Prosthesis and Orthosis (1)

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Acknowledgments:

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توصيف مقرر دراسى

1- بيانات المقرر		
الرمز الكودى :	اسم المقرر : علم الاطراف الصناعيه والاجهزه التعويضيه ١ Prosthesis and Orthosis science 1	الفرقة /المستوى :
التخصص :	عدد الوحدات الدراسية : نظرى 3 عملى 10	

2- هدف المقرر:	
i. To provide an detailed knowledge of the composition, properties and different types of orthotics and prosthetics of the lower limb ii. Acquire an appropriate functional background for the usage of different types of orthoses and prosthesis of lower limb iii. Training on assessment of patients and fitting and fabrication to different kinds of prosthesis and orthosis of lower limbs iv. Develop the basic scientific research skills as well as effective communication and team work attitudes.	
3- المستهدف من تدريس المقرر :	
a1. Recognize the principles of prostheses and orthosis of lower limbs. a2. Understand prosthetic and orthotic measurement techniques for the lower limbs. a3. Identify different types of lower limb amputations and neurological and orthopedic deficits and application of appropriate prosthetic and orthotic devices. A4. Know lower limb prosthetic and orthotic components.	ا. المعلومات والمفاهيم :
1. Comprehend static and dynamic alignment of lower limb prostheses and orthoses with reference of their biomechanical applications. 2.Recognize lower limb orthotic fitting, alignment and function 3. Recognize lower limb prosthetic fitting, alignment and function. 4. Develop design for lower limb orthotic or prosthetic for various patients 5. Evaluate different biomechanical defects in lower limb deficits and formulating management needed	ب- المهارات الذهنية :
1. Demonstrate the ability to choose different lower limb prostheses and orthosis for appropriate treatment. 2. Fitting and fabricating lower limb prosthesis and orthoses for various patients 3. Modifying lower limb prosthesis and orthosis to produce beneficial results 4. Integrate data to clinical and technical specific application in prostheses and orthosis of lower limbs	ج- المهارات المهنية الخاصة بالمقرر:

1- Maintain honesty and integrity in all interactions with teachers, colleagues, patients and others with whom technicians must interact in their professional lives. 2- Recognize the scope and limits of their role as students as well as the necessity to seek and apply collaboration with other workers. 3- Be responsible towards work. 4- Maintain a professional image concerning behaviour, dress and speech. 5- Work in study group 6-Benefit from e-learning 7- Self-evaluation and learning 8- Uses various sources to acquire knowledge	د- المهارات العامة :
Lower limb Prosthesis -Partial foot prosthesis - Syme's prosthesis - Below knee prostheses -Above knee prostheses -knee disarticulation Lower Limb orthosis - Shoes, Shoe modifications - Inserts - Ankle foot orthoses - Knee ankle foot orthoses - Knee orthoses - Hip knee ankle foot orthoses - Trunk hip knee ankle foot orthoses - Hip orthoses Special orthoses (weight bearing , fracture and pediatric or orthoses, assistive devices	4- محتوى المقرر:

1. Lectures **2. Tutorials** **3. Workshops (Practical)**	5- أساليب التعليم والتعلم
If we have to accept these students, students must be able to use his hands and have proper vision, and moderate IQ. If so the normal teaching methods could be used	6- أساليب التعليم والتعلم للطلاب ذوى القدرات المحدودة
	7- تقويم الطلاب :
a. Class work: 1. Quizzes 2. Midterm theoretical 3. Practical exam	أ- الأساليب المستخدمة

b. Final exam: Theoretical and practical	
a. Class work: 1. Quizzes: Quiz I (4th week) \ Quiz II (11th week) 2. Midterm theoretical (7th week) b. Final exam Practical exam (13th week) written theoretical exam (15th week)	ب- التوقيت
Quizzes (5%), 10 marks Midterm theoretical (5%), 10 marks Final Practical exam (40%), 80 marks Final written theoretical exam (50%), 100 marks. Total percentage 100%	ج- توزيع الدرجات
	8- قائمة الكتب الدراسية والمراجع :
Lecture and practical notes for prosthesis and orthosis science 1	أ- مذكرات

1-Chinnathurai R, Short textbook of Prosthetics and Orthotics. 2009 1st edition, Jaypee Brothers Medical Publisher Ltd. 2-Joan Edelstein and Alex Moroz, Lower limb prosthetics and Orthotics Clinical concepts. 2010 1st edition, Slack incorporated	ب- كتب ملزمة
John H. Bowker. Atlas of limb prosthetics: surgical, prosthetic, and rehabilitation principles. American Academy of orthopedic surgeons, Mosby Year book	ج- كتب مقترحة
https://www.oandp.org Journal of Prosthetics and Orthotics	د- دوريات علمية أو نشرات ..... الخ

Contents

Course Description

v. This course will provide a detailed knowledge of the composition, properties and different types of orthotics and prosthetics of the lower limb. The student will acquire an appropriate functional background for the usage of different types of orthoses and prosthesis of lower limb. The student will receive training on assessment of patients and fitting and fabrication to different kinds of prosthesis and orthosis of lower limbs

The course will provide knowledge of the basic scientific research skills as well as effective communication and teamwork attitudes.

Core Knowledge and Understanding

By the end of this course, students should be able to:

- Recognize the principles of prostheses and orthosis of lower limbs.
- Understand prosthetic and orthotic measurement techniques for the lower limbs.
- Identify different types of lower limb amputations and neurological and orthopedic deficits and application of appropriate prosthetic and orthotic devices.
- Know lower limb prosthetic and orthotic components.

Core Intellectual Skills

By the end of this course, students should be able to:

- Comprehend static and dynamic alignment of lower limb prostheses and orthoses with reference of their biomechanical applications.
- Recognize lower limb orthotic fitting, alignment and function
- Recognize lower limb prosthetic fitting, alignment and function.
- Develop design for lower limb orthotic or prosthetic for various patients
- Evaluate different biomechanical defects in lower limb deficits and formulating management needed

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Core Professional Skills

By the end of the course the candidate will be able to:

- Demonstrate the ability to choose different lower limb prostheses and orthosis for appropriate treatment.
- Fitting and fabricating lower limb prosthesis and orthoses for various patients
- Modifying lower limb prosthesis and orthosis to produce beneficial results
- Integrate data to clinical and technical specific application in prostheses and orthosis of lower limb devices.

General and transferable Skills

By the end of the course the candidate will be able to:

- Maintain honesty and integrity in all interactions with teachers, colleagues, patients and others with whom technicians must interact in their professional lives.
- Recognize the scope and limits of their role as students as well as the necessity to seek and apply collaboration with other workers.
- Be responsible towards work.
- Maintain a professional image concerning behaviour, dress and speech.
- Work in study group
- Benefit from e-learning
- Self-evaluation and learning
- Uses various sources to acquire knowledge

Course Overview

		Methods of Teaching/Training with Number of Total Hours per Topic				
ID	**Topics**	**Interactive Lecture**	**Workshop**	**Class Assignments**	**Research**	**Lab**
1	Partial foot prosthesis - Syme's prosthesis	3	10			
2	Below knee prostheses	6	20			
3	Above knee prosthesis and knee disarticulation	6	20			
4	Lower Limb orthosis (Shoes, Shoe modifications, Inserts)	3	10			
5	Ankle foot orthoses	3	10	1.5		
6	Knee ankle foot orthoses Knee orthoses	3	10			
7	Knee ankle foot orthoses	3	10			
8	Hip knee ankle foot orthoses Trunk hip knee ankle foot orthoses Hip orthoses	6	20			
9	Assistive devices and special orthosis	3	10			
TOTAL HOURS (157.5)		**36**	120	**1.5**		

Chapter 1
Lower Limb Prosthesis

Objectives

- Knowledge of different levels of amputation and required Lower limb prosthesis
- Fabrication and fitting methods
- Different components of lower limb prosthesis

Introduction

They must permit comfortable ambulation during gait minimizing the shift of the center of gravity of the body enhanced by a well-fitted socket and proper alignment.

Lower limb Prostheses are used frequently on patients who have had Amputation of the legs at various levels due to various causes, especially due to accidents and diseases.
The Prostheses are made and fitted according to levels of amputations. The considerations when choosing Prosthesis include the following:

- Amputation levels
- Contour of the residual limb
- Expected function of the prosthesis
- Cognitive function of the patient
- Occupation of the client
- Hobbies interests of the client
- Cosmetic importance of the prosthesis

Lower limb Prosthesis:

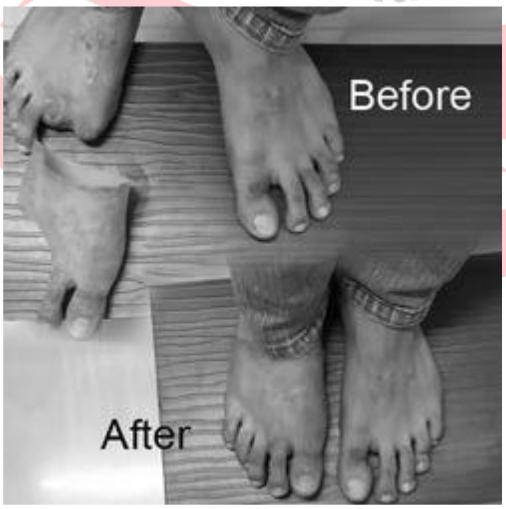
Device shall replace a missing leg and is made up of components fabricated by a manufacturer.
The two main subcategories of lower extremity prosthetic devices are;
1. Trans-tibial (any amputation transecting the tibia bone or a congenital anomaly resulting in a tibial deficiency).
2. Trans-femoral (any amputation transecting the femur bone or a congenital anomaly resulting in a femoral deficiency). In the prosthetic industry a trans-tibial Prosthetic leg is often referred to as a "BK" or below the knee prosthesis while the trans-femoral prosthetic leg is often referred to as an "AK" or above the knee prosthesis.

Level of Amputation:

1. Partial foot Amputation.
2. Syme's Amputation.
3. Transtibial Amputation.
4. Transfemoral Amputation.
5. Knee disarticulation.
6. Hip disarticulation.
7. Hemipelvectomy.

1.1 **Partial foot prostheses.**

The purpose is to restore foot function particularly in walking to simulate the shape of the missing foot segment.
Indication
1. Loss of one or more toes.
2. Trans-metatarsal amputation.
3. Amputation or disarticulation through tarsals.



Syme's prosthesis

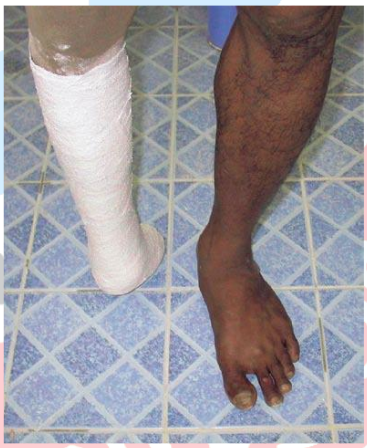
- The procedure described relates to one of the most common types of partial foot amputation,

which is also known as Chopart or mid-foot amputation.

- If full end bearing is not possible, the Patellar-Tendon-Bearing (PTB) design brim should be used.

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 molds and the footprint.



Soft socket fabrication:

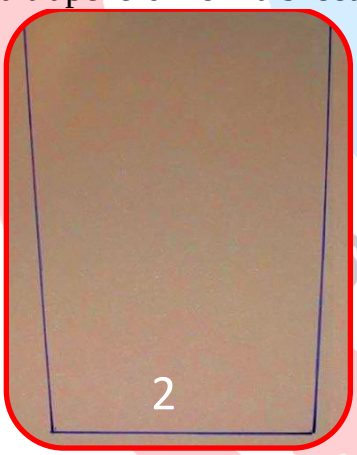
Measurement of EVA foam:

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.



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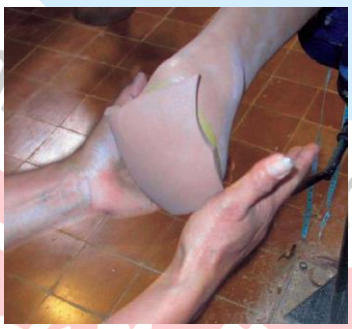
- Trim a 10 mm strip on both lateral sides of the EVA foam to zero millimeters.
- Apply Neoprene contact glue twice on both trimmed sides.
- Once the glue is dry; join the two surfaces to form a cone.



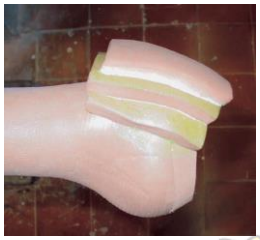

- Dust the plaster positive and the inside of the EVA cone with talcum powder to facilitate sliding.
- Heat the EVA cone in an oven for about 5 minutes at 120°C and then pull it over the plaster positive.
- To keep the EVA foam in the same shape as the plaster positive, secure it with elastic bandages 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.



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



Hard socket fabrication:

- Measurement of PVA sheet:

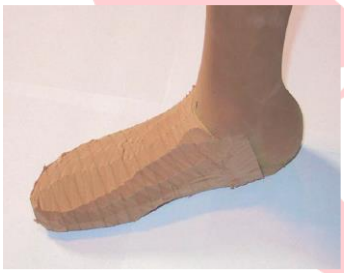
Length from proximal part of plaster positive + 15 cm
Circumference of proximal part of soft socket + 2 cm
Circumference of mid-tibial section + 2 cm
Circumference of foot-ankle (below medial malleoli, including calcaneus) + 5 cm

- Pull PVA after moisturizing with water and close from the end of vacuum tube and the top of socket. Pull 2 layers of Nylon Stockinet +2 layers Fiberglass tube + 2 layers of Nylon Stockinet and pull PVA. close from the end of vacuum and top of cast. keep the vacuum on.
- Lamination resin for fabrication.

Lamination + Hardener/color pastes are easier to mix. pour the lamination from the top and close the end of PVA. unscrew the upper node of cast to distribute the lamination. keep the vacuum on a till dry.

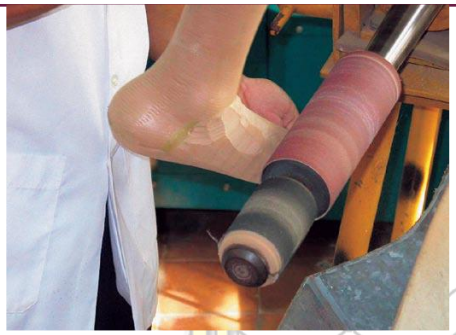
- Pre-shape the forefoot with a knife.

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.



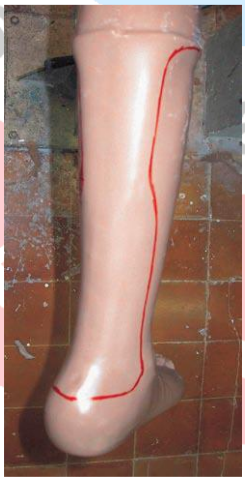
- For finishing, a sheet of 3 mm EVA foam is draped over the foot.

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.

Trim lines:

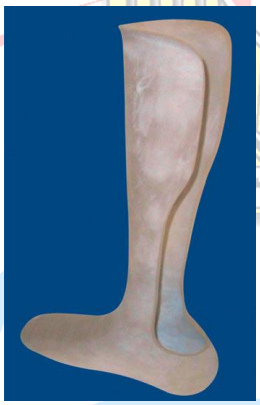
- Proximal trim line:

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.



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

- Grind the trim lines of the plastic and soft sockets.



Fitting :

- 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.

- 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.

Finished partial foot prosthesis:

Covering the prosthesis by natural leather. Same collar of skin.

Straps:

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

1.2 Below knee prostheses

Lower-extremity amputations may be performed for the following reasons;

* Peripheral vascular disease (PVD) : most amputations performed are for ischemic Disease, primarily in elderly persons with diabetes mellitus. These patients often Experience peripheral neuropathy that progresses to trophic ulcers and subsequent Gangrene and osteomyelitis.
* Trauma: severe open fractures with popliteal artery and posterior tibial nerve injuries Can be treated with current techniques; however, treatment is at a high cost, and Multiple surgeries are required. The result is often a leg that is painful, nonfunctional, And less efficient than a prosthesis.
* Tumours: Amputation is performed less frequently with the advent of advanced limb salvage techniques.
* Infections: Treatment of sepsis with vasoconstrictor agents may at times lead to vessel occlusion and subsequent extremity necrosis, necessitating amputation. At other times, eradication of infection from many difficult sources necessitates removal of the affected digit or limbs.
* Congenital limb deficiency: Amputations for congenital limb deficiencies are performed primarily in the pediatric population because of failure of partial or complete formation of a portion of the limb. Congenital extremity deficiencies have been classified as longitudinal, transverse, or intercalary. Radial or tibial deficiencies

Are referred to as preaxial, and ulnar and fibular deficiencies are referred to as postaxial.

Post-surgical management

When amputation of a limb is being considered, it is important to inform the patient

about future rehabilitation [13]. An early visit by the prosthetist can also be helpful. The prosthetist can give specific information about prosthetic options and rehabilitation and can show

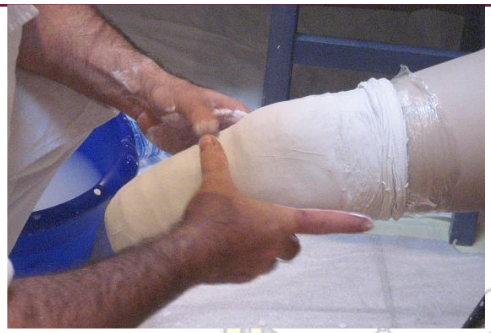
Various types of prostheses to the patient. The prosthetist can also suggest pre-prosthetic management with rigid dressings, elastic bandaging, or prosthetic shirkers to speed the maturation of the residual limb. When then the amputee is ready for prosthetic fitting,

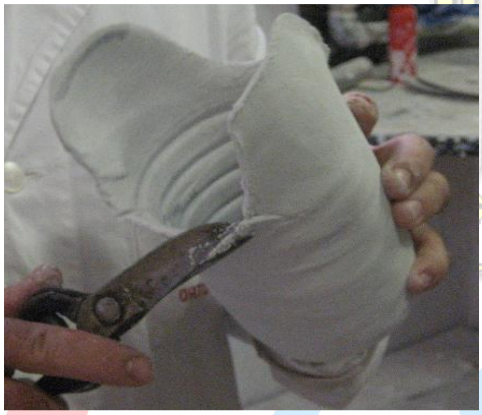
Additional orientation information can be explained about the different stages of the rehabilitation process, including how long the preparatory prosthesis will be used and when the evaluation for a definitive prosthesis will occur.

Socket Design

***Patellar Tendon Bearing*:**

The patellar tendon-bearing (PTB)8 socket consists of a laminated or thermoplastic socket that provides an intimate, total contact fit over the entire surface of the residual limb. The anterior wall of the socket extends proximally to encapsulate the distal third of the patella. Just below the patella, located at the middle of the patellar ligament, is an inward contour or bar that (via other biomechanical forces) converts the patellar tendon (ligament) of the residual limb into a weight-bearing surface. PTB is a misnomer, however, because the patellar tendon is not the only weight-bearing surface used by the PTB socket. The medial and lateral walls extend proximally to about the level of the adductor tubercle of the femur. Together, they serve to control mediolateral/rotary forces applied to the residual limb. The medial wall is modified with an undercut in the area of the medial flare of the tibia, a pressure-tolerant surface and primary weight-bearing area. The lateral wall provides relief for the head of the fibula and the cut end of the fibula. This wall applies pressure along the fibular shaft to enhance medial-lateral stability. In addition, the lateral wall acts as a counter pressure to the medial wall. The posterior wall is slightly higher than the patellar bar and is designed to apply an anteriorly directed force to maintain the patellar tendon on the bar. The posterior wall is flared proximally to allow comfortable knee flexion and is contoured to prevent pressure on the hamstring tendons. The total contact fit provides relief over no pressure-tolerant areas and supports the body's weight over the pressure-tolerant areas of the limb. Total contact is necessary to prevent limb edema, but does not imply equal pressures throughout the socket. PTB socket design is appropriate for nearly all Transtibial amputations, but is seen less often with introduction of the total surface-bearing socket. The PTB prosthesis is designed to maintain the residual limb in slight initial flexion (from 5 degrees to 10 degrees) to convert the patellar bar to a more horizontal supporting force. However, because the patellar bar is not completely horizontal, the residual limb still has a tendency to slide down posteriorly. This tendency must be counteracted by the posterior wall that is contoured to maintain the patellar tendon's position on the patellar bar.





Total Surface Bearing

The total surface-bearing (TSB) socket design is commonly used when a gel liner is prescribed. The gel dissipates pressures throughout the socket and relieves bony prominences. Different from the PTB socket, pressure is intended for global distribution over the entire limb, as opposed to pressure-tolerant areas only. Bone and other sensitive regions are cushioned by the gel liner. Socket contours are smooth and without any obvious reliefs or undercuts lowering peak pressures.9 Similar to the PTB socket, this design also provides a total contact fit for comfort. The TSB socket significantly differs from PTB concepts in modification technique. In the PTB socket, plaster is removed over the patellar tendon, lateral pretibial group, the medial flare, and the popliteal region. Areas of plaster addition are the tibial tubercle, along the tibial crest, and the proximal and distal fibulae. TSB modification does not require buildups. The gel material dissipates pressures throughout the socket and relieves bony prominences. Patients with fragile soft tissues, burns, skin grafts, scarring, or bony residual limbs can benefit significantly from the extra protection offered by the gel liner and TSB design.

Suspension

Suspension Sleeves

Suspension sleeves are available in neoprene, gel, or a breathable elasticized fabric. A neoprene suspension sleeve provides simple, low profile, relatively effective suspension. Its ease of application makes it an ideal option as an auxiliary form of suspension for periods of increased activity. The sleeve is fitted to the proximal third of the prosthesis and onto the midthigh several inches past the prosthetic socks. A small puncture or tear in the neoprene or gel sleeve can significantly impact its effectiveness because it provides suspension through a snug fit, resulting in friction and negative pressure. Activities such as kneeling or other heavy duty use may easily cut through a sleeve, thus hindering the ability to provide partial suction. On occasion, a patient may be allergic to the material. Because sleeves fit snuggly onto the thigh, the patient must have the strength and dexterity for proper application. If this is not the case, a more suitable suspension option should be sought. Heat buildup and perspiration are also concerns. Patients with upper extremity involvement may find the sleeve difficult to pull up onto the thigh. Sleeves do not provide sagittal or coronal stability

Supracondylar/Supracondylar Suprapatellar Design

The supracondylar socket design affords the patient two primary benefits:
(1) its high trimlines offer inherent suspension
(2) it provides some control to a mildly unstable knee joint.
The medial wall encompasses the femoral condyle and contours closely to the femur to purchase just past the level of the adductor tubercle, therefore creating a reduced proximal mediolateral dimension. This tight proximal configuration suspends the prosthesis over the femoral condyles. It is indicated primarily for individuals with short residual limbs to provide increased medial-lateral stability.

Alignment

Prosthetic alignment will change as the patient's range of motion, muscle strength, and balance improves, and as the patient gains confidence and becomes more physically comfortable in the prosthesis. Intervention by physical therapy is crucial during this early period to aid the patient in developing appropriate gait habits. Prosthetic alignment during early fitting, just after amputation, can be significantly different on the same patient one year later when the limb is well healed and the patient returns to high-level activity. As confidence and ability increase and limb contours change, the socket and/or foot will be replaced, resulting in a need for prosthetic alignment change. Initial static and dynamic alignment goals consider the patient's level of ability, limb length, stage of healing, range of motion, and muscle strength. Use of instrumented gait evaluation has also been beneficial in optimizing prosthetic alignment. The goals in each plane during the first fitting/alignment visit are as follows:

Coronal

• Iliac crests are at the same level. Patient's gait is smooth and symmetrical with no excessive trunk lean to either side.

• Foot is inset loading the proximal-medial and distal-lateral aspects of the residual limb and encouraging an energy-efficient, narrow-based gait.

• Socket adduction or abduction matches the residual limb, resulting in a vertical pylon or a foot that is flat on the floor at midstance. On average, sockets are in 5 degrees of adduction, but some patients may actually require an abducted socket.

• There is less than 6 mm of socket displacement during the swing phase.

Sagittal

• No forced knee flexion or extension when standing. Shoe has even contact with floor and is bearing weight evenly.

• Presence of a smooth, energy-efficient gait pattern—including controlled knee flexion after initial contact-loading response—smooth rollover with no recurvatum tendency, or early drop off at late stance.

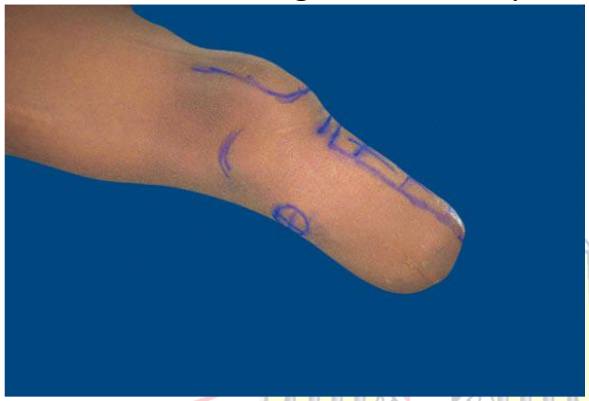
• As previously described, an attitude of initial flexion increases the weight-bearing capacity of all load-tolerant areas. In addition to improving the weight-bearing characteristics, appropriate socket flexion also allows a smooth gait pattern by placing the quadriceps muscles on stretch. Because the knee is maintained in slight flexion, the quadriceps have a mechanical advantage to control the prosthesis. The constant attitude of knee flexion also lessens the possibility of hyperextension of the knee during midstance and terminal stance.

Transverse

• The degree of toe-out on the prosthesis should approximate that of the sound limb. The degree of toe-out should not decrease the patient's stance phase stability.

Measurements and soft socket manufacture:

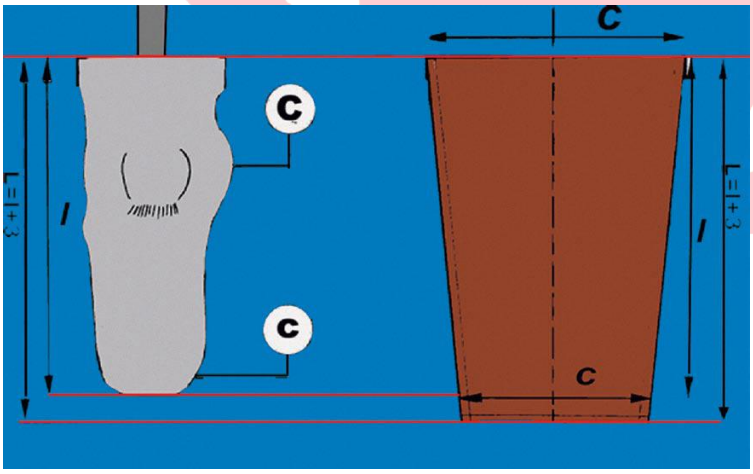
The patient is assessed, a prescription is made, measurements are taken and molding and rectification are performed according to best P&O practice.



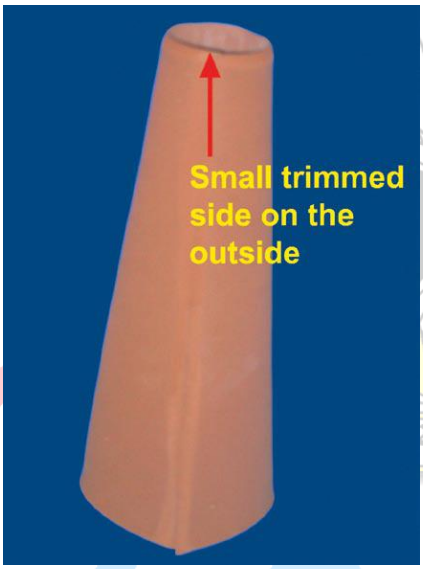
Soft liner manufacture

Measure the plaster mold. Note the:
- smallest circumference;
- largest circumference;
- length.

Draw a trapezoid on a sheet of 6 mm EVA according to the measurements taken but adding 3 cm to the length on the short side of the trapezoid.
Cut the EVA and skive the lateral and the distal sides (about 12 mm).



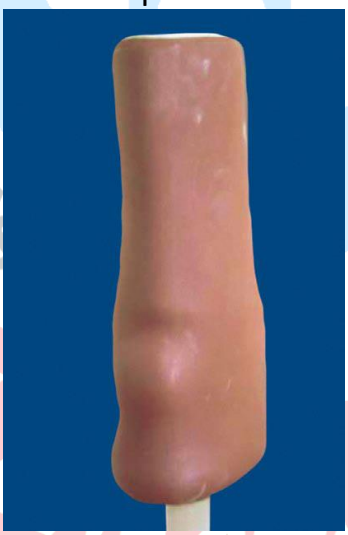
Apply glue on both skived sides and form a cone. Keep the trimmed distal side on the outside of the cone and leave it free of glue.



Apply talcum powder inside the cone and on the plaster model.
Thermoforming is done using the vacuum pump, on a vertical suction hose.

Heat the EVA cone in the oven at 120°C.

Pull the EVA cone over the plaster mould, keeping the glued line on the posterior side, until the trimmed distal side coincides with the tip of the plaster mould. close it securely below the mould with an elastic strap and switch on the vacuum pump.



And covering the end of plaster mold.

Hard socket fabrication:

Measurement of PVA sheet:
Length from proximal part of plaster positive + 15 cm
Circumference of proximal part of soft socket + 2 cm

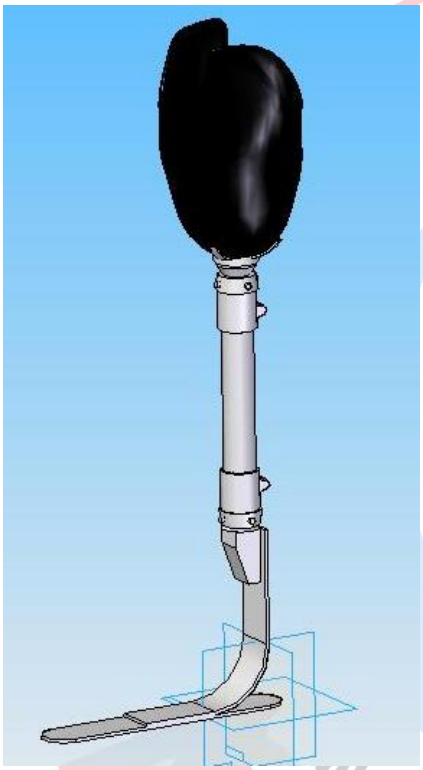
Circumference of mid-tibial section + 2 cm
Circumference of foot-ankle (below medial malleoli, including calcaneus) + 5 cm
 Pull PVA after moisturizing with water and close from the end of vacuum tube and the top of socket. Pull 2 layers of Nylon Stockinet +2 layers Fiberglass tube + 2 layers of Nylon Stockinet and pull PVA. close from the end of vacuum and top of cast. keep the vacuum on.
Lamination resin for fabrication.
Lamination + Hardener/color pastes are easier to mix. pour the lamination from the top and close the end of PVA. unscrew the upper node of cast to distribute the lamination. keep the vacuum on a till dry.

(in case of modular system will be stapling the adaptor socket between stockinet and fiberglass and will be increase the layers of stockinet and fiberglass)
* Cut the socket to the trim lines, remove the plaster without damaging the socket liner and socket, and grind the welding seam down to 3 mm.

Single Axis Foot


SACH+ Foot

SACH Foot Adapter with screw connection



1.3KNEE DISARTICULATION

Socket Design

Socket design for knee disarticulation is often dictated by the degree to which distal weight bearing can be tolerated by the patient, as well as size of the femoral condyles in relationship to the thigh. Although knee disarticulation amputation is able to tolerate partial or full end bearing, the socket should provide total contact over the entire thigh to dissipate pressures over the greatest amount of surface area as possible. Ischial containment socket concepts remain the same, but trimlines and dimensions can be less aggressive than those of the transfemoral prosthetic design, even to the point of totally eliminating ischial containment. The proximal brim of the socket will be near round, terminating just distal to the ischium and pubic ramus to prevent impingement
(similar to the old plug-fit transfemoral socket). Weight bearing will be distributed

over the entire surface area of the residual limb contained in the socket, as well as over the distal end. Sockets are either thermoplastic or laminated and can include a gel liner or a flexible inner liner with a rigid outer frame. In weight bearing, a thin, firm, resilient pad provides the patient with a distal end pad to increase comfort under the bony condyles. During the early stance phase, the patient stabilizes the prosthetic knee in much the same way as a person with a transfemoral amputation: by actively contracting the hip extensors. Therefore, the rotary forces occurring in the sagittal plane during this gait phase will be greatest over the anterior proximal aspect of the thigh and over the distal posterior end of the residual limb. Consequently, the proximal anterior brim of the socket should provide even, comfortable, counter pressure, and the distal posterior socket should provide total contact and comfortable loading. During midstance, the socket will rotate about the distal end of the knee disarticulation, thus generating counter pressure against the proximal tissues of the thigh. Although the long residual limb provides a greater surface area to disperse these forces, the direction of socket rotation concentrates pressures around the distal femur laterally and the proximal thigh medially. In light of these forces, socket design for this level should facilitate comfortable distal loading, the proximal brim should stabilize laterally, and the medial-proximal brim should flare generously to minimize tissue rolls and avoid painful pressure.

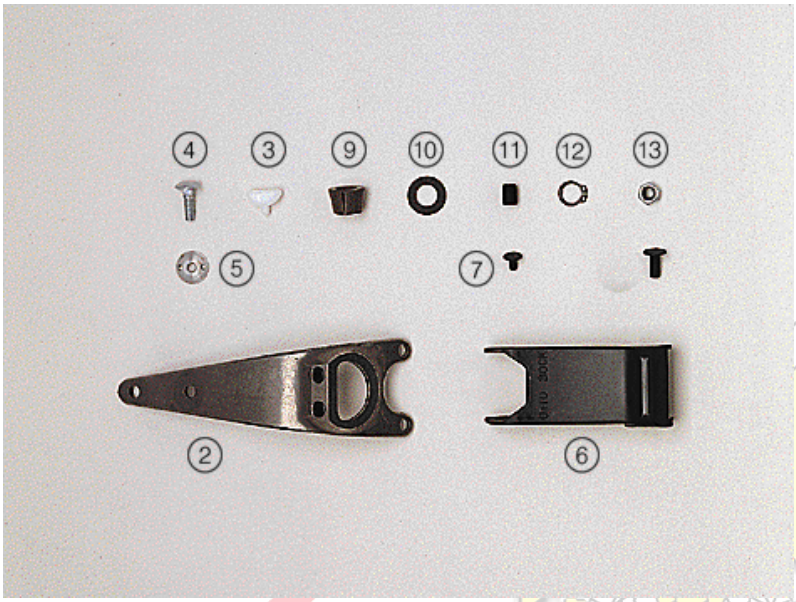
Suspension

The spared femoral condyles offer similar suspension options as the malleoli do in the Syme prosthesis. Supracondylar suspension is obtained with either a pad placed over the flares of the condyles to wedge the limb into the socket or a medial cutout in the distal socket that allows the widest points of the condyles to pass. The cutout is closed to hold the socket in place. A removable medial plate is locked in place over the opening with Velcro (Velcro USA, Inc, Manchester, NH) straps after the prosthesis is donned to securely hold the residual limb in place. A disadvantage of this design is that the opening weakens the structural strength of the socket, and care in fabrication to reinforce this area is necessary. This suspension method works well when the femoral condyles are prominent, but suspension can be compromised by excessive redundant soft tissue or postoperative edema. In such cases, some form of auxiliary suspension is needed. The medial window design is simple and easy to don. The pad or partial sleeve suspension design results in a strong, continuous socket and eliminates circumferential straps about the distal aspect of the socket. It consists of a split cylindrical pad that the patient slips over the lower femur proximal to the condyles, converting the residual limb to a cylindrical shape. Prosthetic socks are used to hold the pad in place. The patient then pushes into the socket until it is firmly seated. Compression of the pad and friction suspend the prosthesis. Because this method does not require a complete liner, no additional bulk is added around the bulbous distal end. Both designs require a socket interface, such as a gel liner, socks, or both. Suspension during swing is maintained by ensuring a tight fit via added sock plies or by increasing the thickness of the suspension pad. If the distal residual limb contours are captured well enough, this can provide suspension and rotational control because the rounded brim cannot be relied on to prevent

rotation.

Knee Selection Considerations

The full length of the femur poses a challenge in that virtually any prosthetic knee joint will result in a lower knee center on the prosthetic side. Historically, outside knee joints were incorporated to minimize knee center discrepancy, but their many disadvantages—most importantly lack of swing phase control—make them rarely used today. The knees of choice at this level are those of the polycentric design, and some knees are designed specifically for the knee disarticulation amputation. They decrease the overall prosthetic length of the thigh section, while decreasing the length of the shin section. In addition, some knees incorporate a linkage that, when flexed to 90 degrees, translates posteriorly under the socket, thereby reducing the thigh section length. As the linkage folds up underneath the prosthetic socket during sitting, the foot will often rise off the floor. The thigh segment will still appear somewhat longer when compared with the sound side. These are common issues, and the patient should be made aware of them during the fitting process. The polycentric design also reduces the length of the shank section during swing, thus facilitating toe clearance.



1.4 TRANSFEMORAL PROSTHESIS: (AK)

Socket Design

Ischial Containment

In 1955, Radcliffe13 described the biomechanics affecting lateral stabilization of the femur and pelvis in the transfemoral prosthesis. These principles are summarized as follows:

• During single limb support on the prosthetic side, the weight of the amputee's body, acting through the center of gravity, causes the pelvis to dip toward the sound side.

• Because of this tendency for the pelvis to rotate toward the sound side, the pelvis can be described as a lever with a fulcrum, or supporting point, located lateral of the ischium.

• The tendency for the pelvis to dip or rotate toward the sound side is resisted by contraction of the hip abductor (gluteus Medius), which exerts a counteracting moment to the pelvic lever.

• For the gluteus Medius to have maximum effectiveness, it should be maintained at its normal resting length.

• This can be achieved if the femur is kept in a normal position of adduction.

• For the person with a transfemoral amputation, the lateral wall of the socket must be shaped to maintain the femur in adduction because contraction of the gluteus medius causes the femur to stabilize against the lateral wall. Pressures thus generated must be distributed evenly, and excess pressure over the distal lateral end of the femoral shaft must be avoided.

• As a result of these forces acting against the lateral shaft of the femur, counter pressure is generated by the medial wall against the proximal medial tissues of the limb.

These principles have not changed, although the ongoing challenge of managing them has produced a gradual evolution toward ischial containment socket designs and changing theories of prosthetic alignment.

One of the primary goals of the ischial containment socket is to provide medial-

lateral stability by controlling the lateral shift of the femur during stance. This is accomplished by the narrow medial-lateral design and closely fitting socket that encases the medial aspect of the ischial tuberosity and ramus.14 Per its name, the ischial containment socket has the ischium within the socket itself. The socket is just wide enough at the level of the ischial tuberosity to allow the ischium to drop down inside the socket. The portion of the socket that extends proximally along the medial aspect of the ischial tuberosity and the ischial ramus is called the medial containment wall. This wall is angled to match the ischial ramus angle and does not follow the line of progression. Because the medial containment wall extends above the ischium, it will not allow the socket to migrate laterally. A tight dimension spanning the area just below the trochanter and at the medial aspect of the ischium maintains the bony structures snugly against the medial containment wall. In the transverse plane, the ischial containment socket tends to follow the anatomical shape of the proximal thigh.

It has been proposed that the ischial containment socket can provide a bony lock via a three-point force system and increase femoral stabilization in the socket during weight bearing. It is also believed that this three-point force system provides additional means for holding the femur in adduction. In 1989, a study by Gottschalk et al15 demonstrated that socket design is not necessarily a primary determinant of femoral adduction. This work showed that there was no significant difference in femoral adduction in the socket when comparing quadrilateral or ischial containment designs. The postsurgical length of the adductor musculature had a much greater bearing on proper femoral adduction.

When the socket trimlines in the perineum are aggressively high to capture the ischium and posterior aspect of the ramus, using a flexible inner liner with a rigid frame is recommended. The frame needs only to support or control the bony structures, thus leaving the flexible plastic to contain the anterior ramus and soft tissues. The added feature of the frame cutouts provides comfort, room for expanding musculature, and some proprioceptive feedback.

Ischial Containment Variants

Once the concept of ischial containment was established, there have been varied iterations of this design. Some sockets accentuate and clearly define the functioning muscle bellies, allowing space for muscle contraction. Others lower the posterior aspect of the socket for sitting comfort. This minimizes gluteal support, but renders a better cosmetic result. Each of these designs follows the basic ischial containment principles with additional specific goals. Furthermore, each prosthetist will custom design any socket a bit differently, given the many contours and trimlines possible with the transfemoral socket.

Quadrilateral

If the ischial containment design is not successful, then the more historical quadrilateral socket may be considered. Quadrilateral refers to the four-sided

shape of the socket when viewed transversely. As Radcliffe13 states: “The four walls of the socket are designed to apply pressures and counter pressures to facilitate comfortable load bearing through soft tissue and underlying structures.” The ischial tuberosity and gluteal musculature are used as primary weight-bearing structures and are supported by a posterior shelf. The ischium is maintained on the shelf or seat by the counter force of an inward contour (Scarpa’s bulge) in the anteromedial socket located over the femoral triangle. Although the femoral triangle contains the femoral artery, vein, and nerve, years of clinical trials have demonstrated that correctly distributed pressure over these structures is well tolerated. A convex contour in the proximal anterolateral socket accommodates the bulk and the contraction of the quadriceps muscle group. The quadrilateral socket may be suspended in a number of ways, including use of suction, a Silesian belt, or a hip joint with a pelvic belt.

Suspension

Suction by Skin Contact

A suction socket offers intrinsic suspension and is held in place by a combination of negative air pressure, surface tension between the socket and the patient’s skin, and muscular contraction against the socket walls. For the socket walls to be in direct contact with the patient’s skin, no socks are worn. A valve, usually located at the distal-medial aspect of the socket, allows air to escape from the socket during weight bearing while preventing air entrance during the swing phase. The patient generally dons a suction socket by removing the valve, applying a donning sleeve over the residual limb, and feeding the loose end of the material through the valve hole. The material breaks the surface tension between the socket and the patient’s skin, allowing the patient to pull the limb comfortably into the socket. By using the donning sleeve to help pull skin and soft tissue into the socket, the patient can usually minimize problems caused by tissue overhanging the socket brim. Patients with a long, muscular limb may choose to push directly into the socket with a small amount of skin lubricant. Either way, it is critical that no distal air pockets remain. If there is lack of total contact distally in a suction socket, the high negative pressures created in the air space can result in circulatory congestion and edema. There are many advantages to selecting suction suspension. The most apparent advantage is elimination of belts and liners. Thus, the patient enjoys an unencumbered, lightweight, and relatively simple-to-apply suspension. The socket is a total contact fit that minimizes the possibility of edema. Suction is a solid form of suspension because once the skin is drawn down into the socket, the residual limb is effectively trapped in the socket, thereby minimizing vertical displacement. Because the socket is firmly attached to the patient’s residual limb, and rotational control is provided by the brim design, patients usually report that they have much better control of the prosthesis when using this form of suspension, especially during the swing phase. One noted contraindication to a suction socket is that limb volume must remain stable to maintain a negative pressure environment. It is common for a patient’s residual limb to change volume over time, especially within the first year postsurgery. Even

the residual limb of a longtime wearer can decrease in volume over the course of the day. Slight fluctuations are normal and generally not problematic, but those seen just after surgery make this suspension option inappropriate. If the patient presents with scarring, which extends across the proximal tissues of the residual limb, it is possible that those scars will break the air seal around the proximal socket and allow air to enter. As a result, suction is not maintained. Donning the suction socket requires strength and balance. If the patient does not possess sufficient ability and endurance, or has upper extremity involvement, another suspension mechanism must be used.

Sealing Liners

Suction is the suspension of choice because it eliminates belts and buckles. To address some of the aforementioned contraindications, a sealing liner as presented in the transtibial section is a good choice. A gel liner with a hypobaric seal is rolled onto the limb and then pushed into the socket. The seal is pressed against the socket wall, and suction is maintained below the level of the sealing ring. A thin sheath is worn below the level of the ring to wick air out through a one-way, push-button release expulsion valve.

Locking Gel Liners

When the two previous suspensions cannot be used, gel locking liners may be considered. The locks can incorporate pins, lanyards, or buckles. The goals of the gel locking liner for the transfemoral design are similar to that of the transtibial socket, with a primary goal to suspend the prosthesis and distribute pressure over the entire surface of the residual limb. As in the transtibial prosthesis, the silicone or gel type liner can provide a significant amount of protection for the residual limb. Locking liners can be applied to virtually any length of transfemoral residual limb. If a locking liner is planned for a long transfemoral or knee disarticulation amputation level, then a lanyard-type suspension may be required. This does not require the use of a long locking mechanism and keeps the prosthetic knee center at or just slightly below the anatomical knee.

The most common advantage for the gel locking liner is an added measure of protection for the residual limb. The use of a liner can provide reduced shear on the residual limb and thus increased protection for fragile tissues. The liner can accommodate varying circumferences of the residual limb, thus ensuring total contact in the socket. As a result, the patient is much less likely to experience the failure of suspension because of suction loss. As an added benefit, donning the locking liner can be much easier than the skin suction socket because the patient is not required to lean over and pull into the socket. Typically, this locking liner suspension only requires that the patient engage the pin or pull up on a lanyard while stepping into the socket. Another significant advantage for the transfemoral patient, who tends to experience volumetric changes of the residual limb, is that the patient can apply prosthetic socks over the locking liner. The socks must have a hole at the distal end, which allows the pin to pass through and engage into the

locking mechanism of the distal socket. As the patient's residual limb volume decreases, the sock ply can be increased accordingly and vice versa.

Silesian Belt

The Silesian belt is a simple, low-profile, belt-type suspension mechanism. Indication for its use is primarily the need for rotational control of the prosthesis. The Silesian belt can be used as an auxiliary to suction suspension and, the in the case of an individual with weak adductors, can even assist the adductor muscles during swing phase. The belt sits firmly over the sound side ilium and may not be as effective with the obese patient. Scarring about the pelvis can also prevent its use because the belt creates friction in this area. If the patient presents with severe mediolateral instability, the hip joint and belt are better choices. The Silesian belt can be easily used with prosthetic socks to suspend the prosthesis while also accommodating residual limb volume fluctuation. The Silesian bandage is an excellent auxiliary suspension for a suction socket fitting for shorter levels. Support of the belt helps to prevent the socket from slipping off when the patient is seated. It also provides additional security during any activity.

Elastic Belt

An elastic suspension belt is fabricated of Neoprene (or polychloroprene; DuPont Performance Elastomers LLC, Wilmington, Del) or similar elastic material. Typically, this kind of belt is fastened anteriorly by Velcro (Velcro USA, Inc, Manchester, NH). Because the belt is made of elastic material, it is not ideal as a primary suspensor. The belt can allow rotation and elongation of the prosthesis. Because of its simplicity, however, it is not uncommon for an elastic belt to be used as an intermediate form of suspension or as an auxiliary suspension (along with suction). If the patient is involved in high-level activities, there might be a concern, on occasion, of losing suction. For those high-level activities, the patient may choose to temporarily apply a belt to the prosthesis in the event that suction suspension is lost. With its simple Velcro closure, it is very easy to don.

Alignment

As described in the section on transtibial prostheses, the prosthetic alignment will change as the patient progresses through the first year post-surgery, especially during early therapy treatment. Improvements in strength, balance, comfort, and confidence will periodically make reassessment of alignment necessary. Much attention is given to knee stability. Not only does moving the knee in relation to the ground reaction line affect stability, but also internal knee adjustments to resistance can reduce the likelihood of unexpected knee collapse and yield a smooth and efficient gait pattern.

Initial static and dynamic alignment goals take into consideration the patient's level of ability, limb length, stage of healing, range of motion, and muscle strength. The goals in each plane during the first fitting/alignment visit are as follows:

Coronal

• Iliac crests are at the same level.

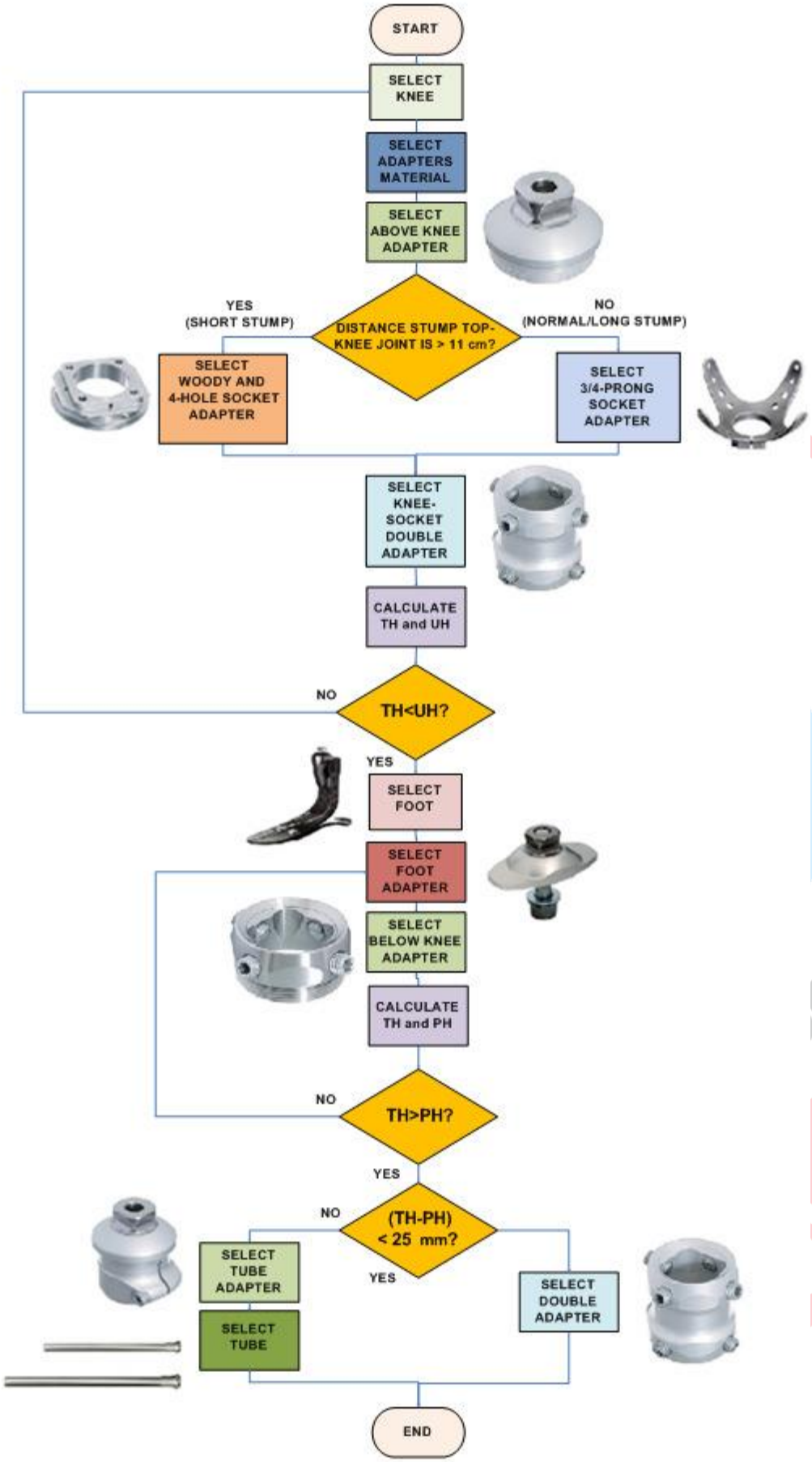
• Patient's gait is smooth and symmetrical with no excessive trunk lean to either side.
• Foot is inset-loading the lateral femur during stance, encouraging a narrow-based and energy-efficient gait.
• The foot/shoe has even contact with the floor and is bearing weight evenly.
• The socket is well suspended and does not drop away from the residual limb.
• There is no vaulting on the sound side.
• There is no abducted or circumducted gait.

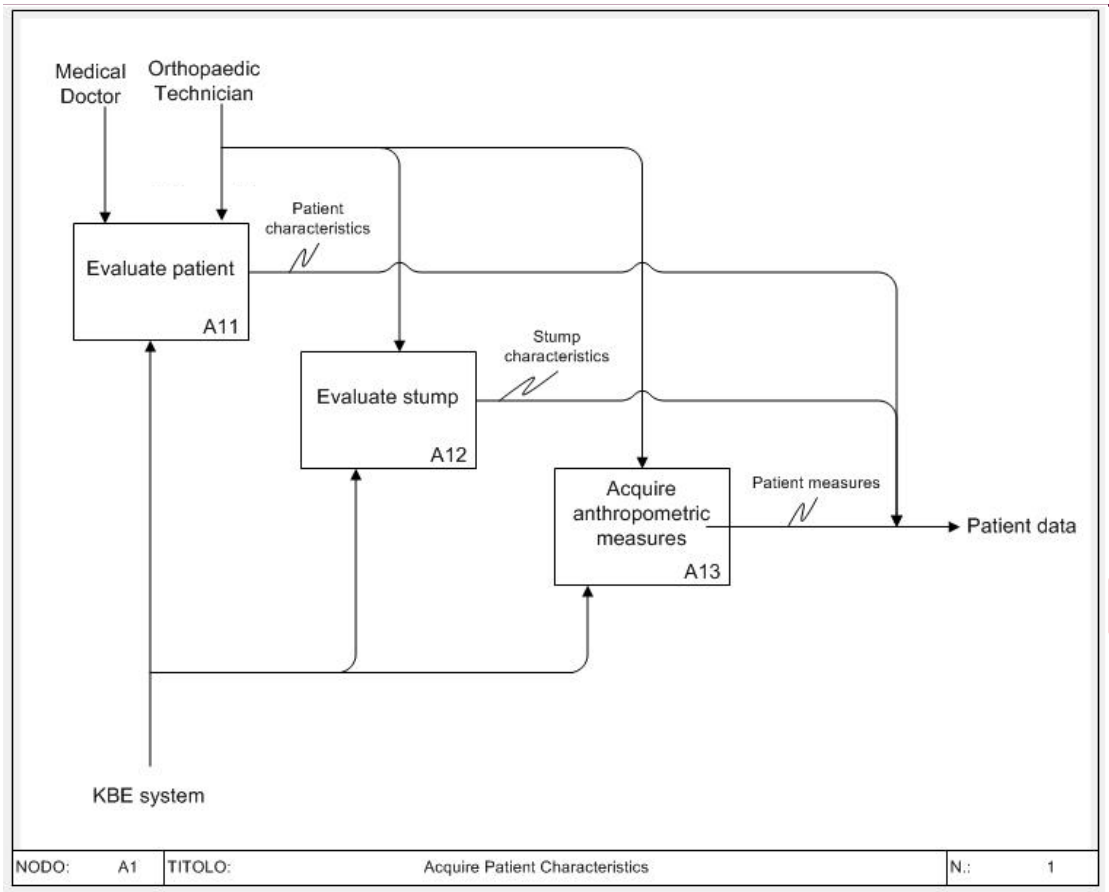
Sagittal

• The prosthetic knee is stable at initial contact/loading response.
• During terminal stance, the foot rolls without dropping off or causing pelvic rise.
• The plantar flexion bumper of the articulated foot is firm and does not allow foot slap.
• Heel rise is not excessive.
• There is no terminal impact.
• Steps are equal.
• Lumbar lordosis is not excessive.

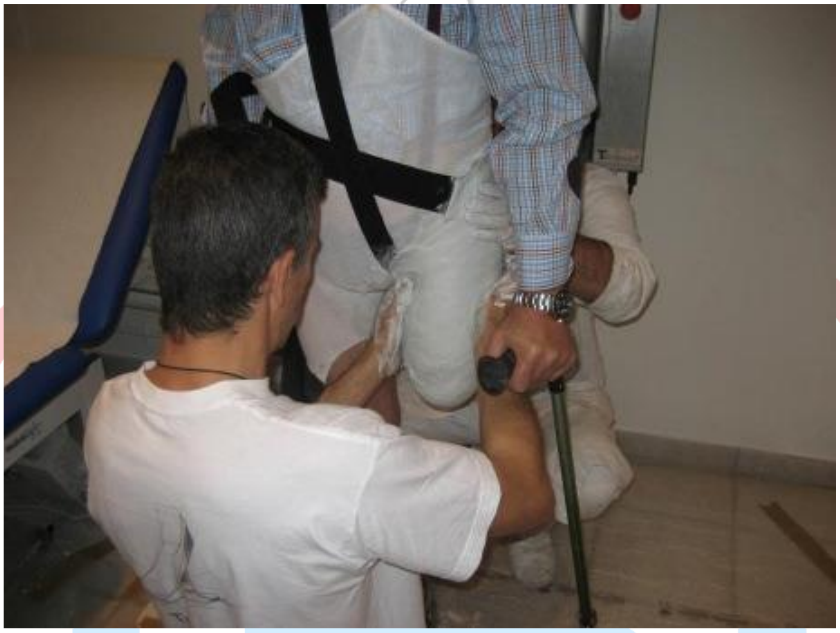
Transverse

• The degree of toe-out on the prosthesis should approximate that of the sound limb. The degree of toe-out should not decrease the patient's stance phase stability.
• There is no medial or lateral whip at terminal stance.
• There is no rotation of foot at initial contact/loading response.

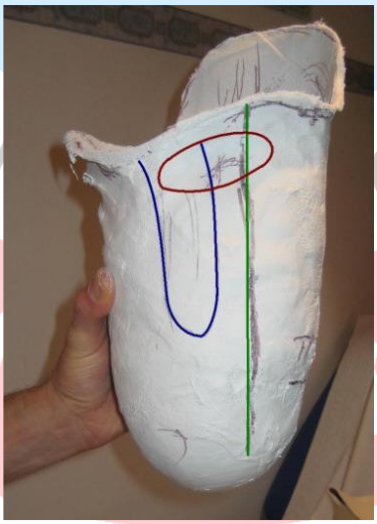

START
SELECT KNEE
SELECT ADAPTERS MATERIAL
SELECT ABOVE KNEE ADAPTER
YES (SHORT STUMP)
DISTANCE STUMP TOP-KNEE JOINT IS > 11 cm?
NO (NORMAL/LONG STUMP)
SELECT WOODY AND 4-HOLE SOCKET ADAPTER
SELECT 3/4-PRONG SOCKET ADAPTER
SELECT KNEE-SOCKET DOUBLE ADAPTER
CALCULATE TH and UH
NO
TH<UH?
YES
SELECT FOOT
SELECT FOOT ADAPTER
SELECT BELOW KNEE ADAPTER
CALCULATE TH and PH
NO
TH>PH?
YES
NO
(TH-PH) < 25 mm?
YES
SELECT TUBE ADAPTER
SELECT TUBE
SELECT DOUBLE ADAPTER
END



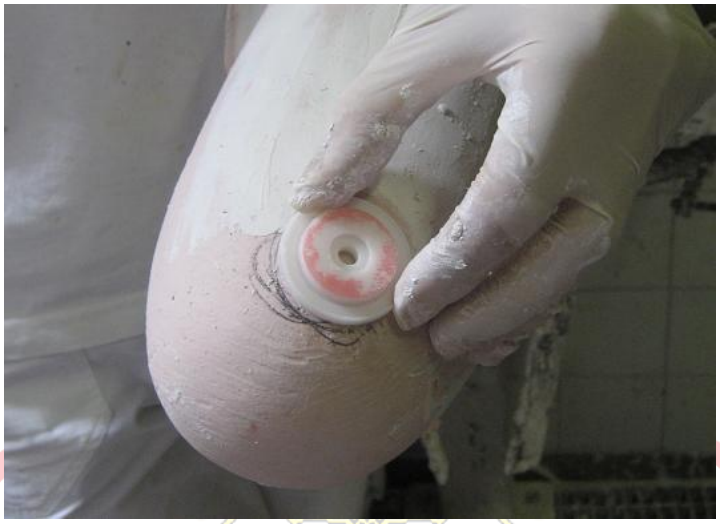
Static alignment of TF prosthesis, lateral (left) and frontal (right).



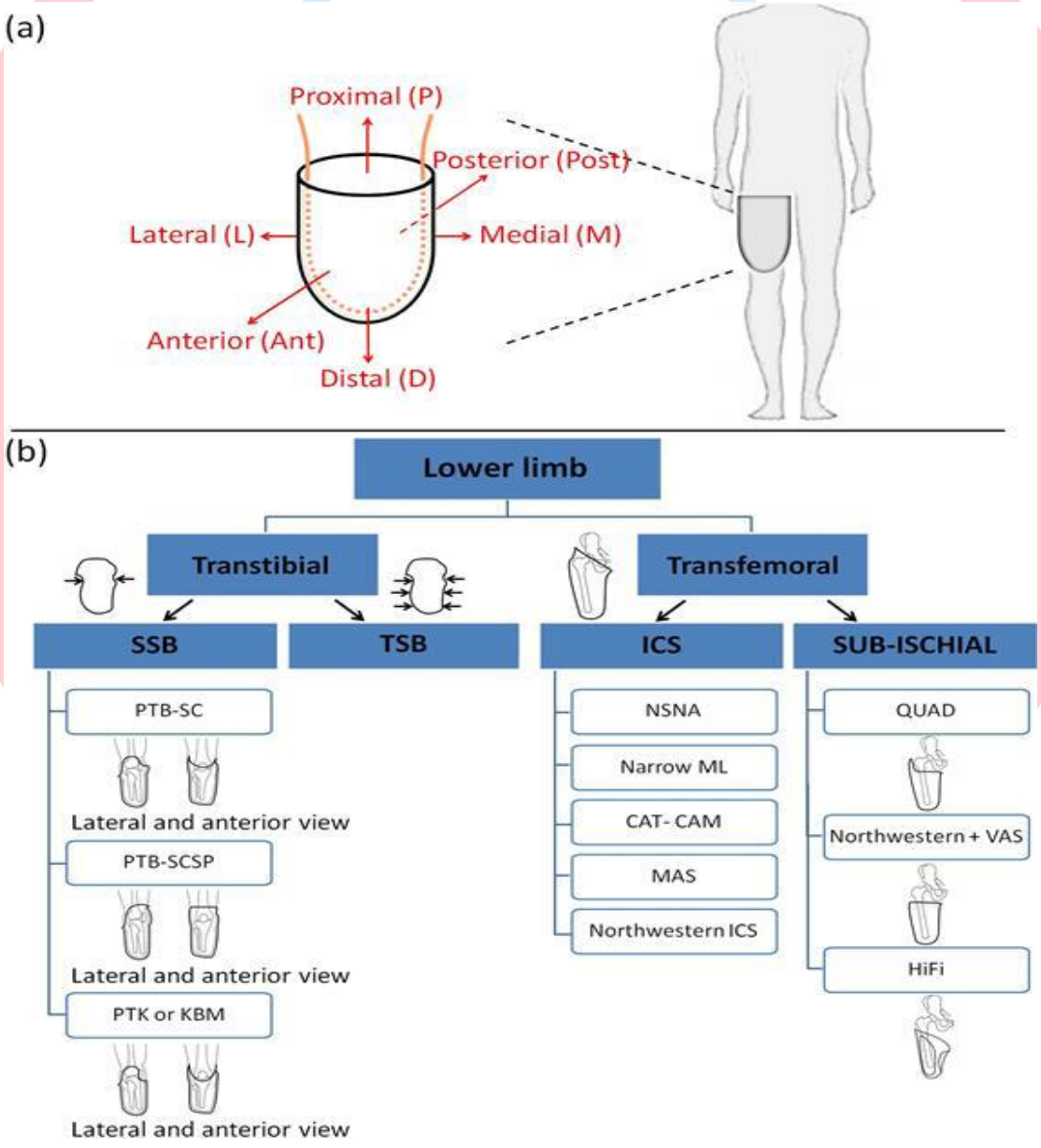
Casting



Critical manipulation areas for a TF socket, marked on a negative plaster cast



Location of the valve zone.



جمهورية مصر العربية
Ministry of Health & Population
وزارة الصحة والسكان

Chapter 2
Lower Limb orthoses

Objectives

- Describe different lower limb orthosis needed
- Methods of fitting and fabrication of lower limb orthosis
- Understanding uses of different Lower limb orthotics

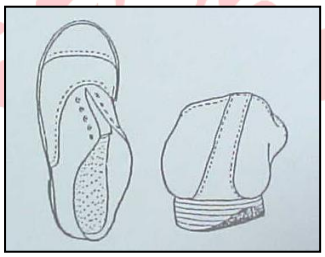
Human Body structure

- Shoes, Shoe modifications - Inserts

PLANOVALGUS FEET:

This deformity is the so-called 'flat-foot'. The term, although used so commonly, is strictly not correct in that the arch of the foot is frequently preserved, but on superficial examination, the appearance suggests that the arch is flattened. Careful inspection however, shows that the deformity is eversion of the foot at the talonavicular and talocalcaneal joints and when viewed from the posterior aspect, the heel is seen to be in valgus, the medial border of the foot approaching the ground in the same way that a bucket handle approaches the side of a bucket when released from the hand. Excessive weight is taken along the medial border of the foot and when footprints in the weight-bearing position are taken, the normal concavity along the medial border of the foot is no longer present. The skin may be in contact with the ground, but the bony arch of the foot can still be present in its normal form.

If the shoe habitually worn by a patient with planovalgus deformity is examined, it will be seen that the weight is taken along the medial border of the sole and the top line of the shoe deviates towards the medial side. In other words, when viewed from above, the axis of the opening of the shoe is not in line with the shoe, but deviated medially. If this deflection is carried to an extreme, the structure of the shoe is broken down over the mid-point of the longitudinal arch



Deformation of shoe in planovalgus foot

COMPLICATIONS

Shortening of the soft tissues on the lateral side of the foot and ankle occurs so that it may not be possible to correct the valgus position of the heel while maintaining full dorsiflexion of the foot. Faulty alignment in the tarsus will lead to degeneration in associated joints.

ASSOCIATED CONDITIONS

Hallux valgus, metatarsus primus varus and pes planus anterior are all commonly seen.

AETIOLOGY

This condition is very commonly seen in small children aged between 2 and 5 years and they frequently have lax ligaments in their knee joints, giving apparent genu valgum. This is so common as to be almost physiological in this age-group. If children are watched, without any form of treatment, but are encouraged to run about normally, the condition usually corrects spontaneously by the age of 5 years. It is probable, there fore, that this is simply a phase of development in which their body- weight exceeds their muscle-power and with the loss of puppy- fat and with the increase of activity at the time of staring school, the deformity is overcome naturally.

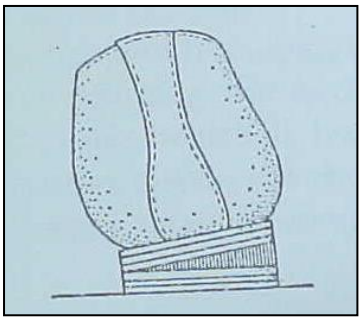
The next age-group in which this is commonly seen is in the 10 to 15 years group, whose parents complain that they wear shoes out rapidly and are often disheartened at not being able to run as fast as their fellows at school. At this age, the foot is still mobile and fixed contractions have not yet developed. The heel can be placed in the normal position under the talus and with concentration, they are usually able actively to maintain the arch for a short period.

The third group is in adult life when the deformity may still be mobile, but is frequently fixed and sometimes symptomless.

APPLIANCES

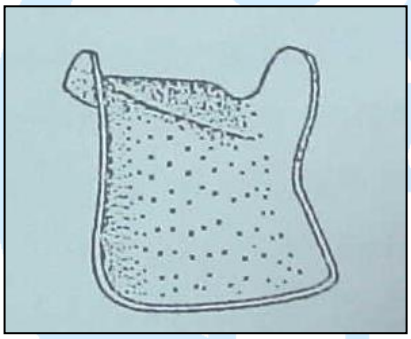
In the young child nothing needs to be done since normal activities in the great majority of cases result in spontaneous correction. If it is decided that treatment is needed, several methods are available.

Wedge heel. A wedge inserted on the medial side of the heel, with or without a wedge on the medial side of the sole, may correct the deformity until body-weight damages the strengthening inserts in the shoe construction. If wedging is to be carried out in the heels, this is best applied to leather heels several layers from that surface in contact with the ground as this facilitates repair of the shoes in the future.

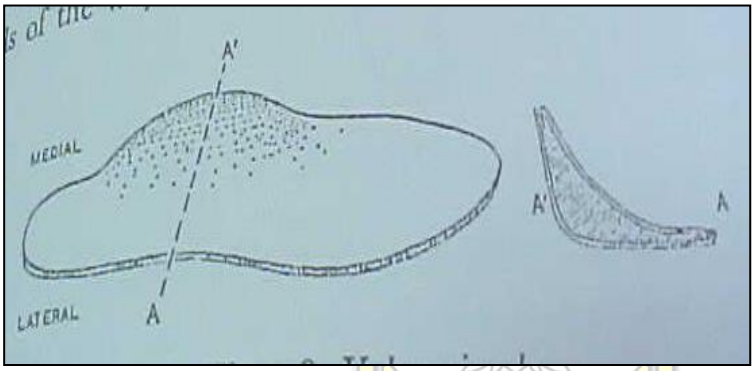


Wedged heel

However, with the increased use of plastics and synthetic rubbers in the construction of children's shoes, this possibility is rapidly receding and one has to rely on a wedge of rubber stuck on the surface. In most children, this wears off within two or three weeks and must be frequently replaced. Cork wedges may be inserted inside the shoe at the heel, but these are impossible to keep in place unless they are stuck in position.
Insoles. Many types of insoles have been devised, both full length and three-quarter. They may be subdivided into two groups, active and passive.
The best example of the active insole was described by Whitman and consists of a metal arch support bearing flanges on its medial and lateral borders, the lateral flange extending up the side of the os calcis in such a way that the heel is gripped between the medial and the lateral flanges. Its shape is such that the os calcis is held in the normal position.

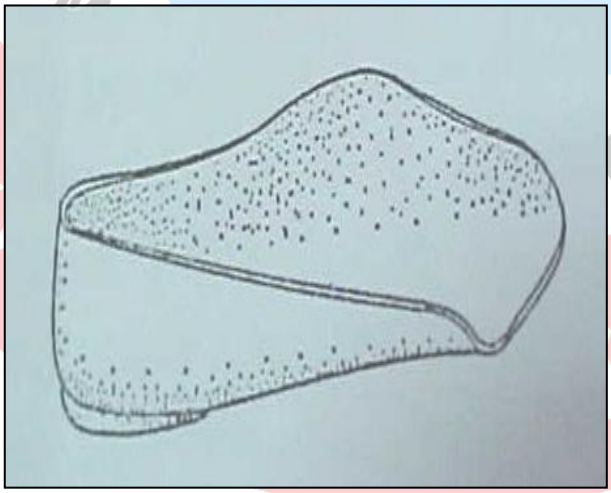


The patient is instructed that when walking, he should throw his weight on to the outer side of his feet. This presses on the outer flange thus lifting the medial side of the sole plate against the foot. If, when walking in this way, the patient turns his toes outwards, he produces pain, and, therefore, tends to adopt the heel-toe gait. The function of this appliance is reminiscent of the kugeleinlage described by spitz which consists of a leather insole on which is mounted a marble underneath the medial arch of the foot. So long as the patient with this appliance maintains the arch actively, there is no discomfort, but when he allows the arch to fall, the marble presses on the underneath of the foot and he instinctively draws it away. This is probably the most effective way of maintaining an arch although by far the most uncomfortable.
Passive supports of the foot are simply props which hold the foot in the desired position without any effort on the part of the patient. They are usually made from, or covered in, leather and there are pads along the medial margin extending two- thirds of the way across the foot. Some have a flange which
Projects up the medial side of the foot and is expected to support the first metatarsal and cuneiform. Since this flange is usually made of thin leather, its long-term effect is negligible. The applied pad on most of these insoles consists of rubber or felt, covered with leather.



Valgus insole

The important face to consider when advising an appliance of this nature is the best shape of the arch which can be achieved without discomfort. If a patient has a rigid flat foot, any attempt at reforming an arch will inevitably produce pain. It is wise, therefore, to ensure that any prop provided does not overcorrect the deformity.
One must also ensure that the structure of that prop is such that it will not pack down after a few weeks. Thus, the best combination that has been found to support a heavy man is a shaped metal insole provided on its undersurface with a pad of solid rubber. In theory, this should be an excellent appliance, but in practice it is not possible to have these metal insoles shaped accurately to a given foot. A compromise can often be achieved by making the insole of a firm plastic to a cast of the foot and sticking sheet rubber in layers on the undersurface, trimming it to produce a contour which approximates to the shape of the inner surface of the shoe.
A shaped heel-socket made of fibre-glass has been devised by Helfet with the aim of gripping the heel and correcting its position by a plantar wedge which is integral with the heel grip. This appliance is worn inside the shoe, but by its nature is so thick that a larger size of shoe is essential.



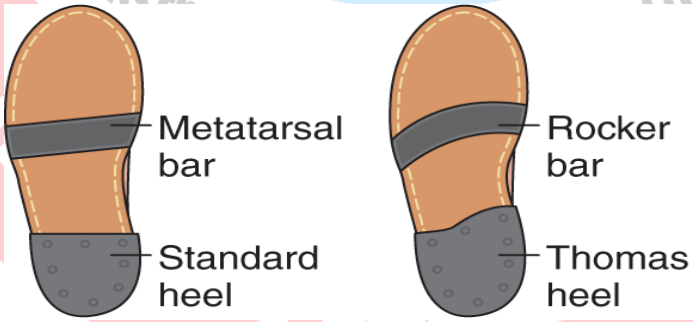
Helfet insole

Experience with this appliance shows that it does correct the deformity very well provided that the original cast on which the fibre-glass is shaped is an accurate representation of the foot. During use, there is inevitably some movement of the heel within the socket and this small range of movement is sufficient to produce frictional changes in the skin. The movement of the os calcis on the fatty plantar tissues of the heel is sufficient to allow a small degree of eversion to occur and this movement thousands of times a day does produce rubbing at the anterior margin of the appliance. Indeed, it is not uncommon for bursae to develop over the medial border of the navicular and although these usually subside rapidly when the appliance is no longer worn, it is possible that the effect is as much due to spitz's kugeleinlage as to the mechanical corrective position of the appliance.

Floated heel. This consists of prolongation of the heel in a medial direction and tends to correct the valgus position of the heel provided the heel of the shoe grips the os calcis firmly.
An elongated (Thomas) heel is often used and is copied in a minor way by at least one shoe manufacturer. This is a prolongation of the heel along the medial border of the shoe to the level of the waist. Its effect is best seen when the eversion of the foot is so great that the deviation of body-weight to the medial side of the shoe is sufficient to destroy the normal arch of the shoe.

Thomas elongated heel

The destruction of the shoe is effectively prevented by the Thomas heel but because of the movement which occurs between even a well-fitting shoe and the foot, it is difficult to see how any correcting force can be transmitted to the foot. this is also trur of the use of wedges in shoes except when they are new and the heel counter is firm and closely fitting. In general, I think it is fair to say that these appliances can all act as suitable props to hold the foot in a corrected position, but one must expect them to have little curative value. It may well be that, in the adult, simple propping up is all that is required and under these circumstances, these appliances fulfil their function.



Ankle foot orthosis

Introduction

The aim of this document is to describe several methods for manufacturing **ankle-foot orthoses (AFO)**, working with the polypropylene.

Choosing between different designs:

Without going into details, some features of different types of AFO are set out below to assist in the choice of design.

Flexible AFO

- Dorsiflexion assistance
- Poor medio-lateral stabilization of the subtalar joint

Rigid AFO

- Blocks ankle movements
- Mediolateral stabilization of the subtalar joint
- Possibility of controlling forefoot adduction/abduction

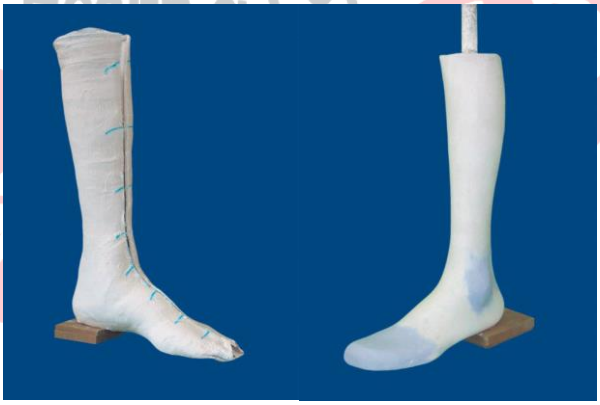
AFO with Tamarack Flexure Joint TM

- Mediolateral stabilization of the subtalar joint
- Free ankle dorsiflexion
- Free or restricted ankle plantar flexion

Flexible AFO

Casting and rectification

Patient assessment, casting and rectification of positive cast impressions are performed in accordance with prosthetic and orthotic (P&O) standards.
For flexible AFO, the cast can be taken with 5 degrees of dorsiflexion so as to provide a preload and ensure some spring action



Moulding of EVA

A flexible AFO does not usually require any EVA. However, in cases where it is necessary the procedure described in section 2.1 (page 8) should be followed.

Orthosis trim line

To achieve the goal of allowing dorsiflexion of the ankle while preventing passive plantar flexion, there are a number of design options..
Mark the trim line as follows:

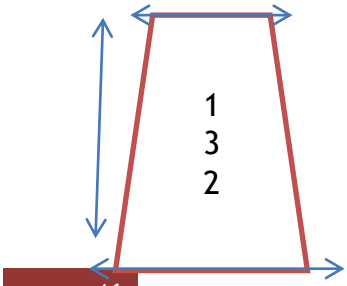
A The top is horizontal, 2 cm below the fibula head.

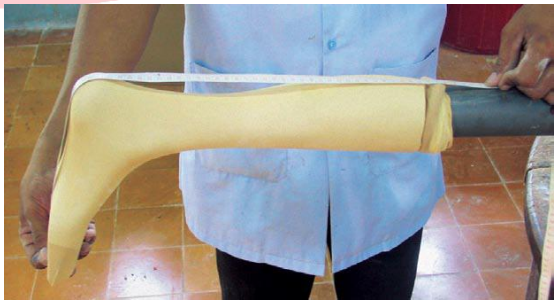
B At the ankle, pass 2 cm behind the tip of the malleoli to allow flexion of the polypropylene.

C At the forefoot, leave the sides of the toes and the head of the metatarsus completely clear and pass the trim line below them. *This will allow the polypropylene to follow the movement of the metatarso-phalangeal joints.*
Pull a stocking over the plaster model.

- Vacuum moulding of the polypropylene

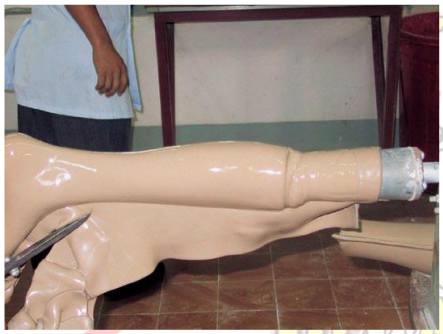
Dust the stocking with talcum powder.
Measurement of the polypropylene sheet:
1 Calf circumference + 10 cm.
2 Instep circumference + 10 cm.
3 Leg and foot length + 10 cm. (See next picture.)
Thickness 3 mm, 4 mm or 5 mm, depending on the patient's weight.





Heat the polypropylene at 180° for 20 to 25 minutes, depending on the thickness of the polypropylene and the efficiency of the oven.
Drape the polypropylene over the plaster model and stick it together along the anterior side.
Tighten the polypropylene around the suction cone by means of a rope or something similar.
Open the vacuum valve.

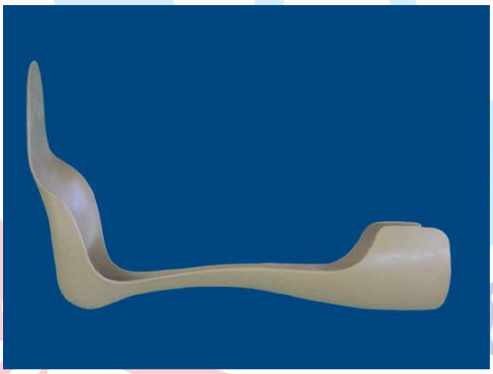
- Cut off the excess PP with a pair of scissors while it is still hot.



Keep the vacuum on until the polypropylene cools down.

Preparation of the polypropylene shell

Draw the trim line on the polypropylene as described in section (page).
Following the outline, cut the orthosis with an oscillating saw.
Remove the plastic shell from the plaster model.
Remove the stocking from inside the AFO.
Grind the orthosis trim line and smooth it.
If an EVA has been moulded, transfer the trim line to the EVA and cut off the excess with a pair of scissors.



Preparation of the straps

A distal strap might be needed, depending on the capacity of the patient's shoe to hold the foot inside the orthosis. If this is needed, follow the procedure described in section

Initial fitting and finishing

If EVA is used, glue it partially inside the orthosis.
The initial fitting is performed according to P&O standards.
Carry out the required modification on the polypropylene and smooth the trim line.
Glue the EVA completely inside the polypropylene, cut off the surplus and smooth the trim line.

Moulding of EVA

EVA (6 mm) may be moulded prior to the draping of the polypropylene, for the following reasons:
- to improve comfort;
- to prevent skin breakage in patients with sensation loss;
- for orthoses used at night.

Follow the procedure described below or, if the case does not require EVA, go on to the next section.

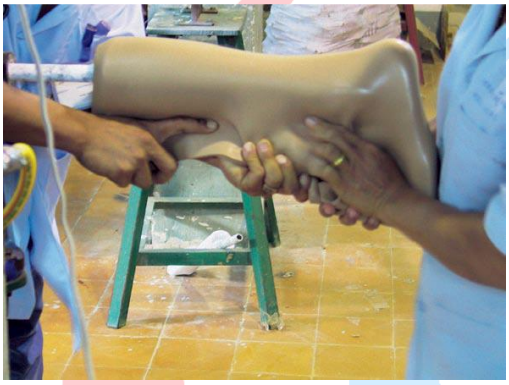
▸ Position the plaster model with the forefoot pointing downwards.

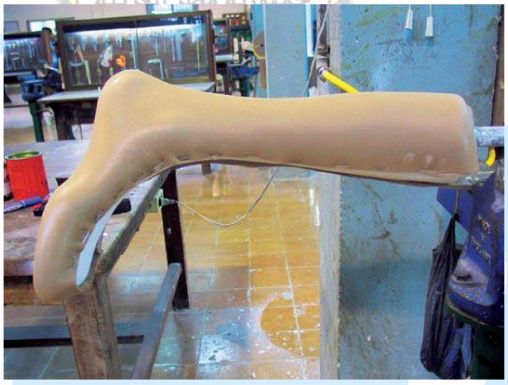
Measurement of the EVA sheet:
- width, instep circumference;
- length, that of the plaster model(leg + foot);
- thickness, 6 mm. Heat the EVA at 120° for 3 to 5 minutes, depending on the efficiency of the oven.

Drape the EVA manually over the plaster model and hold it in place until it has cooled completely.

▸ Cut off the excess with a cutter or a pair of scissors.

Staple the EVA onto the front of the plaster model.





Orthosis trim line

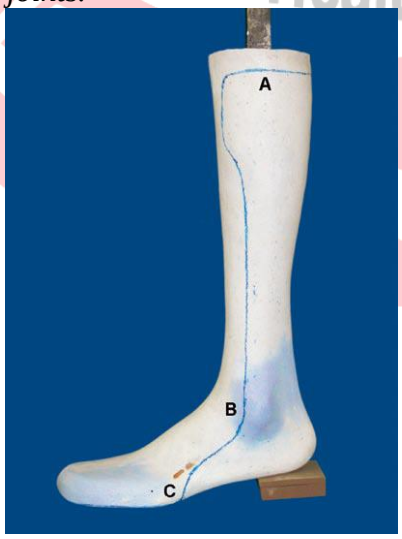
Standard" trim line

▸ Mark the trim line as follows:

A The top must be horizontal, 2 cm below the fibula head.

B At the ankle, pass the line 1 cm anterior to the tip of the malleoli.

C At the forefoot, leave the sides of the toes and the head of the metatarsus completely clear and pass the trim line below them. *This will allow the polypropylene to follow the movement of the metatarso-phalangeal joints.*

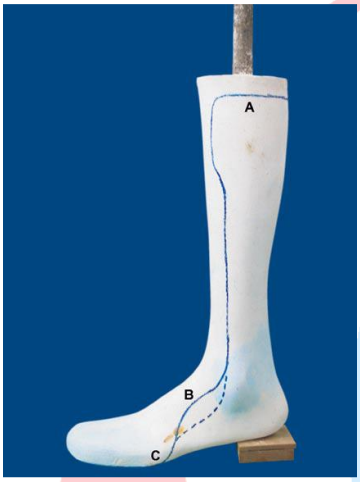


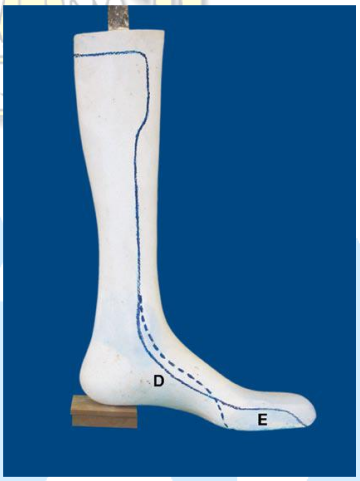
Trim line to correct forefoot adduction

Forefoot adduction is common in cases of clubfoot.

- Mark the trim line as follows:

A The top must be horizontal, 2 cm below the fibula head.
B Increase coverage of the lateral mid-foot, passing in front of the cuboid *to enlarge the area of pressure.*
C At the forefoot, the line must be proximal to the 5th metatarsal head.
D Decrease coverage of the medial mid-foot at the navicular/malleoli, *to facilitate donning.*
E At the forefoot, cover the medial side of the metatarsal head and toe, *to correct forefoot adduction.*



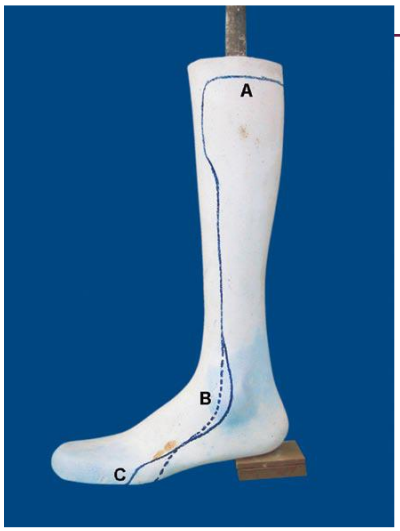


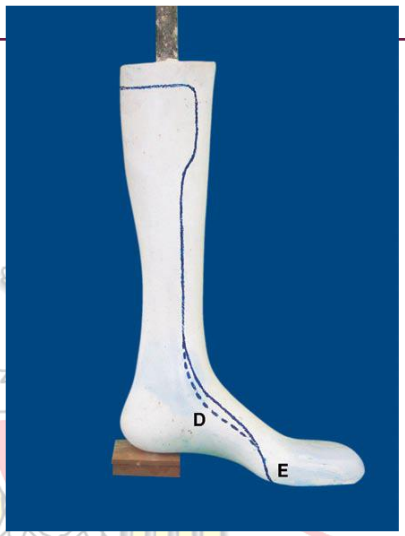
Trim line to correct forefoot abduction

Forefoot abduction is often seen in cases of cerebral palsy.

- Mark the trim line as follows:

A The top must be horizontal, 2 cm belowthe fibula head.
B Decrease coverage at the level of the lateral malleoli, *to ease donning.*
C At the forefoot, the line must be distal to the 5th metatarsal head, *to avoid metatarsus abductus.*
D Increase coverage of the medial mid-foot at the level of the navicular, *to increase mid-foot support.*
E At the forefoot, the line must be proximal to the 1st metatarsal head.





Plastic reinforcement

The AFO may need reinforcement, especially at ankle level. If necessary, use one of the following methods; otherwise go on to the next section.

Double layer of polypropylene

- A second layer of polypropylene covering the ankle and the foot is moulded at the same time as the main layer.

Cut a piece of polypropylene:

- thickness, 3 mm;
- width, instep circumference;
- length, foot length + 10 cm

Grind the last 3 cm at the proximal end to gradually reduce the thickness of the polypropylene.

- The two layers are heated at the same time.

The reinforcement is placed on the plaster model, then the second layer is vacuum-moulded immediately to obtain a perfect seal between the two.

A double layer of polypropylene has the disadvantage of reducing flexibility of the forefoot in relation to the metatarso-phalangeal joint.

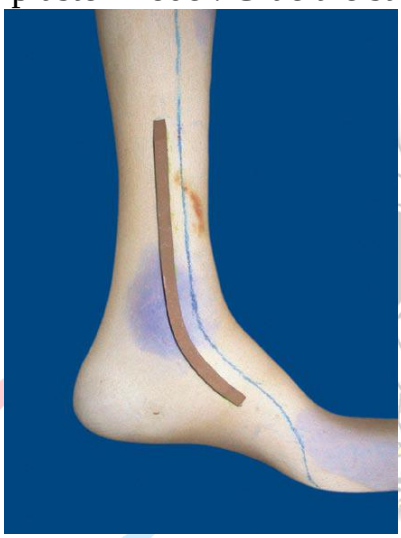
Channels in the polypropylene

The presence of channels in the plastic significantly improves its strength. There are several ways of making these channels.

- Cut two strips of EVA:

- thickness, 6 mm;
- width, 7 mm;
- length, 15 cm.

Grind both distal and proximal ends to gradually reduce the thickness of the EVA.
Pull a stocking over the plaster model. Glue the strip lightly onto the stocking.



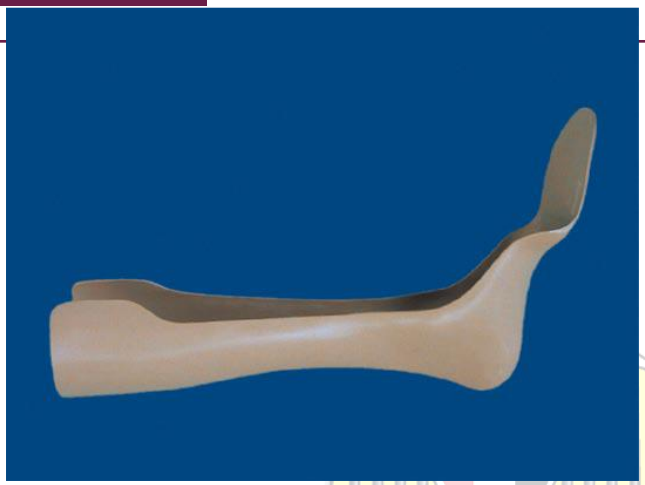
The more anterior the position of the channel, the more the AFO will resist dorsiflexion of the ankle.
Reinforcements prolonged along the side of the mid-foot increase the volume of the orthosis so that it may no longer fit into the patient's shoe.

Vacuum moulding of the polypropylene

If this has not yet been done, pull a stocking over the plaster model. *For maximum efficiency, the EVA used to make channels in the polypropylene must not be covered with a stocking.*
Follow the procedure described in section 1.3 (page 6), taking into account the presence or absence of a double layer of polypropylene (section , page).

Preparation of the polypropylene shell

Draw the trim line on the polypropylene as described in section (page).
Cut the orthosis with an oscillating saw, following the outline.
Remove the plastic shell from the plaster model.
Remove the stocking from inside the AFO.
Grind the orthosis trim line and smooth it.
If EVA has been moulded beforehand, transfer the trim line to the EVA and cut off the excess with a pair of scissors.

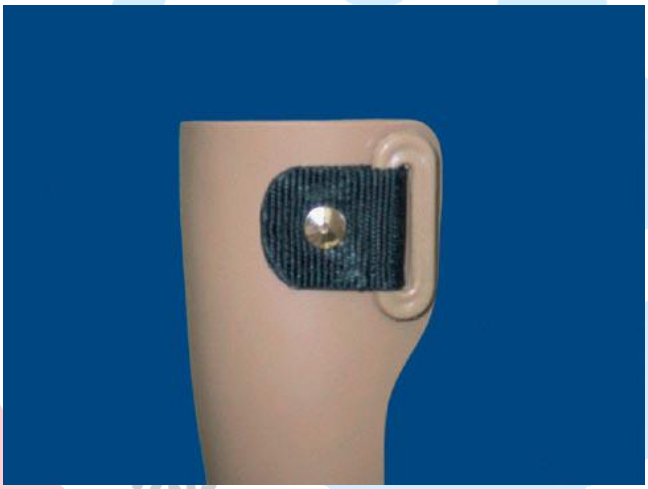


Proximal strap

Use a ready-made Velcro strap 40 mm wide, or make a strap with Perlon webbing or some other strong material.

- With a large tubular rivet, fix the belt holding the loop on the medial side, 1.5 cm below the proximal trim line.

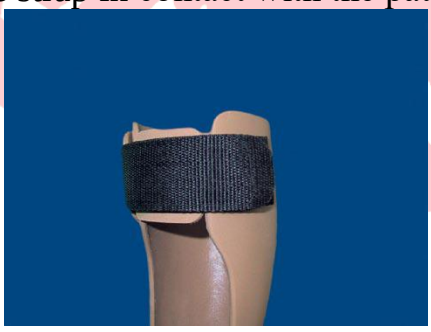
The loop should be placed on the polypropylene and not be in contact with the patient's leg.



- Insert the belt through the loop to measurethe required length.

Fix the strap with a large tubular rivet on the lateral side. Make sure the strap is perfectly horizontal before fixing it.

Cover the surface of the strap in contact with the patient's leg with 3 mm EVA.



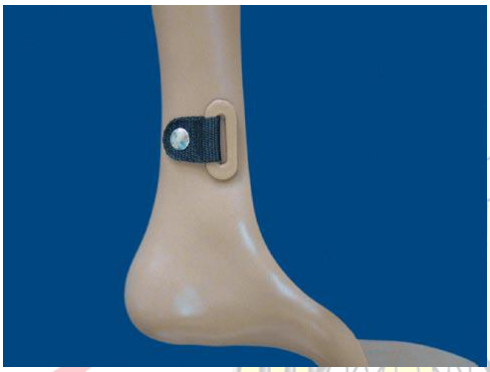
Distal strap

You must choose between a distal strap and an instep strap. The latter has the advantage of holding the calcaneum firmly inside the orthosis (equinus correction).

Use a Velcro strap 25 mm wide.

- With a large tubular rivet, fix the belt holding the loop on the medial side, 4 cm above the malleoli.

The loop should be placed over the polypropylene and not be in contact with the patient's leg.



- Fix the strap with a large tubular rivet on the lateral side. Make sure the strap is perfectly horizontal before fixing it.

Cover the surface of the strap in contact with the patient's leg with 3 mm EVA.

Instep strap

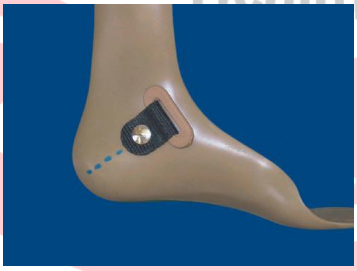
Use a Velcro strap 25 mm wide.

Two techniques are presented, depending on whether the back of the foot is in a neutral position or needs a valgus/varus correction.

Neutral position

With a large tubular rivet, fix the belt holding the loop on the medial side, at an angle of 45° passing through the posterior distal tip of the calcaneum.

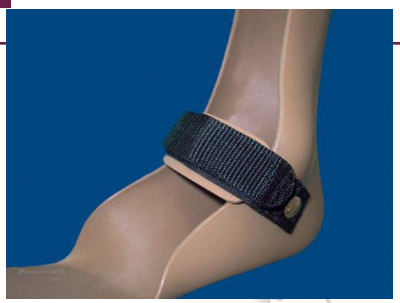
The loop should be placed over the polypropylene and not be in contact with the patient's leg.



- Insert the belt through the loop to measure the required length.

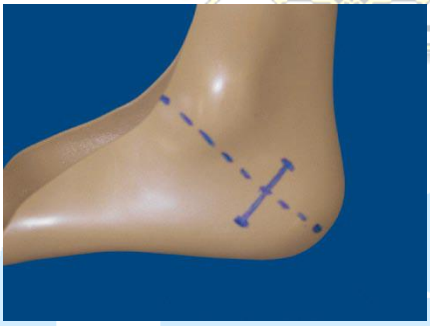
Fix the strap with a large tubular rivet on the lateral side, at the same angle of 45°.

Cover the surface of the strap in contact with the patient's leg with 3 mm EVA.



Varus/valgus correction

The strap will pass through a slot cut in the polypropylene.
* The slot is cut on the lateral side for varus correction and on the medial side for valgus correction.
Mark the position of the slot 40 mm from the back of the foot and perpendicular to a line drawn at an angle of 45° passing through the posterior distal tip of the calcaneum.
The slot should be 30 mm long.



- Make holes along the slot axis with a drill fitted with a 4 mm bit.
- With a cutter, connect the holes with each other.

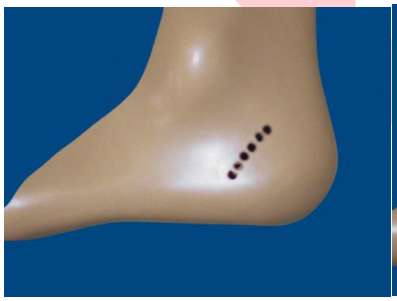
Finally, smooth the trim line with a file.

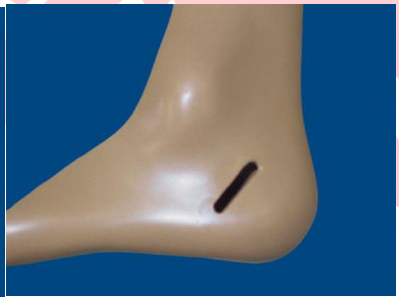
- The loop is placed on the medial side for varus correction and on the lateral side for valgus correction.

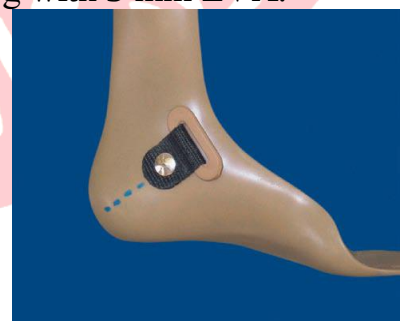
Fix the belt holding the loop with a large tubular rivet, at an angle of 45° passing through the posterior distal tip of the calcaneum.
The loop should be placed over the polypropylene and not be in contact with the patient's leg.

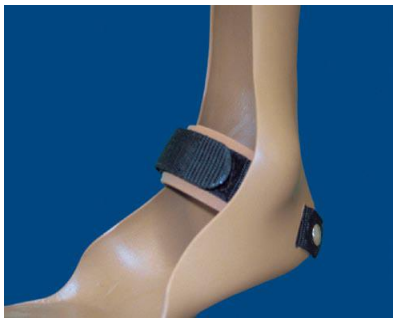
- Insert the belt through the slot on one side and through the loop on the other side to measure the required length.

Fix the strap with a large tubular rivet just outside the slot.
Cover the surface of the strap in contact with the patient's leg with 3 mm EVA.









Initial fitting and finishing

If EVA foam is used, glue it temporarily inside the orthosis.
The initial fitting is performed in accordance with P&O standards.
Carry out the required modifications on the polypropylene and smooth the trim line.
Glue the EVA completely inside the polypropylene, cut off the surplus and smooth the trim line.

AFO with Tamarack Flexure Joint

Moulding of EVA

Follow the procedure described above or go on to the next section if EVA is not required.

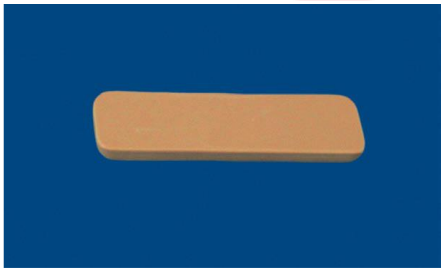
Orthosis trim line

Follow the procedure described above

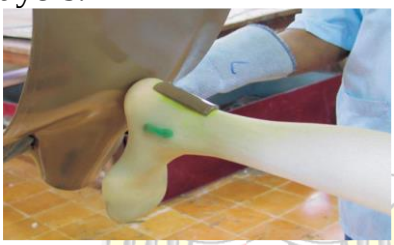
Plastic reinforcement

Posterior reinforcement for greater plantar flexion control is required when the orthosis is intended to prevent plantar flexion (not fully described below).
Follow the procedure described below, or go on to the next section if plantar flexion is left free.
A second layer of polypropylene for positioning at the level of the Achilles tendon is moulded at the same time as the main layer

- Cut a piece of polypropylene:
- thickness, 5 mm;
- width, 2 cm;
- length, 7 cm..



First the reinforcement (heated at the same time as the polypropylene) is placed on the plaster model, then the second layer is vacuum-moulded immediately to obtain a perfect seal between the two layers.



Installation of Tamarack Flexure Joint TM

On the plaster model, mark the position of the joint axis:

- laterally, at the apex of the malleoli;
- medially, slightly posterior to the distal tip of the malleoli.

Make sure that the joints are at the same level on both sides.

▸ Use the moulding dummies to form a snugly fitting cavity for the Tamarack Flexure Joint™.

Nail them vertically onto the plaster model so that the midpoint is located on the ankle axis.

Pull a stocking (cotton stockinet is too thick) over the plaster model.

Vacuum moulding of the polypropylene

Follow the procedure described in section (page), taking into account the presence or absence of a posterior reinforcement (section page).

Preparation of the polypropylene shell

Draw the trim line on the polypropylene as explained in section (page).

Cut *only* the contour of the orthosis with an oscillating saw. Do not cut along the separation between foot section and calf section.

Remove the plastic shell from the plaster model.

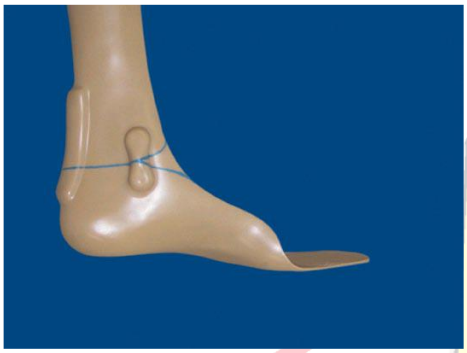
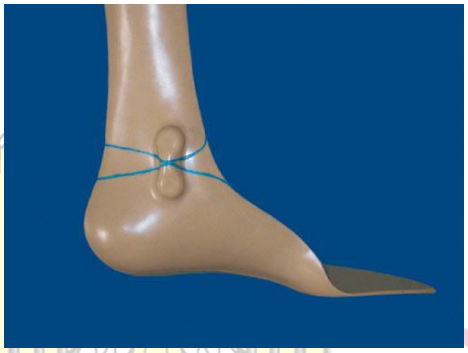
Extract the moulding dummies and the stocking from inside the AFO.

▸ Draw the separation line between the foot section and the calf section:

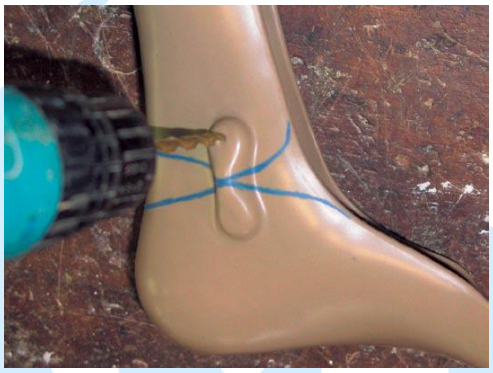
- Mark the middle of the cavities created by the dummies.
- Draw a “V” anterior to the midline of each cavity. Ensure that the “V” does not extend backwards past the centre of the cavity.

*For AFO *with plantar flexion control*, draw a horizontal line posterior to the marks joining the two sides.

- For AFO *with free plantar flexion*, draw a “V” posterior to the midline of each cavity. Ensure that the “V” does not extend forward past the centre of the cavity.

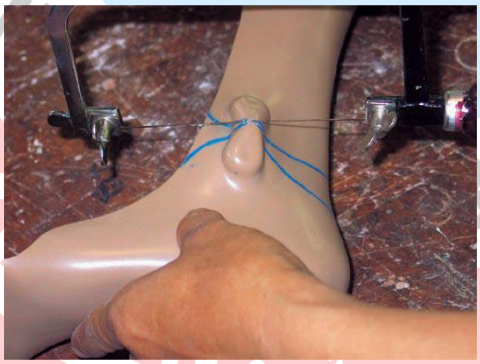



- Drill holes at the dimples left by the holesin the moulding dummies:
  - 5 mm for large size;
  - 4.5 mm for small size.



- Use a *thin-bladed* saw (1/16’’ blade kerf or less) to separate the foot section from the calf section.

Do not use an oscillating saw because too much material is lost along a ragged, wide cut line.



Smooth the trim line edge with a hand deburring tool or a piece of glass. *Do not grind the trim line because this will reduce flexure coverage and reduce the ability of the cavity to anchor and control the flexure effectively.*

- Insert the Tamarack Flexure JointTM and secure with metal fasteners and anchoring screws.

Depending on the thickness of the polypropylene, it may be necessary to adjust the length of the screws if the ends protrude inside the AFO.

Preparation of the straps

For the proximal strap, follow the procedure described in section 2.6 (page 14).
In some cases the patient might need a distal strap. If so, follow the procedure described in section
(page).

Initial fitting and finishing

If EVA foam is used, glue it temporarily inside the orthosis.
The initial fitting is performed in accordance with P&O standards.
Carry out the required modifications on the polypropylene and smooth the trim line.
Glue the EVA completely inside the polypropylene, cut off the excess and smooth the trim line.
Glue the flexure anchoring screws with a removable thread-locking compound (Loctite).

Knee ankle foot orthoses - Knee orthoses

GENU VALGUM

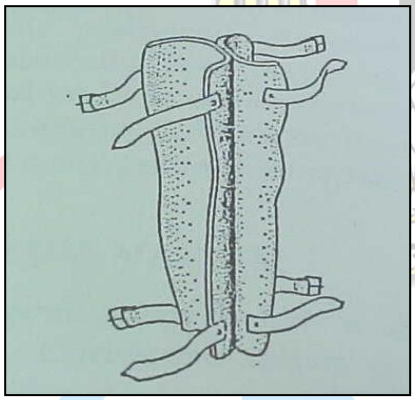
This condition is commonly seen at three ages:
(a) The young child who is frequently fat.
(b) Teenagers and
(c) the adult.

THE YOUNG CHILD

When sitting with knees extended and lower ends of thighs together, the distance between the medial malleoli exceeds 1
inch (2.5 cm.). At this age, the deformity is commonly associated with lax collateral ligaments of the knees, and, indeed, if the knees are pressed firmly together, it is common to find that the medial malleoli can, in fact, be approximated When standing, however, the child usually has his feet a few inches apart, but his knees together and his body weight falling between his knees stretching the medial ligaments. The deformity is, therefore, more apparent than real.
Two methods of treatment are commonly used for this condition:

(i) Wedges to inner border of soles and heels of shoes. It is quite clear that the alteration in posture produced by this addition to the footwear is compensated by inversion of the foot at the subtaloid joint, and no corrective force can possibly be applied to the knees. This appliance, therefore, is of no value.

(ii) Mermaid-type splints. This appliance consists of two metal gutter splints, back-to-back which are inserted between the child's legs, straps being passed round the limb at the Level of the thigh and ankle. A moment's reflection will show that this simply stretches the lateral ligament of the knees and exacerbates the ligamentous laxity which is already present.



Mermaid splint

One must accept that there is no method of conservative treatment available for this type of deformity, but one should also accept that in the great majority of cases no treatment is necessary. If these children are watched at intervals of three to four months, one commonly sees that the distance between the medial malleoli when the knees are together does not increase, although if the angle between the thigh and the tibia remains the same, the distance should become greater becouse of increased length of leg. Reassurance to the parents is needed until the child reaches the age of 5 to 7 years and during this time, one usually finds that the deformity is corrected over a period of a very few months by growth.

THE TEENAGER

The second age at which the condition presents is usually in the early teens. The patient is frequently a short, fat female who has some 2 inches (5 cm.) to 3 inches (7.5 cm.) between her medial malleoli and no ligamentous laxity. One frequently finds that her mother has the same shape. The condition in itself, does not produce symptoms, but the patient or her mother is frequently worried about the appearance. One should then decide whether surgery is indicated to improve the appearance or to avoid later lateral compartment degeneration, but no appliance can be expected to correct the bone structure.

THE ADULT

The third age at which it presents is in patients over 30 years of age, when the patient, still overweight and with considerable genu valgum, begins to develop degenerative changes in the knees. This problem is clearly one of defective weight-bearing and will inevitably lead to osteoarthritis. It is best treated by corrective surgery.

TIBIAL TORSION

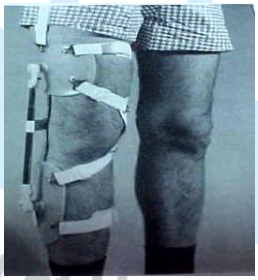
This abnormality, which is usually internal in direction, is commonly associated with one of the various forms of talipes. Denis browne hobble splints and night boots which are used for the latter condition, do attempt to correct the tibial torsion by eversion of the foot when in the splint, but the author has not seen any definite evidence of improvement which could not be explained by growth derotation. In theory, it would be possible to correct tibial torsion by applying an above-knee plaster, with the knee at 90 degrees and the foot plantigrade.
This would undoubtedly apply a torsional strain on the tibia, but it is likely that the strain would be most effective in stretching the ligaments of the knee.

BOWED TIBIA

It is common to see a baby of from three to twelve months old whose mother is worried because his legs are bowed. Careful examination usually shows that the tibia is quite straight and that the bowing is due to the distribution of muscle bulk and fat in a small leg. Carefully positioned anteroposterior X-rays will confirm this and reassurance is all that is required. Should a genuine case of bowed tibiac be found in the clinic, a Mermaid type of night splint has been used, but with little success. It is usually wiser to resort to carly manual osteoclasis.

GENU VARUM

It is uncommon to find genu varum which is not the result of bone disease or trauma. Corrective splints of the mermaid type have been used and the result is that the medial ligament of the knee becomes lax. The only method of treatment likely to be of any value is surgical.



Knee orthosis

Knee ankle foot orthoses

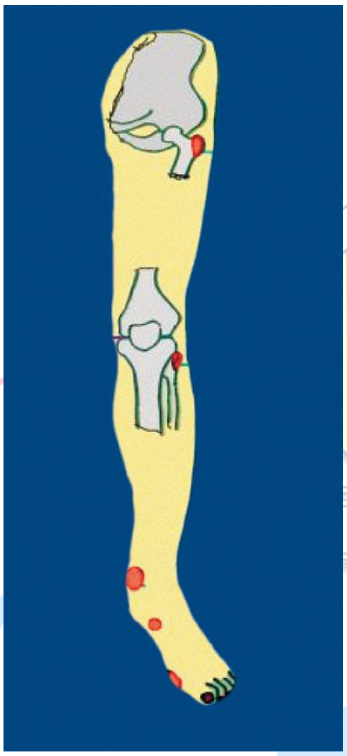
Casting, measurement and rectification:

Some important points should nevertheless be taken into account:

Anatomy and landmarks

- Great trochanter
- Medial tibial plateau
- Head of fibula

- Malleoli
- The 1st and 5th metatarsal heads
- Navicular bone
- Base of 5th metatarsal, if prominent



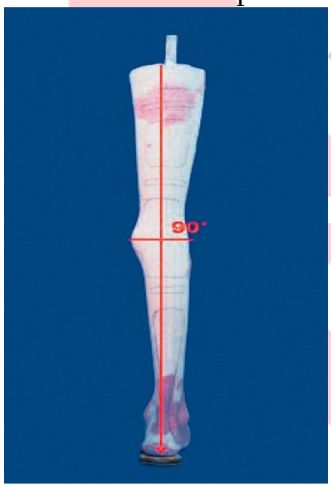
Cast rectification method

Once rectification is completed, check the following:

- The posterior line passes through

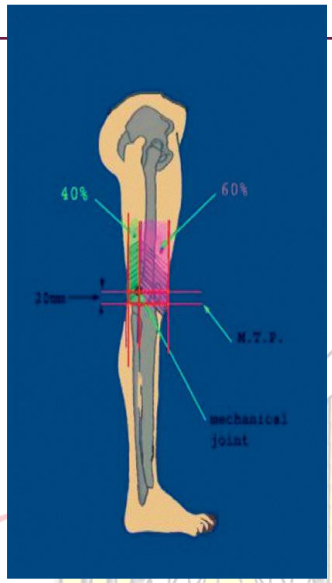
1. the middle of the thigh
2. the middle of the knee
3. the middle of the ankle

- Heel and forefoot are flat on the ground
- The lateral line passes from the great trochanter to the middle of the lateral malleolus



Mechanical knee joint location

- Mechanical axes are defined in accordance with P&O practice, as shown here.



Preparation of reinforcements

The positive plaster remains in a vertical position:

- Drive two nails into the mould at the mechanical knee axis (they should protrude about 5 mm)
- Pull a nylon or cotton stocking over the mould
- Fix the EVA reinforcement according to the measurement card and requirements
- Dust the stocking with talcum powder

Polypropylene draping and vacuum moulding

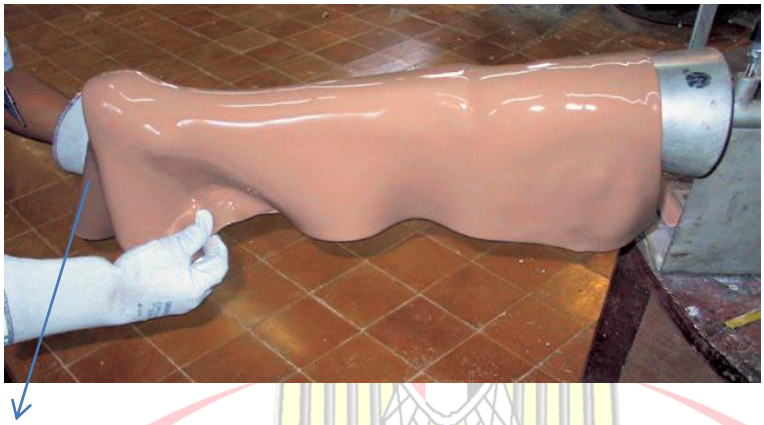
Cut a 5 mm sheet of polypropylene (PP) as follows:

- Upper circumference+10 cm
- Total length+20 cm
- Lower circumference +15 cm

Clean the PP sheet.

- Heat the polypropylene at 180° for 20 to 25 minutes, depending on the thickness of the polypropylene and the performance of the oven.

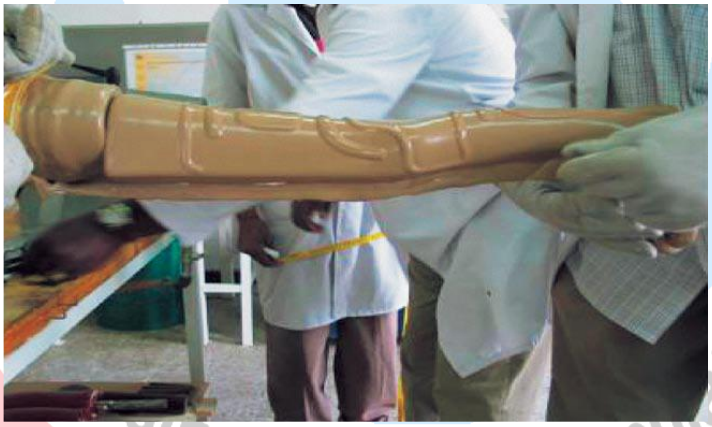
Drape the polypropylene over the plaster model. Lay the polypropylene over the mould without stretching it.



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

- Stick it together along the anterior side.
- Tighten the polypropylene around the suction cone with a rope or something similar.

Open the vacuum valve.



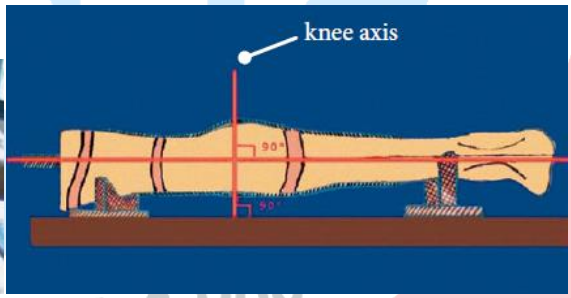
- With scissors or a knife, cut off the excess polypropylene along the welding seam while it is still hot.

Remarks

If the polypropylene sheet cut according to the measurements of the plaster is too big to fit into the oven, prepare two PP sheets instead of one.
Drape the PP around the plaster mould.
Pay attention to the overlap area, pulling the PP gradually and carefully; otherwise it will be stretched too thinly and be too weak.
Open the vacuum valve and remove the excess PP along the seam.

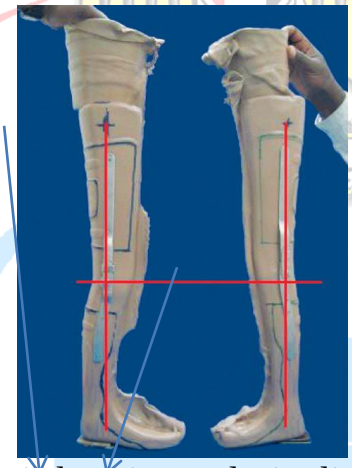
Position of the side bars

- On the bench, the positive mould is installed as follows:
- The position of the knee axis should be marked in relation to the vertical line indicating the location of the mechanical knee joint.



- The uprights are cut to the required length, bent and adjusted following the curves of the PP shells.

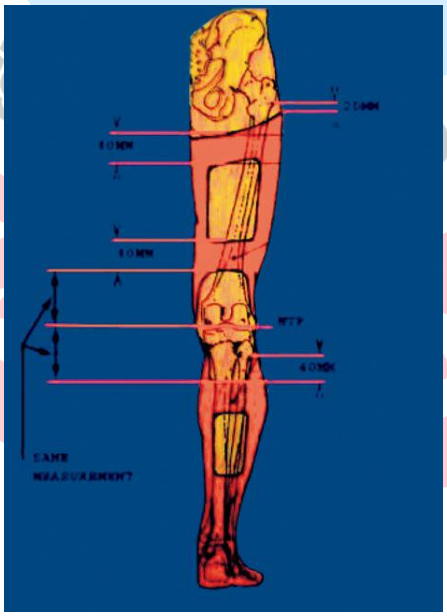
During adjustment of the side bars, the position and parallelism of the knee axis must be respected.



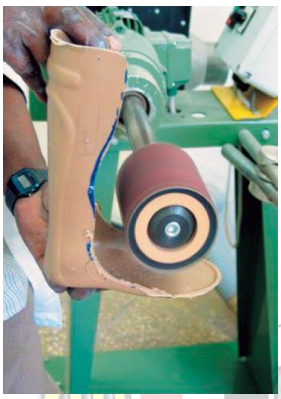
Axis location and trim lines

trim lines

Trim lines depend on the type of correction required and the function of the KAFO. In most cases, trim lines should be drawn according to international P&O standards, as shown here:



The polypropylene is cut off and the trim line contours are ground and polished before temporary assembly of the KAFO for trial.



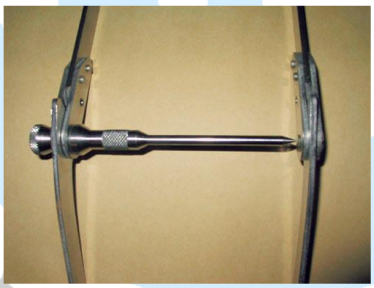
Assembly and parallelism:

- The side bars are temporarily fixed on the polypropylene shells with M3 screws and nuts.

Precise parallelism of the knee joint is of the utmost importance and must be ensured before the first fitting as follows:

- Method 1: Using a Vernier caliper

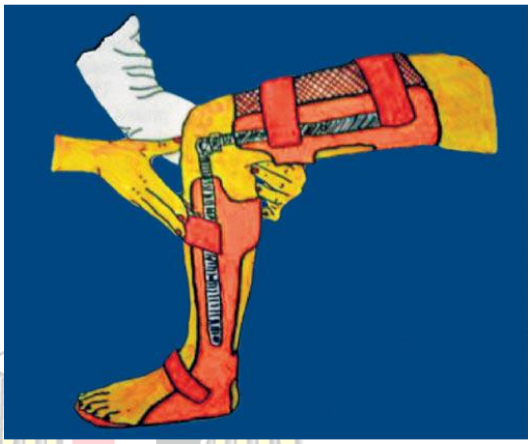
- Method 2: Using the centring pin



initial fittings:

- Strap the KAFO on the patient's lower limb.
- Check the trim lines before the patient stands up.

Once the shoes are on, the patient stands up and gait training can begin.



Finishing

- The straps are fixed with tubular rivets

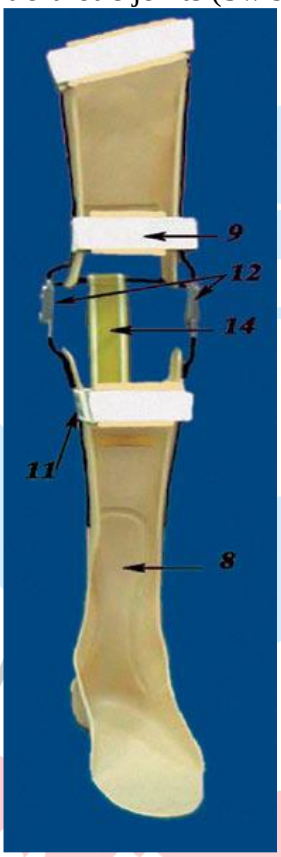
- The parallelism of the knee joint is checked again

- The KAFO is ready for delivery

KAFO Options:

- Some patients need an ischial seat support. In this case the brim has an anterior opening. The shape is similar to that of quadrilateral socket prosthesis.

- The KAFO can be fitted with different orthotic joints (Swiss lock, drop lock, free offset, etc.).



Hip Knee Ankle Foot Orthosis (HKAFO)

This consists of a pair of KAFO with additional pelvic bands and bilateral hip joints. It is used to reduce gait deviations caused by faulty control of hip abduction and rotation (eg. Paraplegia). It is exactly like the KAFO with:

Hip joints and locks.

Most hip joints have a single axis, permitting flexion and extension, and include an adjustable stop to limit hyperextension . By the nature of their design, these joints also

restrict abduction-adduction and rotation. The flexion-extension capability can be restricted by including a pawl or drop type of lock similar to that which is used at the knee joint.

Single-axis hip joint with extension stop

Single-axis hip joint with lock.

Two-position hip locks, which provide for locking at both full extension and 90 degrees of hip flexion, are of limited usefulness for children who have difficulty maintaining the sitting position.

Pelvic bands. To enable the hip joint to accomplish its function of motion control, its upper arm must be stabilized by attachment to a pelvic band, which in turn is stabilized by intimate contact with the pelvis. The type of pelvic band utilized is dependent on the degree of control required and whether one or both hip joints are involved. Since requirement for orthotic stabilization of the hip is usually bilateral, unilateral applications are rare.

Unilateral. Occasionally a unilateral pelvic band is used. It encompasses the pelvis on the involved side between the iliac crest and the greater trochanter, extending from just

medial to the anterior superior iliac spine to approximately 2.5 cm (1 in) lateral to the posterior superior iliac spine. A flexible belt that incorporates the band then encircles the entire pelvis.

Bilateral. The ends of the more commonly used bilateral pelvic band lie just anterior to the lateral midlines of the pelvis. The band then curves posteriorly and downward to contact the most prominent portions of the buttocks and continues slightly upward to overlie the sacrum. Padding and a flexible belt complete the component.

HKAFO

Trunk-Hip- Knee-Ankle-Foot Orthoses(THKAFO)

Incorporates spinal orthosis with HKAFO to control trunk motion, and to maintain or modify spinal alignment, and to reduce loads on spine. Different designs:

1. Reciprocating gait orthosis (RGO):

It is a THKAFO with thoracic extension and bilateral hip joints which are connected by one or two metal cables. As the patient extends one hip the coupling mechanism induces hip flexion on opposite leg and vice versa

RGO

2. Hip guidance orthosis HGO(Para walker)

Consists of ball bearing hip joint, a shoulder orthosis and shoes that fit into loops on flat foot plates. Ambulation occurs from trunk motion similar to RGO

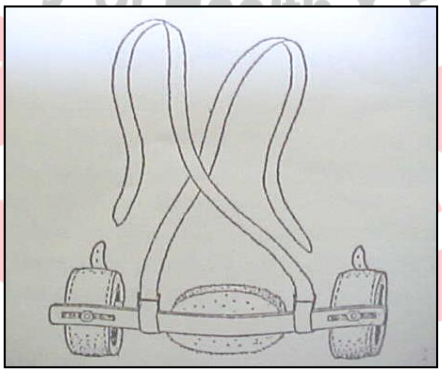
Parawalker

APPLIANCES FOR CONGENITAL DISLOGATION OF THE HIP

These appliances are all based on the assumption that a dislocated hip, once reduced, will remain stable so long as that hip is kept in abduction. Since it is impossible to maintain one hip in full abduction without a comparable position on the other side, the appliances are all symmetrical and control the position of both femora.

THIGH ABDUCTION SPLINTS

Several patterns of this appliance based on the same principle have been described, the main difference being in he method of fixation to the trunk. The basic pattern consists of two thigh corsets made from block leather, plastic or some other firm material. These corsets lie with their central axes in the same straight line and are held apart by a bar of metal which is curved to fit across the lower part of the trunk.



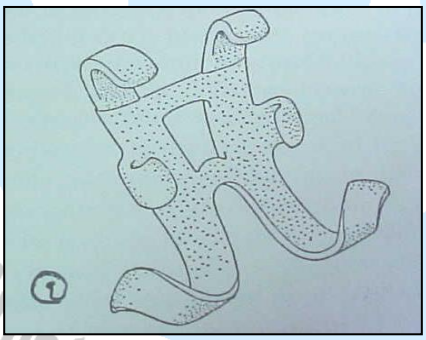
thigh abduction splint

Some authors have considered that the bar should lie across the pubis, whereas others

have described it lying across the sacrum it is clear that if it is applied lying across the sacrum it could rotate to lie either caudally or over the pubic site unless some form of restriction is provided. This may consist either of a waist band and suspensory straps or the full shoulder harness. If applied across the pubis attempted adduction of hips will allow the crossbar to move away from the body and pressure will be applied on the outer margins of the thigh corsets, producing redness and soreness of the skin just above the medial femoral condyles. Nevertheless, the anterior piece is generally more comfortable for the baby since he is able to lie on his back without undue pressure on the sacrum when the crossbar is in the dorsal position the pressure in attempted adduction tends to be more widely spread over the medial surfaces of the thighs and this does not lead to skin trauma, but unless the posterior bar is well padded, discomfort is found over the sacrum when the child is supine. Few children are willing to lie on their faces for most of the day.

THE VON ROSEN SPLINT

This appliance consists of an H-shaped piece of malleable metal covered with a rubber compound. The crossbar of the H is extended on either side. This appliance is very useful for maintaining flexion and abduction of the hip in small babies. In use the appliance is flattened, the baby placed on top and the upper extremities of the H carried down over the child's shoulders. The extended crossbar is then bent to lie round the waist. The hips are then educed and the lower extremities of the H curved in a spiral round the thighs to hold them flexed and abducted at 90° each



Von Rosen splint

This appliance is very useful for the small baby but depends entirely on the child's muscles being unable to overcome the resistance of the metal frame. Thus it is unsuitable for a child who is gaining muscle strength where it is not possible to maintain the hips in the fully abducted and flexed position. Even a young baby can produce remarkable power of extension of the hips unless they are held in the fully flexed position.

SUMMARY

I think it is fair to say that the von Rosen and Frejka appliances are extremely useful in the young baby but are of little value in the older child. The abduction splints described in the carlier part of this chapter are, on the other hand, of more value for a child who is a few months old or who has needed either surgery or a prolonged time in a frog plaster. They could also be conveniently used as night splints in the final stages of treatment.

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