



**Al-Mustaqbal University  
College of Engineering  
Prosthetics and Orthotics Engineering**



## **Lecture 2**

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## Lecture 2

### Prosthetic Alignment for Transtibial Amputations

#### Prosthetic Alignment

Prosthetic alignment refers to the critical process of adjusting the spatial orientation of the prosthetic socket in relation to the foot, directly influencing the functionality and comfort of the prosthesis during the gait cycle. Proper alignment is pivotal for achieving a natural gait and minimizing strain on the wearer's body. This lecture aims to explore the principles, goals, and methods of prosthetic alignment, focusing on transtibial amputations.



#### Goals of Prosthetic Alignment

The primary objectives in aligning a prosthesis are to:

- Facilitate heel strike at initial contact.
- Ensure single limb stability during the stance phase.

- Enable smooth forward progression (rollover) from early to late stance.
- Guarantee adequate swing phase toe clearance.

Achieving these goals requires a dynamic alignment process, allowing for adjustments in all three planes to accommodate an individual's unique gait patterns.

### **Dynamic Alignment Process**

Dynamic alignment is an iterative process that involves the wearer walking on a prosthesis fitted with an adjustable device. This process is essential for:

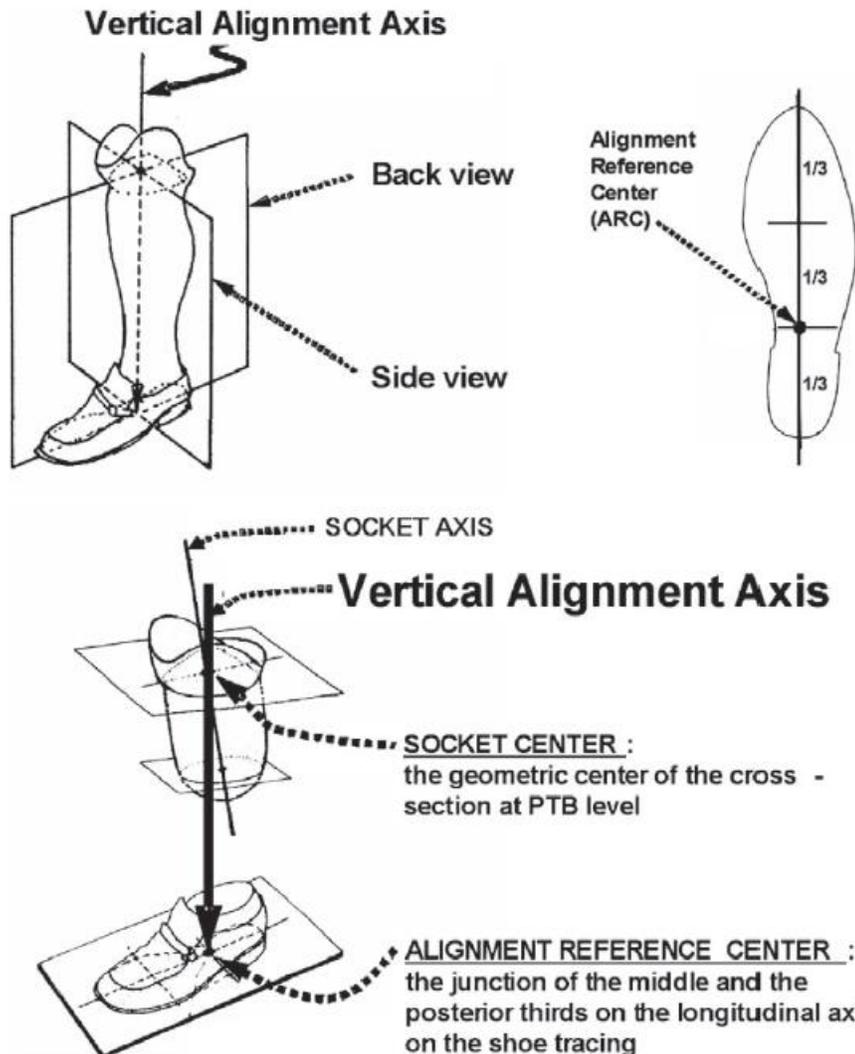
- Adapting the prosthesis to the wearer's gait.
- Addressing pressure issues within the socket.
- Balancing the need for stability, mobility, and comfort.

It involves making precise adjustments to the modular components connecting the socket, pylon, and foot, including angular changes (flexion, extension, abduction, adduction, inversion, eversion, plantarflexion, and dorsiflexion) and linear shifts (medially, laterally, anteriorly, posteriorly).

### **Bench Alignment, The Starting Point**

Bench alignment serves as the initial setup from which dynamic alignment adjustments are made. Key aspects of standard bench alignment include:

- 5 degrees of socket flexion and adduction.
- The top of the prosthetic foot level in frontal and sagittal planes.
- The medial border of the foot parallel to the line of progression.
- Placement of a plumb line from the anatomic knee center to a specific point on the foot to ensure proper load distribution and shock absorption during gait.



### Practical Considerations in Prosthetic Alignment

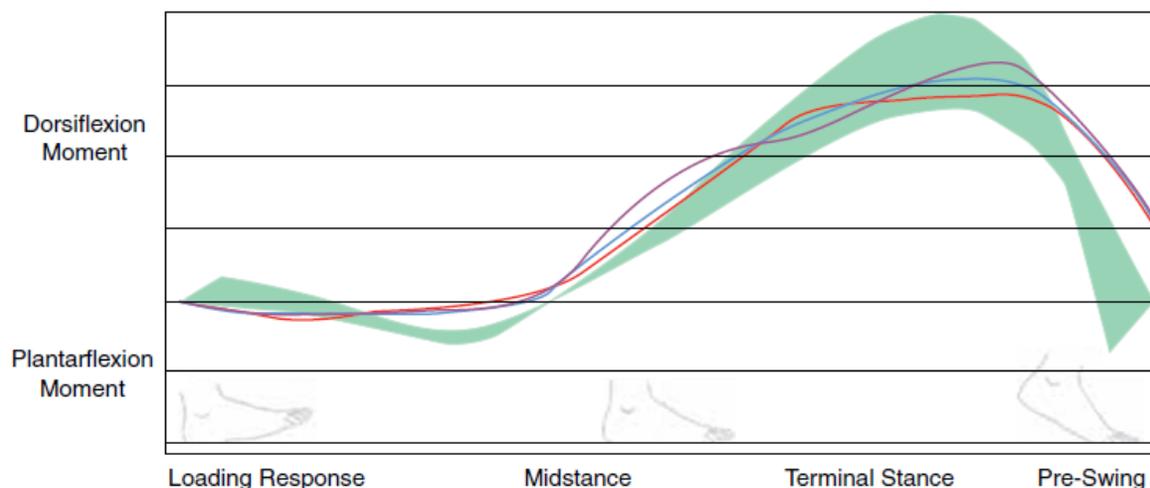
- **Socket Adjustments**, Tilting the socket forward (flexion) or backward (extension) affects how forces are distributed during gait, impacting the wearer's comfort and stability.
- **Linear Changes**, Adjusting the socket's position medially, laterally, anteriorly, or posteriorly helps align the foot directly under the knee, crucial for static and dynamic stability.
- **Customization for Individual Needs**, Prosthetic alignment is highly individualized, taking into account the wearer's anatomy, gait peculiarities, and any specific challenges such as joint contractures or deformities.

## Understanding Electronic Alignment

Electronic alignment leverages cutting-edge technology through the use of embedded electronic sensors within the prosthetic components. These sensors are instrumental in capturing real-time gait data as the user moves. This data includes vital information on the forces and moments exerted on the prosthesis during a complete gait cycle.

## The Role of Technology in Prosthetics

The collected data is transmitted wirelessly to a nearby computer, where specialized software processes this information. The software is capable of superimposing the actual forces and moments recorded during the gait cycle over a set of normalized data. This comparison reveals the "invisible" forces acting on the prosthesis, providing invaluable cues for the prosthetist.



## Benefits of Electronic Alignment

- 1 **Precision in Prosthetic Alignment**, By visualizing the actual forces and moments, prosthetists can pinpoint specific variances from the norm, allowing for a more precise alignment tailored to the individual's unique gait pattern.
- 2 **Prevention of Long-term Damage**, Identifying and addressing alignment issues early on can prevent the development of long-term damage to the user's limb. For instance, detecting an excessive varus moment at the knee can avert premature medial compartmental osteoarthritis.

- 3 **Objective Data Analysis**, The ability to capture and analyze objective data revolutionizes the approach to prosthetic fitting. This objective analysis aids in understanding the biomechanical impact of the prosthesis on the user, leading to more informed adjustments and enhancements.
- 4 **Documentation and Reference**, The objective data collected can be printed and stored in the user's file. This serves as a valuable reference for tracking the evolution of the user's gait pattern, addressing any future problems, or making necessary adjustments to the prosthesis.

