Prosthetic Materials Chapter 7

Transtibial Prosthetics 2018

Prepared by Markku Ripatti

Introduction

- Prosthesis can be made from a wide variety of materials
- There is an idea that local available materials such as wood, bamboo, and leather is better
- But materials like wood and metal are not biomechanically sound because they can not be moulded follow the cast
- Now, modern materials are widely used that can make more comfortable and cosmetic prosthesis

Materials used in PO field

- Plaster-of-Paris (PoP)
- Plastics
- Laminated plastic
- Polyurethane foams (urethanes)
- Silicones
- Pe-lite
- EVA
- Fibreglass
- Carbon fibre
- Leather
- Wood
- Aluminum
- Cloth / fabric

PLASTER-OF-PARIS - POP

- Rigid dressing
- Temporary leg - and can begin to walk
- Casting stage of making prosthesis
- Not good material for long term use

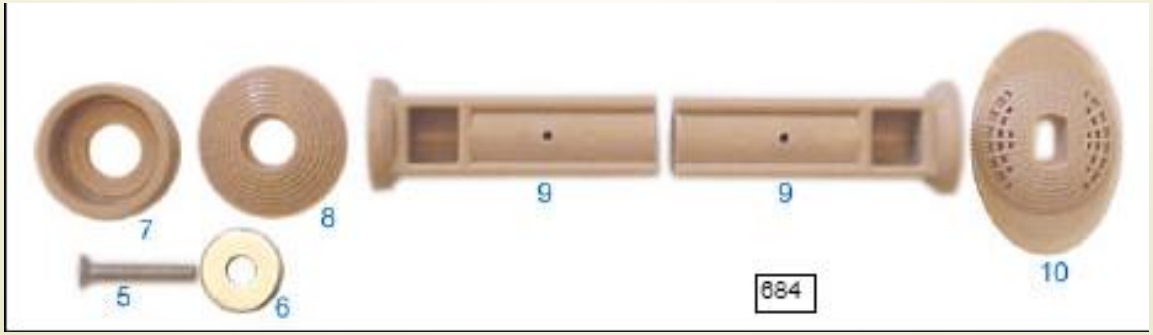
PLASTICS

- Thermoplastics
  - Can be reheated and moulded
- Thermosets
  - Laminated plastics
- Advantages of plastics
  - Strong, light, long-lasting, look good

Thermoplastics - Polypropylene

Very common socket material

- It is a cheap, factory-produced material developed from petroleum.
- It is easy to mould and vacuum form, and is strong, light and durable.

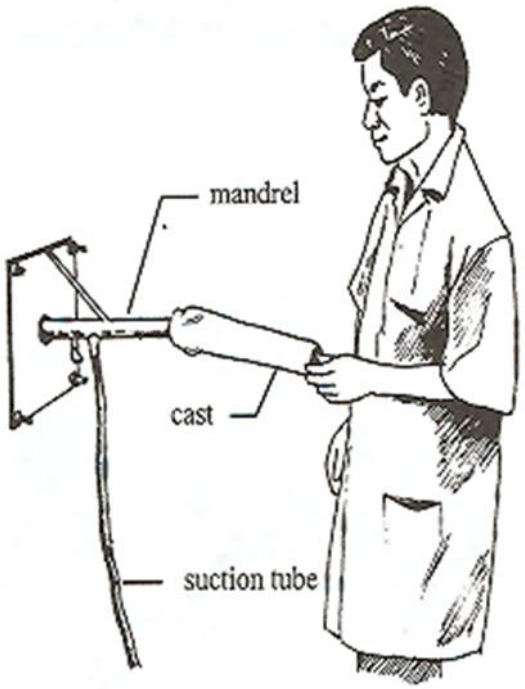


Polypropylene

- The socket is produced by heating the material in an oven
- When softened, it can be vacuum formed onto a cast
- Two methods of draping are available:
  1. Wrap draping
  2. Bubble draping

Wrap Draping

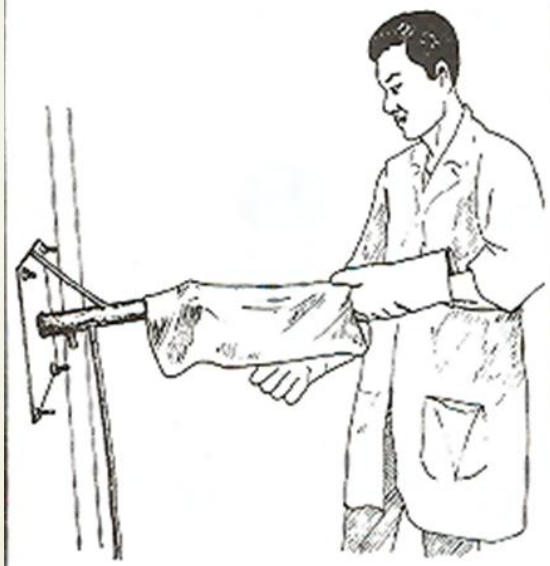
1 The cast is placed in a mandrel which has a suction tube attached. A thin sock is put on the cast.



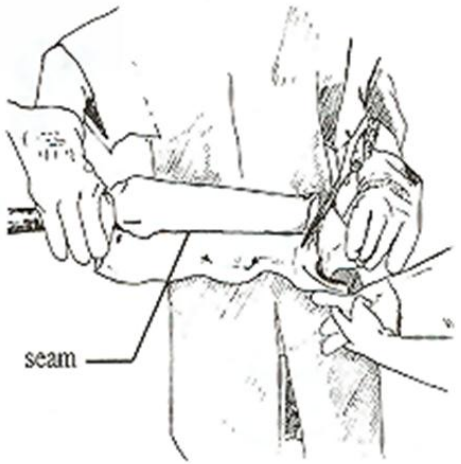
2 A pre-cut sheet of polypropylene is heated in the oven.

Wrap Draping

3 When the polypropylene is soft, it is wrapped around the cast.

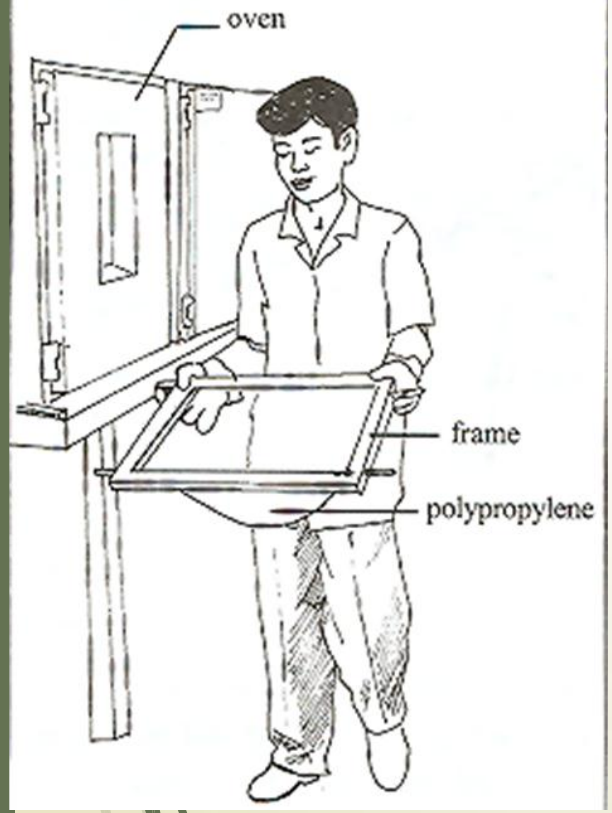


4 The "seam" is sealed and suction is turned on to make the plastic mould to the cast. This production method gives a socket with a seam.

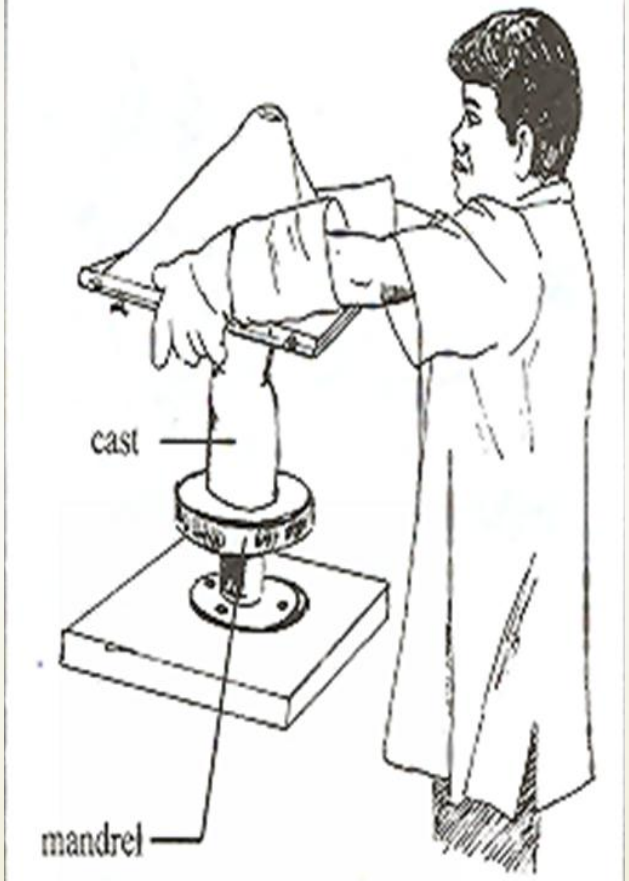


Bubble Drapping

1 A thick sheet of polypropylene is put inside a frame and heated in the oven. When the polypropylene becomes soft and forms a bubble hanging down from the frame, it is taken to the cast.



2 The polypropylene is gently pulled down over the cast.



3 When the polypropylene reaches the mandrel, it is sealed and suction is turned on to make it adhere to the cast. This production method gives a seamless socket.

Laminated plastic

Commonly used in P&O

- Polyester resin + hardener + color
- Acrylic resin + hardener + color
  - Strong and can be reheated for adjustment

Lamination

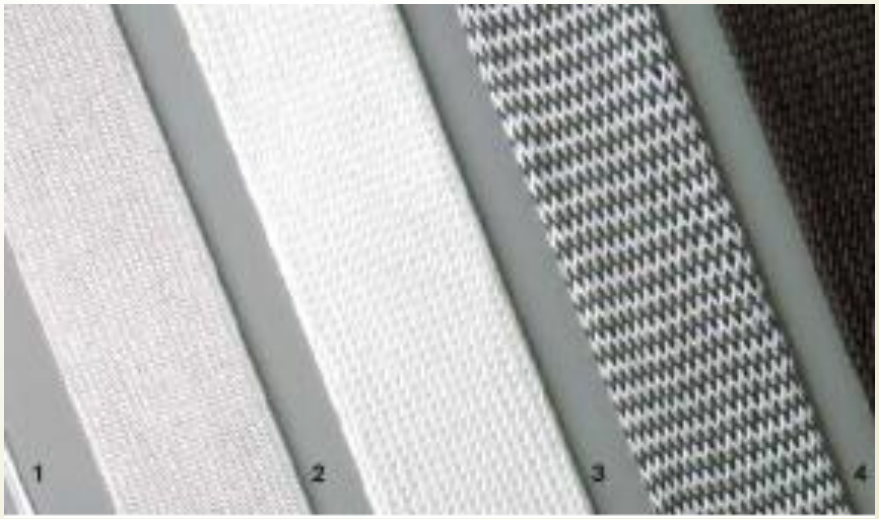
Reinforcement Materials

Laminated plastics can be made stronger with the addition of reinforcement fibers

- Fiberglass
- Carbon fiber
- Other fabrics

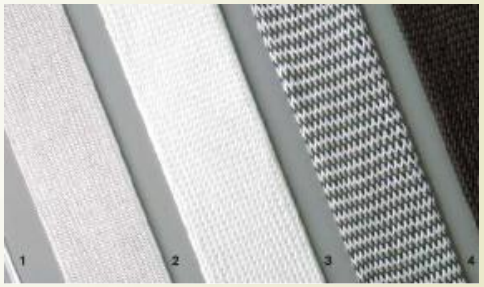
Fiberglass

- Fiberglass is commonly used to reinforce polyester resin laminations where bolts and screws will fasten.
- It is also used to strengthen weak or thin areas.



Carbon fibre

- It is more expensive than glass fibres, but it has better strength and stiffness.
- Twice as strong as steel, aluminum or fiberglass, while remaining very light.
- Carbon fibre prosthetic components such as pylon tubes, knee joints and connectors will reduce the weight of the prosthesis greatly while increasing its strength.



Working Safety

- Both glass fibres and carbon fibres when cutting release small particles of carbon or glass fibres, which are not good for lungs
  - Protect hands and use a mask when working with those materials
- During the setting of resin there are toxic fumes released.
  - Have a good ventilation

Polyurethane foams - PU

- Widely used in prosthetics
- Flexible urethane foams can be used as covers for endoskeletal prostheses
- The soft covers are not suitable for floodwaters, mud, and dust
- Rigid polyurethane foams can provide both strength and shape to exoskeletal prostheses

Silicones

- Flexible rubber-like end pads in sockets
- Silicone gel soft liners (suspension)
- Although the silicone adds weight and bulk to prosthesis, it can help where the patient has burns or sever scarring.
- Expensive

Pelite - EVA

- Synthetic rubber sponge material widely used as a socket-liner
- It is heated and then molded directly onto the rectified cast
- The main socket material (usually PP) is then made over the outside of the liner
- The Pelite provides a shock absorbing surface for the stump

LEATHER

- The main advantage – allow the stump to breathe
- The leather used in sockets is called "blocking leather"
- Leather is softened in water for a few hours before it can be moulded to the cast
- The leather socket is not strong enough on its own and it must be supported by an outer socket of aluminum, plastic or a steel frame
- The leather socket can be useful if the patient is allergic to modern plastics

LEATHER

Disadvantages

- Not suitable for wet and muddy condition
- Easily to lose its shape
- Smelly
- Sweat soaks into leather can lead to skin infections
- Need time for fabrication
- Not suitable for some culture (Hindus)

WOOD

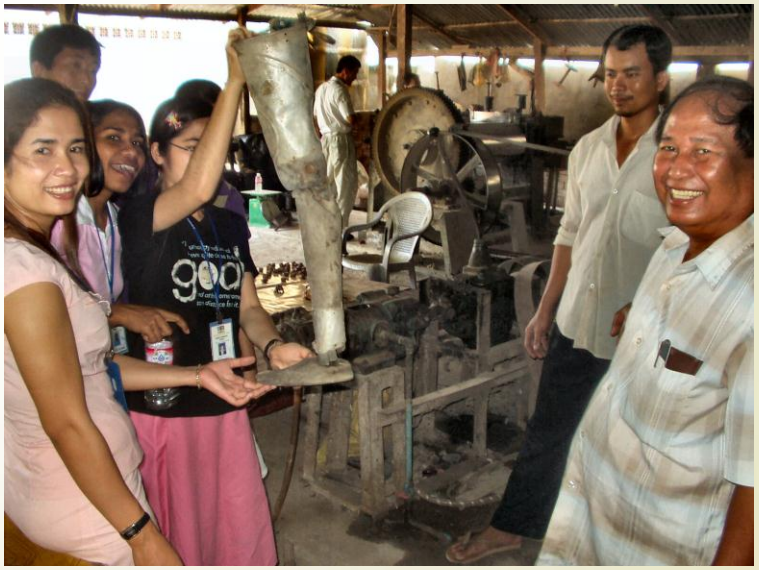
- Wooden sockets are seldom used today.
- Prosthetic knees and shins are made from basswood (linden), willow and poplar because they are lightweight, strong, free from knots and can be shaped easily using ordinary woodworking tools.
- Solid Ankle Cushion Heel (SACH) feet often have an interior hardwood keel that makes the foot strong.

WOOD

- Wooden sockets are made “by eye” rather than by the carefully controlled plaster method, so the fit will not be exactly right.
- If only hardwood is available, it is very heavy and difficult to shape.
- It has to be protected against water, so that it last longer.

ALUMINUM

- Aluminum is used in many developing countries
- Like wood, it cannot be formed according to a cast, so the fit may not be not very good
- Aluminum is easy to find in developing countries and is cool to wear
- However it cracks easily and also can be corroded by sweat and water.



CLOTH / fabric

- Cloth is used for stump socks, waist belts, straps and harnesses in upper-limb prostheses
- Nylon straps
- Velcro closure

Stump socks

- Stump socks are usually made of wool, cotton or blends of these fibers combined with nylon, Orlon, acrylics and other synthetic materials
- Stump socks
  - help to keep the skin dry
  - cushion the limb
  - absorb shear forces
  - take up volume to improve the fit

Cotton stump socks

- Cotton is soft, pliable and absorbent, but not as good as wool
- Cotton is easier to wash and care for
- It is also cheaper than wool
- Both nylon and cotton are used as stockings during the casting procedure to protect the patient's limb

Other cloth, fabrics

Nylon

- Waist belts
- Straps
- Harnesses

"Coretex"

Neoprene

Synthetic leather

Thank You Very Much