**CAST TECHNIQUES**

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**Introduction**

**Cast Care Introduction**

* The function of a cast is to rigidly protect an injured bone or joint. It serves to hold the fracture in proper alignment to prevent it from moving while it heals.
* Casts may also be used to help rest a bone or joint to relieve pain that is caused by moving it (such as when a severe sprain occurs, but no broken bones).
* Different types of casts and splints are available, depending on the reason for the immobilization and/or the type of fracture.
* Casts are usually made of either plaster or synthetic material.

**Casting and Splinting**

Casts and splints are hard wraps used to support and protect injured bones, ligaments, tendons, and other tissues. They help fractures heal by keeping the fragments ends together and as straight as possible. Casts and splints also help with pain and swelling and protect the injured area from more harm.

*Things heal faster in the plaster (L. D. HOWARD)*

Plaster methods of immobilization have been utilized for centuries and despite modern technology, have not lost their usefulness.

Plaster of Paris mixed with water rapidly swells and forms a rigid crystalline structure. During the initial stages of this reaction the plaster is semi solid and may be molded to a desired form. The plaster can be shaped. It is used medically for immobilization.

**PLASTER OF PARIS TECHNIQUES**

It is important to remember that expertise is not acquired overnight, either from a textbook or in the classroom, but in the process of the actual day – to – day application of every variety of the plaster cast.

**Definition**

A cast may be defined as;

* A method of temporary immobilization that circumferentially incorporates a part or parts of a body.
* The term cast implies that the plaster or synthetic encases the entire part of the body.
* Casts and Splints are hard wraps used to support and protect injured bones, ligaments, tendons, and other tissues.
* Externally applied structure that holds bone in one position.
* Is a rigid protective material of plaster or synthetic.
* Is a rigid device applied to immobilize the injured bones and promote healing. It is applied to immobilize the joint above and below the fractured bone so that the bone won't move during healing. These are applied on clients who have relatively stable fractures.
* An orthopedic cast, body cast, plaster cast, or surgical cast, is a shell, frequently made from plaster, encasing a limb (or, in some cases, large portions of the body) to stabilize and hold anatomical structures, most often a broken bone (or bones), in place until healing is confirmed. It is similar in function to a splint.
* Nowadays bandages of synthetic materials are often used, often knitted fiberglass bandages impregnated with polyurethane, sometimes bandages of thermoplastic.

**Various forms of Plaster of Paris cast**

* Slab: only a part of circumference of limb is incorporated.
* Cast: encircle whole circumference of the limb.
* Spica.
* Brace.

 **The major categories of casts are:**

* Upper extremities.
* Lower extremities.
* Spinal and Cervical.
* Spica casts.
* Extremity cast incorporates all or a portion of the designated extremity.
* Spinal and cervical casts incorporate all or a portion of the trunk of the body or the cervical area.
* Spica refers to a cast that incorporates part or the entire trunk of the body and a part or all of one or more extremity.

**CHEMISTRY OF PLASTER OF PARIS**

Plaster of Paris is derived from naturally occurring mineral gypsum. The chemical formula for gypsum is caso4- 2H2O.

The name “Plaster Of Paris” reflects the extensive deposits of gypsum found in the Paris basin in France and more specifically the Montmartre district.

Gypsum is converted into Plaster Of Paris by pulverization and subsequent calcinations. Calcinations transform the crystalline gypsum to an amorphous state and require high temperatures to release water. The reaction is exothermic and is described by the following chemical equation.

2 (caso4-2H2O) changes (CaSo4).H2o + 3H20

Gypsum P.O.P water

The chemical reactions are reversible. When water is added to calcinated gypsum or Plaster of Paris, crystalline gypsum reforms with the release of heat. This exothermic reaction explains the warmth associated with cast setting, the amount of heat give n off by the cast depends on the amount of plaster used and the temperature of the immersion water.

**SUMMARY**

Plaster of Plaster (what it is)

Gypsum=also calcium sulphate

The basic mineral gypsum in rock form is grounded to a fine powder.

This is heated to drive out three-quarters of its intrinsic water content to become Plaster Of Paris.

The Powder is then mixed with cellulose and chemical solvents in this liquid state- it is impregnated by a heating process on the linear cloth.

NB It is open woven, interlocked fabric which holds the Plaster uniformly and provides additional strength when the compound is applied to produce gypsona in bandages and slabs.

**Setting time**: time taken to change from powder form to crystalline form.

**Drying time**: time taken to change from crystalline form to anhydrous form.

**Average setting time**: 3 – 9 minutes.

**Average drying time**: 24 – 72 hours.

***Factors decreasing setting time:***

* Hot water
* Salt
* Borax
* Resin

***Factors increasing setting time***

* Cold water
* Sugar

**Factors That Affect Setting Times for Casts and Splints**

The dipping water should be kept clean and fresh. In general, the temperature of the water should be tepid or slightly warm for plaster, and cool or room temperature for synthetic tape material. These temperatures allow for a workable setting time and have not been associated with increased risk of significant burns. Applying excess material or using an overly compressive elastic wrap also increases the risk of excessive heat production. Therefore, it is best to use only the amount of splinting material and compression required to stabilize the injury.

***A good rule of thumb is that heat is inversely proportional to the setting time and directly proportional to the number of layers used.***

**Characteristics of P.O.P**

• It soaks rapidly.

• Smooth when moulding.

• It is creamy and

• Innocuous to the skin (Innocuous-harmless)

• It sets fast- can be moulded as desired.

• Light cast translucent to X-rays.

• It has a combined strength with durability.

• Low plaster loss properties depending with the brand, examples, gypsona.

**Purpose of cast:**

* Immobilize parts of the body.
* Hold bone fragments in reduction (reduction is bringing the fractured on its anatomical position).
* Apply uniform compression.
* Stabilize joint.
* Correct deformities.
* Support weakened limb.
* Permit early weight bearing on affected side.

**The following are the indications for the use of Plaster of Paris.**

* Immobilization of fractures.
* Immobilization of diseased bones and joints.
* Correction of deformities e.g. club foot.
* Prevention of deformities.
* Emergency Splintage.
* Making of negative and positive casts.
* Immobilization in the treatment of burns and soft tissues injuries.

1. **Immobilization of fractures**

* It must always be remembered that the surrounding soft tissues are damaged when a bone is broken.

**When P.O.P is used**

* Accuracy of alignment is secured and maintained.
* Immobilized limb can be x-rayed and progression towards healing may be observed without any disturbance to the fixation of the limb.
* The patient can retain at least some mobility.
* With Plaster fixation body function is retained during immobilization.

2. **Immobilization of the diseased bones or joints.**

* Resting the diseased bones/joints to prevent complications and deformities resulting from the original conditions. e.g. Chronic Osteomyelitis.

3. **Correction of deformities**

* This can be obtained by two methods.

(a) **Serial Plaster**

It is whereby procedure routine is repeated as often as necessary using P.O.P so that you can achieve the correction of the deformity e.g. club foot.

(b) **Wedging and turnbuckle correction of deformities**

Two instances where wedging may be used.

(i) Adjustment of the alignment of a fracture.

(ii) In the correction of basic deformities in congenital club foot.

NB:

Care should be taken when cutting a Plaster of Paris.

**4. Prevention of deformities**

A patient may sustain a wrist drop or foot drop due to variety of causes. If light removable Plaster Shells/ Splints are made.

(i) Power may be restored.

(ii) Function may also be restored.

**5. Emergency Splintage**

Packed units consisting of Plaster Slab and circular paper bandage are available as First Aid kits.

**Reasons (Indications) of Splintage for the limb (supplementary notes)**

P.O.P is used for the following reasons in traumatic and orthopaedic conditions.

* To support fractured bones, prevent movement of the fragment and restoring damaged soft tissue.
* To stabilize and rest limbs where ligamentous injury has occurred.
* To correct deformity- achieved by wedging of the cast.
* To support and immobilize joints.
* To support and immobilize limbs where nerve and tendon repairs have been carried out.
* To make a removable splint to aid mobilization or prevent deformities, as in rheumatoid arthritis.
* To rest infected tissues, e.g cellulitis.
* To make a negative mould of the body for orthotic use.
* To prevent patients from removing their dressings and disturbing wounds.

   **Advantages of Plaster of Paris**

* Low allergic response.
* Offers rigid protection.
* Easy to apply.
* Inexpensive.
* Shape better than synthetic cast because of easy mouldability.

**Disadvantages of Plaster of Paris**

* Causes circulatory catastrophes’.
* Causes pressures sores
* Are heavy and inconvenient to the patient.
* Stiffness of joint
* Bones become osteoporotic.
* Uncertain immobilization.
* Not water proof.
* Loss of position of the fractures.
* Difficult to inspect the limb so it may conceal trouble e.g. wound breakdown.
* Long drying.
* May crumble and disintegrate at edges.

**Using Sub Standard “Plaster Of Paris”**

* Exothermic reactions – serious burns to patients.
* Medico – Legal costs.
* Serious health hazards – breathing excess dusts.
* Huge costs to the hospitals – repeat applications and rejects.

**Benefits of using standard “Plaster Of Paris” (advantages)**

* Easy, creamy application.
* Excellent moulding properties.
* Low Plaster loss.
* Flexible working time.
* Strong.
* Smooth finish.
* Cost – effective.
* Versatile range.
* Easy removal.
* Customisable.

**Rules of application of Plaster of Paris**

* 8 inch for thigh, 6 inch for leg and 4 inch for forearm.
* One joint above and one joint below.
* Moulded with palm and not with fingers to avoid indentation.
* Joints should be immobilized in functional position.
* Not too tight or too loose i.e. adequate padding.
* Dip pop vertically in water till air bubble ceases to come.
* Uniform thickness of plaster is preferred.
* Prolonged Undisturbed Rigid Extension

**Cast application**

* Before casting material is applied (plaster or synthetic), a "stockinette" is usually placed on the skin where the cast begins and ends (at the hand and near the elbow for a wrist cast). This stockinette protects the skin from the casting material.
* After the stockinette is placed, soft cotton patting material (also called cast padding or Webril) is rolled on. This cotton patting layer provides both additional padding to protect the skin and elastic pressure to the fracture to aid in healing.
* Next, the plaster or synthetic cast material is rolled on while it is still wet.
* The cast will usually begin to feel hard about 10 to 15 minutes after it is put on, but it takes much longer to be fully dry and hard.
* Be especially careful with a plaster cast for the first 1 to 2 days because it can easily [crack](http://www.emedicinehealth.com/script/main/art.asp?articlekey=13763) or break while it is drying and hardening. It can take up to 24 to 48 hours for the cast to completely harden.

**Plaster casts**

* A plaster cast is made from rolls or pieces of dry muslin that have [starch](http://www.emedicinehealth.com/script/main/art.asp?articlekey=162241) or dextrose and calcium sulfate added.
* When the plaster gets wet, a [chemical reaction](http://www.emedicinehealth.com/script/main/art.asp?articlekey=6760) happens (between the water and the calcium sulfate) that produces heat and eventually causes the plaster to set, or get hard, when it dries.
* A person can usually feel the cast getting warm on the skin from this chemical reaction as it sets.
* The temperature of the water used to wet the plaster affects the rate at which the cast sets. When colder water is used, it takes longer for the plaster to set, and a smaller amount of heat is produced from the chemical reaction.
* Plaster casts are usually smooth and white.

**Synthetic materials for casting**

* Synthetic casts are also applied starting from a roll that becomes wet.
* After the roll is wet, it is rolled on to form the cast. Synthetic casts also become warm and harden as they dry.
* Synthetic casts are rough on the outside and look like a weave when dry. They are available in many colors.

**Complications of plaster cast can be divided in to systemic, which affects whole body or local which affects limb where plaster has been applied.**

Local complications of plaster can be further classified as immediate and delayed.

**Systemic Complications of Plaster Cast**

* The most serious is deep venous thrombosis leading to pulmonary embolism. Pain in the calf is an important sign needing medical advice.
* Immobilization in trunk plasters or plaster beds may also produce nausea, abdominal muscle cramps, retention of urine and abdominal distention.
* Good nursing and diet with regular exercises will help ensure that the initial period of extensive immobilization is achieved without complications.

**Immediate Local Complications of Plaster Cast**

**Swelling of the Part**

* A plaster produces constricting effect on the limb and most of it is well tolerated but a moderate constriction will produce compression of the veins, damming the blood, and causing swelling, discomfort or pain, and a blue color in the skin and under the nails.
* Temporary remedies such as elevation of the limb and exercising the digits may be tried, but, if persistent, the constriction must be relieved. The cast can be split and eased or bivalved, taking care not to damage the skin.

**Impaired Arterial Supply**

* A pale skin which is cool and without a palpable pulse indicates that the arterial supply is disrupted. This is a serious complication. Medical advice must be sought immediately.
* Splitting the cast may relieve the arterial compression but sometimes surgery may be necessary.
* Incomplete arterial occlusion may present with pain or aching with loss of power. If in doubt ask for medical advice.

**Pain**

* Pain has many causes. This may be due to tissue damage at injury or reduction, swelling within the cast, muscle spasm, pressure on blood vessels or nerves, skin irritation or sores. Although diagnosis may be difficult, persistent pain or intermittent acute pain should not be ignored. Medical advice must be sought.

**Delayed Local Complications of Plaster Cast**

**Plaster Sores**

* The most common cause of sores is pressure of the plaster on the skin due to poor cast application.
* The patient may report burning, itching or stabbing pain.
* Children may have disturbed sleep and elevated temperature.

**Signs that may suggest plaster sore**

* Heat and swelling of the digits.
* Increased warmth over a localized area of the cast
* Localized odour.
* Visible pus
* Staining of the cast.

**The most likely reasons for plaster sore development are:**

* Poor technique with inadequate padding, or a ridge inside the cast, or failure to trim the ends of the cast correctly.
* Local cast breakdown with skin irritation due to poor care.
* Foreign bodies may easily slip between the cast and the skin. Children especially may insert small toys, coins or beads while hairgrips may fall inside the cast.
Patients should be warned of these damages and also to care for the plaster edges since wetting will cause plaster crumbs to be detached and fall inside the cast.
* Scratching at minor irritation beneath the cast with metal implements or knitting needles may cause trauma and infection. Such irritation should be reported and investigated early.
* Plaster soakage leading to skin damage and infection
* Cut edges of plaster following splinting or [bivalving](http://boneandspine.com/what-is-bivalve-cast/)or window procedures may irritate the skin especially if swelling occurs around the edge.
* **Note**

Development of plaster sore is very painful. It is a constantly nagging pain that does not leave the patient. The patient is often able to pinpoint the sore area. If patient complains of unrelenting pain or digging sensation the part should be examined.

It should not be ignored at any cost otherwise the results could be disastrous consequences.

**2. Loss of Position**

* Because swelling occurs with most fractures especially after reduction, the technician puts [padding](http://boneandspine.com/what-is-unpadded-cast/)under the cast to protect the skin. This padding gets compressed. After 48 hours when the oedema is subsiding, the cast may be too loose to hold the bone ends in position against undesirable muscle action.
* Such displacement may be sudden and cause pain or gradual displacement being first noticed on the next x-ray. This complication may seriously delay sound healing and may produce permanent deformity.
* Medical advice must be sought if the position is suspect.

**3. Nerve Damage**

* Loss of power, tingling and numbness distal to the cast are signs of impaired nerve function. The cause may be direct compression by bone ends or plaster pressure, indirect compression of oedematous tissue or tourniquet effect, or reduced blood flow.
* Routine testing of power and sensation will detect any defect quickly. Corrective action includes relieving cast pressure, supporting and protecting paralyzed parts, and physiotherapy to help restore normal function of muscle and joints.

**Avoiding the Complications of Plaster Cast**

Complications of plaster cast can be reduced by taking all precautions of application of cast, keep a vigilant eye and making sure that patient is well instructed about [care of cast](http://boneandspine.com/care-of-plaster-cast/).

* Application of the plaster cast should be done by a skilled person in proper manner.
* Patient, as a routine should always be called for follow up examination next day. Strict elevation of the limb should be instructed.
* Patient should report on pain that is not relieved, swelling, bluishness or pallor of distal part.
* Patient should be carefully examined in the follow up for probable complications of plaster cast.

**Complications of Plaster of Paris (casts) continues**

* + Loss of position of fracture fragments.
	+ Plaster sores.
	+ Loss of power
	+ Impaired circulation.
	+ General constitutional complications of Plaster
1. **Loss of Position (fractures)**
* Swelling is the main feature of any fracture.
* A cast technician should apply a firm padded plaster to anticipate swelling and ensure the limb is elevated and the extremities exercised.
* A cast can be loose when the swelling has subsided leading to loose plaster- if left like that there will be movement of fragments
* Loss of position of the fracture.
* Solve that –change P.O.P if swelling subsides.
1. **Plaster Sores**

Comes as a result of the following

• Technique

• Instruction

• Supervision

• Foreign bodies

**Technique**

* Inadequate skeletal protection. Failure to trim the extremities of the cast correctly.

**Instructions**

* Failure of the patient to understand how to care for the cast can result to cracking, wetting or friction occurring with inevitable skin damage.

**Supervision**

* Observation for signs of tightness and looseness should be accurate and prompt action taken depending on circumstances.

**Foreign bodies**

* Children in Cast can put small toys, coins and sweets inside the cast and cause pressure sores.

Patients should be warned of dangers of scratching the skin beneath the cast with metal (implements)e,g knitting needles, back scratchers-the trauma cause can result to infected sore. **Recognition of sores**

Friction major cause

***Clinical features***

* Burning
* Itching
* Stabbing pain
* In young children increase in temperature/disturbed sleep.

**Important features of Plaster sores on examination**

* + Heat and swelling of the digits.
	+ Increase in the area of staining which has already been marked in the immediate post-operative period.
	+ Odour detected locally when the extent of the cast has been sniffed over carefully.
	+ A pronounced odour and visible pus. Discharging show that a sore has developed.

**Action to be taken**

* Encourage the patient to pin point the area and then mark it. Patient to report at once.
* Window the part and inspect the underlying skin.
* Cut by electric plaster cutter, plaster saw.
* Dress the sore.
1. **Loss of power**

Inability to extend the fingers, toes suggest loss of power.

It can be due to;

• Pressure of the P.O.P on the superficial nerve.

• Post-operative-due to prolonged tourniquet pressure.

• It is also feature of impairment of circulation.

Management- Split the cast to relieve tension.

1. **Impairment of circulation**

(Impairment venous return)

• Coldness to the extremities blueness and swelling.

• Colour change, bluish and swelling of the extremities.

 ***Management***

• If there is swelling-elevate the part affected.

• Ensure that digital exercise is done.

• If the problem persist and the patient experience a lot of discomforts, split the .PO.P and elevate the limb.

**5. General constitutional complications of Plaster**

* Stiffness of the joint due to inactivity. Free joints are to be kept mobile -. Encourage exercises.
* Muscle wasting- keep the muscles in tone e.g encouraging exercises.
* Venous thrombosis- common sites coronary and pulmonary infarction. Comes about due to blood flow cut off.

*Advise on exercise to maintain general circulation.*

**PLASTER ROOM ENVIRONMENT**

**Basic Principles**

1. Equipment’s
2. Personnel
3. Records
4. Applications
5. Environment

Casting is being done in cast room and so the distinguishing features of such a location are;

* Sink with a plaster trap to protect blockage of the drains by plaster fragments.
* A floor which can be washed down easily, a gutter should drain into a plaster trap.
* Suitable furniture, couch, chair, table and suspension.
1. **Equipment’s**

They can be placed into two groups;

* That which can protect the patient.
* The implements used for applying and removing cast.

 **Protection**

The following is an example of basic equipment’s.

* Dust sheets and other covering material to protect the patient’s clothing are essential.
* Apron and boots will protect the operator.
* Sandbags and supportive pillows for comfort and support of the patient.
* Ring cutters.
* Instruction cards to guide the patient when away from hospital supervision.

**Implements**

The average plaster trolley carries the following items;

* Protective materials – stockinette, felt wool bandages of varying widths.
* Plaster bandages of varying widths.
* Slabs of various widths.
* Plaster Shears and Plaster spreaders
* Plaster scissors, plaster knife, marking pencil.
* Orthopaedic pad/soffban of varying length.
* Electric Plaster Cutter.
* Water buckets.
* Triangular bandages/arm sling/collar and cuff.
* Walking heels, boots/iron for lower limb.
* Steel basin

**Personnel**

* The number of staff required to support the operator will depend on the type of cast to be applied.
* An assistant is very necessary.
* The assistant should be aware of the procedure you want to carry out and sure of the role to play.

**Records**

* A book, card fill/other form of record of each patient should be retained.
* The essential requirements are;
* Name, address and age.
* Diagnosis and plaster type applied, an aesthetic given, manipulation, simple application.
* Instructions given.
* Supplementary appliances given, e.g crutches.
* Date of next return.

**Applications**

* With the equipment’s ready and buckets filled with the water.
* The patient sits comfortably with suitable protective covering.
* The patient must understand what is happening.
* Ensure privacy of the patient.
* The assistant must hold the patient in the desired way.
* Put suitable padding especially around the pressure arears (bony prominence)

**Bandages**

* Immerse the bandage fully in water at angle of 45 degrees so as to encourage the release of the bubbles.
* Hold the bandage gently- otherwise will not penetrate between the layers so effectively.
* After five (5) seconds – the bubbles ceases.
* Keep the leading end free when handling the bandage and squeeze in order to expel water using two hands.
* Keep the leading end free when handling the bandage to the operator.
* Immerse another bandage as the operator unrolls the wet bandage round the limb in an even manner.
* Use circular and spiral turn and no reverse turns should be made.
* Moulding of the bandage should be done by constant smoothing with the palm of the wet hands.
* After obtaining the thickness, the extremities of the cast may require trimming – for free movement of the digits.
* To be done when the cast is still wet not fully dry.

**Slabs**

* Measure the length required and the width.
* Measure the length and the width of the pad.
* Roll the slabs end to end.
* Immerse in water.
* Remove immediately.
* Smooth carefully and quickly on a flat surface.
* Compress the layers together and exclude the bubbles.
* Operator can carry out the remaining procure using gauze roll/crepe bandage.

**Methods of applying Plaster of Paris cast.**

Every Orthopaedist has his own pet method of applying Plaster of Paris cast, but in essence, there are three schools.

1. **The skin tight cast**.

Was advocated by Bohler, the famous Viennese fracture surgeon. The Plaster of Paris is applied directly to the skin without intervening padding, in an effort to gain most efficient immobilization possible.

This type of cast is rarely (if ever) used now.

It required a great deal of skill to apply, was fraught with danger of pressure sores and circulatory embarrassment, and was uncomfortable to remove because the patient’s hair was incorporated into the cast. Unpadded cast

***Skin tight***

Stockinette lining – can’t be called padding. They are discouraged because there is a possibility that it can damage the skin.

**Advantages**

Skilled Operator.

* A light weight.
* Comfortable.
* Perfectly fitting cast is achieved.

**Indication**

* Can be used only in situations where swelling is unlikely to develop.
1. **The Bologna cast**

Emanating from the Rizzori Institute, is advocated by Charnley, and in contrast to contrast to Bohler’s method, generous amounts of cotton wading are applied to the limb and compressed by the plaster bandage with “just the right amount of tension, “This technique is said by Charnley to be demanding, so that most people split the difference and apply a padded cast without tension. We shall call this the third way.

1. **In the third way**

Most people use stockinette, a tubular knitted stocking, which stretches freely in diameter but sparingly in length.

It makes the cast look tidy and pads the sharp margins----main use.

Following the stockinette, sheet wadding is applied from the distal to proximal end of the limb, as smoothly as possible. Each turn should be applied transversely, tearing the border that transverses the greater diameter of the limb so that it lies smoothly.

**CAST PADDING**

The best form of the cast purely for the benefits of the fracture is non – padded cast because it is close contact with the fractured bone.

However, this method has several disadvantages;

1. Limiting allowance for swelling.
2. Friction of the hard cast against the skin and the bone may cause sores.
3. There is no padding to act as a protective barrier against shears and saws on removal of the cast.

***NB.***

Therefore all casts should be adequately padded with the exception of the non – padded removal cast.

Usually two layers of padding are used;

* Tabular gauze/stockinnete
* Cotton wool/soffban

**Tabular Gauze/Stockinette**

The first layer, applied directly to the skin, is synthetic mesh called tabular or thicker stockinette.

Stockinette is more expensive and preferably used with the synthetic casts

**Functions of the tabular gauze/stockinette**

* It helps prevent the limb-hairs from becoming caught in the plaster.
* It removes any roughness caused by the plaster casts edges (the edge of the tabular gauze are turned back over the cast and sealed; this creates a smooth edge which will prevent chaffing of the skin.
* It allows the conduction of perspiration from the limb.
* It aids in the removal of the cast.

***NB.***

Tabular gauze may not be used following operation procedure and where gross swelling is likely to occur as it may be difficult to split the plaster cast.

Orthopaedic padding required. It is unrolled firmly over the full area of the limb to be covered the Plaster of Paris. (Wool Padding)

**Indications of Padding.**

* Where swelling is expected/present i.e. in almost every acute conditions.
* Where the limb is thin and the bones are very superficial.
* When electric plaster cutter are used for removal.
* When wedging is needed.
* It is always wise to protect bony prominences e.g. around joints when any plaster is applied.
* It increases patient comfort.
* To help to absorb blood and serous fluid.

 **Synthetic Casting Tape**

**Indications:**

* Non – displaced fracture.
* Fitted when swelling has subsided.
* Long term casting.

**Advantages:**

* Light weight – less bulky.
* Easy to apply.
* Moisture proof.
* Fast drying (15min).
* With different colors.
* Early weight bearing.
* Radiolucent (x-ray vision can past).
* Strength weight ration.
* Feels cooler in hot weather.
* No crumble.

**Disadvantages:**

* Application requires speed and accuracy.
* May bind if tissues swell (rigid).
* High risk for irritation – tissue breakdown under the cast – extra rigidity.
* Expensive.
* Inner layer dries slowly.
* Risk for over physical mobility – light.

**Six advantages to fiberglass impregnated with polyurethane as a cast material.**

* Lightweight.
* Durable.
* Porous (has breathability).
* Waterproof.
* Sets in 5 minutes; weight bearing in 10-20 minutes
* Are radiolucent.

 **Six disadvantages to fiberglass impregnated with polyurethane as a cast material.**

* More expensive than plaster cast.
* Doesn't mould as easily as plaster cast.
* Extremely rigid so can cause pressure sores if applied unevenly.
* Mildly irritating (wear gloves when applying).
* Packages of casting material cannot freeze.
* If package has hole, moisture can get in causing it to harden.

**Splinting Versus Casting.**

When considering whether to apply a splint or a cast, the physician/Technician must assess the stage and severity of the injury, the potential for instability, the risk of complications, and the patient's functional requirements. Splinting is more widely used in primary care for acute as well as definitive management (management following the acute phase of an injury) of orthopedic injuries. Splints are often used for simple or stable fractures, sprains, tendon injuries, and other soft-tissue injuries; casting is usually reserved for definitive and/or complex fracture management.

Casts and splints serve to immobilize orthopedic injuries. They promote healing, maintain bone alignment, diminish pain, protect the injury, and help compensate for surrounding muscular weakness. Improper or prolonged application can increase the risk of complications from immobilization; therefore, proper application technique and timely follow-up are essential.

**What is the difference between a cast and a splint?**

A cast wraps all the way around an injury and can only be removed in the hospital. All casts are custom-made with fiberglass or plaster.

A splint is like a “half cast.” The hard part of a splint does not wrap all the way around the injured area. It is held in place by an elastic bandage or other material. Unlike casts, splints can be easily removed or adjusted. Many splints are custom-made from fiberglass or plaster. Others are premade (“off-the-shelf”) and come in lots of shapes and sizes for different injuries. The term cast implies that the Plaster or fiberglass encases the entire part of the body.

* A splint supports rather than encases the trunk or extremity.

# A splint provides less immobility, is frequently used on a part time rather than full time basis, and is removable.

**ADVANTAGES OF SPLINTING**

*Splint use offers many advantages over casting.*

* Splints are faster and easier to apply.
* They may be static (i.e., prevent motion) or dynamic (i.e., functional; assist with controlled motion).
* Because a splint is non circumferential, it allows for the natural swelling that occurs during the initial inflammatory phase of the injury.
* Pressure-related complications (e.g., skin breakdown, necrosis, compartment syndrome) increase with severe soft-tissue swelling, particularly in a contained space such as a circumferential cast. Therefore, splinting is the preferred method of immobilization in the acute care setting. Furthermore, a splint may be removed more easily than a cast, allowing for regular inspection of the injury site.
* Both custom-made and standard “off-the-shelf” splints are effective.

**DISADVANTAGES OF SPLINTING**

* Lack of patient compliance.
* Excessive motion at the injury site.
* Splints also have limitations in their usage.
* Fractures that are unstable or potentially unstable (e.g., fractures requiring reduction, segmental or spiral fractures, dislocation fractures) may be splinted acutely to allow for swelling or to provide stability while awaiting definitive care.
* However, splints themselves are inappropriate for definitive care of these types of injuries. Such fractures are likely to require casting and orthopedic referral.

**BackSlab**

The backslab is the simplest and safest form of plaster splint. Instead of using encircling bandages, the Plaster slabs are applied longitudinally to the limb and bandaged in place while still soft. As the Plaster firms up, the slabs conform to the contours of the limb to provide support with less risk of limb constriction than with a complete cast.

**Indications for backslab include;**

* Buckle injuries and minor physeal injuries at the wrist.
* Fresh fractures where swelling is expected.
* Posterior slabs – indicated for injuries for injuries around the joints, supracondylar fractures in children.
* Most elbow fractures. Complete casts are not necessary and are dangerous, even if split.
* Temporary support for many hand and foot injuries.
* Tibial fractures with significant swelling.
* Crush injuries and open fractures.

**Slabs for strengthening areas of potential weakness.**

Slabs are prepared in two ways

* By unrolling a gypsona bandages to a required length.
* The average thickness is 5 to 6 layers. Should avoid short ends.
* Any inequality in length can cause wrinkle/ridge to form.

**Areas required to be strengthened.**

* Large joints areas e.g hip joints region.
* Where the pull of gravity is considerable such as shoulder joint region. (Prevent cracking and loss of apposition)
* Areas as a sole of the foot which are subject able to considerably weight stresses and dampness from sweat.
* If a patient is obese- extra care must be taken to ensure that the cast is suitably reinforced.
* Use of slab to reduce the overall weight of the cast.
* This is mainly confined to large casts especially those that cover the trunk i.e Plaster Jackets. They can be made lighter and less bulky if slabs are applied.

**Drying the cast**

**1. Natural method**

Most commonly accepted method to dry in the presence of circulating air.

Patient in bed should leave the cast uncovered.

If possible patients position to be changed after two to four hours to ensure each drying of both surfaces.

The outpatient should be advised to expose the cast to warm air.

**2. Artificial method**

The use of electrically heated bed cradles for drying cast is discouraged.

Patient can suffer from overheating and cast can dry too quickly, unevenly and become brittle.

The amount of heat used must be controlled accurately.

Example- routine is a half hourly of direct heat followed by half routine without heat.

Parts of the patient not enclosed in the plaster must be protected from scorching.

**The dry cast**

Once the cast is safe from the danger of pressure-walking Plaster sole of wood/rubber may be applied. /bohler iron inserted to give sole protection.

Canvas boots may also be used to give protection from damp. /wet

**Removal of Plaster of Paris (Equipment’s)**

* Plaster Shears
* Plaster Spreader
* Plaster Saw
* Electric Plaster cutter
* Mackin tosh

**Removal of Plaster requires much skills and care just as in the application.**

• Equipment should be available to wash the limb.

• Apply in supportive bandage.

**NB**

It is not applicable to cut the Plaster cast when facing the patient but the operator should be in a position that you can see the patient. (Observation done)

Choice of the operators to be used depends on the following;

1) Unpadded cast/skin tight-use Plaster shear

2) Well-padded cast- you can use the electric plaster cutter.

***In children the electric Plaster cutter is discouraged so use the plaster shears.***

**Procedure**

* You should explain the procedure to the patient and the apparatus introduced- This helps to reduce fear of the patient.
* Gain the patient co-operation and attention-assisting in some ways
* Encourage the patient to play a role.

**Use of Plaster Shear**

* The size depends on the dimension of the cast.
* Draw a guideline along the cast to avoid the bony prominence.
* Try to insert the shear between the cast and the padding wool.
* As you use it, shear must lie parallel to the skin with the handle.
* Align the shear correctly after every cut made.

**Reasons for the above instructions**

* Discomfort.
* Injury.
* Bruising.
* Even laceration to the skin.

After every four to six cuts remove the shear to clear the cutting area. Patient can also relax. Gives position of shearing in good alignment.

**NB**

It is not easy –most operators get tired because of arm movement.

Elbow joint should remain stiff; cutting force should originate from shoulder girdle. These method conserve energy and give the operator controlled power.

**Use of Electric Plaster cutter**

* Used in removing completely padded cast. It has got a cable.
* Position the patient on the desired way.
* Warnings- Electric plaster cutter must not be used in oxygen or any other inflammable gases, since it has the sparks.
* Should be serviced regularly to ensure safety.
* Operator should not use if his/her hands are wet.

**Mark the guideline**

* Introduce the patient to the sound or the noise of the motor.
* Assure the patient that the blade only cuts a hard object but not a soft material.
* Fine oscillation but not through revolution)
* Cutter may sometimes become hot (patient feels scorched) stop immediately and inspect the area when the patient complains.
* Position the blade lightly at the start of the guideline. Exert gentle pressure on the trigger. Move the cutter on along the line smoothly built with a gentle pressure.

**Advantages of electric Plaster cutter**

* Faster/speedy
* Gives a clean cut compared to plaster shear.
* Precaution- never ignore any complain from the patient when using electric plaster cutter.

**Consideration of the part released from the cast**

* Remove the Plaster completely.
* Bivalve of the cast.

Bivalves for inspection. X-ray taking, skin preparation prior to operation.

**Special precautions**

* Two halves are replaced together and then held with bandages until further direction is given.
* When you remove the two halves you are supposed to support between the sand bags. Inspect it fully or any sign of trauma caused during removal procedure.
* Wash and dry the part. Gently massage with oil and spirit mixture to restore normal nutrition and elasticity of the skin.
* After extend of immobilization, oedema is likely to be there;
* Use-Elastoplast
* Elastocrepe
* Advice the patient to extend his/her activities gradually.
* Patient should be advised to rest the part at regular interval when maintaining the digital movement when at rest.
* Plaster removed prior to surgery, skin texture and nutrition should be improved by massage. This can stimulate wound healing.

**CAST SETTING**

The ‘setting’ of a cast is the change of Plaster of Paris to crystalline gypsum. The dipping of the bandages releases the Plaster from the carrier fabric, primarily after application.

The Plaster reacts with water and forms long slender crystals that interlock with each other through the gauze layers, creating slender crystals that interlock with each other through the gauze layers, creating a rigid unlaminated piece of gypsum. If motion occurs during setting, the crystals will be short and join as rigidly, thus weakening the completed cast.

The time interval Plaster of Paris takes to form a rigid dressing after the contact with water is the “setting time”

The cast should be applied rapidly enough to set as one unit.

Warm or hot water speeds the chemical reaction. Plaster bandages thoroughly squeezed of excess water prior to application are said to set faster.

The commercially available Plaster bandages usually fall into two categories; the fast-setting plaster which hardens in 5 to 8 minutes, and the extra-fast bandage, requiring 2to 4 minutes.

**GREEN CAST**

The plaster cast which has just set is in ‘green stage’. Chemical reaction of Plaster of Paris is promoted by an abundance of water; however, the water is not completely bound in the crystalline latticework. This excess water accumulates in pocket and explains the dampness and increased weight of the green cast. Maximum cast strength requires evaporation of the unbound water.

**CAST DRYING**

The cast dries by the evaporation of the excess water. The result is a mature cast containing multiple air pockets that lighter the cast and make it permeable.

The skin’ breathes’ by these air vents through the Plaster bandages.

Cast drying time depends on the amount of water to be evaporated and the thickness of the Plaster cast.

A thin cast reaches maturity more rapidly than a thick one.

Evaporation is also promoted or retarded by the surrounding environment.

A’ green cast’ in a humid atmosphere created by covering blanket dries slowly.

The moisture evaporates more rapidly if the cast is exposed to dry, warm, circulating air. All “green casts” should be kept uncovered until dry.

**IDEAL PLASTER CAST**

* Fit- The cast should have a glove like fit and be molded precisely to the part.
* Extent- Plaster to cover enough of the body to effectively immobilize the injured part. The joint above and the joint below should be included in the cast.
* A long arm cast is required to adequately immobilize elbow joint motion and forearm pronation and supination are transmitted to the fracture site through the proximal fragments.
* A fracture of the Tibia and Fibula requires a long cast to control both knee and ankle joints.

**DANGERS AND COMPLICATIONS CASTS**

 **Pressure**

Skin- cast pressure on the bony prominences e.g (acromion process, olecranon , radial syloid, iliac crests, head of the fibula and the ankle malleoli) compresses the skin and the subcutaneous tissues directly against the underlying bone causing;

**Localized ischemia**

Prolonged ischemia results in tissue necrosis.

Development of pressure sore.

Area of compression may cause pain, however with tissue death nerves are devitalized and the patients lose his symptoms.

Nerve- Pressure sores are not only squeal of a poorly padded or ill fitted cast.

A superficial peripheral nerve may be compressed by the cast against underlying bone.

The common peroneal nerve if compressed-prevents the transmission of the nerve impulses and results in anesthesia and paralysis.

Complete common peroneal nerve palsy is manifested by the” foot drop” and loss of sensation on the dorsolateral aspect of the foot.

Neurologic damage may be incomplete or complete, reversible or not. If recognized the compression on the nerves must be relieved by windowing the cast.

**Constriction**

Constriction of the limb is caused by circumferentially rigid pressure applied to the extremity by the cast. The forces are sufficient to impeded or prevent the venous and arterial circulation.

When venous return is diminished and arterial flow continues, the distal extremity will become swollen and engorged with blood. If thee arterial blood supply is embarrassed or stopped, the distal limb is rendered ischaemic and the stage is set for gangrene.

Constriction caused by improper plaster cast technique is avoidable.

**Constriction from within**

Most frequent cause of constriction is swelling of the limb after cast application. If a circular cast is applied prior to maximum tissue reaction, continued swelling against the unyielding Plaster may occlude venous and arterial flow.

Blood soaked and clotted dressings under Plaster cast that do not yield to the tissue swelling. These may bind the limb tightly and occlude the circulation.

**Recognition of constriction**

Begins with the suspicion. The diagnosis is confirmed by subjective and objective findings.

The five p’s identified below are a valuable checklist.

**Symptoms**

**1. Pain**

Is the symptom of developing circulatory embarrassment from the cast?

The pain is burning or cramping in quality and is not localized. The evaluation of pain must be individualized.

**2. Paresthesia**

The patient may complain of numbness of the exposed fingers or toes. This sensation may be prickly, tingly, or burning in quality consistent with paresthesia.

**3. Paralysis**

The patient may or may not be aware of the inability to move the fingers, toes. The pain maybe so severe as to inhibit any attempt at motion. Paralysis may be both symptom and a sign.

**Signs**

**1. Pulseless**

If vascular embarrassment is suspected, areas affected should be windowed to allow for palpation of the vessels.

Gentle pressure on the nail bed will cause blanching on removal of the pressure the rapidity with which the nail bed returns to its normal colour is an indication of the adequacy of circulation. A pulseless limb may demonstrate adequate capillary refill in the nail beds.

**2. Pallor and poikilothermia**

The exposed fingers and toes are pale and cool with arterial insufficiency. Examining the opposite side both visually and by touch will make this evident. The digits may have decreased sensation to pin prick and light touch. hypesthesia and anesthesia are ominous signs.

**3. Paralysis**

Motor paralysis is a late finding in the ischaemic limb. The patient becomes unable to actively move the fingers or the toes.

Paralysis maybe based on primary nerve injury. If pain is severe, vascular impairment must be considered.

**Correction of constriction**

The result of prolonged circulating insufficiency may be amputation or the irreversible tissue damage of a volkmann’s ischaemic contracture.

Constriction of a limb by a rigid cast or dressing must immediately relieved by removal of cast and the division of all padding and dressing down to the skin. A cast may be bivalve and spread.

**In summary**

- There is first suspicion, then the observation and the recognition, and finally the prompt action to relieve compression.

**AFTER CARE OF P.O.P**

* The “green “cast is protected from stress and supported as necessary with the pillows.
* The Plaster is kept uncovered to promote cast drying.
* The patient is instructed in the danger signals and advised how to care for the cast.
* The supplies and equipment are cleaned, replaced and readied for further use.

**Instructions to patients**

Cards of written instructions regarding the care of Plaster casts should be given to all patients who are going home wearing Plaster cast.

**Danger signs**

**1. Pain**

Patient must immediately report to the physician any increased discomfort after cast application.

Immediately after cast application the patient may be concerned by the heat of the Plaster, re-assurance-this is normal and will pass in 10- 15 minutes.

**2. Swelling**

This swelling may be reduced by elevation of the part above the level of the heart, increasing venous and lymphatic return.

**3. Miscellaneous**

An untoward medical event should also be reported to and evaluated by the physician. Nausea, vomiting, chills, fever or rash may all reflect a complication under the Plaster cast.

**DOS**

* Keep uncovered. The “green “cast should be left exposed to air until mature. The drying time varies with the thickness of the plaster cast but is usually 24hrs to 48 hrs.
* Protect. A cast does not reach maximum strength until completely dry and should be protected. Upper extremity casts are placed in slings until maturity is reached. Lower extremities casts, weight bearing or not, are initially protected by crutches. Patient should be instructed not to bear weight on a walking cast for 24hrs to 48 hrs. after application.
* Keep clean. The cast should be kept clean, for this prevents cast breakdown and somewhat restricts the patient from undesirable activities.
* Avoid moisture. The cast must be kept dry. Water causes the mature plaster to crumble and become soft. The gypsum is washed out and only the gauge bandage remains.
* Exercise joints. The patient should be encouraged to move all the adjacent joints not immobilized by the cast.
* Above knee Plaster cast- patient should exercise the hip joints and toes.
* Above Elbow plaster cast- shoulder, thumb and fingers for exercise.
* Isometric exercises of the muscles immobilized by the cast may be important to maintain good muscular tone.

*NB- This exercise is not routine and must be advised only on the recommendation of the physician.*

**DON’TS**

* Don’t scratch. Many patients develop a tremendous desire to scratch an itch beneath a plaster. Manipulating devices such a coat hanger, back scratcher, or pencil beneath a plaster is prohibited.
* Inserted foreign bodies- No foreign objects should be introduced under the cast. FB may cause localized pressure on the skin with the possibility of pressure sore.Toothbrushes, coins, good luck charms, and may other objects have been associated with skin and tissue necrosis.
* Do not remove padding- Padding aids in immobilization and alleviates much of the uncomfortable sensation of the cast saw.

**Orthopaedic department (Casting Room)**

Please read the following instructions careful.

* Do not wet, cut, heat, or otherwise interfere with this plaster cast.

**Report at once;**

* If it cracks, becomes loose/ otherwise uncomfortable.
* If there is any pain
* If there is any discharge
* If the fingers/toes become numb/difficult to move.
* If the fingers/toes become swollen/blue.

**Advice to the patient**

* The Plaster cast may feel tight for some time after application.
* This can usually be relieved by lying arm/leg on one moving pillows and by constantly moving those joints of the arm and the leg that are not covered by the Plaster cast.
* Patient sign for the instruction cards.

**SUPPLEMENTARY NOTES**

**PLASTER OF PARIS**

History

The writing of Hippocrates discuss in the management of fractures, recommending wooden splints plus exercise to prevent muscle atrophy during immobilization.

The Ancient Egyptians used wooden splints made of bark wrapped in linen. The ancient Greeks also used waxes and resins to create stiffened bandages. The Roman, in AD 30, describes how to use splints and a stiffened with start.

Arabian doctors used lime derived from sea shells and albumen from egg white to stiffen bandages.

The sixteenth century the famous French Surgeon Ambroise Pare; (1517 – 1590) promoted the use of artificial limbs made casts of wax, cardboard, cloth, and parchment that hardened as they dried. The innovation of the modern cast by four military surgeons,

Dominique Jean Larrey,

Louis Seutin

Antonius Mathijsen

Nikolai Ivanorich Pirogou

The first commercial bandages were produced from Germany (1931), and were called cellona.

**DOMINIQUE JEAN LARREY (1768 – 1842)**

One of his patients after the battle of Borodino in 1812 whose arm had to be evacuated immediately following the operation and passed from Russian, through Poland and Germany. On his arrival at his home in France the dressing was removed and the wound found to be healed. Larrey concluded that the wound had been undisturbed had facilitated healing.

After the war Larrey began stiffening bandages using camphorated alcohol, lead acetate and egg white in water.

**LOUIS SEUTIN (1793 – 1865)**

Used cardboard Splints and bandages soaked in a solution of starch and applied wet. These dressings required 2 to 3 days to dry, depending on the temperature and humidity of the surrounding.

Seutin’s technique for the application of the starch apparatus formed the basis of the technique used with plaster of paris today.

**WILLIAM ETON (British)**

Who described a method of treating fractures that he had observed in Turkey that Gypsum (Plaster of Paris) was moulded around the patients leg to cause immobilization. If the cast became loose due to a reduction in swelling, then the liquid gypsum was poured into a hole to fill the space.

**ANTONIUS MATHIJSEN**

Developed a method of applying Plaster of Paris bandages.

Emphasized that only simple materials were required and that the bandage could be windowed or bivalved.

Used coarsely woven materials, usually linen, into which dry plaster of paris had been rubbed thoroughly.

The bandages were then moistened with a wet sponge or brush as they were applied and rubbed by hand until they hardened.

**NILOLAI IVANOVICH PIROGOV (1810 – 1881)**

Plaster of Paris dressings were first employed in the treatment of mass casualties in the 1850s during the Crimean war.

He had observed the use of Plaster of Paris bandages in the studio, who used strips of linen soaked in liquid Plaster of Paris for making model.

Pirogov’s method involved soaking coarse cloth in a Plaster of Paris mixture immediately before application either by stockings or cotton pads.

Large dressings were reinforced with pieces of wood.

**How to prepare Plaster of Paris**

Plaster of Paris is made from crystalline gypsum by heating in controlled conditions. (120c – 160c)

2(caso4.h2o) + heat? 2(caso4, ½ h2o) + 3h2o

Gypsum plaster of Paris water

The POP powder then spread gauze bandage which sets to hard cast when soaked in water.

**POP SETTINGS**

POP rapidly absorbs water which forms growing solid crystals of caso4.2h2o.

2(caso4, 1/2h2o) + 3h2o? 2 (cas04.2h2o.2h2o) + heat

Pop water Gypsum crystals

During this time heat is generated (exotherm) as a result of chemical activity (hydration).

**Stages of setting**

Initial set < 10 min

Crystals become longer and start to interlock.

End of the working time.

If the cast is manipulated after the initial set it will be weak.

If immersed in cold water initial set will be delayed, working time lengthened.

In warm water (<50c) initial set will be accelerated.

>50c the setting rate will slows, > 100c no set.

**Final Set**

* Forming a rigid structure around the gauze mesh.
* Heat is generated at this time.
* End of exotherm period.
* 10 – 45 min

**Hard set**

* Crystals are completely locked together, excess water will be lost by evaporation.
* Strength of the cast increases considerably during first 24 – 72 hours.
* The plaster is then able to withstand considerable forces.
* If the cast subsequently absorbs excess water, it will weaken.
* Drying out will be delayed in cold or moist conditions.
* Accelerated in warm and dry environment.
* Denotes end of the drying out period.

**Preparing to place a splint**

* Expose the injured extremity completely before splinting.
* Clean, repair and dress all open wounds before applying any splint.
* Check for neurovascular compromise.
* Choose the appropriate size and shape of splint to be used.
* Goal is to cover ½ circumference of the extremity without overlap.
* Prevent stiffness and loss of function by;
* Preparing extremities to be splinted in their functional position.
* Preparing extremities to be splinted against gravity.

**Minimize, swelling/edema**

* Rest, Ice, and Elevate
* Ice – apply to area where there is no plaster and more than 15 – 20 minutes/hr at a time for first 2 days.
* Longer may numb the extremity.
* Shorter may not affect swelling.
* Elevate the limb above the heart level.

**Padding**

* To protect skin soft tissue and bony prominences from pressure abrasion and for cast removal.
* To protect the skin from thermal injury during setting.
* Over padding reduce closed fitting of cast and permits excess movement at fracture site resulting in impaired healing.

**Principles of casting making**

**Padding**

* Apply stockinet over the area to be plastered.
* Then apply spl orthopaedic padding overlap each turn by 1/3 in order to secure layers.
* Padding is especially important if
* Swelling is present/expected
* Limb is thin, bones are superficial
* When electric cutter is used.

**Application**

* Get ready equipment and water (25c- 35c)
* Patient in comfortable position and clothing protected and understand what is going happen.
* If patient is tense, cast will loose and inefficient desired position secured and held correctly bandages of the correct size are immersed in water at a time, held until bubble stops.
* Ends are gently squeezed and expel water (not too much – will become unworkable)
* Unroll the wet bandage around the limb in an even manner minimum tension directed towards the centre of the bandage.
* Only circular and spiral turns, reverse turns will lead to ridges inside the cast, moulding done by constant smoothing with wet palm.
* When the required thickness obtained, trim to ensure range of movement at joints not immobilized (this should be done while the cast is wet)
* Patient is instructed in taking care of the cast.

**For Slab**

* After immersed in water, immediately remove, the layers must be pressed together and bubbles excluded, if this is not done the layers become brittle when dry and can separate.
* Setting depends on
* The less water is used, the more linear expansion occurs.
* Potassium Sulphate used as an accelerator.
* Sodium borate as a retarder in order that the plaster can be caused to set more quickly or slowly.

**How do you know if the splint is too tight?**

* If the patient feels numbness, tingling, or increased pain.
* If the fingers or the toes start turning blue.
* If the fingers or the toes become swollen.

**Care of the splint**

* Do not get the splint wet. Use plastic bags to cover the splint while bathing.
* Do not walk on the splint.
* Do not stick anything down the splint to scratch or itch. This may lead to injury and infection.

**Complications of Splinting**

* Rarely occur if applied correctly.
* Most common; sores, abrasions and secondary infections from loose or ill – fitting splints.
* Less common; neurovascular compromise from tight fitting splints, contact dermatitis, and thermal burns from heating of plaster, deep venous thrombosis.

**Follow – up**

* Instruct patient should return if numbness, tingling, increased pain and impaired sensation.
* Re- evaluate in 48 hours for neurovascular compromise.
* 5p’s: pain, pallor, paresthesia, pulselesssness, paralysis.
* Orthopaedic evaluation in 7 – 10 days for casting.

Plaster of Paris: Past, present and future

Hemant Sharma, MS, DNB and Dhanasekara Prabu, MS

No other object is as closely associated with the branch of orthopaedics as Plaster of Paris or POP as we commonly call it. Orthopaedicians have been associated with POP just like cardiologists with ECG and the plastic surgeons with Humby's knife. Its use is ubiquitous and we put it to such a myriad of uses that the list is endless.

1.  History

The name Plaster of Paris (POP) had its origins from the fact that it was extensively mined from Montmartre in Paris district. But its use predates the industrial revolution, they have been found on the insides of pyramids. The need to immobilise the fracture to prevent pain and deformity and all the while allowing mobilisation has been the perennial problem in orthopaedics. Splints made of bamboo and wooden sticks were used in the ancient times but they couldn't be relied upon to hold the reduction. More materials were tried like wax, starch, cardboard but all ended in failure. This was the time POP was beginning to be used in construction and by sculptors, surgeons observing its properties hit upon the idea of using it in orthopaedics. Patients with fractures in the long bones of leg were placed in long narrow wooden boxes and the gaps filled with POP. This was however bulky and alternatives were sought. The idea of incorporating POP in bandages was hit upon by two surgeons, Antonius Mathijsen and Nikolai Ivanovich Pirogov in the 1850's. The results are for us to see.

2.  Evolution of POP and its uses

The uses of POP have only evolved with time. It started out as a method to immobilise and hold reductions in the management of adult and paediatric fractures, for which it still continues to be used. Sarmiento[1](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib1) has shown that the management of low energy fractures of humerus and tibia is possible without functional compromise with a POP cast even in the age of AO and ORIF. In Paediatric orthopaedics POP has revolutionised the management of club foot. What was once considered a surgically treatable condition is now managed by serial casting due to the innovation of Kite and Ponseti.[2](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib2) In DDH Hip spica is used once reduction is achieved either by closed or open methods. Plaster has also been used to treat fracture and deformities in spine. Hibbs introduced postoperative immobilisation using POP jacket in patients of Pott's spine. He also introduced turnbuckle cast that is used in the management of scoliosis.[3](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib3) Risser also introduced a method for treatment of scoliosis by casting.[4](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib4) Plaster of Paris is used in postoperative immobilisation and also in the management of some amputees. Casting over stumps has allowed immediate rehabilitation using prosthesis.[5](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib5) POP was used in the immediate management of Open fractures until the evolution of external fixator. It has also been used in the management of neuropathic joints and diabetic ulcers.[6](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib6) It is used in the correction of deformities like fixed flexion deformity of the knee.

3.  Plaster of Paris – properties and complications

Plaster of Paris is calcined gypsum (roasted gypsum), ground to a fine powder by milling. When water is added, the more soluble form of calcium sulphate returns to the relatively insoluble form, and heat is produced [2 (CaSO4.½ H2O) + 3H2O → 2 (CaSO4.2H2O) + Heat]. The setting of unmodified plaster starts about 10 min after mixing and is complete in about 45 min; however, the cast is not fully dry for 72 h.[7](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib7)

The biggest advantage of POP is the property that allows itself to moulding. This allows POP to be contoured according to the limb that it is applied to. It is sufficiently rigid and allows immobilisation to allow healing to take place. However it is not without its complications. Prolonged immobilisation in a POP makes the skin under the cast vulnerable. The dead skin is not removed and leads to scaling. Other complications like ulceration, maceration, itching can result. Even burns can be caused by the exothermic reaction. Staphylococcal infection of the underlying skin can result in dermatitis. Cast syndrome, associated with body jacket casts, involves obstruction of the third portion of the duodenum from duodenal constriction caused by stretching of the superior mesenteric vessels. The symptoms are nausea, vomiting, fever, and electrolyte imbalance. The most dreaded complication however is compartment syndrome and the resulting sequelae Volkmann's Ischaemic contracture. The nerve palsies have also been associated with poor plaster techniques. The other chronic complication is the “fracture disease” that results from prolonged immobilisation, leading to osteoporotic bones and stiff joints. Complications when casts are used in fracture treatment are loss of reduction, malalignment, delayed and non-union. Localised hypertrichosis has also been reported as rare complication of internal fixation and POP application.[8](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib8)

Recently parameters like cast index and gap index have been developed that predict cast failure.[9](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib9) Cast index is the ratio between the inside diameter of the cast on the lateral view to the inner diameter of the cast on AP view. Gap index is the space between plaster and skin measured as a ratio to inner diameter of the plaster. Higher cast and gap index have been associated with higher failure rate.

However most of the complications can be avoided by adhering to a good plaster technique. They include proper padding especially of the bony prominences, avoiding casts when the limb is swollen, maintaining functional position of joints and preventing pressure points when moulding the cast. To prevent compartment syndrome, care must be taken in children and in patients with soft tissue injury (including burns), multiple trauma, paralysis or paresis, head injury, or altered sensorium (due to medications, substance abuse, or psychosis). Evaluation of neurovascular status and recording of abnormalities are essential.

The factors that cause thermal burns are a dip water temperature of >75F (24 C), use of more than eight layers, and use of a pillow (inadequate ventilation). Plaster residue in the dip water did not increase the exothermic reaction. Moisture on the outside of the cast decreased the temperature of the plaster.[10](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib10) According to Halanski et al, the surface of the cast was 2.7 ± 1.9 C cooler than the internal temperature. A dip water temperature of <24 °C did not result in a temperature high enough to cause burns, regardless of the number of layers. A dip water temperature of >50 °C, a twenty-four-ply cast thickness, use of a plastic pillow, overwrapping of a curing plaster cast with synthetic, and use of a splint folded on itself were associated with temperatures causing burns.[11](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib11)

4.  Recent uses and alternatives

Plaster of Paris or calcium sulphate has found other uses as well. It has been used as bone graft substitute and to fill up bone defects.[12](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib12) It has been used in spinal surgery as a bone graft substitute. POP is also being investigated as an antibiotic delivery mechanism.[13](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib13) However POP usage has been declining in its use as casting material after the advent of fibreglass or polyurethane tapes and splints. Plaster has certain technical advantages over synthetics. Plaster can be tucked or pleated. Plaster requires less tension for application. Gloves are not required. Plaster absorbs fluids, including pus, blood, and sweat. If a cast saw is not available, the plaster cast may be removed by soaking and unrolling or using simple hand-cutting instruments. However, compared with fibreglass, plaster may be difficult to store in humidity and is more difficult to keep clean. Plaster casts are heavier than fibreglass, exhibit more breakdown for short-leg casts, and are judged to be more restrictive and less comfortable.[14](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3880430/%22%20%5Cl%20%22bib14) However in a country like India where the cost considerations come in to play POP still remains the choice of material in casting.

5.  Conclusion

From the early days of orthopaedics when fracture management was mostly conservative to the present era of technological advancement where every fracture is managed aggressively and immediately with internal fixation, POP has been our constant companion, and we can safely hazard a guess that it will remain so in the future. This places a responsibility on the orthopaedic residents to learn proper plaster techniques and not look down upon this simple and effective method for the treatment of fractures. A consideration may also be given in more emphasis of closed management of fractures using POP as a part of orthopaedic curriculum in a developing country like India where access to surgical facilities are limited especially in remote places. We take liberty to state that the days of identifying orthopaedicians in hospital corridors by looking at the white POP stains on trousers and shoes will not be history.

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**Abstract**

**BACKGROUND:**

Plaster has been used for centuries as a stiffening agent to treat fractures and other musculoskeletal conditions that require rest, immobilization, or correction of a deformity. Despite modern metallurgy and internal stabilization, plaster casts and splints remain an important means of external stabilization. Casting is a dying art as modern internal and external fixation replace external immobilization. Proper casting technique is paramount. This manuscript outlines the history and chemistry of immobilization materials and techniques as well as the differences among them and the advantages and disadvantages of each.

**METHODS:**

Historical references, peer-reviewed journals, textbooks, and primary sources were reviewed to provide data for this review.

**RESULTS:**

The history of immobilization reveals a progressive development and refinement of materials that culminated in Mathijsen's plaster bandage in 1851. In 1798, calcium sulfate (plaster of Paris) was introduced. By 1927, crinoline rolls dipped in plaster treated with binding agents’ facilitated application. Synthetic casting "tapes" (45% polyurethane resin and 55% fiberglass) were introduced in the 1970s. Splinting techniques are ancient, with development spurred by treatment of war wounds. Plaster relies on soft-tissue contact to maintain rigidity. There are well-known advantages, disadvantages, and complications of plaster management. Casting materials all create an exothermic reaction. Burns are associated with water temperatures of &gt; 24°C, more than eight layers (ply), and inadequate ventilation. The maximum water temperature must be lower with fiberglass casts. Plaster was the definitive management for most fractures for over 100 years until it was replaced by modern surgical techniques involving internal fixation in the latter part of the twentieth century.

**CONCLUSIONS:**

Plaster casts and splints remain an important treatment method for acute and chronic orthopaedic conditions.

**History of immobilization.**

History tells us of the many methods used by our ancestors in managing fractures, such as wooden sticks fastened around the fractured limb, the placement of the injured extremity in a box filled with sand, and later, the wrapping of the newly invented bandages of plaster of Paris. All these methods shared the objective of immobilizing the fractured fragments as much as possible.

Improvements in anesthesia in the early part of the 20th century and the later discovery of antibiotics made the surgical treatment of fractures a practical reality. The surgical approach appeared to crystallize the dream of anatomical reduction of fractures. The promise that surgery would eliminate the need for immobilization of joints adjacent to the fracture made the new therapeutic modality even more attractive. A parallel loss of interest in nonsurgical treatments was a logical consequence.

**Acceptance of rigid immobilization**

One can also suspect that physicians who believed that immobilization was good for fracture healing must have concluded that rigid immobilization was even better. This goal was thought to have been achieved when the technique of rigid fixation and interfragmentary compression was popularized by the Arbeitsgemeinschaft Osteosynthesefragen (AO) in the late 1950s. The original concept of rigid fixation had been advocated earlier by Danis, a Flemish surgeon.

A similar philosophy regarding the benefit of fracture immobilization had developed among those who were treating fractures by non-surgical means. The principle that joints above and below a fracture must be immobilized became almost universally accepted. Exceptions to the prevailing practice never achieved wide recognition. Delbet, a French surgeon, described a method of treatment of tibial fractures using a “gaiter” firmly applied over the extremity, extending from below the knee to below the ankle. Lucas-Championniere, also a French surgeon, attempted to popularize the concept of massage to the injured limb. His success in disseminating his ideas was limited.

The aftermath of World War I brought about the virtually universal acceptance of the precept that the highest degree of immobilization of fractures was mandatory. Sir Robert Jones, from England, had earlier made the pronouncement that “fractures must be immobilized continuously and uninterruptedly until union is complete.” He was, indeed, reinforcing the teaching of his uncle, Hugh Owen Thomas who is considered the founder of modern orthopedics in the United Kingdom.

**Leading the rebellion**

A rebellion against the premises advanced by Sir Robert Jones seems to have been led by George Perkins, another Briton who advocated skeletal traction of fractured tibias, while encouraging active and passive motion of the knee joint. His method was practiced in Great Britain but failed to receive wide acceptance in Europe and America.

In Central Europe, just preceding the onset of the World War II, Bohler, from Austria successfully popularized the use of “skin-tight” plaster of Paris casts and the parallel active use of the injured extremities. His teachings reached America primarily through his disciple, Ernest Dehne, an Austrian who had emigrated to the United States. As a member of the armed forces, he successfully popularized Bohler’s system. Bohler’s casts adhered, nonetheless, to the traditional belief that immobilization above and below a fracture was necessary.

One of the fractures that had been traditionally managed with casts that included the adjacent joints was that of the humeral diaphysis. Spica casts immobilized the elbow and shoulder joints. The “hanging cast,” popularized in the 1950s for the treatment of this fracture, demonstrated that immobilization of the two joints was not necessary for uneventful healing.

**A new cast is born**

Inspired by the effectiveness of the patella tendon bearing prosthesis (PTB) used by below-the-knee amputees, a cast was designed for the treatment of diaphyseal tibial fractures in the 1960s. The cast was conceived on the assumption that weightbearing stresses could be effectively transmitted from the floor to the patellar tendon and tibial flares, and in that manner prevent shortening of the fractured extremity.

Within a short time, it became obvious that the success of the new cast was not based on the anticipated transfer of stresses proximally but by the support of the soft tissues surrounding the fractured bone. This realization permitted the provision of freedom of motion, not only to the knee but to the ankle joint as well. The below -the-knee functional brace replaced the below-the-knee, PTB cast.

Clinical and laboratory studies eventually demonstrated that, especially in body segments with two bones connected by an interosseous membrane, the initial shortening experienced in closed fractures remains essentially unchanged, and the role of the brace is significantly limited to providing angular stability through a hydraulic- like mechanism. Similarly, it was documented that the motion between the fractured fragments, produced by the active use of the extremity, has a beneficial osteogenic effect.

**Functional fracture bracing benefits**

Functional fracture bracing was extended to the management of other fractures with different degrees of success. Femoral fracture bracing failed to demonstrate a consistent rate of success, since angular deformities were seen with great frequency when the brace was used in the care of fractures above the distal third of the bone. Forearm fracture bracing also never gained popularity, probably because of technical difficulties encountered in the application of the brace and the simplicity of plate fixation. Braces for fractures of the humerus, ulna and distal radius, also developed in the 1960s and 1970s, brought about a high success rate.

Fracture bracing further supported the often-neglected observation that angulation of a few degrees and mild shortening are not complications but inconsequential deviations from the normal.

A review of the literature has revealed that stabilizing devices for fractures resembling modern braces had been used in the past. In England, Gooch described one such device in 1776. Smith, in 1855, in Philadelphia, described “prostheses” for the treatment of non-unions. His appliances resemble modern braces. It is, however, a giant leap of the imagination to conclude that their designs, rationale, underlying philosophy and use were the same as those of contemporary functional fracture braces.

As progress is made in the field of surgical treatment of fractures, comparable advancements are taking place in the non-operative care of long bone fractures. “Gold standards” in fracture treatment do not belong, at this time, exclusively to one single methodology.

The 20th century closed with a record of major advances in the care of fractures. Unfortunately, the universal crisis in the delivery of health care, mainly produced by the high cost of advanced technology, has precluded the extension of such benefits to several in regions of the world where many are unable to afford its implementation. It remains a challenge and responsibility to future generations to address this issue in earnest, and to find practical and humane solutions.

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**TYPES OF SPLINTS**

**Upper extremity splints**

• Figure of eight

• Sling and swathe

• Sugar tong-proximal and distal

• Long arm posterior splint

• Ulnar gutter

* Radial gutter
* Volar splint

• Thumb spica

• Finger splints

**Lower extremity splints**

• Knee splint

• Posterior leg splint

• Stirrup splint

• Budding taping

**UPPER EXTTREMITY CASTS**

**SHORT ARM CAST (SAC)**

**BELOW ELBOW P.O.P**

**Description**

The short arm cast extends distally from the proximal forearm to include the palm and the dorsum of the hand. The plaster completely covers the forearm but does not restrict elbow joint motion. The meta-carpophalangeal joints have complete motion, for the cast ends proximal to the distal palmar crease and the knuckles.

This cast only partially immobilizes the wrist joint because the joints above and below are free. Pronation and supination of the forearm is not controlled.

**APPLICATION**

The patient is supines and the affected arms rests on the cast table with the elbow flexed to 90%. The thumbs and the fingers are steadied by an assistant with the wrist placed in a desired amount of dorsiflexion, palmar flexion, and ulnar or radial deviation. Pronation and supination are also controlled from the hand. Extreme positions of the joints should be avoided. Additional padding is applied to the ulnar styloid. This is required particularly with rotational motion in the cast. The plaster is moulded snugly to the palm and dorsum of the hand. A gentle anteroposterior mold is placed on the forearm. The cast is trimmed proximally to permit complete elbow joint motion. The plaster is removed distally to allow 90 degrees of flexion at the distal palmar crease and prevent irritation of rubbing on the knucks. The plaster frequently is heaped up and becomes too thick in the thumb web and must be trimmed to allow pinch between the index and the thumb.

**SHORT ARM CAST WITH FINGER SPLINT**

**Description**

A short arm cast has either and aluminiumn or Bohler finger splint incorporated into the plaster in the palm. The splint is fashioned to accept the finger in the position of function. The finger is firmly held to the splint with adhesive tape. The tape is not sufficiently tight to cause constriction of the circulation on excessive pressure of the finger against the splint. This device immobilizes the fingers and respective metacarpals.

**Indications**

Phalangeal fractures, unstable metacarpal fractures, and ligamentous injuries to phalangeal and metaccurpo-phalangeal joint.

**THUMB-SPICA**

**Description**

Short arm cast including the thumb.’ Spica’ refers to the figure – eight or spiral of the bandages at the function of distal and proximal portions of a cast.

Occurs between the thumb and the hand. The cast extends distally on the thumb beyond the distal joint, exposing just the tip.

Spica –immobilizes the thumb metacarpal and phalanges. This cast decreases mobility of the wrist joints primarily of the radial carpal bones that is the navicular and the greater and lesser multangular.

**Indication**

Fractures of the thumb ,metacarpal and phalanges, ligamentous injuries to the thumb joints and fractures of carpal navicular.

 **SUGAR TONG CAST**

**Description**

Single set of plaster splint extending from just proximal to the knuckles up the dorsal forearm/ snugly /wrapping about distal humerus and coursing distally down the volar forearm to the distal palmar crease.

This devise partially immobilizes the wrist joint and restricts pronation and supination more effectively than does the short arm cast.

Elbow 90% of flexion. Additional padding is placed over the bony prominences of the medial and lateral epicondyles of the distal humerus. Excessive pressure is avoided at the area if the medial epicondlye to protect the ulnar nerve.

**Indications.**

Immobilizes fracture of the distal radius (colles fracture)

**LONG ARM CAST (A/E P.O.P)**

**Description**

A long arm cast extends distally from the uppermost portion of the arm to include the palm and dorsum of the hands. The elbow thus is incorporated into the cast . This cast provides excellent immobilization of the forearm and is superior to a short arm cast in restricting wrist motion, for pronation and supination is prevented. Powerful immobilization is afforded the elbow joint and distal humerus. The elbow is usually positioned at 90% of flexion with the desired amount of pronation or supination of the forearm. The patients arm should be relaxed during application. The ulnar styloid, olecranon, and medial and lateral epicondyles of the humerus require additional padding.

**Indications**

* Unstable ligamentous injuries of the wrist joint.
* Unstable fractures of the carpal bones.
* Fractures of one or both bones of the forearm.
* Stable injuries of the elbow joint.
* Stable fractures of the distal humerus.

**LOWER EXREMITY CASTS**

**SHORT LEG NON –WEIGHT –BEARING CAS**

**Description.**

Extends from just the knee joint distally to the base of the toes. The plantar surface of the plaster is often carried beyond the toes, providing support and protection in the form of a toe plate.

Knee joint motion is full, but flexion of toes may be restricted by the volar plate. The ankle joint and metatarsal shafts are only partially immobilized by this cast, for the joints above and below the structures are free.

