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Application of Plaster of Paris, Splints and Casts in Plastic Surgery

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Abstract

Plaster of Paris has traditionally been the preferred material for splints and Casts. The ability to properly apply casts and splints is a technical skill easily mastered with practice and an understanding of basic principles. Once the need for immobilization has been determined, the physician must decide whether to apply a splint or a cast. Splinting involves subsequent application of a non-circumferential support held in place by an elastic bandage. Casting involves circumferential application of plaster or fiberglass. This review article gives an overview of application of Plaster of Paris, Splints, Casts in Plastic Surgery.

Keywords: Plaster of Paris; Splints; Casts.

INTRODUCTION

The ability to properly apply casts and splints is a technical skill easily mastered with practice and an understanding of basic principles. The initial approach to casting and splinting requires a thorough assessment of the skin, neurovascular status, soft tissues, and bony structures to accurately assess and diagnose the injury. Once the need for immobilization has been determined, the physician must decide whether to apply a splint or a cast.[1]

Plaster has traditionally been the preferred material for splints. Plaster is more pliable and has a slower setting time than fiberglass, allowing more time to apply and mould the material before it sets. Materials with slower setting times also produce less heat, thus reducing patient discomfort and the risk of burns. Fiberglass is a reasonable alternative because the cost has declined since it was first introduced. It produces less mess, and it is lighter than plaster. Fiberglass is commonly used for non-displaced fractures and severe soft tissue injuries.

Splinting involves subsequent application of a non-circumferential support held in place by an elastic bandage.

Casting involves circumferential application of plaster or fiberglass.[2]

PLASTER OF PARIS

Plaster of Paris is a hemi hydrated calcium sulphate.

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To make Plaster of Paris, gypsum is heated to drive off water.[3] When water is added to the resulting powder original mineral forms and is set hard. 2(Caso4 $2H_2O$) +Heat (Caso4 1/2 H_2O) + $3H_2O$.

The name Plaster of Paris (POP) originated from an accident to a house built on deposit of gypsum near the city of Paris. The house was accidentally burnt down.When it rained on the next day, it was noted that the foot prints of the people in the mud had set rock hard. Plaster of Paris was first used in orthopaedics by Mathysen, a Dutch surgeon, in 1852. It is made from gypsum which is a naturally occurring mineral. It is commercially available since 1931.

Types of POP

Indigenous

Prepared from ordinary cotton bandage role smeared with POP powder.

COMMERCIAL

Plaster of Paris rolls commercially prepared consists of rolls of muslin stiffened by starch POP powder and an accelerator substance like alum. This commercial preparation sets very fast and gives a neat finish unlike the indigenous ones.

Plaster bandages and splints are made by impregnating crinoline with plaster of Paris [$(CaSO_4)2H_2O$]. When this material is dipped into water, the powdery plaster of Paris is transformed into a solid crystalline form of gypsum. The bandage should remain submerged until bubbles ceases to raise. The amount of heat given off is determined by the amount of plaster applied and the temperature of the water.[4] The more plaster and the hotter the water, the more heat is generated. The temperature of the water varies as to whether slow or quick setting is required. The Plaster of Paris sets more quickly when hot water is used; as a rule a temperature of 35 degree C will provide the optimum setting time. The interlocking of the crystals formed is essential to the strength and rigidity of the cast. Motion during the critical setting period interferes with this interlocking process and reduces the ultimate strength by as much as 77%.[5] The interlocking of crystals (the critical setting period) begins when the plaster reaches the thick creamy stage, becomes a little rubbery, and starts losing its wet, shiny appearance. Cast drying occurs by the evaporation of the water not required for crystallization. The evaporation from the cast surface is influenced by air temperature, humidity, and circulation about the cast. Thick casts take longer to dry than thin ones. Strength increases as drying occurs.[6]

Factors That Affect Setting Times for Casts and Splints[7]

Factors that speed setting times

Higher temperature of dipping water

Use of fiberglass

Reuse of dipping water

Factors that slow setting times

Cooler temperature of dipping water

Use of plaster

Additives are used to alter the setting time

Three variations are available

Extra-fast setting takes 2 to 4 minutes

Fast setting takes 5 to 6 minutes

Slow setting takes 10 to 18 minutes

Advantages of POP

It is cheap

It is easily available

It is comfortable

It is easy to mould

It is strong and light

It is easy to remove

It is permeable to radiography

It is permeable to air and hence underlying skin can breathe

It is non inflammable

Standard Materials and Equipment for Splint and Cast Application[8]

Adhesive tape (to prevent slippage of elastic wrap used with splints)

Bandage scissors

Basin of water at room temperature (dipping water)

Casting gloves (necessary for fiberglass)

Elastic bandage (for splints)

Padding

Plaster or fiberglass casting material

Sheets, underpads (to minimize soiling of the patient's clothing)

Stockinette

***Conditions That Benefit from Immobilization*[9]**

Fractures

Sprains

Severe soft tissue injuries

Reduced joint dislocations

Inflammatory conditions: arthritis, tendinopathy, tenosynovitis

Deep laceration repairs across joints

Tendon lacerations

SPLINTS

Splinting involves subsequent application of a non-circumferential support held in place by an elastic bandage. Splints are faster and easier to apply; allow for the natural swelling that occurs during the acute inflammatory phase of an injury; are easily removed for inspection of the injury site; and are often the preferred tool for immobilization in the acute care setting. Disadvantages of splinting include lack of patient compliance and increased motion at the injury site.[10]

Indications

Acute and definitive treatment of select fractures

Soft tissue injuries (sprains, tendons).

Acute management of injuries awaiting orthopedic intervention.

Advantages

Allows for acute swelling

Decreased risk of complications

Faster and easier application

Commercial splints available and appropriate for select injuries

May be static (preventing motion) or dynamic (functional; assisting with controlled motion)

Disadvantages

Lack of compliance

Increased range of motion at injury site

Not useful for definitive care of unstable or potentially unstable fractures

Splints are classified based on the movement permissible as

- Static
- Dynamic
- Serial Static
- Static Progressive

CASTS

Casting involves circumferential application of plaster or fiberglass.As such, casts provide superior immobilization, but they are more technically difficult to apply and less forgiving during the acute inflammatory stage; they also carry a higher risk of complications.[11]

Indications

Definitive management of simple, complex, unstable or potentially unstable fractures.

Severe, nonacute soft tissue injuries unable to be managed with splinting.

Advantages

More effective immobilization

Disadvantages

Higher risk of complications

More technically difficult to apply

Table 1: Commonly Used Splints and Casts

Area of injury	Type of splint	Type of cast
1 land/finger	Ulnar gutter, radial gutter, thumb spica, finger	Ulnar gutter, radial gutter, thumb spica
Forearm/wrist	Volar/dorsal forearm, single sugar-tong	Short arm, long arm
Flhnw/fnrearm	1 nng arm pnstprinr. dnuhlp sugar-tong	l nng arm
Knee	Posterior knee, off-the-shelf immobilizer	Long leg
Tibia/fibula	Posterior ankle (mid-shaft and distal fractures), bulky Jones	Long leg (proximal fracture), short leg (mid-shaft and distal)
Ankle	Posterior ankle ("post-mold"), stirrup, bulky Jones, high-top walking bool	Short leg
Foot	Posterior ankle with or without toe box, hard-soled shoe, high-top walking boot	Short leg, short leg with toe box for phalanx fracture

Source: Boyd article on Splints and Casts: Indications and Methods

Table 2: Upper Extremity Splinting and Casting Chart

Region	Type of splint/cast	Indications	Pearls/pitfatk	Follow-up/referral
Ulnar side of hand	Ulnar gutter splint/ cast	Fourth and fifth proximal/ middle phalangeal shaft fractures and select metacarpal fractures	Proper positioning of MCP joints at 70 to 90 degrees of flexion, PIP and DIP joints at 5 to 10 degrees ol flexion	One to two weeks Refer for angulated, displaced, rotated, oblique, or intra-articular fracture or failed closed reduction
Radial side of hand	Radial gutter splint/ cast	Second and third proximal/ middle phalangeal shaft fractures and select metacarpal fractures	Proper positioning of MCP joints at 70 to 90 degrees of flexion. PIP and DIP joints at 5 to 10 degrees ol flexion	One to two weeks Refer for angulated, displaced, rotated, oblique, or intra-articular fracture or failed closed reduction
Thumb, first metacarpal, and carpal bones	Thumb spica splint/ cast	Injuries to scaphoid/ trapezium Nondisplaced, nonangulated, extra-articular first metacarpal fractures Stable thumb fractures with or without closed reduction	Fracture of the middle/ proximal one third of the scaphoid treated with casting	One two weeks Refer for angulated, displaced, intra-articular, incompletely reduced, or unstable fracture Refer displaced fracture of the scaphoid.
Finger injuries	Buddy taping	Nondisplaced proximal/ middle phalangeal shaft fracture and sprains	Encourage active range of motion in all joints	Two weeks Refer for angulated, displaced, rotated, oblique, or significant intra-articular fracture or failure to reqain full range of motion
	Aluminum U-shaped splint	Distal phalangeal fracture	Encourage active range of motion at PIP and MCP joints	
	Dorsal extension-block splint	Middle phalangeal volar plate avulsions and stable reduced PIP joint dislocations	Increase flexion by 15 degrees weekly, from 45 degrees to full extension Buddy taping permitted with splint use	
	Mallet finger splint	Extensor tendon avulsion from the base of the distal phalanx	Continuous extension in the splint for six to eight weeks is essential	
Wrist/hand	Volar/dorsal forearm splint	Soft tissue injuries to hand and wrist Acute carpal bone fractures (excluding scaphoid/ trapezium) Childhood buckle fractures of the distal radius	Consider splinting as definitive treatment for buckle fractures	One week Refer for displaced or unstable fractures Refer lunate fractures
	Short arm cast	Nondrsplaced. minimally displaced, or buckle fractures of the distal radius Carpal bone fracturot other than scaphoid/trapezium		
Forearm	Single sugar-tong splint	Acute distal radial and ulnar fractures	Used for increased immobilization of forearm and greater stability	Less than one week Refer for displaced or unstable
Elbow, proximal forearm, and skeletally immature wrist injuries	Long arm posterior splint, long arm cast	Distal humeral and proximal/ midshaft forearm fractures Nonbuckle wrist fractures	Ensure adequate padding at bony prominences	Within one week Refer for displaced or unstable fractures
	Double sugar-tong splint	Acute elbow and forearm fractures, and nondrsplaced, extra-articular Colles fractures fractures	Offers greater immobilization against pronation/Supination	Less than one week Refer childhood distal humeral fractures

DIP mdalal interphalangealj MCP = metacarpophalangeal; PIP = proximal mterphalangeal

Source: Boyd article on Splints and Casts: Indications and Methods

Table 3: Lower Extremity Splinting and Casting Chart

Region	Type of splint/cast	Indications	Pearts/pit falls	Follow-up/referral
Ankle	Posterior ankle splint ("post-mold")	Severe sprains Isolated, nondtsplaced malleolar fractures Acute foot fractures	Splint ends 2 inches distal to fibular head to avoid common peroneal nerve compression	Less than one week Refer for displaced or multiple fractures or significant joint instability
Ankle	Stirrup splint	Ankle sprains Isolated, nondisplaced malleolar fractures	Mold to site of injury for effective compression	Less than one week
Lower leg, ankle, and foot	Short leg cast	Isolated, nondtsplaced malleolar fractures Foot fractures—tarsals and metatarsals	Compartment syndrome most commonly associated with proximal mid-tibial fractures, so care is taken not to over-compress Weight-bearing status important; initially non-weight bearing with tibial injuries	Two to four weeks Refer for displaced or angulated fracture or proximal first through fourth metatarsal fractures
Knee and lower leg	Posterior knee splint	Acute soft tissue and bony injuries of the lower extremity	If ankle immobilization is necessary, as with tibial shaft injuries, the splint should extend to include the metatarsals	Days
Foot	Short leg cast with toe plate extension	Distal metatarsal and phalangeal fractures	Useful technique for toe immobilization Often used when high-top walking boots are not available	Two weeks Refer for displaced or unstable fractures

Source: Boyd article on Splints and Casts: Indications and Methods

APPLICATION OF SPLINTS AND CASTS

Upper Extremity Splints and Casts

Ulnar Gutter Splint

The splint begins at the proximal forearm and extends to just beyond the distal interphalangeal (DIP) joint. Cast padding is placed between the fingers.[12]

Fig. 1: Ulnar gutter splint with underlying stockinette and circumferential padding.

Source: Boyd article on Splints and Casts: Indications and Methods

Fig. 2: Ulnag gutter cast.

Source: Boyd article on Splints and Casts: Indications and Methods

ULNAR GUTTER CAST

Ideally, the cast is applied 24 to 48 hours or more after the initial injury to allow swelling to decrease. Placement of the casting materials is similar to that of the ulnar gutter splint, except the plaster or fiber glass is wrapped circumferentially.

RADIAL GUTTER CAST

The splint runs along the radial aspect of the forearm to just beyond the DIP joint of the index or fiberglass is wrapped circumferentially. The cast is usually placed two to seven days after the initial injury to allow for resolution of swelling.[13]

Fig. 3: Radial gutter cast.

Source: Boyd article on Splints and Casts: Indications and Methods

THUMB SPICA CAST

The cast uses the same position of function as described for a thumb spica splint, but requires circumferential application of casting materials.

Fig. 5: Thumb spica cast.

Source: Boyd article on Splints and Casts: Indications and Methods

THUMB SPICA SPLINTS

The splint covers the radial aspect of the forearm, from the proximal one third of the forearm to just distal to the interphalangeal joint of the thumb, encircling the thumb.

Fig. 4: Padded thumb spica splint.

Source: Boyd article on Splints and Casts: Indications and Methods

Buddy taping (dynamic splinting)

The injured finger is taped to the adjacent finger for protection and to allow movement.

Dorsal Extension Block Splint

In reduced, volar avulsion fractures, the splint is applied with the PIP joint at 45 degrees of flexion and secured at the proximal finger, allowing flexion at the PIP joint. With weekly lateral radiography, the flexion is decreased 15 degrees until reaching full extension over four weeks. Buddy taping should follow. Treatment of reduced PIP joint dislocations is similar, but requires a starting angle of 20 degrees.[14]

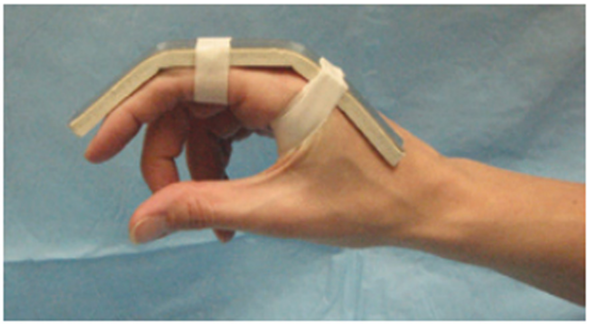

Fig. 6: Dorsal extenion block splint.

Source: Boyd article on Splints and Casts: Indications and Methods

Aluminum U shaped Splint

The aluminum splint wraps from the dorsal fingertip around to the volar fingertip and immobilizes only the DIP joint in extension.

Mallet Finger Splint

The DIP joint is placed in slight hyperextension with a padded dorsal splint, an unpadded volar splint, or a prefabricated mallet fingersplint. Continuous extension in the splint for six to eight weeks is essential, even when changing the splint. Compliance is assessed every two weeks. Night splinting for an additional two to three weeks is recommended.[15]

Volar/Dorsal Forearm Splint

The splint extends from the dorsal or volar mid-forearm to the distal palmar crease.

Short Arm Cast

The cast extends from the proximal one third of the forearm to the distal palmar crease volarly and just proximal to the MCP joints dorsally.

Single Sugar Tong Splint

The splint extends from the proximal palmar crease, along the volar forearm, around the elbow to the dorsum of the MCP joints.

Long Arm Posterior Splint

The splint extends from the axilla over the posterior surface of the 90-degree flexed elbow, and along the ulna to the proximal palmar crease.[16]

Long Arm Cast

The cast extends from the mid-humerus to the distal palmar crease volarly and just proximal to the MCP joints dorsally.

Double Sugar Tong Splint

Physicians should start by placing a single sugar tong splint. A second sugar tong splint is then applied, extending from the deltoid insertion distally around the 90 degree flexed elbow, and proximally to 3 inches short of the axilla.[17]

LOWER EXTREMITY SPLINTS AND CASTS

Posterior ankle splint ("Post-mold")

The splint extends from the plantar surface of the great toe or metatarsal heads along the posterior lower leg and ends 2 inches distal to the fibular head to avoid compression of the common peroneal nerve.

Stirrup Splint

The splint extends from the lateral mid-calf around the heel, and ends at the medial mid-calf. The position of function is with the ankle flexed to 90 degrees (neutral).

Short Leg Cast

The cast begins at the metatarsal heads and ends 2 inches distal to the fibular head. Additional padding is placed over bony prominences, including the fibular head and both malleoli.[18]

Toe Plate Extension

A plate is made by extending the casting material beyond the distal toes, prohibiting plantar flexion and limiting dorsiflexion.

Posterior Knee Splint

The splint should start just below the gluteal crease and end just proximal to the malleoli.

Complications of Splints and Casts[19]

Compartment syndrome

Ischemia

Heat injury

Pressure sores and skin breakdown

Infection

Dermatitis

Joint stiffness

Neurologic injury

CONCLUSION

Splinting involves subsequent application of a non-circumferential support held in place by an elastic bandage. Casting involves circumferential application of plaster or fiberglass. Both splints and casts have its own advantages and disadvantages. Once the need for immobilization has been determined, the physician must decide appropriately whether to apply a splint or a cast.

REFERENCES

1. Chudnofsky CR, Byers S. Splinting techniques. In: Roberts, Hedges JR, Chanmugam AS, eds. Clinical Procedures in Emergency Medicine. 4th ed. Philadelphia, Pa.: Saunders; 2004:989.
2. Eiff MP, Hatch R, Calmbach WL, eds. Fracture Management for Primary Care. 2nd ed. Philadelphia, Pa.: Saunders; 2003:1-70.
3. Parmelee-Peters K, Eathorne S. The wrist:

common injuries and management. Prim Care. 2005;32(1):35-70.

4. Hong E. Hand injuries in sports medicine. Prim Care. 2005;32(1):91-103.
5. General principles. In: Simon RR, Sherman SC, Koenigsknecht SJ, eds. Emergency Orthopedics: The Extremities. 5th ed. New York, NY: McGraw-Hill; 2007:1-29.
6. Boyd AS, Benjamin HJ, Asplund C. Principles of casting and splinting. Am Fam Physician. 2009;79(1):16-22.
7. Benjamin HJ, Mjannes JM, Hang BT. Getting a grasp on hand injuries in young athletes. Contemp Pediatr. 2008;25(3):49-63.
8. Lee SG, Jupiter JB. Phalangeal and metacarpal fractures of the hand. Hand Clin. 2000;16(3):323-332.
9. Slade JF, Magit DP, Geissler WB. Scaphoid fractures in athletes. Atlas Hand Clin. 2006;11(1):27-44.
10. Overly F, Steele DW. Common pediatric fractures and dislocations. Clin Pediatr Emerg Med. 2002;3(2):106.
11. Bong MR, Egol KA, Leibman M, Koval KJ. A comparison of immediate postreduction splinting constructs for controlling initial displacement of fractures of the distal radius: a prospective randomized study of long-arm versus short-arm splinting. J Hand Surg [Am]. 2006;31(5):766-770.
12. Sollerman C, Abrahamsson SO, Lundborg G, Adalbert K. Functional splinting versus plaster cast for ruptures of the ulnar collateral ligament of the thumb. A prospective randomized study of 63 cases. Acta Orthop Scand. 1991;62(6):524-526.
13. Plint AC, Perry JJ, Correll R, Gaboury I, Lawton L. A randomized, controlled trial of removable splinting versus casting for wrist buckle fractures in children. Pediatrics. 2006;117(3):691-697.
14. Benjamin HJ, Hang BT. Common acute upper extremity injuries in sports. Clin Pediatr Emerg Med. 2007;8(1):15-30.
15. Haller PR, Harris CR. The tibia and fibula. In: Ruiz E, Cicero JJ, eds. Emergency Management of Skeletal Injuries. St Louis, Mo.: Mosby-Year Book; 1995:499-517.
16. Roberts DM, Stallard TC. Emergency department evaluation and treatment of knee and leg injuries. Emerg Med Clin North Am. 2000;18(1):67-84.
17. Kerkhoffs GM, Struijs PA, Marti RK, Assendelft WJ, Blankevoort L, van Dijk CN. Different functional treatment strategies for acute lateral ankle ligament injuries in adults. Cochrane Database Syst Rev. 2002;(3): CD002938.
18. Court-Brown CM. Fractures of the tibia and fibula. In: Rockwood CA, Green DP, Buchholz RW, eds. Rockwood and Green's Fractures in Adults. 6th ed. Philadelphia, Pa.: Lippincott Williams and Wilkins; 2006:2079-2146.
19. LaBella CR. Common acute sports-related lower extremity injuries in children and adolescents. Clin Pediatr Emerg Med. 2007;8(1):31-42.