Chapter 15
Soft Tissue Injuries

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Injury to soft tissue encompasses a vast array of entities due to an assortment of mechanisms. The etiology of an injury can include physical, biological, thermal, metabolic, and chemical means. A sports medicine précis of soft tissue injuries includes sprains, strains, contusions, hematomas, and tendinitides. There are commonalities across this wide assortment of maladies however. The application of mechanical force to human tissue can cause one of two changes: a change in shape (deformation) or a change in velocity (deceleration or acceleration). If tissue tolerance is exceeded, a push can cause *contusions*, *hematomas*, and *fractures*, while a pull results in *sprains*, *strains*, and *dislocations*. A large magnitude of force applied to tissue results in *macrotrauma*, such as sprains, strains, and crush injuries. Smaller forces that recur over long and/or repetitive sequences result in *microtrauma*, such as stress fractures and overuse syndromes.

Acute Management

Acute management of the common soft tissue injuries is still governed by the acronyms RICE or PRICE. The R indicates rest, but this is *relative rest* to protect the injured structure(s) while maintaining or increasing the integrity of the surrounding structures. I stands for *ice or the application of cold*. This therapeutic modality

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reduces the heat (calor) and decreases the pain (dolor) of the inflammatory process. C entails *compression* by wrapping the injured area to prevent increased edema and swelling. This is most commonly accomplished with an ace wrap, but there are several options including sleeves, stockinette, or braces available to accomplish the task. E implies *elevation* in an attempt to drain accumulated fluid away from the injured area.

The P of the longer acronym is *protection* of the injured tissues. This may be as simple as sturdier shoes or an off-the-shelf ankle brace to more complicated and involved methods as crutches and casts.

Ice should be applied in a plastic bag directly on the skin for 20–30 min. Applying ice in this fashion every 2 h is as effective as leaving the ice on for the entire 2 h. The standard practice is to apply ice two to three times a day while symptoms persist. Other acceptable applications include cold immersion, cold whirlpools, or the commercially produced cold packs.

Compression and elevation both attempt to reduce the swelling and edema associated with musculoskeletal injuries. This is advantageous for two reasons. Reducing the amount of edema will improve the range of motion and vascular flow. Improved range of motion will assist in regaining muscle strength and function. Improved perfusion reduces the secondary ischemic mechanisms of injury. In fact, this is the strongest argument for using ice rather than heat in the management of injuries. The increased muscle range of motion will increase blood flow throughout a 24-h period more effectively than the vasodilation that occurs with the application of heat for minutes during a day.

A reasonable treatment program for soft tissue injuries must fulfill four requirements. The first is to minimize pain, swelling, hemorrhage, inflammation, and muscle spasm. The second requirement is protection and immobilization of the damaged tissue. The intent of this second requirement is to prevent repeat bleeding, secondary injuries, and early distension or lengthening of healing structures. The third requirement emphasizes controlled mobilization. This begins at the 2–3 week mark, but the demands of an active season may necessitate an advancement of the timing. The fourth requirement is simulation of activity-specific stress to ensure a complete return to the desired activity level. Approximately 6–8 weeks after a significant injury, collagen fibers can withstand tensile stress relatively well. Rehabilitation can then be geared to a complete return.

In the primary care setting, there are several advantages using splints as opposed to casting. Splinting techniques are easy to learn. In many cases, they can be used for definitive treatment in primary care. The splint is used to protect the injured joint or fracture while maintaining as much function as possible for the patient. Splinting techniques described here can be used in the office and/or athletic training room as opposed to an emergent situation in which both the distal and proximal joints should be splinted for patient transport.

Casting requires maintenance of technique, various sizes of cast tapes, cast padding, and stockinette. In addition to this, a cast saw is required. Splinting gives the advantages of increased flexibility and ease of application. Prefabricated splints can be purchased. This chapter will focus on custom splints, as they are more cost

effective and usually more comfortable for the patient. After injury, the extremity commonly swells, and casts must be "vented" with a cast saw by a healthcare provider. Splints can be loosened by the patient or nursing personnel by reapplying the ace wrap holding the splint in place. This chapter will cover some of the more common splinting compression techniques.

Basic Splinting and Bracing Principles

A few basic principles provide the guidelines for effective splinting and bracing. Neurovascular patency of the extremity must be evaluated prior to, during, and after application of the splint or brace. Immobilization of an injury should include the joints proximal and distal to the injury. Remember to allow for accommodation of swelling, especially with acute injuries.

A thorough initial evaluation will entail evaluation of the neurologic and vascular systems of the injured extremity. The patient should be instructed to notify the provider of any changes in condition during the application of the device, i.e., numbness, tingling, coldness. Neurovascular status should again be assessed once the appliance is in place and again a few minutes after application.

In order to effectively protect the injured structure, temporary immobilization should take place from the joint above to the joint below the injury. (After radiographs are obtained and the pathology is identified, this rule may no longer be necessary.) If the ankle is involved, immobilization should be from the knee to the foot. If the radius is the involved structure, the elbow and the wrist should be immobilized. Even if the injury requires "complete rest," (i.e., crutches or sling and swath) immobilization should be considered to limit movement of the injured area due to movement caused by incidental contact with the appendage.

Edema should be considered when applying an immobilization device. The first few minutes or hours after an acute injury may see significant accumulation of swelling at the site of injury. If the injury is subacute or chronic, site edema may vary depending on activity level or gravity-dependent positioning. Splints or braces that can be adjusted or removed and reapplied by the patient allow for changes in swelling, thus providing better protection of the injured structure.

Selection of Materials

When considering options for bracing and splinting, a wide variety of materials are available. Prefabricated splints and braces exist for almost every application. However, stocking the array of braces in the variety of sizes possible may not be feasible. Common braces that may be valuable to have available include crutches, walking boots, knee immobilizers, slings, hand-wrist-thumb braces, and stacks splints.

A wide array of splints and braces can be fabricated in the clinical or field setting with a supply of a few versatile items, such as AlumaFoam®, Orthoplast™, Orthoglass®, fiberglass casting tape (ridged and semi-ridged), plaster of Paris, elastic wraps, surgical or linen tape, webril, stockinette, and compressionette.

Thumb Spica Splint *(See Table 15.1 and Fig. 15.1a–d)*

The patient should be seated in a comfortable position with the affected extremity supported. The hand should be held in the "safe hand" position (see Fig. 5.6). The thumb is not placed in anatomic position or abducted in the "hitch hiker" position. The patient can be instructed to hold the hand as if holding a "favorite cold beverage" to demonstrate the safe hand position. The splint can be applied using stockinette, then cast padding, then tape. A splint material that has everything integrated is also available. This is the author's preferred method. The splint material is first placed in water. (If the water is hot, the casting tape will set up prematurely. If the water is cold, the casting tape may take up to 45 min to set.) The splint is folded around the distal part of the thumb. The MP joint is immobilized. The elastic bandage is overlapped by approximately one-half width and a very slight amount of tension is placed on the ace wrap. If too much tension is placed on the ace wrap, it will constrict the hand and the patient will complain of pain. The splint ends should cover approximately three-quarters of the forearm, and the excess casting padding should be folded back. The elastic bandage is wrapped until the splint is completely covered and the patient is held in a position of function until the material hardens (see Fig. 15.2). Proper instruction for care should be given to the patient. This splint may be removed when treating DeQuervain's tenosynovitis or it may be kept in place until the patient has a follow-up. The splinting material should not be allowed to become wet and should be covered in plastic when bathing. Splints function well for 7–14 days and are not designed to be used for prolonged therapy. Depending upon the patient's diagnoses, the splint may be replaced as many times as necessary at follow-up office visits.

Table 15.1 Thumb spica

Indications	Contraindications
Fall on outstretched hand	Compound fractures
Tenderness at anatomic snuffbox	Displaced fractures
Ulnar collateral ligament injury of the thumb (Gamekeeper's thumb)	Multiple trauma
DeQuervain's tenosynovitis	Open wound
Nondisplaced distal radius fractures	The inability to have the patient come in for proper follow-up
	The inability of the patient to follow instructions (developmentally disabled, child)

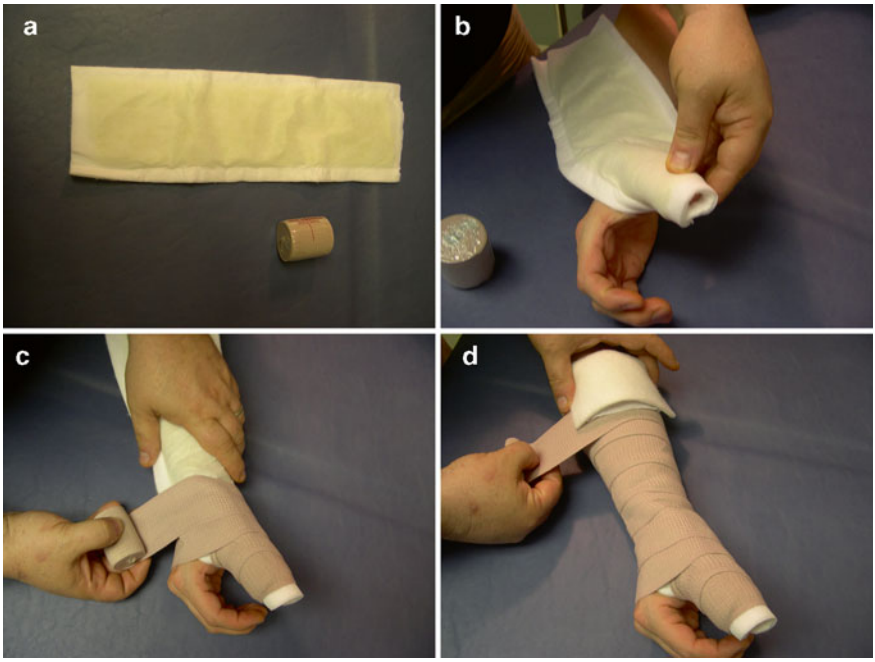

Fig. 15.1 Thumb spica splint. (**a**) Two or four inch prepackaged splint material (padding included) and a 2 in. ace wrap. (**b**) Padded side of splint applied facing toward the patient. Fold splint around distal thumb. Immobilize MP joint. (**c**) Wrap with 2 in. ace; overlap by one-half inch with *slight* tension. Do not over tighten. Notice how to efficiently wrap spica by unwrapping ace in a counter-clockwise direction. (**d**) Fold proximal aspect of splint material so splint only covers three-quarters of forearm and does not impinge upon the antecubital fossa

Fig. 15.2 After the splint is applied, mold the splint to the MP joint of the thumb by applying pressure as shown. Keep wrist in neutral position. Patients have a tendency to flex wrist, which is not acceptable

Sugar Tong Splint *(See Table 15.2 and Fig. 15.3a–d)*

The sugar tong splint may be used to immobilize the elbow and the wrist. When applying a sugar tong splint, it is imperative that the MP joints are allowed to flex 90°. When the wrist is splinted, the palmar aspect of the splint should be a number of inches shorter than the dorsal aspect of the splint. Excess material at the palmar aspect of the hand can be folded to allow the metacarpal phalangeal joints to flex 90°. It is important to keep the patient in an anatomic position. The wrist should be in a neutral position. Extension as well as radial and ulnar deviation should be avoided.

Arm Sling *(See Table 15.3)*

The sling should fit comfortably over the back of the shoulder and should not be placed around the patient's neck. The arm should rest comfortably at about breast level. The sling can be universal for both the right and left sides and can be modified for extra support. A large ace wrap could be wrapped around the arm and the chest to further immobilize the upper extremity. It is important to adjust the sling so the patient feels comfortable. The patient should be instructed to keep the wrist in neutral position. If the wrist is flexed, the median nerve may be compressed and the patient will complain of paresthesias.

Stax Splint *(See Table 15.4 and Fig. 15.4a–d)*

The stax splint places the distal phalangeal joint in slight extension. It is much more efficient in reducing and maintaining the position of a malfinger splint than a simple dorsal splint with the use of tape. The splint should be kept in place and should not be removed at all during treatment.

Table 15.2 Sugar tong splint

Indications	Contraindications
Transport patients with fracture of elbow or radius	Compound fractures
Short-term immobilization	Displaced fractures
Nondisplaced elbow fractures	Multiple trauma
Immobilization for treatment of distal radius fracture (some clinicians prefer thumb spica splint with use of arm sling)	Open wound
	The inability to have the patient come in for proper follow-up
	The inability of the patient to follow instructions (developmentally disabled, child)

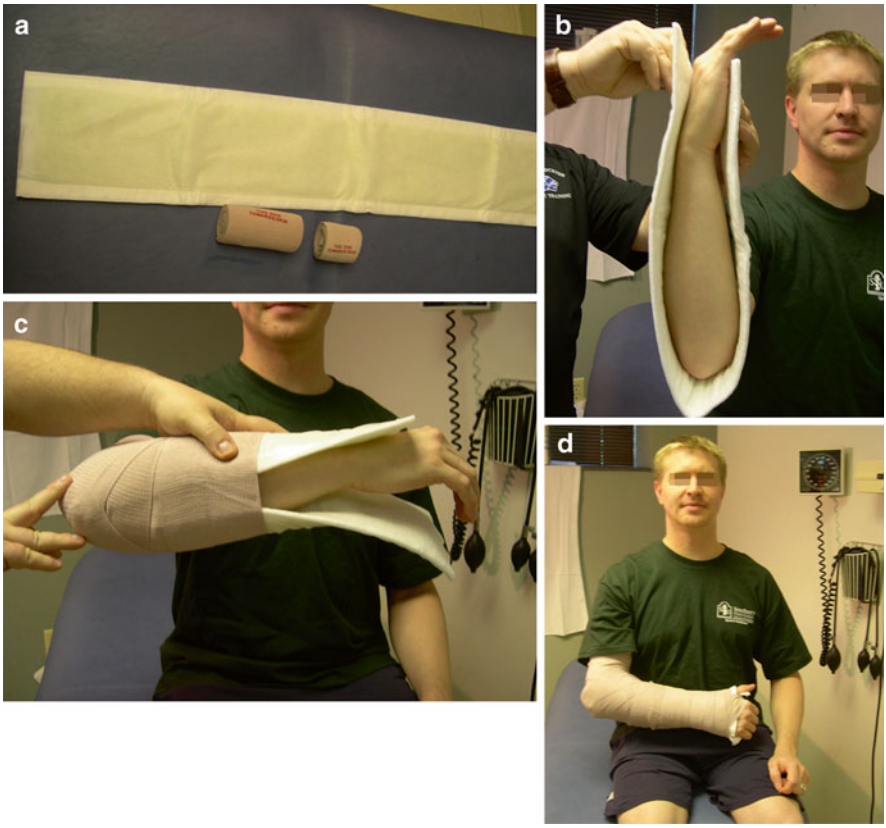

Fig. 15.3 Sugar tong splint. (**a**) Two or four inch packaged splint material and a 2 and 4 in. ace wrap. Should be long enough to immobilize elbow to forearm twice. If splint is not long enough, use two shorter splints and overlap them. (**b**) This is the most important step. Immobilize the elbow in 90° flexion. The splint should immobilize the wrist but allow for at least 90° of flexion of the MP joints of the hand. The dorsal aspect of the splint may slightly overlap the MP joints. (**c**) Apply 4 in. ace wrap around elbow, overlapping by one-half inch, very slight tension. After 4 in. wrap in place, use 2 in. wrap to hold splint around the wrist. (**d**) Complete, proper application of upper extremity sugar tong splint. Elbow held at 90°, wrist complete extension and the patient should be able to flex MP joints 90°. Always use an arm sling with this splint (not shown here)

Table 15.3 Arm sling

Indications	Contraindications
AC separation	The patient should not be put in sling for prolonged periods without follow-up
Fractured clavicle	Severe injury of the C-spine
Nonsurgical treatment of rotator cuff injury	
Treatment of patient recovering from a relocation of a dislocated shoulder	

Table 15.4 Stax splint

Indications	Contraindications
Mallet finger fractures (see Chap. 6)	Unstable fracture (fracture involves over 1/3 of the joint)
	Evidence of infection
	Open fractures

Extension Block Splint *(See Table 15.5 and Fig. 15.5a–d)*

A dorsally placed extension block splint is the preferred method for splinting patients with an injury to the volar plate of the PIP joint. This allows better hand function than a palmar splint. The material is measured to start proximally at the dorsal aspect of the hand and is secured with an elastic bandage. An elastic tape is used to secure the proximal phalanx. The distal phalanx is not taped which allows the patient to flex the finger at the PIP joint. To prevent the joint from being injured by extension, the splint is molded in the safe hand position but can be modified to keep the finger in more flexion. The same splint technique can be used for a fracture. In this case, the hand and finger should always be kept in the safe hand position and the distal phalanx should be taped.

Knee Immobilizer *(See Table 15.6)*

Although straight knee immobilizers are commonly used in the emergency room, their use is somewhat controversial. Patients with large knee effusions cannot completely extend their knee to fit comfortably in the knee immobilizer. Other options include a lock-out brace which permits a slight amount of knee flexion (5–10°) or a large (6–8 in.) ace wrap to support the knee. Patients often are not able to ambulate on crutches acutely and need to be placed in a wheelchair. Patients placed in a knee immobilizer over 4–5 days may develop quadricep muscle atrophy, thus increasing the rehabilitation time of the patient.

Knee Sleeve *(See Table 15.7)*

Many clinicians use various types of knee sleeves to help with proprioception at the joint and to allow the joint muscles to stay warmed up during exercise. These sleeves should not be considered supportive in any way. They are for patient comfort and performance and should be accompanied with an appropriate rehabilitative program.

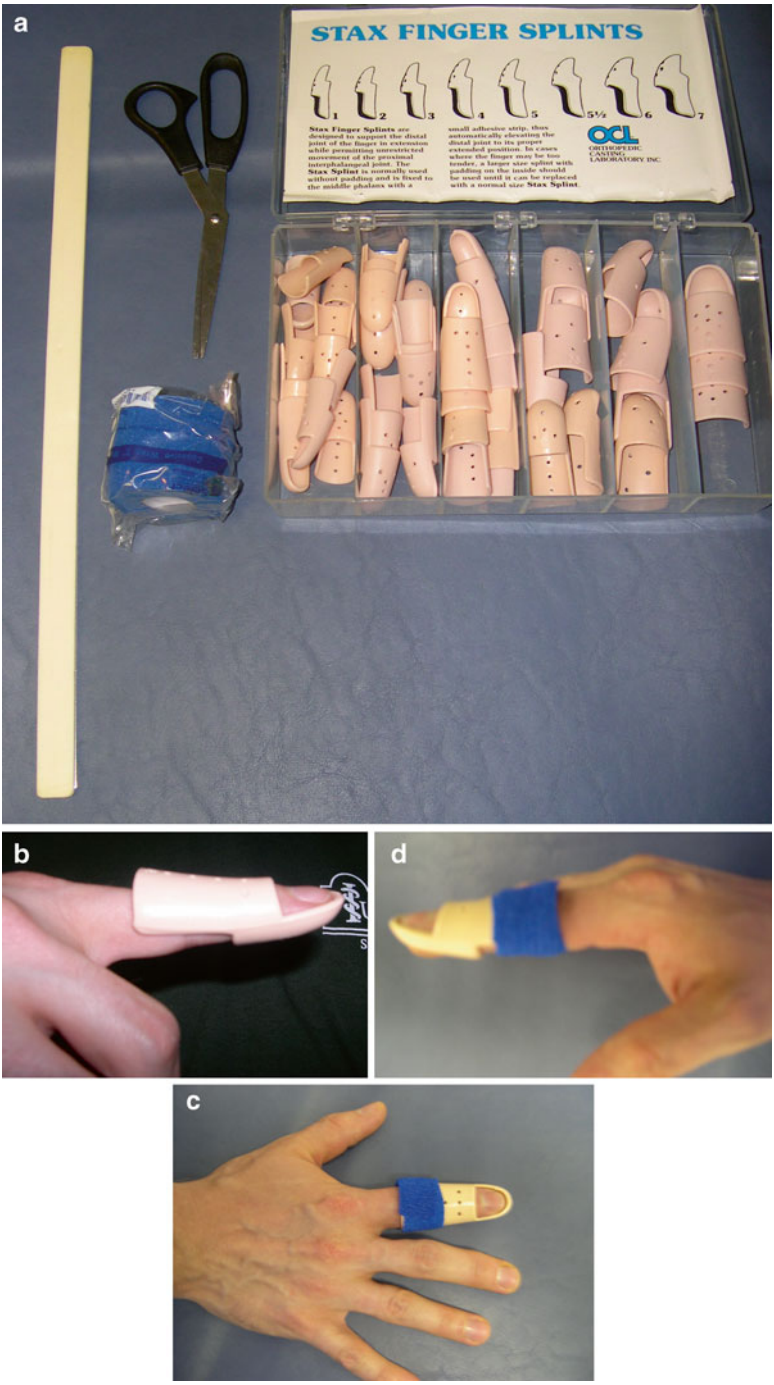

Fig. 15.4 (**a**) Application of mallet finger or stax splint. (**b**) Allow the patient to try on a number of splints on opposite, corresponding finger to get an idea of the size needed. The proper size should hold the DIP joint in slight extension without putting too much pressure on the skin. The PIP joint must be able to flex freely. (**c**) After the splint is applied, 1 in. wrap or cloth tape is used to "marry" the splint to the finger. The splint is *not removed to wash*, etc. This is the reason for the ventilation holes. (**d**) Proper application of a mallet finger splint – *medial view*

Table 15.5 Extensor block splint

Indications	Contraindications
Volar plate injury	Unstable fracture (fracture involves over 1/3 of the joint)
Displaced angulated rotated fracture of the proximal two phalanges	Open fracture
	Evidence of infection

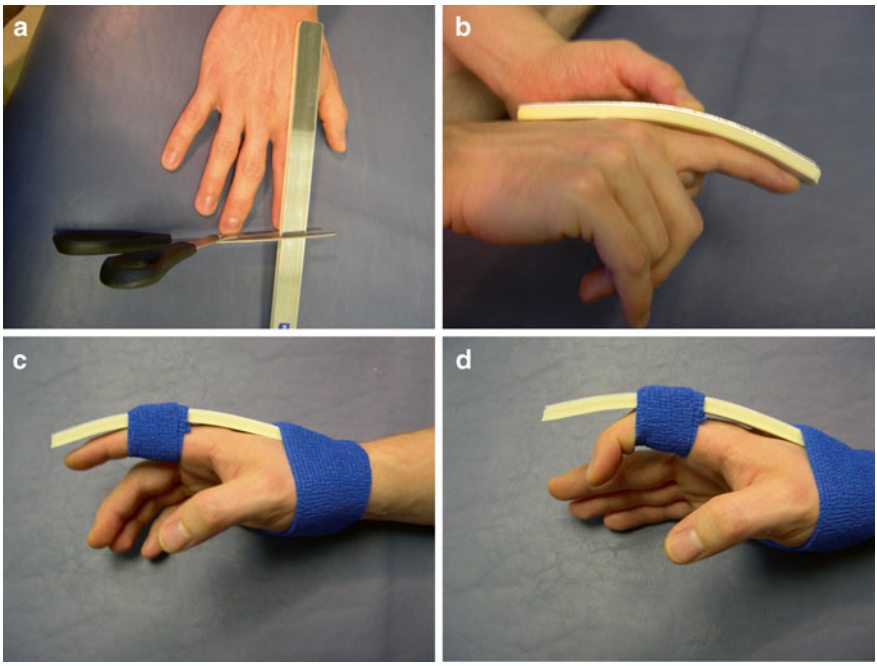

Fig. 15.5 Extension block splint. (**a**) Measure splint material from base of wrist to distal phalanx (the patient should be able to flex and extend wrist). (**b**) Mold dorsal splint to finger in "safe hand" position. (**c**) Apply 2 in. wrap to base of splint at wrist. Then apply 1 in. wrap to proximal phalanx of finger. (**d**) The extension block splint allows the patient to flex the PIP and DIP joint but blocks extension. If complete immobilization is desired, a 1 in. wrap is applied to distal phalanx and splint

Table 15.6 Knee immobilizer

Indications	Contraindications
Transport nondisplaced fracture	Long-term use over 1 week
Dislocated/relocated patella	Inability for the patient to follow-up
Temporary immobilization for suspected torn meniscus	Complex fracture
	Trauma
	Multiple ligament injuries suspected without consultation
	Vascular injury without consultation

Table 15.7 Knee sleeve

Indications	Contraindications
Dynamic splinting of the patella	Elastic, latex, neoprene allergy
Increase in proprioception of the knee after injury or rehabilitation	Dermatologic conditions such as eczema
	Skin infection

Table 15.8 Ankle sugar tong splint

Indications	Contraindications
Nondisplaced ankle fracture	Long-term use over 1–2 weeks
Transport of more serious fractures	Inability for the patient to follow-up
	Complex fracture
	Trauma
	Multiple ligament injuries suspected without consultation
	Vascular injury suspected without consultation

Ankle Sugar Tong Splint *(See Table 15.8 and Fig. 15.6a–d)*

A sugar tong splint is easily put in place with the patient in prone position and the knee flexed. The foreleg and ankle may be supported by the examiner or an assistant. The splint material is then put in place using the same technique discussed above for the upper extremity. Some clinicians prefer this splint over a posterior splint.

Ankle sprains are a common injury, usually involving the ligaments on the lateral aspect of the ankle. The typical mechanism is an inversion injury with plantar flexion, supination, and adduction of the foot relative to the ankle. The need for X-rays can be assessed using the Ottawa ankle rules (see Chap. 10). The immediate development of a hematoma on the ankle usually precludes an immediate return to full activity. If the person can bear weight and perform required duties, it is reasonable to attempt a quick return to activity with some form of protection. Taping and strapping are two common methods, and there are numerous off-the-shelf braces available for support. An important criterion is the symmetry of foot and ankle posture while weight bearing. If the patient is unable to keep the toes in front of the heel in a posture that mirrors the uninjured foot, then crutches are a consideration to unload the injured extremity.

Proper Use of Crutches

Patients should demonstrate the proper technique of crutch use before leaving the treatment area. Simply showing the patient how to use the crutch or providing them with written instructions alone is not adequate. The crutch should be adjusted to a position two to three finger breadths below the axilla. If the crutches press against

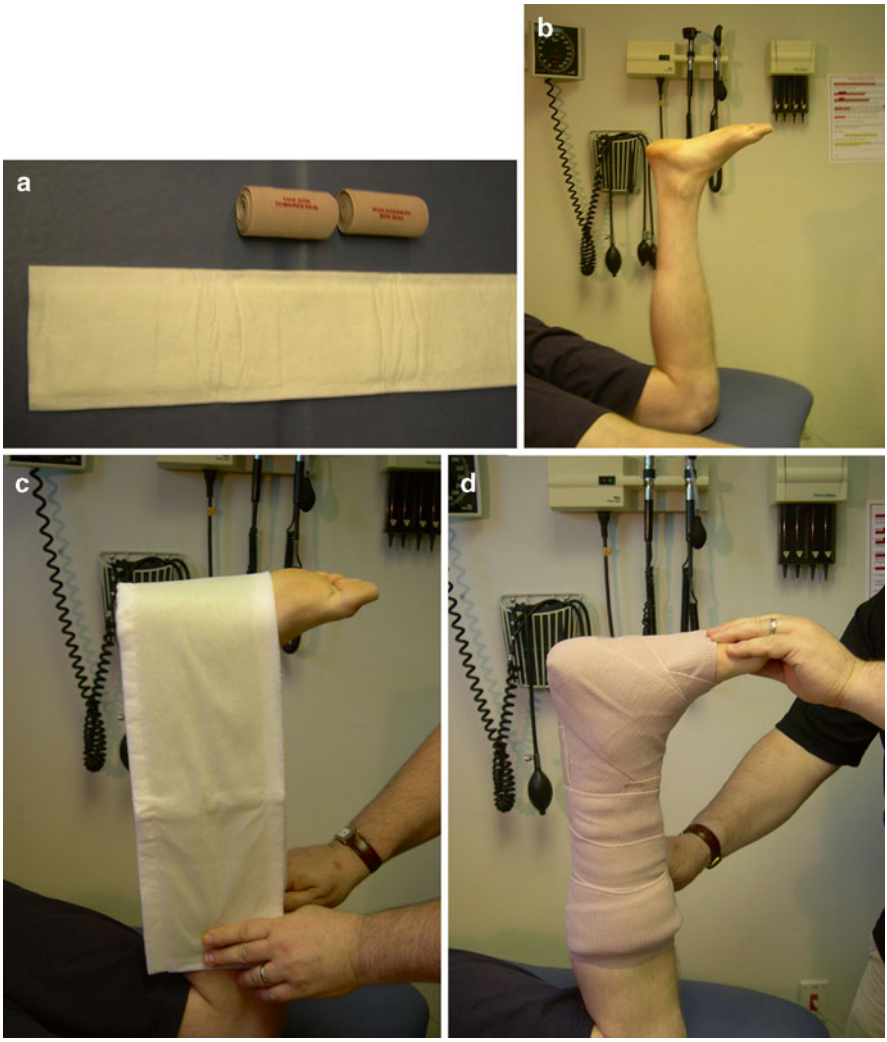

Fig. 15.6 Lower extremity sugar tong splint. (**a**) Four to six inch splint material and two 4 in. ace wraps or one 4 and 6 in. ace wrap (depending upon size of the patient). Splint material should be long enough to immobilize ankle and cover three-quarters of foreleg twice. If splint is not long enough, overlap two shorter splints. (**b**) Have the patient lie on table in prone position (*face down*) and flex the knee 90° and ankle 90°. (**c**) Apply the splint, padded side down, facing the patient. Notice that the splint covers the foot at least to midfoot and overhangs the heel just slightly. (**d**) Apply ace wrap proximal to distal, overlap bandage by one-half inch. The splint should keep the ankle at 90° and extend proximally to one-half to three-quarters of the foreleg

the brachial plexus of the axilla, the patient will experience paresthesia and pain. The patient should not "bear weight" using the axilla. The handles need to be adjusted so the elbow is completely extended so the patient's weight is supported by the palms of their hands. If the handles are too high, the patient's axilla will prematurely fatigue. Patients should not use crutches on escalators, slick surfaces, or stairs.

Suggested Readings

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