aspirin, then switched to clopidogrel long term.
- Dual antiplatelets - for up to 1 month in crescendo TIAs or TIA on monotherapy
- Statins – lower cholesterol.
- Blood Pressure lowering agents - Pre-existing agents (eg ACE Inhibitors) are continued unless hypotension is of concern. Aim for target BP of 130/80
- Anticoagulation (TIA with atrial fibrillation) – with Direct Oral Anticoagulant (DOAC)

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Life Style Changes

- Smoking Cessation
- Exercise
- Weight loss/control
- Diet
- Alcohol

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Break – 10 minutes

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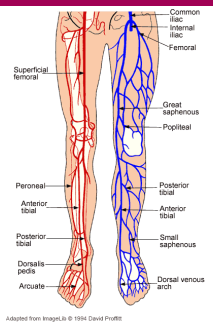
Lower Limb Vascular Anatomy



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Peripheral Vascular/Arterial Disease (PVD/PAD)

- Usually caused by atherosclerotic disease
- Chronic Limb Ischemia
  - Intermittent claudication
  - Critical Limb Ischemia
- Acute Limb Ischemia

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Stats

- Limited evidence on the prevalence of peripheral arterial disease in the general population.
- Effects about 20% of UK population aged 55-75.
- 5% have symptoms.

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Assessment in the Vascular Studies Unit

- Ankle-Brachial Pressure Index (ABPI)
  - With or without exercise
- Lower limb arterial duplex scan
- Toe Pressures/ Toe-Brachial Pressure Index (TBPI)
- Transcutaneous Oxygen Pressures - $tcpO_2$

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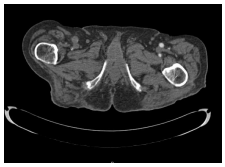
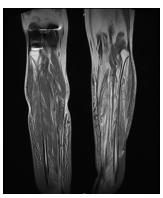
Other Imaging

- Magnetic Resonance Angiogram (MRA)
- Digital Subtraction Angiogram (DSA)
- Computerised Tomography Angiogram (CTA)





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Intermittent Claudication

- Pain/cramping in the limb brought on by exercise.
- Caused by lack of blood getting to the muscle
- Short and long distance.
- Goes away upon resting

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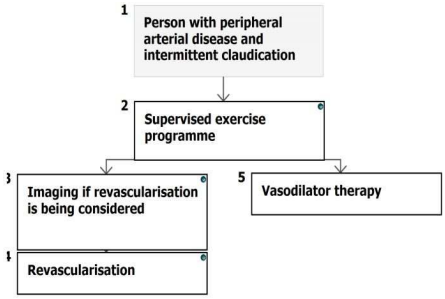
Claudication - The NICE Pathway



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Ankle Brachial Pressure Index (ABPI)

- Patient laid flat – removes effect of gravity
- Uses hand held Doppler machine and blood pressure cuff
- Take pressure in the ankles and compare with pressure in the arm (proxy for the heart).

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ABPI Interpretation

- Normal ratio is 1.0-1.4
- <1.0 indicates arterial disease
  - Due to pressure drop across disease
- >1.4 indicates arterial calcification

Resting ABPI	Severity of disease (suitability for compression treatment)
>1.4	Incompressible indicating calcified vessels
>1.0	Normal (apply compression)
1.0 – 0.81	Mild peripheral arterial disease (apply compression with caution/ reduced compression)
0.8 – 0.5	Intermittent claudicant indicating moderate/ severe arterial disease (compression contra-indicated)
<0.5	Severe disease (compression contra-indicated)

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Contra-indications

- DVT confirmed in the last 6 months
- Superficial thrombophlebitis.
- Graft extending into lower calf
- Severe pain in the lower limb

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Exercise Testing

- For patients with claudication
- Most useful for patient with normal or borderline ABPI result at rest.
- Ankle pressures can drop after exercise.
- Quantify how far patient can walk.
- Different protocols exist
  - RUH – patient selects pace that brings on symptoms and walks till they have to stop (or 10 minutes elapse).
  - Other centres have a set pace and time.

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Exercise Programme

- Recommended by NICE
- Two hours of supervised exercise a week for a 3-month period.
- Encouraging people to exercise to the point of maximal pain
- RUH doesn't currently have one but is in the process of setting one up.

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Lower Limb Arterial Duplex

- Often arterial tree is scanned from aorta to ankle
- Can assess for:
  - Stenoses
  - Occlusions
  - Aneurysms
- Can also assess arterial stents and bypasses

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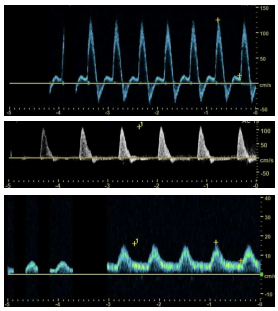
Waveform Analysis



- Triphasic waveforms are typical of healthy arteries in the peripheral circulation (i.e. arms and legs).
  - Very different to waveform in a healthy internal carotid artery.
- As degree of disease increases transition from biphasic and then monophasic waveforms.
- Also spectral broadening – indicative of turbulent flows.

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Critical Limb Ischemia

- Rest pain (can be worse at night)
- Dependent rubor (red or purple colour of the leg when not elevated), early pallor on elevation of the extremity, and reduced capillary refill
- Skin changes, including impaired wound healing, ischaemic ulcers, and gangrene.
- Absent foot pulses

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Arterial Ulcer

- Punched out and deep
- Irregular shape
- Unhealthy wound bed
- Presence of necrotic tissue
- Minimal exudate unless infected

Images taken from https://www.vascularsociety.org.uk/patients/conditions/12/arterial_ulcer and Evaluation and Management of Lower-Extremity Ulcers, Singer et al 2017

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Acute Limb Ischemia

- Sudden onset of symptoms
- 6 Ps – Pain, Pulseless, Pallor, Paralysis, Paraesthesia, Perishing cold.
- Can be embolic or thrombotic

Image taken from http://dailymedfact.com/acute-limb-ischaemia/

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Embolic Acute Limb Ischemia

- Due to an embolus, often from the heart in AF patients.
- Can be caused by sudden occlusion of bypass graft
- Acute onset (seconds to minutes)
- Severe (no time for collaterals to develop)
- Often no history of claudication
- Pulses in other leg usually present.

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Thrombotic Acute Limb Ischemia

- Due to thrombosis secondary to atherosclerosis
- Acute on chronic.
- Insidious onset (hours to days)
- Less severe
- Often a history of claudication
- Pulses in other leg may also be absent.

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To Treat or Not to Treat

- All surgical and interventional radiology procedures have their risks.
- Could make things worse rather than better!
- About a 5% risk of major complication – including heart attack, stroke, kidney failure, chest problems, loss of circulation in the legs or bowel, or infection.

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Life Style Changes/Medication

- Smoking cessation
- Diet, weight loss and exercise
- Lipid modification/statins
- Prevention/management of diabetes
- Blood pressure management/anti-hypertensives
- Antiplatelet therapy

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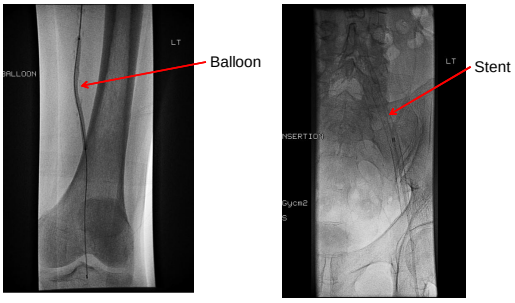
Angioplasty/Stenting



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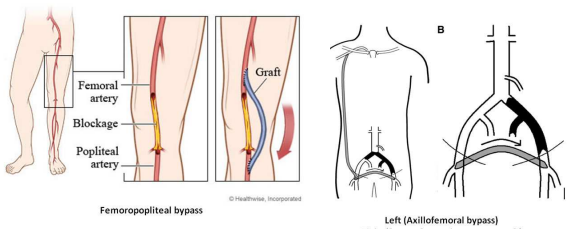
Bypass Grafts



Femoropopliteal bypass

Left (Axillofemoral bypass)
Right (femorofemoral crossover graft)

Taken from https://www.nqvascular.com.au/bypass-surgery/

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Bypass Grafts

- Supra-inguinal – prosthetic (Dacron or PTFE)
  - Aorto-bifemoral
  - Fem-fem cross over
  - Axillo-femoral or axillo-bifemoral
  - Ilio-femoral
- Infra-inguinal – vein or prosthetic
  - Fem-pop
  - Fem-distal (as far down as DPA)
  - Pop-distal

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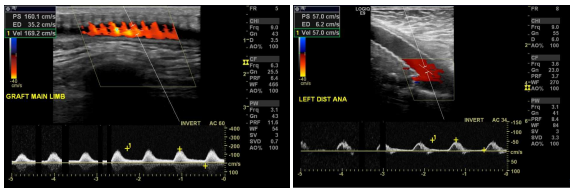
Grafts on Ultrasound - Dacron



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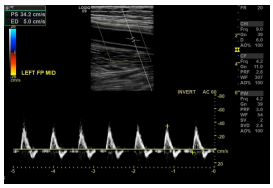
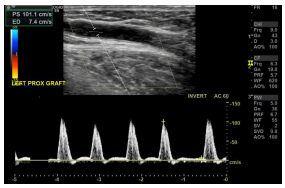
Grafts on Ultrasound – PTFE and Vein



Polytetrafluoroethylene - PTFE



Vein

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Upper Limb Arterial Disease

- Relatively uncommon presentation compared to lower limb arterial disease.
- Thoracic outlet syndrome
- Embolic event

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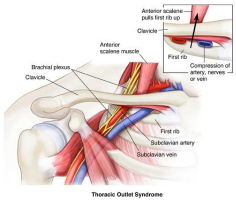
Thoracic Outlet



Thoracic Outlet Syndrome

- Space between clavicle and first rib.
- Subclavian artery and vein and brachial plexus nerve pass through this opening.

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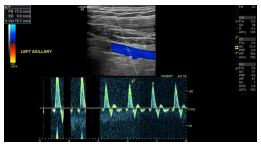
Thoracic Outlet Syndrome (TOS)



- Can be caused by compression of the nerve, vein or artery:
  - >90% Neurological
  - 3-5% Venous
  - 1% Arterial
- Venous TOS can cause thrombosis eg Paget-Schroetter disease
- In arterial TOS significant reduction/complete cessation of flow can be seen with certain arm movements. Also stenosis or aneurysm
- Can also occur in asymptomatic patients

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Surgery for arterial TOS

- Removal of 1st rib or anomalous rib (e.g. cervical rib).
- Scalenectomy
- Subclavian artery repair – if aneurysm, embolising lesion or thrombotic occlusion.

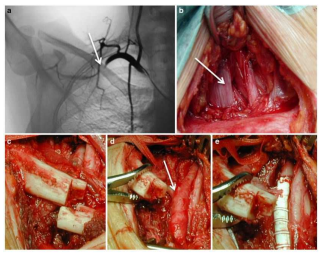

Image taken from Surgical treatment of thoracic outlet syndrome in young adults: Single centre experience with minimum three-year follow-up, Ciampi et al 2011

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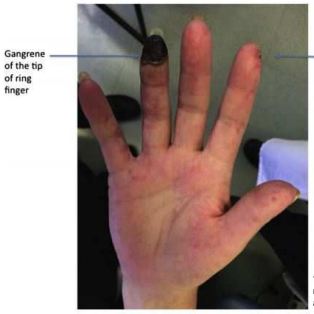
Embolic Event



Taken from Digital Gangrene Following Transradial Coronary Angiogram, Singh et al 2016

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Activity 2 – 10 minutes

- Come up with a possible pathway for someone with lower limb arterial disease.
- Think about:
  - Clinical presentation
  - Investigations
  - Treatment

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Venous Disease

- Deep Vein Thrombosis (DVT)
- Venous incompetence

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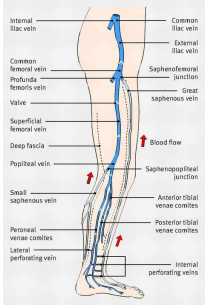
Deep and Superficial Venous Systems



- Superficial system is close to the surface of the body. Deep system is deeper.
- Deep veins are paired with arteries. Superficial veins aren't.
- Superficial venous system drains into deep venous system

Image taken from BMJ "The management of superficial venous incompetence"

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Deep Vein Thrombosis (DVT)

- Clot in the deep veins of the body – often in the lower limbs but can also be seen the upper limbs (e.g. PICC line associated thrombus.
- DVT can lead to a Pulmonary Embolism (PE) – The clot migrates from the lower limb and ends up in the lung. Usually proceeded by propagation.
- PE can be fatal

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Stats

- DVT has an annual incidence of about 1 in 1,000 people
- DVT can be found in 70-80% of people with PE
- It is estimated that around 25,000 people who are admitted to hospital die from preventable blood clots each year.
  - Accounts for 10% of all patients who die in hospital

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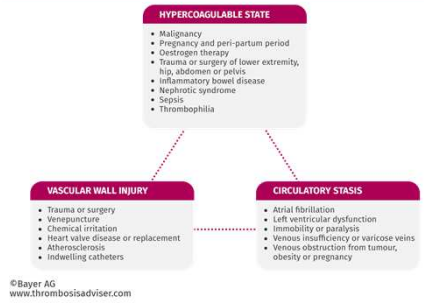
Virchow's Triad



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PE - CTPA

Negative scan

Positive scan

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Other Risk Factors

- Previous DVT
- Age - >60 years old
- Family History
- Dehydration

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Signs and Symptoms

- Limb pain and tenderness along the deep venous distribution.
- Swelling of the calf or thigh (usually unilateral).
- Pitting oedema.
- Distension of superficial veins.
- Increase in skin temperature.
- Skin discoloration (erythema or occasionally purple or cyanosed).

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Wells' Score

Modified Wells' score (for use in outpatients, to assess pre-test probability):

Clinical feature	*Score*
Active cancer (treatment ongoing or within previous 6 months or palliative)	1
Paralysis, paresis, or recent plaster immobilization of the lower extremities	1
Recently bedridden for more than 3 days, or major surgery within 12 weeks	1
Localised tenderness along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling > 3 cm compared with asymptomatic leg (10 cm below tibial tuberosity)	1
Pitting oedema confined to the symptomatic leg	1
Collateral superficial veins (non-varicose)	1
Previous documented DVT	1
Alternative diagnosis at least as likely as DVT	- 2

Total < 2 = unlikely; do a D-dimer, only refer for scan if D-dimer > 500 ng/ml
≥ 2 = likely; refer for scan

Clinical score 'unlikely' and normal D-dimer means < 1% risk of DVT; no need for a scan.

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D-dimer

- A molecule produced a by the degradation of fibrin.
- A small protein fragment present in the blood after a blood clot is degraded by fibrinolysis.
- Positive test - >500 µg/L
- D-dimer level may be raised by a number of illnesses - trauma, cancer, sepsis and inflammatory disorders.
- Also raised in pregnancy and old age.

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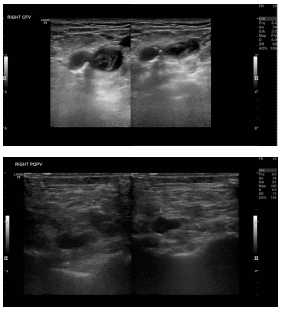
Ultrasound Assessment for DVT



- Assess common femoral vein using colour and spectral Doppler to look for good colour filling and phasic flow – rules out occlusive iliac thrombus.
- Perform compression ultrasound in femoral, popliteal and calf veins. No/partial collapse of vein indicates thrombus.
- If lack of phasic flow or occlusive thrombus in the CFV assess iliac vein and inferior vena-cava for phasic flow and good colour filling.

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Anticoagulation - Heparin

- Anticoagulation prevents clots getting bigger and helps the body to break them down.
- Patient started on heparin prior to scan – stop clot extension.
- Low Molecular Weight Heparin (LMWH) has gradually replaced Unfractionated Heparin.
- Heparin is fast acting (within minutes).
- Heparin activates antithrombin, which accelerates the inactivation of coagulation factors IIa (thrombin), IXa, Xa, XIa and XIIa.

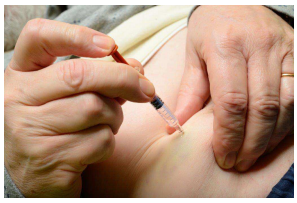

Image taken from https://www.stoptheclot.org/about-clots/blood-clot-treatment/low-molecular-weight-heparin/

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Anticoagulation - Warfarin

- If scan is positive patient is commenced on warfarin.
- Warfarin inhibits the availability Vitamin K, which is required to activate synthesis of coagulation factors II, VII, IX, and X as well as regulatory factors protein C and protein S
- Warfarin and Heparin taken in conjunction until International Normalisation Ration (INR) is stable and in range. Usually 2.0-3.0. Heparin then stopped.

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Direct Acting Oral Anticoagulants (DOACs)

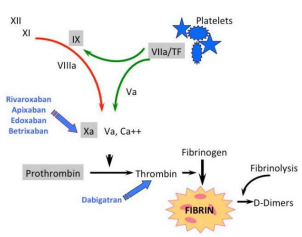

Image taken from New Direct Oral Anticoagulants (DOAC) and Their Use Today, Schwarb and Tsakiris 2016

- Also know as non-vitamin K antagonist oral anticoagulants (NOACs).
- Rivaroxaban and the other 'xaban's work by inhibiting factor Xa.
- Dabigatran works by inhibiting factor IIa (thrombin)

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Advantages of DOACs

- No need to routine monitoring
- Works quicker than warfarin. Warfarin can take 5-7 days to be fully active, hence the initial treatment with heparin.
- Treatment doesn't change in light of a positive scan – just keep taking it.
- Oral – No need for injections
- Absence of interactions with food. Many foods, especially green vegetables, have vitamin K in them, a warfarin antidote.

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Disadvantages of DOACs

- No antidote to reverse anticoagulation at the moment. Effects of warfarin can be reversed by vitamin K.
- Difficult to monitor compliance. Compliance with warfarin can be measured by INR

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Post Thrombotic Syndrome (PTS)

- Chronic condition that occurs as a result of DVT.
- >1/3rd of patients with DVT develop PTS.
- Symptoms include: redness, swelling, ulcers, and chronic leg pain
- DVT causes damage to the veins, due to obstruction of the vein increasing pressure on the vein walls which in turn damage the one way venous valves.

Image taken from Five things to know about …Postthrombotic syndrome, Kayssi and Roche-Nagle 2014

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Venous Insufficiency

- Occurs when the one way valves in the veins aren't working properly, meaning blood doesn't return properly to the heart.
- Instead it pools in the limb, causing venous stasis.
- Symptoms include
  - Varicose veins.
  - Skin changes
  - Limb Swelling
  - Venous ulceration.

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Stats

- Varicose veins effect:
  - 20-25% of adult females
  - 10-15% of adult males
- Estimated the 3-6% of people with varicose veins will develop venous ulcers.
- 2009-10 - 35,659 varicose veins procedures carried out in the NHS.
- Rate of recurrence after surgery is likely to be 10-30%

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Venous Valves

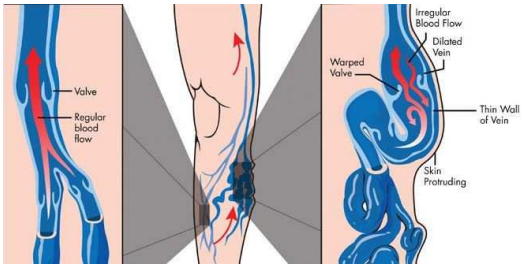

Image taken from https://www.lifeextension.com/Magazine/2013/8/The-Importance-of-Maintaining-Optimal-Vein-Health/Page-01

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Varicose Veins

- Primary
- Secondary (to something else such as DVT/PTS).
- Recurrent

Image taken from https://www.surgery.wisc.edu/2018/02/06/updates-in-varicose-vein-treatment/

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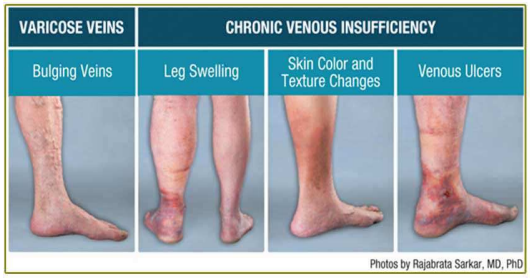
Chronic Venous Insufficiency (CVI)



Taken from https://www.centerforvein.com/10-myths-about-venous-insufficiency/

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Comprehensive Classification System for Chronic Venous Disorders (CEAP)

- C0 No visible or palpable signs of venous disease
- C1 Telangiectasies or reticular veins
- C2 Varicose veins
- C3 Edema
- C4a Pigmentation or eczema
- C4b Lipodermatosclerosis or athrophie blanche
- C5 Healed venous ulcer
- C6 Active venous ulcer

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Venous Ulceration

Image taken from Pathogenesis of venous ulcer, Comerota and Lurie 2015.

- Most common type of leg ulcer, accounting for >90% of all cases.
- Moderate pain, improved on elevation
- Irregular, sloping edges
- Associated oedema,
- 'Atrophie blanche', localised loss of skin pigmentation
- Lipodermatosclerosis a hardening of the skin
- Associated superficial varicose veins or "ankle flare", a collection of small, dark, engorged superficial veins

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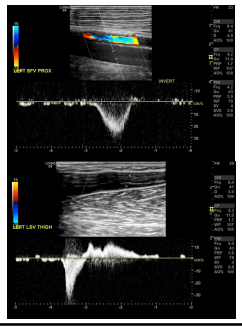
Ultrasound Assessment of CVI



- Patient is stood up.
- A calf squeeze or Valsalva manoeuvre is performed
- Blood is forced in the correct direction, up towards the heart (flow below the base line).
- Flow above the line is back towards the foot i.e. the wrong direction.
- Measure time that flow is above the line:
  - 0-0.5 seconds – Normal
  - 0.5-1 seconds – Mild
  - 1-2 seconds – Significant
  - >2 seconds - Gross

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Interventions

- Surgery – Striping and high tie
- Endovenous treatment
  - Radio frequency ablation
  - Laser treatment
- Foam Sclerotherapy
- Avulsions
- Compression bandaging.



Images taken from http://www.smith-nephew.com/south-africa/products/wound_management/product-search/profore/profore---detailed-product-information/, https://www.veindirectory.org/content/endovenous-ablation/radiofrequency-occlusion, and https://vascularconsultancy.com/treatments/varicose-vein-avulsions/

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Ulcers – Mixed Aetiology

Caused by a combination of chronic venous insufficiency and peripheral arterial disease.

Images taken from Management of mixed arterial and venous lower leg ulcers, Perrin et al 2013.

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Psychosocial aspects of vascular disease

Psychosocial - having to do with the mental, emotional, social, and spiritual effects of a disease.

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Psychosocial aspects cont.

- Mental/Emotional:
  - Panic attacks - "Will I have another TIA?"
  - Fear - "Will I lose my leg?"
  - Shock - "I actually had a stroke? But I'm always so healthy"
  - Guilt - "I should have reported my symptoms earlier", "If only I hadn't smoked"
  - Frustration - "Why won't my body do what I want it to?", "I can't walk as far as I did"
  - Depression - "What's the point?, I'm stuck like this forever"

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Psychosocial aspects cont.

- Social:
  - Isolation - Limited mobility, "my ulcers smell"
  - Feeling abnormal – "I can't wear skirts in public with these legs"
  - Burden to family
  - Role and employment in life - Limited by claudication, leg swelling
- Spiritual:
  - Question faith – "Why me God?"

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Other Vascular Ultrasound Scans

- Transcranial Doppler
- Renal Access Ultrasound
- Temporal Arteritis
- Mesenteric Arteries
- Renal Doppler
- Endovascular Aneurysm Repair Surveillance
- False aneurysms

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Further reading

- ABC of Arterial and Venous Disease. Eds Connelly and London.
- Vascular Ultrasound: How, Why and When. Thrush and Hartshorne.
- NICE website
- Circulation Foundation website
- Stroke Association website