MANUFACTURING GUIDELINES

PARTIAL FOOT PROSTHESIS

Physical Rehabilitation Programme

ICRC

ICRC

International Committee of the Red Cross
19 Avenue de la Paix
1202 Geneva, Switzerland
T + 41 22 734 60 01 **F** + 41 22 733 20 57
E-mail: icrc.gva@icrc.org
www.icrc.org

All photographs: ICRC/PRP

Table of contents

Foreword

The ICRC polypropylene technology

Since its inception in 1979, the ICRC's Physical Rehabilitation Programme has promoted the use of technology that is appropriate to the specific contexts in which the organization operates, i.e., countries affected by war and low-income or developing countries.

The technology must also be tailored to meet the needs of the physically disabled in the countries concerned.

The technology adopted must therefore be:

- durable, comfortable, easy for patients to use and maintain;
- easy for technicians to learn, use and repair;
- standardized but compatible with the climate in different regions of the world;
- low-cost but modern and consistent with internationally accepted standards;
- easily available.

The choice of technology is of great importance for promoting sustainable physical rehabilitation services.

For all these reasons, the ICRC preferred to develop its own technique instead of buying ready-made orthopaedic components, which are generally too expensive and unsuited to the contexts in which the organization works. The cost of the materials used in ICRC prosthetic and orthotic devices is lower than that of the materials used in appliances assembled from commercial ready-made components.

When the ICRC launched its physical rehabilitation programmes back in 1979, locally available materials such as wood, leather and metal were used, and orthopaedic components were manufactured locally. In the early 1990s the ICRC started the process of standardizing the techniques used in its various projects around the world, for the sake of harmonization between the projects, but more importantly to improve the quality of services to patients.

Polypropylene (PP) was introduced into ICRC projects in 1988 for the manufacture of prosthetic sockets. The first polypropylene knee-joint was produced in Cambodia in 1991; other components such as various alignment systems were first developed in Colombia and gradually improved. In parallel, a durable foot, made initially of polypropylene and EthylVinylAcetate (EVA), and now of polypropylene and polyurethane, replaced the traditional wooden/rubber foot.

In 1998, after careful consideration, it was decided to scale down local component production in order to focus on patient care and training of personnel at country level.

Objective of the manuals

The ICRC's "Manufacturing Guidelines" are designed to provide the information necessary for production of high-quality assistive devices.

The main aims of these informative manuals are as follows:

- To promote and enhance standardization of ICRC polypropylene technology;
- To provide support for training in the use of this technology;
- To promote good practice.

This is another step forward in the effort to ensure that patients have access to high-quality services.

ICRC
Assistance Division/Health Unit
Physical Rehabilitation Programme

Introduction

The aim of this document is to describe a method for producing **partial foot prostheses**, working with the ICRC polypropylene technology and orthopaedic components used at the Regional Physical Rehabilitation Centre in Battambang, Cambodia.

The casting, rectification and alignment methods used correspond to international prosthetic and orthotic (P&O) standards of practice and are therefore not described in these ICRC manufacturing guidelines.

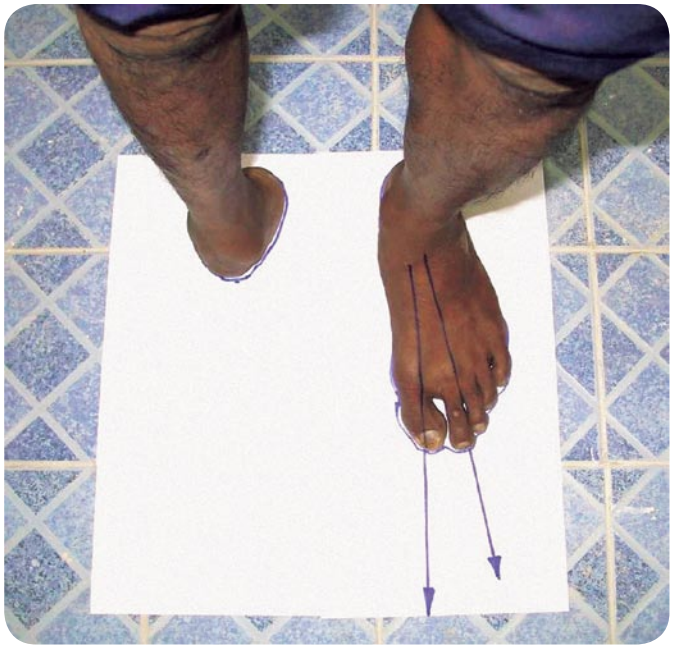
Remarks

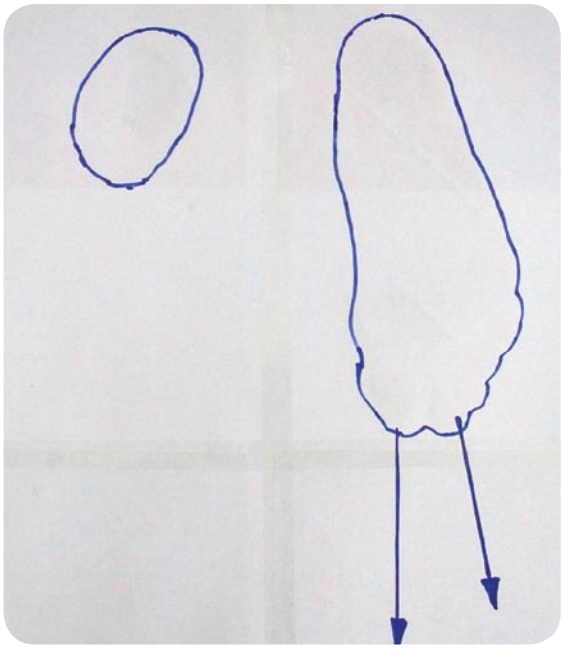
- The procedure described relates to one of the most common types of partial foot amputation, which is also known as Choppart or mid-foot amputation.
- If full end bearing is not possible, the Patellar-Tendon-Bearing (PTB) design brim should be used.

1 FOOTPRINT OF SOUND SIDE

- Copy the sound-side footprint on a sheet of paper and mark the foot rotation (~10°).

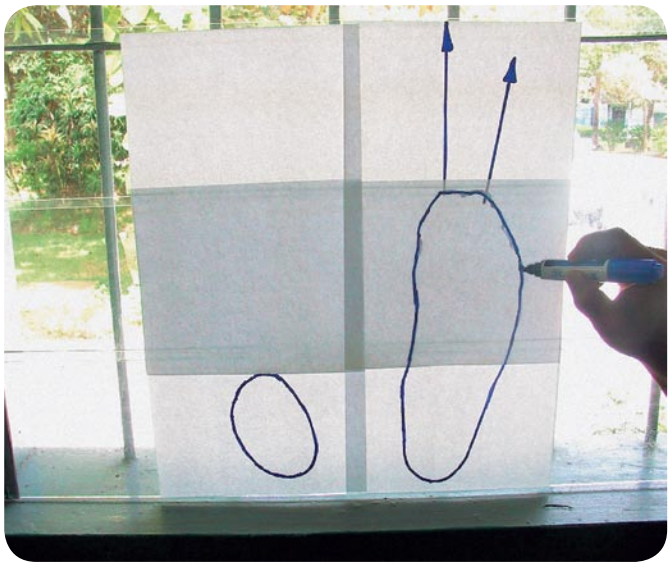
  Insert frontal line.





- Fix the paper against a window and copy the reverse side of the footprint.

  The print will help in positioning the build-up of the foot on the prosthesis.

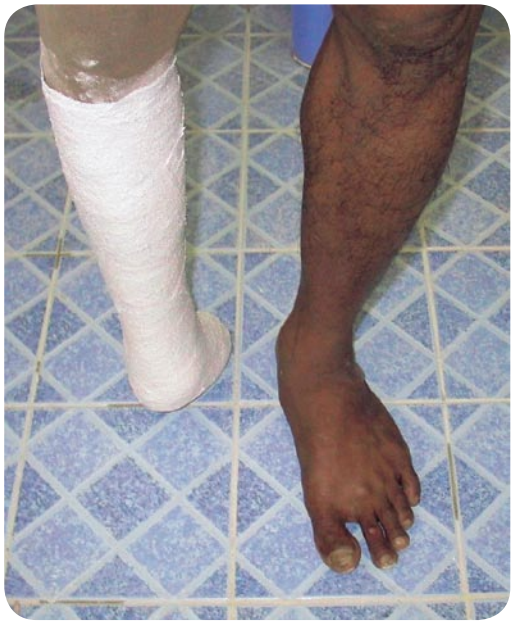


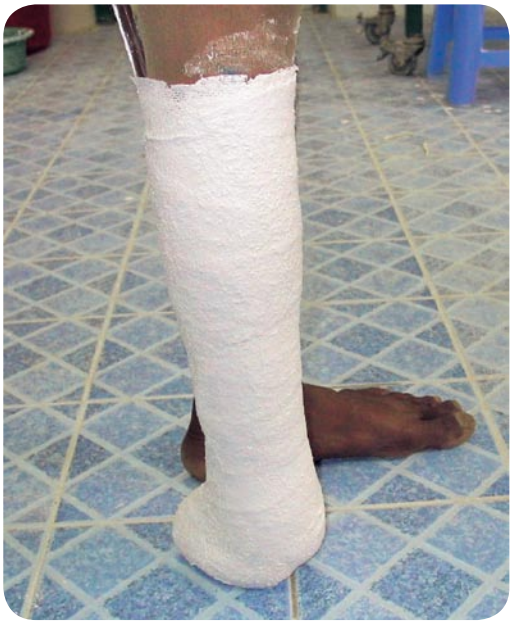
2 CASTING AND RECTIFICATION

Patient assessment and casting are performed in accordance with P&O standards. However, the cast is taken while the amputee is sitting down.

Patients who will have their full weight bearing on the prosthesis should stand before the plaster bandages have hardened. For more sensitive stumps the patient should stand on a layer of soft foam, and if necessary a heel wedge may be added to compensate for equinus position of the stump or the height of the shoe heel.

Care must be taken to ensure that the calcaneus is held in a neutral position.

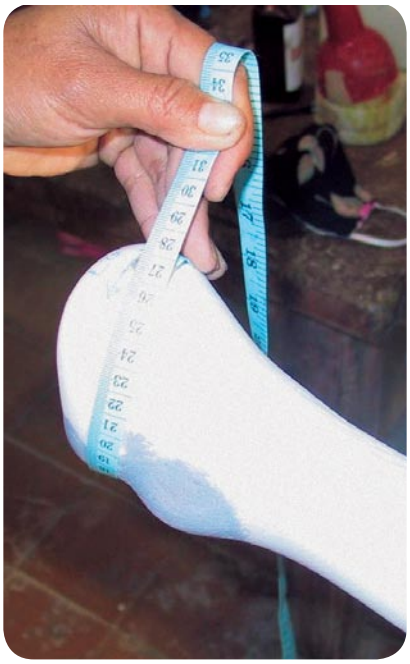




Rectification of the positive cast impression is performed in accordance with P&O standards.

- Reference lines can be added on the moulds and the foot print.

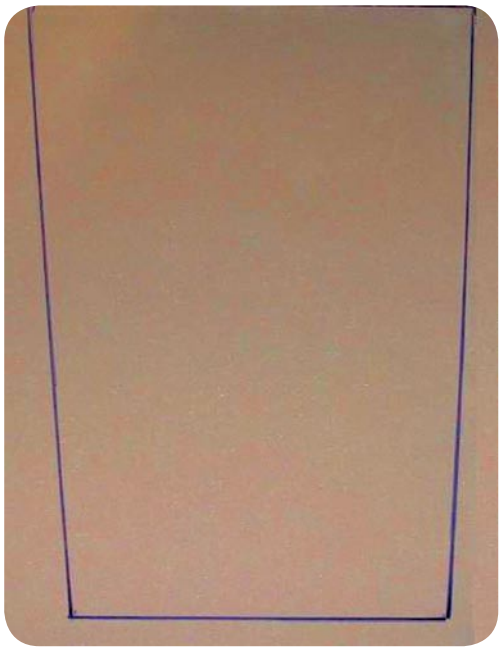
3 SOFT SOCKET FABRICATION

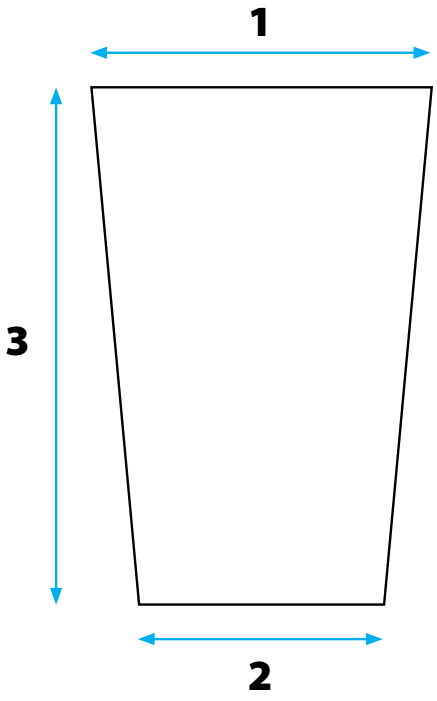


Measurement of EVA foam:

1 Circumference 2 cm above the head of the fibula.
2 Circumference middle of the calcaneus.
3 Length of plaster cast.

Cut a trapezoid from a sheet of 6 mm EVA foam according to the above measurements.



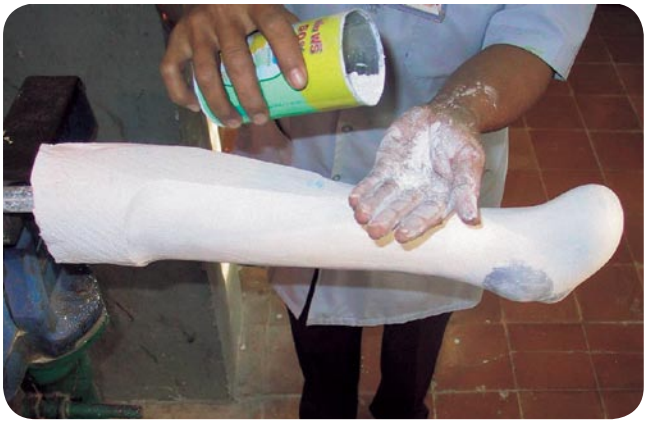


- Trim a 10 mm strip on both lateral sides of the EVA foam to zero millimetres.

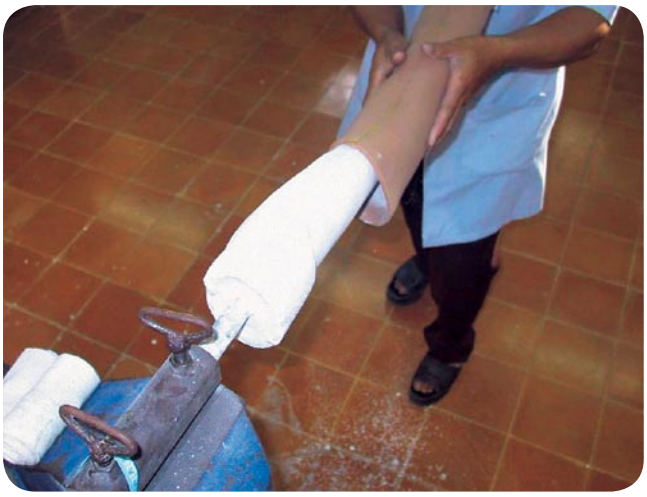
- Apply Neoprene contact glue twice on both trimmed sides.

- Once the glue is dry, join the two surfaces to form a cone.

- Dust the plaster positive and the inside of the EVA cone with talcum powder to facilitate sliding.

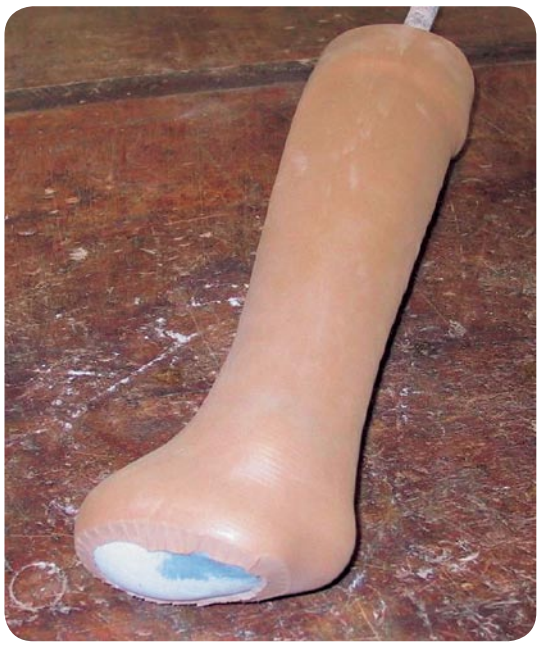


- Heat the EVA cone in an oven for about 5 minutes at 120°C and then pull it over the plaster positive.



- To keep the EVA foam in the same shape as the plaster positive, secure it with elastic bandages or place it under vacuum until it has cooled down.

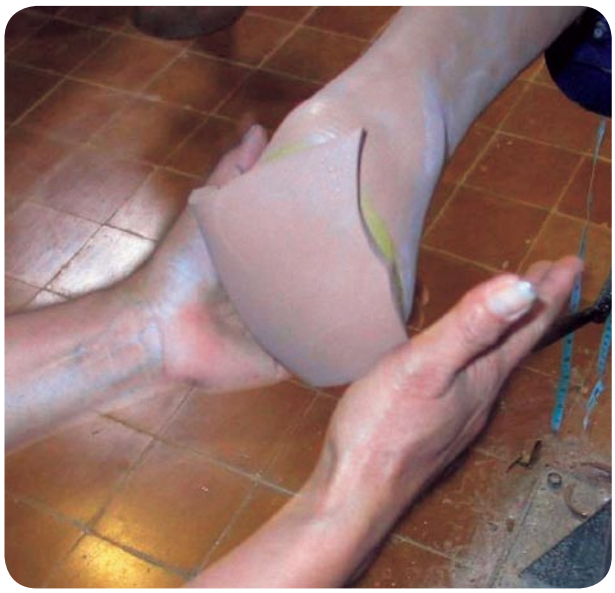
- Trim the distal section of the EVA cone with a knife and smooth it by grinding.



- Apply two layers of Neoprene contact glue to the trimmed section and to the 12 mm EVA foam socket cap.

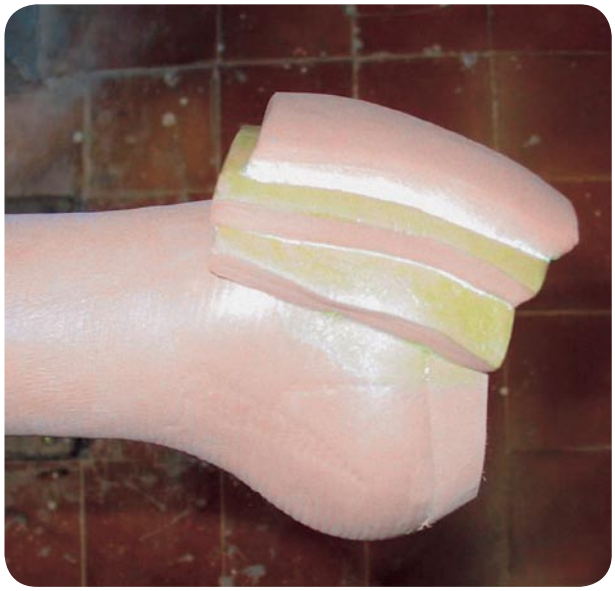
- Heat the cap for 2 to 3 minutes at 120°C in an oven and glue it onto the soft socket.

  Cut off and grind to remove the excess EVA foam.

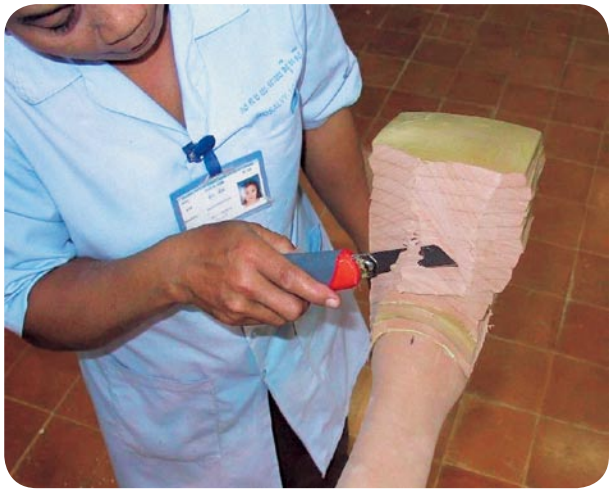


4 FOREFOOT BUILD-UP

- Glue layers of 12 mm EVA foam corresponding to the length of the sound foot measured before casting.

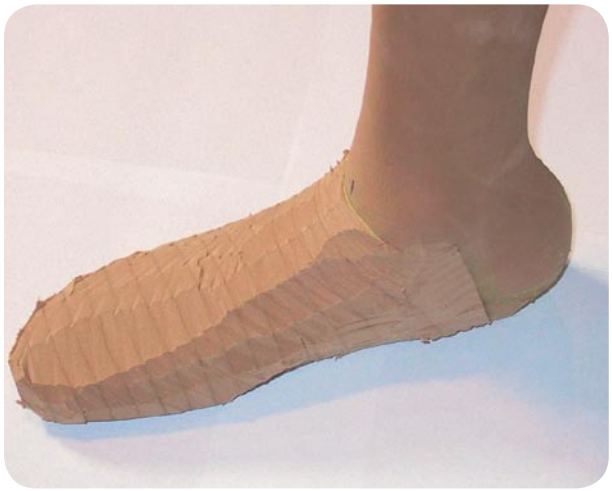


- Pre-shape the forefoot with a knife.



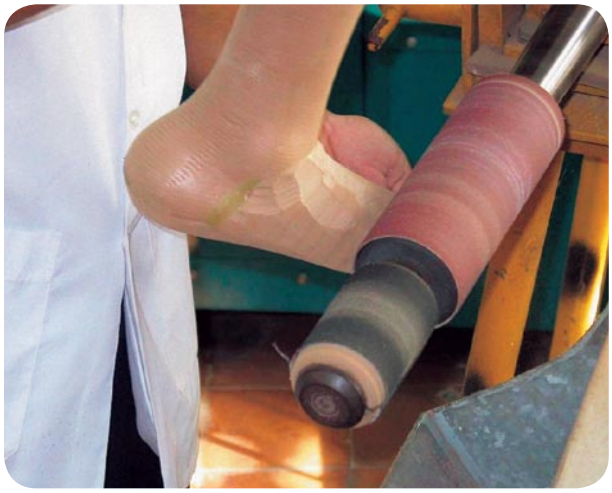
- Use the footprint taken before casting to determine the correct foot rotation.

  Check the anterior/posterior and the lateral/medial alignments against the measurement card (e.g. heel height).



- Finish shaping the forefoot on the grinding machine.

  Make sure that the plantar sole between heel and toes is parallel and, if necessary, that the heel height is correct. Where possible, shape the longitudinal arch support.

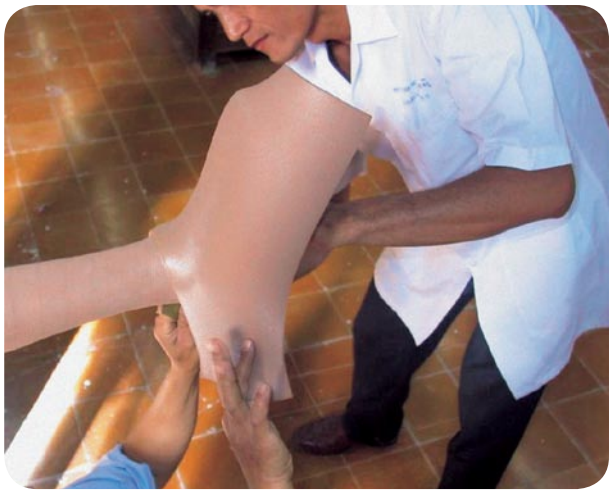


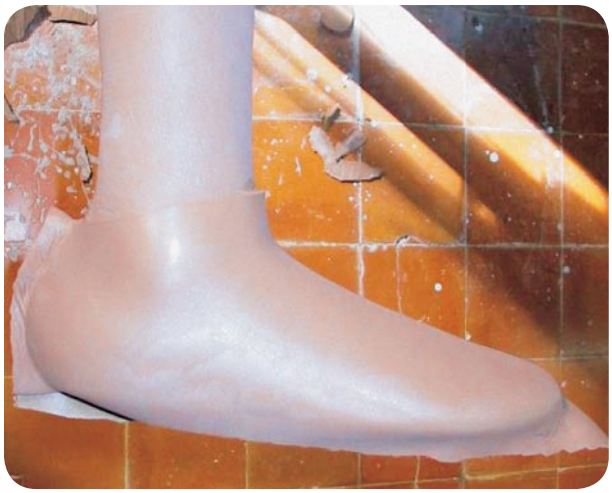
- For finishing, a sheet of 3 mm EVA foam is draped over the foot.

  Fit the sheet of EVA foam on the foot by cutting it round around the ankle.

  Apply two layers of Neoprene contact glue, then heat the 3 mm EVA foam in the oven for 2 minutes at 120°C before draping it. Cut and smooth the edges. A further sheet of 3 mm EVA foam may be added (glued) to the sole.

  This operation can also be carried out after the first fitting of the soft socket on the amputee, described below.





5 FIRST FITTING OF SOFT SOCKET

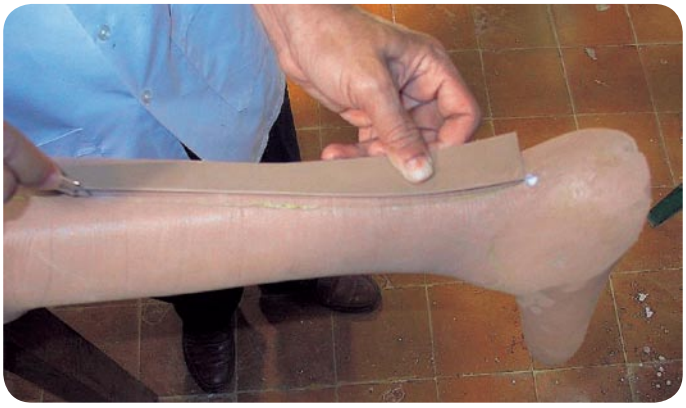
- Before the polypropylene is draped, the soft socket must be checked on the patient.

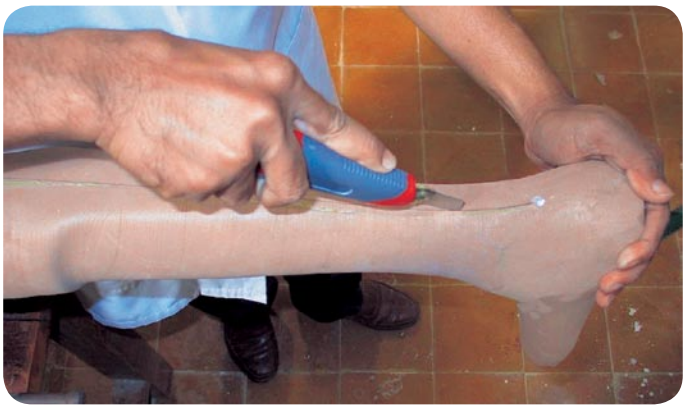
  The soft socket must be removed from the plaster positive without breaking it.

  On the posterior side, punch a 4 mm hole just above the calcaneus. This helps avoid tearing of the EVA foam when the soft socket is being removed from the plaster.

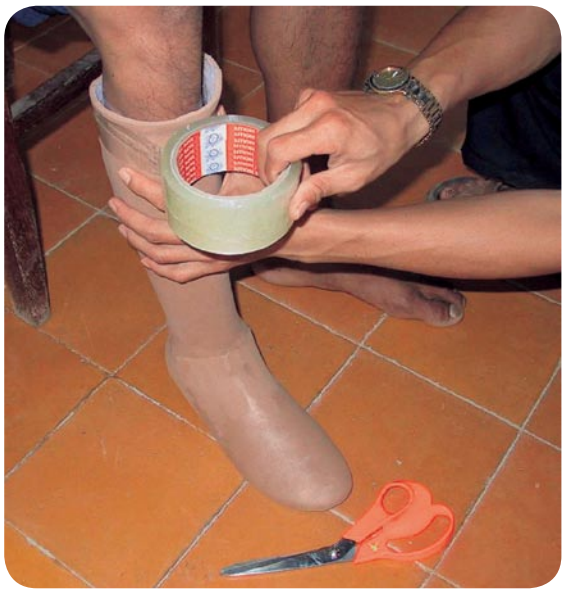
  Draw a line or use a ruler to make a straight cutting line up to the proximal end of the socket.

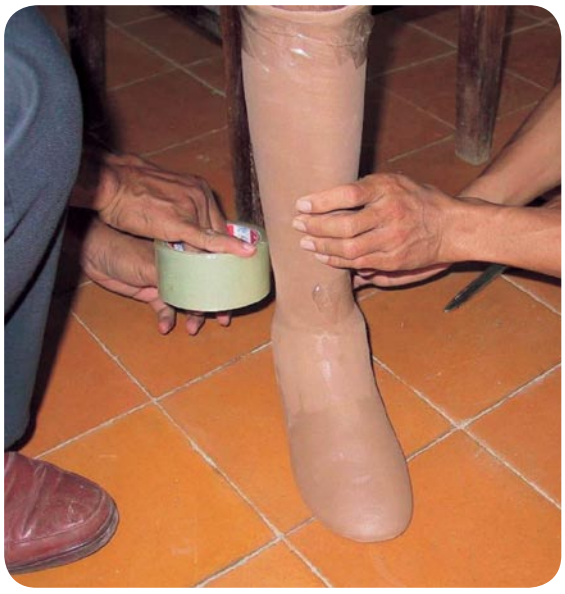
  Remove the soft socket carefully and keep the plaster positive.



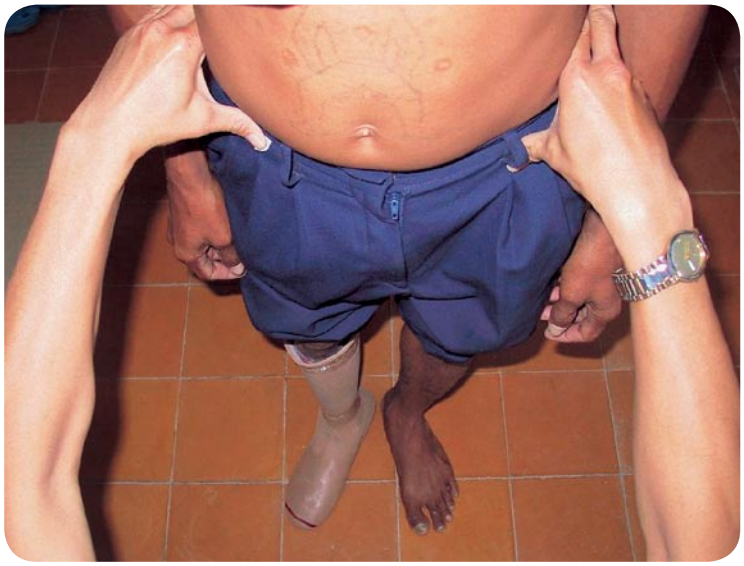


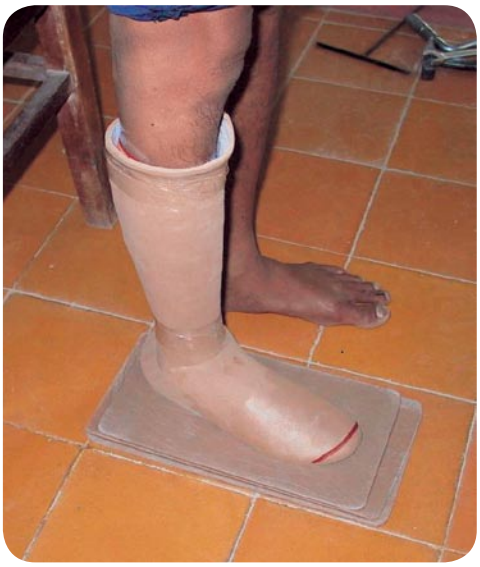
- To check the fit, alignment and length of the soft socket, fix it with tape.





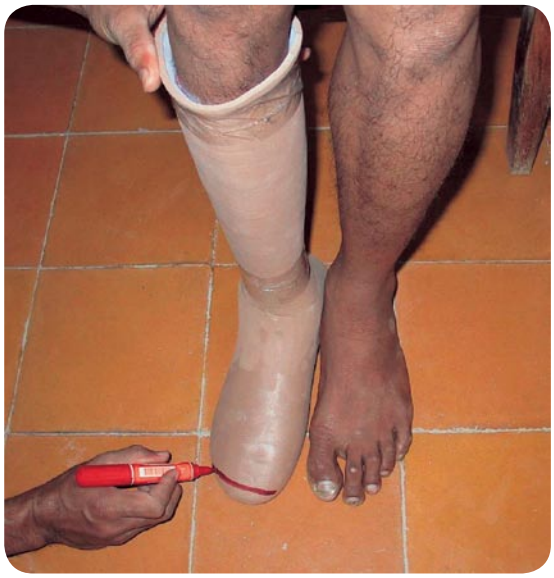
- Check the height of the prosthesis and its static alignment. Make the necessary modifications/ corrections by grinding off or adding EVA foam.

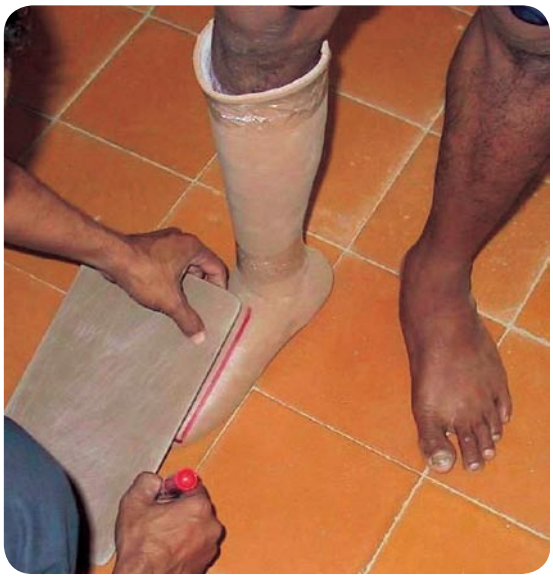




- Check also the length and rotation of the foot, and adjust it as described above.

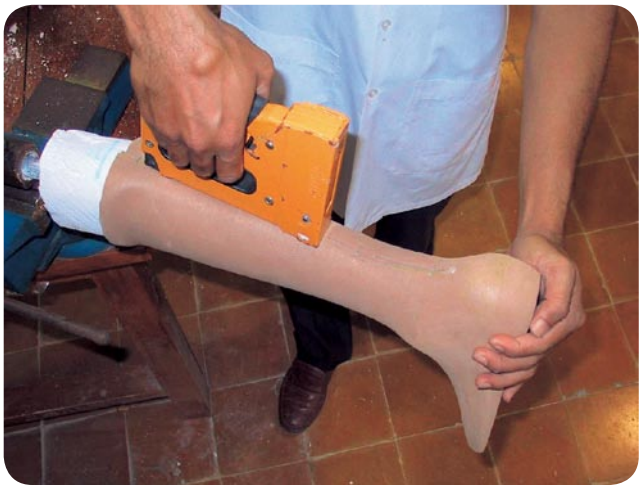
  At this point it is not recommended that the patient be allowed to walk, as the socket and forefoot are too flexible. However, the amputee may take some steps inside parallel bars so that the dynamic alignment can be checked.





6 DRAPING OF POLYPROPYLENE

- Put the soft socket back on the plaster positive and staple or tape the sides of the posterior seam together.



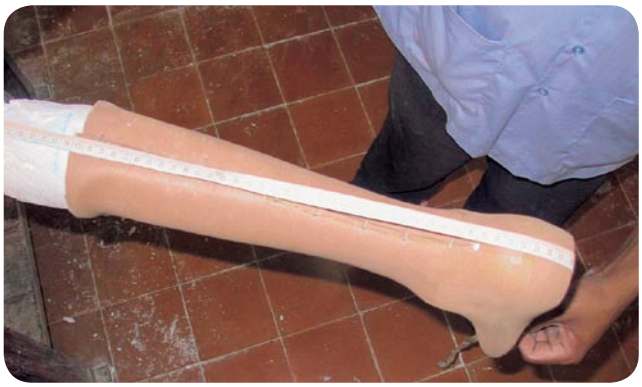
- Measurement of polypropylene sheet:

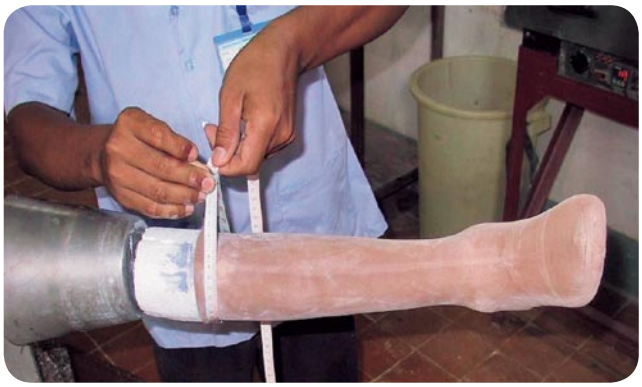
  Length from proximal part of plaster positive to toes + 15 cm

  Circumference of proximal part of soft socket + 2 cm

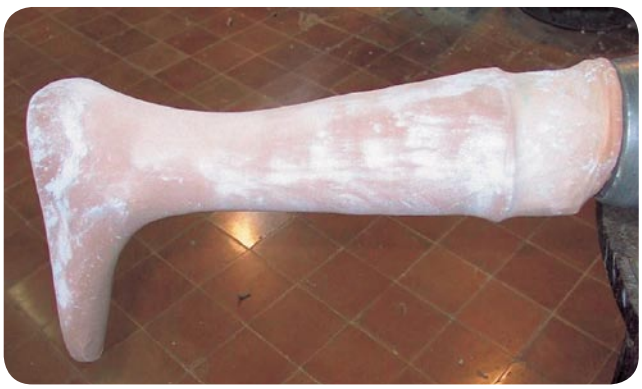
  Circumference of mid-tibial section + 2 cm

  Circumference of foot-ankle (below medial malleoli, including calcaneus) + 5 cm



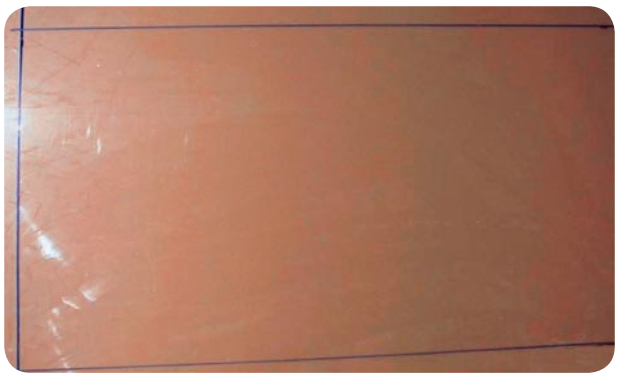


- Before draping the polypropylene, pull a nylon stocking over the soft socket and dust it with talcum powder.



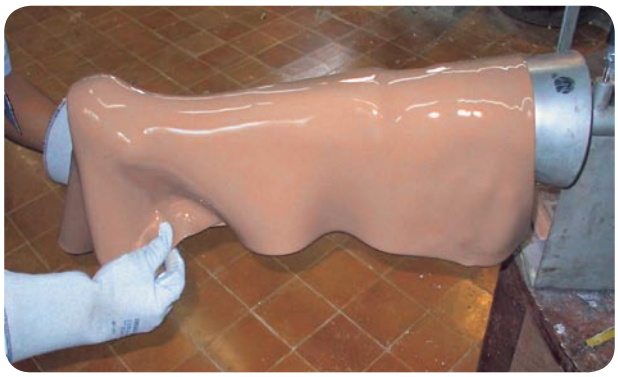
- Cut a 5 mm sheet of PP corresponding to the measurements taken above.

  Heat the PP in an oven for about 20 minutes at 180°C.



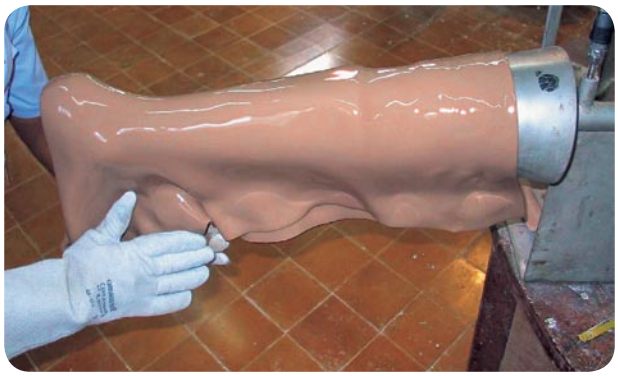
- Lay the PP over the mould without stretching it.

  Drape it first over the ankle towards the middle anterior part of the prosthesis. Then pull it around the forefoot.

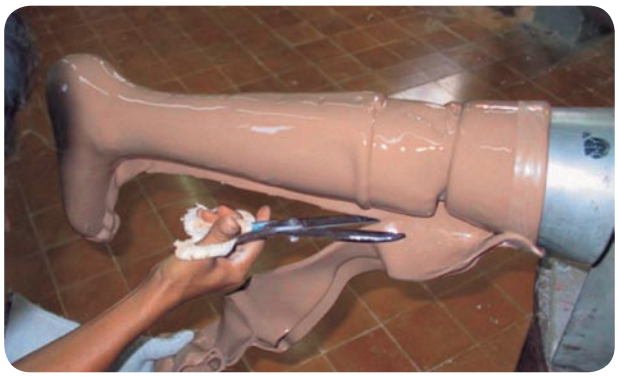


- Finish draping the PP and stick it together along the middle anterior side of the prosthesis.

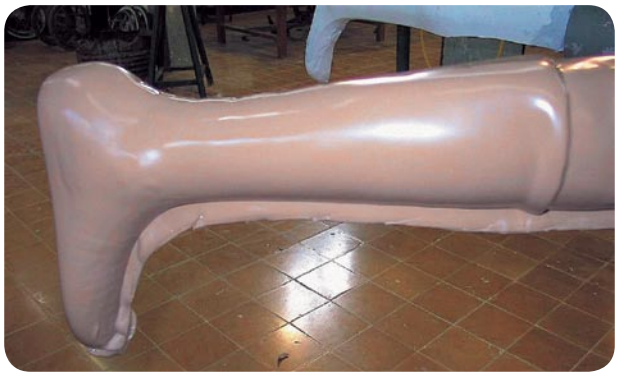
  Tighten the PP around the suction cone with a bicycle inner tube, a rope or a stocking and open the vacuum valve.



- With scissors or a knife, cut off the excess along the welding seam while the PP is still hot.



- Keep the vacuum on for about 5 min., but wait until the PP has completely cooled down before removing the mould from the vacuum cone.

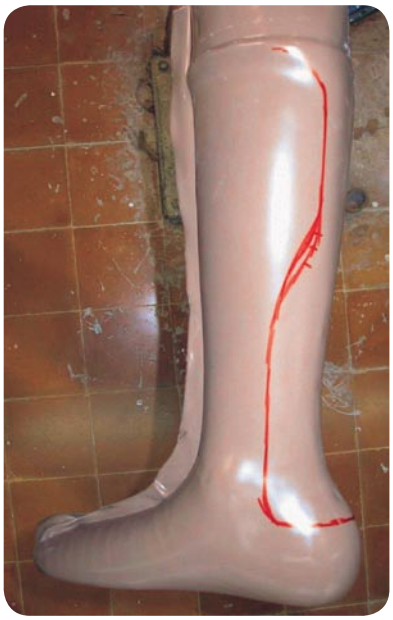


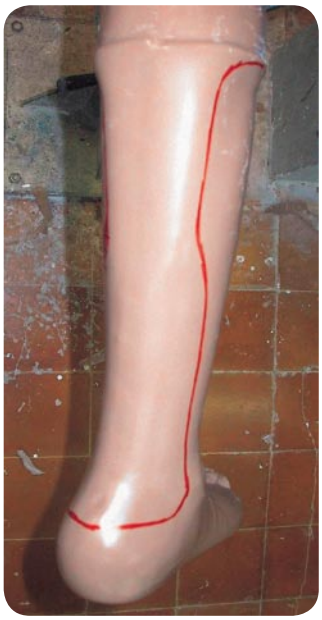
7 TRIM LINES

- Proximal trim line:
  1 to 2 cm below the fibula head.

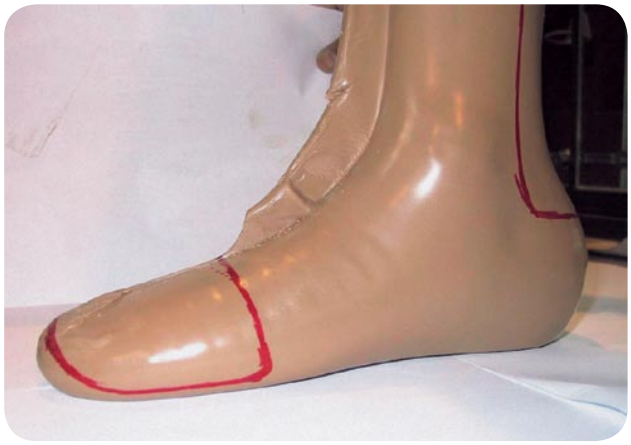
  Lateral/medial trim lines:
  On 1/3 of the proximal tibial section, 2 to 3 cm wider than the 2/3 distal tibial trim line, which is drawn straight up just behind the lateral and medial malleoli.

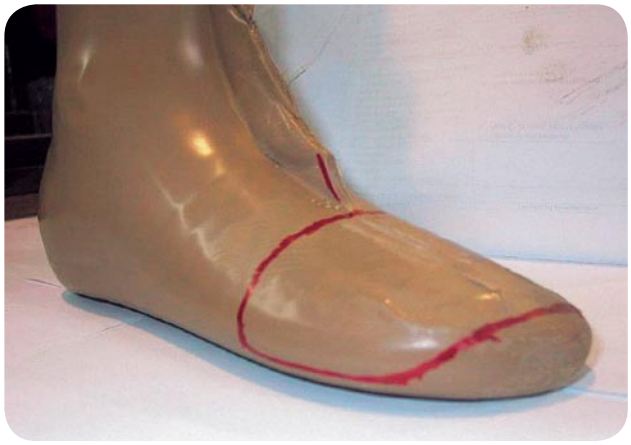
  Distal/posterior trim line:
  Along the calcaneus tuberosity.



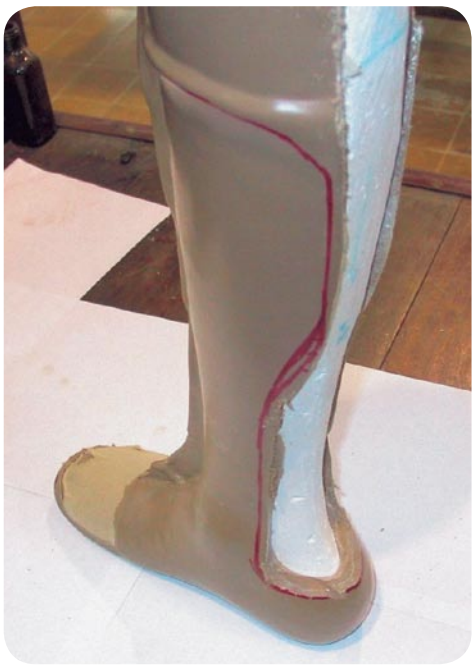


- Forefoot trim line:
  5 mm posterior to the 1st metatarsal to distal phalanges, but keep the PP tip for protection of the EVA foam.

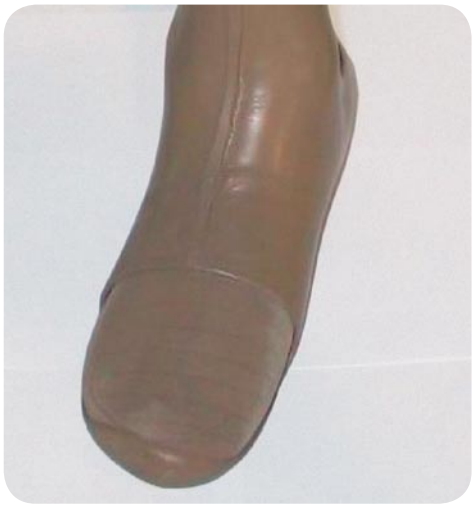




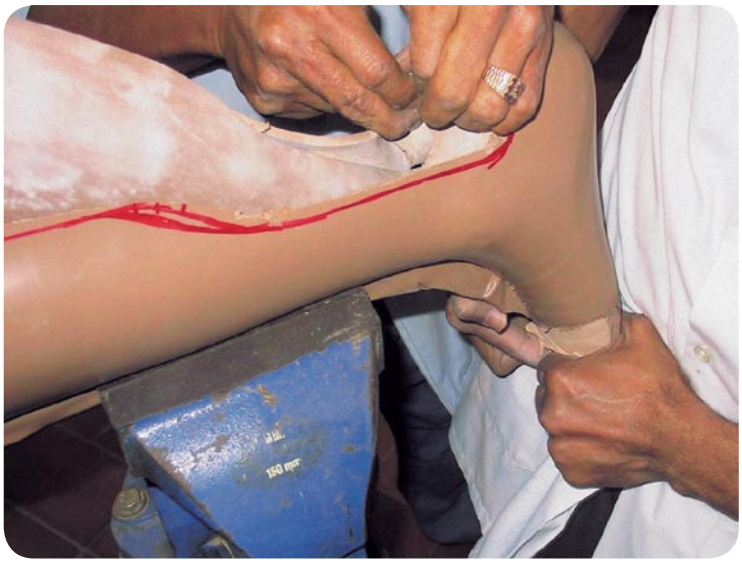
- Cut the posterior opening with an oscillating saw.



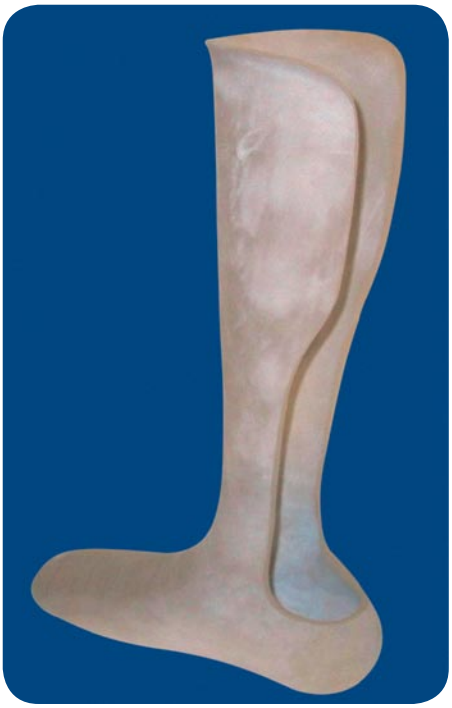
- To avoid damaging the EVA foam, do not cut the forefoot opening with an oscillating saw or knife. Instead, carefully grind it off.



- Remove the soft socket from the plastic socket. Bear in mind that it might be difficult to extract the soft socket from the PP shell.



- Grind the anterior PP welding seam down to 5 mm and shape the trim lines of the plastic and soft sockets.



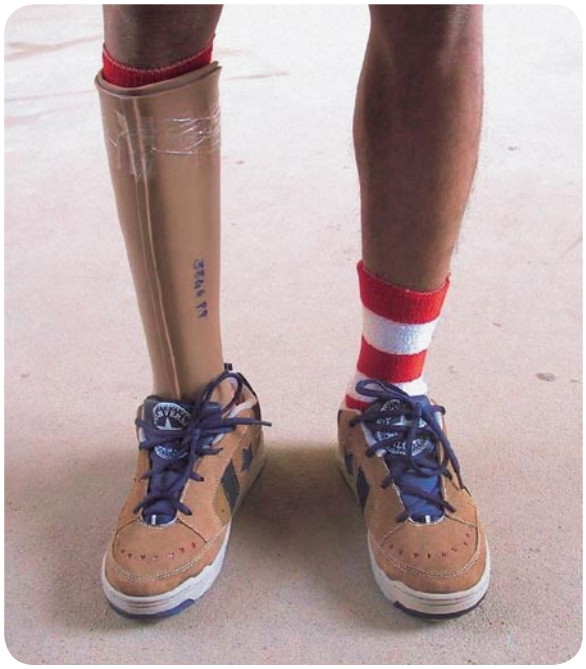
- Shape also the trim lines of the forefoot opening.

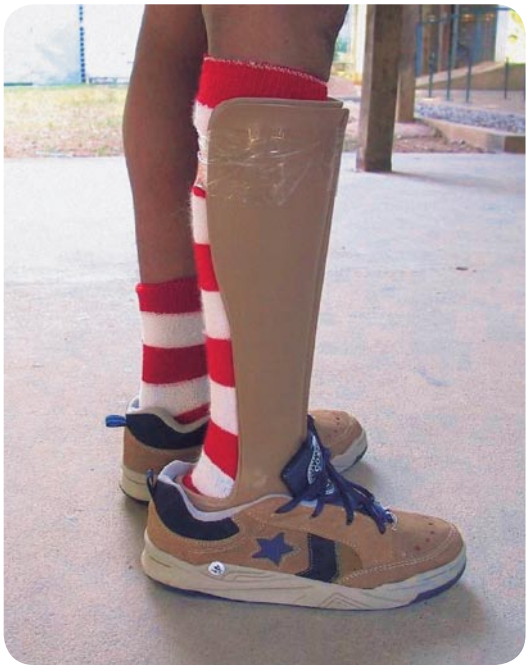
8 FITTING

- During fitting and gait training, fix the proximal part of the prosthesis with tape.

  Modifications can still be made to the alignment, especially to correct the eversion or inversion of the foot, and to the heel height by adding EVA foam on the sole.

  If the prosthesis is too long, compensate for the difference in length either inside the shoe or on the sole of the sound leg.

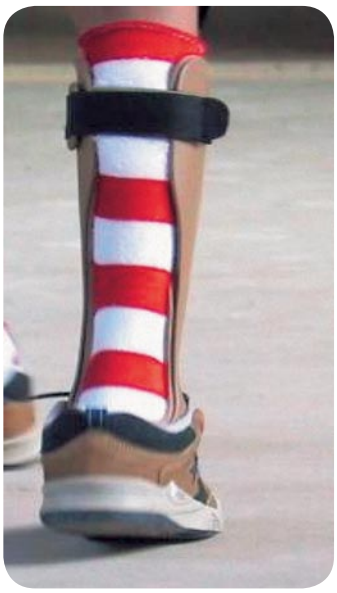




9 STRAPS

- Position a Velcro strap (width: 25 or 40 mm) just below the fibula head.

- Fix the loop on the medial wall and the Velcro strap on the lateral wall with tubular rivets.



10 FINISHED PARTIAL FOOT PROSTHESIS

List of manufacturing materials

ICRC Code	Description	Unit of measure	Quantity
MDREBANDP12	Plaster bandages 12 cm	Each	According to stump dimension
OMIS	Plaster of Paris	Each	According to cast dimension
OPLAEVAFERA03 OPLAEVAFERA06 OPLAEVAFERA12 OPLAEVAFKIN03 OPLAEVAFKIN06 OPLAEVAFKIN12 OPLAEVAFLIV03 OPLAEVAFLIV06 OPLAEVAFLIV12	EVA foam 3 mm, terra brown EVA foam 6 mm, terra brown EVA foam 12 mm, terra brown EVA foam 3 mm, beige EVA foam 6 mm, beige EVA foam 12 mm, beige EVA foam 3 mm, olive EVA foam 6 mm, olive EVA foam 12 mm, olive	Each	According to cast dimension
OHDWGLUENEO4	Glue, Neoprene contact	Each	According to soft socket
OMIS	Tubular nylon stocking 60 mm for PP draping	Each	1 length according to prosthesis
OPLAPOLYCHOC05 OPLAPOLYSKIN05 OPLAPOLYLIV05	Polypropylene 5 mm, terra brown Polypropylene 5 mm, beige Polypropylene 5 mm, olive	Each	According to cast dimension
OSBOSTRVP325 OSBOSTRVP440	Velcro strap with loop 25 mm or Velcro strap with loop 40 mm	Each	1 length according to patient size
OHDWRIVET081 OHDWRIVET131	Tubular rivet 8 mm x 9 mm or Tubular rivet 13 mm x 12 mm	Each	2

MISSION

The International Committee of the Red Cross (ICRC) is an impartial, neutral and independent organization whose exclusively humanitarian mission is to protect the lives and dignity of victims of war and internal violence and to provide them with assistance. It directs and coordinates the international relief activities conducted by the Movement in situations of conflict. It also endeavours to prevent suffering by promoting and strengthening humanitarian law and universal humanitarian principles. Established in 1863, the ICRC is at the origin of the International Red Cross and Red Crescent Movement.

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0868/002 09/2006 200