# An Introduction to Doppler

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# The doppler effect

- The Doppler Principle was described by Physicist and mathematician Christian Doppler in 1842 to explain the movement of stars and the wave forms they created.

# Doppler principle…

- The Doppler principle is the change in frequency of sound waves reflected off a moving object (Blood moving through an artery)

- As an object (blood) approaches the observer (arterial wall) the frequency of the sound waves increases, and as it moves away from the source the frequency decreases.

As a motorcycle speeds forward, the frequency (and pitch) of the sound waves in front of the motorcycle become higher, and the frequency (and pitch) of the sound waves behind it become lower.

Precision Graphics

# Doppler ultrasound

- Doppler ultrasound can be used to determine the velocity (the speed in a given direction) of blood.
- The output from a Doppler ultrasound is usually presented as an audible signal, so that a sound is heard whenever there is movement of blood in the vessel being examined or seen as a waveform on a chart recorder.
- Doppler probes of varying frequencies can be used to obtain signals from vessels at different depths.
- The lower the frequency of probe the deeper the penetration of the signal.
- Generally probes of 5MHz and 8MHz are used for vascular assessment, the 5MHz giving deeper penetration.

# Probe sizes

- 5MHz – Used for oedematous limbs and deep lying vessels
- 8MHz – Easier detection of peripheral vessels and calcified arteries.

# Why do Doppler assessment ?

- To establish if arterial disease is present.
- To gain some indication of its severity.
- To assess suitability for high compression.
- To gain information on healing potential.
- To monitor the arterial status over time.
- Doppler may also be used to evaluate venous disease.
- Palpation of pulses is not sufficient and 10% of the population have an absent dorsalis pedis
- Best practice: It is supported by National guidelines and written in to local policy

# So what are we measuring?

**ABPI = Ankle Brachial Pressure Index**

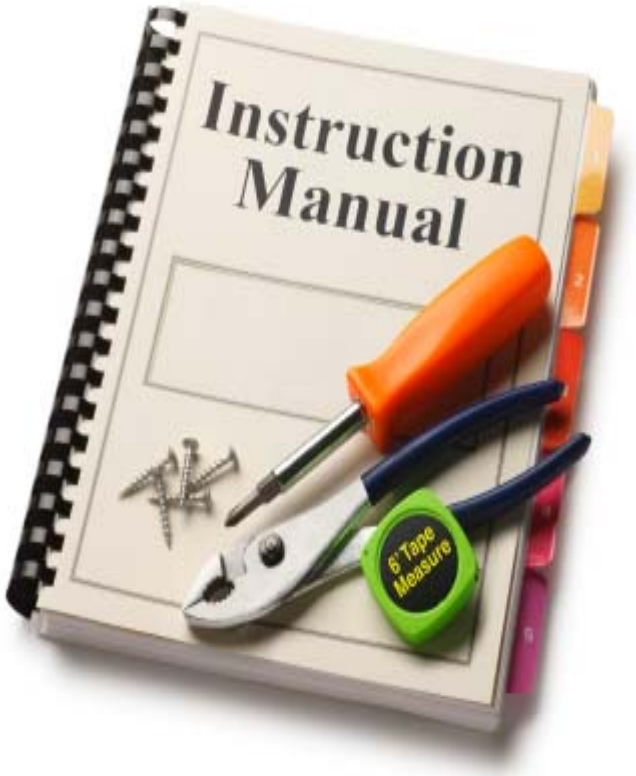
- Ratio of the ankle to the brachial systolic pressure.
- ABPI= $\frac{\text{Ankle systolic pressure}}{\text{Highest brachial systolic pressure}}$

# Ankle brachial pressure index

- Under normal conditions, systolic blood pressure in the legs is equal to or slightly greater than the systolic pressure in the upper limbs. In the presence of an arterial stenosis, a reduction in pressure occurs distal to the lesion. The ankle brachial pressure index, which is calculated from the ratio of ankle to brachial systolic pressure, is a sensitive marker of arterial insufficiency.

# The procedure..

Talk me through it….



# Procedure for carrying out An ABPI using Doppler ultrasound.

| Procedure | Rationale |
| --- | --- |
| 1. Ensure equipment is in good working order | Low battery power can result in unnecessary concern when pedal pulses cannot be heard. Sphyg' maintenance should be carried out annually and zero calibrated. |
| 2. Lie the patient as flat as possible for 15 – 20 mins and explain procedures carefully. | Ensures systolic BP is not artificially elevated due to stress or exercise. If unable to lie flat, position as most comfortable and document position. If arm is raised above heart level an over-estimation will result. |
| 3. Place sphygmomanometer cuff around arm. Apply gel over the brachial pulse. (Ensure correct US gel is used to give effective transmission of the signal) | Check cuff is appropriate size. It should be long enough to ensure that 80% of the circumference of the upper arm or ankle can be covered by the sleeve and the width is at least 40% of the limb circumference. BP will be over estimated if bladder is too short or too narrow. |

| Procedure | Rationale |
| --- | --- |
| 4. Hold 8MHz Doppler probe gently over the brachial pulse until a good signal is obtained | The best Doppler signal will be obtained with the probe at an angle between 45 – 60° to the artery. The artery may not be parallel to the skin and adjustment of the probe may be required to obtain a good signal. |
| 5. Inflate the cuff until the signal disappears. Gradually lower the pressure until the signal returns. This is the Brachial Systolic Pressure. Repeat the process at least one more time. | Care should be taken in patients with atrial fibrillation. The cuff may be slowly deflated to ensure the correct pressure is recorded. The Brachial Systolic reading can vary between limbs. Differences of greater than 15mmHg suggest underlying aortic arch or upper limb arterial disease. |
| 6. Repeat these stages using the other arm. Take the highest of the readings. | This ensures that the systolic pressure is closest to the systemic pressure, especially if arterial disease is present |

| Procedure | Rationale |
| --- | --- |
| 7. Place the sphyg' cuff around the leg immediately above the ankle (Place a piece of cling film or dressing towel over any area of ulceration). | The position of the cuff is important. The measurements reflect the pressure required to occlude the artery between the cuff, not where the Doppler is held. If you are not applying the cuff to the ankle you are not recording a resting pressure index of the ankle. |
| 8. Locate the pedal pulse using the Doppler probe. Avoid excessive pressure. | Excessive pressure may occlude the underlying artery, particularly in thin patients. |
| 9. Inflate the cuff until the signal disappears. Deflate the cuff until the signal returns. This is the Ankle Systolic Pressure. Repeat the process at least one more time. Repeat using at least one more pedal pulse. Make a note of each of the readings. | In practice, it is often only possible to use 2 of the pedal pulses for measurement. Avoid frequently inflating the cuff or leaving the cuff inflated for long periods of time as the pressure reading will fall. In large or oedematous limbs a 5MHz probe may give better results. |
| 10. Repeat this stage using the opposite leg. | |

# Calculate the resting pressure index for each limb separately.

ABPI= $\frac{\text{Ankle systolic pressure}}{\text{Highest brachial systolic pressure}}$

**Remember – 'Leg over arm'**

**i.e. Highest brachial = 148**

**Highest pedal = 118**

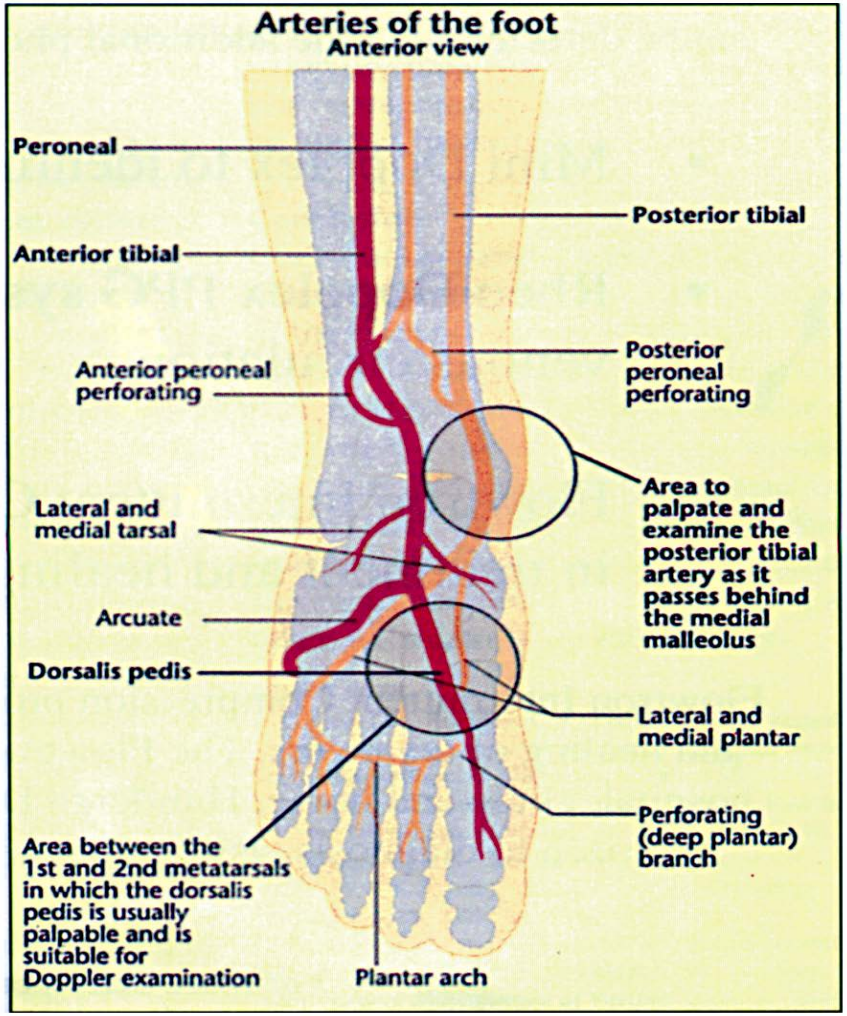
**ABPI = 118 ÷ 148 = 0.79**

**Use a calculator**

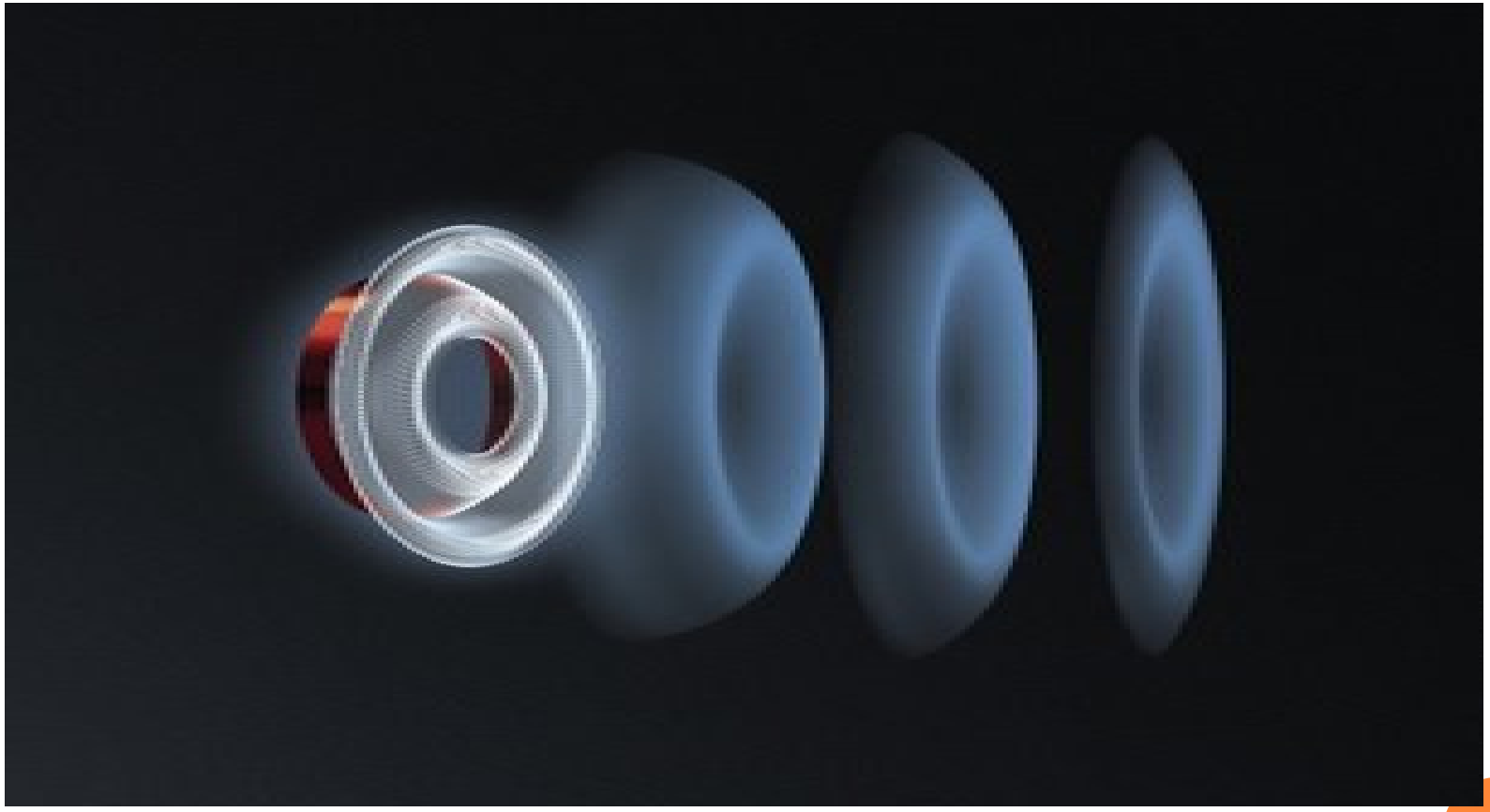
# Interpretation of ABPI

| ABPI 1.0 – 1.3 | Normal | Apply high compression therapy as per local guidelines (Repeat ABPI annually) |
|---|---|---|
| ABPI = 0.8 – 1.0 | Mild arterial disease | Apply high compression therapy as per local guidelines (Repeat ABPI every 6 months) |
| ABPI 0.6 – 0.8 | Significant arterial disease | If asymptomatic and healing then consider low compression and monitor. Repeat ABPI every 12 weeks.<br>If symptomatic i.e. claudication pain, non healing ulcer routine referral to vascular team |
| ABPI < 0.6 | Severe arterial disease | Urgent referral to vascular team particularly if symptomatic. Repeat ABPI 3 monthly or as per vascular advice. |
| ABPI > 1.3 | Medial wall calcification | Seek advice from TV – may benefit from modified/ reduced compression. Optimise management of co morbidities. |

# Finding the pedal pulses

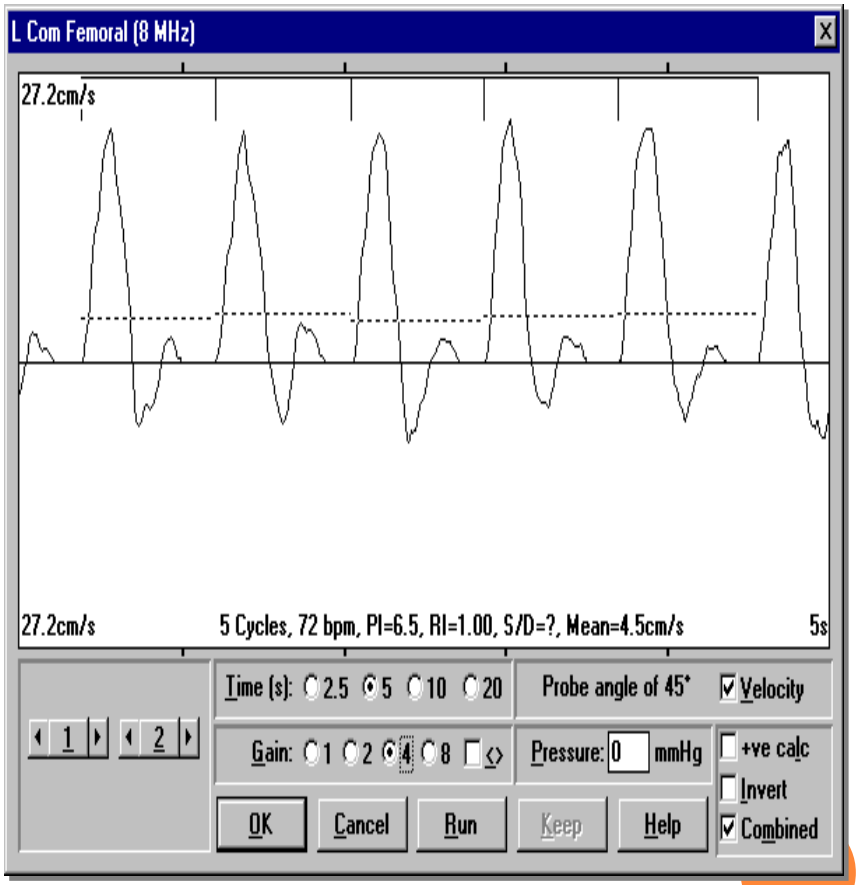


# Interpreting the sounds



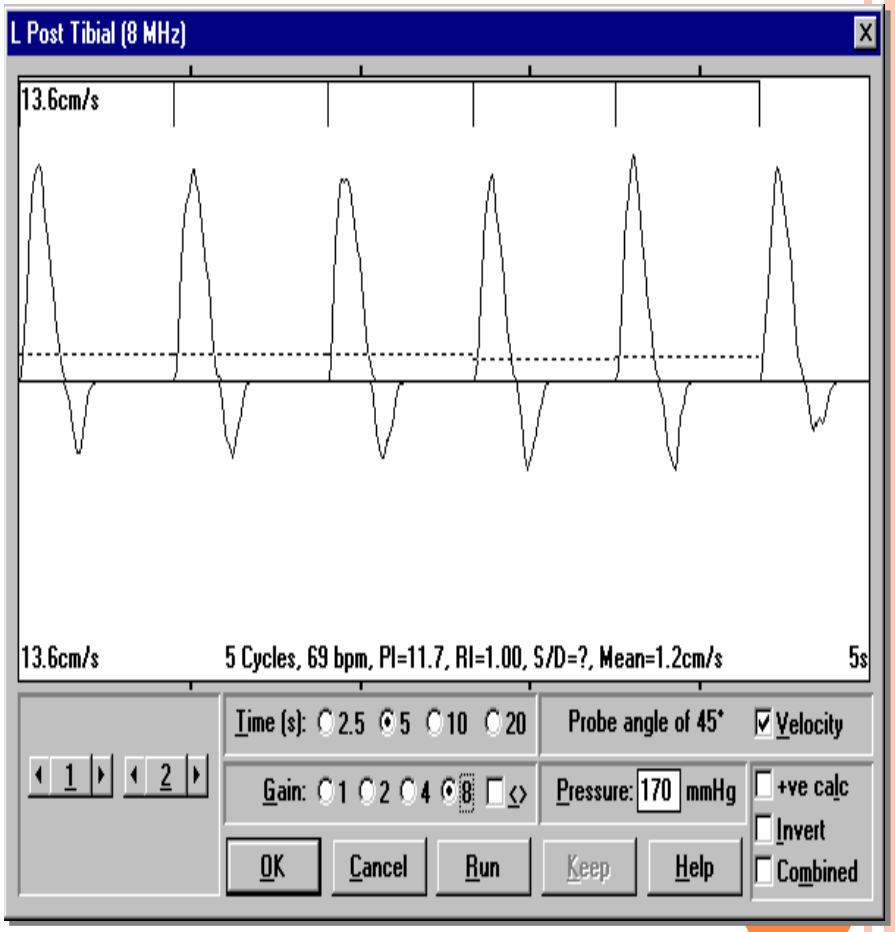
# Triphasic – a 3 phase process

- 1. In systole, the heart contracts, blood flow accelerates in forward direction within the vessel.
- 2. A drop in peak systolic pressure leads to reverse flow within the blood vessel.
- 3. Elastic recoil of the vessel as the heart muscle relaxes leads to a further forward flow of blood in the vessel.



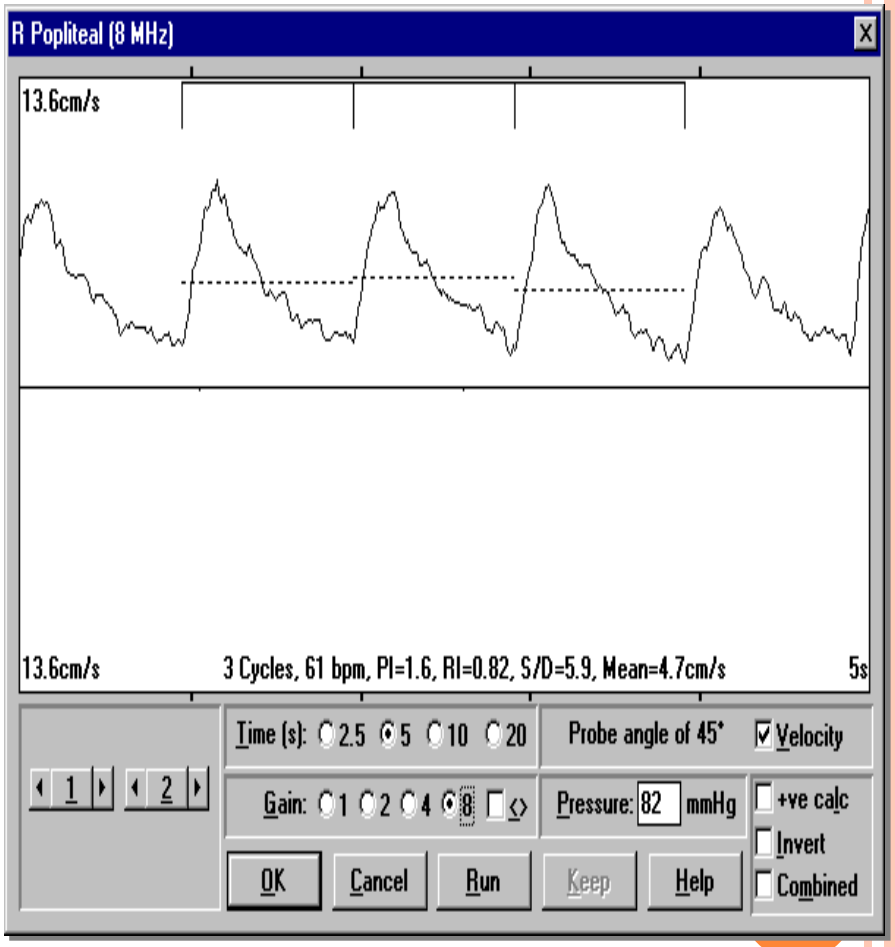
# Biphasic

- Vessels naturally lose their elasticity as part of the aging process.
- This results in a bi – phasic signal
- During this process the reverse flow (phase 3) is lost.



# Monophasic

- Only produces one sound and usually denotes vessel damage.
- The sound heard may be lower in pitch and illustrates the loss of phase 2 and 3 and reduced blood flow during systole (phase 1)



# Sounds

- Triphasic 
- Biphasic 
- Monophasic 

# Factors affecting accuracy

| Inadequate preparation (ie room temperature) | Vaso constriction |
|---|---|
| Patient anxious and un relaxed | Resulting in raised blood pressure |
| Incorrect positioning of the patient | Falsely elevated ankle pressures |
| Incorrect gel | Interference due to air bubbles. |
| Incorrect size of Sphyg cuff | Incorrect pressure measurements |
| Incorrect Doppler probe size | Ultrasound cannot penetrate depth of vessel |
| Incorrect position of Doppler probe over vessel | Incorrect pressure measurements |

# Factors affecting accuracy Ctd…

| Excessive pressure on vessel during procedure | Collapsed vessel |
|---|---|
| Releasing sphyg too rapidly | Risk of missing systolic pressure point |
| Prolonged inflation of the cuff/ re-inflation | Hyperaemic effect on the limb |
| Moving Doppler during measurement | Incorrect pressure measurement |
| Inexperience of carrying out procedure | A practical skill that requires assessment by peers to ensure competence and safe practice. |

# When wouldn't you perform a Doppler?

- Suspected DVT
- Cellulitis present
- Excessive pain

# Ready for a demonstration?