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Department of prosthetics and orthotics engineering

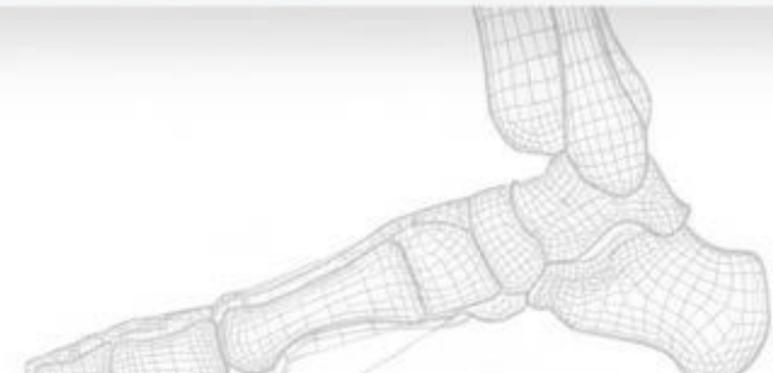
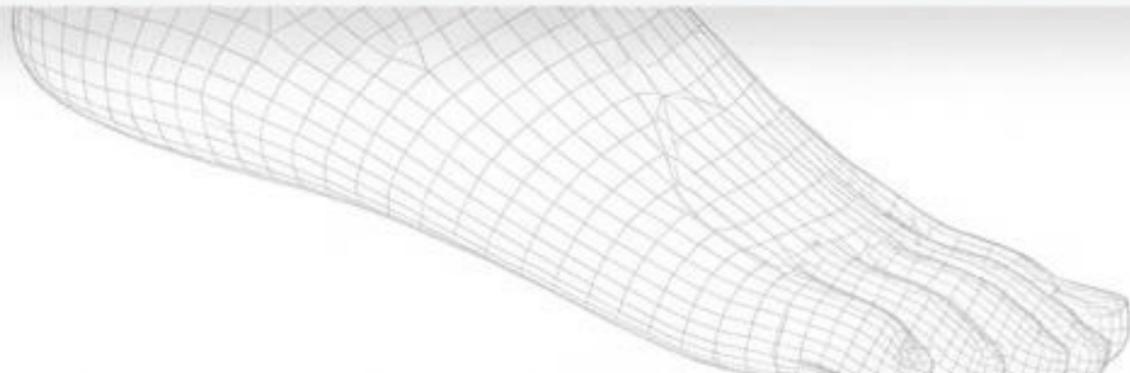
Third Stage

By:  
Eng. Aya Talib

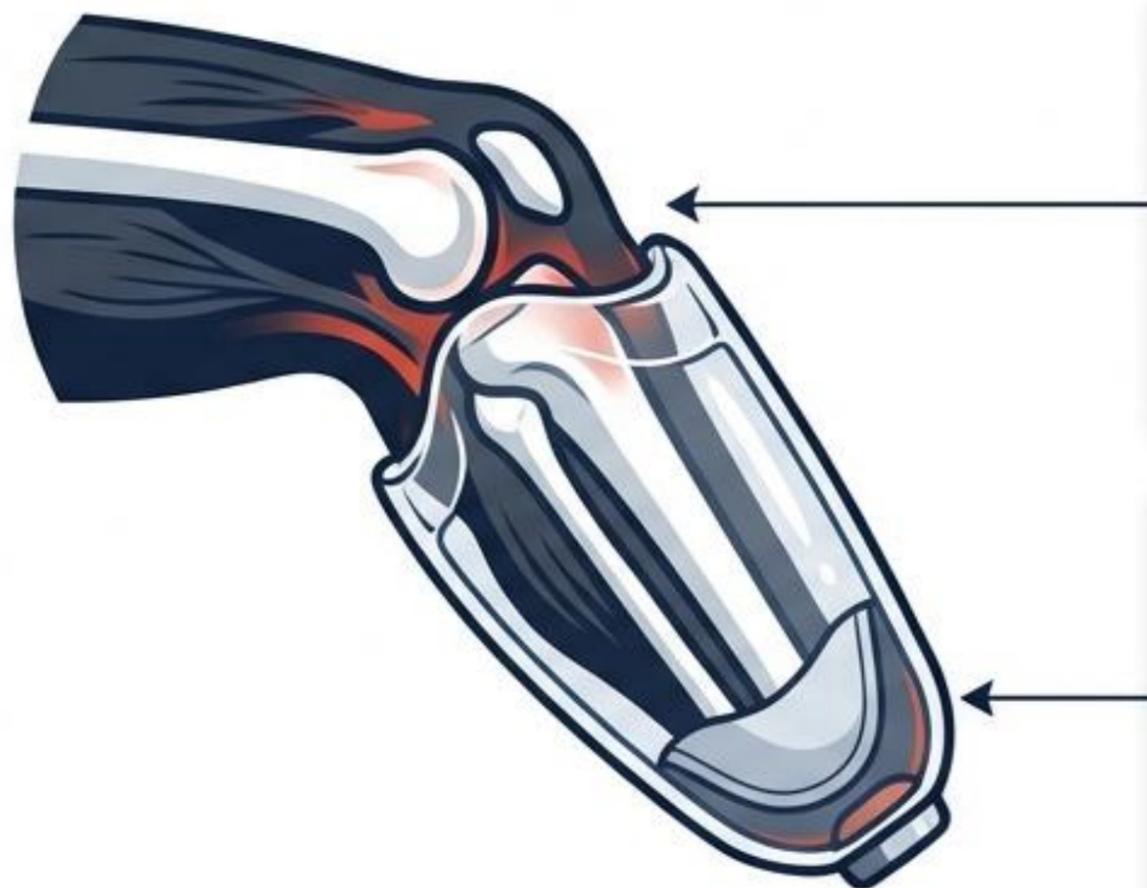


# Biomechanics of Prosthesis Interface Pressure

From Measurement to Clinical Application



# The Prosthesis-Patient Interface



## The Contact Region

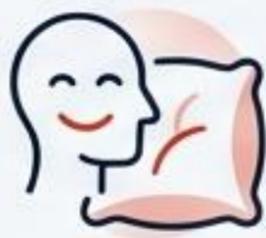
The **exact boundary** between the residual limb and prosthetic socket.

## Force Transfer

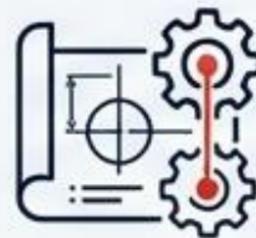
The **critical zone** where body weight and movement forces are transferred.



Prevent skin damage



Improve comfort



Optimize socket design



Improve gait performance

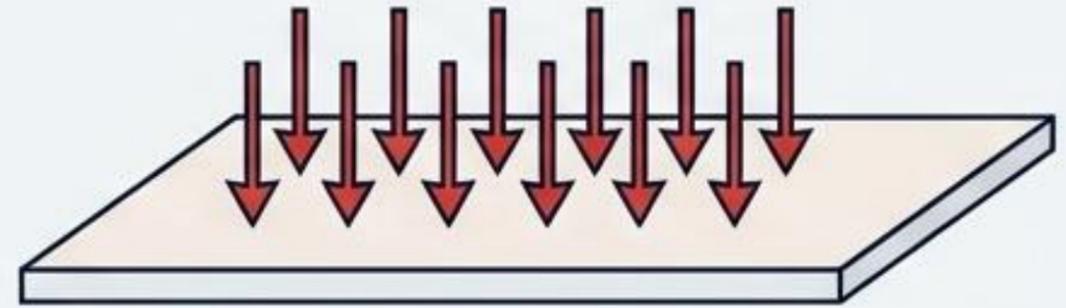
# The Biomechanics of Pressure

$$Pressure = \frac{Force}{Area}$$

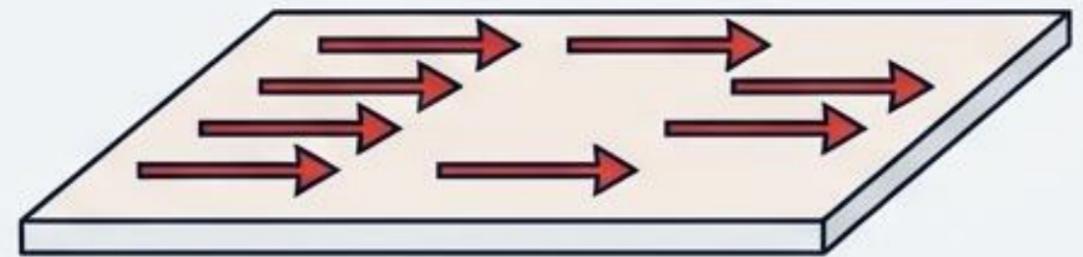
## Primary Influencing Factors:

- Body weight
- Socket shape
- Soft tissue thickness
- Prosthetic alignment

Normal Pressure



Shear Stress



Note: Both **critically** influence tissue health and viability.

# Human Body Parameters



## Limb Length

Impacts leverage and force distribution.



## Soft Tissue Thickness

Acts as natural padding (or lack thereof).



## Bone Prominences

**Critical high-risk zones** for pressure spikes.



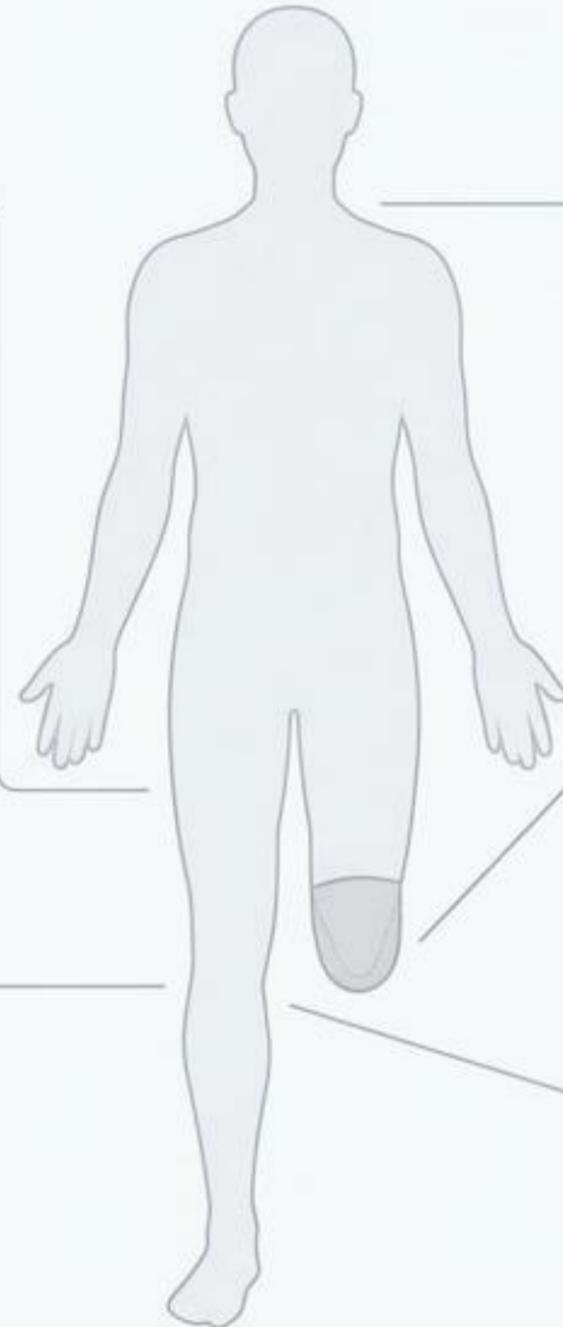
## Skin Condition

Determines tissue tolerance to stress.



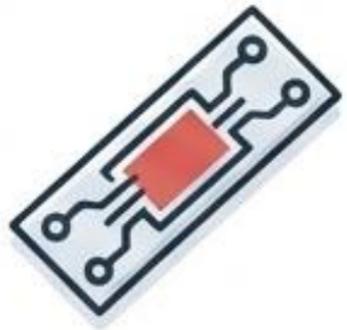
## Body Weight

The primary vertical force generator.



# Pressure Measurement Methods

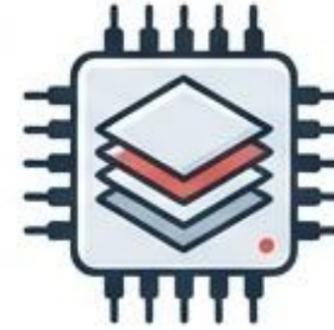
The Goal: Ideal sockets distribute load evenly across pressure-tolerant areas.



## 1. Force Sensitive Resistors (FSR)

Principle of deformation:

- Force sensitive resistor, in sensing and large conductive pressure.



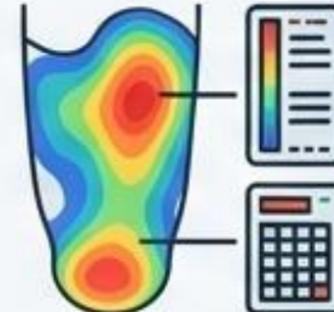
## 2. Capacitive Sensors

Brief sensitive deflections on capacitive plate all indicate sensing.



## 3. Air Bladder Systems

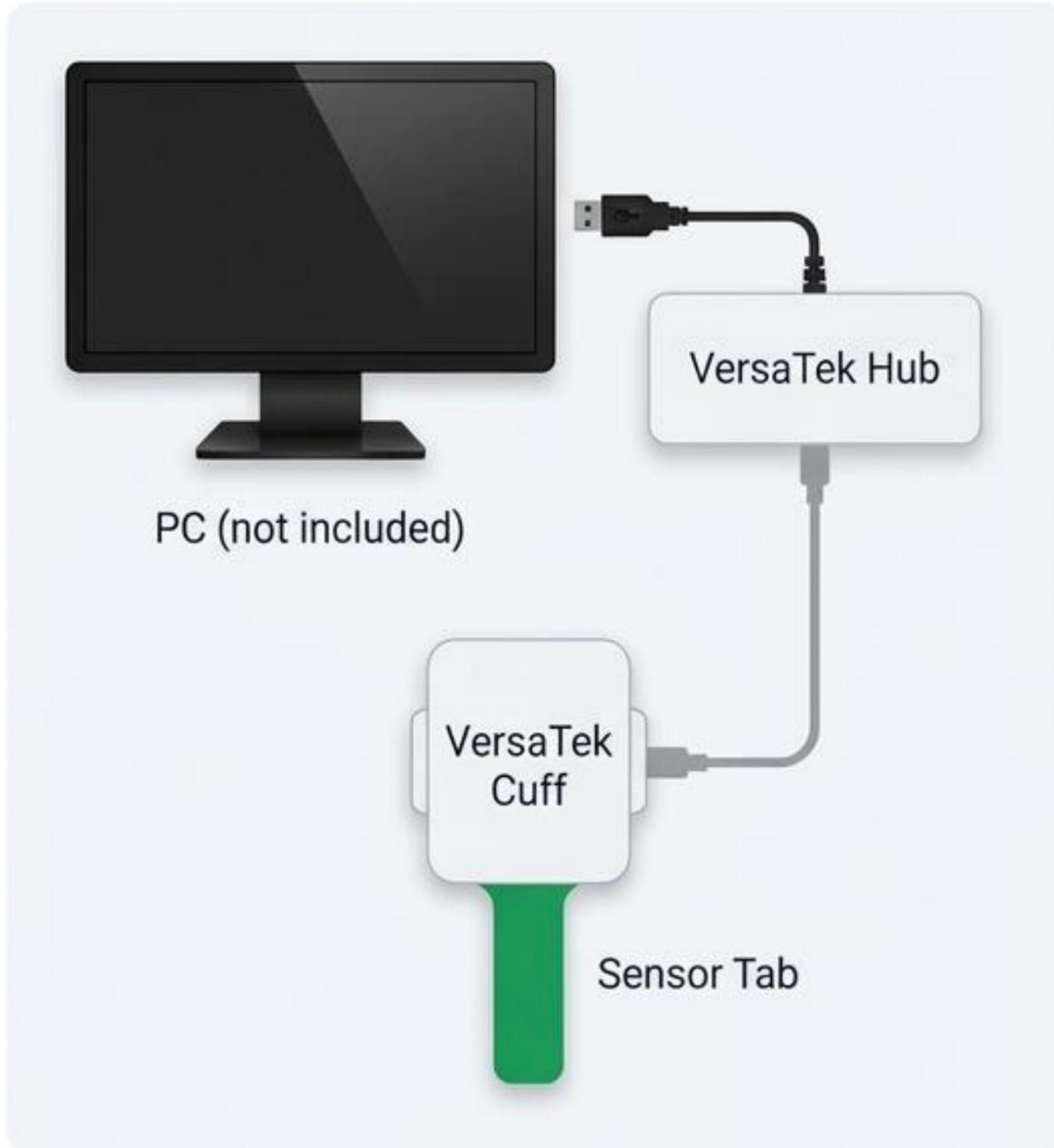
Pneumatic pump uses regulation to soft in air bladder cushion.



## 4. Pressure Mapping Systems

Advanced function of pressure mapping systems, and identify high pressure areas.

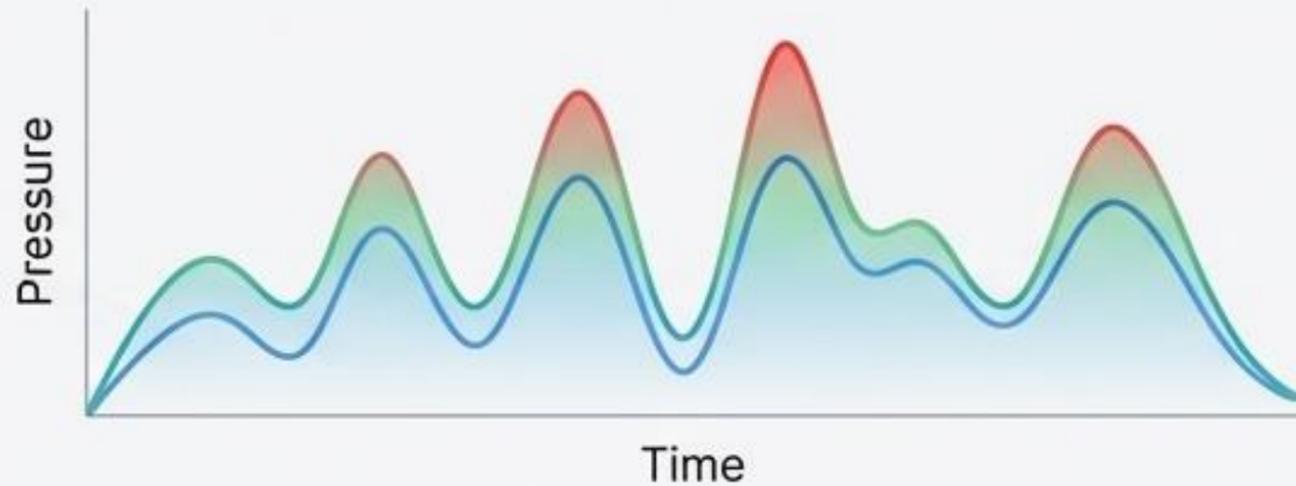
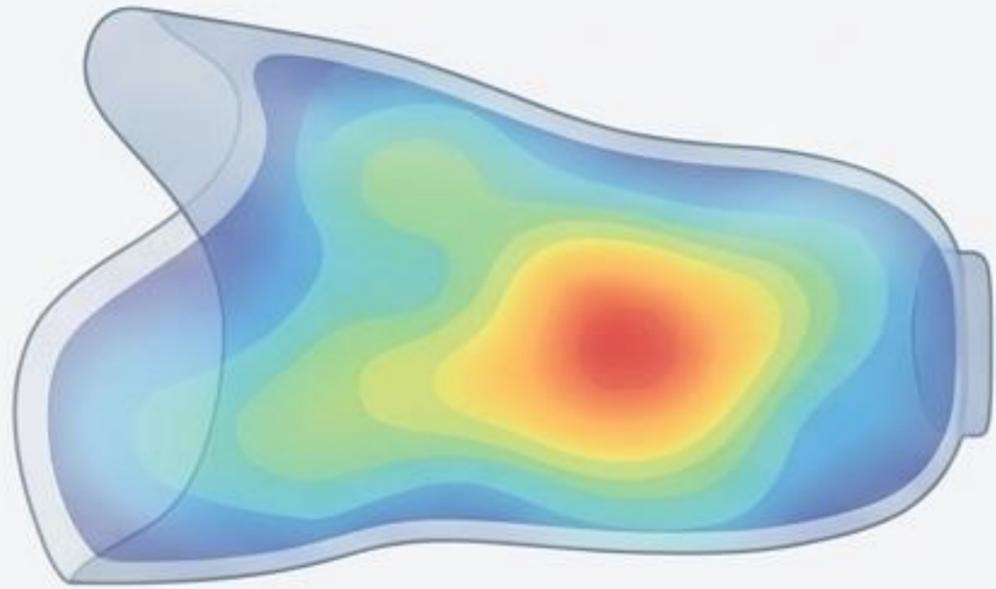
# Pressure Mapping Systems in Action



## The Process

- Sensors are placed directly inside the socket.
- Data is captured dynamically while the patient stands or walks.
- Gait Phases Measured: Heel strike, Mid-stance, Push-off.

# Translating Data to Insights



— Pressure Heat Map    — Time-Pressure Graph

## System Outputs:

- Visual Pressure Maps (identifying hot spots)
- Peak Values
- Time-Pressure Graphs

### Maximum Pressure

The absolute peak pressure detected at the limb-socket interface. Used to evaluate prosthetic fit and immediately improve patient comfort.

# Clinical Case Study: Pressure Distribution in a PTB Socket

## Patient Profile

Inter Heading	Inter Heading
<b>Age/Gender:</b>	45 years, Male
<b>Amputation:</b>	Transtibial (Traumatic injury)
<b>Time since amputation:</b>	10 months
<b>Prosthesis:</b>	Patellar Tendon Bearing (PTB) socket

## The Complaint

- Pain during walking.
- Redness over the tibial crest.

# Physical Examination Findings



Slight limp observed during walking.



Mild trunk lean toward the prosthesis (compensation mechanism)

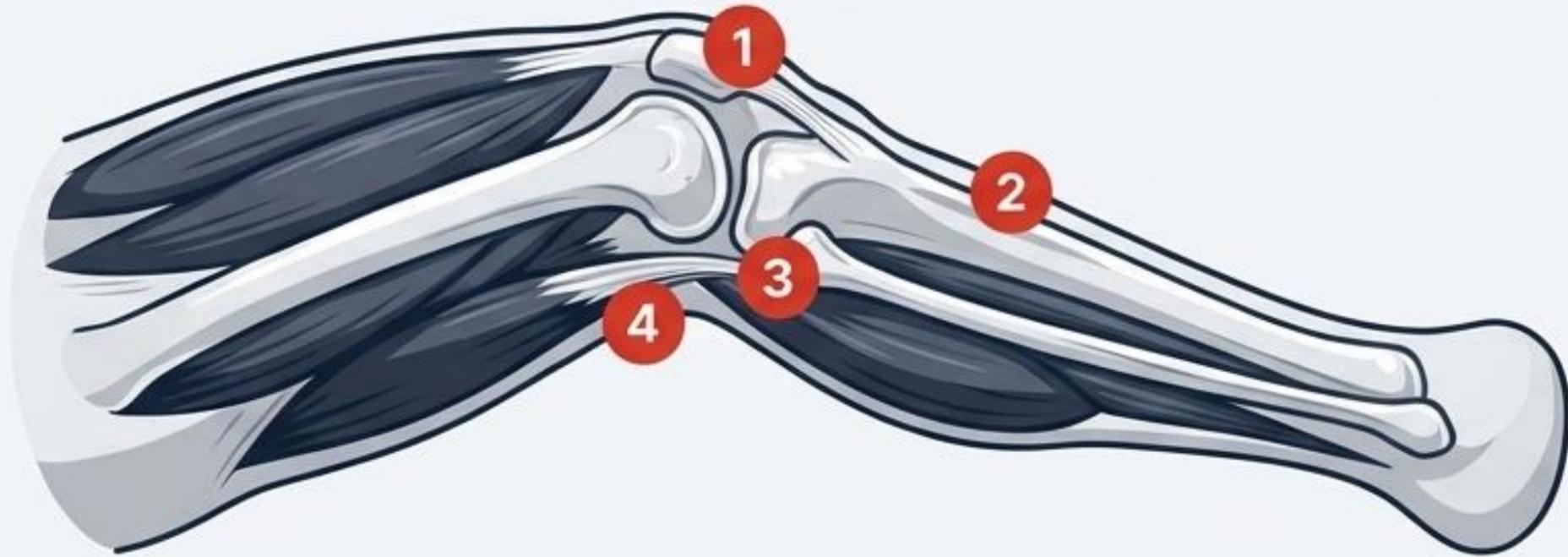


Shorter step length specifically on the prosthetic side



Skin Assessment: Distinct redness localized over the tibial crest after exactly 20 minutes of walking.

# The Diagnostic Setup



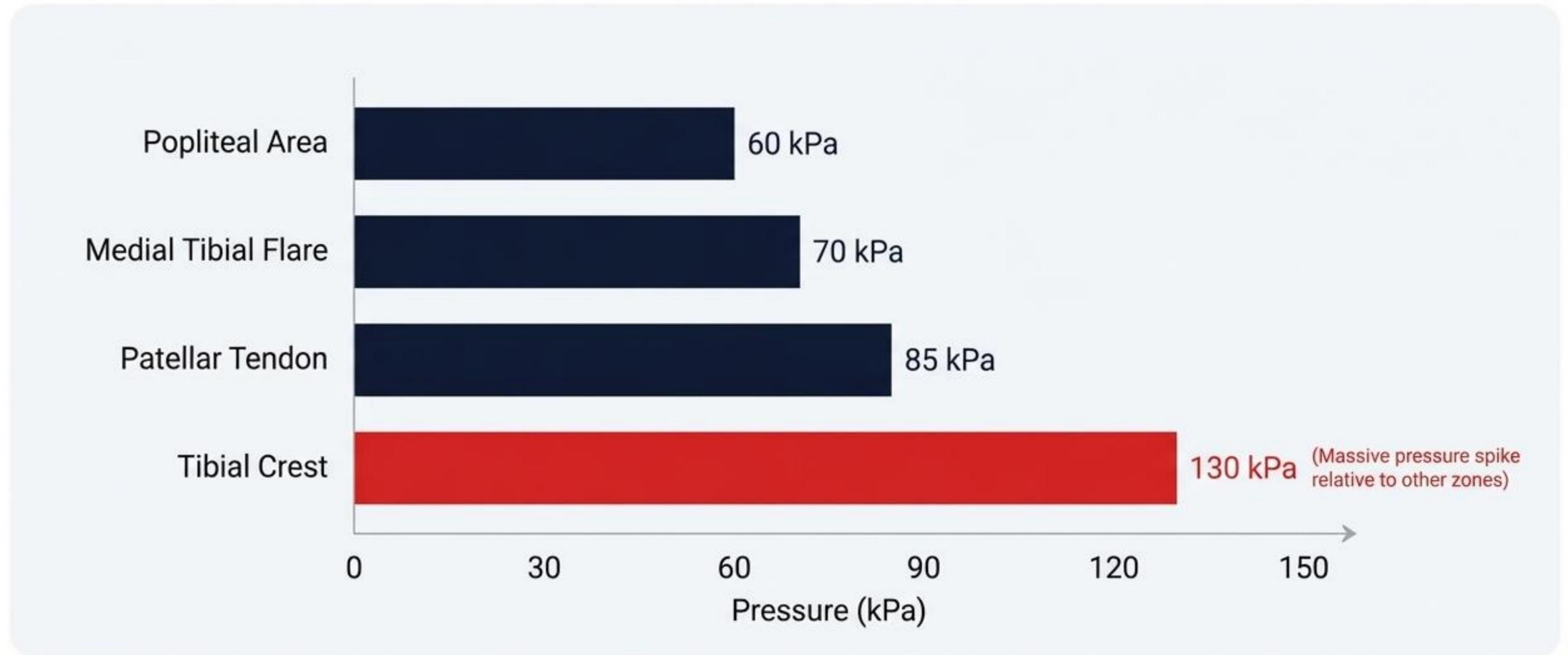
## Sensor Placement Zones:

- 1. Patellar Tendon
- 2. Tibial Crest
- 3. Medial Tibial Flare
- 4. Popliteal Area

## Test Parameters:

Pressure captured continuously during standing and walking on level ground.

# Interface Pressure Results



# Pressure Map Interpretation

**130 kPa Spike**



**Skin Redness on  
Tibial Crest**

## **Analysis:**

- High pressure concentration located precisely at the tibial crest.
- Evidence of highly uneven load distribution.
- Severe overloading of a known pressure-sensitive anatomical area.

**Clinical Conclusion:** The quantitative data confirms an improper socket fit.

# Biomechanical Root Cause Analysis

## Possible Causes (The 'Why')

- Incorrect socket shape
- Improper prosthetic alignment
- Insufficient padding
- Limb volume change (shrinkage/swelling over the 10 months post-amputation)



## The Biomechanical Effect (The 'Result')

Increased **localized pressure** directly causing tissue stress and acute discomfort.

# The Clinical Solution

## Action Plan



### **Modify**

Increase socket relief specifically at the tibial crest.



### **Protect**

Add strategic padding in sensitive areas.



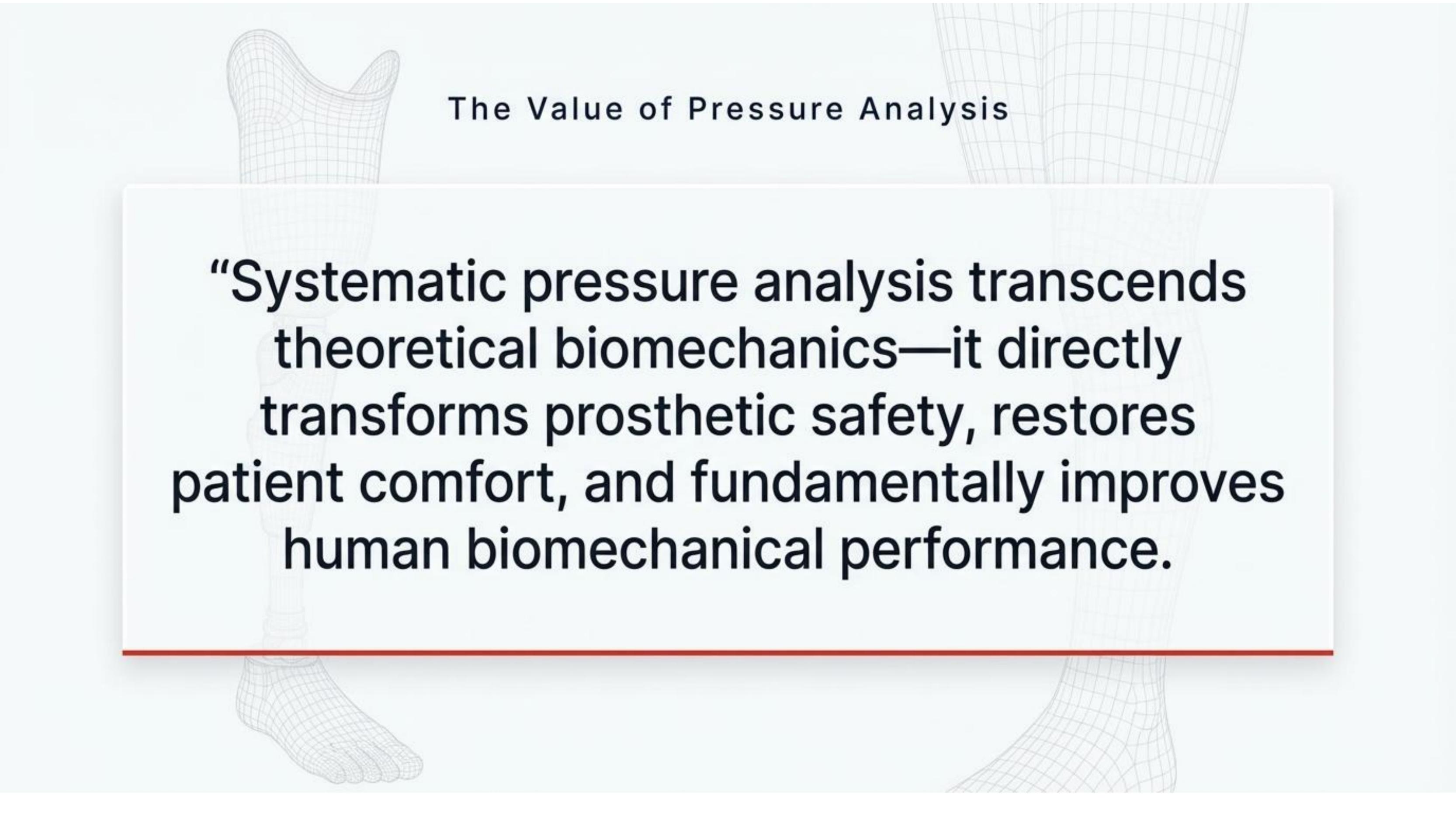
### **Re-align**

Adjust prosthetic components to correct the trunk lean and step length.



### **Reassess**

Evaluate the new gait pattern post-adjustment to confirm load distribution.

The background features two wireframe models of a lower leg and foot. On the left, a prosthetic leg is shown with a grid overlay, representing pressure analysis. On the right, a human leg is shown with a similar grid overlay. The title 'The Value of Pressure Analysis' is centered at the top.

## The Value of Pressure Analysis

**“Systematic pressure analysis transcends theoretical biomechanics—it directly transforms prosthetic safety, restores patient comfort, and fundamentally improves human biomechanical performance.**

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