



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



Second Stage

2st term

2025/2026

Prosthetics I

College of Engineering

(UOMU0103041)

2010

Lecture 1

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Lecture 1

Understanding Prosthetic Suspension Systems

Introduction

In the field of prosthetics, one crucial aspect that significantly affects the comfort, functionality, and overall user satisfaction with a prosthesis is the method by which the prosthesis is attached and held to the limb, known as the "suspension." The ideal suspension system ensures that there is no relative motion between the socket (the part of the prosthesis that encases the residual limb) and the limb itself. This lecture will delve into the principles of prosthetic suspension, the undesirable effect known as "pistoning," and the various suspension strategies employed to optimize prosthetic use and wearer comfort.

➤ The Challenge of Pistoning

Pistoning refers to the unwanted motion between the prosthesis socket and the limb, akin to the motion of a piston in a cylinder of an internal combustion engine. When a prosthetic suspension system is inadequate or faulty, pistoning occurs, subjecting the limb to abnormal loading patterns. This can lead to discomfort, pain, skin breakdown, and diminished control over the prosthesis. Thus, minimizing this motion is paramount in prosthetic design.

➤ Suspension Strategies

To combat pistoning and ensure a secure fit, various suspension techniques have been developed. These can be used individually as the primary mode of suspension or in combination for enhanced stability and comfort.

1. Waist Belt Suspension

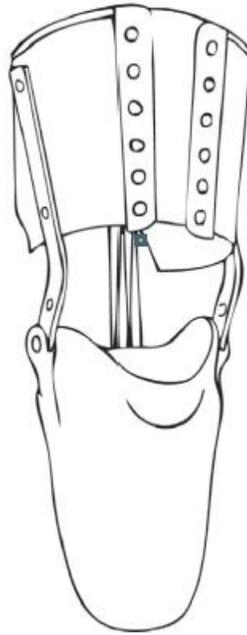
- A. Historically used for early transtibial prostheses, this method employs a waist belt connected to the thigh corset via an elastic strap. The belt wraps around the pelvis, and its adjustable nature allows for a personalized fit. The key feature is an inverted Y-strap that connects to the socket, designed to accommodate hip and knee joint movements.
- B. **Benefits**, The system's elasticity and the Y-strap design permit hip and knee flexion during the gait cycle, reducing the risk of pistoning. The wearer can

adjust the tension for comfort, with enough tension to control socket movement yet allowing slack when seated.



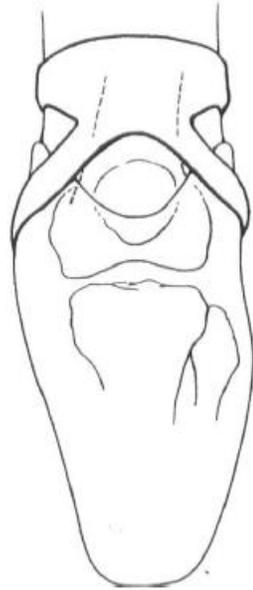
2. Joints and Corset Suspension

- A. **Description**, This system combines suspension with a weight-bearing function, especially beneficial when the thigh corset is accurately fitted over the femoral condyles. It uses a stiff corset, typically made of leather, which can be secured with straps or laces. Steel knee joints provide a stable connection to the socket.
- B. **Benefits**, The joints and corset system is adept at providing a secure fit, reducing pistoning, and enhancing comfort during knee flexion. It's particularly suitable for individuals with knee ligament instability, offering a controlled range of knee motion and potentially limiting terminal knee extension to prevent excessive wear and noise.



3. Cuff Strap Suspension

- a) The cuff strap consists of a flexible leather cuff that attaches to the socket, positioned just posterior and proximal to the anatomical knee center. It features an adjustable strap that encircles the thigh, providing suspension by leveraging the patella and femoral condyles.
- b) **Functionality**, After the socket is donned, the cuff is secured to allow the prosthesis to hang comfortably during standing and walking. The design aims to offer a secure suspension while allowing free knee flexion. However, due to its reliance on the geometry of the thigh and the lower height of the socket walls, this method is less suitable for individuals with short residual limbs or significant muscle or adipose tissue around the lower thigh.

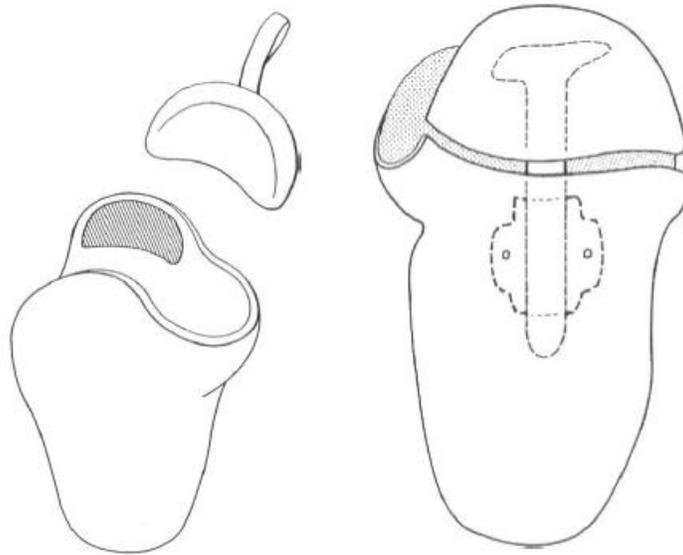


- c) **Advantages and Limitations**, The cuff strap is simple, quickly fabricated, and effectively secures the prosthesis. However, it lacks weight-bearing capacity and mediolateral stability, limiting its suitability to certain user profiles.

4. Supracondylar Suspension

- a) **Description**, This technique achieves suspension by fully encompassing the femoral condyles within a rigid transtibial socket. By extending the medial and lateral trim lines of the socket above the adductor tubercle, the socket's top narrows, capturing the femoral condyles to prevent upward movement.
- b) **Benefits** Supracondylar suspension enhances mediolateral stability by increasing the lever arm length proximal to the knee center. This method, especially when combined with a PTB-style socket (PTB-SC), significantly improves the stability and control of the prosthesis.
- c) **Donning Techniques** To facilitate donning, given the tighter fit around the condyles, two main approaches are used: a detachable medial wall or a supracondylar wedge within a soft insert. The first approach involves a removable steel bar that locks into place once the limb is inserted, while the second employs a flexible liner with a built-in wedge, allowing for easier insertion into the rigid socket.
- d) **Considerations**, A minimum difference in width between the knee joint and the thigh proximal to the adductor tubercle is essential for effective suspension. Adjustments near the condyles can enhance comfort when seated, though the

visibility of high medial and lateral walls through clothing when the knee is flexed may be a concern for some users.



Feature	Waist Belt Suspension	Joints and Corset Suspension	Cuff Strap Suspension	Supracondylar Suspension
Description	Uses a waist belt connected to a thigh corset via an elastic strap.	Combines a thigh corset and knee joints for suspension and weight-bearing.	Consists of a flexible leather cuff that attaches to the socket, using the thigh's anatomy for suspension.	Employs a rigid socket that fully encompasses the femoral condyles for suspension.
Primary Suspension Area	Pelvis and thigh	Thigh, over femoral condyles	Thigh, proximal to patella	Femoral condyles within the socket
Adjustability	High, with adjustable tension for comfort	Moderate, with adjustments through straps or laces	High, via an adjustable strap	Low, fit is crucial for effectiveness
Joint Movement Accommodation	Good, accommodates hip and knee flexion	Good, designed to enhance sitting comfort and accommodate knee flexion	Good, allows for knee flexion without restraint	Moderate, increased stability but may restrict movement
Mediolateral Stability	Low	High, especially if corset is well-fitted	Low	High, due to narrow socket design

Weight-Bearing Capacity	Low	High, if corset is properly fitted	None	None
Ease of Donning	Moderate	Moderate	High	Low to moderate, depending on the donning method used
Suitability for Short Residual Limbs	Moderate	Moderate to high	Low	High, with careful design
Aesthetic Considerations	Visible across hip and knee joints	Less visible but can be bulky	Low profile	High medial and lateral walls may be visible through clothing
Special Considerations	Flexibility in seated position	Suitable for ligamentous instability of the knee	Not suitable for those with significant muscle or adipose tissue around the lower thigh	Requires precise fit; visibility through clothing may be a concern

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