Al-Mustaqbal University

Collage of Engineering

Prosthetics and Orthotics Engineering

Third Stage

PROSTHETICS II

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1st term – Lecture 1

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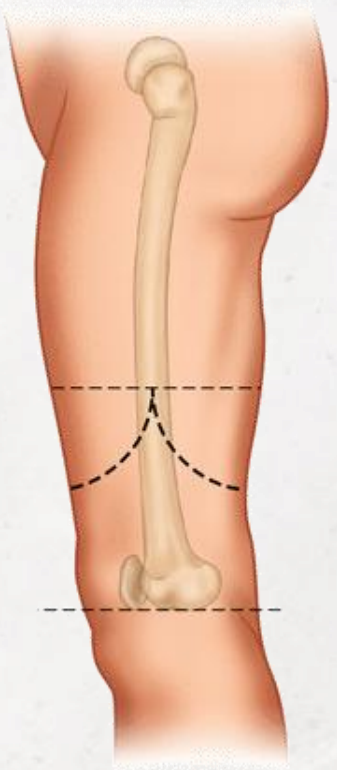


1

Transfemoral Amputation

Transfemoral amputation (above-knee amputation) is the surgical removal of the lower limb through the femur, above the knee joint.

It is one of the most common major lower-limb amputations after transtibial amputation.

Indications include:

- Peripheral vascular disease.
- Trauma.
- Malignancy.
- Severe infection or gangrene.

This level of amputation results in the **loss of the anatomical knee joint**, requiring a **prosthetic knee joint** for functional mobility.

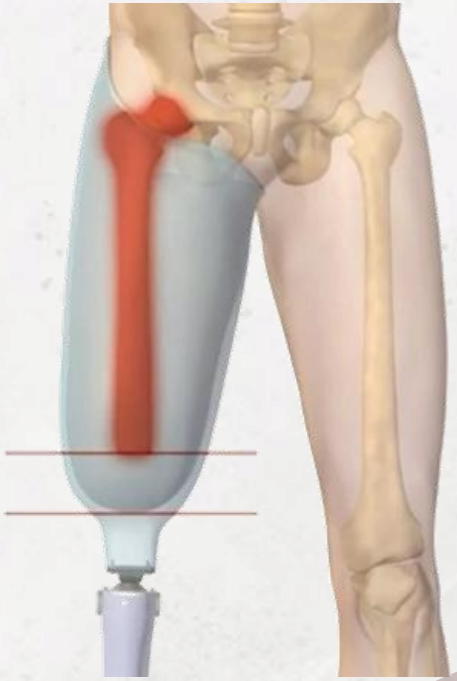
2

Transfemoral Prosthesis

Difficulties in Creating an Effective Prosthesis:

Weight-bearing challenges

The ischial tuberosity is located proximal to the propulsive structure (thigh).



Joint replacement complexity

- Passive mechanical substitution of two major joints:

Knee

Ankle

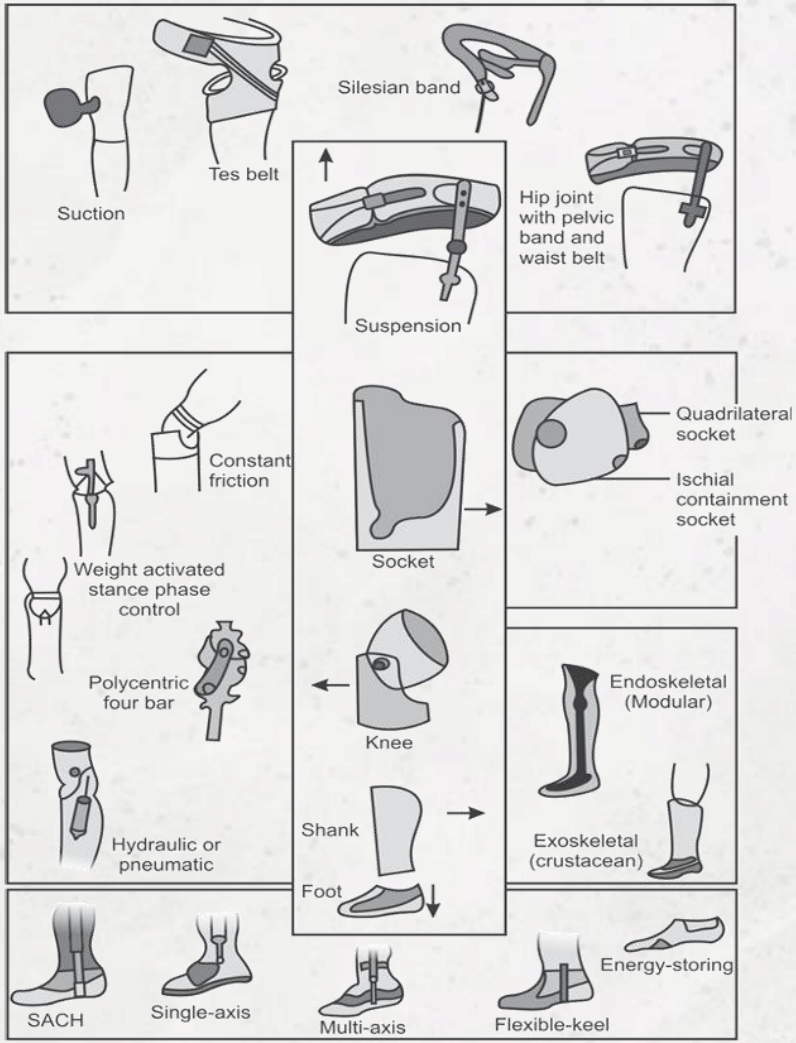
- Plus, replacement of the foot.

Technological limitations

Current prosthetic technology still has functional restrictions compared to the natural limb.

3

Components of Transfemoral Prosthesis



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Transfemoral Sockets

Two common types of sockets used in transfemoral prosthesis:

Ischial Containment Socket

Quadrilateral Socket

5

Ischial Containment Socket

- Developed in the early 1990s and shaped differently from the quadrilateral socket.

Anatomical coverage:

- Encloses the ischium and part of the pubic ramus.
- Provides more weight distribution due to increased side-wall area.

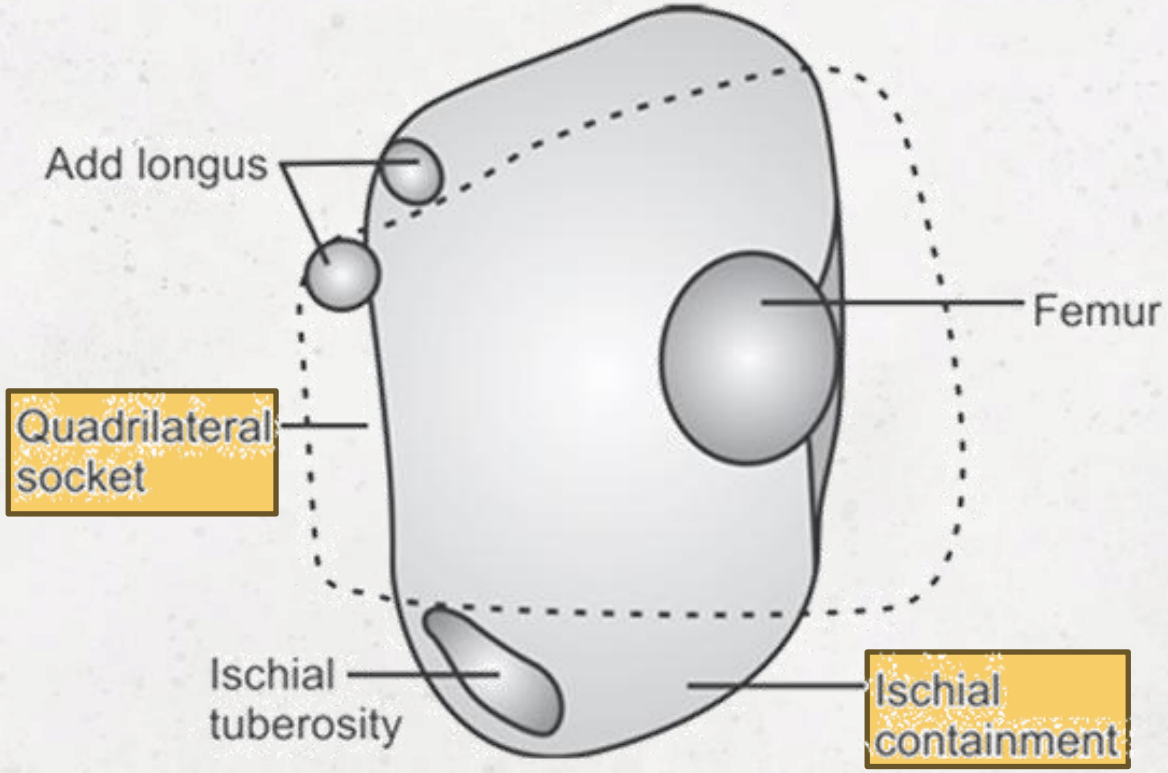
Design features:

- Narrow mediolateral dimension keeps the ischial tuberosity within the posteromedial wall of the socket.
- Lateral wall covers the trochanter for added stability.
- Distal socket uses total contact design to improve comfort and load distribution.

- Two main types of ischial containment sockets:

1. **CATCAM** – Contour Adducted Trochanteric Controlled Alignment Method
2. **NSNA** – Normal Shape Normal Alignment

Ischial Containment Socket



Quadrilateral Socket

Development: Developed in the late 1950s, named for its four walls.

Distal Socket: Contoured for total contact with the residual limb.

Posterior Wall:

- Provides the major weight-bearing area.
- Contains an ischial seat for the ischial tuberosity and glutei muscles:
  - *Thicker medially and thinner laterally.*
- Internally provides relief for the hamstring muscles.
- Height is at the level of the ischial tuberosity.

Quadrilateral Socket

Anterior Wall:

- Extends 5 cm above the height of the posterior wall.
- Contains an anteromedial femoral bulge (Scrap's projection) to keep the ischial tuberosity in place.
- Convex laterally.

Lateral Wall:

- Normally extends to the same height as the anterior wall.
- For short residual limbs, it is trimmed above the trochanter to increase stability and control.
- Inclines medially with 10° adduction (normal femoral adduction angle).

Medial Wall:

- Vertical and parallel to the sagittal plane.
- Provides internal relief for the adductor muscles posteromedially.

Comparison

Feature	Ischial Containment Socket	Quadrilateral Socket
Shape	Narrower, anatomically shaped	Quadrilateral with four walls
Ischial Seat	No distinct ischial seat; weight distributed over larger area	Present for weight bearing
Femoral Bulge	Absent	Present
Weight-bearing Area	Larger, better load distribution	Smaller
Mediolateral Dimension	Narrow	Long
Anteroposterior Dimension	Long	Narrow
Pelvic Control	Good	Fair
Rotational Stability	Good	Fair
Lateral Wall	Extends above greater trochanter for short stumps	Extends below trochanter (except short stumps)
Energy Efficiency	More efficient	Less efficient
Indications	Can be used with short stumps and gluteus medius weakness	Standard stumps

Problem

A transfemoral prosthesis is subjected to an average interface pressure of 300 kPa. Assume the socket is a semi-cylinder with an average radius of 6 cm and a lamination thickness of 3 mm. If the tensile strength of the material is 50 MPa and the modulus of elasticity is 2 GPa, calculate the factor of safety of the prosthetic socket.


Thank
you