University of Medical Technology

Department of Prosthetics and Orthotics

Transfemoral Prosthetic Course

Gait Analyses

Content

- TF Gait Deviation Analyses
- Causes of TF Gait Deviations
- Correction of TF Gait Deviations

Introduction

- Patient’s gait pattern can tell us what is happening to prosthesis and amputee

- Trans femoral amputee gait is more complicated than lower level amputee

Causes of gait deviations

- Causes of gait deviations:
  - **Patient causes**
  - **Prosthetic causes**

- It is important that problems are identified and analyzed to solve them accordingly

Transfemoral Gait deviations

1. Instability of the prosthetic knee
2. Swing phase whips
3. Circumduction
4. Vaulting
5. Abducted gait
6. Lumbar lordosis
7. Lateral bending of the trunk
8. Rotation of foot on heel strike
9. Terminal swing impact
10. Rotation of foot on heel strike
11. Drop-off
12. Uneven heel rise
13. Uneven Gait (uneven timing, uneven length of steps, uneven arm swing)

Group Work

- Group the gait deviations according to the plane you can observe.
  - E.g.
    - Coronal plane
    - Sagittal plane
    - Transverse plane

Gait Analysis

Coronal Plane

- Abducted gait
- Lateral trunk bending
- Circumduction
- Vaulting
- Whips
- Foot rotation at heel strike

Sagittal Plane

- Knee instability
- Lumbar lordosis
- Terminal swing impact
- Uneven heel rise
- Drop-off
- Uneven gaits

1. Instability of prosthetic knee

- **Description:**

  The prosthetic knee tends to flex during the prosthetic stance phase, creating a danger of falling

- **When to observe:**

  During stance phase

- **How to observe:**

  From the side

Causes of Instability of prosthetic knee

Amputee causes

1. Weak hip extensors
2. Hip flexion contracture

Prosthetic causes

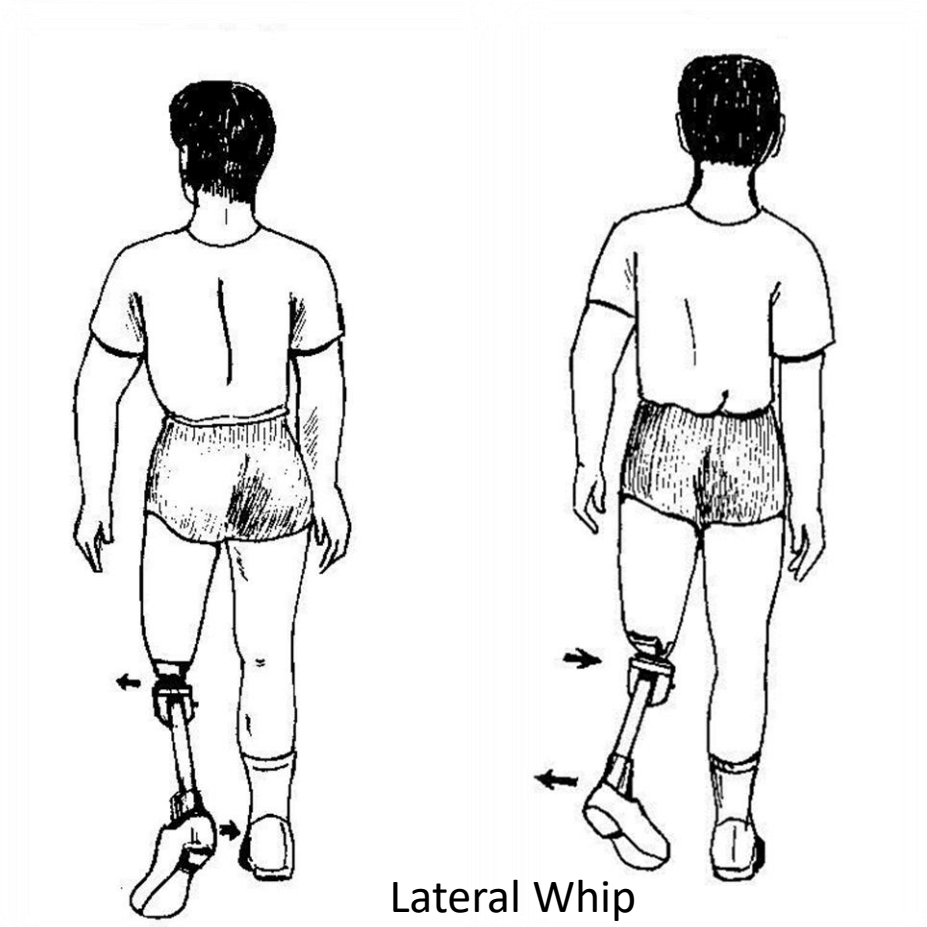
1. Knee joint too far ahead of TKA line
2. Socket aligned in insufficient flexion
3. Too much plantarflexion resistance
4. Too much dorsiflexion

2. Whips

- **Description:**
  - A medial whip occurs at toe-off when the heel moves to the inside (medially) as the knee begins to bend.
  - A lateral whip occurs at toe-off when the heel moves to the outside (laterally) as the knee begins to bend.
- **When to observe:**

  At or just after toe-off
- **How to observe:**

  From behind the amputee



Medial Whip

Lateral Whip

Causes of whips

Amputee causes

1. Prosthesis is put on incorrectly
2. The stump may have weak, loose musculature, in which tissues rotate freely around the femur

Prosthetic causes

1. Knee too much external or internal rotation
2. Silesian belt attached incorrectly
3. Socket too tight/loose
4. The toe break may not be set at the correct angle to the line of progression

3. Circumduction

- **Description:**

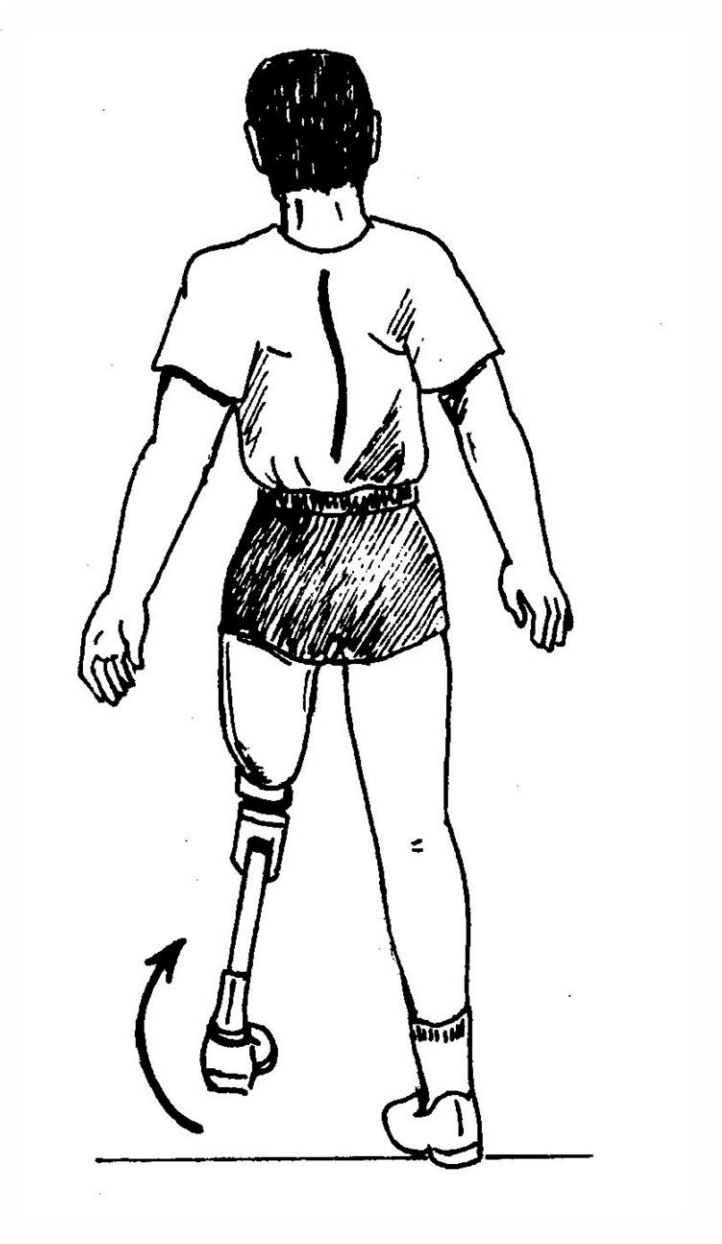
  The prosthesis is swung in a half-circle away from the body

- **When to observe:**

  Throughout swing phase

How to observe:

From behind the amputee



Causes of Circumduction

Amputee causes

1. Abduction contracture
2. The amputee uses little or no knee flexion because of insecurity or fear
3. Habit

Prosthetic causes

1. Prosthesis appears too long
   - Manual knee lock, too much friction, or a tight extension aid may prevent the knee from bending
   - Inadequate suspension may allow the prosthesis to slip off the stump (piston action)
   - The foot is set in plantarflexion
   - The socket is too small/tight. The ischial tuberosity is above the ischial seat
2. Prosthesis is actually too long
3. Discomfort in the perineal area(although they would tend to walk with adducted gait in stance and swing)

4. Vaulting

- **Description:**

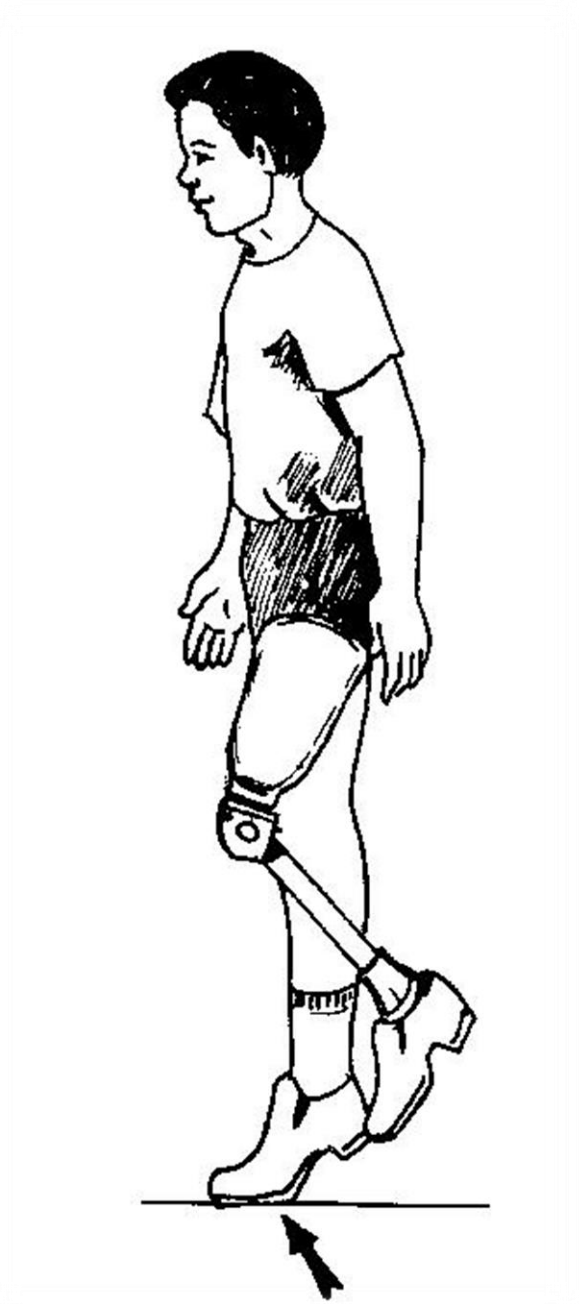
  The amputee's center of gravity moves up and down excessively. The entire body is raised by excessive plantarflexion of the sound foot. You can observe that the normal foot is raised onto the toes while walking

- **When to observe:**

  During sound leg stance phase

- **How to observe:**

  From behind the amputee or from the side



Causes of vaulting

- **Amputee causes**

1. Poor hip flexors
2. Habit

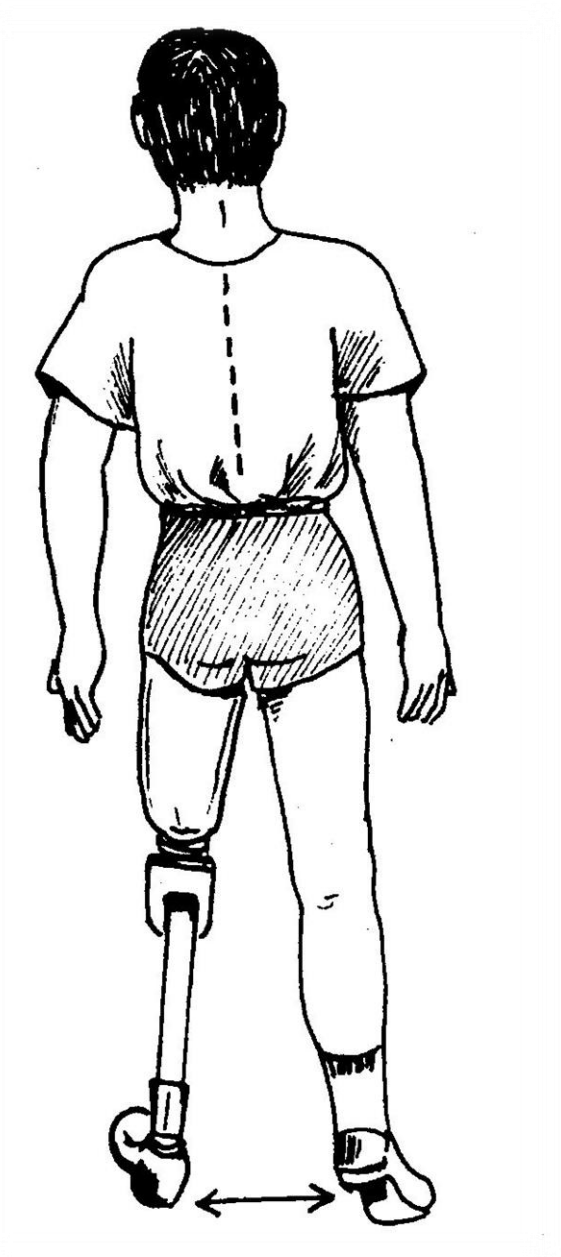
- **Prosthetic causes**

1. Prosthesis appears too long
2. Prosthesis is actually long
3. Not enough control of heel-rise (less heel rise)

5. Abducted Gait

- **Description:**
  - The width of the walking base is much greater than the normal range of 50-100 mm
  - There is usually exaggerated lateral displacement of the pelvis and lateral bending of the trunk
  - You will observe that the prosthesis is always put out to the side while walking

- **When to observe:**
  - During the period of double support
- **How to observe:**
  - From behind the patient



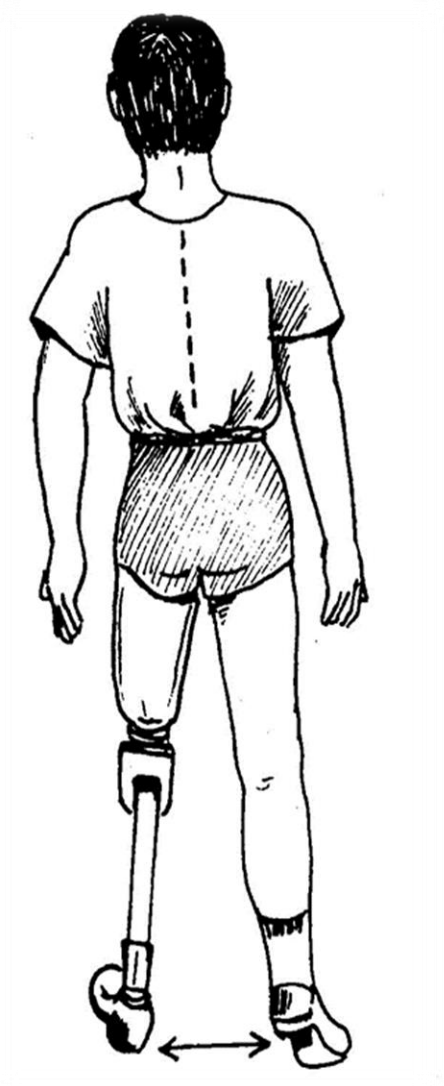
Causes of Abducted Gait

Amputee causes

1. Abduction contracture
2. Lack of confidence / balance

Prosthetic causes

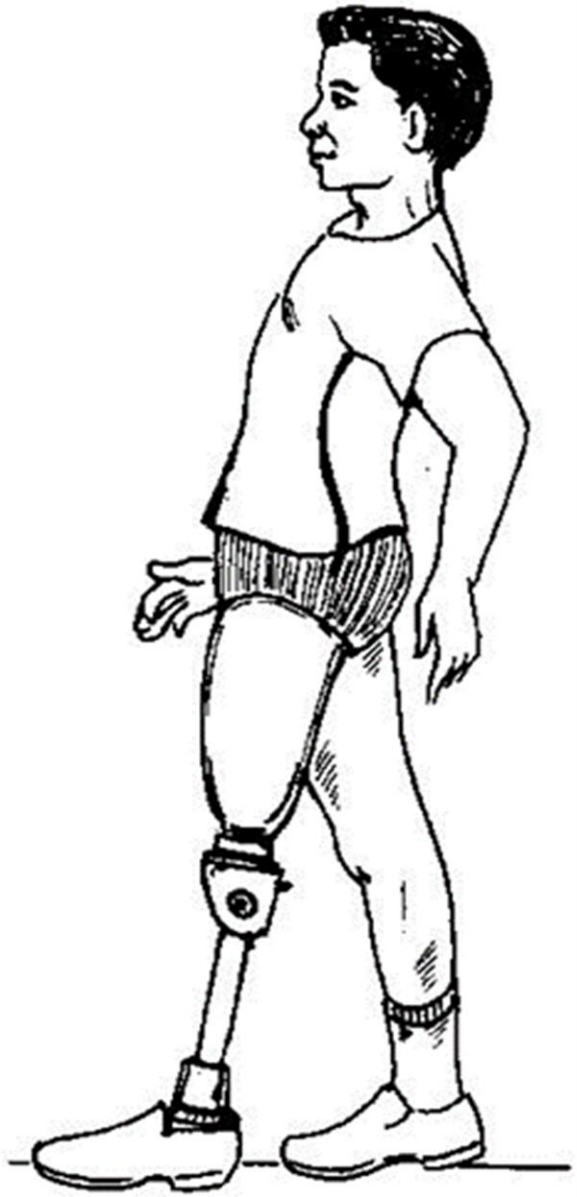
1. Prosthesis appears long
2. Medial brim discomfort (trim line too high /Adductor roll)
3. Socket and shank are aligned in valgus position(too much Adduction
4. Pelvic band joint wrong alignment (if it is placed)



6. Lumbar Lordosis

- During prosthetic stance phase the lumbar lordosis is exaggerated, especially from mid-stance to toe-off

- **When to observe:**
  - Throughout stance phase
- **How to observe:**
  - From the side



Causes of lumbar Lordosis

Amputee causes

1. Weak hip extensors
2. Hip flexion contracture

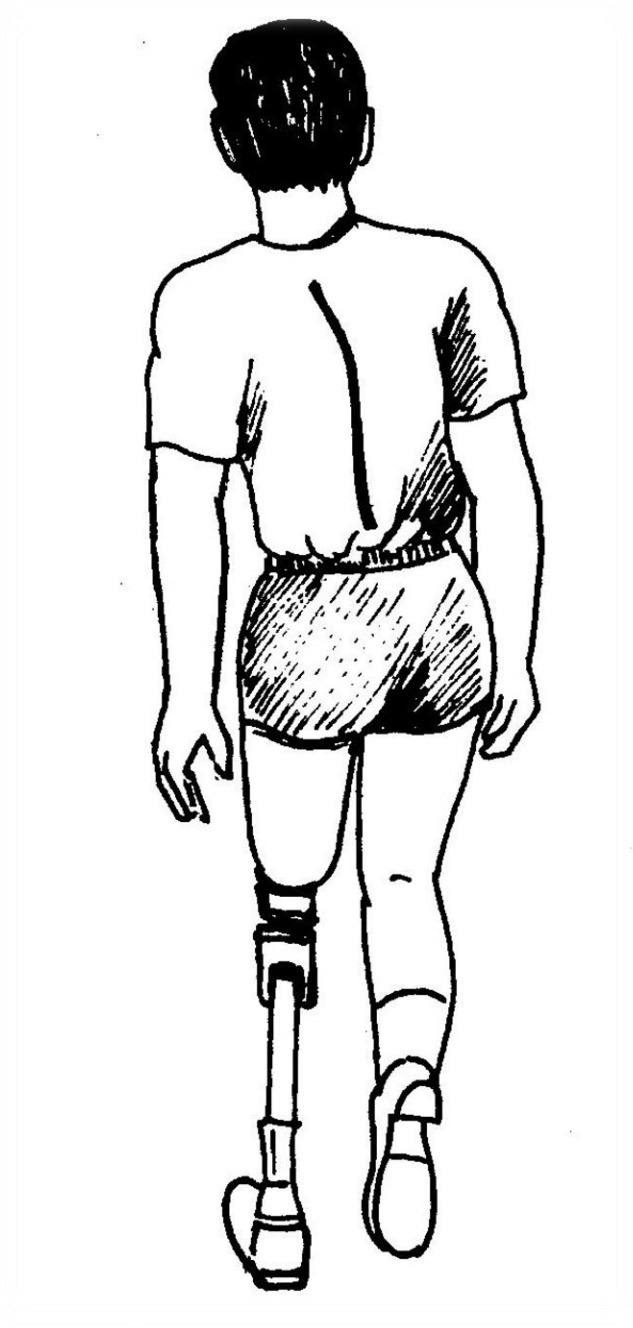
Prosthetic causes

1. Not enough socket flexion
2. Knee is unstable
3. Ischial discomfort
4. Not enough anterior support

7. Lateral Trunk Bending

- **Description:**
  - The patient leans the body towards the prosthetic side when the prosthesis is in stance phase, shifting the patient's center of gravity towards the prosthesis

- **When to observe:**
  - From just after heel strike to mid-stance
- **How to observe:**
  - From behind the patient



Cause of lateral Trunk Bending

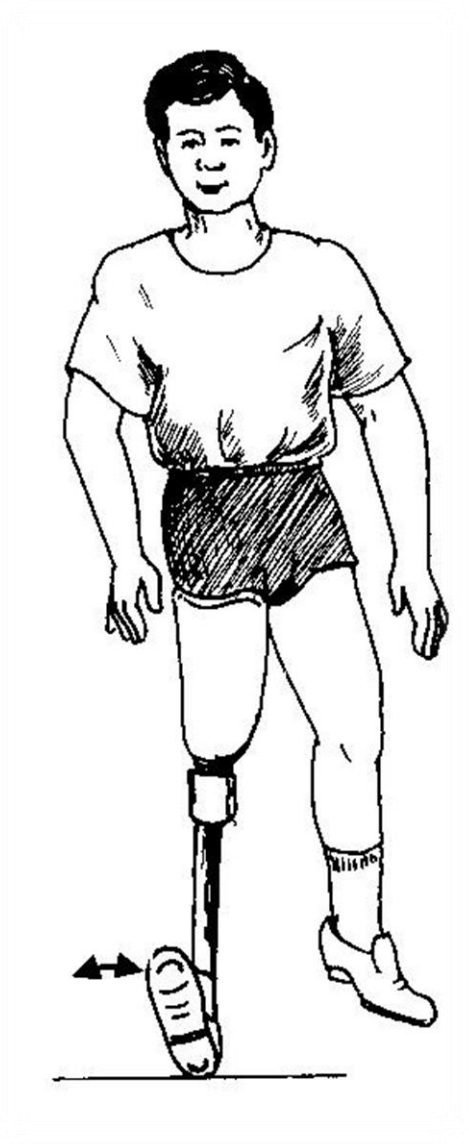
Amputee causes

1. Abduction contracture of stump
2. Very short stump
3. Weak hip abductors

Prosthetic causes

1. Lack of lateral support to femur
2. Prosthesis too short
3. Socket too abducted
4. Distal lateral pressure / pain
5. In combination with abducted gait

8. Rotation of the foot at heel strike



- **Description:**
  - As the heel contacts the ground, the foot rotates laterally, sometimes with a vibratory motion.
- **When to observe:**
  - At heel strike
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- **How to observe:**
  - From in front of the patient

Causes of foot rotation at heel strike

Amputee causes

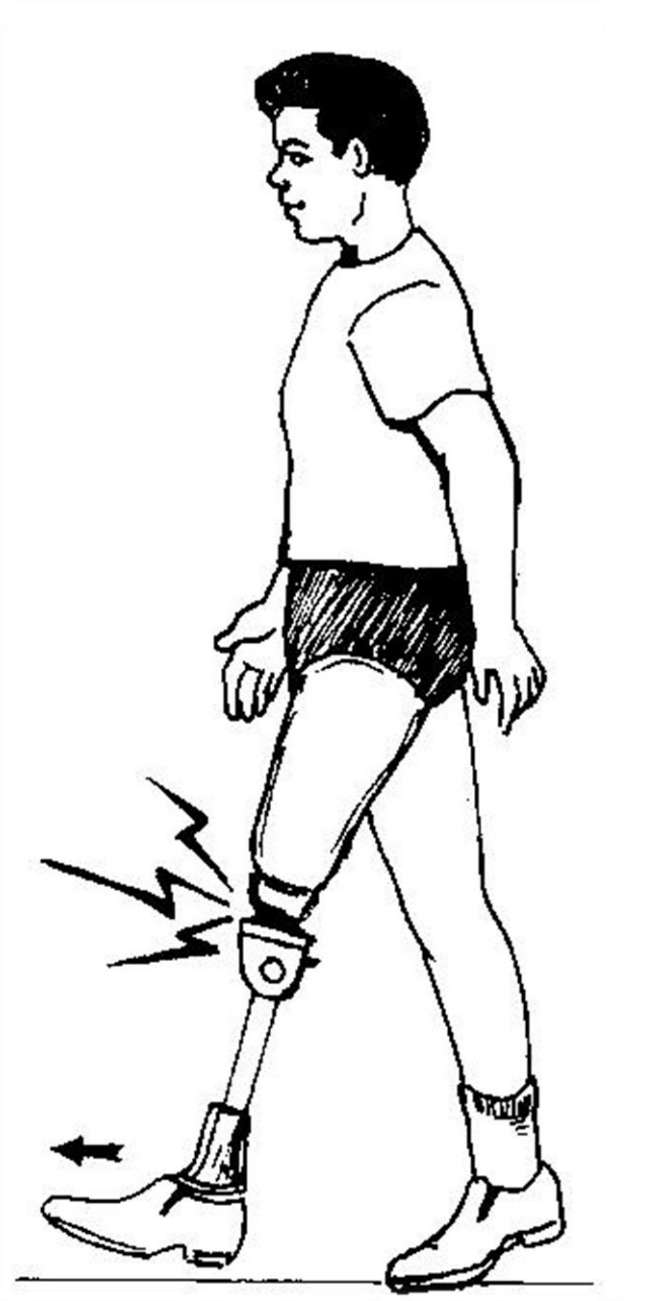
1. Poor muscle control
2. Correcting for a lateral whip

Prosthetic causes

1. Plantar bumper / Heel cushion is too hard
2. Socket too loose
3. Socket too tight
4. Too much toe out?

9. Terminal swing impact

- **Description:**
  - The prosthetic shank comes to a sudden stop with strong impact as the knee goes into extension
  - You may hear a noise when the prosthesis is fully extended
- **When to observe:**
  - At the end of swing phase
- **How to observe:**
  - From the side



Causes of terminal swing impact

Amputee causes

1. Lack of confidence in knee stability (forceful flexion of the hip at the beginning of swing to ensure knee is full extended at heel strike)

Prosthetic causes

1. Knee friction too loose
2. Extension assist too tight



10. Drop off

- **Description:**
  - At the end of stance phase, as the body moves forward over the prosthesis there is a downward movement of the trunk

- **When to observe:**
  - At the end of stance phase

- **How to observe:**
  - From the side

Causes of drop off

Amputee causes

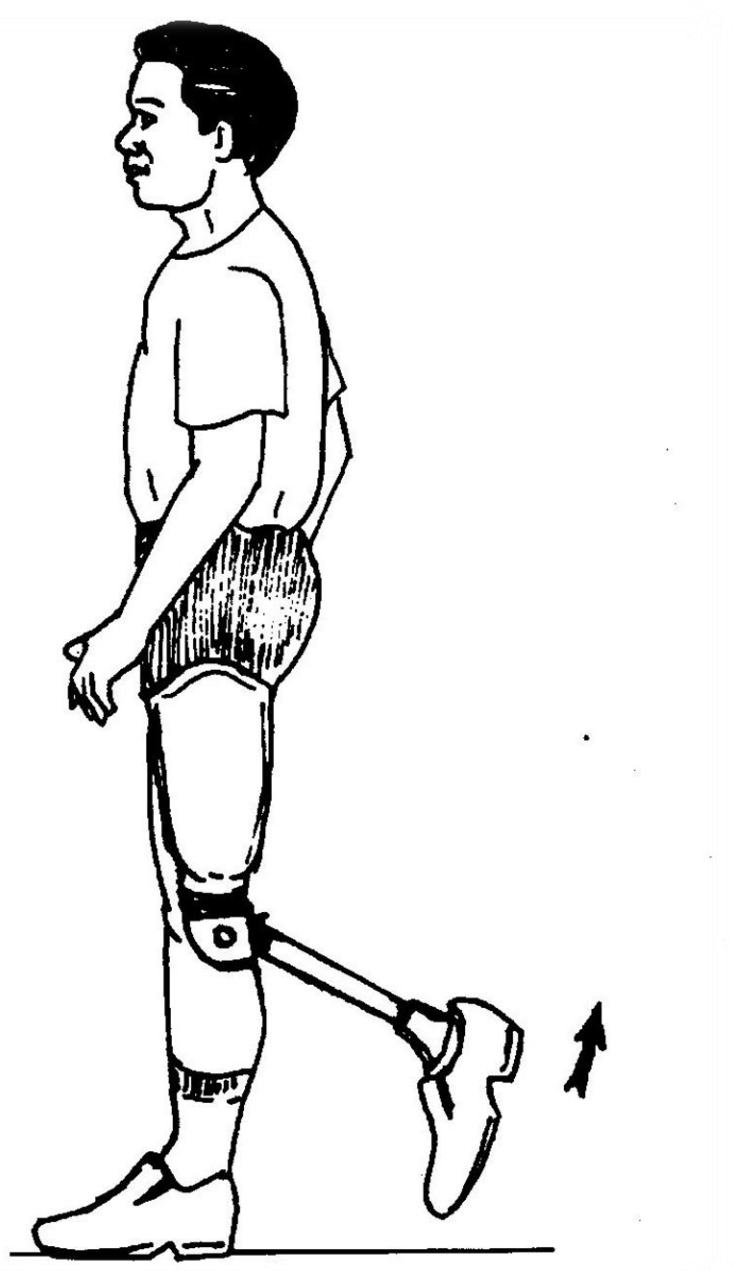
1. Use heel height shoes inappropriately

Prosthetic causes

1. Dorsiflexion bumper is too soft
2. Foot is too small
3. Socket too anterior

11. Uneven heel rise

- **Description:**
  - ➢The prosthetic heel rises higher than the sound heel, or the prosthetic heel shows a smaller rise than the sound heel.
- **When to observe:**
  - ➢During initial swing phase
- **How to observe:**
  - ➢From the side



Causes of too much/too little heel rise

Too much heel rise may be caused by:

- Not enough control (friction / pneumatic / hydraulic) on the prosthetic knee.
- No extension aid, or not enough tension in the extension aid.
- The patient forcefully flexing the stump to ensure that the prosthetic shank will be fully extended at heel strike.

Too little heel rise may be caused by:

- Too much control (friction / pneumatic / hydraulic) on the prosthetic knee.
- The extension aid being too tight.
- Fear and insecurity, as the amputee walks with little or no knee flexion.
- Manual knee lock.

12. Uneven Gait: Timing, Step length, Arm swing

Uneven Step length

- The amputee makes shorter or longer steps on the prosthetic side

Uneven Timing

- The amputee spend less time on prosthetic side

Uneven arm swing

- The amputee does not swing the arms normally and evenly

12. Uneven Gait:

Amputee causes

1. Lack of confidence
2. Pain
3. Muscles weakness

Prosthetic causes

1. Unstable prosthesis

Summary

- Gait Deviations are needed to analyzed carefully and identified the root causes.
- Correct the gait deviation one by one
- There are many gait deviations in TF compare to TT
- Look at the movie and identify which gait deviation occur

Questions ?

Thank you