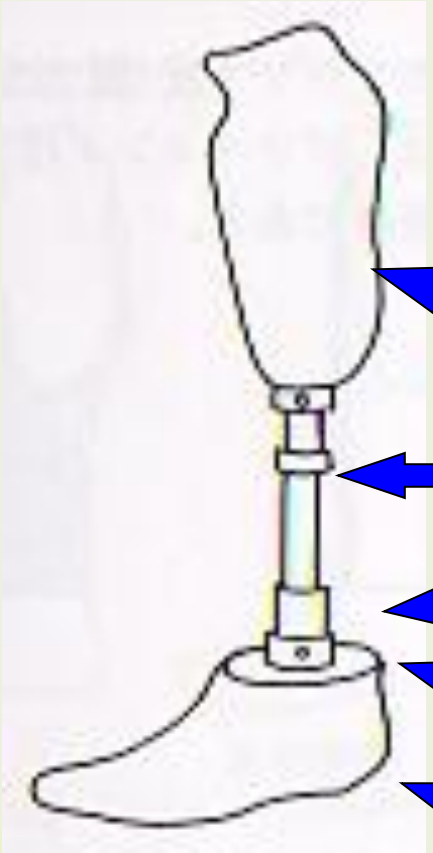
Chapter 8 - Transtibial Prosthetic Components 2018

Prepared by Markku Ripatti

Introduction to TT components



- Suspension
- Cosmesis
- Socket
- Shank
- Alignment device
- Ankle
- Foot

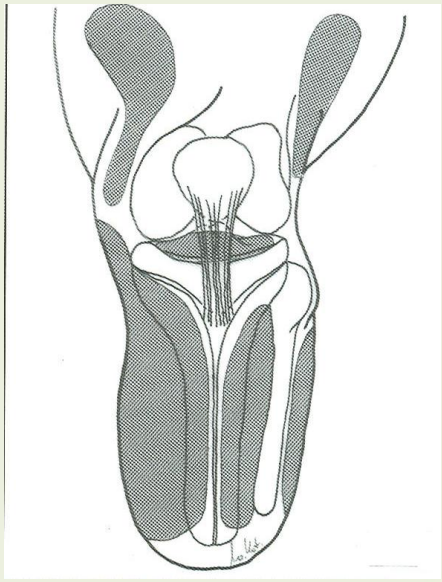


SOCKET



Function of the socket

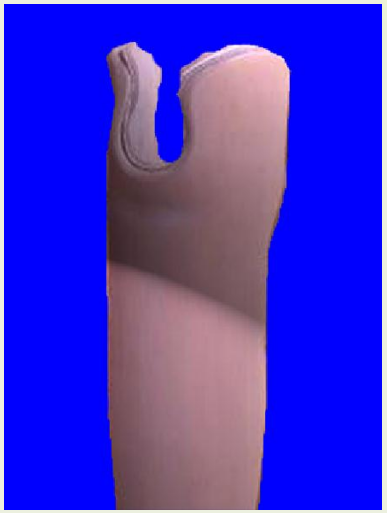
- Holds patients stump
- Transfers patients weight comfortably through the prosthesis to the ground



Socket designs

- PTB with cuff
- PTB-SC
- PTB-SC SP
- PTB with thigh corset



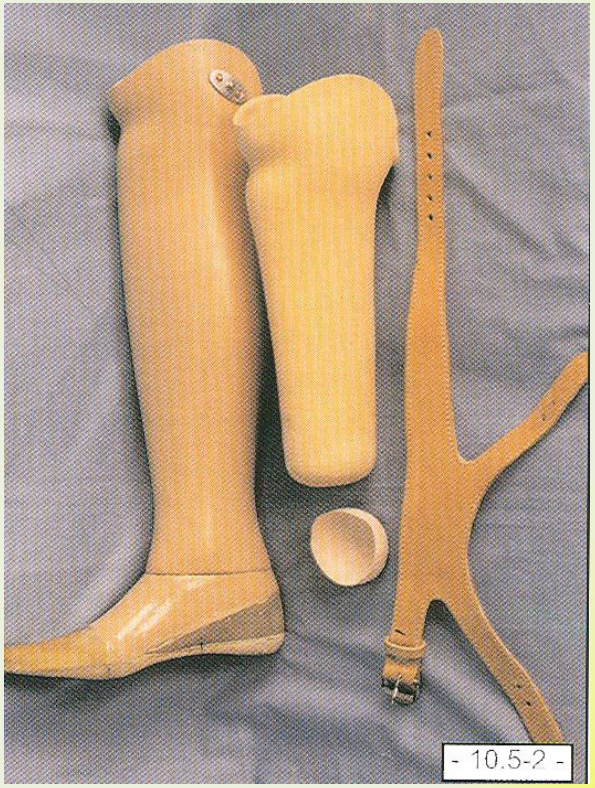






PTB socket

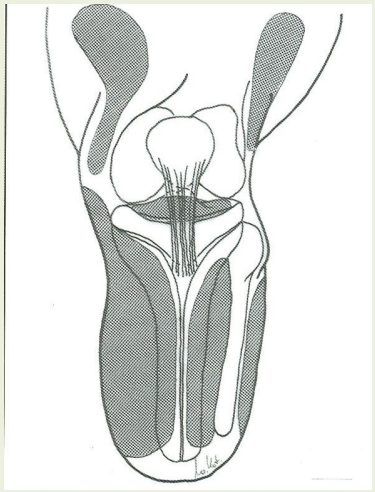
- Patellar Tendon Bearing (PTB) socket
- Ideally total contact
- Hard socket or with a soft liner



Charles Radcliffe & Jim Foort

PTB Socket – Anterior view

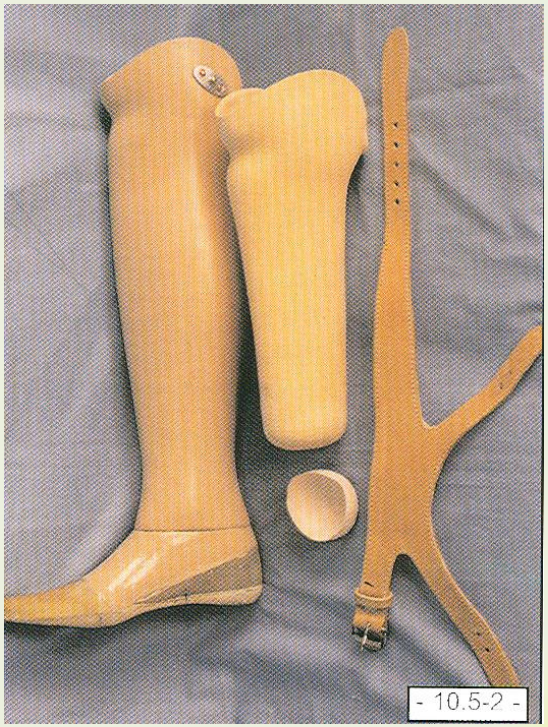
- Trim line **1/3 up the patella**
- Weight bearing on:
  - PTB bar
  - Medial flare
  - Lateral flare





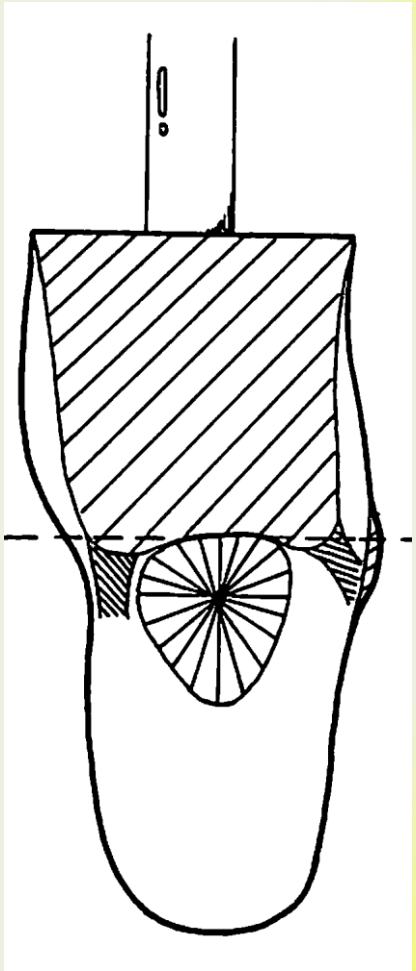
PTB Socket - Medial view

- Trim line at level of the **adductor tubercle**
- Proximally lateral wall has pocket for the head of fibula
- Medial tibial flare (weight bearing)



PTB Socket - Posterior view

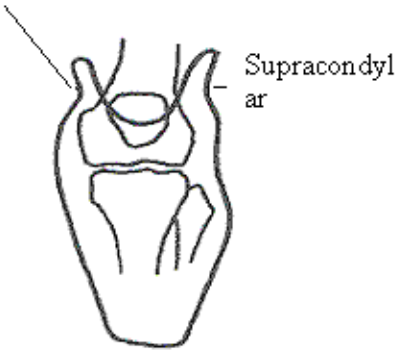
- Posterior wall flared at the top to allow for hamstrings
- Presses on the popliteal fossa, push stump forward
- PTB socket can be used for all transtibial stumps except those with specific problems, very short, contracture (Prescription Principles)



- **Posterior view is same in PTB-SC and PTB-SC SP**

PTB-SC

- Extends above the condyles to provide suspension
- Anterior trim is 2/3 up the patella
- Height of lateral and medial wall should be the same.



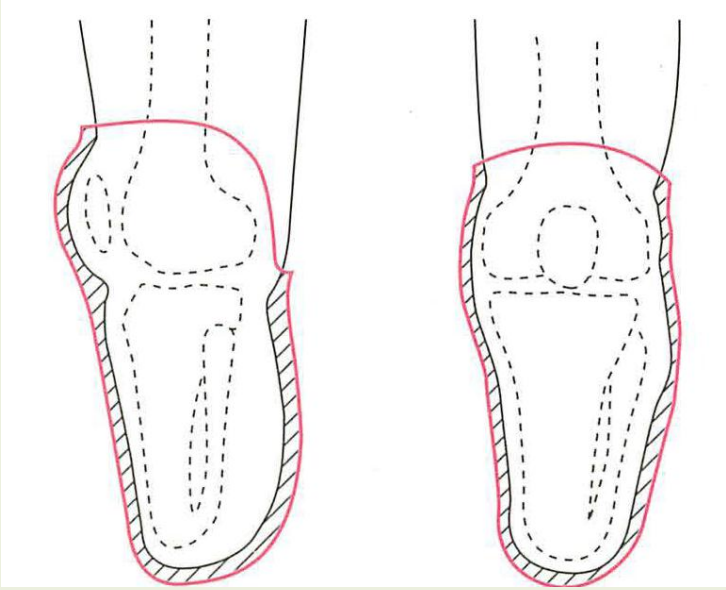
Anterior view



Lateral view

PTB-SC SP –anterior view

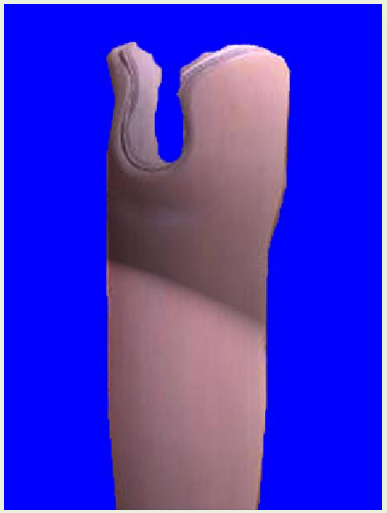
- Medial and lateral walls same height as PTB-SC
- Anterior wall above patella



Suspension

- PTB with cuff suspension
- PTB-SC
- PTB-SCSP
- PTB Thigh corset
- Locking mechanism
- Knee sleeve
- Other suspension









PTB with Cuff suspension

- Suspends the prosthesis on the stump while moving
- Acts slightly against hyperextension when patient standing
- Can be made individually
- Buckle on the lateral side

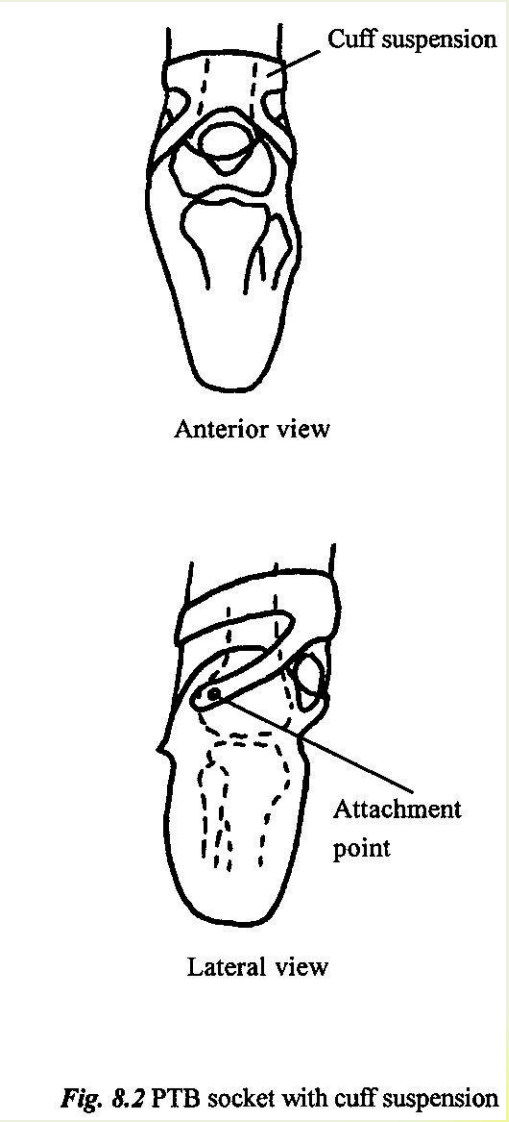


Fig. 8.2 PTB socket with cuff suspension

Cuff suspension

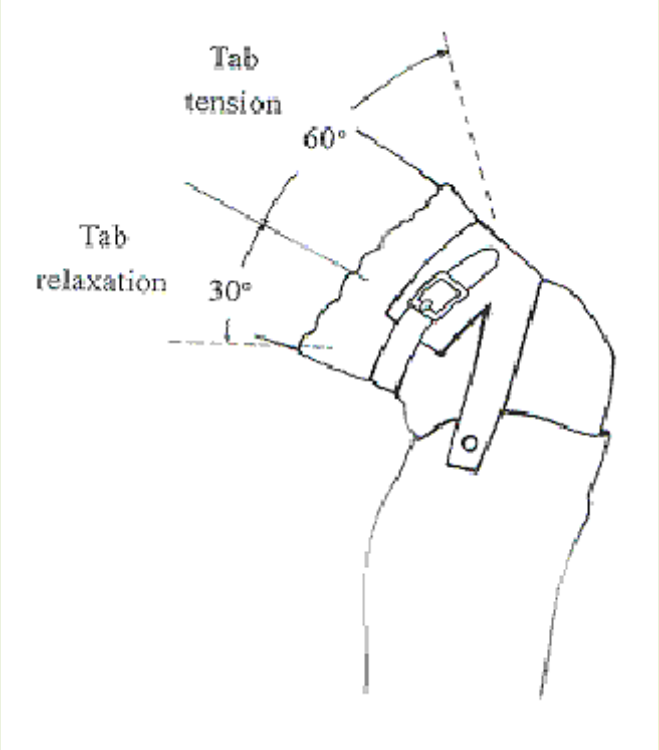
- Usually made of leather
- Fastens tight above condyles
- Knee flexed – straps shorten

Advantage

1. Gives good security to patient

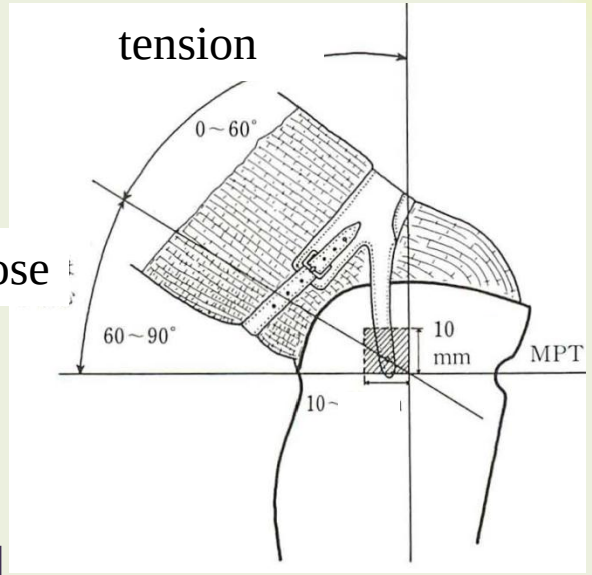
Disadvantages

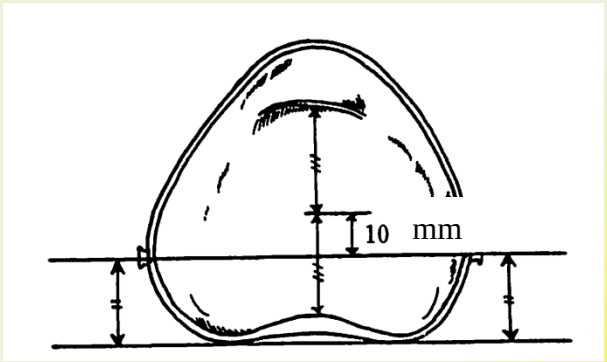
1. Restricts circulation-muscle atrophy if too tight
2. Can't use scarring tissue at suspension
3. Unstable



Cuff suspension - Attachment points

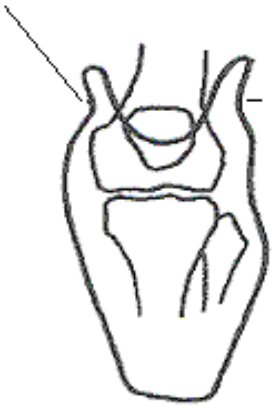
- From the middle patellar tendon line center 1cm posteriorly and 1cm proximally
- Line between points should be horizontal and points parallel to posterior wall.
- Position of tabs should be checked during fitting.
- Tabs should maintain tension up to 60˚ before relaxing





Supracondylar socket (PTB-SC)

- Extends above the condyles to provide suspension
- Anterior trim is 2/3 up the patella



Anterior view



Lateral view

Supracondylar socket (PTB-SC)

Advantages

1. No need of straps
2. Secure suspension
3. Less pistoning



Disadvantages

1. Not secure in muddy conditions
2. Scaring tissue at suspension area
3. Might uncomfortable to sit long time

Suprapatellar socket (PTB-SCSP)

- Medial and lateral walls same height as PTB-SC
- Anterior wall above patella

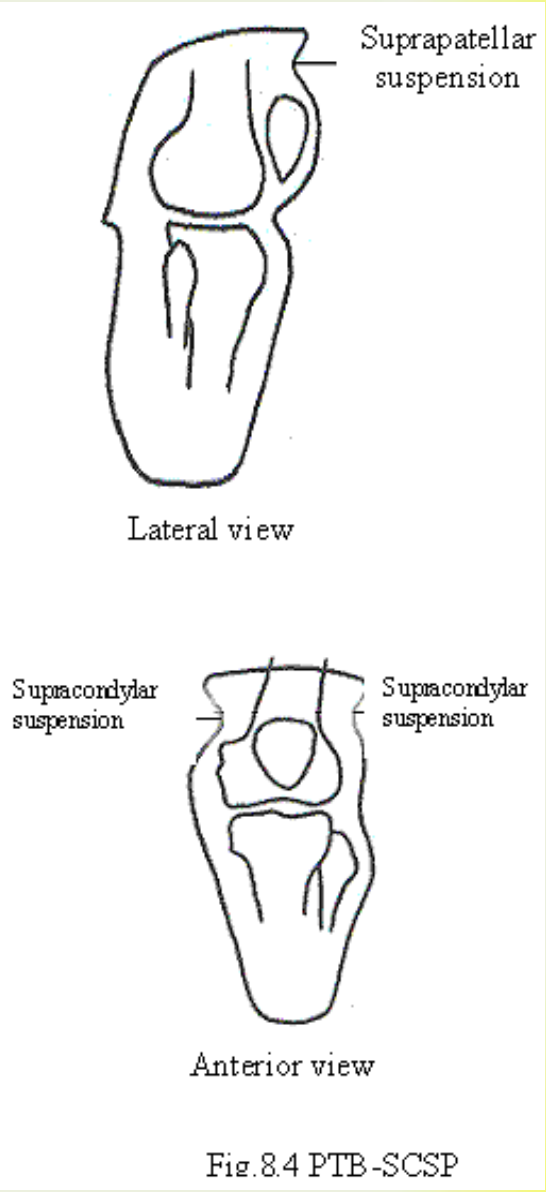


Fig.8.4 PTB-SCSP

Suprapatellar socket (PTB-SCSP)

Advantages

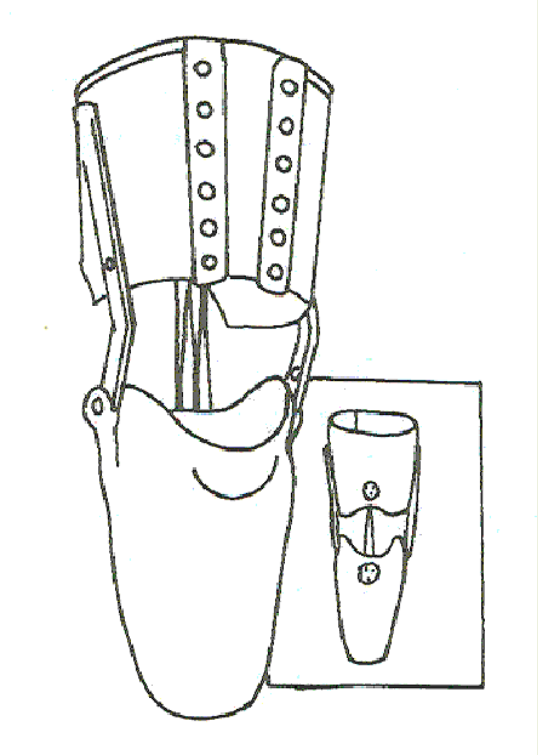
1. Good for short stumps or mildly unstable stumps
2. More contact area to distribute pressure
3. Quadriceps bar reduces tendency towards hyperextension
4. No need to cuff suspension

Disadvantages

1. Difficult to get good fit
2. High anterior wall can make kneeling difficult
3. Might uncomfortable to sit long time

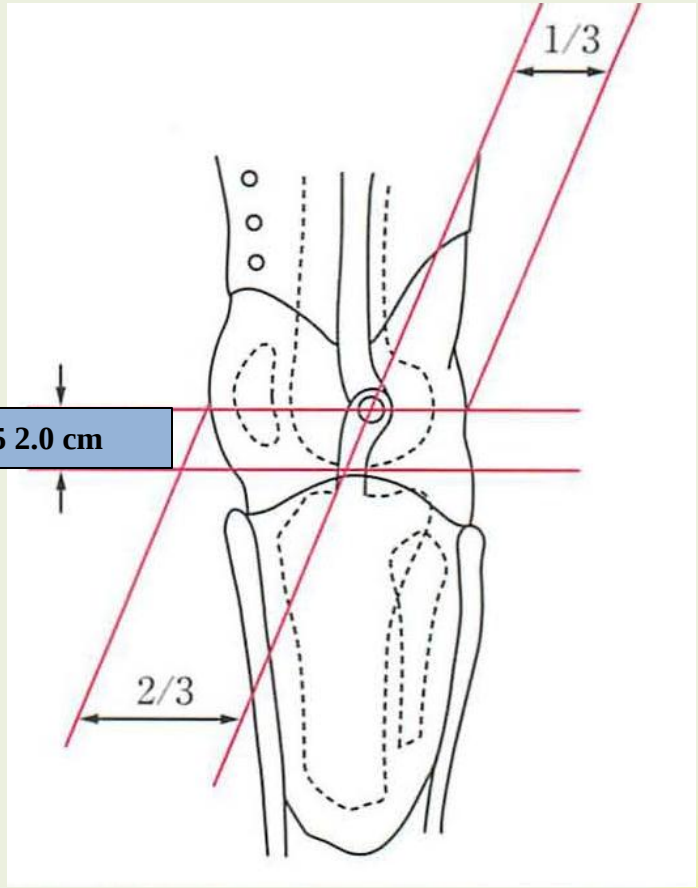
Joint and thigh corset

- Corset often made by leather
- Sometimes of thin PP
- Anterior distal above patella
- Posterior distal 3-4 cm
- Proximal few cm below groin
- Attached by metal knee joints



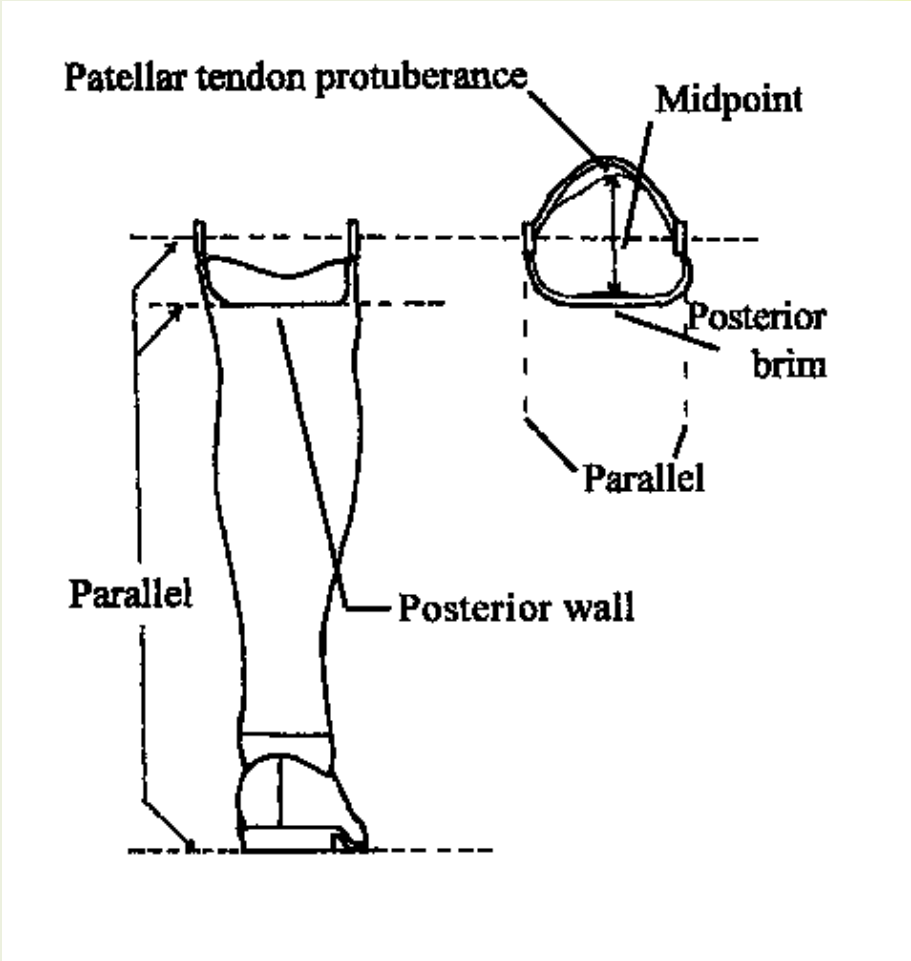
Positioning the joints

- Anatomical knee joint is multi-axis joint
- Femoral condyles roll & slide on tibial condyles
- Amount of sliding & rolling determines axis of rotation of the knee joint at any movement



Place of mechanical knee joint

- About 1.5 to 2.0 cm above medial tibial plateau and posterior 1/3 of the knee diameter (Anterior-posterior)
- Has to be Parallel
  - To each other in all planes
  - To posterior wall of the socket when look down into the socket
  - To the ground and posterior wall when look from the back



Joint and thigh corset

Advantages

- Can be used to take weight off the stump if it is badly scarred, painful, or for very short stump

Disadvantages

- Bad for the circulation
- Cause often muscle wastage

Liner

- Pelite liner
- Silicone liner
- Polyurethane liner
- Copolymer liner

Different types of material has different features

SHANK

Functions of the shank

- Holds foot and socket in right position
- Transfers pt weight from socket to foot
- Gives cosmesis to the prosthesis

Two basic types of shanks

- Exoskeletal shank
- Endoskeletal shank

Exoskeletal shank

- Cosmetic cover also carries weight of patient
- Usually made of glass reinforced plastic (GRP), aluminum or polypropylene (PP)
- Shank is aligned by alignment jig, which is the replaced by wood in transfer of alignment



Exoskeletal shank

Advantages

- Strong
- Durable
- Cheap
- Easy to clean
- Can match activity level



Disadvantages

- Alignment is difficult to adjusted
- Socket is difficult to change
- Cosmesis maybe poorer

Endoskeletal shank

- Tube of metal or plastic connect socket to ankle
- Tube carries all weight
- Called modular systems
- Parts made by mass production and later put together in workshop
- Alignment devices part of the structure
- Alignment locked



Fig. 67

Endoskeletal prosthesis

Advantages

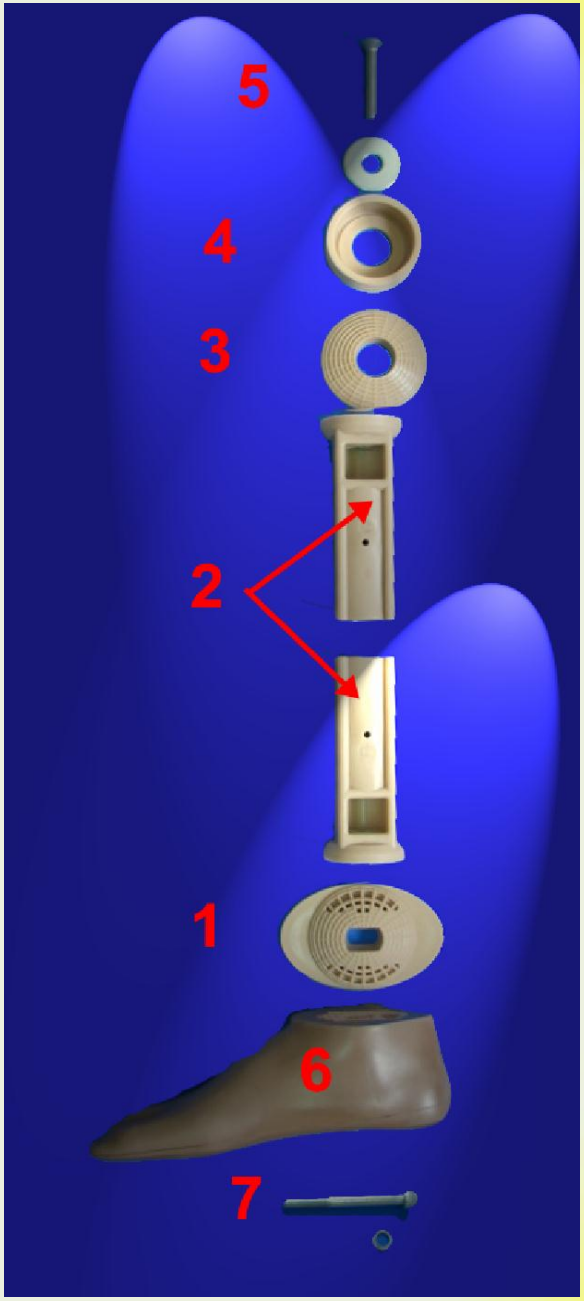
- Alignment changes are easy
- Socket replacement is easy
- Soft cosmesis is more appealing to patients
- Lightweight

Disadvantages

- Expensive
- The soft cover is easily damaged and may require replacement

Alignment devices (ICRC)

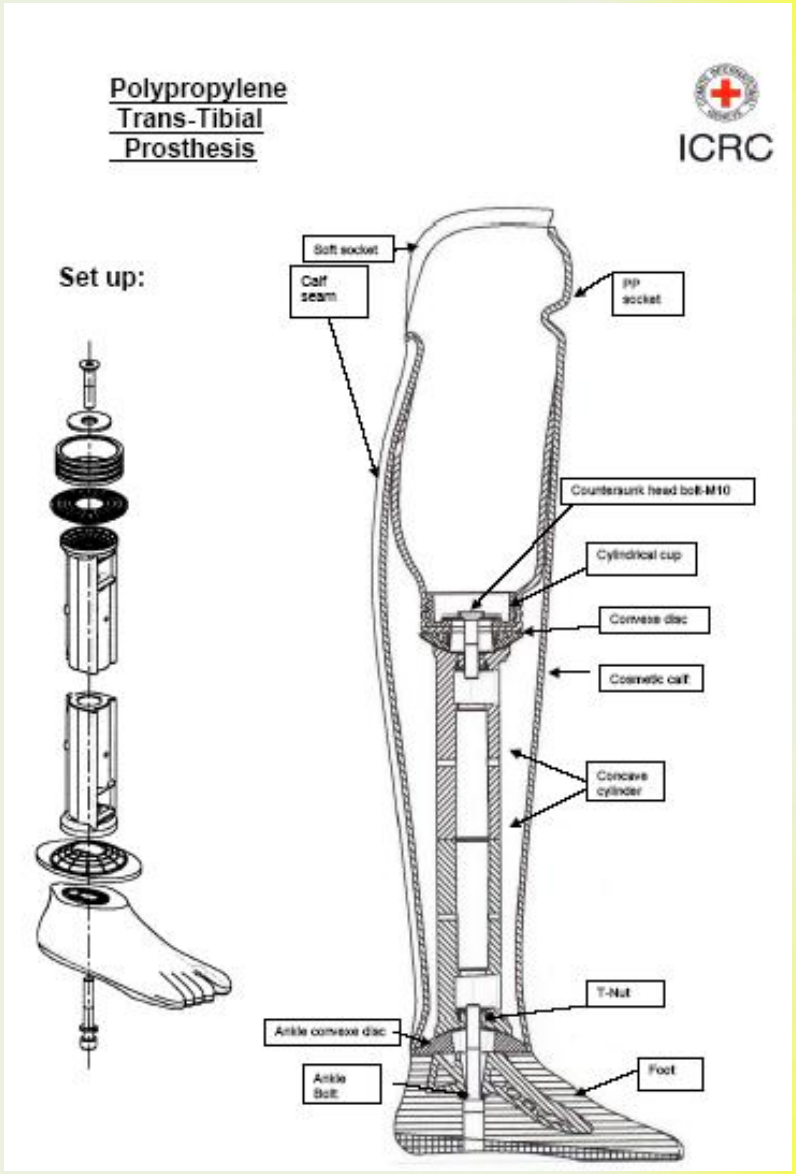
1. Convex ankle
2. Two concave cylinders
3. Convex disc
4. Cylindrical TT cup
5. Flat steel washer and countersunk head bolt
6. SACH foot
7. Hexagonal head bolt and lock washer



1st and 2nd TT project components

- Alignment can be changed by tilt / shift
- Convexed / concave discs
- Large alignment range





Alignment devices (Modular system)

- Alignment changed by changing angulations, making a tilt
- Limited alignment range
- Otto Bock











3rd TT project components

- Alignment changed by changing angulations, making a tilt
- Regal



3rd TT project components

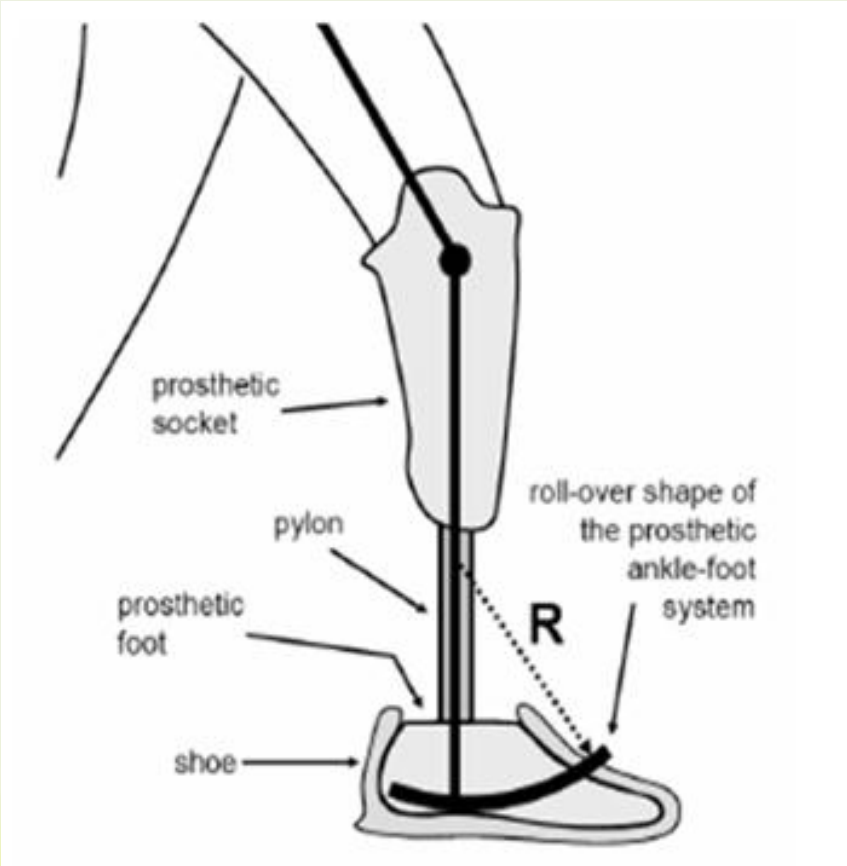




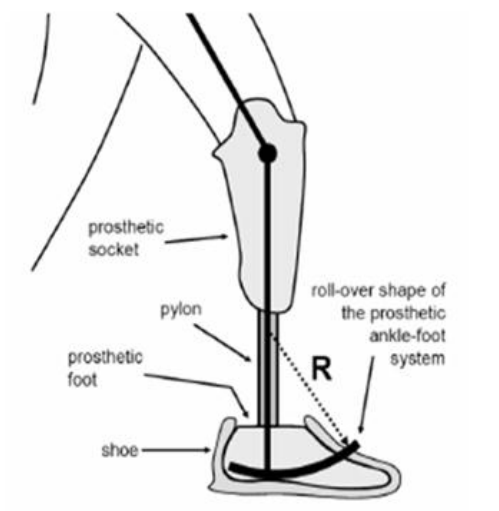


- Regal

PROSTHETIC FOOT

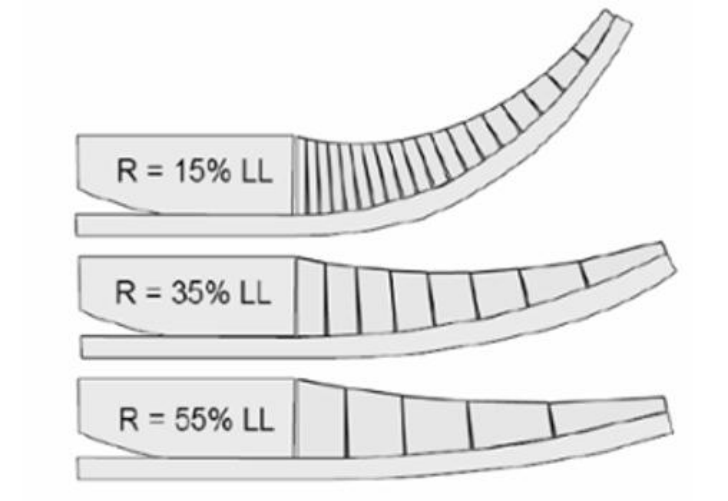


- How much prosthetic foot bends, depends on the user's weight, walking speed and materials of the foot



Prosthetic foot

- Roll over shape of the foot is important to create smooth walk
- Approximately the radius of 35% of the foot length provides smooth gait



FOOT AND ANKLE

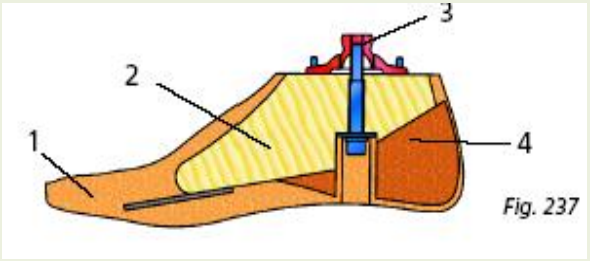
Many options



- SACH foot
- Single axis foot
- Multi-axial foot
- Dynamic response/Energy storing foot
- Heel height adjustable foot
- Specialized foot

SACH (solid ankle cushion heel) foot

- Developed by Charles Radclife and J-Foort in 1958
- Common everywhere
- Functions well



- Heel cushion (4) absorbs shock at heel strike
- Springy toe section (1) creates some push-off
- Light weight
- Very strong (2)
- No moving parts





SACH foot

Advantages

- Several heel heights, weight categories, activity level
- Option for syme's
- Durable-low maintenance
- Inexpensive option
- Lightweight
- Provide shock absorption

Disadvantages

- Poor multi-axial abilities
- Not suit for someone has knee instability
- Poor shock absorption
- Difficult to change cushion heel

Variety of SACH foot



Ohio willow wood



Kingsley(Syme's SACH)



Otto Bock



College park

http://www.ottobock.com/cps/rde/xchg/ob_com_en/hs.xsl/5767.html

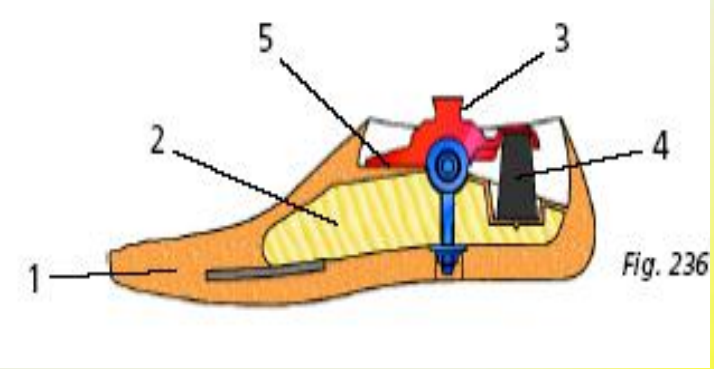
Single axis foot





- Metal ankle joint
- No inversion / eversion
- Plantarflexion bumper absorbs the shock at the heel strike
- Toes rubber creates push-off
- Bumpers are interchangeable





Single axis feet

Advantages

- Accommodate uneven terrain(saggital plane)
- Bumpers are replaceable
- Relatively inexpensive
- Indicated when knee is unstable

Disadvantages

- Increased maintenance
- Heavy
- Contraindicated if knee is stable
- Can't use in dirty and wet condition
- Poor cosmesis
- Tendency to be noisy

Variety of Single axis foot



Otto Bock



Ohio Willow Wood









Regal

Multi-axis foot

- Can move easily plantarflexion, dorsiflexion, pronation / supination and in rotation
- Motion controlled by rubber ring bumper around a ball joint
- Resistance - firmness can be changed





Multi-axis foot

- Mostly used in endoskeletal shanks
- Very natural foot action
- Not so stable in standing position
- Heavy foot (not always)
- Rubber buffer ring wears out quickly
- Not suitable for dusty and wet conditions

Multi-axis foot

Advantages

- Accommodates to uneven ground
- Provides a smooth / natural gait pattern
- Reduces torque on the stump

Disadvantages

- Increased cost
- Increased maintenance
- Heavy

Variety of Multi-axis foot



Endolite/ Multi flex foot



Otto Bock/ 1A30
Greissinger plus foot



Ossur / Flex-Foot Axia
(without cosmetic cover)



RSL steeper/ Tribute
(without cosmetic cover)

Dynamic response / Energy storing feet



- Originally designed for running and fast walking
- Strong heel spring absorbs high load in running and very string toe spring gives high energy needed in push-off





Dynamic response/ Energy storing foot

Advantages

- Returnes stored energy for forward progression
- Absorb the high load

Disadvantages

- Expensive
- Different cosmetic finishing for each products

Variety of Dynamic response feet



RSL steeper/ Soleus

(without cosmetic covers)



Otto Bock/ 1C60 Triton



Ossur/ Vari-Flex EVO



Ossur/ Reflex Rotate

Heel height adjustable feet







Advantages

- can wear different heel height shoes / without shoes

Disadvantages

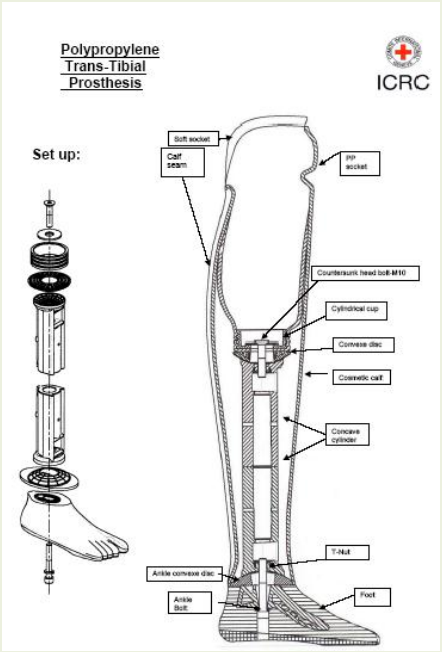
- More expensive
- Heavier
- Need more maintenance

COSMESIS

Exoskeletal

- Lamination



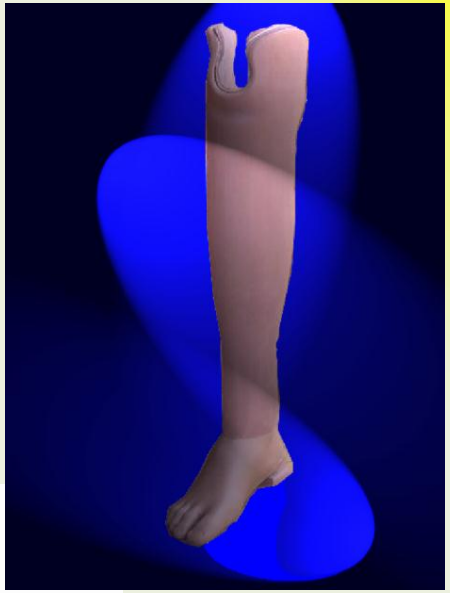


Endoskeletal

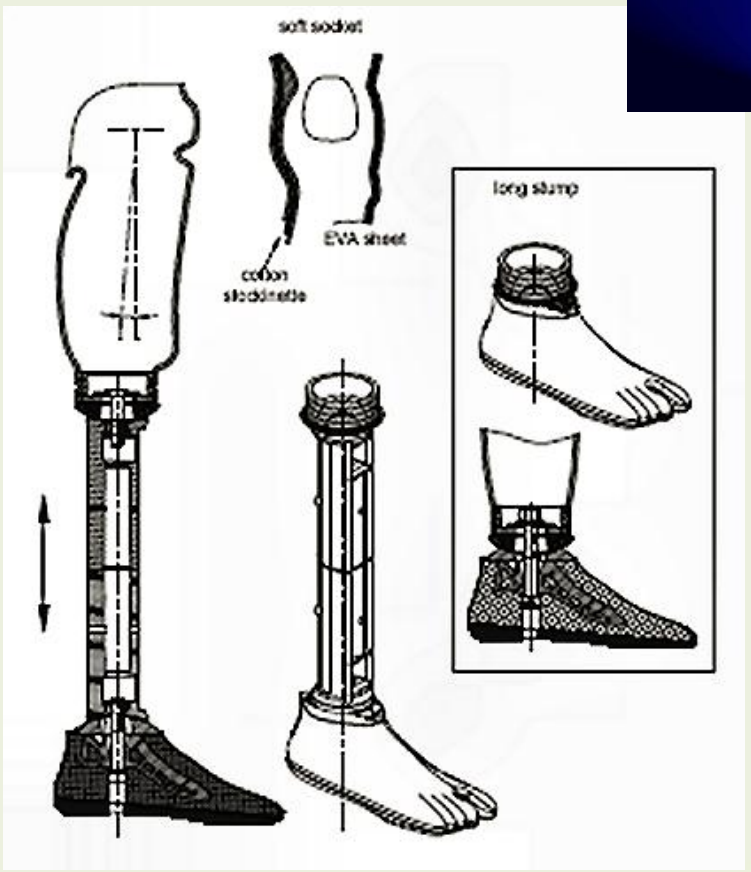
- Hard material
  - ✓Polyproperene
  - ✓Durable
  - ✓Water resistant
  - ✓Not good for mobile ankle
- Soft material
  - ✓Form cover
  - ✓Easy to change shape
  - ✓Easy to change alignment
  - ✓Good for mobile ankle

SUMMARY

- Socket
- Suspension
- Shank
- Foot and Ankle







Any questions?

Thank you