PLASTER OF PARIS AND OTHER FRACTURE IMMOBILIZATION METHODS

ICRC PHYSIOTHERAPY REFERENCE MANUAL

REFERENCE

ICRC

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INTRODUCTION

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

This second edition of this manual on the use of plaster of Paris and other immobilization methods for limb fractures was written in collaboration with physiotherapists working in the field. It draws on the expertise of the ICRC's Physical Rehabilitation Programme in delivering care to people affected by armed conflict, including those suffering from fractures or other trauma and those living with disability. The manual also draws on recent literature and the experience of esteemed experts to provide evidence-based guidance for health-care professionals whose work involves immobilizing fractures.

The Physical Rehabilitation Programme was established in 1979. Since then, our work has diversified and expanded throughout the world. As the scope of our activities has grown, we have developed our own technology and expertise. We are committed to supporting physical rehabilitation services and advancing the social inclusion of people with disabilities, a mission that has received broad recognition.

Physiotherapists are experts in the anatomy in movement, and physiotherapists working in ICRC hospital programmes oversee the creation of plaster of Paris (POP) casts and take part in follow-up treatments. In conjunction with surgeons and other hospital staff, physiotherapists usually run the cast room. After surgeons apply traction, it is physiotherapists and nurses who manage the patient's care and ensure proper immobilization settings.

This manual was designed as part of the ICRC's training and resource programmes. It is intended for all types of health-care professionals – regardless of their level of academic training – who provide care to people with fractures in conflict zones or as part of humanitarian work.

The objectives of this publication are to:
- highlight the needs of patients in uncertain and/or dangerous settings
- serve as a user-friendly guide on how to provide appropriate care
- enable users to properly create and use slings, casts, traction and other immobilization methods
- share the ICRC's expertise in managing war wounds
- highlight the importance of physiotherapy for patients undergoing immobilization
- improve international health-care standards and recommendations for fracture immobilization.

More than ever, clear guidance is needed on how to adapt and deliver the best possible care. We hope that this manual will be useful for rehabilitation and health-care professionals around the world, enhancing the efficiency and quality of care.

Our sincere thanks to the people who worked with us to update this resource.

ICRC Physical Rehabilitation Team

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ABBREVIATIONS

ASIS anterior superior iliac spine

DPC delayed primary closure

ICRC International Committee of the Red Cross

IP interphalangeal

MCP metacarpophalangeal

MTP metatarsophalangeal

POP plaster of Paris

1. SURGICAL MANAGEMENT

OBJECTIVES
Understand the ICRC's approach to surgical management of weapon wounds with bone fracture.
Know how to manage different types of fractures associated with war/weapon wounds.
Know the advantages and disadvantages of each immobilization method.
Learn validated protocols and be able to discuss them with surgeons and other team members.
Know the average period for immobilization and healing of bones.

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1.1 FRACTURES

1.1.1 THE FRACTURE AS PART OF THE WOUND

Surgeons treating fractures begin by making a complete initial assessment of the wound. They establish an exact diagnosis and choose the treatment method with the best functional outcome. In areas affected by armed conflict, 50–75 per cent of fractures occur in limbs. They often are comminuted open fractures.

The patient only receives treatment to recover function once the wound has been properly debrided and blood supply has been restored. Thus, the first step to recovery is always proper and complete wound management and treatment.

Surgeons often practice delayed primary closure (DPC): once the excision has been carried out, the wound is left open for about five days prior to skin closure. During this period, the bone and joints are kept in correct alignment using POP slabs or traction. This phase is called "initial holding" and requires good multidisciplinary team coordination.

The ICRC manual *War Surgery Volume 2* (second edition), provides the following recommendations to surgeons:
"The image of the fracture as seen on an X-ray is only one aspect of the wound complex. [...] The first and essential step to bone healing and the recovery of function is correct treatment of the soft-tissue wound. [...] The management of war wounds with fractures includes a number of standard steps.

1. Transformation of a contaminated war wound into a clean one by meticulous debridement.
2. Reduction and immobilization of the fracture at the initial wound debridement by the simplest and least invasive method possible.
3. Transformation of a clean wound with an open fracture into a closed one by DPC.
4. Definitive method of fracture immobilization decided at DPC [...].
5. Restoration of optimal physiological function possible through physiotherapy and physical rehabilitation."

1.1.2 IMMOBILIZATION METHODS IN CONFLICT ZONES

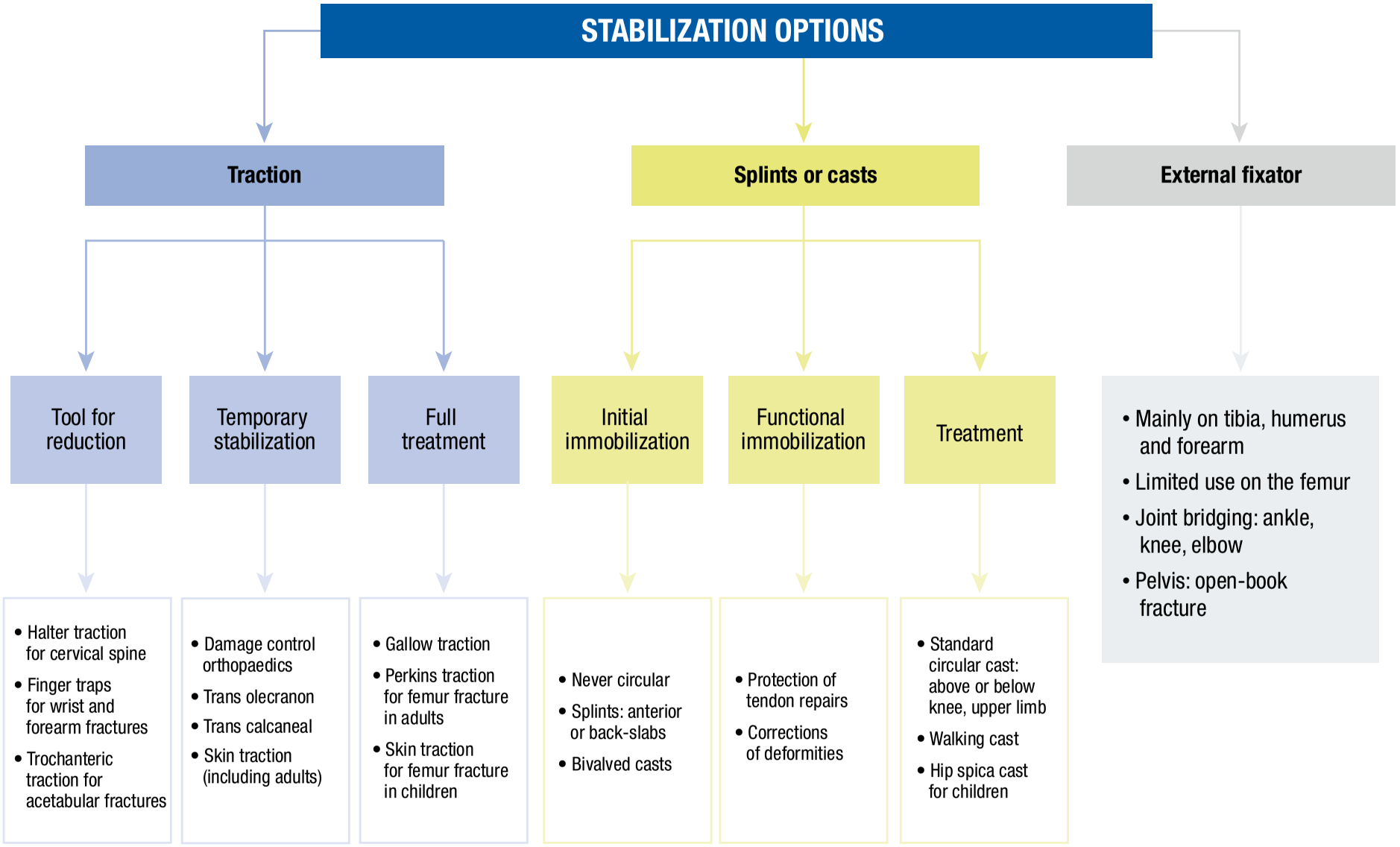
Definitive immobilization treatment will be applied after surgery. Surgeons often have to perform several operations until the wound is clean. Different methods are available to immobilize fractures resulting from war trauma. However, it is important to note that internal fixation devices are used in the initial management of fractures in conflict zones due to the infection and complication risks, as well as the level of expertise, equipment and hygiene that they require.

CONSERVATIVE	SURGICAL
Functional (including bandages and slings)	External fixation
Casts and slabs	
Traction	

Table 1.1: Immobilization methods used at the ICRC

It is important to monitor the general condition of patients with immobilized limbs, since anaemia and poor nutrition can delay wound healing.


M. A. Mortvedt/ICRC


STABILIZATION OPTIONS
Traction
Splints or casts
External fixator
Tool for reduction
Temporary stabilization
Full treatment
Initial immobilization
Functional immobilization
Treatment
• Halter traction for cervical spine
• Finger traps for wrist and forearm fractures
• Trochanteric traction for acetabular fractures
• Damage control orthopaedics
• Trans olecranon
• Trans calcaneal
• Skin traction (including adults)
• Gallow traction
• Perkins traction for femur fracture in adults
• Skin traction for femur fracture in children
• Never circular
• Splints: anterior or back-slabs
• Bivalved casts
• Protection of tendon repairs
• Corrections of deformities
• Standard circular cast: above or below knee, upper limb
• Walking cast
• Hip spica cast for children
• Mainly on tibia, humerus and forearm
• Limited use on the femur
• Joint bridging: ankle, knee, elbow
• Pelvis: open-book fracture

1.2 BONE IMMOBILIZATION METHODS

1.2.1 CASTS AND SLABS

Definition
Bandages consisting of a firm covering (often made of POP), which immobilize broken bones while they heal.

A cast is applied around the circumference of the limb. Split casts are often used in primary fracture care after reduction of complex fractures. Non-split casts are rarely indicated in definitive fracture care.

There are two main types of casts, based on the material used:
- POP
- synthetic (fibreglass).

Bandages, tapes and splints (or slabs) made from other materials do not surround the circumference of the limb and therefore allow soft-tissue expansion during the post-traumatic inflammatory phase.

Slabs are often used in initial fracture care, as well as for sprains, tendon injuries, soft-tissue injuries, nerve injuries and post-operative care. Slabs make it easier to examine or re-dress wounds, because they are easier to remove than a fully circular (closed) or split plaster cast.

Both POP and fibreglass can be applied for primary, temporary, secondary or definitive treatment of acute fractures, sprains and strains.

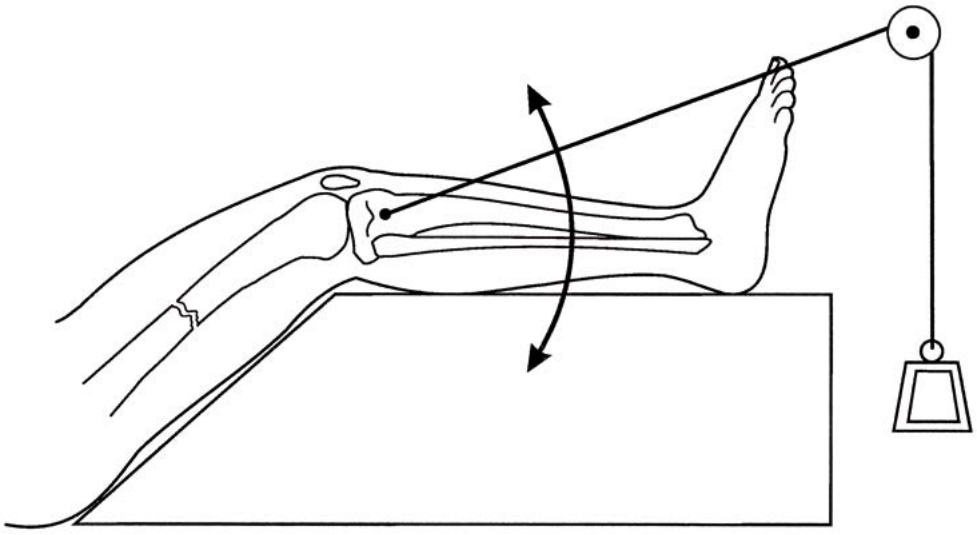
ADVANTAGES	DISADVANTAGES
Inexpensive	Fresh supply necessary
Little or no special equipment necessary	Bulky
Least invasive method Allows for other surgical options	Joints encased in POP are immobilized
Flexible Good temporary measure and definitive treatment	Poor access to wounds Not satisfactory for large wounds or burns
Early mobilization of patient on crutches	Too loose = non-union Too tight = tourniquet
Early discharge from hospital	Shortening and malunion common with comminuted fractures
	Poor patient hygiene and comfort (particularly in hot and humid climates)

Table 1.2: Advantages and disadvantages of POP

Source: Adapted from War Surgery Volume 2 (second edition), page 121

1.2.2 TRACTION

Definition
Application of a pulling force used to reduce and treat fractures while maintaining bone alignment. There are two types: skeletal traction and skin traction. Force is transmitted along the limb using pins, pulleys and weights.



Dr Rowley/ICRC

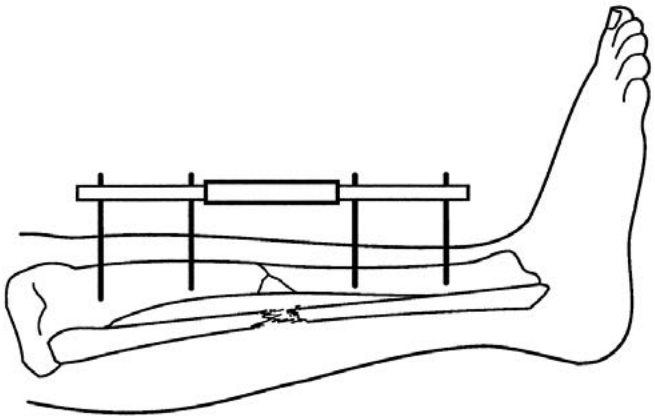
ADVANTAGES	DISADVANTAGES
Good temporary measure	Not appropriate in absence of good nursing care and physiotherapy Constant monitoring of weights and axis of traction and repeated control X-rays
Possibility to revert to other techniques	Requires special frame
Rapid bone healing	Difficult bone alignment, but more common after closed fractures
Good access to wounds of anterior aspect of thigh	Poor access to wounds of posterior aspect of thigh
Allows for early mobilization of joints	Patient immobilized in bed
	Not appropriate in case of military necessity of evacuation (use Thomas splint, POP slab or external fixation instead)

Table 1.3: Advantages and disadvantages of traction

1.2.3 EXTERNAL FIXATION

Definition
Procedure that stabilizes and joins the ends of fractured bones by inserting pins into the extremities of the bones and securing them together outside the skin with clamps and rods.

External fixation is not covered in this manual. Refer to the ICRC manual War Surgery Volume 2 (second edition).



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1.3 BASIC PRINCIPLES OF FRACTURE MANAGEMENT

1.3.1 RESUSCITATE AND STABILIZE THE PATIENT

All patients with trauma should receive an initial cABCDE assessment (also called a primary survey), which involves addressing the following aspects in order:

- catastrophic haemorrhage control using direct pressure
- Airways (and cervical spine protection)
- Breathing and oxygenation
- Circulation
- Disability and neurological evaluation
- Exposure and environment (hypothermia and exposure to other injuries).

Using the cABCDE method ensures that life-threatening injuries are identified and treated in order of clinical priority. The first priority is to stop catastrophic external haemorrhage, which is often from damage to a major blood vessel in a limb. Catastrophic limb haemorrhage is controlled using a compressive bandage, tamponade, proximal digital pressure, wound packing (particularly in junctional areas, i.e. axilla and groin) or a tourniquet. It takes priority even over airway and cervical spine control.

Pelvic fracture	Up to 3 L
Closed femoral fracture	1–1.5 L
Closed tibial fracture	500 ml–1 L
Haemothorax	2 L
Rib	150 ml each

Table 1.4: Blood loss volumes by wound site

Fractures, and actions taken to reduce and immobilize them, can cause severe pain. Pain relief is extremely important and should be given according to protocol. Otherwise, limb injury management should wait until the cABCDE assessment or primary survey has been completed.

M. Unternaehrer/ICRC

Femoral and pelvic fractures can result in significant blood loss and should be managed under the "circulation and haemorrhage control" part of the cABCDE assessment. Splinting femoral and pelvic fractures helps to prevent hypovolemic haemorrhagic shock and is an essential part of the primary survey and initial trauma management. A pelvis fracture can be splinted using a purpose-designed commercial pelvic brace, or with a bed sheet. A femoral fracture can initially be manually splinted, and the leg pulled out to length prior to the application of a splint.

After the person has been resuscitated and life-threatening injuries have been identified and treated, management of limb wounds and fractures should include splinting, performing X-rays and administering tetanus toxoid and antibiotics for open fractures as per existing protocols. Splints may be made of POP; however, if POP is not available, alternatives such as cardboard or plastic guttering can be used with padding (to avoid pressure necrosis) and bandages.

1.3.2 IMMOBILIZE BONES BEFORE SURGERY

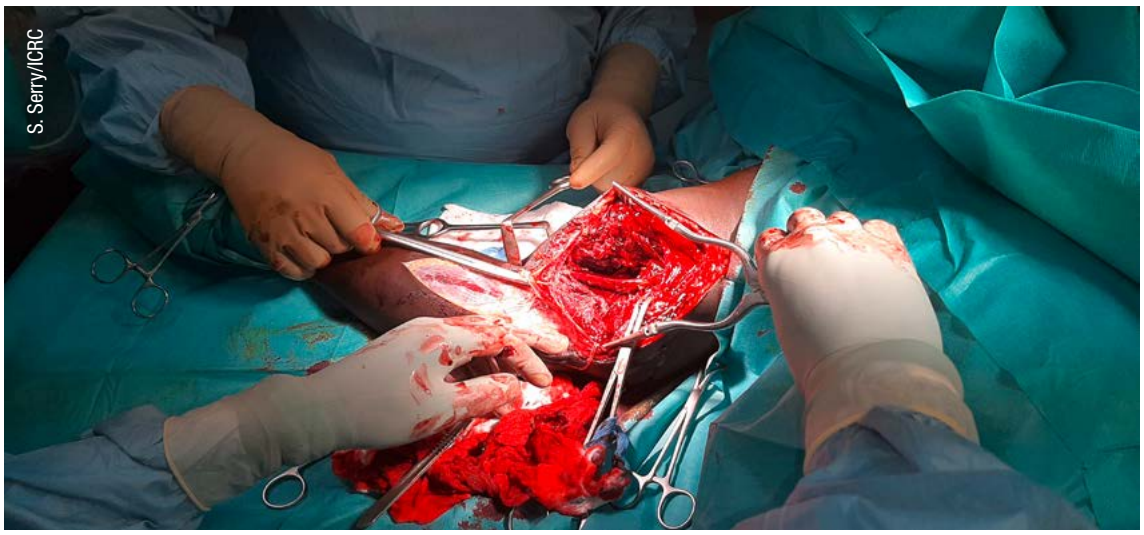
Different types of immobilization techniques may be applied before the initial surgery, especially if surgery cannot be performed immediately and/or the patient needs to be transported (refer to the section on emergency immobilization splints, p. 141).

1.3.3 TREAT THE WOUND

People with wounded limbs account for 50–75 per cent of all patients admitted to hospitals during armed conflict.

Although they are no longer a major cause of mortality, injuries to the soft tissues and bones of the limbs are the most significant contributor to long-term disability. This is an important consideration in low-income countries where resources for disability services are scarce.

The surgeon carries out thorough excisions and surgeries of the wound, eliminating all dead and severely contaminated tissues (debridement) and all unattached bone fragments. When the wound is clean, the surgeon closes the wound with sutures or a skin graft after four to six days. If the wound remains infected, it should be debrided again and left open for DPC. Every time a new debridement is performed, a new immobilization is applied.



1.3.4 PREVENT AND CONTROL INFECTIONS

During and after the operation, all the principles of aseptic surgery must be applied. Established protocols for aseptic techniques must be followed. Monitoring, prevention and basic hygiene protocols must be followed by the entire team. Patients with open fractures should receive intravenous antibiotics according to protocol as soon as possible after the injury.

1.3.5 IMMOBILIZE BONES BETWEEN AND AFTER SURGERIES

Casting is the most common treatment for managing limb fractures. Casts are applied for 34 per cent of all fractures.

Health-care staff must be competent in casting techniques and caring for patients with casts to ensure favourable outcomes, reduce expenses and prevent cast-related complications.

“Primary intention” is the emergency immobilization of a fracture, or the main/most appropriate immobilization method for a specific type of fracture. “Secondary intention” is an immobilization method that is not meant to be the only one for a specific fracture, or comes at a later stage in the consolidation process (to decrease immobilization/support to a part of the body).

The initial technique (reduction and initial holding of the fracture) is applied when the wound is first excised. Most fractures can be safely held by a POP slab or using skeletal/skin traction between the first and second operations (four or five days). The limb must be elevated during this period.

The definitive procedure is carried out at the time of DPC. The surgeon assesses the bone and periosteal defect and selects a method of fracture holding.

Different interventions are applied depending on the immobilization method chosen. They all have the same objectives:

- properly immobilizing the fracture
- keeping the patient mobile
- restoring function
- preventing secondary complications.

Bone immobilization should not be painful. It is always important to choose a treatment that alleviates suffering. All staff should know about appropriate pain relief and should conduct pain assessments regularly.

Although surgeons may delegate the task of immobilizing a fracture to a cast technician or another trained staff member, the surgeon prescribing the cast must take final responsibility for the type of immobilization used and how it is applied.

1.3.6 APPLY AN EVIDENCE-BASED, MULTIDISCIPLINARY APPROACH FOLLOWING SURGERY

All staff applying and managing casts must be properly trained. Casting is multidisciplinary work.

The application of immobilization always requires a multidisciplinary team for assessment, the procedure itself and follow-up. The team comprises the surgeon, nurses, specialized health workers who apply the plaster or bandage, a physiotherapist, an X-ray technician, etc.

Physiotherapists who work in ICRC hospital programmes oversee making POP casts and take part in follow-up treatment.

Physiotherapy improves functional outcomes by ensuring rapid mobilization and providing follow-up care. Physiotherapists help to prevent complications and produce better results by providing physical exercises and instructions to patients on how to manage their condition. Rehabilitation is therefore essential. Task-sharing or -shifting can ensure the best functional outcome based on the patient's goals.

1.4 MINIMUM IMMOBILIZATION PERIOD AND BONE HEALING

The duration of immobilization varies depending on the type and location of the fracture, the overall treatment received and the patient's age and condition. The period of bone consolidation is different for adults and children. When providing care to children, it is important to bear in mind that the location of the fracture and how it is treated can impact their growth.

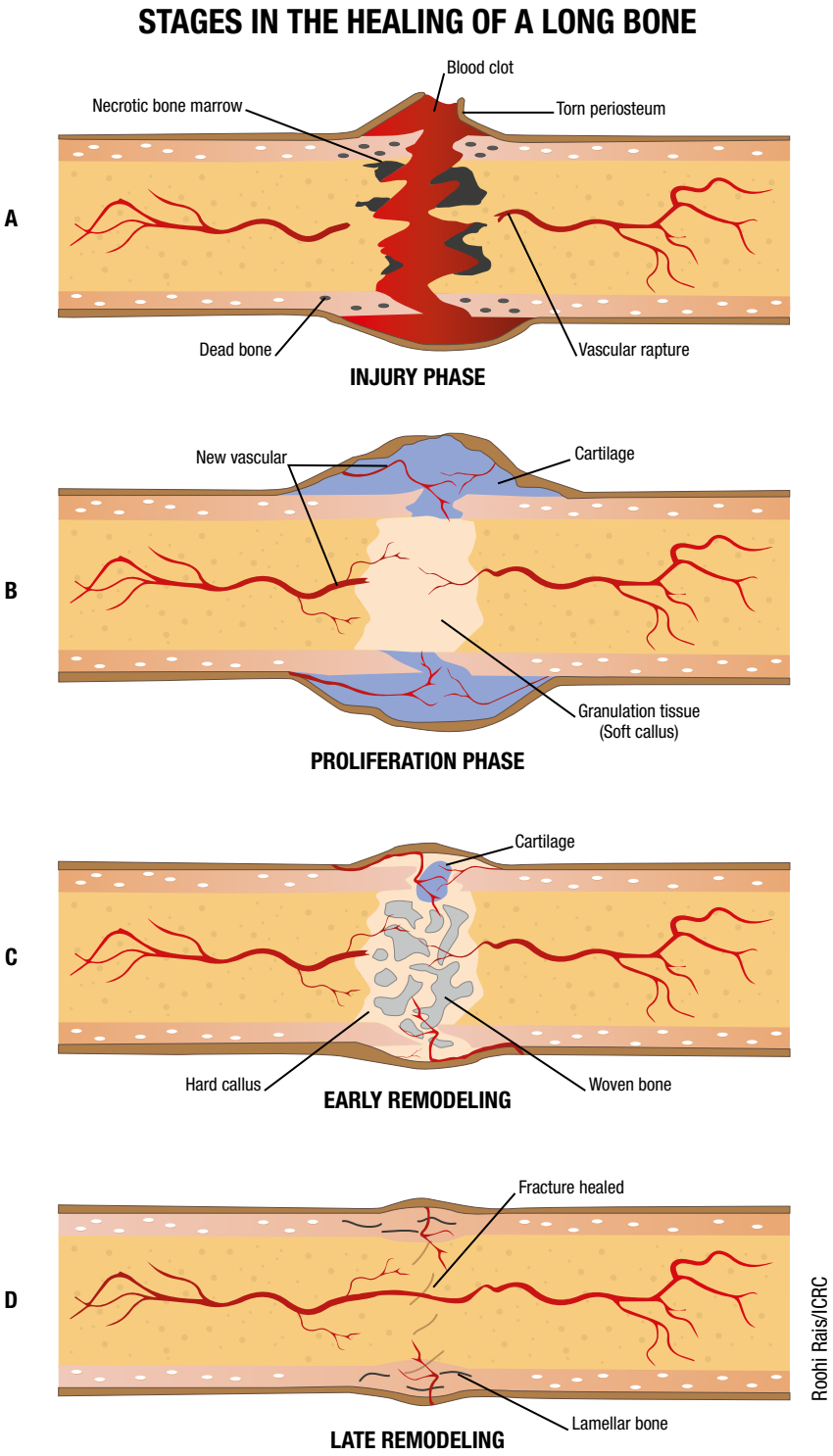
BONE	MOST COMMON IMMOBILIZATION PROTOCOLS WITH NO COMPLICATIONS		AVERAGE CONSOLIDATION PERIOD WITH NO COMPLICATIONS	
	ADULT	CHILD <10 years	ADULT	CHILD <10 years
Metacarpal	4–6 weeks	2–3 weeks	6 weeks	4–6 weeks
Scaphoid	8–12 weeks	8–10 weeks	15–20 weeks	12 weeks
Carpal	4–6 weeks	2–3 weeks	6 weeks	4–6 weeks
Ulna	4–6 weeks	3–4 weeks	6–8 weeks	4–6 weeks
Radius	4–6 weeks	3–4 weeks	6–8 weeks	4–6 weeks
Humerus	4–6 weeks	3–4 weeks	6–8 weeks	4–6 weeks
Clavicle	4 weeks	2–3 weeks	4 weeks	2–3 weeks
Scapula	4 weeks	2–3 weeks	4 weeks	2–3 weeks
Ribs	4–6 weeks	2–4 weeks	4 weeks	2–3 weeks
Vertebral bones	6–8 weeks	4–6 weeks	12 weeks	6–8 weeks
Pelvic bones	6–8 weeks	4–6 weeks	6–8 weeks	4–6 weeks
Femur	6–8 weeks	4–6 weeks	12 weeks	6–8 weeks
Tibia	6–8 weeks	4–6 weeks	12 weeks	6–8 weeks
Talus	6–8 weeks	4–6 weeks	12 weeks	6–8 weeks
Calcaneus	6–8 weeks	4–6 weeks	12 weeks	6–8 weeks
Phalanges	4–6 weeks	2–3 weeks	6 weeks	4–6 weeks

Table 1.5: Immobilization and consolidation time by bone and patient age

Bone healing is impeded by a number of factors that can lead to delayed union or non-union:
- excessive movement or misalignment of the fracture
- extensive damage and soft tissues caught within the fracture ends
- reduced/disrupted blood supply to the fracture site
- infection.

Bone healing is promoted by movement of the limb, which:
- increases muscle activity
- stimulates vascularity (venous and arterial flow)
- stimulates callus maturation
- prevents thromboembolic complications.

Note: It takes several months after consolidation for bones to recover their strength.



Additional factors that negatively affect healing:

- advanced age
- obesity
- anaemia
- endocrine conditions: diabetes mellitus, parathyroid disease and menopause
- steroid use
- malnutrition
- smoking.

2. IMMOBILIZATION

OBJECTIVES
Know how to set up and organize a plaster room.
Know how to care for and maintain plaster equipment.
Know how different types of casts and slabs are made, their advantages and disadvantages.
Know the steps in applying the different materials used to make slabs for the upper and lower limbs.
Understand the follow-up procedures and possible complications when using circular casts.
Learn how to perform gypsotomy, including corrections, bivalving and removal.

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2.1 PLASTER OF PARIS

POP cast

2.1.1 HISTORICAL BACKGROUND

The unique properties of plaster have been known since ancient times, but the earliest casts and splints were made from materials such as wood, leather, wax or eggs.

In the 1880s, surgeons began to use plaster casts to treat open wound fractures, which dramatically improved the chances of survival for both the limb and the patient.

2.1.2 CHEMICAL TRANSFORMATION

Plaster is made from gypsum, or calcium sulfate dihydrate: CaSO4 2·H2O. When gypsum is heated, it loses water and becomes calcium sulfate hemihydrate, or POP: CaSO4½·H2O. When immersed in water, the POP can be moulded into a cast. POP can be recycled and reused.

$$CaSO_4 \cdot 2H_2O \rightarrow CaSO_4 \cdot ½\ H_2O + 1\ ½\ H_2O$$

2.1.3 DILUTION AND HEAT

It is important to add the right amount of water when making a POP cast or slab. Too much water will make the cast fragile after drying. Not using enough water will make the moulding process more difficult.

Drying time depends on the amount of water left in the plaster. Increasing the water temperature shortens the drying time.

Cold water should be used for long POP so that the layers dry together as one solid cast. Otherwise, the water should usually be at room temperature. The higher the water temperature, the higher the temperature generated inside the POP.

WATER TEMPERATURE	POP TEMPERATURE
24° C	38° C
38° C	57° C
>50° C	hot enough to burn skin

Table 2.1: Effect of water temperature on POP temperature

2.1.4 POP PRODUCTS

POP powder

POP rolls

POP rolls are the easiest product to apply. In case of severe shortage and/or a large influx of patients, POP rolls can be made from POP powder and cotton bandages. Roll the bandage after spreading a thick layer of plaster powder on it.

2.2 FIBREGLASS

Fibreglass, also called glass-reinforced plastic, is a fibre-reinforced polymer made of a plastic matrix strengthened by fine glass.

A fibreglass or synthetic cast is a newer alternative to POP that was developed in 1970. It is lighter and more durable than a traditional POP cast: three times stronger but only one-third the weight.

Fibreglass casts are not used in acute settings (e.g. before surgery) because they are less accommodating to swelling and do not allow for moulding (fibreglass is less malleable, more rigid and dries fast). Because fibreglass sets so quickly, it takes experience to time the application well.

Fibreglass does not change properties when wet, and its setting time decreases with humidity and warmth, which makes it a good option in tropical climates. It is also a good alternative for fracture immobilization in children because of its light weight. Generally, fibreglass is the better choice if the injured limb must be X-rayed during the healing process.

Advantages of synthetic material (fibreglass) over plaster:

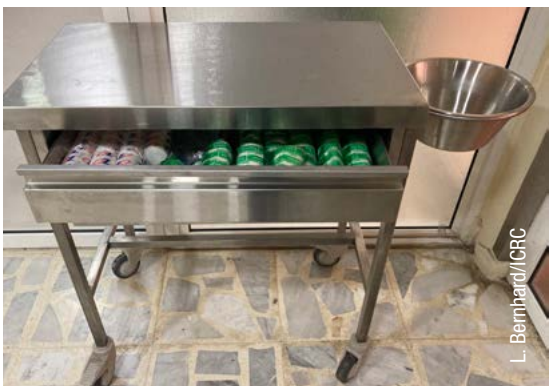
- It allows for air flow, so the skin can dry in case of sweating or if the cast gets wet.
- It is more durable.
- It weighs less, so the cast will be lighter.
- It is water-resistant (but not waterproof: once set, contact with water will break it).
- It is more comfortable.
- It puts fewer restrictions on day-to-day activities.

2.3 CAST ROOM LAYOUT

A cast room should be a simple and well-organized area that offers privacy for patients and comfortable work conditions for hospital staff. It must have:

- an area of at least 12 m² (to allow free movement around the plaster table or plaster frame)
- good ventilation to avoid humidity
- good natural light if possible
- a door wide enough for stretchers and wheelchairs to pass through
- easy-to-clean surfaces (tile or other washable material is recommended for the floor and walls)
- a stable and comfortable plaster table
- access to water and a sink fitted with a filter to catch plaster particles
- a system for getting rid of dust
- easy access to all tools and consumables (cupboard or wall containers, mobile plaster trolley, etc.)
- electrical sockets.

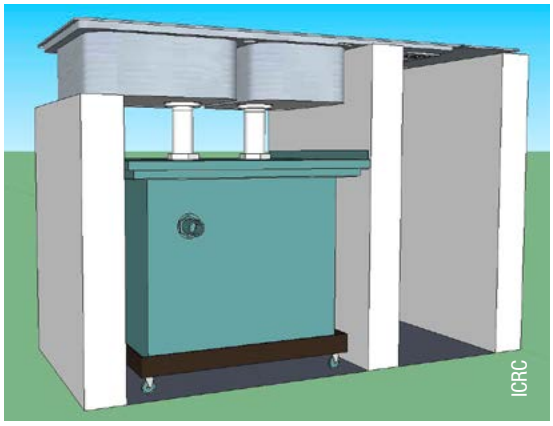
A well-lit room with a stable plaster table in the middle allowing ample working space around it.



A mobile plaster trolley is essential.

Access to water is very important in the cast room:

- The plaster sink should have an easy-to-clean surface.
- When cleaning POP off of equipment, some plaster will fall into the water. Water containing diluted plaster ("plaster water") should not be disposed of in the regular plumbing, because the plaster will harden and clog the pipes.
- Water in the bucket or basin (made of inox or plastic) used for dipping and wetting plaster will also become plaster water.
- Plaster water can be dumped in sinks that connect to a sedimentation tank and not the plumbing system.
- All water used in the application and cleaning of POP should be disposed of according to the specific procedures in place.



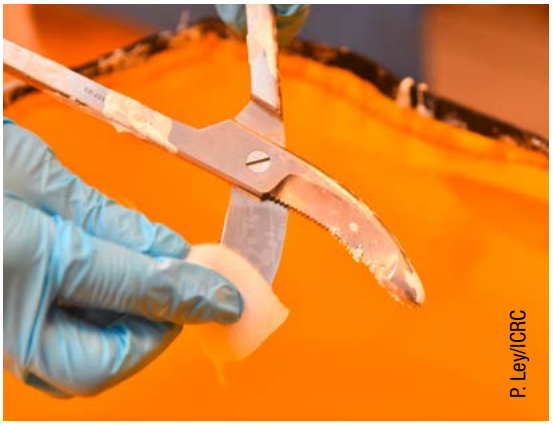
Sedimentation tank front.

Waste management should also be considered when working with plaster.

2.4 MAINTENANCE OF PLASTER EQUIPMENT

General maintenance

- Remove plaster from the equipment: use a cloth, soft sponge or plastic brush rather than steel wool or a sharp metal tool, as the latter make scratches that will eventually rust.
- Wash all materials with clean water or 0.1 per cent chlorine solution after making POP. Do not use soap, as soap hardens the plaster.
- Dry all equipment with a towel or a piece of cloth immediately after washing to avoid rust, and put all items back in their proper places.
- Sharpen blunt scissors using a metal file.
- Tighten loose screws in all equipment (e.g. scissors and shears).
- Oil all moving parts with an appropriate lubricant once per week if the equipment is used every day.



ICRC plaster removal kit

Oscillating plaster saw

- Unplug the saw from the electrical socket before maintenance or cleaning.
- Avoid any contact between electrical parts of the saw and water/humidity.
- Clean the blade with a damp cloth. Do not put the blade under running water while the saw is plugged into an electrical socket.
- Use air pressure (if available) to blow plaster dust out of the oscillating part of the saw.
- When changing a blunt blade, make sure the grooves are in the right place and tighten the bolt. Always have a spare blade that fits the saw available in the cast room.
- Avoid winding the electrical cable attachment too tightly so as not to strain the rubber connector.
- Do not put the saw on a hard surface while it is oscillating.
- The saw should be used only for cutting POP, unless it has separate blades for other uses.

2.5 MAIN MATERIALS AND EQUIPMENT


L. Bernhard/ICRC

Goniometer


L. Bernhard/ICRC

Measuring tape


L. Bernhard/ICRC

Plumb line


L. Bernhard/ICRC

Tubular bandages (stockinette): 8 and 10 cm


L. Bernhard/ICRC

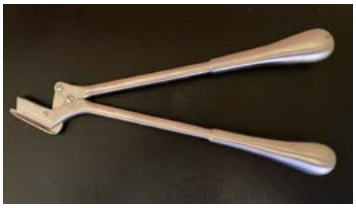
Bandage padding: 10 and 15 cm


L. Bernhard/ICRC

POP rolls: 10, 15 and 20 cm


L. Bernhard/ICRC

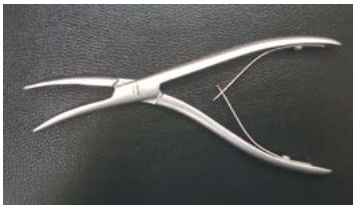
Scissors


L. Bernhard/ICRC

Plaster shears (Stille)


L. Bernhard/ICRC

Cast spreader


S. Albarawi/ICRC

Cast breaker


L. Bernhard/ICRC

Plaster scissors (Bruns)


J. Senet/ICRC

Plaster knife (Esmach)


J. Senet/ICRC

Elastic bandages: 10 and 15 cm


L.Bernhard/ICRC

Walking heel


L. Bernhard/ICRC

Bridge for POP splints


L. Bernhard/ICRC

Polycentric joint


L. Bernhard/ICRC

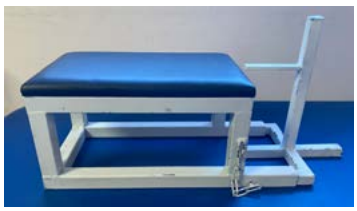
Cast support


L. Bernhard/ICRC

Posture cushions


L. Bernhard/ICRC

Oscillating saw


L. Bernhard/ICRC

Spica table


B. Laouway/ICRC

Plaster table

	USE				
TOOL/MATERIAL	Measuring and assessment	Cast making	Cast removal	Protection and hygiene	Positioning and support
	Goniometer	POP bandage: 10, 15, 20 cm	Plaster shears	Betadine	Cast support
	Measuring tape	Bandage padding: 10, 15 cm	Cast spreader	Gloves	Treatment table
	Plumb line	Cotton wool	Cast breaker	Mask	Crutches
	Dermographic pencil	Tubular bandage (stockinette) 8, 10 cm roll	Plaster knife	Glasses	Walker
		Elastic bandage 10, 15 cm	Plaster scissors	Gown	Posture cushions
		Bridge for POP splints	Scissors	Plastic sheet/apron	Spica table
		Polycentric joints	Oscillating saw		Triangular bandage
		Walking heel/cast shoe			
		Water basin			
		Adhesive tape: 2.5 cm			

Table 2.2: Materials and tools needed to apply POP casts

2.6 MAKING CASTS AND SLABS

2.6.1 INFORMED CONSENT

All patients must be informed about their care, and consent must be given before each POP application. Information about possible complications should also be clearly communicated.

After a complete examination and study of the type of fracture shown in the X-ray, the patient should be told about the intended treatment.

In emergencies, informed consent is often only given orally. For non-emergency fracture treatment, the patient must be fully informed about the risks, possible complications and alternative treatment options.

Consent must be given before applying a cast. An informed patient will be more cooperative, and the outcome will usually be better. Most importantly, the rights of the patient should be respected at all times and their wishes should be considered.

The patient must be involved in the decision-making process from the start, and should be informed about:
- the immobilization method
- the risks and complications
- the alternatives
- the follow-up procedures.

2.6.2 PREPARATION OF MATERIALS

Since different cast materials have different properties, the person applying the cast must select the material that will best suit the type of fracture or lesion, the body part and the age of the patient.

Prior to an immobilization procedure, ensure that all the required materials are available (see Table 2.2). Remember that plaster has a limited working and setting time, so it is important not to interrupt the procedure. Always prepare a number of plaster bandages (more than just a few rolls), as the POP should be made all at once to ensure the continuity of its structure.

The working time for POP is about 3–5 minutes, depending on the water temperature and the plaster brand.
The initial setting time is 10–12 minutes.
The complete setting time is 24–48 hours, depending on the thickness of the cast.

Protect the work area with plastic sheeting.


B. Laouwayi/ICRC

2.6.3 STAFF ROLES AND RESPONSIBILITIES

The creation/application of a cast or splint always requires at least two – and at most three – people working hands-on with the patient, depending on the type of cast or splint applied. There must be:

- at least one sufficiently qualified medical professional
- at least one assistant.

Additional staff might be required for specific procedures such as fracture reduction, wound care, cleaning, etc. Any health worker, regardless of disciplinary background or training level, can assist. Ideally, the staff chosen to assist will continue in the same role for future POP applications.


P. Ley/ICRC

The role of the assistant is to help throughout the application of the POP cast or slab. This includes:

- preparing the room
- gathering the materials needed
- preparing the patient
- applying the POP according to the instructions of the qualified medical professional.

The number of staff required to assist the physiotherapist depends on the procedure. Additional staff might be required for specific procedures during and after the application of a POP cast or slab, such as:

- a nurse to dress the wound before the application of POP
- an anaesthetist to evaluate/prescribe pain relief if the pain is not tolerable
- janitorial staff to clean the room as soon as the POP application is complete.

The role and responsibility of each team member should be decided before starting the procedure. The physiotherapist should be in a suitable position to work without obstruction or difficulty.

In the operating theatre, a physiotherapist may be asked to apply a POP cast or slab while the patient is under anaesthesia.

2.6.4 POSITION OF THE PATIENT

Before you begin to apply POP, prepare the cast table, other furniture and posture cushions to support extremities so that the patient can be positioned appropriately for the specific procedure. The patient should be as comfortable as possible.

2.6.5 ANATOMICAL AND FUNCTIONAL POSITIONS

The patient's joints must be positioned according to the fracture location and type of cast or slab to be applied.

When a joint is in functional position, the antagonistic muscle groups are balanced, with less deforming tension across the fracture. Should the joint become stiff, the recommended functional position is the one that least interferes with important activities of daily life. Immobilizing joints in functional position leads to better functional recovery.

Shoulder

When beginning immobilization of the shoulder, it should be in 80° flexion, 40° abduction and 20° internal rotation.

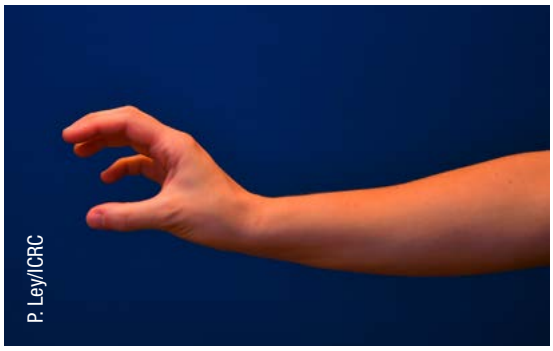
Elbow

The functional position of the elbow is 90° flexion.

Proximal and distal radioulnar joints

The functional position of proximal and distal radioulnar joints is 10° pronation.

Wrist



The functional position of the wrist is 20°–30° dorsal flexion (extension) with full fist closure possible.

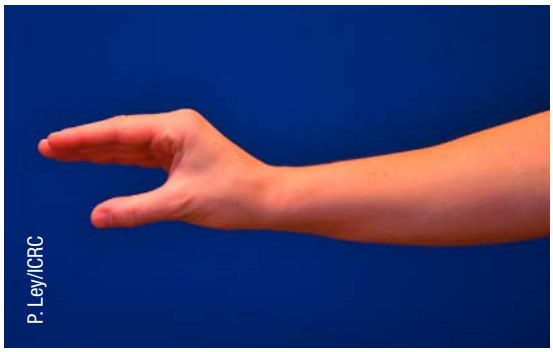
Thumb

There should be slight flexion (15–20°) in the metacarpophalangeal (MCP) joint and 10° in the interphalangeal (IP) joint. The thumb should be opposed to the fingers.

Fingers II–V

The functional position of the MCP joints is 45–40° flexion with the IP joints in 20–30° flexion. The fingers are positioned as if they are holding a bottle.

Intrinsic plus



The intrinsic-plus position of the hand allows for better preservation of finger function, particularly MCP flexion range, compared with the functional opposition position described above. In the intrinsic plus position, the MCP joints are in 70–90° flexion with the IP joints in extension. The collateral ligaments of the MCP joints are placed under tension, so they do not contract while immobilized. The proximal IP and distal IP joints, immobilized in full extension, are at lower risk of developing flexion contractures.

Hip, knee and ankle

The functional position of the hip joint is 15° flexion, with neutral abduction and approximately 15° of external rotation.

The functional position of the knee is 10–20° flexion. In a weight-bearing cast, knee flexion should be close to 10° to achieve better walking function.

For the ankle, a functional position of 90° flexion is advised. Keep in mind that, when relaxed, the foot falls into “drop foot” position (supination and plantar flexion). It is important to preserve a plantigrade foot position, with the plantar surface parallel to the ground when the tibia is upright.

2.6.6 EDGES

The proximal and distal edges of a slab or cast must be properly placed to allow functional movement of the joints not immobilized by the POP and thus avoid complications.

Once the POP cast or slab is complete, assess the actual range of movement in the free joints above and/or below the cast. Do not simply rely on a measurement or indication.

For example, with a short leg back slab, the "two fingers below the head of fibula" rule is used to allow unrestricted flexion of the knee joint.

How to identify the dorsal and palmar MCP line

The MCP line should be identified by the proximal palmar crease.

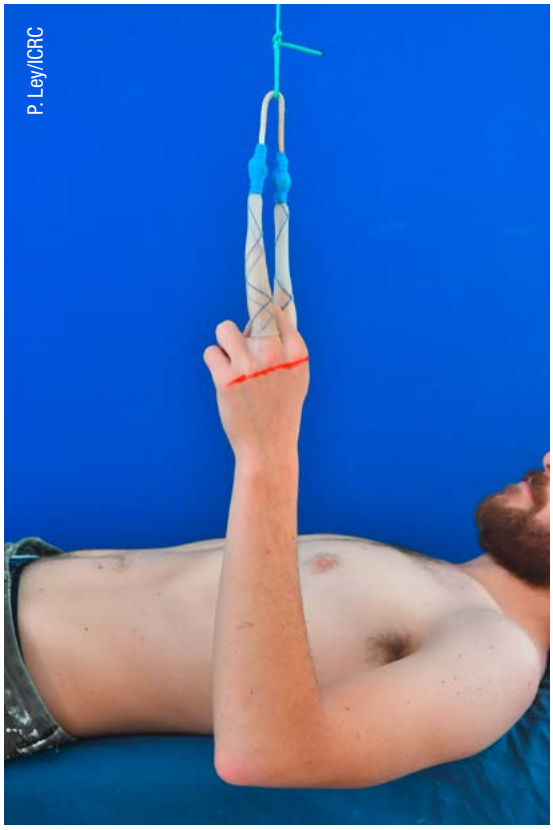
The images below show where each proximal phalanx ends. Keep this in mind for every type of hand immobilization, so that you know whether to include or exclude the phalanx.

Dorsal view

Palmar view

When free MCP joints are indicated, thumb opposition should always be possible.

Finger trap



Every time an upper limb needs to be suspended while the patient is lying down with their elbow in 90° flexion, a finger trap should be used as shown.

2.7 BASIC RULES OF APPLICATION

- Never apply cast material directly to unprotected skin.
- Cover the edges of the cast with soft undercast material so it does not rub or puncture the skin.
- Mould cast material with the palms of your hands, not your fingertips.
- For circular casts, start applying cast material from the fracture site and continue to the joint near the fracture. Continue application towards the proximal and distal ends up to the edges (boundaries).
- Apply continuously so that the cast dries as a single, solid piece.
- Keep checking the functional position of the joint and the fracture alignment until the cast is set.
- Conduct a pain assessment once the procedure is over.

2.8 GENERAL PROCEDURE FOR POP CASTS

Choose a tubular bandage with the correct diameter for the extremity to be plastered.

The tubular bandage is the first layer of material to be applied, directly on the skin of the limb if the fracture is closed and/or the wound has already healed and no wound dressing is needed. Clean and dry the skin as well as possible before applying the tubular bandage to avoid odour and discomfort inside the cast.

Apply the tubular bandage over the entire area to be covered with the cast, plus an extra length to be folded back at both ends.

Once the tubular bandage has been applied, keep the joint and limb in the desired position. Use the cast support or cushions as needed. Avoid wrinkles, as they can lead to pressure sores beneath the cast.

Identify sensitive areas to be protected:

- fracture site
- bony prominences
- nerves
- vessels
- wounds.

Roll the bandage padding around the limb, starting at the distal end, with 50 per cent overlap. The overlap creates a double layer of padding, which is sufficient in most cases. The bandage must extend slightly beyond the planned length of the cast so that when the end of the tubular bandage is folded over, the end of the cast will be padded.

Apply additional padding (cotton wool or soft bands) over sensitive areas, which should never be compressed and must be well padded.

Hold the POP roll between thumb and fingers and dip it in the water at a slight angle.

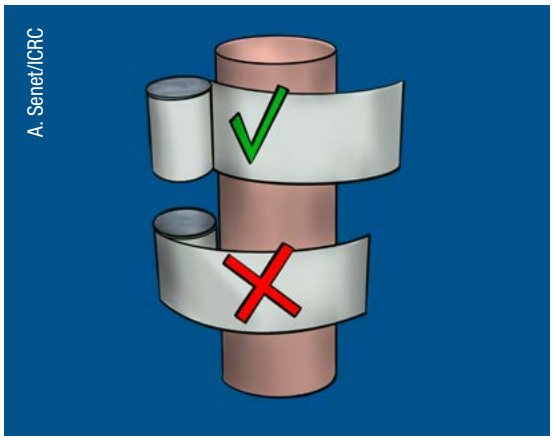
While the POP roll is in the water, leave one end free and support it with your long fingers.

Leave the roll fully immersed in clean water until the last air bubble is visible.

The depth of the water should be at least 20 or 30 cm.

When several rolls are to be used, the next roll may be put in the water while applying the previous one.

Squeeze the excess water from the soaked roll and apply immediately around the limb.



It is important to hold the POP roll correctly during application, so that it can be rolled – not pulled – on.

Roll the POP bandage around the limb. Start distally or at the fracture site, depending on the type and location of the fracture.

At each turn, cover at least half of the width of the preceding layer of POP bandage.

The POP should be applied smoothly, with uniform tension on the bandage (neither too tight nor too loose).

Once the POP bandages have been applied, massage them to spread the wet plaster paste over the pores in the bandage. Avoid any dents or depressions to minimize localized pressure points on the limb.

Maintain the angle specified by the surgeon (or the functional position, by default) when applying plaster over a joint (e.g. ankle, knee or elbow).

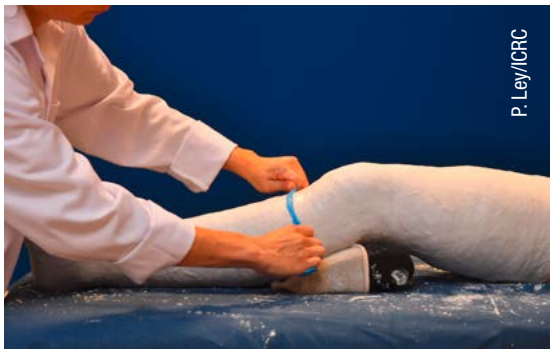
On the joint, apply POP bandages crossing over three or four times in a figure of eight.

Always leave an extra length of tubular bandage under the padding, and an extra length of padding under the POP rolls.

Before applying the last layer of POP, fold the end of the tubular bandage back over the edges and roll the last layer over it.

The additional padding and the tubular bandage will make a soft rim and protect the skin.

When you have finished applying the POP, smooth the finished cast in the direction in which the roll was applied. Make sure that the POP ends are also smooth.



Give the cast a smooth surface by passing a piece of plastic, or a plastic glove, backwards and forwards over it while the plaster is still wet.

Elevate the limb on a stand or pillow.

The patient should avoid putting weight on the cast before it is dry, i.e. approximately 24–48 hours.

When weight-bearing is authorized, attach a rubber walking heel or cast shoe.

Write the "calendar" on the cast: date of fracture, date of application of cast, date of removal and date of next visit for an X-ray check-up.

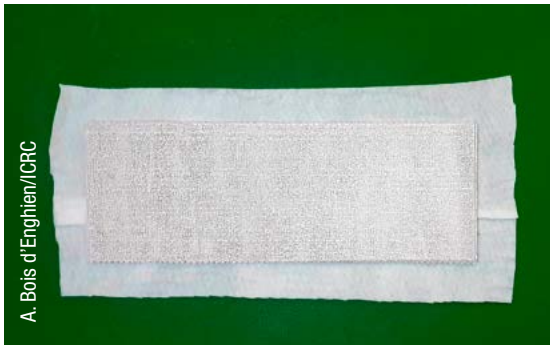
2.9 GENERAL PROCEDURE FOR POP SLABS

First, measure the patient's limb by unrolling a length of bandage padding, depending on the fracture site and landmarks. This will give you the required length for the POP bandages.

Apply a tubular bandage on the limb if the fracture is closed and/or the wound has already healed and no wound dressing is needed. When immobilizing an open wound, a tubular bandage is not needed.

Unroll a couple layers of bandage padding, then unroll the POP bandages over the bandage padding. (The bandage padding should be longer and wider than the POP bandages.)

Prepare a minimum of six layers of POP bandages of the required length.



Add at least 3 cm above and 3 cm below the POP landmark to compensate for shrinkage when the bandage is soaked.

Immerse the prepared POP bandages quickly in water, holding one end in each hand.

Wring out the POP bandages to remove excess water with the help of an assistant. Sufficient water should remain on the bandage to create a thick fluid paste.

On an even surface, smooth the layers with open palms and place them on top of the prepared padding.

Fold the edges of the padding down over the POP bandage.

Place the limb in the position requested by the surgeon.

Apply the POP slab and mould it smoothly, following the contour of the limb.

Roll elastic bandages over the POP slab from the distal to the proximal end (neither too tight nor too loose). Stretch the slab during the process.

Secure the elastic bandages with adhesive tape.

Avoid pressing with your fingers during application. Before the slab dries, check that its edges are smooth and that there are no wrinkles on it.

Maintain the position until the slab is dry.

If the slab is going to be worn for a long time and/or be used as a splint, it can be given a cosmetic finish once it is dry.

The dry slab should be comfortable to wear. Do not remove the bandage too quickly: the slab should be dry enough to maintain its rigidity.

Elevate the limb using pillows and tubular bandage for 48–72 hours after application to reduce swelling.

Back slabs are often used in primary intention to stabilize a fracture before a circular cast is applied. A back slab can be converted into a circular cast by adding extra padding in front (1) then applying POP bandages over the top (2).

2.10 FOLLOW-UP AND COMPLICATIONS

2.10.1 SHORT-TERM FOLLOW-UP

There are several risks associated with plaster cast immobilization. Complications can be reduced by taking all due precautions when applying the cast.

A routine cast check must be done 24 hours after application: during this check, some complications might appear.

Before discharge, make sure that the patient has been well informed about the possible complications and has been taught about cast care.

Individuals known to have diabetes or sensory impairments due to spinal cord injury need particular attention, both while applying the cast and afterwards.

The day after the cast is applied, the patient must be evaluated by the surgeon or a physiotherapist. The patient should be checked for the following:

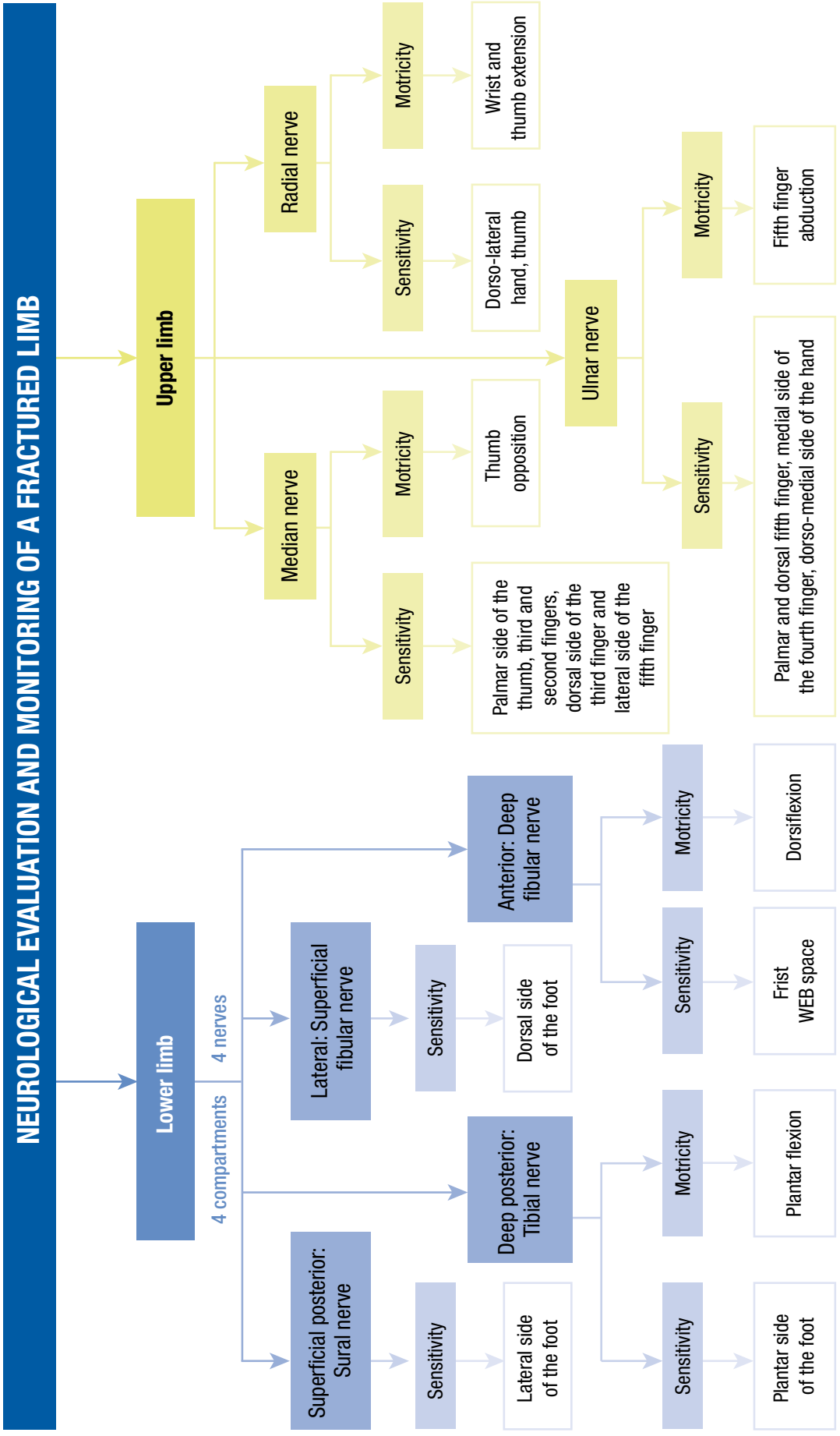
- swelling distal to the cast
- excessive generalized or focalized pain
- inadequate blood circulation (use capillary refill, or cardiac pulses if possible)
- loss of active mobility (inability to move fingers or toes)
- alteration or loss of sensation (tingling, sense of touch)
- signs of compartment syndrome:
  - excessive pain
  - tight swelling
  - passive stretching tolerance
  - reduced sensation and/or motor strength.

Immediate removal of the cast is highly recommended if any of the above occur.

Capillary refill.

Clinical supervision of signs and symptoms must be checked regularly during the whole time the patient is wearing a cast.

2.10.2 NEUROLOGICAL EVALUATION



2.10.3 COMPARTMENT SYNDROME

Compartment syndrome is the most serious complication that can result from casting or splinting. It occurs when increased pressure within a closed space compromises blood flow and tissue perfusion. Compartment syndrome causes ischaemia and potentially irreversible damage to the soft tissues.

In the case shown here, compartment syndrome led to amputation of the limb.

Sometimes surgery is required to prevent permanent injury.

If any sign or symptom of compartment syndrome appears, the cast or splint must be removed immediately.

2.10.4 PATIENT AND CARETAKER EDUCATION

Patients must be taught how to recognize the signs of complications. They should check for signs regularly throughout the immobilization period. Other issues that can appear over time include:

- itching
- skin irritation and/or allergy
- loosening of the cast
- blisters
- hygiene-related complications (dampness beneath the cast, odour, unclean aspect, etc.).

If POP is applied to a child, parents must regularly check for the above signs and be trained to handle the cast or slab correctly during activities of daily living.

Tell patients to come back as soon as possible if they notice any signs or symptoms. The cast should then be evaluated, and gypsotomy techniques can potentially be applied.

Recommendations and instructions before discharge:

- POP should not be covered with cloth, varnish or a blanket until it is fully dry (approx. 48 hours).
- POP must not touch water or any other liquid.
- Raise or elevate a leg with POP regularly, using a pillow, to decrease swelling.
- Perform isometric contraction under the POP to prevent amyotrophy and phlebitis.
- Keep free joints mobile.
- Never walk on the cast without a shoe cast or a walking heel.

2.10.5 LONG-TERM COMPLICATIONS

The following long-term complications can appear after removal of the POP, either as a result of the fracture or the immobilization:

- bone complications
  - non-union or delayed union
  - secondary displacement
  - osteomyelitis
  - osteoporosis

- neurovascular complications
  - algoneurodystrophy
  - compartment syndrome
  - thromboembolism
  - deep vein thrombosis.

2.11 GYPSOTOMY

Gypsotomy is the act of cutting or opening a plaster cast, including for:

- making corrections
  - wedging
  - rotation
- creating a window
- bivalving
- removing the cast.

Gypsotomy is carried out:

- at the end of the immobilization period, when the cast can be removed
- in case of displacement of the fracture in the plaster, a misaligned fracture, a badly positioned fracture, compartment syndrome, pain, etc.

Qualified health staff and assistants must wear masks, gloves and gowns for gypsotomy procedures. Plastic sheets should be used to cover and protect the treatment table from dust and wet plaster.

2.11.1 WEDGING FOR CORRECTION

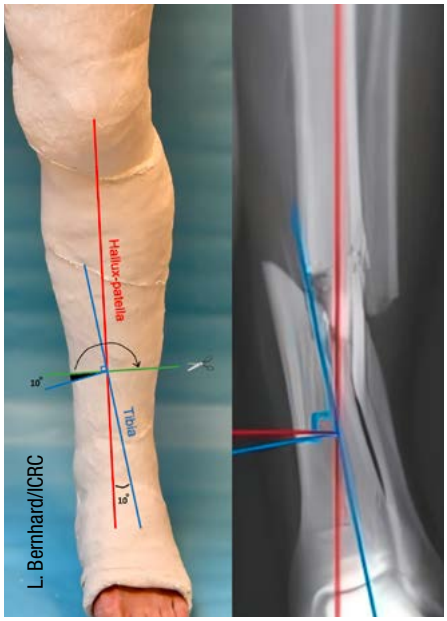
Indication

Wedging cuts are performed to correct a misaligned angulated fracture in a circular POP cast.
The technique can be used for both upper and lower limbs.

Gypsotomy with wedging avoids the risk of causing pressure at the fracture site, which can lead to skin damage.

Procedure

Make sure to have the X-ray beside you.



On the X-ray, draw lines as shown on the picture:

- red line: the hallux-patella-anterior superior iliac spine (ASIS) axis
- blue line: the axis of the tibia.

Measure the angle of the intersection of these two lines: this is the angle of the correction to be made.

On the cast, draw the same red and blue lines as shown in the image, copying the lines from the X-ray. The red line corresponds to the physiological alignment of the leg. The blue line corresponds to the axis of the tibia before correction.

Where the red and blue lines intersect, draw a perpendicular line around the circumference of the cast (green line).

Draw another blue line that intersects with the green line at the correction angle, this time on the side of the cast where the correction is to be made (shaded black in the picture above).

Cut all the way around the cast along the green line.

Cut out a wedge on the side where the correction is to be made (the part shaded in black). This cut in the plaster should be made at the level of the intersection of the red and blue lines (not at the fracture level).

Be extremely careful when carrying out the correction.

Move the wedge-shaped piece that you cut out to the opposite side of the cast. Take care not to pinch the skin.

Re-attach the pieces of the cast using a plaster bandage and stabilize the newly modified cast with a new POP roll.

Check by X-ray that the angle is now correct.

2.11.2 ROTATION FOR CORRECTION

Indication

Gypsotomy with rotation is used to correct a rotation misalignment of a fracture in a circular POP.

Procedure

The reference for the rotation angle is the hallux-patella-ASIS line.

Draw a line around the circumference of the cast at the level where the fracture is misaligned.

Cut the cast along this line.

Rotate the distal part to realign the hallux-patella axis.

While rotating, slight traction can be applied based on the fracture type and the X-ray.

Make sure the alignment is correct by checking the position of the foot in relation to the patella.

Re-attach the two pieces of the cast using a POP bandage to maintain the new correct position.

When possible, re-check the fracture site with an X-ray.

2.11.3 BIVALVING AND REMOVAL

To bivalve a cast means to cut a circular cast in two halves along its length. This makes it possible to open the cast and separate it into two parts.

Indication

Bivalving can be used to:

- access the skin or wound when frequent inspections or dressing are needed
- release pressure
- reduce the immobilization of a fracture at a stage of advanced consolidation
- serve as an alternative to multiple non-lasting back slabs (a bivalved cast is stronger and longer-lasting)
- remove the cast upon approval.

Depending on the reason for bivalving the cast, the next step will be to:

- completely remove the cast
- keep one part (most often the posterior part)
- keep both parts.

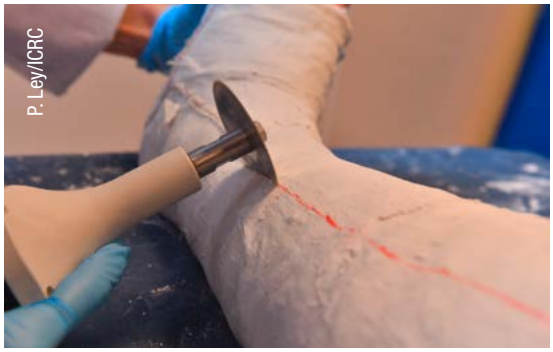
Procedure

Place the patient in a comfortable position and support the immobilized limb.

Draw a straight line mediolaterally on the cast.

Reassure the patient and demonstrate (by touching the blade to your palm) that the oscillating saw will not cut their skin.

Support the saw with one hand and rest the other hand on the cast. Ask the patient to tell you if they feel heat from the blade.



Always cut in small perpendicular movements. Avoid longitudinal movement of the saw, which could heat up the blade and cut or burn the skin.

Cut through the plaster on both sides, constantly checking the depth of the blade throughout the process.

Shears can be used if there is no electricity or electric plaster saw available. Do not apply pressure to the patient's skin; incline the shears so they are parallel to the skin.

Separate the two parts of the cast using a cast spreader.

Cut out the additional padding using a pair of scissors.

Inspect the skin and check the physical stability of the fracture site.

Keep the posterior slab in case the fracture is not stable.

If the posterior slab is to be kept in place, make a smooth edge with POP powder, or place a thin bandage along the slab.

If the fracture is stable with enough callus visible on the X-ray, remove the cast and dispose of it in an appropriate container.

Removal of the cast must be approved by the surgeon. If removal is approved, inspect the skin and check the physical stability of the fracture site, clean the patient's skin with soap and water, then dry the skin.

2.12 SPECIFIC PROCEDURES FOR WOUNDS

The wound is dressed in the operating theatre, the wards or the plaster room.

Place a thick layer of gauze on top of the dressing to mark where to add a window in the cast.

Apply a tubular bandage, taking care not to displace the dressing over the wound, or use tape to keep the dressing in place.

Apply padding on top of the tubular bandage.

Apply a POP cast as usual.

Cut a window in the cast to provide access to the wound, allowing ample space around it. The blade of the saw should be slightly inclined to facilitate removal of the window cover.

Using gloves for protection, remove the window cover and cut away the undercast material and tubular bandage over the dressing.

Smooth the edges of the window by trimming the excess undercast material and plaster.

After dressing or treating the wound, always put the cover back in place and secure it with tape or an elastic bandage.

3. SLABS

OBJECTIVES
Know the types of slabs used for different types of limb fracture.
Understand when use of a slab is indicated for each type of fracture.
Know where to place the edges of each type of slab.
Know the application method for each type of slab.

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3.1.1 Short leg back slab 64

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3.1.3 Ankle U-slab 68

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3.1 LOWER-LIMB SLABS

3.1.1 SHORT LEG BACK SLAB

Indication		• All fractures of the ankle • All fractures of the foot • Dislocation of ankle joints (after reduction)
Edge	**Proximal**	• Two fingers below the head of the fibula
	Distal	• Metatarsophalangeal (MTP) joint • Slab can extend the length of the whole toes, depending on the site of the fracture
Position of joints		• Ankle: 90° (except for some distal fractures of the tibia and fibula) • Foot: neutral inversion-eversion and 10–15° external rotation
Sensitive areas		• Lateral and medial malleolus • Popliteal fossa
Set-up & materials *(All quantities are for adults)*		• Patient lying supine or prone
		• Tubular bandage (if needed) — Ø 10 cm
		• Padding bandage — 1 roll
		• POP — 3 rolls of 15 cm
		• Elastic bandage — 2 rolls of 15 cm
		• Adhesive tape — 2.5 cm
		• Crutches
Number of people required		

A. Senet/ICRC

Table 3.1: Short leg back slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps of application.

P. Ley/ICRC

Mark the proximal and distal landmarks.

Unroll the POP bandages on the padding bandages according to the measurements taken.

Place the wet slab and mould it, paying attention to the malleolus and Achilles tendon. Secure the slab with an elastic bandage by making a figure of eight around the ankle from distal to proximal.

When the slab is bent around the ankle, special attention must be paid to avoid wrinkles, which can cause pain.

Keep the ankle joint at 90° (or according to specific indications) until the plaster sets. Flex the knee slightly to relax the gastrocnemius.

The slab should cover two-thirds of the total circumference of the limb.

Check for sharp edges and ensure the patient is comfortable.

3.1.2 LONG LEG SLAB

Indication		• All fractures of the tibial shaft • All fractures and dislocations of the knee	
Edge	**Proximal**	• Four fingers below the great trochanter	
	Distal	• MTP joint	
Position of joints		• Ankle: 90° (except for some distal fractures of tibia and fibula) • Knee: 15° flexion • Foot: neutral inversion-eversion and 10–15° external rotation	
Sensitive areas		• Lateral and medial malleolus • Head of the fibula • Popliteal fossa	
Set-up & materials *(All quantities are for adults)*		• Patient lying supine	
		• Tubular bandage (if needed)	Ø 10 cm
		• Padding bandage	2 roll
		• POP	6 rolls of 20 cm
		• Elastic bandage	2 rolls of 20 cm
		• Adhesive tape	2.5 cm
		• Crutches	
Number of people required			

A. Senet/ICRC

Table 3.2 Long leg slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

In some cases, three staff members might be needed for this procedure:
- two people to hold the leg and the wet slab, protecting the fracture site
- one person to roll elastic bandages around the slab.

P. Ley/ICRC

Mark the proximal and distal landmarks.

Place the wet slab and mould it, paying attention to the malleolus and Achilles tendon.

When the slab is bent around the ankle, special attention must be paid to avoid wrinkles, which can cause pain.

Secure the slab with an elastic bandage by making a figure of eight around the ankle and knee, from distal to proximal.

The main difficulty is in maintaining the position of the leg when rolling the elastic bandage over the slab.

3.1.3 ANKLE U-SLAB

Indication		• All stable fractures of the malleolus at ankle level • All fractures of the foot • Dislocation of ankle joints (after reduction) • Added control over the valgus and varus movements • Can be applied depending on the wound position
Edge	**Proximal**	• Lateral and medial proximal leg
	Distal	• Around the plantar surface of the foot
Position of joints		• Ankle: 90°

Sensitive areas	• Lateral and medial malleolus	
Set-up & materials *(All quantities are for adults)*	• Patient lying prone or sitting with knee in flexion	
	• Tubular bandage (if needed)	Ø 10 cm
	• Padding bandage	1 roll of 10 cm
	• POP	3 rolls of 15 cm
	• Elastic bandage	2 rolls of 10 cm
	• Adhesive tape	2.5 cm
	• Crutches	
Number of people required		

A. Senet/ICRC

Table 3.3: Ankle U-slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

P. Ley/ICRC

Mark the distal and proximal landmarks.

Protect the medial and lateral malleoli with additional padding.

Apply the slab to the lateral aspect of the lower leg at mid-calf, around the plantar surface of the foot and back up the medial aspect of the lower leg.

Smooth out the slab using your palms to mould it to the contours of the lower leg and ankle.

Wrap the elastic bandage over the slab distally to proximally, making a figure of eight around the ankle.

Maintain the ankle at 90° of flexion until the plaster sets.

Check for sharp edges and make sure that the patient is comfortable.

3.2 UPPER-LIMB SLABS

3.2.1 DORSAL FOREARM SLAB

Indication		• Applied under some injuries of the hand and distal forearm, e.g. wounds on the lateral sides of the hand
Edge	**Proximal**	• Two fingers below the flexion crease of the elbow
	Distal	• MCP line, allowing movement of the fingers
Position of joints		• Forearm: Neutral prono-supination • Wrist: 20–30° extension (functional position)
Sensitive areas		• Styloid process of ulna and radius • Popliteal fossa
Set-up & materials *(All quantities are for adults)*		• Patient seated with forearm horizontal on the plaster table
		• Tubular bandage (if needed) — Ø 10 cm
		• Padding bandage — half roll
		• POP — 2 rolls of 15 cm
		• Elastic bandage — 1 roll of 15 cm
		• Adhesive tape — 2.5 cm
		• Triangular bandage
Number of people required		

A. Senet/ICRC

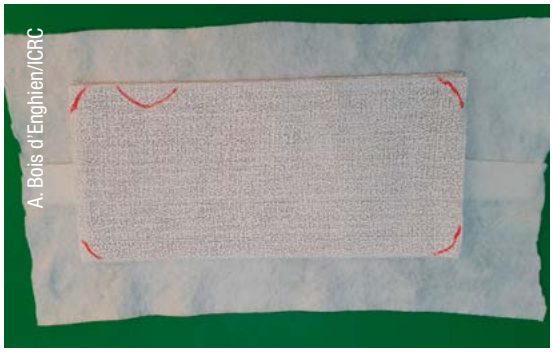
Table 3.4: Dorsal forearm slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

A. Bois d'Enghien/ICRC

Mark the proximal and distal landmarks.



Unroll POP bandages on the padding bandages according to the measurements taken.

Trim the edges of the POP bandages, paying particular attention to the functional position of the thumb.

Place and mould the slab on the limb.

Secure the wet slab on the dorsal aspect of the forearm with elastic bandages.

Keep the wrist in 20–30° extension (functional position) – or according to the surgeon's specifications – until the slab sets.

Check for sharp edges and support the limb with a triangular bandage.

3.2.2 PALMAR FOREARM SLAB

Indication		• All distal fractures at forearm level, including fractures of the wrist joint	
Edge	**Proximal**	• Two fingers below the flexion crease of the elbow	
	Distal	• Proximal palmar crease	
Position of joints		• Forearm: Neutral prono-supination • Wrist: Depends on the fracture type (follow surgeon's instructions)	
Sensitive areas		• Styloid process of the ulna and radius	
Set-up & materials *(All quantities are for adults)*		• Patient lying or sitting	
		• Tubular bandage (if needed)	Ø 10 cm
		• Padding bandage	half roll
		• POP	1 roll of 15 cm
		• Elastic bandage	1 roll of 15 cm
		• Adhesive tape	2.5 cm
		• Triangular bandage	
Number of people required			

A. Senet/ICRC

Table 3.5: Palmar forearm slabs at a glance

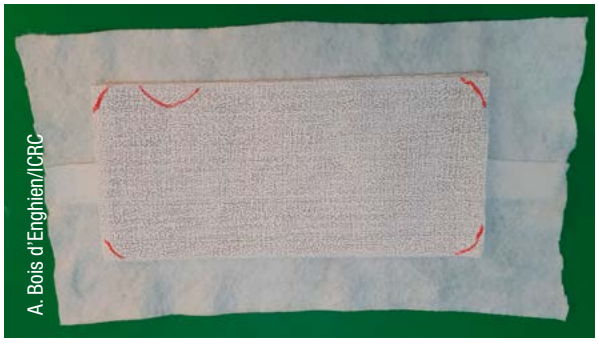
Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

Protect the skin between the fingers to avoid maceration.

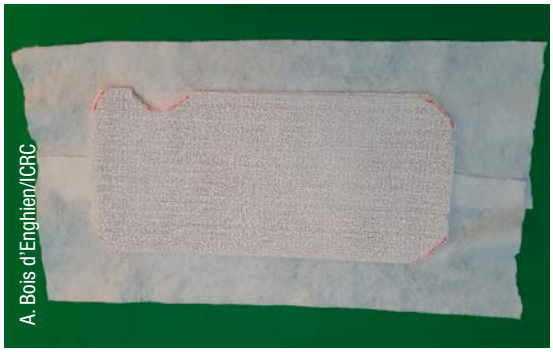
A. Bois d'Enghien/ICRC

Mark the proximal and distal landmarks.



A. Bois d'Enghien/ICRC

Prepare six to eight layers of POP bandages of the required length.



Cut out the four corners around the MCP joints and create a space for the thenar eminence.

Place the wet slab and mould it on the palmar or dorsal side of the forearm, depending on the fracture site and/or the surgeon's instructions.

Secure the slab with elastic bandages. When rolling the elastic bandage, make sure that the thumb remains in opposition to the other fingers.

Make sure that the MCP joint of the fifth finger is not compressed.

Make sure that the fingers and thumb can grip properly.

Check for sharp edges and support the limb with a triangular bandage.

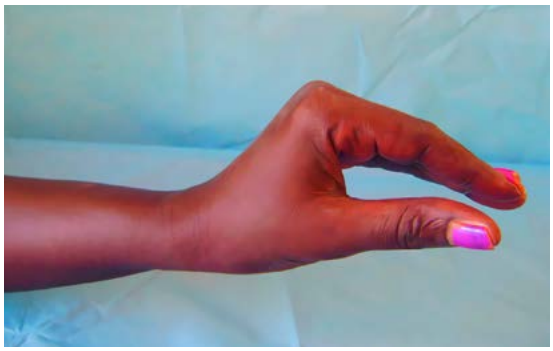
3.2.3 COCK-UP SLAB

Indication		• Fractures of metacarpal bones and phalanges	
Edge	**Proximal**	• Two fingers below the flexion crease of the elbow	
	Distal	• Distal end of fingers	
Position of joints		• Wrist: 20–30° extension (functional position) • MCP: 90° flexion • Proximal and distal IP: full extension	
Sensitive areas		• Styloid process of the ulna and radius	
Set-up & materials *(All quantities are for adults)*		• Patient lying or sitting	
		• Tubular bandage (if needed)	Ø 10 cm
		• Padding bandage	half roll
		• POP	1 roll of 15 cm
		• Elastic bandage	1 roll of 15 cm
		• Adhesive tape	2.5 cm
Number of people required		• Triangular bandage	

A. Senef/ICRC

Table 3.6: Cock-up slabs at a glance

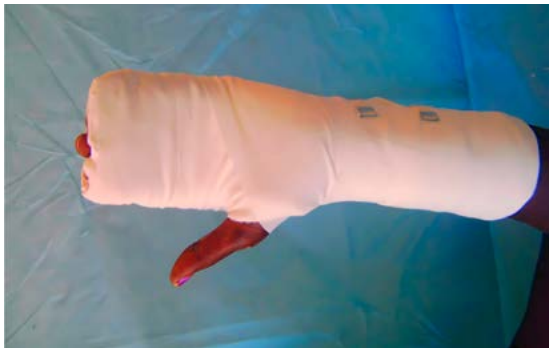
Method of application



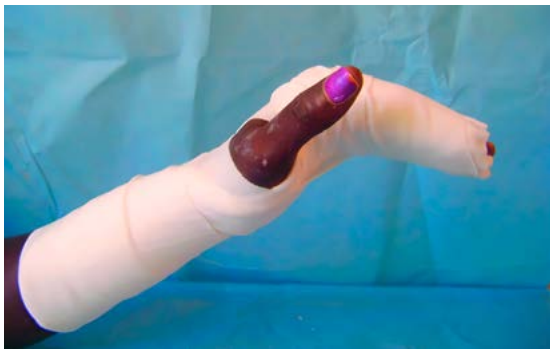
Refer to the general procedure for slabs (p. 45) for the first steps.

The method of application is the same as for the palmar forearm slab (see p. 72).

Protect the skin between the fingers to avoid maceration.



Palmar view



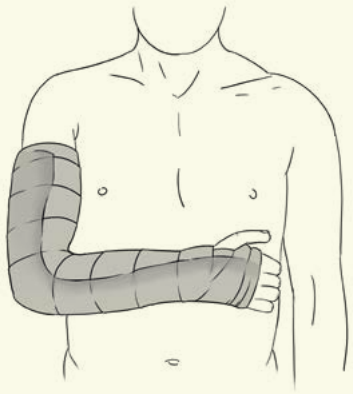
Lateral view

Dorsal view

View of the hand from above without the elastic bandages

3.2.4 LONG ARM SLAB

Indication		• Initial management of all fractures of the radius and ulna
Edge	**Proximal**	• Below the distal deltoid muscle insertion • Avoid the axilla
	Distal	• MCP line • Variable (from free wrist to locked prono-supination, according to surgeon's instruction)
Position of joints		• Elbow: 90° flexion • Forearm: neutral prono-supination • Wrist: depends on level and type of fracture • When in doubt, place the forearm in supination and wrist in 20–30° extension (functional position)
Sensitive areas		• Epicondyles of the humerus • Olecranon tip • Styloid process of the radius and ulna
Set-up & materials *(All quantities are for adults)*		• Patient sitting or lying (if under anaesthesia)
		• Tubular bandage (if needed) — Ø 10 cm
		• Padding bandage — 1 roll
		• POP — 3 rolls of 15 cm
		• Elastic bandage — 2 rolls of 15 cm, 1 roll of 10 cm
		• Adhesive tape — 2.5 cm
		• Triangular bandage
Number of people required		



A. Senet/ICRC

Table 3.7: Long arm slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

P. Ley/ICRC

Mark the proximal and distal landmarks.

Prepare six to eight layers of POP bandages of the required length.

Place the wet slab on the limb and mould it.

Secure the slab with elastic bandages.

When the POP slab is bent around the elbow, pay special attention to avoid wrinkles, which can cause pain.

Make sure the ulnar nerve is not compressed by asking the patient if the inside of their elbow is comfortable.

After bandaging, maintain the elbow and wrist in the proper position until the slab dries.

Check for sharp edges and support the limb with a triangular bandage.Make sure the ulnar nerve is not compressed by asking the patient if the inside of their elbow is comfortable.

3.2.5 HUMERUS U-SLAB

Indication		• All fractures of the humerus shaft	
Edge	**Proximal**	• Over the shoulder laterally • Below the axilla medially	
	Distal	• Below the elbow	
Position of joints		• Elbow: 90° flexion • Forearm: neutral prono-supination	
Sensitive areas		• Condyles of the humerus • Olecranon tip • Acromioclavicular joint • Axilla	
Set-up & materials *(All quantities are for adults)*		• Patient sitting or lying (if under anaesthesia)	
		• Tubular bandage (if needed)	Ø 10 cm
		• Padding bandage	1 roll
		• POP	3 rolls of 10 cm
		• Elastic bandage	1 roll of 15 cm, 1 roll of 10 cm
		• Adhesive tape	2.5 cm
		• Triangular bandage	
Number of people required			

A. Senet/ICRC

Table 3.8: Humerus U-slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.

A. Albarawi/ICRC

Protect the elbow joint with additional padding.

Mark the distal and proximal landmarks. Extend to cover the deltoid eminence up to the acromion.

Place the wet slab and mould it. U-slabs should be kept light, as heavy slabs can cause delayed union.

Have an assistant maintain the two proximal ends of the slab while the physiotherapist applies the elastic bandage.

Start bandaging with a figure of eight around the elbow joint, then extend to the axilla.

Check for sharp edges and support the limb with a triangular bandage.

3.2.6 FOREARM U-SLAB

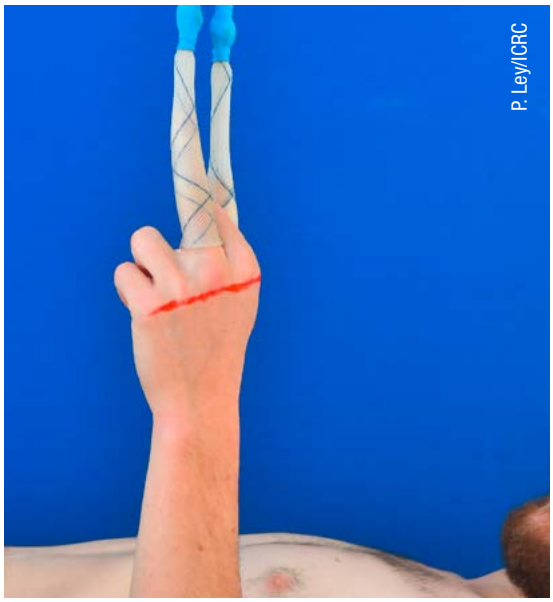
Indication		• Distal radius and ulna fractures • Wrist fractures • When thumb and elbow are included, provides control of rotation of the forearm	
Edge	**Proximal**	• Around elbow	
	Distal	• Palm: palmar crease • Back of the hand: MCP line	
Position of joints		• Elbow: 90° flexion • Wrist: 20–30° extension (functional position)	
Sensitive areas		• Elbow • Olecranon tip • Styloid process of radius and ulna	
Set-up & materials *(All quantities are for adults)*		• Patient lying prone or sitting with knee in flexion	
		• Tubular bandage (if needed)	Ø 10 cm
		• Padding bandage	1 roll of 10 cm
		• POP	3 rolls of 10 cm
		• Elastic bandage	1 roll of 10 cm
		• Adhesive tape	2.5 cm
		• Triangular bandage	
Number of people required			

A. Senet/ICRC

Table 3.9: Forearm U-slabs at a glance

Method of application

Refer to the general procedure for slabs (p. 45) for the first steps.



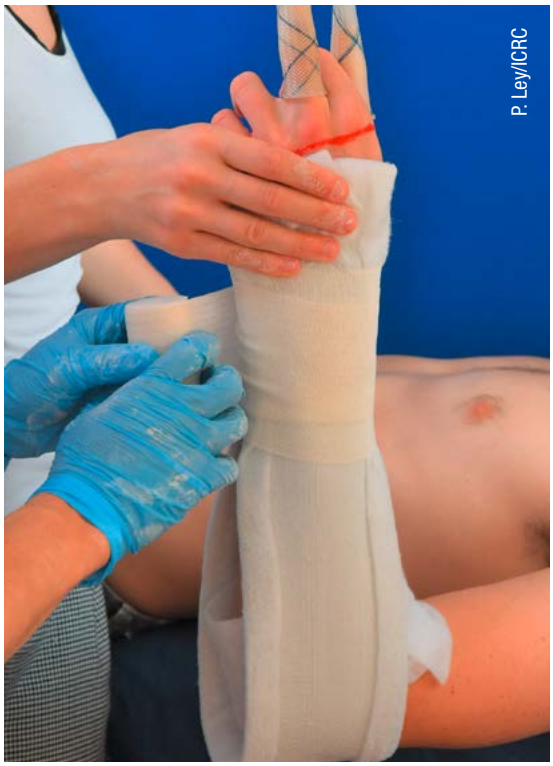
P. Ley/ICRC

The assistant suspends the arm by holding the fingers, or places the fingers in a finger trap.

Protect sensitive areas with additional padding.

Mark the distal and proximal landmarks.

Apply the slab around the elbow, on the lateral sides of the forearm, and to the dorsal and palmar metacarpal joints.



Wrap elastic bandages over the slab, proximally to distally, making sure to mould to the contours of the forearm and the position of the joints.

Maintain the position of the joints until the slab sets.

Check for sharp edges and support with a triangular bandage.

4. LOWER-LIMB CASTS

OBJECTIVES
Know the type of cast used for each type of fracture.
Understand when use of a cast is indicated for each type of fracture.
Know the application method for each type of lower-limb cast.

4.1 Short leg cast **86**

4.2 Lower-limb cylinder cast **89**

4.3 Long leg cast **91**

4.4 Bridge cast **95**

4.5 Polycentric joint cast **98**

4.6 Hip spica **103**

4.1 SHORT LEG CAST ("BOOT POP")

Indication		• All fractures of distal third of the leg • Foot fractures	
Edge	**Proximal**	• Two fingers below the head of the fibula	
	Distal	• MTP joint • And/or covering the whole toes, depending on the site of the fracture	
Position of joints		• Ankle: neutral position • Foot: neutral position	
Sensitive areas		• Tibial crest, lateral and medial malleolus	
Set-up & materials *(All quantities are for adults)*		• Patient lying prone or supine OR Patient seated on the edge of the bed with knee at 90° and leg hanging	
		• Tubular bandage	Ø 10–20 cm
		• Padding bandage	2 rolls
		• POP	1 roll of 20 cm, 3 rolls of 15 cm, 1 roll of 10 cm (in case of a walking heel)
		• Walking heel or cast shoe if needed	
		• Crutches	
Number of people required			

A. Senet/ICRC

Table 4.1: Short leg casts at a glance

Note: Short leg casts should be considered in situations where Sarmiento casts were applied in the past (as a second cast applied after removing a long leg cast, to allow knee flexion).

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

C. Lotto/ICRC

Mark the distal and proximal landmarks.

Place additional padding around the ankle joint to avoid pressure on the malleolus.

Reinforce the cast at the ankle by applying POP bandages in a figure of eight, from distal to proximal, crossing over the ankle joint.

While adding POP bandages, continue moulding the cast. Carefully mould to fit the sole of the foot, the malleolus and the Achilles tendon.

Give the cast a cosmetic finish and make sure the patient is comfortable.

Respect landmarks and check function: toes are free, head of fibula is free and ankle joint position matches surgeon's indications (displacement of fracture).

4.2 LOWER-LIMB CYLINDER CAST

Indication		• Conservative treatment of patella fracture • Femur condyle fracture • Patellectomy • Immobilization, i.e. septic arthritis, ligament injury of the knee
Edge	**Proximal**	• Three fingers (5 cm) below the gluteal fold
	Distal	• Immediately above the malleolus, mould cast over the malleolus with extra padding
Position of joints		• Knee: 15° flexion (except for patella fracture: knee joint should be in full extension) • Ankle: free to move
Sensitive areas		• Head of fibula • Tibial crest • Patella • Free the Achilles tendon • Malleoli • Popliteal fossa
Set-up & materials *(All quantities are for adults)*		• Patient lying supine • Support the injured leg in the correct position with cushions
	• Tubular bandage	Ø 20 cm
	• Padding bandage	3 rolls
	• POP	2 rolls of 20 cm, 1 rolls of 15 cm
	• Crutches	
Number of people required		


A. Senet/ICRC

Table 4.2: Lower-limb cylinder casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.


C. Lotto/ICRC


C. Lotto/ICRC

Start at the site of the injury/fracture and continue towards the distal end.

Finish proximally.

Apply pressure above the lateral and medial femoral condyles and maintain pressure for five minutes.

Respect 15° flexion of the knee to allow ground clearance while walking.

The cast should not slide down when the patient is standing; this could put pressure on the malleolus or hurt it.

4.3 LONG LEG CAST

Indication		• All tibia/fibula fractures (except stable distal fractures) • Dislocated knee • Post-ligament reconstruction	
Edge	**Proximal**	• Four fingers (approx. 5 cm) below the gluteal fold	
	Distal	• MTP joints	
Position of joints		• Knee: 15° flexion • Ankle: neutral position • Foot: neutral position	
Sensitive areas		• Head of fibula • Tibial crest • Patella • Medial and lateral malleolus • Popliteal fossa	
Set-up & materials *(All quantities are for adults)*		• Patient lying supine	
		• Tubular bandage	Ø 20 cm
		• Padding bandage	3 rolls
		• POP	3 rolls of 20 cm, 4 rolls of 15 cm, 1 roll of 10 cm (if walking heel is needed)
Number of people required		• Walking heel or cast shoe, if needed	
		• Crutches	

A. Senet/ICRC

Table 4.3: Long leg casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

If the patient's leg cannot be suspended, an assistant will be needed to hold it. The assistant should stand on the opposite side, holding the leg with the palm of their hand. The limb may be suspended from the distal end of the tubular bandage.

Apply tubular bandage, allowing extra length for folding back, or suspend the limb.

Mark the bone prominences.

Use cushions to keep the fractured leg in position during application.

Unroll padding bandages all around the limb.

Apply two rolls of POP bandages in figure-of-eight turns around the ankle and knee joints. Be sure to follow the general principles set out at the beginning of this manual.

Give the cast a smooth finish by passing a piece of plastic or a plastic glove back and forth over it while it is still wet.

Affix a walking heel to the cast while it is still wet, if requested by the surgeon.

The centre of the walking heel should follow the tibial crest axis.

Walking heel application.

Inspect the landmarks and functional position with the patient standing.

4.4 BRIDGE CAST

Indication	• Distal fracture with an open wound • Anytime access to the wound is needed	
Sensitive areas	• Depends on the cast • POP edges near the wound, depending on the size of the dressing for fixing of the bridges	
Set-up & materials additional to the circular cast *(All quantities are for adults)*	• POP	3 rolls of 10 cm
	• Bridge POP splints	3 pieces (1set)
	• Walking heel or cast shoe, if needed	
Number of people required		

Table 4.4: Bridge casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

Ensure that there is an appropriate dressing over the wound.

Before applying the POP cast, mark the edges of the dressing on the tubular bandage.

Make two casts, one above and one below the fracture/wound.

Fold back the edges of the tubular bandage next to the wound.

Choose the position of the bridges to allow easy access to the wound and ensure stability and comfort for the patient. Three bridge bars offer more stability, but make access less easy.

The location of the wound will determine the position of the bars. All bars should be at equal distance from one another.

The three bars are positioned:

- medially
- laterally
- anteriorly.

An exception to this rule is when the wound is located on the medial or lateral side of the leg. Then, to allow easy access, the position of the bars will be postero-lateral and postero-medial.

If the fracture is stable but the wound is consequential, two bars may be used.

Connect each end of the bridge bars to the casts using 10 cm plaster bandages, and at the same time give a cosmetic finish to the edges of the cast next to the wound.

The bolt heads of the medial bar should be facing the cast to avoid hurting the other leg.

The alignment and rigidity of the bridge should be checked at the beginning of weight-bearing and regularly throughout the immobilization period.

4.5 POLYCENTRIC JOINT CAST

Indication		• In secondary intention, to free the knee joint • Articular fracture, such as tibia plateau fracture, when a certain degree of knee flexion is allowed (the fitting must be perfect)	
Edge	**Proximal**	• Three fingers below the gluteal fold	
	Distal	• Three fingers above the malleolus	
Sensitive areas		• Depends on the cast • Fibular head • Malleoli	
Set-up & materials additional to the circular cast *(All quantities are for adults)*		• POP	3 rolls of 10 cm
		• Polycentric joints	2 pieces (one set)
Number of people required			

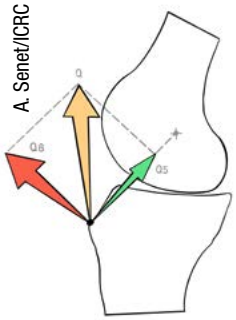
Table 4.5: Polycentric joint casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps, and to the method of application for a long leg cast (p. 91).

Mark the middle of the patella on the POP.

On the **anterior** part of the cast, draw a vertical line down the middle of the patella for reference. Then draw a horizontal line across the middle of the patella and through the knee axis as shown in the pictures above. The intersection of these lines should mark the centre of the patella.

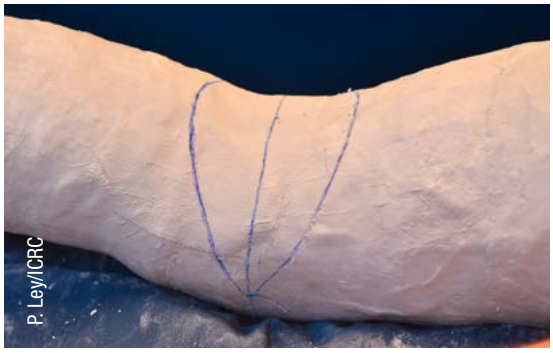


On the **lateral** and **medial** parts of the cast, mark the rotation centres of movement in the middle of each condyle as shown in the pictures.

Make a mark two fingers (3–4 cm) above the horizontal line on the anterior part of the cast. Connect this mark to the lateral and medial marks on the condyles.

On the **posterior** part of the cast, draw a horizontal line connecting the lateral and medial marks on the condyles.

Make a mark three fingers (5 cm) above and below the horizontal line.



Connect these marks to the lateral and medial marks on the condyles in a semi-circular curve, dividing the popliteal fossa in quadrants, as shown in the picture above.

Draw a perpendicular line along the axis on the medial and lateral sides.

These perpendicular lines serve to maintain the alignment and position of the polycentric joints.

Cut along the lines you have drawn with a plaster saw.

Remove the part of the cast you have just cut away.

Fold back the tubular bandage and the undercast material.

Give the cast a cosmetic finish on the edges by securing it with a 10 cm POP bandage.

On the posterior side:

On the anterior side:

Affix the two extremities of the polycentric joints using POP rolls, in line with the knee axis (use the perpendicular lines you have drawn to maintain alignment).

Clean the leg and check that the cast allows sufficient mobility of the knee.

4.6 HIP SPICA

Hip spica casts are mainly indicated for femur fractures in children, generally after a period of skin traction. They are rarely used on adults. They are generally applied so that patients can be discharged earlier, but the results for the fracture and the functional outcomes are extremely poor. Moreover, hip spica casts are not easy to make. And because they are heavy and hot to wear, having to wear one for weeks can be burdensome. They also require a lot of care: to prevent damage to the skin, they must be cleaned every day and closely tended to. They do allow the patient to get out of bed and they make some daily activities possible (moving about, using the toilet). But they restrict the patient's mobility and impose a degree of dependence on others, especially for dressing and washing.

The ICRC does not promote the use of hip spica casts in its hospital programmes.

Indication		• Mainly for children • Never as an initial form of management • Femur shaft fracture • After an initial period of skin traction • Congenital dislocation of the hip, after pelvic osteotomy	
Edge	**Proximal**	• Lowest ribs • Three fingers above the iliac crest	
	Distal	• Three fingers above the malleoli	
Position of joints		• Knee: 15° flexion • Hip: - 30° flexion - 10–15°abduction - 10–15° external rotation • Heel at the same level as the sacrum and chest, horizontally aligned	
Sensitive areas		• Sacrum • Iliac crest • Great trochanter • Head of fibula • Tibial crest • Abdomen	
Set-up & materials *(All quantities are for adults)*		• Patient lying on a spica table	
		• Tubular bandage	Ø 15–20 and Ø 30–40 cm
		• Padding bandage	3 rolls
		• POP	2 rolls of 20 cm, 6–8 rolls of 15 cm
		• Adhesive tape	2.5 cm
		• Hip reinforcements	3
		• Crutches	
Number of people required			

A. Senet/ICRC

Table 4.6: Hip spica casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

Apply a large tubular bandage to the trunk.

Add extra material (here a towel) on the abdomen to provide space for the stomach.

Roll padding bandages around the abdomen.

Apply tubular bandage and roll padding bandages around the limb as described in the general procedure.

Start applying POP bandages, making three figures of eight around the hip, passing 2 cm above the iliac crest, then down to the pubic area.

Reinforce the hip joint at three points, with 20–30 cm wood or plastic sticks placed anteriorly and laterally to the joint.

Apply the proximal part first, with a cosmetic finish on the edges, then continue plastering the leg.

When you have finished applying the spica, check the patient's comfort in a standing position.

Leave enough space at the back for easy passage of stools.

A hip spica can be reduced to above-knee level in secondary intention to allow the knee to move. This is subject to the surgeon's instructions after an X-ray examination confirms that there is visible callus at the fracture site.

5. UPPER-LIMB CASTS

OBJECTIVES
Know the types of casts used for each type of fracture.
Understand when use of a cast is indicated for each type of fracture.
Know the application method for each type of upper-limb cast.

5.1 Scaphoid cast 108

5.2 Short arm cast 111

5.3 Upper-limb cylinder cast 113

5.4 Long arm cast 116

5.5 Shoulder spica 119

5.1 SCAPHOID CAST

Indication		• Fracture of the scaphoid
Edge	**Proximal**	• According to surgeon's instruction: Two fingers below the flexion crease of the elbow or at the deltoid's insertion
	Distal	• Thumb: proximal phalange covered by the cast • Hand: proximal palmar crease/MCP joints
Position of joints		• Thumb: 30° abduction • Wrist: 20–30° extension (functional position)

Sensitive areas	• Styloid process of the ulna and radius	
Set-up & materials *(All quantities are for adults)*	• Patient sitting (or lying if under anaesthesia)	
	• Tubular bandage	Ø 10 cm
	• Padding bandage	1 roll
	• POP	3 rolls of 10 cm
	• Triangular bandage	
Number of people required		

A. Senet/ICRC

Table 5.1: Scaphoid casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

A. Bois d'Enghien/ICRC

To ensure the thenar and hypothenar eminence are well padded, make a hole in the tubular bandage and the undercast material for passage of the thumb. Apply padding around the thumb.

Continue padding up to two fingers' width below the flexion crease of the elbow or until the deltoid's insertion.

Start applying the cast at the fracture site: first the wrist, then the thumb and the hand.

When the fracture site is secured, proceed with the rest of the cast.

Check the grip of the first and second finger.

Do a functional check (the patient should be able to hold a glass of water).

5.2 SHORT ARM CAST

Indication		• Distal radius fracture • Distal ulna fracture	
Edge	**Proximal**	• Two fingers below the cubital fossa • One finger below the olecranon tip	
	Distal	• Proximal palmar crease allowing movement of the fingers • Dorsal MCP line	
Position of joints		• Wrist: flexion, neutral position or extension, based on the surgeon's instructions	
Sensitive areas		• Styloid process of the ulna and radius	
Set-up & materials *(All quantities are for adults)*		• Patient seated (or lying if under anaesthesia)	
		• Tubular bandage	Ø 8 cm
		• Padding bandage	1 roll
		• POP	2 rolls of 10 cm
Number of people required		• Triangular bandage	

A. Senet/ICRC

Table 5.2: Short arm casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 111) for the first steps.

A. Bois d'Enghien/ICRC

To ensure the thenar and hypothenar eminences are well padded, make a hole in the tubular bandage and the undercast material for passage of the thumb.

A. Bois d'Enghien/ICRC

Start applying the cast at the fracture site.

Provide extra reinforcement of the cubital border of the hand using extra POP bandages.

Cast the hand. To limit the space between fingers and thumb, twist the POP rolls over at every turn as shown.

It is better to keep the fingers abducted while applying the cast material to avoid any risk of simultaneous compression of the medial and lateral edges.

Finish the cast and check that the patient can move their fingers.

Check the function of all fingers and various grips.

5.3 UPPER-LIMB CYLINDER CAST

Indication		• Distal fracture of humerus	
Edge	**Proximal**	• Insertion of deltoid	
	Distal	• Two fingers above the styloid process of the ulna and radius	
Position of joints		• Elbow: 90° flexion • Forearm: neutral prono-supination	
Sensitive areas		• Cubital fossa • Olecranon tip • Condyles of the humerus • For humeral fractures, check the radial nerve status	
Set-up & materials *(All quantities are for adults)*		• Patient is seated	
		• Tubular bandage	Ø 10 cm
		• Padding bandage	1 roll
		• POP	2 rolls of 10 cm
Number of people required		• Collar and cuff or triangular bandage	

A. Senet/ICRC

Table 5.2: Short arm casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

P. Ley/ICRC

Place additional padding over the elbow area.

Start applying POP bandages at the fracture site(s).

When applying POP bandages around the elbow, make a figure of eight to strengthen the cast.

During casting, apply bilateral pressure on the distal part of the cast to make an oval shape; this limits prono-supination of the forearm.

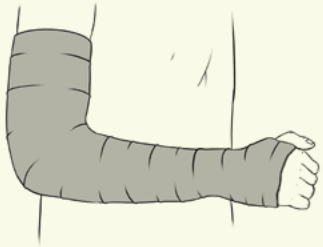
Support the limb with a triangular bandage to balance the cast.

The alignment of the traction force must be checked by X-ray before discharge.

Close monitoring of alignment is required to avoid delayed union and/or non-union.

5.4 LONG ARM CAST

Indication		• Radius fracture • Ulna fracture • Supracondylar humerus fracture
Edge	**Proximal**	• Two fingers below axillary crease and deltoid insertion
	Distal	• Dorsal MCP line • Proximal palmar crease allowing movement of the fingers
Position of joints		• Elbow: 90° flexion • Forearm: neutral prono-supination • Wrist: 20–30° extension (functional position)
Sensitive areas		• Condyles of the humerus • Styloid process of the ulna and radius • Cubital fossa • Olecranon tip
Set-up & materials *(All quantities are for adults)*		• Patient sitting or lying
		• Tubular bandage — Ø 10 cm
		• Padding bandage — 2 rolls
		• POP — 2 rolls of 10 cm, 1 roll of 15 cm
Number of people required		• Triangular bandage



A. Senet/ICRC

Table 5.4: Long arm casts at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.

P. Ley/ICRC

Have an assistant help suspend the arm, maintaining the elbow and hand in the correct position, or place the patient's finger in a finger trap. It is important to monitor the position of the hand consistently throughout the application process.

The assistant should hold the patient's thumb with one hand and the patient's fingers with the other.

Start applying POP bandages at the fracture site.

When applying POP bandages around the elbow, make a figure of eight to strengthen the cast.

Finish by casting the hand, taking special care with the thumb space (first interdigital space) and without compressing the lateral/medial edges of the hand by keeping fingers abducted.

Check the mobility of the MCP joints and the patient's ability to grip before discharge.

Support the limb with a triangular bandage.

5.5 SHOULDER SPICA

Shoulder spica casts are not easy to make. They are heavy and hot to wear, and having to wear one for weeks can be burdensome for both adults and children. Shoulder spica casts also require a lot of care: to prevent damage to the skin, they must be cleaned every day and closely tended to. They do make it possible for patients to get out of bed and do some daily activities (moving about, using the toilet). However, they restrict the patient's mobility and make them dependent on others, especially for dressing and washing.

The ICRC promotes alternative immobilization methods that use lighter materials, such as a combination of Kramer splints and slabs. When considering a spica cast, evaluate the need with a multidisciplinary team and get the advice of an orthopaedic surgeon.

Example of shoulder spica made from Kramer splints, aluminium supports (from trocars of chest drains), padding and bandages.

Indication		• Only in rare cases • All highly unstable fractures of mid and proximal shaft of the humerus
Edge	**Proximal**	• Above and along a line passing from the acromion-clavicular joint of the injured arm to the opposite side, four fingers below the axilla
	Distal	• Upper limb: two fingers above the styloid pro-cess of the radius and ulna • Trunk: homolateral iliac crest
Position of joints		• Shoulder: 30° abduction, 30° anteversion • Elbow: 90° flexion • Forearm: neutral position
Sensitive areas		• Axilla • Olecranon tip • Iliac crest • Ribs, abdomen, rachis, scapular spine and breasts (for women)
Set-up & materials *(All quantities are for adults)*		• Patient is sitting or half-sitting up
		• Tubular bandage — Ø 10 and 90 cm
		• Padding bandage — 3 rolls
		• POP — 1 roll of 20 cm, 6 rolls of 15 cm, 1 roll of 10 cm
		• Adhesive tape — 1 roll, 2.5 cm
Number of people required		• Cast bridge — 1


A. Senet/ICRC

Table 5.5: Shoulder spica at a glance

Method of application

Refer to the general procedure for circular casts (p. 37) for the first steps.


P. Ley/ICRC

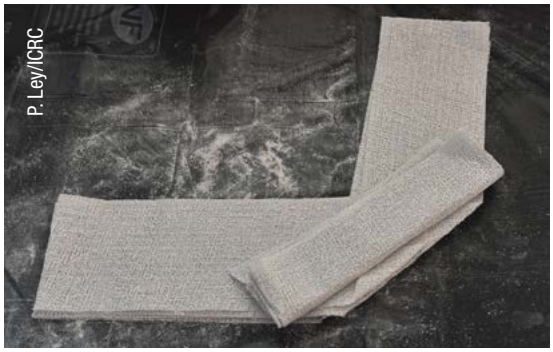
Prepare two pieces of tubular bandage for the trunk and the arm. Join the two together with tape at the torso.

Mark the sternum on the tubular bandage, as shown in black on the picture above.

Before applying a layer of padding, place an extra piece of padding directly on the skin in the axillary area and on the stomach, just below the xiphoid process.

Start casting the trunk with a brace over the shoulder.

When the trunk plaster is complete, adjust the position of the arm. Ensure that the cast rests on the iliac crest on the affected side.



Apply a plaster support under the arm.

Then continue applying the cast from the fracture site to the wrist. After casting the arm, apply a rigid support under the arm as shown below.

Apply the cast bridge or the self made support fixing it to the cast with POP bandages. The support should go from the underside of the middle part of the forearm to the iliac crest.

If you do not have a ready-made cast bridge, you can make one, as shown in the picture.

Throughout casting, an assistant should continuously smooth the surface of the cast to avoid wrinkles.
Give the cast a cosmetic finish.

Check the patient's overall comfort in the cast and possible pressure points along its edges.

Lighter materials can be used to make a shoulder spica so long as the correct position is maintained and the fracture is well aligned and well immobilized.

Make sure there is enough extra room so that the stomach can expand.

6. BANDAGES AND SLINGS

OBJECTIVES
Know when to use temporary immobilization methods for the upper limbs.
Know the main immobilization techniques for the upper limbs using tubular bandages, triangular bandages and other materials.
Know the application procedures of bandages and slings to the upper limbs.
Learn how to advise patients on managing their bandages and slings.
Understand the differences between the types of emergency immobilization splints.

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6.1 GENERAL PRINCIPLES

Bandages and slings are used to stabilize injuries for temporary or permanent (until the fracture is healed) immobilization of fractures, to limit movement and minimize pain in an injured limb. Bandages and slings are needed for all POP casts and slabs on the upper limbs.

Bandages and slings should give the injured limb and/or joint(s):
- a minimum of functional movement
- maximal protection at the fracture/lesion level.

Before applying a bandage or sling, remember the following:
- Bandages and slings should stabilize the joints below and above the injury.
- An upper-limb bandage should cover the hand but leave the fingers free so that discoloration can be detected.
- Bandages and slings should not be applied directly to a wound. Wounds should be dressed and covered before a bandage is applied.

6.1.1 MAIN MATERIALS AND EQUIPMENT


J. Senet/ICRC

Triangular bandage


L. Bernhard/ICRC

Tubular bandages: 8 and 10 cm


L. Bernhard/ICRC

Bandage padding: 10 and 15 cm


J. Senet/ICRC

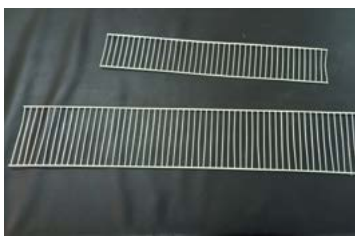
Elastic bandages: 10 and 15 cm


L. Bernhard/ICRC

Scissors


J. Senet/ICRC

Cardboard


C. Lotto/ICRC

Kramer splints: 8, 10, 12 and 15 cm


J. Senet/ICRC

Adhesive tape: 2.5 cm

6.1.2 CARE AND COMPLICATIONS

Bandages and slings should always be kept clean and dry.
Patients should be advised to place a plastic bag over the bandage when it rains.

Check a least twice daily for:

- finger swelling or discolouration
- increased pain
- slippage or change in position
- signs of discomfort
- dampness or soiling of the bandage or sling.

Advise the patient to come in for a consultation immediately if they notice any of the above signs.

6.2 TRIANGULAR BANDAGE: BROAD-ARM SLING

Indications

- First intention (first aid) for arm injuries and lacerations: to support the limb and/or splint and elevate it to prevent distal swelling.
- To support an arm in a cast and elevate to prevent distal swelling.

Method of application

Prepare a triangular bandage.

Ask the patient to sit and support their forearm. If the patient is sedated, an assistant should support the forearm. Slide the bandage under the axilla with one end over the shoulder and neck.

Secure the end of the bandage behind the elbow with a safety pin or a knot.

Fold the bandage around the arm and tie a knot with the opposite corner on the posterior-lateral side of the neck.

6.3 TRIANGULAR BANDAGE: HIGH SLING IMMOBILIZATION

Indications

- Anytime the hand should be kept above the elbow to reduce swelling:
  - First intention (first aid): high elevation for severely swollen extremities, active bleeding
  - Temporary high elevation, i.e. patient requires strict elevation of the forearm for a short period
  - Infections in hand or arm wounds that are at risk of further bleeding (to prevent haematoma).

Method of application

Position the patient's arm in flexion with the hand to the opposite shoulder (as shown here).

Place the sling across the patient's chest: one end under the axilla, one end on the stomach and one end over the shoulder.

Fold the sling around the arm and hand (as shown here).

Knot the axilla and shoulder ends together above the shoulder.

The patient's hand remains on the chest, near the opposite shoulder.

Fold the edge over the elbow. Secure the folded edge with a safety pin or a knot.

Posterior view

6.4 COLLAR AND CUFF SLING

Indications

- Fractures of the humerus that include head and proximal epiphysis, to allow gravity to align the fracture using the weight of the arm
- Longer-term/more comfortable immobilization than the triangular bandage broad-arm sling
- Supracondylar fractures in children (Blount immobilization).

Method of application

Cut and prepare the collar, string and cuff. Connect the cuff to the collar with the string.

The edges of the collar and cuff should be smooth and comfortable.

The cuff should cover one-third of the surface area of the forearm to avoid pressure.

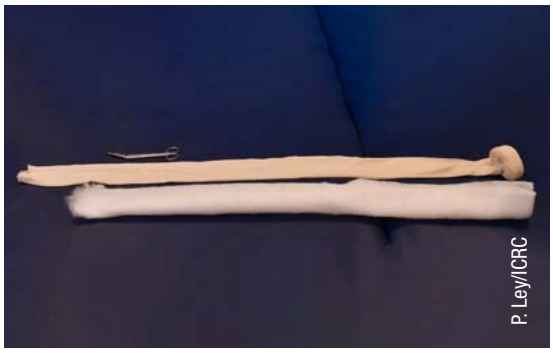
Fashion the collar to fit the patient's neck, leaving enough room to allow extension.

Note: Keep the elbow in the degree of flexion specified by the surgeon.

6.5 COLLAR AND CUFF: VARIATIONS WITH TUBULAR BANDAGE

This type of sling should be tied higher or lower depending on the level of the fracture and the surgeon's instructions.

Method of application



Use a tubular bandage to measure the patient's arm with the elbow held at the angle specified by the surgeon.

Make a roll of additional padding and insert it into the tubular bandage.

Stretch the tubular bandage until the padding is uniform.

Adjust the padded tubular bandage to obtain the correct angle of elbow flexion according to the surgeon's instructions and tie the bandage with a knot.

Fasten the two portions of the padded bandage together with a piece of tubular bandage.

If flexion of the elbow is required, the tubular bandage can be tied around the wrist and then directly around the neck.

Check that the knot does not slide.

Check that the patient is comfortable.

6.6 FIGURE-OF-EIGHT SLING

Indication

- Clavicular fracture

Figure-of-eight slings are being used less and less, because patients find them painful to wear. They are also ineffective in keeping clavicular fractures fully immobilized and in alignment.

Method of application

Measure the circumference of the axilla bilaterally using the tubular bandage.

Insert padding into the tubular bandages.

Make two rings by tying the end of the tubular bandage back on itself.

Insert the patient's arms in the rings and ask them to place their hands on their head.

Tie the rings together at the patient's back using a piece of tubular bandage or gauze.

The distance between the two rings should be determined based on potential compression symptoms, as well as the inevitable stretching of the tubular bandage material.

Let the patient's arms hang free.

Pad the knots on the patient's back and at pressure points to increase comfort.

6.7 TUBULAR BANDAGE: SHOULDER IMMOBILIZATION (MAYO OR GILCHRIST BANDAGE)

Indication

- Fractures of the proximal humerus and shoulder girdle

Method of application

Measure out a piece of tubular bandage four times the length of the patient's arm.

Cut a hole in the middle of the bandage piece you have measured out.

Insert the injured arm in the hole.

Fold a piece of additional padding and insert it into the tubular bandage to prevent excessive pressure behind the neck.

Bring the tubular bandage behind the patient's neck down to their wrist.

Cut the end of the tubular bandage and tie it around the wrist, with additional padding.

Cut a hole in the tubular bandage at the wrist level to free the hand and allow movement of the fingers and wrist.

Bring the distal end of the tubular bandage behind the torso and around the body. This end should pass between the torso and the affected arm.

Wrap the same end around the injured upper arm and attach it around the arm just above the elbow. Place additional padding in the tubular bandage.

Posterior view

Lateral view

6.8 EMERGENCY IMMOBILIZATION SPLINTS

Indication

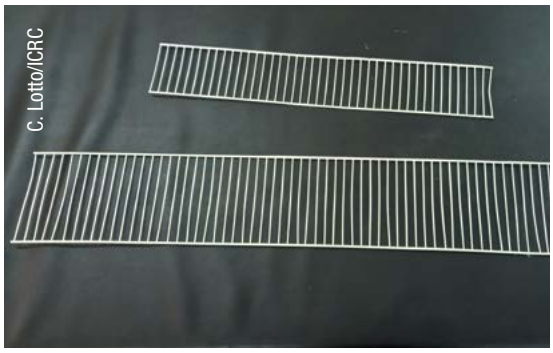
- Emergency situations, mainly as short-term immobilization during transportation
- Arm, forearm, wrist and hand injuries; ankle, foot and lower-leg injuries.

Emergency immobilization splints can either be pre-made or custom-made and cut to fit specific body parts of different sizes. Some are improvised for a unique injury and made from soft materials like pillows, blankets, crepe bandages and slings. Others are more rigid and made from materials such as stiff cardboard, padding or plaster and applied in hospitals.

6.8.1 KRAMER SPLINT

Kramer splints are made of epoxy-coated steel and can be moulded by hand. They can be adjusted to fit the body part to be immobilized. Kramer splints exist in different widths and lengths for upper- and lower-limb fractures and for different sizes of limbs.

Method of application



Cover the Kramer splint with cotton padding.

Wrap the splint with elastic bandage to keep the cotton firmly in place on the Kramer wire.

Adjust and fold the splint to fit the fractured limb.

Apply the splint to the limb using elastic bandages.

6.8.2 CARDBOARD SPLINT

Cardboard splints can be pre-fabricated or, if not available, self-made (see procedure below) and can be used for upper and lower limb temporary immobilization.

Method of application

Draw the shape you need on a piece of cardboard and cut it to fit the location of the injury. Mark and cut out spaces for the elbow and deltoid.

Cardboard splints are often placed too low. Make sure that the cardboard is wide enough to ensure good contention at the top.

Apply a tubular bandage from the wrist to the shoulder and add additional padding, such as a small towel, between the cardboard and the injured limb. Padding provides better comfort and more contact around the injury so that there is less room for movement within the splint.

Place the cardboard over the arm and secure it with tape.

Fold back the two ends of the tubular bandage over the cardboard.

Secure the cardboard splint around the limb using tape or bandages.

Support the limb and place the elbow at the required angle of flexion using a sling.

7. TRACTION

OBJECTIVES
Know the principles of traction and when it is used, depending on the fracture (or dislocation) site.
Understand the principles of skeletal and skin traction: application, advantages and disadvantages.
Understand follow-up procedures and possible complications from traction.
Know how to set up, adapt and remove traction on limbs.
Be able to set up skeletal traction for different fracture sites, including weight prescriptions (after setting the pin).

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7.1 GENERAL PRINCIPLES

7.1.1 PURPOSE

Traction is usually applied to treat fractures and/or dislocations in the limbs. In ICRC hospital programmes, it is used to treat both open and closed fractures. Traction has been used to treat fractures for a very long time. Skin traction by means of a Thomas splint was standard care for femur fractures during World War I. And during World War II, skeletal traction proved to be a safe, simple method for mass treatment of the same type of fracture.

Traction is the application of a pulling force to treat muscle or skeletal disorders, i.e. to reduce a fracture, stabilize and maintain bone alignment, relieve pain or prevent spinal injury.

Traction is usually applied to the arms, legs, spine or pelvis to treat fractures, dislocations and long-duration muscle spasms and to prevent or correct deformities.

Even as trauma care and fracture management have modernized, traction remains one of the most widely used treatments in places where the ICRC works.

The basis for traction as a treatment lies in the concept of ligamentotaxis. Imagine the limb as a cylinder of soft tissues that are stretched by the traction force: when a pulling force (weight) is applied, the bone fragments are pulled into place until callus has formed and is "sticky" enough to maintain length.

Traction may be used for:
1. reduction
2. temporary stabilization
3. full treatment.

A. Senet/ICRC

Traction serves several purposes:
- It maintains fracture reduction.
- It decreases muscle spasms and pain.
- It allows time to manage soft-tissue problems.

Two main types of traction are commonly used:
- **Skeletal traction** is applied directly on the bone by means of a pin inserted at the end of the bone.
- **Skin traction** is applied on the skin by means of adhesive tape and bandages.

The elongating force opposes the tone in the muscles surrounding the fracture site, thus slowly pulling the bone fragments into alignment as the muscle tone is reduced. The elongating force is applied either via a physical force (weight in the case of physiological or functional traction), adhesive tape (skin traction) or a pin (skeletal traction).


C. Lotto/ICRC

7.1.2 PRECAUTIONS

- People with possible bone infection issues (osteomyelitis) should be carefully evaluated before skeletal traction is applied, since the pins may trigger additional infection or inflammation.
- People with skin disorders (allergies) should not undergo skin traction.
- Circulatory disorders and varicose veins can also be aggravated by skin traction.

7.1.3 SKELETAL TRACTION

Traditionally, the names of skeletal traction types refer to the site of the pin and not the fractured bone. Skeletal traction can be applied for various types of fractures:

- Olecranon traction is for fractures of the humerus.
- Distal femur traction is for fractures of the pelvis and hip.
- Proximal tibial traction is for fractures of the femur (most common application).
- Calcaneal traction is for fractures of the tibia.
- Skull traction is for fractures of the neck vertebrae (not covered in this manual).
- Proximal femur traction is for proximal fractures of the femur and fractures of the hip and pelvis (very rarely used).

Skeletal traction requires an invasive procedure in which pins, screws or wires are surgically implanted into the bone for use in long-term traction that requires heavy weights. It is applied when the required force is more than what skin traction can bear, or when skin traction is not appropriate given the type of fracture or the patient's age. The weights used in skeletal traction generally range within approximately 10 per cent of the patient's bodyweight for lower limbs and much less for upper limbs, depending on the fracture type and the muscle mass of the patient.

It is important to place the pins correctly, because they may have to stay in place for several months and are the hardware to which the weights and pulleys are attached. The pins must be clean to avoid infection. Damage may occur if the alignment and weights are not carefully calibrated.

There are different kinds of pins (e.g Kirschner wire, Steinmann pin) and traction bows (e.g Kirschner, Bohler) for skeletal traction They can vary depending on the fracture location and the size or age of the patient.

7.1.4 SKIN TRACTION

Skin traction is indicated for fractures of the femur in infants, children and frail older people who require only a small amount of traction.

Skin traction is used when the weight required to maintain reduction does not exceed 4 kg. The weight is applied using tapes and straps. The skin must be checked regularly.

Application of skin traction requires adhesive strapping after the skin has been properly degreased with tincture of benzoin or ether. It can be used for both initial and definitive immobilization.

7.1.5 RISKS AND COMPLICATIONS

The main risks associated with skin traction are:

- epidermolysis triggered by the tapes creating lesions on the skin
- compression caused by a bandage applied with too much force, triggering obstruction of venous return that can result in distal oedema.

To avoid complications, ensure the following:

- Make patient comfort a priority when applying the grip or hold.
- The grip or hold on the patient's body must be sufficient and secure.
- Provide for counter-traction (you can use the patient's own bodyweight and/or tilt of the bed).
- Make sure there is minimal friction on the cords and pulleys.
- The line and extent of the pull, once established, must be maintained.
- Avoid cord friction or the applied weight touching the ground.
- Check the traction set-up and continue checking to ensure it functions correctly.
- Monitor the traction treatment and apparatus to ensure they do not cause further injury (i.e. skin conditions or infections).

Both types of traction can lead to complications associated with long periods of immobility. These include bed sores, reduced respiratory function, urinary problems, muscle weakness/atrophy and circulatory issues.

7.1.6 MAIN MATERIALS AND EQUIPMENT

ICRC

Traction frame

ICRC

Stabilizer

ICRC

Hook

ICRC

Monkey chain

ICRC

Sandbag

P. Ley/ICRC

Pulley and rope

ICRC

Traction set

ICRC

Pin cutter

ICRC

Universal handle (pin removal)

P. Ley/ICRC

Skin traction set (adult and child size)

A. Bois d'Enghien/ICRC

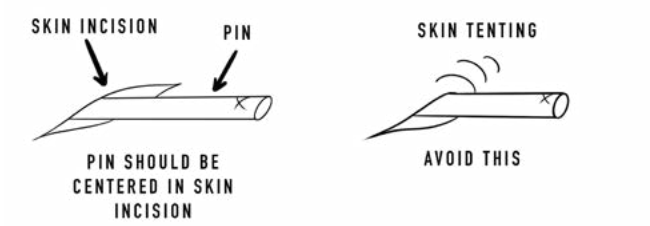
Bed block

7.2 PREPARATION AND MANAGEMENT

7.2.1 GENERAL APPLICATION PROCEDURE (SKELETAL TRACTION)

1. A traction pin with a stirrup is installed in the operating theatre.

- The pin is inserted through an incision in the skin, advanced through soft tissues and the bone, then exits through another incision.
- If properly applied, the skin should not be tented.



2. Prepare a bed, mattress and bedframe appropriate for the type of traction to be applied.
   - With the help of a nurse, place the bed so it is accessible from both sides.
   - The bed should be on wheels so it can be transported to the X-ray machine if no portable X-ray is available.

3. While the patient is still under anaesthesia, position them in the bed with the help of an assistant or nurse.
   - The rope should be coaxial with the injured bone.
   - The weight should hang freely.
   - Constant monitoring of the rope and weight is required.
   - **For lower-limb traction:**

- The patella should be pointed at the ceiling.
- The external rotation of the foot should be approximately 10–15° (otherwise compared to the contralateral foot).
- Monitor the length of the limb segments using bony landmarks:
  - thigh: from the ASIS to the upper pole of the patella
  - leg: from the lower pole of the patella to the tip of the medial malleolus
- Measure the circumference of the thigh, marking the skin approximately 12 cm proximal to the upper pole of the patella, to monitor atrophy of the quadriceps.

- **For upper-limb traction:**
- The elbow should be at 90° flexion.
- The forearm should be in neutral prono-supination.
- The wrist should be supported in a functional position when not actively mobilized.

4. Set the traction according to the surgeon's instructions.

5. Once the traction frame has been installed, make sure the main pressure points are protected with padding and/or positioning cushions.

6. Elevate the foot end of the bed with bed blocks, if necessary, to provide counter-traction.

The initial X-ray should not be done until 48 hours after the traction has been applied, so that the whole system has time to get into balance.


P. Ley/ICRC

Never remove the traction until instructed to do so by the surgeon. Not even for:
- exercises
- manipulation of the limb
- transfer
- activities of daily living.

7.2.2 GENERAL APPLICATION PROCEDURE (SKIN TRACTION)

Skin traction should be applied while the patient is under sedation or, if the patient is a child, under mild anaesthesia.

Treatment with traction requires skillful application of the device and careful attention to detail with constant monitoring throughout the treatment period to avoid skin problems or vascular complications.

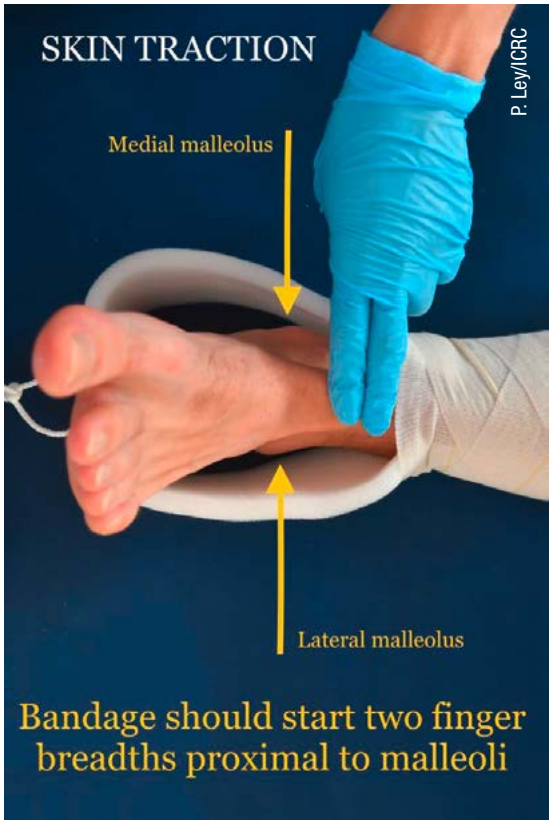
1. Prepare a bed, mattress and bedframe appropriate for the type of traction to be applied.
   - With the help of a nurse, place the bed so it is accessible from both sides.
   - The bed should be on wheels so it can be transported to the X-ray machine if no portable X-ray is available.
2. Examine the skin for suitability. The limb should be shaved if the person has a lot of hair, then washed with mild soap and water, then dried.
3. Skin traction may be applied on a traction frame, flat on the bed or using gallows traction (90/90 traction).
4. Remove the plastic film from the sticky side of the traction tape and apply it to the lower leg from the level of the knee to the supramalleolar region.


C. Lotto/ICRC

5. Apply the tape along the length of the fractured bone while stretching it to avoid wrinkles which can cause blisters.


P. Ley/ICRC

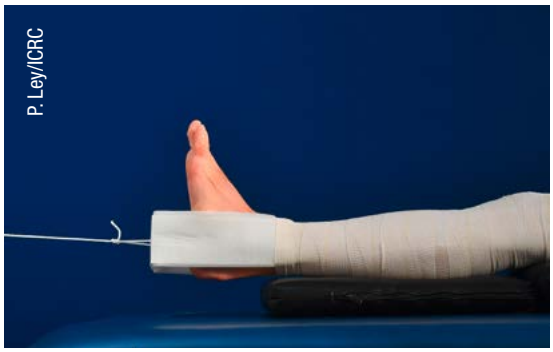
6. Secure the tape with an elastic bandage, reducing tension on the bandage from just above the malleoli to the top of the strip.



7. The spreader should be placed 4 cm from the foot (the ankle must be in neutral position) and lie transversely, i.e., parallel to the sole of the foot.

8. Perform regular neurovascular observations and check for loosening of the bandage.

9. While the patient is still under sedation or anaesthesia, position them in the bed with the help of an assistant or nurse.
   - The rope should be coaxial with the injured bone.
   - The weight should hang freely.
   - Constant monitoring of the rope and weight is required.



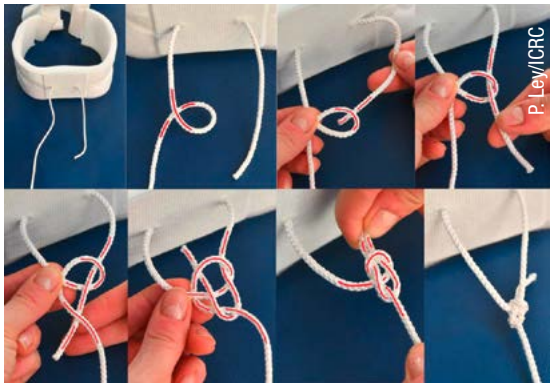
The initial X-ray should not be done until 48 hours after the traction has been applied, so that the whole system has time to get into balance. Perform regular neurovascular observations and check for loosening of the bandage.

Never remove the traction until instructed to do so by the surgeon. Not even for:
- exercises
- manipulation of the limb
- transfer
- activities of the daily living.

7.2.3 WEIGHT AND DIRECTION OF TRACTION

- Skeletal traction should never exceed 10 per cent of the patient's bodyweight, or 7 per cent (1/15) bodyweight for bilateral fractures.
  - The physiotherapist should take weight fluctuation into consideration when there is a bone loss.
- Weight can be reduced after a few days (under X-ray control) as the patient's muscle tone decreases.
- Weight applied for skin traction should be less than or equal to 4 kg for adults. For children under three, only the child's own bodyweight should be used. Make sure the alignment follows medical guidelines.
- The rope should run smoothly on the pulleys and the weight should hang freely. A daily check is strongly advised.
- There should be an X-ray check-up 72 hours after applying traction, following an increase/decrease in the traction weight.
- Early mobilization is essential.

Note on the traction rope knot:
Use a bowline knot for correct and easy application/removal of the pulley and weight.



7.2.4 AFTERCARE

- The bandage supporting the limb should be checked daily and kept clean and dry.
- Encourage the patient to do breathing exercises and range of motion exercises with unaffected parts of the body to avoid bed rest complications. They should also be taught how to use a trapeze (overhead support bar) to shift on and off of a bedpan, since they will not be able to get up to use the toilet.
- Aftercare for skin traction involves keeping the limb aligned and caring for the skin so that it does not become sore and irritated. The patient should also be alert to any swelling or tingling in the limb, which would suggest that it has been wrapped too tightly.
- Aftercare for skeletal traction is more complex. The patient is likely to be immobile for an extended period. The pin sites should be inspected every day and cleaned regularly to avoid infection.

7.2.5 PIN CARE

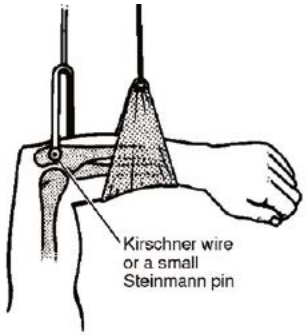
- When pins have been inserted, special care must be taken to clean and dress the pin sites so that infection does not enter the bone.
- Following normal dressing procedures, clean the pin and surrounding skin with a normal saline solution.
- Remove any exudate (pus) and apply Betadine gauze dressing around the pins as per ICRC disinfection procedure. The dressing enables the exudate to drain rather than collect around the pin, which can lead to infection. Large amounts of exudate and obvious instability of the pins are signs of infection. They must be reported to the nurse in charge and/or the surgeon.

7.3 SKELETAL TRACTION

7.3.1 OLECRANON TRACTION

Indication	• Supracondylar fracture of the humerus and displaced intra-condylar fracture of the humerus
Position of pin	• Inserted through the olecranon
Set-up	• Patient lying supine, shoulder at 90°, elbow at 90° • Forearm is supported on a sling
Traction direction	• Suspension is set up on an overhead beam

Table 7.1: Olecranon traction at a glance



Weight : < 5 kg

Method of application

Place a suspension frame over the head of the bed.

Mount the pulley system on the frame.

Set the arm with the shoulder joint and the elbow joint at 90° flexion.

Support the forearm and wrist with a sling.

Apply the prescribed weight.

If necessary, complete the reduction with the surgeon while the patient is still under anaesthesia.

Apply the weights and the rope as described in the general application procedure for skeletal traction (p. 151).

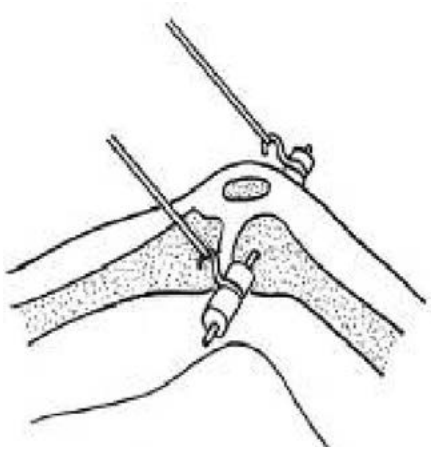
P. Ley/ICRC


P. Ley/ICRC

7.3.2 FEMORAL TRACTION

Indication	• Proximal fracture of the femur and fracture of the hip and pelvis • Not commonly used
Position of pin	• Inserted through the distal end of the femur
Set-up	• Patient lying supine, with the knee in 45° flexion on a traction frame
Traction direction	• Line of pull is parallel to the fracture site

Table 7.2: Femoral traction at a glance



Weight: up to 10 per cent of bodyweight

Method of application
Choose a traction frame (e.g. Bohler Braun type) that fits the patient's leg, or adjust the frame as necessary.

Dress the traction frame by applying bandages in a figure of eight (See picture on page 160). Remember to add padding to the proximal end of the frame to prevent pressure at the gluteal fold.

Measure the length of the patient's thigh and adjust the frame accordingly. It is important that the part of the frame supporting the thigh is the correct size.

Make sure that the leg is well positioned on the frame and that the fracture is properly aligned. To correct a possible angulation, apply extra padding or adjust using a small positioning cushion.

Elevate the foot end of the bed with bed blocks, to provide counter-traction.

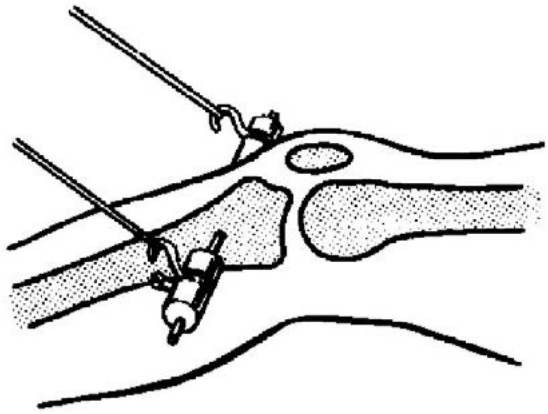
Apply the weights and the rope as described in the general application procedure for skeletal traction (p. 151).

Note: The pin is inserted through the tissue, tearing the fascia and muscles and causing the patient considerable pain. It often breaks the skin at the pin site during mobilization of the knee and quadriceps training. Should be used only in selected cases.

7.3.3 TIBIAL TRACTION WITH A TRACTION FRAME

Indication	• Mid-shaft femoral fracture and stable fracture of the lower third of the femur
Position of pin	• Inserted 2 cm below the tibial tuberosity
Set-up	• Patient lying supine, with the knee in 45° flexion on a traction frame
Traction direction	• Line of pull is parallel to the femur

Table 7.3: Tibial traction using traction frame, at a glance



Weight: up to 10 per cent of bodyweight

Method of application

Choose a traction frame (e.g. Bohler Braun type) that fits the patient's leg, or adjust the frame as necessary.

Dress the traction frame by applying bandages in a figure of eight (see picture below). Remember to add padding to the proximal end of the frame to prevent pressure at the gluteal fold.

Measure the length of the patient's thigh and adjust the frame accordingly. It is important that the part of the frame supporting the thigh is the correct size.

A traction stabilizer (see picture) must be available to place between the mattress and the frame.

Adjust the traction according to the location of the fracture:

- For **mid-shaft** and **proximal fractures**, keep the leg in 45° flexion and abduct the leg by 10° to keep the whole limb in a neutral position.
- Lower the plane of pull and increase the flexion of the knee to relax the action of the gastrocnemius at the insertion point. This will allow for reduction of the distal fragment.

Make sure that the leg is well positioned on the frame and that the fracture is properly aligned.

To correct a possible angulation, apply extra padding or adjust using a small positioning cushion.

Make sure the main pressure points (heel, inguinal areas) are protected with padding and/or positioning cushions.

Elevate the foot end of the bed with bed blocks, to provide counter-traction.

Apply the weights and rope as described in the general application procedure for skeletal traction (p. 151).

7.3.4 PERKINS TRACTION

Indication	• Closed and open femur fractures • Particularly well suited for open comminuted fractures
Position of pin	• Between the tibial tubercle proximally, and a point 3–4 cm distally in the tibia • Inserted at a 90° angle to the tibial shaft
Set-up	• Patient lying supine in a Perkins traction bed • Patient sitting, with full knee flexion allowed
Traction direction	• Line of pull is parallel to the femur • Allows micromovement at the fracture site that promotes callus formation

Table 7.4: Perkins traction at a glance

Make sure the patient's bed fits the requirements for Perkins traction: the distal third or half of the bed should be removed or broken down at a 90° angle to allow complete flexion of the patient's knee while in traction.

Weight: 7–10 per cent of bodyweight

Perkins traction is easy to set up and it does not require additional material. It only needs a modified hospital bed additionally to the rope, pulley and weight.

Hospital bed modification: the distal third or half of the bed should be removed or broken down at a 90° angle to allow complete flexion of the patient's knee while in traction.

Method of application

Install the patient in the adapted bed with the appropriate traction weight for their bodyweight. The device holding the pulley over which the traction cord is passed must fit the diameter of the cord.

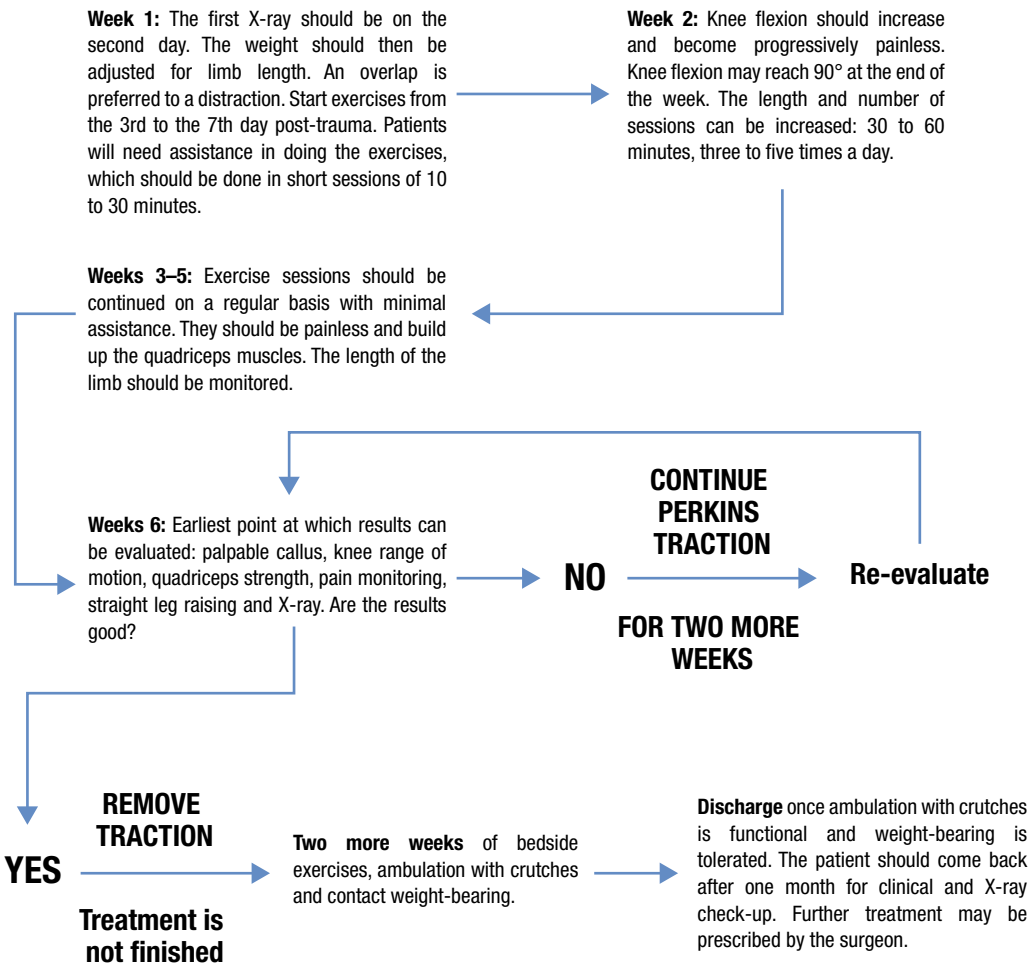
Make sure that the cord clears the patient's toes.

Elevate the foot end of the bed with bed blocks.

After 48 hours, the patient should have an X-ray exam in situ with traction. You can then adjust the traction weight according to the results of the X-ray. If it is not possible to get an X-ray, you can simply measure the length of the patient's thigh using a tape measure and compare it with the contralateral side, then reduce the traction weight accordingly.

Exercises must be started as soon as possible, generally between the third and seventh day post-trauma.

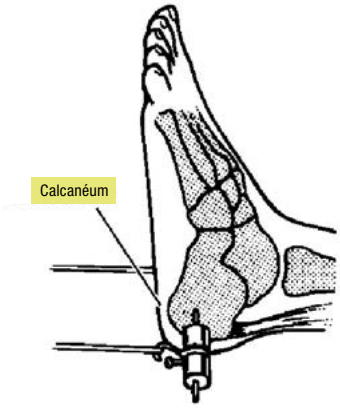
Standard Perkins traction flowchart



7.3.5 CALCANEAL TRACTION

Indication	• Fracture of the tibia at mid-shaft to lower distal third
Position of pin	• Inserted 2 cm through the calcaneus
Set-up	• Patient lying supine with knee in 45° flexion on a traction frame
Traction direction	• Line of pull parallel to the tibia

Table 7.5: Calcaneal traction at a glance



Weight : < 2 kg

Method of application
Choose a traction frame (e.g. Bohler Braun type) that fits the patient's leg, or adjust the frame as necessary.

Dress the traction frame by applying bandages in a figure of eight (see picture below). Remember to add padding to the proximal end of the frame to prevent pressure at the gluteal fold.

The direction of pull is parallel to the tibia.

The ankle should be kept at a 90° angle.

Support the foot at the distal end using a tubular bandage with additional padding, or a cushion if there is foot drop.

Make sure that the fracture is properly aligned. Elevate the foot end of the bed with bed blocks, if necessary, to provide counter-traction

Relieve pressure on the heel using a ring, or loosen the distal bandage.

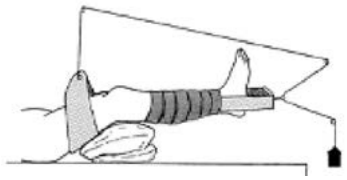
Apply the weights and rope as described in the general application procedure for skeletal traction (p. 151).

7.4 SKIN TRACTION

7.4.1 LOWER-LIMB SKIN TRACTION

Indication	• All limb fractures for which force of < 4 kg is enough to maintain reduction • As temporary immobilization, either in first intention (before application of another type of immobilization) or in second intention if pin site is infected
Traction direction	• Line of pull is always parallel to the fractured bone
Set-up	• Patient lying supine

Table 7.6: Lower-limb skin traction at a glance



Weight: < 4 kg

Method of application

Skin traction can be applied with the injured limb either directly on the bed (longitudinal) or on a traction frame. For children between the ages of two and 12, skin traction is applied without a traction frame: the knee is kept in extension to avoid inhibiting growth plate development.

A. Bois d'Enghien/ICRC

The limb should be slightly elevated to prevent oedema.

Follow the steps in the general application procedure for skin traction (p. 153).

Elevate the foot end of the bed with bed blocks, if necessary, to provide counter-traction.

Apply the weights and rope as described in the general application procedure for skin traction (p. 153). Apply the weight according to the surgeon's instruction considering the age and weight of the person.

Provide slight support for the foot in case of foot drop while ensuring that the support does not undermine the traction force.

Check the neurovascular status of the distal parts.

7.4.2 GALLOWS TRACTION

Indication	• Fracture of the femur in children • Patients with less than 15 kg bodyweight
Set-up	• Patient lying supine • Sacrum suspended 3–4 cm above the mattress • Both legs in traction to avoid kicking • Malleoli are free to move
Traction direction	• Line of pull is parallel to the fractured bone

Table 7.7: Gallows traction at a glance

Weight: < 4 kg

Method of application

- Position the patient supine on a bed. Both legs are suspended at 90° to avoid kicking.
- Start with the uninjured side as this causes less pain.
- Apply the long adhesive bandages from ankle to hip to distribute the skin tension forces over a large area to prevent blisters and skin necrosis (as described in the general procedure for skin traction (p. 153).

The rope can be attached to the suspension frame (see picture), or a pully and weights can be used for the same purpose (see picture).

The buttocks must be slightly raised off the bed sheets.

Gallows traction requires close monitoring to ensure that the sacrum stays suspended above the mattress. If a compress or a diaper is used to cover the child's buttocks, it should not touch the mattress.

The malleoli should be protected with foam.

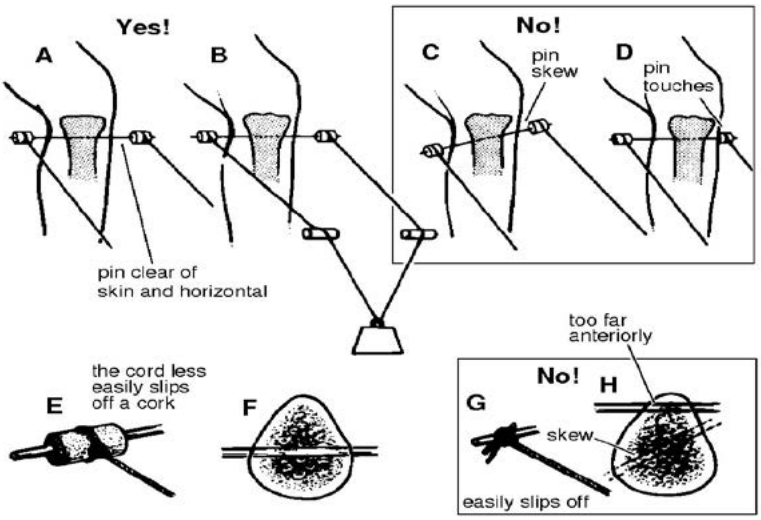
The mother can lie on the bed with the child to breastfeed.

7.5 SUPERVISION AND FOLLOW-UP

7.5.1 CHECKING THE PIN, ALIGNMENT AND PULLEY SYSTEM

- Check by X-ray after 24h of traction installation that the bone fragments are correctly aligned.
- Assess the suitability of the set-up by eye. The anatomical boundaries are good references, as are simple tests such comparing the lengths of the legs. Make sure the leg is aligned with the traction.
- Check that the rope or stirrup is firmly fixed on the pin and that the pin is clear of skin (see illustration below).
- Check that the pulley is running freely on the traction frame and that the rope is in the groove of the pulley.
- Make sure the weight is not resting on the bed or on the floor.

TIBIAL TRACTION – RIGHT AND WRONG



7.5.2 CHANGING THE PLANE AND REDUCING WEIGHT

- The plane changes when the knee is flexed. Keep the angle of the plane low to reduce tension in the gastrocnemius muscle.
- The distal fragment should be pushed upwards.
- Place a pad at the fracture site to maintain position.
- Correction is achieved by changing the plane.
- Reduce the weight when callus is visible on the X-ray.

7.6 REMOVAL

When the fracture site is clinically stiff, or when good callus is visible on the X-ray, weight is reduced by 1 kg per week.

Removal of traction is determined by clinical consolidation (followed by one week of bed rest). Exercises in bed continue during this period.

Skin traction may be removed earlier if there is skin intolerance or break-down.

7.6.1 SKELETAL TRACTION (USUALLY DONE BY A SURGEON)

1. Remove the weight by detaching the rope from the stirrup.
2. Using a screwdriver or pliers, release the screw from the pin and remove the stirrup.


C. Lotto/ICRC

3. Ensure the whole area has been washed.
4. Clean the pin and pin site with soap and water.


C. Lotto/ICRC

5. Apply Betadine to the entire area.
6. Cut the pin with a pin cutter.

7. Wash the skin a second time.
8. Attach a universal handle to the lateral side of the pin.
9. Stabilize the limb, with an assistant's help if necessary, and pull the pin while rotating back and forth to break potential adherences from the entry point while turning the universal handle.
10. Clean the pin sites again after the pin has been removed.
11. Apply separate dressings to both sites, following all aseptic protocols.

7.6.2 SKIN TRACTION

1. Release the weight from the traction system.
2. Remove the adhesive tape very carefully from the skin (as shown in the picture above).
3. Inspect the skin for blisters.
4. If indicated, apply a suitable splint and/or cast.
5. Start joint mobilization exercises during bed rest.

8. PHYSIOTHERAPY AND BONE IMMOBILIZATION

OBJECTIVES
Know the general principles of physiotherapy for people treated with slabs and casts.
Learn the aims of physical rehabilitation during and after bone immobilization.
Understand the necessity of always pairing immobilization with rehabilitation.
Recognize the importance of involving everyone in physiotherapy: a multidisciplinary team, patients and their families.
Recall the steps of the rehabilitation process.

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8.1 GENERAL PRINCIPLES

Physiotherapy exercises aim to improve range of motion in the joints and strengthen muscles. An exercise programme should get underway as soon as possible, taking into account the patient's pain level and need for pain relief. The emphasis should be on the joints above and below the fracture area. For upper-limb fractures, mobility exercises should include all free joints and the shoulder. For lower-limb fractures, exercises help to ensure that the bones can tolerate weight-bearing. When designing a rehabilitation plan, the treatment goals and the type of cast or traction applied should also be kept in mind.

8.1.1 COMMUNICATION

Patients should be kept informed of their diagnoses, timelines for treatment and expected outcomes. The rehabilitation plan should be patient-centred and evidence-based. It must be explained to patients, and patients must give their consent before beginning. If the patient is not willing and motivated, the treatment will not succeed.

J. A. Serrano Redondo/ICRC

8.1.2 ASSESSMENT

During the acute phase, a rehabilitation assessment is usually carried out at the patient's bedside and involves identifying the specific details of the immobilization method used and the patient's tolerance for pain. This assessment should be comprehensive and describe the patient's functional abilities, the range of motion in the joints of their free limbs, their pain level in motion and at rest, and their level of autonomy in day-to-day activities. The assessment results and follow-up interventions must be recorded and added to the patient's file. The assessment should always include a pain assessment. The rehabilitation plan should then be designed to meet the patient's goals and adapted based on their progress.

8.2 AIMS OF PHYSIOTHERAPY

Before formation of callus:
- maintain proper bone alignment
- ensure comfort and appropriate position to prevent pressure sores
- ensure stability of the immobilization system
- maintain cardiovascular functions during bed rest and limb immobilization
- stimulate callus formation with static contractions (before weight-bearing)
- maintain range of motion in the joints
- maintain muscle tone of agonist and antagonist muscles.

After formation of callus, restore:
- joint mobility
- muscle strength
- stability, proprioception/dexterity and good balance
- optimal functional status
- gait (based on progress towards weight-bearing).

8.3 PREVENTION OF PRESSURE SORES

Pressure sores, also known as bedsores, are caused by prolonged immobility coupled with shearing forces between bone and the overlying skin and subcutaneous fat, exacerbated by loss of body mass. They are a very common complication and can develop quickly. But with regular monitoring, proper mobilization and consistent physical therapy, they are easy to prevent. The patient must be monitored for pressure sores and kept mobile while bedridden, and the alignment of the immobilized limb must be maintained.

All rehabilitation professionals working in multidisciplinary teams must:
- regularly assess the skin in at-risk areas.
- make sure the patient and environment are clean.
- make sure the patient receives proper nutrition.
- use correct technique and apply padding over bony pressure points (heel, malleoli, head of the fibula and olecranon) to prevent the formation of sores. Excessive padding does not compensate for poor technique, however: it results in an ill-fitting cast that allows for undue movement.
- administer massage with oil or powder.
- attach an overhead ring, bar or sling to the foot of the bed to help patients lift themselves off the mattress. This makes it easier to use a bedpan and relieves pressure.
- promote constant movement.

8.4 PREVENTION OF RESPIRATORY PROBLEMS

Chest therapy is recommended during the acute phase starting the first day post-surgery, in addition to passive and active movements. It is important to talk to the patient to find the position in which they can breathe best. Respiratory therapy should include as much active movement as possible. Spirometry, breathing exercises and segmental breathing prevent atrophy of the respiratory muscles, secretion, etc.

8.5 PREVENTION OF CARDIOVASCULAR COMPLICATIONS

Passive, assisted or active exercises are essential to prevent deep vein thrombosis in the limb(s) not undergoing fracture treatment. The rehabilitation plan should aim to maintain range of motion, muscle strength and blood flow in the unaffected joints. Increasing range of motion in the affected limb will decrease stiffness and support healing through increased blood flow. Starting isometric exercises early will also promote blood flow.

8.6 PREVENTION OF CRAMPS AND JOINT CONTRACTURE

Muscle cramps and contracted joints can be prevented through:

- supervised free active movement of unaffected joints (e.g. foot, fingers)
- passive and active mobilization of free joints (including the patella) in all directions
- stretching (recommended, if possible)
- moving the joints above and below the injury.

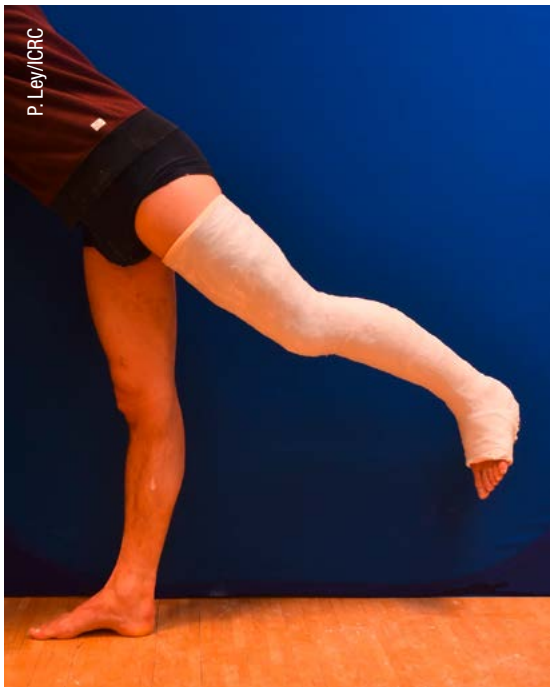
8.7 PREVENTION OF MUSCLE ATROPHY

Muscle atrophy is inevitable for patients who must stay in bed for medium to long periods. It is physiotherapists' duty to limit muscle atrophy by prescribing active exercises for all bedridden individuals. The exercises should be done under the physiotherapist's supervision at first. As soon as possible, the patient should be given an exercise plan to follow on their own.

- Start active muscle training after the first week post-surgery, as pain subsides.
- Static muscular contractions are the preferred muscle-strengthening exercises at the start of therapy.
- Increase the intensity of the exercises progressively, under supervision.
- Muscle atrophy and joint stiffness can be prevented through active exercise and isometric contractions, including in the fractured limb after reducing the spasm.

8.8 FUNCTIONAL THERAPEUTIC EXERCISES

The rehabilitation plan should include supervised functional activities for the rest of the patient's body. Exercises may be done in a sitting position if permitted by the surgeon. Any resistive exercises involving unaffected limbs should be carefully monitored and should not affect the fracture site (muscle chain).



8.9 RESUMPTION OF STANDING, WEIGHT-BEARING AND WALKING WITH CRUTCHES

Once reduction is achieved and the callus is stable, traction can be removed and the treatment may be changed to a circular cast or back slab. At this point, rehabilitation comprises the gradual introduction of:

- upper-limb exercises with various grips
- standing using parallel bars/frame/crutches
- walking (with gait training) from no weight-bearing to full weight-bearing.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8.10 MENTAL HEALTH

Many people, especially young people, do not easily tolerate being confined to a bed for weeks on end. Psychological support is therefore essential. The scientific literature shows a strong link between physical activity and well-being, and early mobilization helps to maintain patients' morale. A multidisciplinary system should be in place to coordinate work that includes the physical rehabilitation, mental health and psychological support teams.

8.11 PHYSIOTHERAPY FOR PEOPLE WITH CASTS

As long as the patient is wearing a cast, the physiotherapist must do the following:

- Monitor the cast for complications.
- Educate the patient on how to maintain the cast and keep it clean.
- Prescribe active exercises, within the patient's pain limit, for all free joints.
- Prescribe static contraction of muscles under the cast.
- Promote overall mobility, transfers and activities of daily life with the cast.
- Show the patient how to use and manage mobility aids, if necessary.
- Provide exercises for the patient to do at home (given to the patient before they are discharged from the hospital).

8.11.1 BACK SLABS

Slabs are used as a primary intervention and are not intended to allow weight-bearing. Special attention should be given when patients with lower-limb fractures move out of bed.

8.11.2 CIRCULAR CASTS

Patients should do exercises that incorporate resistance, especially the weight of the cast (i.e. raising the injured leg off the bed). Exercises should gradually become more strenuous but should stay within the patient's pain limit.

Patients with lower-limb fractures under circular casts can generally be permitted to put weight on the limb. While the limb is immobilized, they should gradually move from putting partial weight on the limb – under close medical supervision – to full weight-bearing. Two conditions must be followed, however: a walking heel must be attached to the cast, and the physiotherapist must follow the surgeon's exact instructions on how much weight can be borne.

8.12 PHYSIOTHERAPY FOR PEOPLE IN TRACTION

Managing traction is an active process. A dedicated multidisciplinary team is essential, because patients in traction are necessarily bedridden. Understanding what traction can achieve is important for successful management. The patient's overall position and the position of the limb in traction should be checked several times a day by all members of the team for the first two weeks, as they can easily get out of proper alignment. All team members should also be involved in monitoring the patient's skin and pin sites for infection or adverse effects on the soft tissues. The main objective of physiotherapy is to minimize the consequences of prolonged bed rest and avoid all possible complications during the period of immobilization.

Physiotherapy for people in traction aims to:
- prevent complications from traction and prolonged bed rest
- maintain function
- reduce patient's dependence on others while bedridden
- promote healing and callus formation
- position the patient and the injured limb to be as comfortable and functional as possible
- prepare for mobilization as soon as the patient is out of traction
- restore optimum independent functioning to prepare for ambulation
- limit the time the patient spends in the hospital.

The physiotherapist should make sure that the uninjured distal joints (i.e. ankle and feet) can be moved and are well positioned in case of peripheral nerve damage. Start exercises early: anytime from the first to the seventh day post-trauma, but the sooner the better. On average, traction lasts eight weeks: as with "plaster disease", lean body mass is lost during skeletal traction. Muscle mass can be maintained through exercises, and attention should always be paid to nutrition.

Removal of the traction does not mean that the treatment is over.

8.12.1 PROGRESSIVE THERAPEUTIC MODEL

Physiotherapy for people receiving treatment that includes traction is always progressive. The rehabilitation plan usually follows the following model:
1. while in traction: in-bed mobility and exercises, transfers and weight shifts (using overhead beams, bed blocks, etc.)
2. out of traction: switch to plaster slabs/cast
3. out-of-bed mobility
4. walking with crutches
5. partial weight-bearing and gradual introduction of independent walking
6. functional activities and exercises
7. soft-tissue manipulation, joint mobilization (if required)
8. strengthening and endurance-building.

8.12.2 REHABILITATION DURING AND AFTER PERKINS TRACTION


A. Bois d'Enghien/ICRC

Perkins traction is unique in that the patient is encouraged to flex and extend their knee while in traction. This is made possible by removing the distal third or half of the bed to allow the knee to be flexed up to and beyond 90 degrees.

The patient can soon use their uninjured leg to support the other while doing the flexion and extension exercise. After a couple of weeks, the patient should be able to flex their knee, actively and unsupported, to 90 degrees. As the patient gains autonomy, daily sessions should increase in frequency and duration.

Exercises must be started as soon as possible, generally between the third and seventh day post-trauma. Exercises can be started even before the wound has been completely debrided.

8.13 SOCIAL INCLUSION

Community care and social inclusion must be considered when providing advice and guidance to the patient, and rehabilitation professionals should be familiar with the local and national referral system. When patients are discharged from the hospital or physical rehabilitation centre, they must be informed of the importance of pursuing rehabilitation if it is needed. When possible, self-management and home rehabilitation exercises should have been taught and promoted.

For more than 30 years, the ICRC's Physical Rehabilitation Programme has been actively working to increase the social inclusion of people living with disability. Often their lives have been shattered by injury, and we aim to ensure that they are reintegrated into their communities. Social inclusion can be promoted through community rehabilitation, sports activities and microfinance initiatives, for example.

F. B. Seriex/ICRC

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The ICRC helps people around the world affected by armed conflict and other violence, doing everything it can to protect their lives and dignity and to relieve their suffering, often with its Red Cross and Red Crescent partners. The organization also seeks to prevent hardship by promoting and strengthening humanitarian law and championing universal humanitarian principles.

People know they can count on the ICRC to carry out a range of life-saving activities in conflict zones and to work closely with the communities there to understand and meet their needs. The organization's experience and expertise enables it to respond quickly and effectively, without taking sides.

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