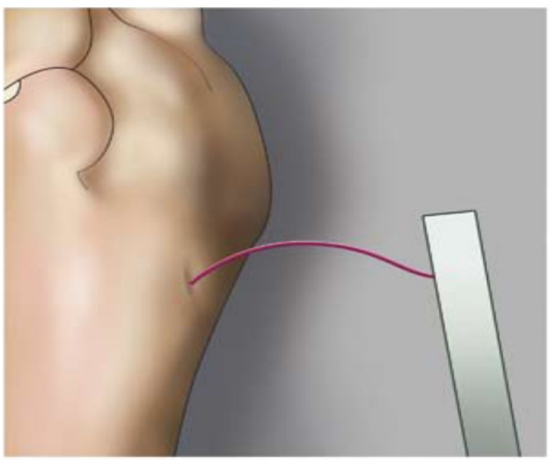
BANGLADESH UNIVERSITY OF HEALTH SCIENCES

Faculty of Public Health

Department of Noncommunicable Diseases (NCD)

TRAINING MODULE ON DETECTION OF DIABETIC FOOT PROBLEM AT THE EARLY STAGE



By

Palash Chandra Banik, Nirmalandu Bikash Bhowmik and Professor Liaquat Ali

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Health Care Development Project (HCDP) of BADAS

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Bangladesh University of Health Sciences (BUHS)

125/1, Darus Salam, Mirpur-1, Dhaka-1216, Bangladesh.

Phone: 00 880 2 9010952; 9010932

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Acknowledgement to

1. **Dr. Farhana Zaman,** MBBS, MPH (CM) Sr Lecturer, Department of Community Medicine, Bangladesh Institute of Health Sciences (BIHS).

2. **Md. Moniruzzaman**, Sr Research Fellow, Department of Community Medicine, Bangladesh Institute of Health Sciences (BIHS).

Introduction

Why foot care is important for patients with Type 2 Diabetes?

Foot problems from diabetes represent a significant burden of care for primary care physicians. Most of the adverse outcomes of a diabetic foot are preventable with resources currently available in primary care settings where most patients with diabetes get their care.

The Center for Disease Control estimates that in 2010:

• 1 in 12 adults Americans, and 1 in 4 adult American Indians, has diabetes.
• Approximately 90% of these patients are managed by primary care providers.
• Of the diabetes patients seen, 20% will present with an acute foot problem.
• Over the course of their care, 15% will experience a foot ulcer.
• 5 – 10% will need lower limb amputation.
• 50% of those who get an amputation die within 5 years.

How is this training set up?

This Training can be used in a variety of different ways:

• Read the Essential Elements that offer a detailed explanation.
• Just want the key points? Then browse through the Quick Facts.
• Use these printable notes if you want to be able to write alongside the information offered.

Feel free to use any of these avenues to better enhance your learning needs.

Objectives:

At the end of this training, you will be able to:

1. List four risk factors for diabetic foot complications.
2. Be able to conduct a complete diabetic foot exam.

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Screening for High Risk Patients: Overview

Foot ulceration and amputation are preventable with resources currently available in primary care settings where most patients with diabetes get their care. There are several principle risk factors for ulceration and lower extremity amputation (LEA) among patients with diabetes:

- Neuropathy
- Deformity
- Limited joint mobility
- Prior ulcer/ LEA
- PVD
- Onychomycosis

It is also important to assess non-foot related risk factors; some of them are potentially modifiable:

- Male sex
- Duration of diabetes
- Age
- Hyperglycemia
- Hypertension
- Dyslipidemia
- Smoking
- Poor vision
- Other complications such as renal disease

Patients at high risk for foot ulcer and amputation can be identified with simple criteria that involve several testing and inspection measures. Patients with all normal criteria are at low-risk, while those with insensitivity, deformity, absent pulses, or prior foot ulcers or amputations are at high-risk. These simple criteria have been validated in Indian Health Services (IHS) and adopted by most professional and public health organizations including the American Diabetes Association (ADA) and World Health Organization (WHO).

- Sensory testing with a 10 gram monofilament
- Foot inspection for deformity
- Reports of prior ulcer or amputation
- Checking for pedal pulses and taking measurements for an ABI pressure
- Checking joint mobility with goniometer

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Screening for High Risk Patients: Sensation

A test using a 10 g monofilament is the recommended method for assessing for neuropathy of the foot. Loss of protective sensation at any site on the foot indicates evidence of neuropathy, increasing the risk of ulceration and other complications.

Equipment: 10 g monofilament
Monofilament is the test used to help identify high risk feet in people with diabetes. The monofilament exam involves using a 10 gram monofilament to test sensation on the tip of the great toe, little figure and 1st, 3rd and 5th metatarsal heads & heel of each foot.

The technique for monofilament testing is as follows:

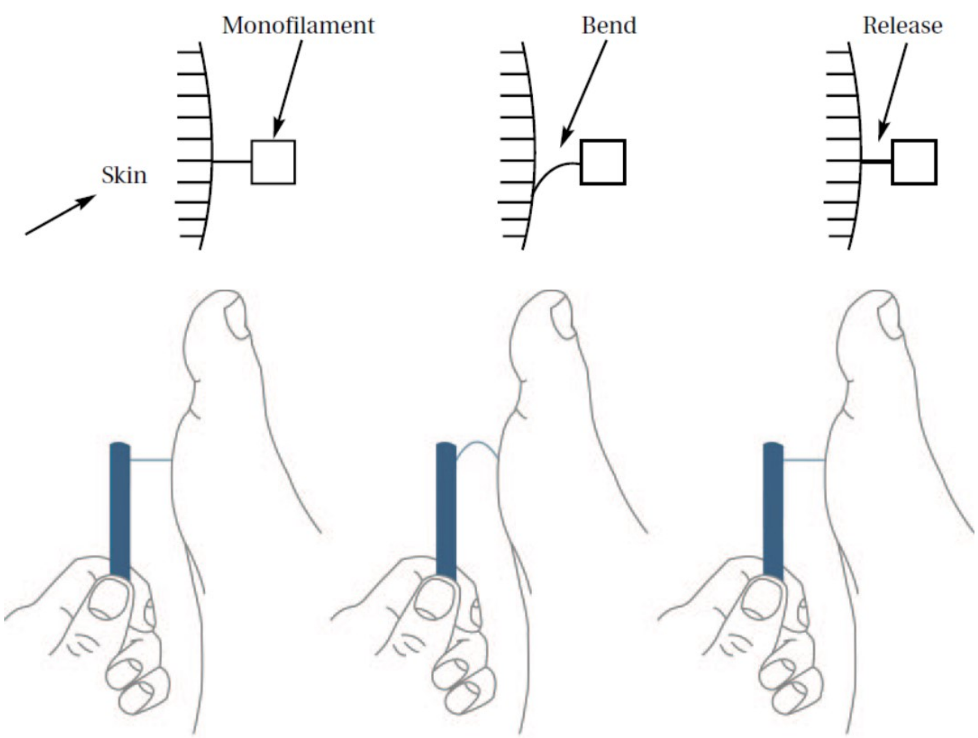
Directions for use of Semmes- Weinstein Monofilament

1. Assess integrity of monofilament (no bends/breaks).

2. Show the monofilament to the patient. Place the end of the monofilament on his/her hand or arm to show that the testing procedure will not hurt.

3. Ask the patient to turn his/her head and close his/her eyes or look at the ceiling.

4. Hold the monofilament perpendicular to the skin.



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5. Place the end of the monofilament on the sole of the foot. Ask the patient to say 'yes' when he/she feels you touching his/her foot with the monofilament. DO NOT ASK THE PATIENT "did you feel that?" If the patient does not say "yes" when you touch a given testing site, continue on to another site. When you have completed the sequence RETEST the area(s) where the patient did not feel monofilament.

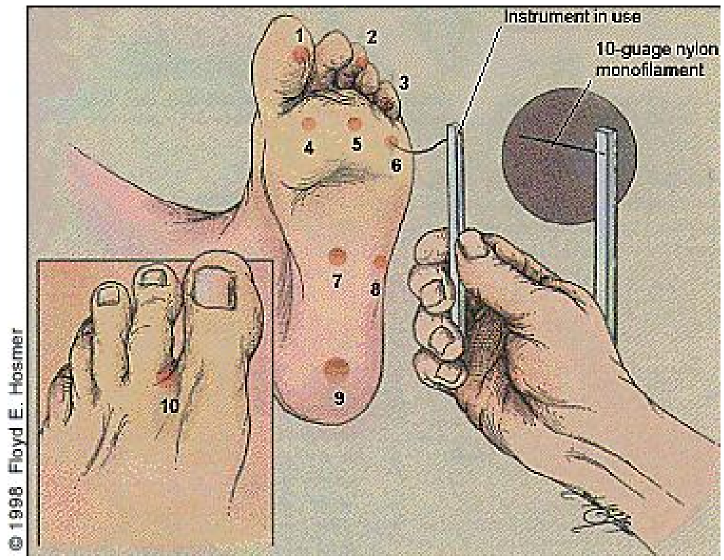
6. Push the monofilament until it bends, then hold for 1-3 seconds.

7. Lift the monofilament from the skin. Do not brush or slide along the skin.

8. Repeat the sequence randomly at each testing site on the foot (see pictures below).

Sites on the sole of the foot for monofilament testing

Loss of protective sensation = absent sensation at one or more sites



Using the monofilament, test the sites listed. Do not test over heavy callus.
- *digits: 1st, 3rd, 5th*
- *MTH: 1st, 3rd, 5th*
- *midfoot: Medial, Lateral*
- *heel*
- *top (dorsum) of foot*

N. B.:
Apply only to intact skin. Avoid calluses, ulcerated or scarred areas. DO NOT use a rapid or tapping movement.
■ If the monofilament accidentally slides along the skin, re-test that area later in the testing sequence.

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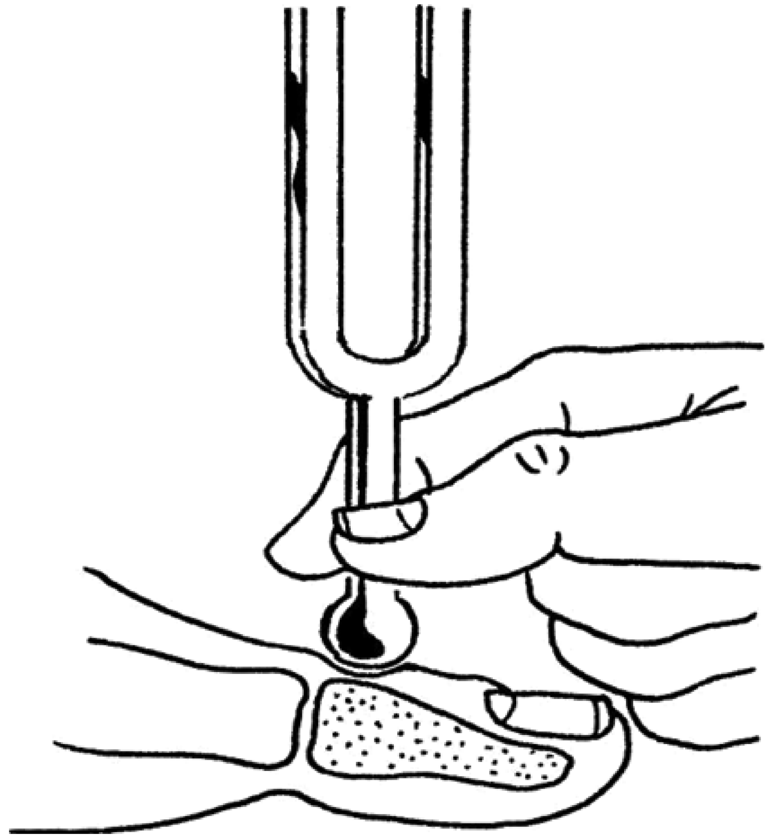
■ Store the monofilament according to the manufacturer's instructions.
■ Clean the monofilament according to agency infection control protocols.
■ The filament should be cleaned after use with an alcohol swab or dilute bleach solution and returned to its case.
■ Do not apply the filament directly on an ulcer, callous, scar or necrotic tissue. Apply the filament on near-by normal tissue.



Tuning fork

• The sensory examination should be carried out in a quiet and relaxed setting. First, apply the tuning fork on the patient's wrists (or elbow or clavicle) so that he/she knows what to expect.
• The patient must not be able to see whether or where the examiner applies the tuning fork. The tuning fork is applied on a bony part on the dorsal side of the distal phalanx of the first toe.
• The tuning fork should be applied perpendicularly with constant pressure.
• Repeat this application twice, but alternate this with at least one 'mock' application in which the tuning fork is not vibrating.

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• ***The test is positive if the patient incorrectly answers at least two out of three applications, ('at risk for ulceration') and negative with two out of three correct answers. (A test is positive if it identifies the risk).***
• If the patient is unable to sense the vibrations on the big toe, the test is repeated more proximally (malleolus, tibial tuberosity).
• Encourage the patient during testing by giving a positive feedback.

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Screening for High Risk Patients: Foot Deformities

To understand foot deformities, it is important to recognize that foot structure and function is incredibly complex and can easily go awry. Normal foot architecture is maintained through a balance of forces applied by muscles and tendons on bones. Atrophy of a muscle group through nerve damage can lead to deformity. It is important to watch areas that can be open to friction and repetitive micro-trauma as those sites can lead to callus and ulceration.

Types of foot deformities include:

• The **bunion**, or **hallux valgus**, increases the risk for ulceration through a mechanism of increased pressures and friction and repetitive micro-trauma that out paces the healing capacity at the bunion site.

• **Hammer** and **claw toe** deformities develop from atrophy of the small muscles between the toes. Both the dorsal and plantar aspects of the involved toes are at risk for friction and pressure related trauma with subsequent ulceration.

• C**harcot foot** is one of the most severe diabetic foot deformity in which the entire mid-section of the foot collapses and forms a classic "rocker bottom" sole. It is caused by a combination of sensory and autonomic nerve dysfunction in which microscopic fractures to the tarsal bones trigger an inflammatory response and subsequent dissolution of the tarsal and metatarsal bones of the foot. The arch becomes inverted, which causes high plantar pressures, and is at extreme risk for ulceration.

Bunion

Charcot Foot

Hammer toe and other toe deformities

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Hammer toe – **bent middle joint**

Claw Toe – joint at base of toe is bent up and middle joint is bent down

Halgus Valgus or Small Bunion (Mild/Moderate)
– Joint at the base of big toe is pushed to the side

Hallus Valgus or Large Bunion (Severe)
– Big toe may move under second toe

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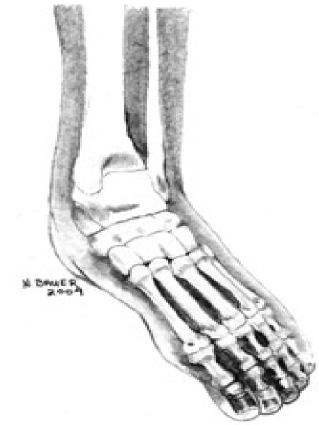
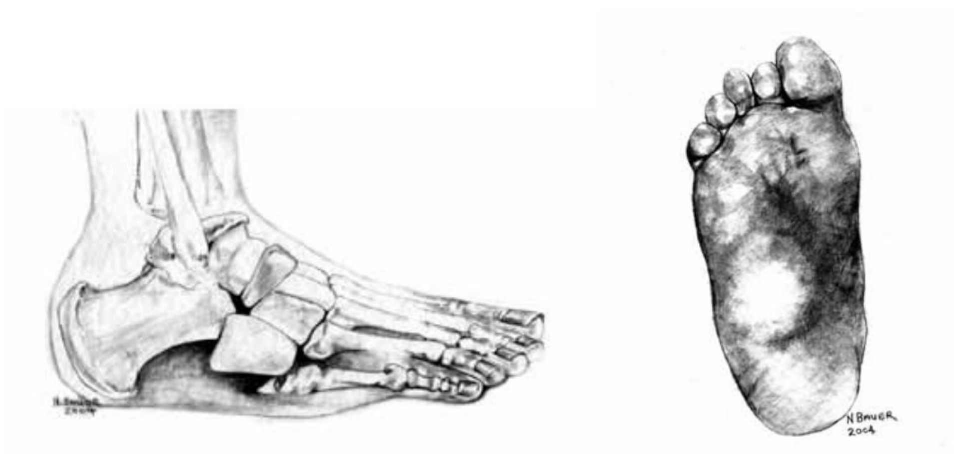


Pes Planus

Pes Cavus



Charcot Arthropathy

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Pes planus produces flattening of the foot. Pes planus feet have increased lateral talometatarsal angle and increased second metatarsal length (Ledoux, Shofer, Ahroni, Smith, Sangeorzan & Boyko, 2003). There are many reasons for this condition, the first of which is heredity. Many have this condition and never have any problems of any kind.

However, others will have this condition created through years in soft, unsupportive shoes on hard surfaces, injury, pregnancy, or other factors. This often leads to other problems.

The arch in the foot is caused by a broad band of fibrous connective tissue, called the longitudinal ligament. A ligament is nothing more than connective tissue that connects bone to bone. The longitudinal ligament connects the metatarsal phalangeal joints to the os calcis or heel bone. Like a string on a bow, they hold the two ends together and create an arch. This arch is a shock absorption structure and it also helps to maintain all the tarsals in proper erect anatomic position. As this arch decreases, impact from the concrete becomes worse.

When the arch ligament stretches or tears, the arch falls. If it falls far enough, the tarsals may begin to shift to the inside or create pronation or a valgus (greater than 90 degree erect) position at the ankle. This can cause problems in the origin area, (the metatarsals) or in the heel. It also may cause pressure on the medial (inner) knee and perhaps the hip and back. It is like pulling the string on a marionette too tight, the result is a kinked mass on one side. The human body is much the same, put too much tension on major muscle groups and the joints kink and yell back.

In pes cavus, the arch is abnormally high on weight bearing. The heel is often tilted inwards at the ankle (but not always). In many, the toes will appear clawed. When not standing the front half of the foot (forefoot) will appear to be dropped below the level of the rear foot. Ledoux et al. (2003) identified biomechanical differences among pes planus and pes cavus feet in persons with diabetes. They found pes cavus feet had more prominent metatarsal heads, bony prominences, hammer/claw toes, increased hallux dorsiflexion and Pes Cavus decreased hallux plantarflexion.

Charcot joint is a form of neuroarthropathy that occurs most often in the foot. **Nerve damage from diabetes causes decreased sensation, muscle and ligamental atrophy and subsequent joint instability**. Walking on this insensitive and weakened joint can cause even more damage to the foot structure. In the acute stage there is inflammation and bone reabsorption which destroys the bone. In later stages, the arch falls and the foot may develop a rocker bottom appearance. Weight distribution of the sole is altered causing deformities leading to pressure points that enhance ulcer development. Signs to assess for are: hot on the onset, pain, discomfort, erythema, swelling, rigid deformities, limited joint mobility, callus formation (ADA, 2001; Bowker & Pfeifer, 2001). One in 680 people with diabetes develop Charcot joint with an incidence of 9-12% individuals with documented diabetic peripheral neuropathy (Royal Melbourne Hospital, 2002). It is important that the Charcot foot is recognized early so that appropriate treatment of the foot can be provided to prevent further injury and promote a stable foot (Lavery et al., 1998).

Screening for high risk patient: Vascular

There are three non-invasive assessments for detecting peripheral vascular disease:

The palpitation of pedal pulses is most simple and fastest. The dorsalis pedis and posterior tibial are the two main arteries in the foot.

- The dorsalis pedis is on the dorsum or top of the foot.
- The posterior tibial is palpitated behind the medial malleolus, or inside the ankle bone.

Pedal Pulse Assessment:

Locating a pedal pulse is part of the trauma patient assessment and performed before and after lower extremity splint application as well as long backboard immobilization. Locating a pedal pulse can be difficult even in healthy patients. Use these tips to find a patient's pedal pulse:

1) First assess the patient's radial pulse rate and rhythm so you know what you are seeking.

2) Move shoes, socks, tights, and anklets out of the way to expose the patient's skin.

3) Move, if not compromised by injury, the patient's foot towards the normal anatomical position.

4) Check for either the dorsalis pedis pulse (on the top of the foot) or the posterior tibial pulse (located behind the medial malleolus — the ankle bone).

5) For dorsalis pedis, first visualize because you might see the skin pulsating above the artery. If you are unable to see anything, hold two or more fingers lightly against the skin. Move up from the toes towards the leg until you locate the pulse.

6) For posterior tibial — on the medial side of the ankle — use two or more fingers. Sometimes you may need more pressure to find this pulse.

If you are unable to find the pedal pulse on one leg, switch to the patient's other leg. Knowing the location of one pulse might help you find the other.

Once you have found a pedal pulse, consider using a ballpoint or felt pen to make a light mark at the pulse location to make reassessment easier. Finally, if the patient's foot is warm with normal color, it is adequately perfused.

-------------Picture of clinical examination (removed due to ethical issue) -----------

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Ankle Brachial Index (ABI):

• An Ankle Brachial Index (ABI) can be performed with a handheld Doppler and a blood pressure cuff.

To obtain an ABI:

1. First measure brachial pressures in each arm.
• Apply the cuff to the upper arm
• Locate the brachial pulse with the Doppler and mark with a pen
• Inflate the cuff, apply Doppler, deflate the cuff and record the pressure at which flow is heard.

2. Next measure pressure in each ankle.
• Apply cuff to the calf
• Locate the posterior tibial pulse with the Doppler and mark with a pen.
• Inflate the cuff, apply Doppler, deflate the cuff and record the pressure at which the flow is heard.

3. ***To calculate ABI,*** divide the ankle pressure by the greater of the toe brachial pressures. While there is no clear threshold for increased risk, most accept a value of below 0.9 or 0.8 as conferring moderately high risk.

Example: Calculate ankle brachial index by dividing systolic ankle pressure by systolic brachial pressure e.g. ankle pressure is 120 mmHg and brachial pressure is 132 mmHg, ankle brachial index is 120/132 = 0.9

Some data suggests the Toe BI measurement is more accurate than the ABI, but it requires specialized equipment and is not routine in primary care.

Normal	0.9 – 1.2	Risk of vascular foot ulcer is small
Definite vascular disease	0.6 – 0.9	Risk of vascular ulcer moderate, depending on other risk factors
Severe vascular disease	Less than 0.6	Risk of vascular foot ulcer very high

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N.B.: Ankle brachial index may not be able to be reliably calculated in some people with diabetes as the arteries in the ankles may be calcified.

Assess peripheral circulation with thorough palpation of **pedal pulses** (dorsalis pedis and posterior tibial). If there are no palpable pulses, and calculate ankle brachial index or consider referral to a vascular specialist. **Absent pulses**, **calf claudication**, **absence of hair on the feet**, **altered temperature** (a cold foot) and **thin**, **bluish skin** are suggestive of **peripheral arterial disease**. A bounding, easily detected pulse in a **warm**, **dry foot** is suggestive of **autonomic neuropathy**, which causes abnormal arterio-venous shunting.

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Screening for high risk patient: Foot mobility

Limited Joint Mobility:

Progressive stiffening of collagen-containing tissues leads to thickening of the skin, loss of joint mobility, and potential fixed flexor deformity. Up to 30% of patients with diabetes may have limited joint mobility. Reduction in mobility of the ankle joint may cause increased plantar pressure when walking and be a major risk factor in the pathogenesis of diabetic foot ulcers (Fernando, Masson, Veves & Boulton, 1991; Zimny, Schatz & Pfohl, 2004). Achilles tendon contracture is a common cause of limited joint mobility causing increased pressure on the forefoot during ambulation (Armstrong, Lavery & Bushman, 1998; Mueller, Sinacore, Hastings, Strube & Johnson, 2004).

Starting position:

For all of the measurements, the same starting position is used. Position the participant on the bed / plinth in long sitting, reclined to about 45 degrees. Place a pillow under upper part of the lower legs to flex the knee to 20-30˚ and lifting the heels off the surface of the bed / plinth. Ensure the patient is comfortable during the measurements. If it is not possible for the patient to get into the starting position then the measurements could be taken sitting, as long as the knee remains more than 20 degrees flexed and the heel is not directly resting on a support.

-------------Picture of clinical examination (removed due to ethical issue) -----------

Measuring the range of motion

For the purposes of the trial, measure the uninjured ankle (if appropriate) and then the injured ankle.

Ask the patient to move as far as comfortable, not into pain. Measure how far the patient can move the foot / ankle themselves, do not assist the movement.

Ankle dorsiflexion and plantar flexion
Angles are measured from neutral (plantar grade), which is measured as 0˚.

-------------Picture of clinical examination (removed due to ethical issue) -----------

Positioning and alignment of the goniometer:

-------------Picture of clinical examination (removed due to ethical issue) -----------

Goniometer axis

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The axis of the goniometer placed approximately 1.5 cm inferior to the lateral malleolus.

Stationary arm

Parallel to the longitudinal axis of the fibula, lining up with the fibula head.

Moveable arm

Parallel to the longitudinal axis of the 5th metatarsal.

Instructions:

Dorsiflexion: Ask the patient to pull their foot towards them (Normal range is typically 0-20˚)

-------------Picture of clinical examination (removed due to ethical issue) -----------

Plantar flexion: Ask the patient to point their foot away (normal range is typically 0-50˚)

-------------Picture of clinical examination (removed due to ethical issue) -----------

Measure and record the angle between the movable and stationary arms in degrees.

Ankle inversion and eversion

Angles are measured from neutral, which is measured as 0˚.
Key bony landmarks that help to orientate the goniometer

Positioning and alignment of the goniometer:

-------------Picture of clinical examination (removed due to ethical issue) -----------

Goniometer axis
The axis of the goniometer is placed on the front of the ankle at the mid-point between the medial and lateral malleoli.

Stationary arm
Along the tibial crest (prominent line of bone down the front of the shin)

Moveable arm
In line with the 2nd metatarsal (lining up with the base of the second toe)