VIDEOS IN CLINICAL MEDICINE

# Basic Splinting Techniques

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## INDICATIONS

Patients frequently present to primary care offices, urgent care clinics, and emergency departments with musculoskeletal injuries. Many distal-extremity injuries can initially be managed in an outpatient setting with the use of basic splinting techniques. Splinting immobilizes injured extremities and prevents further injury, decreases pain and bleeding, and allows healing to begin. The most common indications for splint placement in an outpatient setting include fractures, dislocations, and sprains. Stabilization of an extremity fracture with a splint will preserve proper bone alignment and alleviate discomfort. After reduction of a dislocated joint, anatomical positioning is maintained by application of a splint. Splinting may also be used to maintain the position of function and to alleviate pain for patients with ligamentous sprains.

## CONTRAINDICATIONS

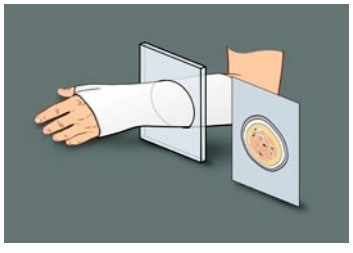

**Figure 1. A Circumferential Cast, with Limited Allowance for Swelling.**

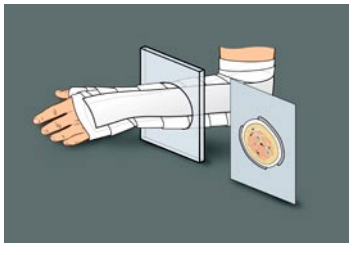

**Figure 2. Open Construction of a Splint, Allowing for Swelling to Occur.**

Although there are no absolute contraindications to applying a temporary splint to an injured extremity, there are some unique circumstances that must be considered. The natural swelling of an extremity that occurs after an injury can present challenges in determining the safest method of immobilization. Swelling often precludes the circumferential casting of an extremity fracture in the early period after the injury (Fig. 1),[1,2] since continued swelling can lead to neurovascular compromise inside a rigid cast. Splints are an excellent alternative, because their open construction provides adequate immobilization while allowing for the natural swelling process to occur without marked neurovascular compression (Fig. 2). For injuries that are prone to severe swelling, even a splint can become restrictive as the swelling increases. Extra padding may be placed under the splint if extensive swelling is anticipated, allowing room for expansion.

When neurovascular compromise is present as a result of a fracture or dislocation, splints should not be placed without first attempting immediate reduction. Clinicians should be alert for motor deficits, sensory abnormalities, and decreased or absent pulses, which are signs of compromise to adequate blood flow or peripheral-nerve function. These findings mandate reduction before splint placement to restore vascular perfusion or nerve function. An orthopedic specialist should be consulted for fractures requiring urgent surgical evaluation, such as open fractures, which may require operative management. Temporary splints can be placed to alleviate pain and to prevent additional injury during transport to an emergency department or while awaiting evaluation by a specialist.

## EQUIPMENT

Use appropriate universal precautions for potential exposure to bodily fluids when open wounds are present. The materials needed for basic extremity splint placement include a stockinette, cotton padding, plaster or fiberglass rolls or sheets, elastic bandages with clips or adhesive tape, heavy-duty scissors, and a bucket of water.

Whenever possible, use sheets or pads to protect the patient's clothing during splint application. As an alternative to plaster rolls or sheets, a variety of prefabricated splint materials are commercially available. Be sure to have all materials within easy reach before beginning the splint-application process.

### PREPARATION

Carefully examine the injured extremity before placing the splint. Failure to expose the injury site fully may result in unidentified injuries, with poor outcomes. Evaluate pulses, motor function, and sensory function to determine whether emergency intervention or evaluation by a specialist is necessary. Treat skin or soft-tissue injuries appropriately before placing a splint.

Before constructing the splint, drape the patient with a sheet to protect clothing. Complete any necessary reduction of fractures or dislocations and remove all jewelry from the extremity. Analgesics or anesthetics may be necessary to control pain during the splinting procedure, particularly if reduction is needed before splint placement. Place the patient in a comfortable position that allows you to have adequate access to all sides of the injured extremity, as well as to the equipment needed for the procedure.

### BASIC SPLINTING TECHNIQUES

The first step in splint construction is to apply a protective layer to the extremity with the use of a fabric stockinette (Fig. 3). Avoid wrinkles and cut a sufficient length to extend beyond each end of the splint. For an upper-extremity splint, cut a small hole in the stockinette where it lies across the base of the thumb and then pull it over the digit. Place cotton padding material over the stockinette for comfort and to allow for swelling. Wrap the padding around the extremity, overlapping the previous layer by 25 to 50% and placing two layers of padding (Fig. 4). In areas of bony prominence or expected irritation, or if substantial swelling is expected, apply additional layers of padding. The cotton material can be stretched or torn to allow uniform application, but avoid excessive stretching of the padding, which can cause too much circumferential pressure. Avoid excessive padding on the anterior aspect of the elbow joint in long-arm splints, since it can result in skin pressure points and swelling under the splint. When splinting a joint at an angle, wrap the extremity in the expected final position. This will prevent wrinkles, which can lead to skin pressure points under the splint.

**Figure 3. Application of a Fabric Stockinette.**

**Figure 4. Wrapping Cotton Padding around the Extremity.**

Select a piece of dry plaster that is slightly wider than the limb. Measure the length of splint material required, then cut or tear the dry plaster material. To limit discomfort caused by moving an injured limb, measure the unaffected extremity to determine the length of plaster that will be needed. Use at least 8 layers of plaster material for upper-extremity splints and 12 layers for lower-extremity splints to ensure that the completed sprint is sufficiently strong.[2] Use additional layers of plaster if extra strength is required.

Fill a bucket with lukewarm water and immerse the plaster material until it is saturated. Warm water leads to faster drying of the plaster, whereas cool water provides additional time for molding. An exothermic reaction causes heat to be released as the plaster dries, and thermal injuries may be prevented by avoiding water that is too hot (>50°C), keeping splint thickness at less than 24 layers, and avoiding the use of insulating materials such as pillows during the drying process.[2,3]

Hold the wet plaster sheets vertically over the bucket and manually compress the layers, using two fingers in a downward motion. This ensures lamination of the layers while removing wrinkles and excess water.

Place the plaster material over the cotton padding (Fig. 5). Smooth the plaster to mold it to the contours of the extremity in the appropriate anatomical position.

**Figure 5. Placement of Wet Plaster Material over Cotton Padding.**

**Figure 6. Wrapping with Cotton Padding.**

**Figure 7. Application of an Elastic Bandage.**

Apply an additional layer of cotton padding to hold the splint in place (Fig. 6), and fold the ends of the stockinette back over the splint. Use an elastic bandage to secure the splint in place by wrapping it in a distal-to-proximal direction (Fig. 7), taking care to avoid excessive compression of the extremity.

Before the plaster dries, place the extremity in the desired anatomical position. Use the palms of your hands to mold the splint gently to the extremity, taking care to avoid creating indentations that might lead to pressure points. Allow the splint to dry without further manipulation or movement on the patient's part. The time required for drying will vary depending on splint thickness, water temperature, and the amount of water removed during the splint-construction process. Once the splint has dried completely, check for adequate immobilization, anatomical positioning, strength of the splint, and patient comfort. At this point, radiographs may be needed for fractures or dislocations that required reduction before splint placement.

## UPPER-EXTREMITY SPLINTS

### *Volar Splint*

A volar splint (Fig. 8A) can be used to immobilize a wrist sprain, a triquetral fracture or lunate dislocation, or a second-through-fifth metacarpal head fracture. This splint should extend along the volar aspect of the forearm from the metacarpal heads to a point just proximal to the radial head, allowing unencumbered flexion of the elbow.[4] Place the forearm in a neutral position with the thumb upward and the wrist at 20 degrees of extension.[5,6]

### *Ulnar Gutter Splint*

An ulnar gutter splint (Fig. 8B) is designed to immobilize fractures along the ulnar aspect of the hand, including injuries to the fourth and fifth phalanges and metacarpals.[4] This splint extends from the distal interphalangeal joint of the little finger to the proximal forearm. Place the forearm in a neutral position with the wrist at 20 degrees of extension. The metacarpophalangeal joints should be flexed at 50 degrees with the proximal and distal interphalangeal joints in slight flexion.[6]

### *Thumb Spica Splint*

A thumb spica splint (Fig. 8C) is applied to the radial aspect of the forearm to immobilize the thumb and prevent flexion and extension of the wrist. This splint is useful for fractures of the scaphoid and lunate,[7] first metacarpal, and thumb.[4] This splint extends from the tip of the thumb to the proximal forearm.[4] Place the forearm in a neutral position with the wrist at 20 degrees of extension and the thumb slightly flexed.

### *Long-Arm Splint*

A long-arm splint (Fig. 8D) will immobilize fractures of the proximal forearm and elbow. It can also provide temporary stabilization of intraarticular fractures of the distal humerus and olecranon while the patient is awaiting surgical care.[4] This splint prevents flexion and extension of the elbow and limits supination and pronation of the forearm. It extends along the posterior arm from the wrist to the proximal humerus. Place the elbow at 90 degrees of flexion while maintaining a neutral position for the forearm and wrist.[4]

### *Sugar-Tong Splint*

A forearm sugar-tong splint (Fig. 8E) is used for fractures of the wrist and distal forearm. It immobilizes the wrist and forearm and prevents supination and prona-


**Figure 8. Types of Upper-Extremity and Lower-Extremity Splints.**

Panel A shows a volar splint, Panel B an ulnar gutter splint, Panel C a thumb spica splint, Panel D a long-arm splint, Panel E a sugar-tong splint, Panel F a posterior-leg splint, and Panel G a posterior-leg splint with a stirrup.

tion of the forearm.[4] The splint extends from the metacarpophalangeal joints on the dorsum of the hand, along the forearm, around the elbow, and back to the volar aspect of the midpalmar crease.[2] Place the elbow at 90 degrees of flexion while maintaining a neutral position for the forearm and wrist.[4]

## LOWER EXTREMITY SPLINTS

### *Posterior-Leg Splint*

A posterior-leg splint (Fig. 8F) is used to stabilize severe sprains, reduced ankle dislocations, and fractures of the distal leg, ankle, and foot. The splint extends from the metatarsal heads to just below the fibular head while maintaining a 90-degree angle at the ankle.[2] Be sure to keep the fibular head free in order to avoid compression of the adjacent peroneal nerve. Lower-extremity splints are not designed to bear weight, and the patient should use crutches.

### *Posterior-Leg Splint with Stirrup*

Adding a lateral stirrup component to a posterior-leg splint increases the stability of the splint and prevents inversion and eversion of the ankle (Fig. 8G).[4] This splint provides greater immobilization and stability for fractures near the ankle. The stirrup splint is similar to the sugar-tong splint for the upper extremity. Apply the splint to the medial and lateral leg; it should extend from the tibial tuberosity to

## REFERENCES

1. Moeller M. Splints versus casts. Postgrad Med 1990;87:34.
2. Shaw DC, Heckman JD. Principles and techniques of splinting musculocutaneous injuries. Emerg Med Clin North Am 1984;2:391-407.
3. Halanski M, Noonan KJ. Cast and splint immobilization: complications. J Am Acad Orthop Surg 2008;16:30-40.
4. Howes DS, Kaufman JJ. Plaster splints: techniques and indications. Am Fam Physician 1984;30:215-21.
5. Harrison BP, Hilliard MW. Emergency department evaluation and treatment of hand injuries. Emerg Med Clin North Am 1999;17:793-822.
6. Chudnofsky CR, Byers S. Splinting techniques. In: Roberts JR, Hedges JR, eds. Clinical procedures in emergency medicine. 4th ed. Philadelphia: Saunders, 2004:989-1009.
7. Ritchie JV, Munter DW. Emergency department evaluation and treatment of wrist injuries. Emerg Med Clin North Am 1999;17:823-42.




wrap around the foot and end just below the fibular head. Mold the splint with the ankle at a 90-degree angle.

### *Commercially Available Products*

Commercially available hook-and-loop ankle or wrist splints may be used to alleviate discomfort after a sprain, but they typically do not provide the necessary stability for fractures. When applying a splint that requires additional strength, another commercially available option to consider is prefabricated splinting materials. These materials come prepackaged with padding and splint supplies and can be used to create a wide variety of splints for injured extremities, using modifications of the techniques described above.

## AFTERCARE

Reevaluate the extremity immediately after completing the splint placement. Evaluate distal motor and sensory function. Palpate for pulses, evaluate the color of the distal extremity, and assess for appropriate capillary refill. Be sure that the completed splint is comfortable and not overly restrictive and that the patient's pain is controlled. Address any discomfort by applying additional cotton padding under the splint, loosening the elastic bandage, or considering the use of an arm sling with long-arm splints.

Routine care after the application of a splint should include extremity elevation, application of ice packs, administration of medications for pain or itching, and appropriate communication of instructions for medical follow-up. Instruct the patient to keep the splint clean and dry and not to remove it prematurely.

## COMPLICATIONS

Give the patient oral instructions and a written list of signs and symptoms that would necessitate urgent return for further evaluation. The open construction of a splint makes the development of a compartment syndrome less of a concern than with circumferential casting. However, a splint can cause constriction from the layers of cotton wrapping as swelling progresses. Patients should return immediately if there are any signs of neurovascular compromise or a compartment syndrome, such as increased swelling, worsening of pain, discoloration of the distal extremity, difficulty moving the fingers or toes, or a change in sensory function.

Splinting plays a major role in the initial management of musculoskeletal injuries, particularly those involving extremity fractures, joint dislocations, and severe sprains. A properly applied splint will stabilize the injured extremity, alleviate discomfort, and allow the healing process to begin. Depending on the type of injury, a splint may be the only treatment required, or it may be an important measure for alleviating discomfort until further evaluation or surgical intervention is undertaken.

No potential conflict of interest relevant to this article was reported.