Al-Mustaqbal University
Collage of Engineering
Prosthetics and Orthotics Engineering

Second Stage

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Prosthetics I

(UOMU0103041)

Lecture 5

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Subject: Prosthetics 2
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Prosthetic Gait Biomechanics - Loading Response

1. Sagittal Plane Dynamics

Knee Flexion Moment

- The knee should flex smoothly up to about 20 degrees during the loading response as the forefoot contacts the ground, which facilitates forward limb progression and shock absorption.
- An excessive knee flexion moment could be due to a foot set too far back, excessive dorsiflexion, or a rigid heel. Conversely, insufficient knee flexion moment might result from a too-soft heel or a foot set too far forward, risking knee hyperextension.

Adjustment Strategies

- Prosthetic adjustments might include modifying the heel lever length, its stiffness, and the foot's orientation to ensure an appropriate degree of knee flexion.

Frontal Plane Dynamics

1. **Even Loading**
   - The foot should be parallel to the ground at initial contact to avoid excessive moments at the knee during rapid loading.
   - The plantar surface should remain level during this phase, providing stability and balance.
2. **Foot Adaptability**
   - Modern prosthetic feet with inversion and eversion capabilities can adapt upon weight bearing, which is beneficial for ambulating on uneven surfaces.
   - Observation of the foot's motion during loading on a flat surface can indicate if alignment adjustments are necessary.

Transverse Plane Dynamics

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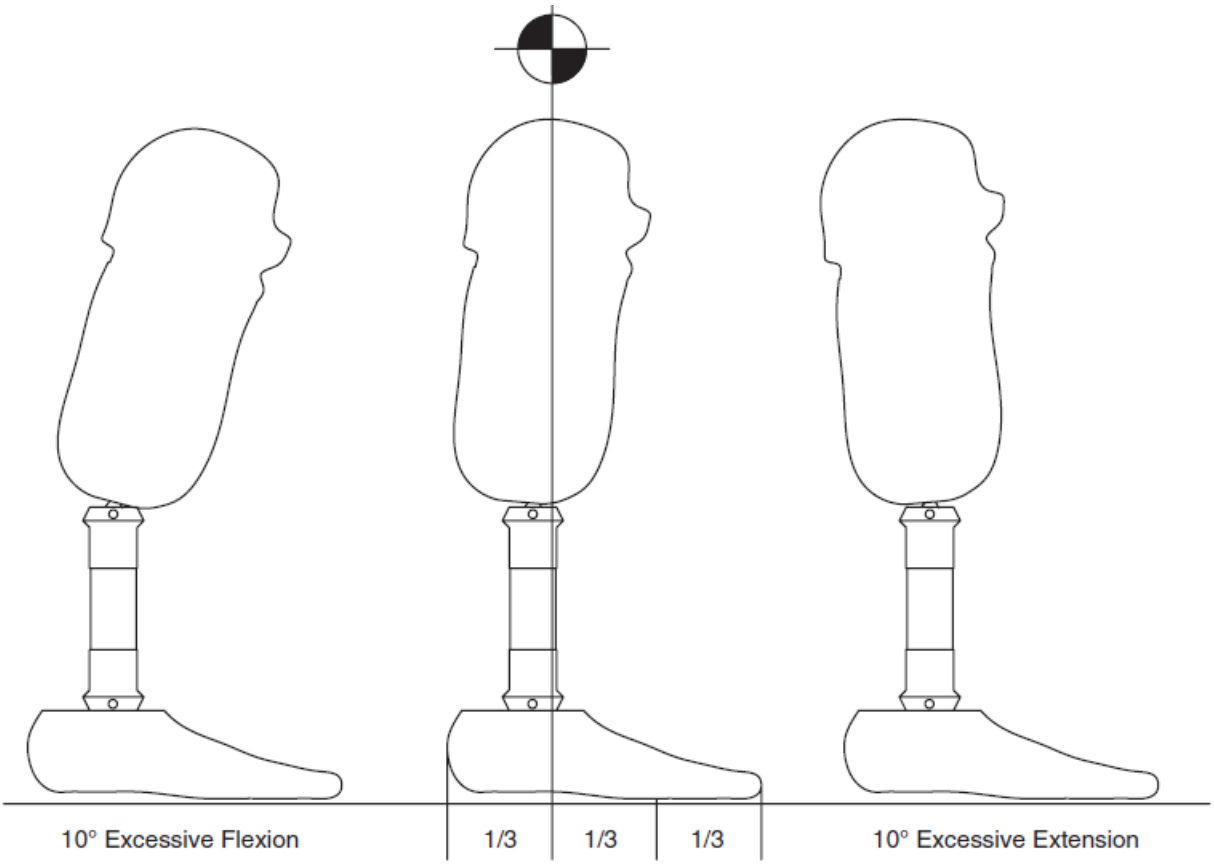
1. **Foot Rotation**

- Rotation during loading suggests a potential issue with the torsion adapter, which could be loose or faulty, causing uncontrolled rotary moments.
- Prosthetic feet that exhibit excessive toe-in or toe-out can lead to rotational forces that should be managed with torsion adapters to control the motion.



Prosthetic Gait Biomechanics - Midstance to Swing Phase

Midstance Mechanics

1. Frontal Plane

Heel Rise and Knee Flexion

- The heel should lift off the ground as the knee flexes, pivoting over a point between the first and second toes. Any significant deviation can result in instability and reduced step length.
- The knee should maintain a straight path without any lateral motion; any deviation could cause a lateral whip during the swing phase.

2. Transverse Plane

Toe Load and Prosthesis Rotation

- Toe load is at its peak during midstance, and improper alignment can result in rotational issues.
- Excessive external or internal rotation of the prosthesis can be caused by malalignment, like a foot that is too far outset or inset or improperly rotated.

Preswing Mechanics

1. Sagittal Plane

Weight Transfer and Toe-off

The prosthesis should facilitate a smooth roll-over motion for toe-off. Toe-drag can indicate a plantarflexed foot or suspension issues.

2. Frontal Plane

Knee Movement

Medial or lateral knee motion during preswing can indicate problems such as an incorrectly rotated foot, an improperly set foot, or socket alignment issues.

3. Transverse Plane

Stability

Proper attention to transverse plane alignment is necessary to avoid instability in preswing, which can be caused by similar factors that affect stability in the frontal plane.

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Swing Phase Mechanics

1. Sagittal Plane

Ground Clearance

The prosthesis should provide sufficient clearance during swing phase. A lack of clearance, despite appropriate knee flexion, could point to suspension issues or a plantarflexed foot.

Pistoning

Pistoning, or vertical movement of the prosthesis in the socket, should be minimal. Excessive pistoning may require suspension adjustments.

2. Frontal Plane

Socket Stability

Instability of the socket during swing phase can be due to faulty suspension or a loose fit. Remedies may include increasing sock ply or improving suspension systems.

3. Transverse Plane

Whip

- Rotation or 'whip' during swing phase can result from misalignments or improper loading patterns. Medial whip indicates inward movement of the heel in early swing, while lateral whip is the opposite.
- Adjustments may include realigning the prosthetic foot or addressing hip function through strengthening and range of motion exercises.