Cast and Splints in Orthopedic Practice

By:

Dr. Adel Abdelazeem Ahmed

Zagazig University

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Acknowledgments

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Special thanks to the Minister of Health and Population Dr. Hala Zayed and Former Minister of Health Dr. Ahmed Emad Edin Rady for their decision to recognize and professionalize health education by issuing a decree to develop and strengthen the technical health education curriculum for pre-service training within the technical health institutes.
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Course Specifications

1. Course Specifications:

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<td>Title in Arabic:</td>
<td>جراحة العظام: الجبهة والجبل في جراحة العظام</td>
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2. Overall Aim of Course:

The purpose of the course is to identify different types of orthopaedic splints as regard types, indications of use, benefits and hazards of use. The course also covers practical aspects of applying orthopaedics splints and casts.

3. Intended learning outcomes of the course (ILOs):

i. Knowledge and Understanding:

By the end of this course, students should be able to:
1. Recognize different types of orthopaedic splints
2. Recognize the indication of use and function of each type
3. Recognize how to apply this type of splint.
4. Thorough knowledge about the hazards and complications of mal use and wrong applications of every type of these splints and casts.

ii. Intellectual Skills:

By the end of this course, students should be able to:
1. Select the suitable type of splint suitable to a specific pathology or injury
2. Identify complications that may follow application of different types of casts and splints

III. Professional Skills:

By the end of this course, students should be able to:
1. How to apply different types of splints, casts and traction methods in the right way.
2. How to remove the cast and splint in the right way without doing harm to the patient.
3. Patient management after splint application as regard follow up and early identification of any threatening complications following splint and cast.
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### Assessment Schedule:

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<th>b. Final exam:</th>
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<td>1. Multiple choice questions</td>
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#### Weight of Assessments:

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<th>C- Weight of Assessments:</th>
<th>1. Quizzes and classworks (5%), 10 marks</th>
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<td>2. Practical (40%), 80 marks.</td>
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<td>3. Mid term exam (5%) 10 marks</td>
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<td>4. Final written theoretical exam (50%), 100 marks.</td>
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<td>Total percentage 100%</td>
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### List of References:

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<th>a- Course notes:</th>
<th>Lecture and practical notes for orthopaedic casts and splints</th>
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### c- Recommended books

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<tr>
<th>No.</th>
<th>Author(s)</th>
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<th>Publisher</th>
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<tr>
<td>2</td>
<td>S. Terry Canale MD, James H. Beaty MD, Willis C. Campbell</td>
<td>Campbell's operative orthopaedics, 12 edition</td>
<td>Philadelphia, PA Elsevier</td>
<td>2017</td>
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### d- Periodicals, web sites, د- دوريات علمية أو نشرات

- Egyptian knowledge bank
- www.google.com
- www.pubmed.com
- Expert consult
Course description

This course discusses different types of casts and splints in orthopaedic surgery. It involves description and indications of use of each type. The technique of application of every type is described. The complications and how to avoid them are also detailed.

Core Knowledge

5- Recognize different types of casts and splints.
6- Identify the correct technique of application of each type of cast and splint
7- Identify various complications of orthopaedic casts and splints and how to prevent them and how to deal with them if occurred.

Core Skills

By the end of this course, students should be able to:
3. Identify types of cast and splints
4. Identify how to assist or share in application of different casts and splints
5. Recognize complications results from cast or splints application and how to prevent and manage them
## Course Overview

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<th>Date</th>
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<td>2nd week</td>
<td>Cast application</td>
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<tr>
<td>3rd week</td>
<td>Cast removal and wedging</td>
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<tr>
<td>4th week</td>
<td>Casts of the upper limb</td>
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<td>5th week</td>
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<td>6th week</td>
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<td>Cast complications</td>
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<tr>
<td>12th week</td>
<td>Infection control</td>
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Chapter 1
History of Orthopaedic Surgery

The term orthopaedic is derived from the Greek words ortho which means straight or correct and paidion which means child. This is because originally, orthopaedics was only used to treat musculoskeletal deformities in children.

In the times of old Egyptians splints were made out of wood and padded with linen.

In other times splints were made of blood of horses which is left to dry to produce a rigid splint. This unhygienic method was used by some especially in the war times. During this time period, people attempted to create artificial prostheses. Wooden legs, iron hands and artificial feet were found.

Wars were always the continuous stimulator to people to practice and develop orthopaedic practice.

Plaster of Paris was first seen in 1851 when Antonius Mathijsen, a Dutch military surgeon, created the plaster of Paris cast which is still used today.
The advent of plaster of Paris cast was considered the trigger of the new era of orthopaedic practice. If it wasn’t for the invention of the plaster cast, there probably wouldn’t be such thing as orthopaedic surgery.

Later the field of orthopaedic practice had many progressive efforts for development

A major development in orthopaedics was in the 19th century when Hugh Owen Thomas, a Welsh surgeon, invented his Thomas splint which was used to treat femoral fractures in children and adults and is used effectively till now.

During the First World War Thomas Splint was used for initial treatment of fractures of the femur, decreasing mortality from compound femur fractures from 87% to less than 8% between 1916 and 1918.

Later on, Gerhard Küntscher of Germany established the use of intramedullary rods to treat fractures of the femur and tibia. This accelerated German soldiers’ recoveries during the Second World War and opened the doors to a more widespread use of intramedullary rods to treat fractures of long bones.

In 1960 Sir John Charnley (Figure 1) stars the era of artificial joint replacement. Sir Charnley found that damaged joint surfaces could be replaced by implants attached to the bone. This was the base of development of the current joint replacement surgery

![Figure 1: Sir John Charnley and total hip prosthesis](image)

In 1980 a Russian orthopaedic surgeon Gabriel Ilizarov (Figure 2) had invented the ring fixator. This type of external fixator was the magical solution for many unsolved problems in orthopaedic practice. Instead of amputation limb lengthening, bone transport, excision of diseases bone segment due to cancers and infection became possible after using that apparatus.

![Figure 2: Ilizarov and his ring fixator](image)
Recently the thought of less invasive or minimally invasive orthopaedic surgery was developed. This idea becomes more applicable since the advent of arthroscopy (Figure 3). Arthroscopy enables orthopaedic surgeons to perform many minimally invasive intra-articular procedures without open surgical approach.

Medical progression will not stop so long as there is continuous fight between humans and disease. In many situations humans beings defeated diseases but till now the war do not stop.
Chapter 2
Cast application

Objectives

Provide detailed information about the rational, technique and materials used in cast

Overview

There are two important events in the practice of orthopaedic surgery since ancient decades. The first event is the advent of plaster of Paris cast while the second event is the advent of internal fixation by nails and plates. The first era in recent orthopaedic surgery starts with the use of plaster of Paris cast

► Rationale of casting

1 - Provide immobilization: one of the important aims of casting is to provide immobilization to the injured part. This immobilization may be considered as a temporary measure waiting for the definitive management or considered in some situations the definitive management for treatment

2 - Prevent further injury: motions at the fracture site can produce injury to the nearby nerves, blood vessels or soft tissue as muscles and tendons. Application of cast will eliminate motions at the fracture site and prevent further injury

3 - Decrease pain: motions at the fracture site are very painful so that it can cause neurogenic shock. Application of cast will minimize motions at the fracture site, reduce pain and provide patient comfort.

4 - Facilitate transport: in some fractures patient transport cannot be done except after patient immobilization in cast or splint.

► Indications of cast

1 - Treatment of fractures either as a temporary step before definitive management or as a definitive management

2 - Treatment of ligament sprains

3 - Immobilization after reduction of joints dislocations

4 - Post operative: different types of casts are used after many types of surgical operations
in orthopaedic practice as

- Fracture reduction and fixation
- Tendon surgery
- Nerve surgery
- Deformity correction
- Open reduction of some types of joint dislocations as elbow joint dislocation

Post-operative casting has different aims in these conditions as

- Relief of post-operative pain
- Protect tendon and nerve repair
- Maintain reduction and prevent redislocation of dislocated joints
- Protect internal fixation if fractures and after deformity correction if the method of fixation is not secure enough

Types of casts (Table 1)

1 - Plaster of Paris cast

It chemically composed of sheets impregnated with calcium sulphate. It transforms into a rigid material when immersed into water and then exposed to air. Immersion of plaster of Paris cast into water results in heat release (exothermic reaction). The more the temperature of water the more heat generated from the cast. This may be responsible for minor burns that can occur with some cases

2 - Fiberglass cast

It composed of sheets of fiberglass with added adhesive material. It has the same exothermic reaction that occurs with the plaster of Paris cast

<table>
<thead>
<tr>
<th></th>
<th>Plaster of Paris cast</th>
<th>Fiberglass cast</th>
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<tbody>
<tr>
<td>Durability</td>
<td>Less</td>
<td>more</td>
</tr>
<tr>
<td>Water resistance</td>
<td>Poor</td>
<td>Excellent</td>
</tr>
<tr>
<td>Strength</td>
<td>Less</td>
<td>more</td>
</tr>
<tr>
<td>Radiolucency</td>
<td>Less</td>
<td>more</td>
</tr>
<tr>
<td>Weight</td>
<td>Higher</td>
<td>Lower</td>
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<tr>
<td>Cost</td>
<td>Less</td>
<td>More</td>
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Table 1: The difference between plaster of Paris cast and fiberglass cast

Follow up after cast application

Health care provider role

The health care provider should take care of the following after cast application

1 - Limb swelling and tightness of the cast

2 - Limb circulation: this can be noted by limb temperature, presence of any pallor or bluish discoloration and capillary refill. Any coldness or bluish discoloration the cast should opened completely at once and the specialist physician should be called
Capillary refill is a simple and quick test to check the circulation (Figure 4). It is performed by gentle pressure on the nail bed till it becomes white, then pressure is removed the normal pink color of the nail bed should return in less than two seconds. Delay in time of refill indicates impaired circulation to the tested limb.

![Figure 4: Capillary refill test](image)

3 - Neurological function: Regular observation of the neurological function of the casted limb both motor and sensory functions.

4 - Condition of the cast:
- Edges: the edges of the cast should be smooth not sharp and well covered with a layer of pad or cotton to prevent skin injury due to sharp cast edge.
- Break or fissuring: any break or fissuring of the cast should be reinforced immediately.
- Loose cast: Any cast loosening should be noted. This is common if there is some limb swelling and resolved by time, this will make the cast loose. Loose cast should be changed.

**Patient role**

The patients should be given some instructions and precautions by the health care provider personnel. Patients should be informed by these instructions in oral and written forms.

1 - Limb elevation.
2 - Continuous motions of fingers if allowed by the physician.
3 - Protect the cast against water.
4 - No weight bearing is allowed on cast unless instructed by the physician.
5 - Inform the health care provider immediately if one of the following occurs:
- Limb swelling or tight cast.
- Fever either systemic fever or increase temperature of the casted limb.
- Coldness of the casted limb.
- Unusual pain or parenthesis.
- Break in the cast.
- Sharp edge of the cast.
- Wet or Soaked cast (may be due to infection of skin or wound under the cast).

▶ **Technique of casting procedure**

**Before cast application**
1. Explain what you will do the patient. The patient should be informed that some heat will be generated during and shortly after cast application. This is temporary and rapidly subsides.

2. Collect all materials you need to complete the process of casting.

3. Seat the patient in the correct position according to the type of the fracture e.g. some fractures require casting while the patient is sitting on a chair as fracture humerus while others done with the patient in recumbent position.

4. Any wound should be cleaned and covered with sterile dressing before casting.

5. As a rule joint above and joint below the fracture should be involved in the cast e.g. for tibial fractures the cast should extend above the knee (joint above) and below the ankle (joint below).

**Padding**

- Choose the correct size of the pad rolls suitable to the size of the patient`s limb.
- Start padding from distal to proximal.
- Make 50% overlap between rolls except the first and the last rolls where 100% overlap is required (Figure 5).
- The bony prominences as tip of olecranon, malleoli and ulnar styloid process should be extra padded to prevent formation of pressures ulcers of the skin over these prominences.
- The direction of padding should be angled not transverse to prevent gapping between rolls.
- During padding take care that it should be well fitted nut not tight by any means.
- Padding should extend beyond the limits of the cast to prevent skin injury by edges of the cast.

*Figure 5: 50% overlap while padding with an angle in direction*

**Water**

Do not use too hot or too cold water. Hot water speeds the hardening time of the cast and produces more harmful exothermal reaction while cold water slows the hardening time.

Do not use the same water from cast to cast.

**Cast tape application**

Immersion of cast tape in water. The tape is immersed in water for 3 - 5 seconds till air bubbles release stop, then apply gentle pressure on cast tape to squeeze extra water from the tape.

It is applied in the same manner as padding:

- 50% overlap except the first and last rolls.
- Start from distal to proximal.
- Oblique in direction

**Cast molding**

Gentle molding of the cast is required for the cast to take the shape of the underlying limb.

**Limb support**

The limb should be supported by the physician or an assistant in the correct position till the cast hardens otherwise changes of position can occur producing unwanted position of joint deformity.

The cast should be handled at a hard part, handling of the cast at a soft part will cause focal pressure and depression of the cast in that part causing skin pressure underlying the cast.
Chapter 3

Cast Removal

Objectives

Provides detailed information about the correct way of cast removal and wedging of cast.

Overview

Cast removal as a technique is not a simple procedure. Improper technique of cast removal can also lead to limb injury.

Required equipments

1. Oscillating saw (Figure 6) (The blade moves forth and back)
2. Hand saw
3. Cast spreader (Figure 7)
4. Scissor

Cast is removed with an oscillating saw which is designed to cut hard materials as cast but not soft material as skin or cotton. It is essential in cutting the fiberglass cast while plaster of Paris cast can be removed by a hand saw. The presence of cast spreader helps to separate parts of the cast after being cut by the saw.

Figure 6: Electric oscillating saw

Precautions when using the oscillating saw

- When applying the blade to the cast gently push it into the cast, and then proceed to cut in an up and down and in and out directions. Do not drag the saw blade along the cast longitudinally in one direction as this will increase heat production.
• The blades of the oscillating saw should be changed from time to time as dull blades will generate more heat that may harm the patient
• The temperature of the blades should be checked frequently during work, if hot it can be cooled by saline or alcohol

![Figure 7: Cast spreader](image)

Complications of the oscillating saw
• It can generate a significant amount of heat that can cause minor skin burns
• Wrong use can produce skin injury

► Cast window (Figure 8)

Some cases require make a window in the cast as the following
• Wound care under the cast
• To check a painful area under the cast
• To check limb pulsations

![Figure 8: Cast window](image)

► Cast wedging (Figure 9)

Aim: Correct angulations of long bones fractures or can be used to extend a contracted joint. It can be an opening wedge or closed wedge

Open cast wedge

Precautions when doing open cast wedge
• Cut about two thirds of the circumference of the cast and leave one third to maintain stability of the cast
• The wedge should be exactly opposite the level of angulation to be corrected
- The cut is gently opened with the spreader until the fracture is reduced to the required position
- Confirm the reduction with X-ray or fluoroscopic images
- Add extra padding if there is gaps after opening the wedge
- At the end cover the wedge by cast material

Requirements
- Hand saw or an oscillating saw
- A piece of wood or plastic
- Cast spreader
- Padding material
- Cast material

Closed cast wedge

Requirements
- Hand saw or an oscillating saw
- Padding material
- Cast material

Precautions
- The site of the wedge should be opposite the angulation to be corrected
- Do not pinch the skin between the edges of the cast during closing
- Add padding if there is gaps
- After closing the wedge add layer or layers of cast materials to support the closed wedge
- Confirm the reduction with X-ray or fluoroscopic images

Figure 9: Cast wedging
Cast bivalving (Figure 10)

It longitudinal division of the cast on both sides in case of presence of edema after the cast has been set, so bivalving splits the cast into two halves aiming for limb decompression.

For minimal edema single split (monovalving) is indicated. After bivalving the cast is wrapped with crepe bandage loosely.
Chapter 4

Upper extremity casts

Objectives

Provide basic and applied clinical information about upper limb casts as regard their description, indication and techniques of application.

Overview

There are various types of upper limb casts, they are not the same and each type has its contraindications and technique of application although they nearly share in the same precautions during and after application.

**U shaped - Slab (Figure 6)**

U slabs are used for immobilization of humeral shaft fractures

Patient position: The patient should be setting on chair with the elbow flexed 90 degrees and the wrist is supported

The slab extends from the top of the shoulder down to the outer side of the arm then around the elbow then up on the inner side of the arm to one hand’s breadth below the axilla.

U-slabs that do not reach the top of the shoulder are at risk of gradually slipping down the arm.

Apply extra padding around the elbow to protect bony prominences from pressure by the cast

The arm is supported in a collar-and-cuff sling

Figure 6: U Slab
**Long arm cast** (Figure 7)

► **Description**
It extends distally from the knuckles and the distal palm crease to the uppermost position of the arm proximally.
This cast offers complete immobilization of the wrist joint and full restriction of supination and pronation.

► **Indications**
- Pediatric and adult forearm fractures
- Unstable distal radius fractures
- Pediatric and adult elbow fractures

It is never used in acute fractures; a posterior slab is applied first till edema subsides then change it into complete cast, however, it is mandatory to do complete cast it should be bivalve.

► **Precautions during application**
- Additional padding is required to protect the bony prominences as the ulnar styloid process and the olecranon process.
- The cast should not extend beyond the thenar crease which is opposite the metacarpophalangeal joints to allow complete finger flexion (Figure 8).
- The hand thenar eminence should not be covered by cast to allow complete thumb flexion.
- No edge of padding rolls or cast rolls is allowed to lie in the cubital fossa, not to cause pressure over the cubital fossa with its important neurovascular contents.

![Figure 7: Long arm cast](image)

![Figure 8: Distal extension of long arm cast](image)
Technical points
- Make short arm cast first then continue to long arm cast provided that its upper limit does not reach the cubital fossa
- The elbow is placed in 90 degrees of flexion
- The shape of the forearm is not cylindrical but flattened so the cast should be gently molded to be flattened like the forearm (Figure 9)
- If the thumb will not be included in the cast the cast should not extend beyond the radial styloid process not to cause pressure on dorsal veins of the lateral side of the hand leading to edema

Sugar tongue slab (Figure 10)

Description
- It is composed of plaster sheet extends dorsally from the knuckles up to the dorsal forearm and around the distal humerus then on the volar aspect of the forearm down to the distal palmer crease
- It controls supination and pronation better than short arm cast but do not firmly control wrist flexion and extension like short arm cast.

Indications: fracture distal radius

It is applied in acute conditions where edema is expected to occur. After the acute condition subsided it can be transformed into complete circular cast
Cast and splints

► Precautions
  • It is applied with the patient in supine position, the elbow flexed 90 degrees and the fingers are held by assistant.
  • Extra padding is needed over the bony prominences as the ulnar styloid process and humeral epicondyles
  • The splint is molded by the palm of the hand to well fit with the forearm

Short arm cast (Figure 11)

► Description
This cast extends from distal palmar crease volar and the knuckles dorsal up to the proximal forearm to end shortly below the elbow joint.
It only controls wrist flexion and extension but does not control supination and pronation.

► Indications
  • Wrist sprains
  • Fractures of the carpal bones except the scaphoid
  • Fractures of distal radius in children

► Precautions during application
  • Extra padding is needed around the wrist to protect the ulnar styloid process
  • The cast should not extend beyond the distal palmar crease to allow complete finger flexion. Proximally it should end at enough distance from the elbow joint to allow full elbow flexion.
  • The edges of the cast should be smooth and well covered not to cause skin injury.
  • The cast is gently molded at the forearm and palm of the hand.

Thumb spica (Figure 12)

► Description
It is a short arm cast that includes the thumb. This splint immobilized the thumb metacarpals and phalanges and to a lesser extent decreases mobility of the radial side of the wrist joint including the scaphoid bone.

► Indications
  • Fractures of thumb metacarpals and phalanges
  • Fractures of the scaphoid bone
Precautions during application

- The thumb is placed in line with the forearm
- The degree of wrist flexion, extension and ulnar deviation is determined by the nature of the fracture
- Extra padding is needed around the wrist to protect the ulnar styloid process
- The cast should not extend beyond the distal palmer crease to allow complete finger flexion. Proximally it should end at enough distance from the elbow joint to allow full elbow flexion
- The edges of the cast should be smooth and well covered not to cause skin injury
- The cast is gently molded at the forearm, thumb and palm of the hand
Chapter 5
Lower limb casts

Objective

Provide basic and applied clinical information about lower limb casts as regard their description, indications and applications

Overview

There are various types of lower limb casts each type has its own indications and technique of application. They all have similar precautions during and after application

Below knee cast (Figure 13)

► Description

It extends from just below to the knee joint down to the base of the toes distally. It can be extended distally to beyond the toes on the planter surface to act as a toes plate which support the toes. This cast should support the metatarsal heads but extension beyond the toes is indicated in certain situations

Figure 13: Below knee cast

► Indications

- Ankle sprains
- Stable ankle fracture
- Metatarsal fractures
- Tarsal fractures as calcaneus and talus
Precautions during application

- Application technique
  - It is applies with the patient sitting on the edge of a bed or table
  - The ankle is immobilized in 90 degrees flexion
  - Additional padding is required over the malleoli and the fibular head
  - Cast is molded at the sole of the foot, around both malleoli and on both sides of Achilles tendon
  - The cast ends proximally at a short distance from the knee to allow full flexion, distally the cast should allow full toes extension

Patellar tendon weight bearing cast (Sarmeinto) (Figure 14)

Description
It likes the short leg cast but with additional proximal extension covering the patellar tendon, both femoral condyles and both tibial condyles. It extends anteriorly to the mid-point of the patella and posteriorly 2.5 cm distal to the popliteal crease. The distal extension is like below knee cast

Indications
Stable tibial fracture after some callus formation, so it is not a primary treatment it is used after some time which fracture callus forms and acute edema subsides. This cast is intended to allow the patient to walk. This type of cast allows transmission of forces from the ground during walking directly to the knee bypassing the fracture so can be used as a weight bearing cast for stable tibial fractures

Contraindications
- Acute fracture
- Non union
- Unstable fracture
- Presence of limb edema

Precautions during applications
- The patient sits on the edge of the table
- The ankle is placed in 90 degrees flexion
- The least amount of padding is required in this type to make the cast well fitted
Additional padding over the bony prominences of the malleoli and the fibular head.

This cast is done in three steps, the first part is applied to the ankle and foot, the second step the cast extends proximally to below the tibial tuberosity and the third part is the extension around the knee joint. The third part is applied while the knee is flexed 45 degrees not 90 degrees.

The back of the cast is trimmed to allow knee flexion.

The cast is molded to take a triangular shape in the leg region.

**Above knee cast** (Figure 15)

**Description**

It extends from the base of toes distally to the upper thigh to reach the groin proximally. This cast immobilizes the foot, ankle and knee but gives insufficient immobilization to the femur. For the immobilization to be adequate joint above and joint below the fracture should be involved in the cast. In case of above knee cast if fracture femur is present this cast immobilized the knee but does not immobilize the hip so give inadequate stability to the femur.

**Indications**

- Unstable fracture of the ankle (short leg cast is used for stable ones)
- Tibial fracture
- Knee fractures
- Stable fractures of the distal femur

**Precautions during applications**

- It is done in two stages first below knee then above knee with the knee place in supine position
- The knee is place in 15 degrees of flexion to relax ligaments around the knee. In complete knee extension ligaments are tight so the femur and tibia becomes one unit and move together while if these ligaments are relaxed with knee flexion femoral motions are not transmitted to tibia. This is important in knee and tibial fracture while cast allows motions of the femur these motions should not be transmitted to tibia not to disturb fracture stability so the knee should be kept in slight flexion.
- Additional padding is needed around bony prominences ad the malleoli, head fibula and the patella.
• The cast should extend as high as possible to get the best possible control of femoral motions

**Cylindrical cast** (Figure 16)

► **Description**

It extends from the upper thigh to just above the malleoli at the ankle joint. It partially immobilized the knee, proximal tibial and distal femur.

![Figure 16: cylindrical cast](image)

► **Indications**

Stable fractures around the knee joints (knee distal femur and proximal tibia)

► **Precautions during application**

- It is applied with the patient supine
- Extra padding is need around bony prominences as the head of fibula and the patella
- This type of cast is liable to slipping distally because the foot is not included within the cast and its conical shape (wider proximally and narrower distally). This can be prevent by careful molding of the cast and slight flexion of the knee
Chapter 6
Spica cast

Objectives

Provide applied clinical information about the types of spica, technique of application and indications

Overview

Spica cast although appears annoying to the patients and the parents still has a value in orthopaedic practice especially for management of cases of developmental hip dysplasia and after surgeries for brachial plexus palsy

Shoulder spica

It is a combination of long arm cast and trunk jacket

► Description

The spica cast aims to immobilize the limbs to the trunk. Shoulder spica immobilized the upper limb to the trunk while hip spica immobilized the lower limb to the trunk.

The upper limb is immobilized except the hand which is kept free

It immobilized the elbow and shoulder

Figure 17: shoulder Spica
► **Indications**

- After brachial plexus palsy surgeries (tendon transfer, tendon and joint release and nerve repair)
- After arthrodesis shoulder till union occurs
- Fractures and dislocations around the shoulder. This indication was in the past, now recent techniques of internal fixation eliminate the need of shoulder spica in these conditions. It is rarely needed if the patient is unfit for surgery or when surgery is contraindicated.

► **Precautions during application**

- The patient should be either sitting or in erect position.
- It is done in two steps, the long arm cast and the body jacket, and then both parts are connected at the shoulder
- Extra padding is required at bony prominences as elbow condyles, top of the shoulder and iliac crest
- A wooden rod is used as a bridge between the arm part and trunk part to support the spica
- Take care of the size of the trunk jacket, it should allow free chest and abdominal motions and not interfere with breathing.
- The edges of the cast should be smooth and well-padded to prevent skin injury

**Hip spica**

► **Description**

It immobilized the lower limb one or both to the trunk

- Single hip spica: Cast includes the trunk and one lower limb
- One and half hip spica: cast includes the trunk, one lower limb and the other limb to just above the knee joint
- Double hip spica: cast includes the trunk and both lower limbs

The trunk jacket extends proximally just below the nipple line

Single hip spica does not immobilize the hip joint as movements of the pelvis are transmitted to the hip side in the cast. One and half spica encloses the pelvis completely and completely immobilizes the hip.

Double hip spica immobilized both hips and both femora by controlling the pelvic and knee motions.
**Indications**

- After closed reduction of developmental hip dysplasia and after open reduction surgery
- Fracture shaft femur in infants and children
- Fracture pelvis in children
- Various hip surgeries in children as femoral osteotomies

**Precaution during applications**

- It is applied with the patient supine on a special table designed for making hip spica (figure 18b).
- It is performed in steps first the trunks then the lower limb.
- The side of trunk part should accommodate any abdominal distension and not to interfere with free breathing.
- It should be well padded and the bone prominence as the iliac crest, greater trochanter, sacrum, head fibula and the patella should be well protected.
- The two legs are held abducted and supported by a wooden bar.
- The perineal area should be kept open enough to allow for perineal hygiene. Its width should be 4 fingers and extends from the symphysis pubis anterior to the proximal end of the anal cleft in the back.

*Figure 18 a: Hip spica (a) single (b) one and half (c) double*

*Figure 18b: Table for hip spica cast*
Chapter 7
Cast complications

Objectives

Provide information about various complications about cast application and how to avoid them

Overview

Although casting is a simple procedure yet it can lead to serious complications that may threaten limb survival. Good knowledge about the proper technique of cast application the expected complications and their management greatly increase the safety of casting and lessens its complications

► Complications of Immobilization

Excessive length of immobilization may lead to problems

1 - Joint stiffness: Cast application can produce joint stiffness especially if applied for long time. The more the time of cast application the more the risk of joint stiffness. With the advent of the new methods of fracture fixation the need for prolonged cast application is minimized but still some faults of cast application that may cause joint stiffness.

2 - Muscle atrophy: due to prolonged muscle inactivity

3 - Osteoporosis: disuse osteoporosis due to prolonged non weight bearing

4 - Deep venous thrombosis (DVT) is a significant problem after lower extremity immobilization.

► Compartment Syndrome

Compartment syndrome is defined as increase pressure within a closed compartment. The cast is not expansible cannot accommodate any limb swelling. If any swelling occurs after cast application the pressure within the limb increase leading to increase pressure and occlusion of the microcirculation leading to the serious complication known as acute compartment syndrome

Acute compartment syndrome cause ischemia of muscles and nerves leading to loss of their function with subsequent loss of sensation and motor function of the limb and later joint contracture and deformities

If this occurs urgent removal of the cast and any surrounding bands then proceed to surgical
treatment

► Faults in limb and joints position and cast limits (Figure 19)

Figure 19: Correct position of hand immobilization immobilization MPJ in 70° flexion and full extension of IP joints. The cast not extending beyond the MPJ allowing full finger flexion

► Neurovascular complications (Figure 20, 21)

Faulty pressure on nerve or blood vessel by focal area of tight cast will produce nerve compression injury as pressure on the common peroneal nerve by a tight cast producing nerve palsy and foot drop.

On performing above knee cast faulty pressure of the cast on the popliteal fossa can produce compression injury to the neurovascular structures present in the popliteal fossa

Figure 20: Faulty cast edge pressing on the common peroneal nerve
Figure 21: Fault pressing on the popliteal fossa will cause neurovascular compression

- **Complications due to wet cast**

Wet casts should be changed failure to do so may result in skin irritation, skin breakdown, and infection.

A foul-smelling cast may be a sign of wound infection. The cast should be removed or windowed to inspect the source of the odor.

**Summary of common mistakes during cast application**

1. The amount of padding is too little or too much: little padding will not offer enough skin protection against thermal injury or friction by cast edges. Too much padding will cause the cast to be loose resulting in inadequate immobilization.
2. Placing the cast material in a hot water: it is preferred by some doctors to decrease the time of cast hardening, but this will increase heat production from the cast and can produce thermal injury.
3. Tight cast: can cause pressure ulcers of the skin and neurovascular compromise
4. Joint immobilization in wrong positions can result in joint contracture and stiffness
5. Improper use of cast saw can result in skin injury
6. Leaving the cast untrimmed with sharp edges may cause skin injury
7. Leaving the cast before it hardens enough. This can lead to abnormal joint position e.g. equinus position of the ankle or wrist flexion
Chapter 8

Traction in Orthopaedic Practice

Objectives

Identify different types of traction, the aim, and techniques of insertion, complications and after care of each type

Overview

Limb traction can be considered a temporary stabilization of acute fractures or definitive treatment of some fractures when indicated. Traction is classified into two categories, skeletal traction and skin traction. Each type has its indications and technique of application.

Rationale

Traction by weight on a fractured bone or dislocated joint will help:
- Gradual Reduce a fracture
- Maintain position of a fracture or reduced dislocated joint
- Immobilize the limb to reduce pain and prevent further soft tissue injury by fracture fragments
- Gradual correction of some cases of joint contractures and stiffness

Types

► Skeletal traction
  - Femoral
  - Tibial
  - Calcaneal
  - Cervical

► Skin traction

► Thomas splint

Skeletal Traction

► femoral skeletal traction (Figure 23)

It is done by placing a transverse pin in the distal part of the femur and connecting the pin with a weight secured to the bed

Types of traction pins (Figure 22)
1 - Steinmann pin: smooth tapered pin. It has sixes of 4mm, 5 mm and 6 mm
2 - Denham pin: like Steinmann pin but its middle segment is serrated

Figure 22: The pin used for traction

Figure 23: Femoral skeletal traction. The pin, stirrup, traction cord, pulley and the weight are shown

► Indications: Traction of femoral, pelvic or hip fractures and dislocations

► Equipments
  • Traction pin
  • Power drill
  • Stirrup
  • Weight
  • Pulley
  • Traction cord

► Precautions
  • Traction pin is inserted from medial to lateral
  • The pin should be inserted perpendicular to the bone to offer a uniform traction
  • The pin should be horizontal and parallel to the ground
  • The sharp end of the pin of the pin should be covered to avoid patient injury
  • The weight should not be more than 10% - 15% of body weight

► After care
  • Pin care: Daily cleaning and dressing of the skin around the traction pin. Remove and crusts and clean with saline
  • Be sure that the traction cord is stretched
  • Be sure that the weight is not touching the ground
- Check frequently correct limb position and correct it if needed
- Check neurovascular limb condition frequently
- Encourage active range of motions of the limb joints not involved in traction
- Take care of pressure ulcers especially of the hell and buttock and use air mattress if necessary

**Tibial skeletal traction** (Figure 24)

It is done by placing a transverse pin in the proximal tibia and connecting the pin with a weight secured to the bed

► Indications
Traction of distal femoral fracture and fractures around the knee joint

► Equipments
- Traction pin
- Power drill
- Stirrup
- Weight
- Pulley
- Traction cord

► Precautions (The same as femoral skeletal traction)
- Traction pin is inserted from lateral to medial
- The pin should be inserted perpendicular to the bone to offer a uniform traction
- The pin should be horizontal and parallel to the ground
- The sharp end of the pin of the pin should be covered to avoid patient injury
- The weight should not be more than 10% - 15% of body weight

![Figure 24: Tibial skeletal traction](image)

► After care (The same as femoral skeletal traction)
- Pin care: Daily cleaning and dressing of the skin around the traction pin. remove and crusts and clean with saline
- Be sure that the traction cord is stretched
- Be sure that the weight is not touching the ground
- Check frequently correct limb position and correct it if needed
- Check neurovascular limb condition frequently
- Encourage active range of motions of the limb joints not involved in traction
- Take care of pressure ulcers especially of the heel and use air mattress if necessary

**Calcaneal skeletal traction** (Figure 25)

- Calcaneal traction is done by insertion of a transverse traction pin through the posterior part of the calcaneus

- Indication: traction of tibial fractures and fractures around the ankle joint
  
  Equipments: The same as tibial and femoral skeletal traction

- Precautions: The same as tibial and femoral traction noting that the traction pin is inserted from the medial side like femoral traction

![Figure 25: Calcaneal traction](image)

**Cervical traction (Halo traction)** (Figure 26)

Indications

Halo traction is used to stabilize the cervical spine after surgery or accident.

A ring (Halo ring) surrounds the head attached by pins to the outer portion of the skull

This traction device is composed of

- A ring
- Synthetic jacket underneath
- Support rods
- Skull pins.

![Figure 26: Cervical skeletal traction](image)
Chapter 9
Skin Traction

Objectives
Provide applied clinical information about the indications and technique of skin traction

Overview
Skin traction although offer less power of traction than skeletal, still have value as a temporary treatment of some injuries

Skin traction involves applying adhesive taps to the skin directly below the fracture with the traction rope is fastened directly to these adhesive tapes and connected to the weight (Figure 27).

► Characters
- It is less invasive than skeletal traction
- It produces less traction effect than skeletal traction
- It’s usually used as a temporary way to stabilize a broken bone until the definitive surgery is performed.

► Indications: being less powerful than skeletal traction it is done as temporary step for fracture stabilization definitive management

► Precautions
Contact of the adhesive tapes with the skin can be irritant or produces allergic reaction
**Thomas splint** (Figure 28)

▸ **Indications**

- Immediate splinting of femoral shaft fractures
- Treatment of certain femoral shaft fracture where surgery is not indicated or not suitable for the patient

▸ **Description**

It is composed of two rods on each side of the limb joined together proximally by a ring parallel to the groin and distally by cross bar beyond the extremity.

The two metal rods converge slightly from proximal to distal to conform to the limb.

The lateral rod extends proximal to the area of the greater trochanter while the medial rod extends just distal to the perineum.

![Figure 28: Thomas splint](image)

**Application** (Figure 29)

- Longitudinal skin traction is applied from the distal femur down to just above the malleoli by adhesive taps
- The ends of the taps are connected to traction cords which are tied to the end of the Thomas splint while being maximally stretched to apply limb traction

**Precaution during applications**

- The ring and the metal rods should be well padded
- The size of the ring should be suitable to the size of the upper thigh. Narrow rings will constrict the thigh while wide rings will impinge against the testis and perineum
- The limb should be in neutral rotation no external or internal rotation is allowed
- Check peripheral pulsations and neurological functions of the limb after application and regularly
Patient’s instructions after application of Thomas splint

- The limb is placed in some abduction to keep the ring away from the testis and perineum
- The Thomas should be kept lean and protected from patient urine especially in children
- A small pillow is placed under the distal end of the Thomas splint to keep the heel away from the bed to protect it against bed sores
- Regular inspection of the skin under and around the rings to detect any changes
- Continuous active motions of the foot and toes to prevent flexion contracture.

Complications after Thomas splint

- Skin ulcers of the perineum of over the skin of the upper lateral thigh due to tight ring
- Heel bed sores
- Mal rotation of the limb due to inappropriate traction
- Ankle stiffness or equinus contracture
- Deep venous thrombosis due to prolonged immobilization
General complications of traction

► Pin tract infection: infection around the pin insertion site is very common. It can be present up to 100% of cases. It ranges from simple infection that responds to repeated dressing and local antibiotic to sever infection that needs removal of the pin

Risk factors of pin traction infection

- Improper pin care
- Immuno-compromized patients as diabetic patients
- Prolonged time of traction

► Skin ulcers: The buttocks, the heel and skin overlying the sacrum are liable to get pressure sores due to prolonged immobilization. Frequent change in patient position is recommended with the use of air mattress

► Deep venous thrombosis: prolonged immobilization leads to stasis of venous circulation this will lead to venous thrombosis of the low limb

► Disuse osteoporosis, muscle atrophy and joints contracture from prolonged immobilization

► Skin irritation by the adhesive tape in cases of skin traction
Chapter 10
Fabricated Splints of the upper limb

Objectives

Provide information about different parts of fabricated splints as regard their type, indications and application

Overview

Variable methods of treatment are present to treat orthopaedic disorders. The use of fabricated splints is more comfortable and tolerable. They are not definitive treatment in most cases they act as a complementary treatment after cast or surgery.

Rationale

Fabricated splints have the same immobilizing role of casts to relief pain and curative role in some conditions; however in most cases they offer less immobilizing effect than casts. They may have a complementary role after cast removal. The use of fabricated splints is specific to each disease in each region. Various types of splints are available in the market and each has a specific role

Splints of the upper limb

- Finger splints
- Wrist brace
- Thumb brace
- Elbow support
- Humeral brace
- Shoulder support
- Figure of 8 brace
Finger splints

► Mallet splints
This type of splints is used for treatment of extensor tendon injuries of the terminal phalanx. They have different forms (Figure 31).

![Figure 31: Mallet splint](image)

Precautions for use
- They should not be tight, rough or skin irritant
- The terminal phalanx should be kept hyperextended in the splint to facilitate tendon healing

► Finger strapping (Figure 32)
It is a method used to immobilize phalangeal fractures of the hand and foot. The injured finger is strapped to a neighboring finger with adhesive tape. The health finger acts as a splint for the fractured one.
This method can be used alone or in combination with a protective slab.
This method can be used for simple stable no displaced fracture otherwise internal fixation is needed.

Precautions for use
- Strapping should not be tight by any means
- A soothing material (soft gauze) should be placed in between the fingers to prevent skin maceration

![Figure 32: Finger strapping](image)

► Wrist brace (Figure 33)
It is used for wrist immobilization in simple wrist sprains that does not require cast immobilization or it can be used as a complementary treatment for various wrist fractures and operations following cast removal

![Figure 33: Wrist brace](image)
Precautions for use
- When applied it should be well fitted but not tight
- The edges should be smooth not to cause skin injury
- They should be made of non-irritating material

Cock up splint (Figure 34)
This type of splints is used to support the wrist and prevent wrist drop in case of radial nerve injury.
In case of radial nerve injury the wrist extensor muscles are paralyzed so that the wrist drops to prevent this and extension splint is used to support the wrist.
The fingers are not involved in this splint because extension of proximal and interphalangeal joints is mediated by the intrinsic muscles of the hand supplied by the medial and ulnar nerves not the radial nerve.

Thumb support (Figure 35)
It is dorsal or volar splint applied to the thumb.
It used in wide variety in disorders of the thumb as
- Ligamentous sprains
- Tenosynovitis of the thumb tendons
- Factures of the thumb as a primary treatment or as a complementary treatment after surgery or cast removal
Elbow support (Figure 36)

It is an elastic circular bandage wrapped around the elbow. It is used for relief of pain in certain elbow conditions as:
- Sprains
- Tendinitis
- After cast removal in case of fractures and dislocations

Precautions for use
- It should be well fitted, not tight
- It should be made of non-irritating, non-allergic material

Shoulder support (Figure 37)

It is composed of elastic material wrapped around the shoulder and the upper arm with a belt extending around the chest wall to prevent the shoulder support from slipping down.

Indication
- Painful conditions of the shoulder as tendinitis, bursitis, and sprains
- During recovery following fracture and dislocations
- Following surgery of the shoulder joint
Humeral brace (Figure 38)

It is made of plastic or fiberglass.
It is wrapped around the humerus
It is used to support fracture humerus in certain situations
  • Inoperable cases where this splint will be used continuously
  • As complementary treatment after cast removal
  • After surgical fixation of humeral fractures

Figure 38: Humeral brace

Figure of 8 brace - clavicular brace: (Figure 39)

This type of braces is used to support fractures of the clavicle as a primary treatment for non-displaced fractures or after surgical fixation of clavicular fractures

Figure 39: Clavicular brace
Chapter 11

Fabricated splints of the lower limb and the trunk

Braces of the lower limb

- Hip Abduction brace
- Pavlik harness splint
- Knee braces
- Ankle brace

**Hip abduction brace (Figure 40)**

It is a plastic brace lined with foam. It wraps around the waist and both thighs keeping both thighs widely abducted

**Indications**

It used mainly in children to treat specific hip disorders

- Cerebral palsy with tight hip adductors and after adductor tenotomy
- Legg perthes diseases: placing the hip joints in abduction maintains the femoral head in the acetabulum and prevents subluxation of the head out the acetabulum
- Developmental dysplasia of the hip to maintain femoral head within the acetabulum after open reduction surgery

![Figure 40: abduction brace](image)

**Precautions**

- It should be well fitted not tight not loose
- It should be well lined with not irritating material that can absorb sweat
- The edges should be smooth and well-padded not cause friction with skin
- The child should be learnt to walk with this brace and should not left alone in the start because of high risk of falls due to the hip position.
- During the side of the brace frequent inspection of the skin for early detection of any skin injury or irritation.

**Pavlik Harness splint** (Figure 41)

It is specific for treatment of developmental dysplasia of the hip from birth to 6 months of life to support the femoral head provided that the femoral head is well reduced inside the acetabulum after using the brace.

It is designed to get the hip joint in flexion and abduction. This position makes the femoral head reduces inside the acetabulum.

This brace is adjustable. The degree of hip abduction and flexion can be changed till the femoral head is well seated in the acetabulum.

Pavlik harness splint is removed after the femoral head is stable and not dislocatable.

**Knee braces**

There are many types of knee braces: Soft braces, hinged braces, fixed knee immobilizers.

- **Soft knee support**: it is used for mild knee pain due to sprains and arthritis.
Fixed knee immobilizes: They are usually used for high grades of collateral ligament injuries instead of cast. Treatment starts with the fixed immobilizer that after healing progresses it is replaced by the hinged immobilizer.

Hinged immobilizers: they are the commonest in use. They are used in wide variety of knee disorders. They stabilize the knee and at the same time allow knee flexion and extension. The degree of knee motion can be controlled by certain lock which can control the degree of flexion and extension allowed.

Indications
- Medial and lateral collateral ligament injuries
- Following cruciate ligament surgery
- Following knee arthroscopic surgery
- After cast removal in case of knee fractures
- After acute trauma to the knee

Ankle braces (Figure 42)

Ankle brace are either soft or rigid ankle immobilizers.

Soft ankle supports are used for simple ankle sprains and after cast removal done for various fractures or surgeries about the ankle.

Ankle immobilizers are rigid and give more stability than soft ankle supports.

Indications
- Foot drop following sciatic or common peroneal nerve injury
- Ankle instability following ankle collateral ligament tears
- Following surgeries around the ankle joint
- After cast removal after fracture healing to support the ankle till complete union occurs

Figure 42: ankle braces (a) soft support (b) rigid immobilizer
Braces of the spine

► Rational: braces of the spine are used for treatment of wide variety of spinal disorders as it provide support to the spine

► Functions of back braces

- Decrease range of motion of the spine so improves pain and improves the chance of rapid healing of injuries structures following trauma or surgery
- Unloads the back muscles ligaments and intervertebral disc so relives pain of disc or muscle origin
- Provide additional support to the back: so they have a great benefits in cases of spinal instability as spondylolisthesis and weak back muscles
- Reduces muscle spasm through the warmth offered by the brace

► Indications

- Back stabilization after trauma as muscle strain or vertebral fractures
- Relief pain in various disorders as case of disc prolapse, spondylosis and inflammatory conditions
- Postoperative after various spine disorders to relief pain and helps soft tissue healing
- Maintains spine position in case of spinal deformities as kyphosis or scoliosis

► Side effects of spine braces

- Back muscle atrophy due to dependency on the brace, so it is advisable not to use them permanently and used it few hours a day and on need only

► Types of back braces (Flexible - Semi rigid - Rigid) (Figure 43)

Figure 43: types of back braces (a) Flexible (b) Semi rigid (c) Rigid
Semi rigid and Flexible: They are used in mild and moderate back pain

Rigid: they are used for severe cases of back pain and instabilities and in cases of fractures and in cases of spinal deformities

- Providing significant support to take pressure off of weakened or injured spinal structures, including the muscles, joints, discs, and nerve roots
- Significantly reducing range of motion to prevent most forward, backward, and side-to-side bending, as well as most rotation of the trunk
- Drastically reducing micro-motion at a spinal segment or fracture, improving the chances of successful healing by limiting irritation from the shock of jarring motions
- Reducing muscle tension through the warmth of the brace

Cervical collars

The aim of use of cervical collars is to immobilize the cervical spine and keep it in neutral alignment

- Indications
  - Injury to cervical spine to prevent further injury and relief pain
  - Immobilize the neck to relief pain in cases of neck muscle spasm due to various disorders as disc prolapse, muscle strain, spondylosis and inflammatory conditions

Types

- Soft collar: it is used to relief pain for mild cases
- Hard collar: it is used in cases of fractures or dislocations also in cases of severe painful disorders
- Philadelphia collar (Figure 45): it is a special type of rigid collars. It gives more stability to the cervical spine than the ordinary rigid type as it has proximal extension to support the chin and distal extension to the chest. It is the preferred type in cases of cervical fractures and dislocations.

Figure 44: Types of cervical collar (a) soft (b) rigid
Philadelphia Collar

Figure 45: Philadelphia cervical collar
Chapter 12

Infection control

Objectives

Identify the possible causes and sources of infection during casting and splinting and the measures to prevent infection.

Overview

Although application of casts and splints is mostly non-surgical procedures yet there still risk of infection transmission to and from the patients. This issue can be summarized in the following questions.

Q 1: How can infections transmitted to the patients due to application of cast or splint?

Q2: How can infections transmitted to the health care providers during application of cast or splints?

Q3: What are the common transmitted infections?

Q4: What are the measures followed to prevent infection to and from the patient?

Methods of infection transmission to the patient

- Wound contamination: skin injury accompanying skeletal trauma can by a portal of patient infection
- Infected bullae and skin blisters following cast applications. these blisters form as the results of fracture edema
- Skin injury by sharp cast or fabricated edges
- Iatrogenic injury by sharp instruments as scissors, knives or blades of oscillating saw
- Surgical wound infection during performing skeletal traction
- Pin tract infection after skeletal traction
- Infected pressure sores due to prolonged rest in bed or due to faulty pressure by cast or splint
Methods of infection transmission to the health care provider

- Brick by needles or sharp instruments contaminated with patient’s blood
- Contact with wounds as in open fractures especially when there is skin injury of the health care provider

Common transmitted infections

- Viral infections: HCV, HBV & HIV
- Bacterial infections: staph, strep, pseudomonas & tetanus

Prevention of infection

1 - Health care providers should use protective gloves and gowns when doing any procedure
2 - Water of cast should be changed every time
3 - Do not apply any cast or splint before skin cleaning
4 - Skeletal traction should be done in the operating room under complete aseptic conditions
5 - Continuous pin tract care to guard against pin tract infection
6 - All instruments that used in casting process as saw blades, cast spreaders and scissors should be clean, sterile
7 - Cast room beds, ground, walls should satisfy standards of infection control
8 - Do not apply any cast or splint if there any skin injury except after wound debridement and coverage with sterile material
9 - Urgent interference if any bad smell arising from the casted limb or soaked cast appears

10 - Immunization of health care providers with the available vaccines

11 - If patient history denoted current or previous infection special precautions should be taken

12 - Bed and cast tables should be covered with sterile disposable waterproof sheets not to transmit infection from one patient to another

13 - Take care of any sharp instruments not to injury yourself or injury the patients

14 - Wash your hand before and after cast or splint application

15 - Prevent common use of instruments used in cast application or removal

Book Coordinator; Mostafa Fathallah

General Directorate of Technical Education for Health