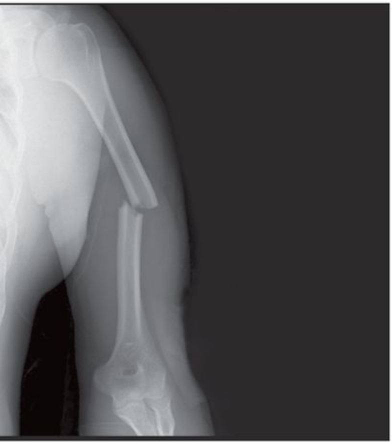
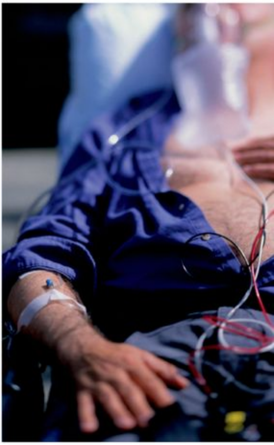
Orthopaedic EMERGENCIES





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Series Preface

Emergency physicians care for patients with any condition that may be encountered in an emergency department. This requires that they know about a vast number of emergencies, some common and many rare. Physicians who have trained in any of the subspecialties—cardiology, neurology, OBGYN and many others—have narrowed their fields of study, allowing their patients to benefit accordingly. The Oxford University Press *Emergencies* series has combined the very best of these two knowledge bases, and the result is the unique product you are now holding. Each handbook is authored by an emergency physician and a sub-specialist, allowing the reader instant access to years of expertise in a rapid access patient-centered format. Together with evidence-based recommendations, you will have access to their tricks of the trade, and the combined expertise and approaches of a sub-specialist and an emergency physician.

Patients in the emergency department often have quite different needs and require different testing from those with a similar emergency who are inpatients. These stem from different priorities; in the emergency department the focus is on quickly diagnosing an undifferentiated condition. An emergency occurring to an inpatient may also need to be newly diagnosed, but usually the information available is more complete, and the emphasis can be on a more focused and in-depth evaluation. The authors of each *Handbook* have produced a guide for you wherever the patient is encountered, whether in an outpatient clinic, urgent care, emergency department or on the wards.

A special thanks should be extended to Andrea Seils, Senior Editor for Medicine at Oxford University Press for her vision in bringing this series to press. Andrea is aware of how new electronic media have impacted the learning process for physician-assistants, medical students, residents and fellows, and at the same time she is a firm believer in the value of the printed word. This series contains the proof that such a combination is still possible in the rapidly changing world of information technology.

Over the last twenty years, the Oxford Handbooks have become an indispensible tool for those in all stages of training throughout the world. This new series will, I am sure, quickly grow to become the standard reference for those who need to help their patients when faced with an emergency.

Jeremy Brown, MD
Series Editor
Associate Professor of Emergency Medicine
The George Washington University Medical Center

Preface

This book is intended to be a rapid reference guide to the approach and initial management of the more common orthopaedic injuries. It aims to provide basic information about the initial management of musculoskeletal (MSK) injuries in general, including reduction, splinting, and casting techniques for specific fractures and soft tissue injuries. It is meant to be a "how-to" guide to the most basic of orthopaedic procedures and management. This book shares knowledge and "tricks of the trade" typically acquired through the apprenticeship model whereby new practitioners learn procedures and techniques from more experienced individuals. It will guide practitioners in how to avoid the most common pitfalls in casting and splinting and ideally limit the morbidity of inexpertly applied splints and casts which can include skin breakdown, impaired fracture healing, permanent loss of joint motion and compartment syndrome. The intended audience is emergency physicians, orthopaedic residents, family practice physicians, and other primary care providers as well as medical students and midlevel providers. Emergency medical services (EMS) personnel and other frontline heath care providers who need a quick access to key information will find this book to be a handy reference.

This book is not intended to be a reference for definitive treatment of injuries, although a brief discussion of definitive treatment is provided where appropriate. Many of the injuries listed here will need further nonoperative or operative management for long-term healing. Much of orthopaedic evaluation and treatment can be provided on an outpatient basis, and our hope is to convey how to best manage these outpatients versus those that require admission. There are certain procedures and injuries are that are beyond the scope of this reference but are described so as to improve time to recognition and involvement of orthopaedic surgeons. In addition, there are true, but rare, orthopaedic emergencies that require immediate orthopaedic specialist intervention as a life- or limb-saving procedure and these are briefly described.

In summary, the goal of this text is to help the reader properly identify orthopaedic injuries, provide guidance for initial management, distinguish those patients who can be appropriately treated as outpatients, and improve recognition and stabilization of those patients who require urgent and emergent orthopaedic consultation. It will aid in communication between practitioners providing the initial management and the final treating physician.

This book would not have been possible without the help of many people. Dr. Humbyrd thanks her father, Dr. Dan Humbyrd, for introducing and guiding her in the field of orthopaedics and her husband, Kent Grasso, for his continued love and support. Dr. Petre would like to thank his loving and caring family, Kristen, Grace and Hannah for their continued support. Dr. Chanmugam would like to extend thanks to his family, Karen, Sydney, William, Nathan, Sarah and Tamara for their wonderful support and terrific inspiration as well his both his parents, Malathi and Jayarajan who instilled the love of learning in their children. Dr. Laporte would like to thank her wonderful family, Paul, Sydney, Zachary, and Cooper, for their patience and for always making her smile, and her parents, Jere and Michael, for their unwavering faith and encouragement. As a group, we would like to thank our editor, Andrea Seils, for her advice and guidance. Many thanks to Derek Papp, MD for contributing the chapter on pelvic injuries and to Melinda J. Ortmann, PharmD, BCPS for her review and feedback on the analgesia chapter. Lastly, we thank the members of West Bay Orthopaedic Associates, Warwick, RI for their review of the manuscript and guidance. Their insight has been invaluable in making sure the manuscript is widely applicable to audiences in all practice settings.

Chapter 1

Introduction

Purpose of the Book

Improve Recognition and Management of the Most Common Fractures and Dislocations

This book is intended to be a rapid reference guide to the approach and initial management of the more common orthopaedic injuries. It aims to provide basic information about the initial management of musculoskeletal (MSK) injuries in general, including reduction, splinting, and casting techniques for specific fractures and soft tissue injuries. It is meant to be a "how-to" guide to the most basic of orthopaedic procedures and management. The intended audience is emergency physicians, orthopaedic residents, family practice physicians, and other primary care providers as well as medical students and midlevel providers. Emergency medical services (EMS) personnel and other frontline heath care providers who need a quick access to key information will find this book to be a handy reference.

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Guide to Effective Immobilization

Nonsurgical Management of Injuries

The musculoskeletal system is one of the few systems in the body where major injuries to the system can be overcome, regenerated, and healed solely by placing the two broken or injured parts in proximity and stabilizing them in place. An important concept to note when caring for injuries is that bones can repair and remodel, and tendons and ligaments can heal, but cartilage damage is often irreversible. Healing and recovery takes time (in children, as little as a few weeks), while at the other end of the spectrum, adults with comorbidities can take many months to heal. The key to healing is bringing the injured ends together and holding them there long enough to allow for healing to occur. The main point is to provide appropriate stabilization because motion may prevent healing in many circumstances.

In order to limit motion of a broken bone, three things must happen. The bone itself must be immobilized, the joint above the bone must be immobilized, and the joint below the bone must be immobilized. To illustrate this, picture a tibia broken directly in the center of the tibial shaft. If the knee is not immobilized, extension of the knee requires the quadriceps to act through the patellar tendon, pulling up on the tibia, but only the proximal fragment of the fracture. The distal fragment will be left behind. The same is true when the hamstrings are activated to flex the knee. Activation of the knee through the quadriceps or the hamstrings creates motion at the fracture site, which often is painful, but more importantly, the motion decreases the chance of effective healing.

In contrast to immobilization of bones, immobilization of a joint to allow for healing requires that the bone above the joint not move in relation to the one below. However, the joints not involved in the extremity usually can all move without jeopardizing healing. To illustrate this, picture a soft tissue injury to the knee. As long as the femur and tibia stay immobilized, the patient can move his or her hip, ankle, foot, and toes. This is why a knee immobilizer is an effective treatment for soft tissue injuries about the knee.

Importance of Immobilization Prior to Definitive Surgical Treatment

There are circumstances in which surgical intervention will be required to treat an injury, as there is no effective nonoperative treatment that can be tried first. In these circumstances the question is often asked: “If surgery is needed, why put the patient through the process of reduction and splinting in the meantime?” This question seems to have logical merits on the surface. There are a few extremely important reasons to insist on reduction and splinting, or at the very least, just simple splinting, of almost all injuries.

The first reason and arguably most important, is for soft tissue rest. A fracture or injury to the MSK system causes swelling and inflammation at the time of injury. Continued abnormal motion of a joint or motion at a fracture leads to ongoing swelling and soft tissue damage, which is a major contributing factor to failure of surgery and compartment syndromes; both are disastrous complications. Inadequate reductions or splinting in improper positions can also lead to contractures, articular cartilage death, soft tissue compromise, nerve compression, and other irreparable complications while the patient awaits surgery. Finally, there may be extenuating circumstances that prevent definitive treatment (certain cardiovascular events or associated injuries that prevent surgery, or the patient may have difficulty in timely follow-up for definitive care.) Therefore, the initial treatment needs to be as good as possible. The key point is to provide the necessary stabilization in all situations, for several reasons, not the least of which is that the initial stabilization may end up being the only treatment.

Circumstances Requiring Orthopaedic Consultation

Operative Interventions

This book is meant for frontline providers seeing the patients in emergency and or primary care settings. The operative treatment of traumatic injuries encompasses volumes of textbooks and can be found elsewhere.

Life or Limb-Threatening Injuries

True orthopaedic emergencies are rare. There are only a handful of orthopaedic injuries that have an immediate risk of loss of life or loss of limb. These need orthopaedic involvement as soon as possible. Recognition of these injuries is critical, but treatment will not be discussed in this text. These injuries include:

- Open-book pelvis injury with hemodynamic instability
- Spinal injury with any neurologic change including cauda equina syndrome
- Compartment syndrome of any compartment
- Septic arthritis, especially if the patient is acutely septic and unstable from the septic arthritis
- Injuries resulting in neurologic manifestations or vascular compromise.

Open Fractures

The acute treatment of open fractures has been evolving in the past decade and will likely continue to evolve long after this text. The current accepted practice is as follows:

- Open fractures with an opening < 1 cm and no exposed bone:
  - Appropriate antibiotics and consideration of tetanus booster immunization with timely irrigation and debridement either in the emergency department (ED) or operating room (OR) depending upon age of the patient, and orthopaedist's evaluation of the wound character. Appropriate treatment of the fracture.

- Open fractures with wounds 1–10 cm:
  - Appropriate antibiotics and consideration of tetanus booster immunization
  - Thorough irrigation and debridement in the ED with temporary stabilization of the fracture. Formal irrigation and debridement in the operating room with definitive or temporary fixation of the fracture in 6–12 hours.
- Open fractures >10 cm, grossly contaminated, vascular compromise, or large soft tissue defect:
  - Immediate tetanus and appropriate antibiotics. Cursory irrigation and debridement with temporary stabilization and formal treatment in the OR within usually 1–2 hours from injury.

Soft Tissue Injuries

Pyogenic flexor tenosynovitis of the hand may be caused by a number of pathophysiological processes, but for the purposes of this text, it should be considered an infectious process requiring immediate antibiotics and orthopaedic consultation for urgent surgical debridement. It is best characterized by the original description provided by Kanavel:

1. Finger held in slight flexion
2. Fusiform swelling
3. Tenderness along the flexor tendon sheath
4. Pain with passive extension of the digit

Infections

Septic arthritis, which is an infection of a joint, requires antibiotics and orthopaedic consultation and prompt intervention to prevent permanent damage to the joint and to prevent progression to systemic infection.

Importance of Imaging

Radiographs

Of the utmost importance to the diagnosis and treatment of musculoskeletal injuries is imaging. This is the stethoscope of MSK injuries; it is the electrocardiogram (EKG) equivalent for bone and soft tissue. Imaging is becoming more complex every year as there are more tools and techniques available all the time. Often, however, it is the classic radiograph that gives the most cost-effective and rapid information. Throughout training and practice, there will always be resistance to reordering radiographs, getting additional studies, including a joint above and a joint below, or obtaining tests with "less information" when a more advanced imaging modality is already available. We cannot emphasize enough the need for the proper imaging and the importance of radiographs.

Using Imaging to Plan Your Management

Radiographs

Plain radiography is often the diagnostic modality of choice. It is an invaluable tool for the orthopaedist and primary practitioner. Plain radiographs are inexpensive to obtain, have a very low morbidity for the patient, are fast, are widely available, and often provide all necessary information without a more involved test. Almost every injury listed in this text will have associated radiographs that are necessary for diagnosing the injury or ruling out other injuries with similar presentations. One can never settle for inadequate or incomplete imaging series as every radiograph in a series is designed to tell the practitioner very specific information. Both for the care of the patient and for medical-legal reasons, inadequate or incomplete series should be repeated without hesitation.

Computed Tomography. CT scanning is now widely available in many emergency centers. It is often a necessary test in orthopaedics but rarely a first-line imaging study. Computed tomography when compared with plain radiography is excellent for showing bony detail but is often less desirable for showing the "whole picture." There are some injuries that require CT scanning for complete diagnosis and treatment and these will be identified.

As a general rule, fractures involving articular surfaces should have CT scans after the reduction is complete and the injury is stabilized. CT scans are helpful for both assessment of reduction and preoperative planning. Due to the complexity of the bones involved, spinal pathology and pelvic pathology generally require CT scans.

Magnetic Resonance Imaging. MRI certainly has its role in orthopaedic diagnostic testing. It is an excellent modality to look for occult bony injuries and soft tissue injuries. However, many of these injuries can also be diagnosed by physical exam, and advanced imaging modalities can be delayed or performed on an outpatient basis.

There are many other useful diagnostic imaging tools available, including bone scans, tagged white cell scans, myelograms, contrast-enhanced arthrograms, and so forth. These will be reviewed where appropriate. They are rarely first-line diagnostic tools.

Postreduction Radiographs—the Need for Post-Splint/Cast Radiographs

Just as diagnostic imaging is crucial to the diagnosis and treatment of orthopaedic injuries, postprocedure radiographs are as important. An incomplete or poor reduction, an errant fold in a splint or cast, or an inadequate procedure can cause significant harm to patients. These often cannot be seen with the unaided human eye. Even if the reduction "felt good" and the limb looks well aligned, traumatic injuries are often unstable, and one needs to evaluate and document that the procedure was successful. Postreduction films are necessary to confirm that any splint or cast that was applied will not cause harm and is holding appropriate reduction. Without the use of postprocedure radiographs, the practitioner is sending patients out based on the guess that their intervention has helped.

Follow-up Imaging

For injures when an occult fracture is suspected but cannot be demonstrated on radiograph, it is recommended that the affected limb be splinted. The injury should be reimaged in 10–14 days when an occult fracture is better identified on a radiograph. In other words, a negative radiograph is a true negative only when it is taken 10–14 days after the injury.

Describing Fractures

Recommended Radiographic View for Specific Injuries

Just as describing an EKG to colleagues has its own vernacular, so does describing radiographs of musculoskeletal injury. For example, saying "normal sinus rhythm with ST elevations in the anterior leads" provides much more information to the person you are communicating to than does "the squiggly lines all look the same except sometimes the medium-sized bumps after the really big ones are higher." The following scheme will allow one to communicate efficiently with orthopaedic colleagues. Although a full orthopaedic glossary is presented in Chapter 10 of this book, here are some basic words used to describe fractures:

- Open versus closed. Any full-thickness skin defect in the zone of injury is considered open. Please note that a superficial skin injury near the musculoskeletal injury does not constitute an open fracture (e.g., road rash). An open fracture requires a full-thickness skin defect.
  - "I have a patient with a closed…"
- Identify the bone of interest and the location of the fracture in the bone:
  - "…distal third tibia fracture…"
- Describe the type of fracture using appropriate words. (Please note a full orthopaedic glossary is presented in Chapter 10 of this book.)
  - Simple: One fracture line
  - Comminuted: Multiple fracture lines
  - Butterfly: A triangle or wedge that has broken off at the site of the fracture
  - Segmental: Fractures above and below a segment of a bone such that it is free floating

- Displacement: The amount of translation one segment has compared with the other. Fractures can be nondisplaced (often difficult to see on radiograph), minimally displaced, or displaced. Displaced fractures can be described by the percent of the width of the bone in question.
- Angulation: The degree and direction of the distal segment compared with the proximal segment
- Apex: The point of a fracture
- Direction of the fracture line: Transverse, oblique, spiral, buckle, and so forth
- Intra-articular: Extending into or involving a joint
- Extra-articular: Outside of the joint
  - "…that is comminuted, extra-articular, angulated 30 degrees with the apex anterior and displaced 100%."
- Subluxation: Partial dislocation; loss of normal joint congruity
- Dislocation: Complete incongruity of a joint
- Certain fractures have epynomic classification schemes that are widely used and understood. Because of this, they can provide a large amount of information with a small amount of description. Where appropriate, these will be described in this book.

Pediatric Fractures

Classification of Pediatric Physeal Fractures (Salter-Harris)

Because children have growth plates and fractures can occur in or through them, a special descriptive classification system has been developed to describe physeal fractures, these can be seen graphically in Figure 1.1:

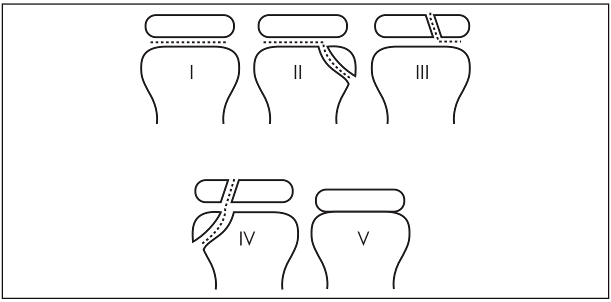

Figure 1.1 Diagram of Salter-Harris classification.

- Type I: Physeal separation
- Type II: Traverses the physis and exits through the metaphysis
- Type III: Traverses the physis and exits through the epiphysis
- Type IV: Passes through the epiphysis, physis, and metaphysis
- Type V: Crush injury to the physis

SALTR: A simple mnemonic to help remember the Salter-Harris fracture classification.

- I-S = Slipped (or straight across). Fracture of the cartilage of the physis (growth plate)
- II-A = Above. The fracture lies above the physis.
- III-L = Lower. The fracture is below the physis in the epiphysis.
- IV-T = Through. The fracture is through the metaphysis, physis, and epiphysis.
- V-R = Rammed (crushed). The physis has been crushed.

Chapter 2

Basic Techniques

Basic Techniques in Splinting and Casting

When to Splint versus When to Cast

This is a common question that does not have a perfect answer. Compared with splints, casts are more stable and more rugged and can be designed to be weight bearing. The disadvantage of a cast is that its circumferential nature does not allow for expansion secondary to swelling. An improperly placed cast can cause a compartment syndrome and in the worst case scenario can lead to limb loss.

In general, splinting is preferable to casting, especially if there is concern for future swelling—which is the case in most circumstances. In young children (under 4 years of age), it is important to provide as much structure as necessary, which generally means casting. Although these young children need more substantial immobilization, if concerns exist about swelling, it may be more appropriate to cast and then bivalve the cast with a cast saw and subsequently wrap the cast with an elastic wrap.

Here are some guidelines regarding splints and casts:

- If the patient will need an operation—splint
- If the patient is an adult and the injury is acute (less than a week old or still very swollen)—splint.
- If the patient is a child and the immobilization will be the definitive treatment—cast and bivalve in the acute setting, cast alone in the chronic setting.

General Principles of Immobilization—How to Avoid the Major Pitfalls

There are a few major pitfalls and complications associated with casting and splinting. We will review them individually and how to avoid them.

Compartment Syndrome: Often caused by the swelling from the injury, this can be accelerated by a bad cast or splint.

- Never use a material that won't expand in circumferential wraps (Kling or Kerlix should always be avoided).
- Never cast an acute adult fracture; use a splint that will allow for expansion
- Elevate once complete.
- Never wrap any layer, especially ace wraps, tightly.
- The more layers circumferentially placed with any material around a limb, the tighter and less expansile the entire construct becomes. Minimize unnecessary layers!

Pressure Sores or Cast Ulcers: These occur when the cast is improperly padded and pressure is placed chronically in one place. Pressure sores/cast ulcers result in skin breakdown if left unchecked. This can happen anywhere, but they usually occur in a place where there is motion and a lack of padding, typically at the very top or very bottom of the cast, and bony prominences (heel, patella). Ways to avoid cast problems are listed below.

- Pad bony prominences well.
- Add extra padding at the very top and very bottom of casts.
- Never allow the rigid casting/splinting material to go beyond the padding
- Avoid moving a joint when the padding/rigid material is being applied. Movement may result in folds. Folds cause pressure and pressure causes unnecessary skin breakdown.
- Place the proper molds to minimize the cast/splint motion and slippage

"A Bad Cast": Often people with less experience find themselves in a position where the postcast/splint radiographs look less than ideal due to positioning, folds, reduction, and so on. (This can happen to anyone!) Bad casts should always be redone. Reductions of articular surfaces or physes should be limited to three attempts to minimize shear on these sensitive structures. To avoid the "bad cast":

- Be prepared! Have more than enough materials at the bedside every time. That way when you accidentally drop a crucial material in the middle of the procedure, you do not have to start over.
- Get help. Many of these procedures are more than a one-person job. Getting a trustworthy extra pair of hands or two is crucial to doing it right the first time
- Exert the necessary force (don't wimp out.) Even with the best analgesia, these procedures can cause some discomfort and pain. This discomfort is usually quick and temporary. Doing it right the first time despite patient discomfort will prevent the patient from having to go through it all again. Explaining the uncomfortable steps beforehand so they know what is coming will often make the patient more tolerant and helpful during the painful parts. Once the bones are in the best alignment, the patient will feel better. Attention to analgesia prior to starting the procedure can minimize or eliminate discomfort.
- Get the proper positioning before you start. Avoid moving during casting or splinting as it causes the dreaded folds. See above.

Three-Point Mold (see Figure 2.1)

The mold of a cast or a splint determines the position of the fracture. A proper mold requires three points of applied force (the mold), and the force should be applied to counteract the forces displacing the fracture. The concept of a three-point mold is analogous to a seesaw, in which the fulcrum of the seesaw is balanced on either side by forces in the opposite direction.

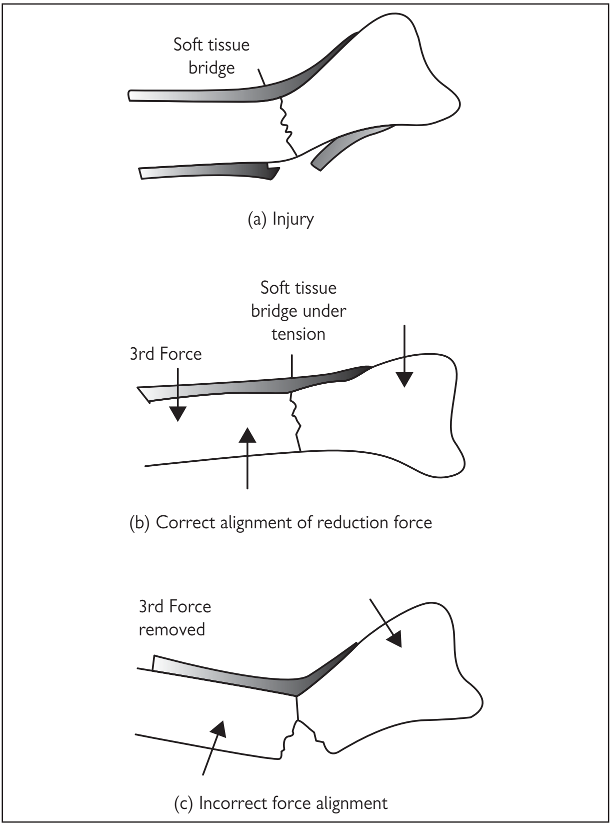

Figure 2.1 Diagram of a three-point mold with a fracture.

Techniques for Patient Padding: Sandwich Technique or Overwrap Technique

There are two general ways to place padding between the patient and the rigid material. The "sandwich" is a one-step method that essentially pads the rigid material first and then is placed on the patient. The second technique is the "overwrap" method, which is a two-step process. The first step pads the patient, then the rigid material is added. Casts always use overwrap; splints can use either.

The Sandwich Technique (see Figure 2.2)

1. The rigid splinting material is measured out, and the proper number of layers are created and laid out on a table.

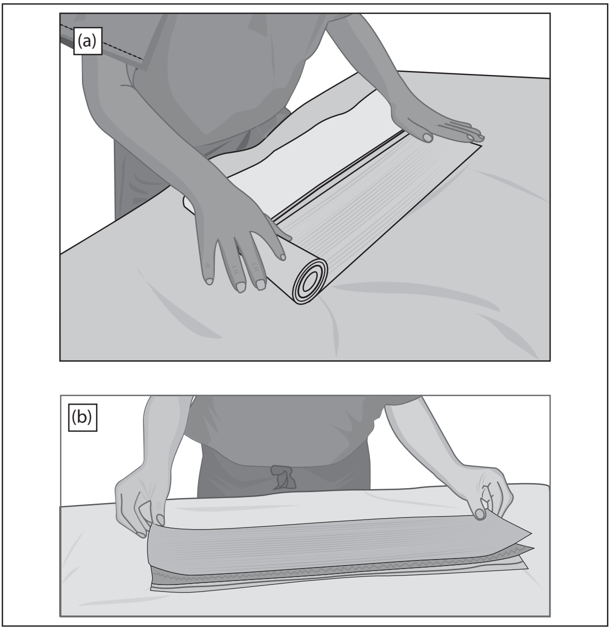

Figure 2.2 Sandwich technique. a. The sandwich technique requires three layers to be rolled out: Sof-Roll, followed by plaster, followed by Sof-Roll. b. The sandwich is assembled by stacking the three layers of the sandwich.

2. The padding material is then laid out on top of the splinting material and layered to give the appropriate padding. The padding should be slightly larger in all dimensions (wider and longer) than the rigid material to make sure all aspects of the rigid material are covered.
3. A final single layer of padding is measured off to cover the outside of the plaster to prevent the elastic wrap from sticking to the plaster.
4. The plaster or fiberglass is then activated with water and is placed between the padding that will be touching the patient and the single covering layer. Then, the entire construct is placed on the patient.
5. The construct is then held in place typically with an elastic wrap, and the proper mold is introduced until the rigid material has hardened.

The Overwrap Technique (see Figure 2.3)

1. The rigid splinting material is premeasured or casting material is at hand.
2. Position the extremity into position of immobilization NOW and do not move again.
3. Wrap the padding layers circumferentially around the extremity, making sure to go above and below where you plan to end the rigid material.
4. Use a 50–50 wrap where each layer overlaps the last by 50% of its width.
5. Take care to provide adequate padding to bony prominences.
6. Add the rigid material in either a splint or casting fashion and secure with elastic wraps.
7. Apply proper mold.

Padding the Splint—Importance and Techniques

Proper padding is a large part of the art of immobilization. Too little padding, especially at bony prominences, causes serious skin breakdown and can lead to infections and other serious complications. However, the converse of too much padding will prevent the rigid layers from holding the extremity immobilized and can lead to nonunion.

- Splints that are only to temporarily hold immobilization while awaiting definitive procedures should always get extra padding as holding the perfect reduction is less important than preventing skin breakdown, which will delay surgery.

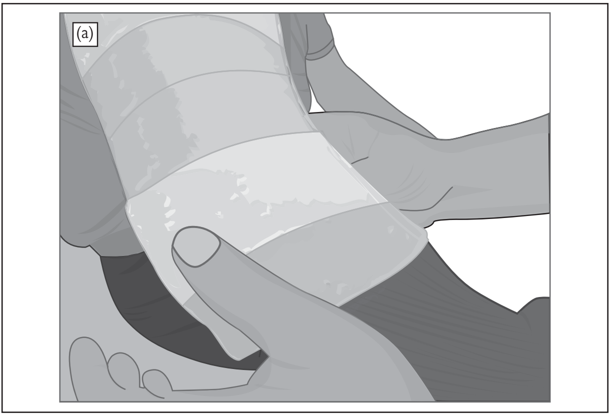

Figure 2.3 Overwrap technique. a. Fifty–fifty overwrap.

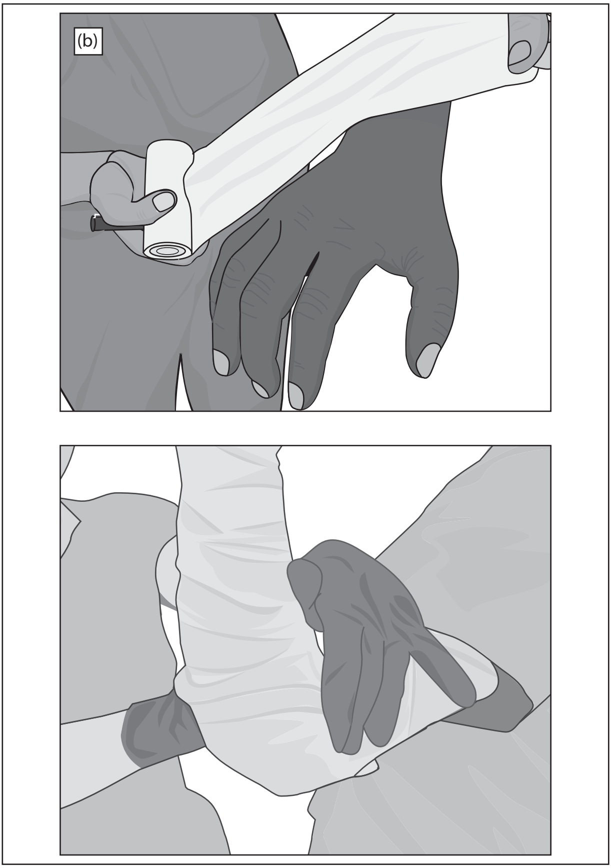

Figure 2.3 (Continued) b. Correct way to roll out an Ace. c. Padding bony prominence; applying extra padding to the elbow.

- Splints and casts that are holding reductions and immobilization should have just slightly more that the minimum padding at the areas that are crucial to maintain the reduction while other areas are padded more to prevent pressure sores.
- Bony prominences such as the olecranon or heel are often the problem locations and should get addressed with specific padding directed at preventing pressure sores.

Splinting Materials

Immobilizing Materials: Fiberglass, Plaster, Elastic Wrap

Fiberglass

- Extremely rigid. When laminated together can create a lightweight strong construct.
- Less pliable than plaster
- Mild-moderately exothermic when curing
- Can be water resistant
- Comes in rolls and premade "sandwiches" with padding built in

Plaster

- Extremely rigid when enough layers laminated together
- Heavier than fiberglass for similar rigidity
- Extremely pliable when wet, can be made into almost any shape and allow for odd bony prominences
- Not water resistant
- Moderately to significantly exothermic when setting and has been known to cause burns if used improperly. Using cool water is the best way to prevent this.
- Comes in rolls or sheets

Elastic Wraps

- Poor rigidity
- Extremely lightweight
- No curing necessary, therefore no heat
- Useful for creating gentle pressure, holding other materials in place, or to create a gentle decrease in the range of motion at a joint

Padding Materials: Sof-Roll, Kerlix, Gauze, Bulky Jones Cotton, Army Basic Dressing Pads

Sof-Roll

- Very soft, thin padding material
- Tears easily
- Can be stacked or rolled to create multiple layers increasing the padding
- Comes in various sizes
- Some stretch to allow for swelling

Kerlix

- Thinner than Sof-Roll and less padding per layer
- Extremely strong in axial stretch
- Does not allow for stretch from swelling

- Comes in various sizes
- Not recommended for most padding applications, preferred as a positioning tool

Gauze

- Fairly soft thin padding material
- Limited in sizes, usually in sheets only
- Little to no stretch
- Strong, resists tearing

Bulky Jones Cotton

- Extremely soft, thick padding
- Thickness allows for swelling/prevents pressure sores.
- Thickness decreases ability to hold reduction.
- Tears easily

Army Basic Dressing (ABDs—Sometimes Called Abdominal Pads)

- Thick, well-padded gauze
- Limited sizes
- Strong, resists tearing
- Excellent for padding bony prominences

Patient Management

How to Care for Your Cast or Splint

- The vast majority of casts and splints are NOT waterproof and should be kept dry at all times.
- Because they are not waterproof, cleaning them is difficult, and therefore the cast or splint should be kept clean and protected at all times.
- Garbage bags, newspaper bags, Saran Wrap, and commercially available "cast bags" can all be used to keep a cast or splint dry when bathing.
- The majority of casts and splints are non-weight-bearing and will deteriorate or break quickly if subjected to weight-bearing stress.
- Casts or splints should never be rewrapped by untrained practitioners.
- New pain or worsening pain in casts or splints is always concerning and should be evaluated by a qualified practitioner.

Standard Discharge Instructions

With any splint or cast, the patients and their families need to be counseled on key points. Discharge instructions are absolutely vital to ensure the integrity of the splint or cast:

1. Keep clean and dry
2. Call or return to provider for pressure sores, any new numbness, tingling, or weakness. Also return to provider if there is an increase in pain or if pain is not controlled by medication.
3. Elevate
4. If the cast or splint becomes loose, NEVER rewrap at home, return to be evaluated by a provider. There are case reports of parents rewrapping bandages or splints causing ischemia and amputations of their child's limbs.

After Splinting/Casting Emergencies (i.e., Compartment Syndrome)

Compartment syndrome (see Chapter 7, "Orthopaedic Emergencies and Urgencies") can be caused by an improperly placed cast or splint or excess swelling in a cast or splint. This is a limb-threatening surgical emergency. All patients and family members should get educated about the signs and symptoms of compartment syndrome before being discharged from any medical center with a new cast or splint. They need to understand that they must return to a medical facility at once if these signs or symptoms occur. If a patient or family cannot comprehend this or does not have some ability to return, the patient should be kept for 24–48 hours for observation.

Cast Removal Technique, Including Bivalving of Casts and Wedging

Splints can be removed by using a sharp pair of trauma shears or cast shears (scissors with a protected blunt end on one side). The layers of a splint should be sequentially cut off starting with the outer layer and progressing inward toward the patient's skin. It is easiest to work between the slabs of rigid material.

Casts are more difficult to remove as they are circumferential, and therefore there is no space between slabs in which to insert scissors. Therefore, a cast saw is usually required to cut the plaster or fiberglass.

Technique (see Figure 2.4)

1. Talk to the patient and family about the cast saw: how it works, how it is designed to not cut skin, that it is extremely loud, and how it sometimes gets hot when it has been on for a short period of time.
2. Check that the cast saw blade is sharp and free of defects.

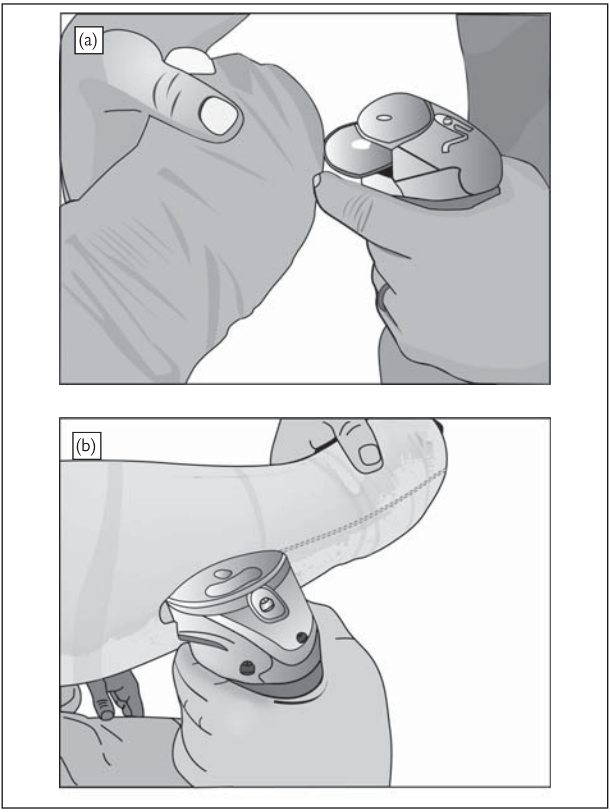

Figure 2.4 Cast removal. a. Positioning the hand to use the cast saw. b. Cutting the cast in a straight line.

3. Check that the cast saw blade is securely attached to the saw as the nut that secures the blade often loosens.
4. NEVER use a saw that is in any disrepair.
5. Plan the cuts before beginning. You should never work in a concavity such as in the antecubital fossa when the arm is bent. Working in a concavity greatly increases your chance of injuring a patient.
6. The cast saw is designed to move directly in and out perpendicular to the cast.

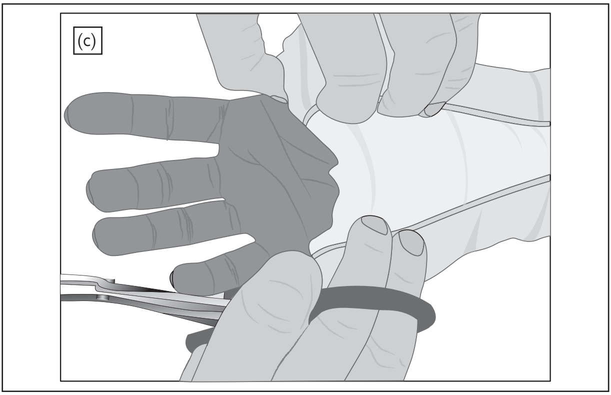

Figure 2.4 (Continued) c. Splitting open a bivalved cast.

7. Important: The saw should NEVER be moved longitudinally up or down the cast while still inside the cast. Remove the blade completely, move down slightly, and then repeat cut.
8. The saw blade heats up. Check the blade frequently to ensure it is not too hot, as the blade can burn the skin. If it is hot, stop and allow blade to cool.

Patient Positioning: How to Hang the Upper or Lower Extremity Using Kerlix (see Figure 2.5)

- Double a length of Kerlix and pass the loop through the second webspace from palmar to dorsal. Then, take the end of the loop at end of Kerlix dorsally and pull over the index and middle fingers (toes) and pull taut.
- Secure free ends to a stable IV pole or weighted IV pole.
- We discourage the use of ceiling-mounted IV poles as they are not strong enough to hold an extremity, and cannot move with the patient if the stretcher needs to be moved.

Splinting and Casting the Upper Extremity

Coaptation Splint

Gear List

- Six inch stockinette (3× length of Sof-Roll)
- Two to three 4 inch plaster rolls

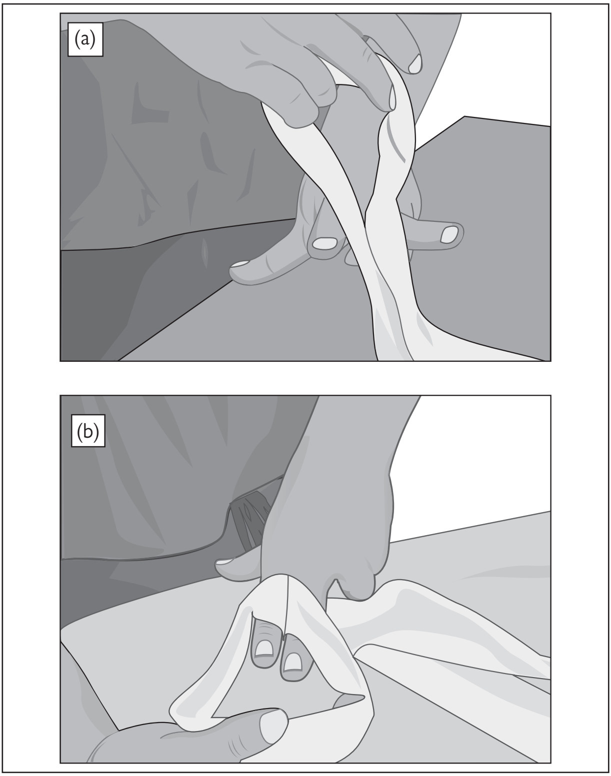

Figure 2.5 Patient positioning—how to hang an arm using Kerlix. a. Putting Kerlix between the fingers to be suspended. b. Pulling Kerlix loop over the fingers to be suspended.

- Three 6 inch Sof-Rolls
- Two 6 inch ace wraps

Patient Positioning

- Position the patient sitting up on a stretcher or a chair and have an assistant support the wrist to maintain the arm in 45 degrees abduction at the shoulder, elbow bent to 90 degrees. When applying the splint, the assistant can remove the upper hand and assist with supporting the splint in the axilla. The lower hand is maintained on the wrist. If an assistant is not available, the patient can support their hand on a Mayo stand or on their

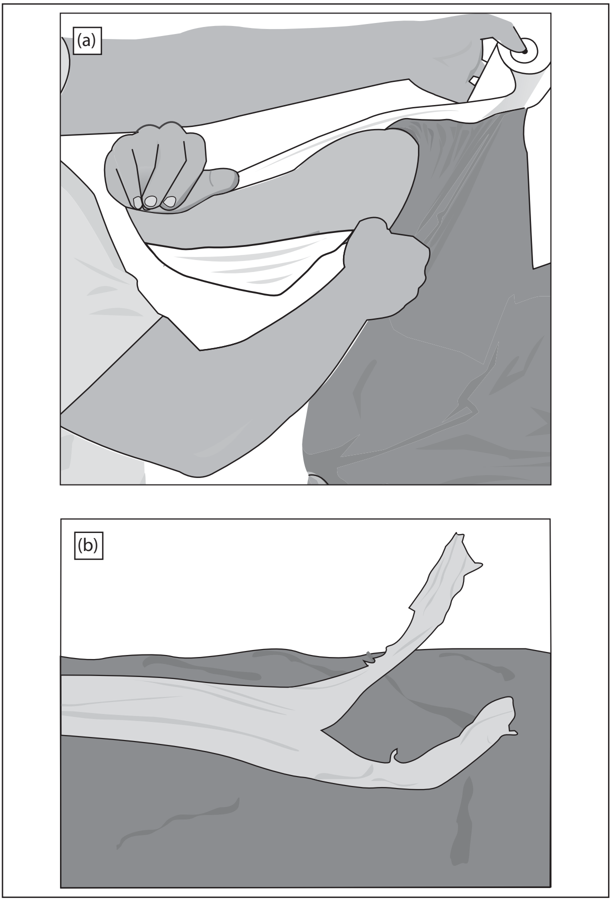

Figure 2.6 Coaptation splint. a. Measuring the splint's length. b. Cutting the stockinette.

abdomen. The goal is to have the elbow at 90 degrees and arm in some abduction. The splint needs to extend into the axilla (with appropriate padding).

Preparing the Splint

- Measure length of plaster from AC joint around lateral arm and then around elbow and up the medial arm to the axilla.
- Roll out 10 layers of plaster to this length

Figure 2.6 (Continued) c. Tying the second axilla knot.

- Measure Sof-Roll to extend 1 inch beyond plaster at both ends (six layers minimum on skin side and two on outer side of plaster).
- Measure stockinette to be 3× length of Sof-Roll and split proximal and distal 1/3 with scissors to make two "tails" on both sides (should be enough stockinette to cover entire Sof-Roll).

Technique (Sandwich Technique of Splinting) (see Figure 2.6)

1. Dunk plaster in cool water.
2. Squeeze out excess water.
3. Stretch and smooth plaster for laminating.
4. Plaster onto premeasured padding.
5. Apply top layer Sof-Roll.
6. Insert sandwich into stockinette.
7. Place splint on the medial aspect of arm as high into axilla as possible and, if available, have assistant hold splint in axilla.
8. Place stockinette over the shoulder and tie into place using the tails of the stockinette (tight enough to hold plaster into axilla).

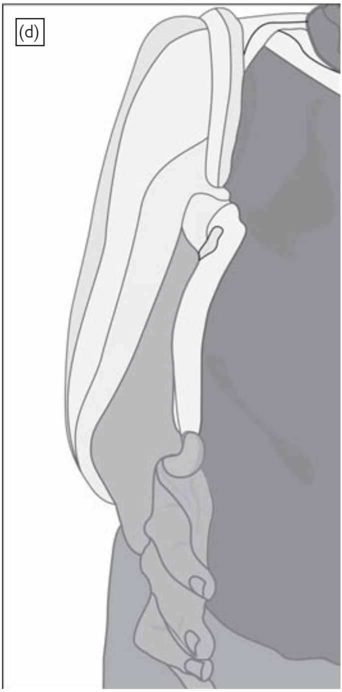

Figure 2.6 (Continued) d. Splint applied and tied, before molding and application of Ace wrap.

9. Wrap around elbow and up lateral arm so end lies on top of existing knot in stockinette and then tie second knot in axilla stockinette over the shoulder stockinette.
10. Wrap ends of the shoulder stockinette around to the contralateral axilla and secure.
11. Apply Ace wraps along length of arm.
12. Mold splint to fracture.
13. Apply sling and swathe/shoulder immobilizer.
14. Remove knot at contralateral axilla and check to ensure the knot in the ipsilateral axilla has not gotten too tight with the addition of the many layers.

Pearls and Pitfalls

Pearls

- Patients should be wearing only gown (no undergarments).
- Always measure off the good arm.

Figure 2.6 (Continued) e. Completed splint.

- Mold based on fracture
- Place ABD pad or extra padding in axilla.
- Because fractures tend towards a varus (distal segment has inward angulation) position, the mold should place the elbow in abducted position compared to the proximal humerus.
- Weight of splint is important in achieving fracture reduction and therefore the elbow in the sling should never be higher than the contralateral elbow (do not make sling too tight).
- Do not need anatomic reduction—reduction will continue to improve with proper splinting

Pitfalls

- Axilla portion of the splint is always lower than you think it is, so the splint must extend all the way into the axilla; otherwise it will slide down and inevitably lever against fracture site.
- Superior portion of splint must extend to the lateral border of the neck, at least to the AC joint, to immobilize the shoulder.
- The axilla knot should be tied no more lateral than the AC joint.

Sugar Tong Forearm Splint

Gear List

- Four 3 inch or 4 inch plaster rolls (plaster should be approximately the width of a closed fist).

- Three Sof-Rolls (go up in size [width]) of Sof-Roll compared to plaster) → two for padding, one for wrap.
- Kerlix or set of finger traps
- Three 4 inch Ace wraps
- IV pole
- Weight (for distal radius reduction) for traction
- One 1L IV bag (for distal radius only)

Patient Positioning (see Figure 2.7)

- Hang hand from IV pole either with Kerlix or finger traps (patient can be seated or supine).
- The elbow should be at 90 degrees.
- Specific fractures require traction, and this should be applied prior to splint application, and traction radiographs obtained before splinting (more detailed instructions on reduction maneuvers unique to particular fractures are covered in Chapter 3).

Preparing the Splint

- Measure the width of the plaster to approximate the width from the first webspace (between the thumb and second finger) to the ulnar side of the palm.
- Measure the length of the plaster from the distal palmar crease around the elbow to the MCP (metacarpophalangeal) joints at the dorsum of the hand.
- Roll out 10–12 layers of plaster.
- Measure Sof-Roll to be 1 inch longer than the plaster at both ends:
  - Sof-Roll should have six layers for the skin side.
  - Sof-Roll should have two layers for the outer surface.

Technique

1. Reduction if indicated (see Chapter 3, "Upper Extremity Injuries," under specific fractures)
2. Dunk plaster in cool water.
3. Squeeze out excess water.
4. Stretch and smooth plaster for laminating.
5. Plaster onto premeasured padding.
6. Apply top layer Sof-Roll.
7. Lay splint from distal palmar crease along volar forearm and around elbow and over dorsal forearm and hand to the MCP joints.
8. Wrap Sof-Roll circumferentially around splint at wrist to hold in place (optional).
9. Apply Ace wraps to secure plaster.
10. Mold plaster according to the injury. Traditionally, a 3-point mold is utilized. The mold for dorsally displaced distal radius fractures is demonstrated in diagram 2.7e and 2.7g.
11. Apply sling.

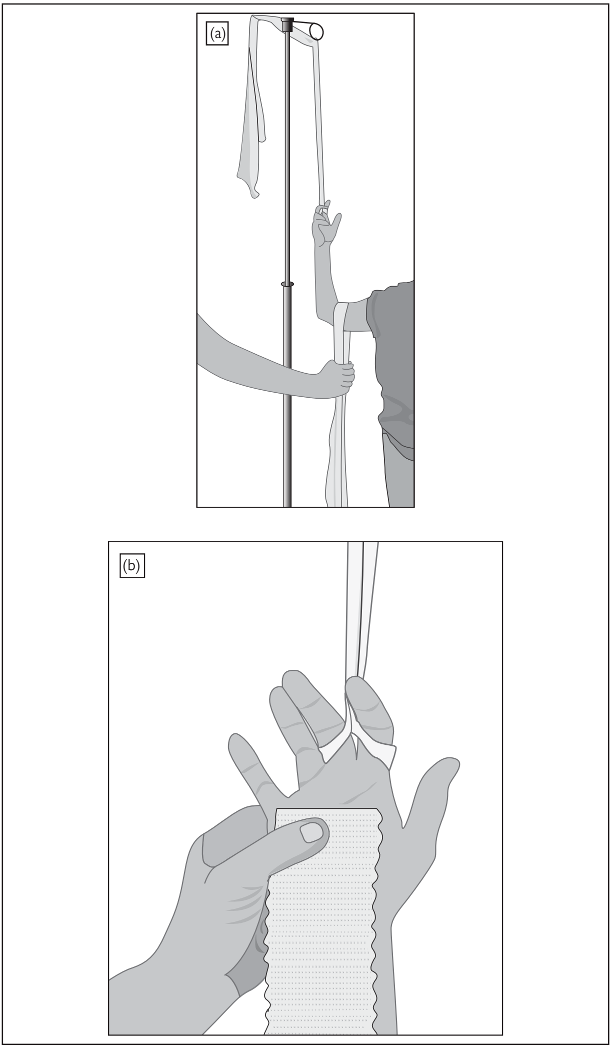

Figure 2.7 Sugar tong splint. a. Patient positioning. b. Measuring the width of the plaster.

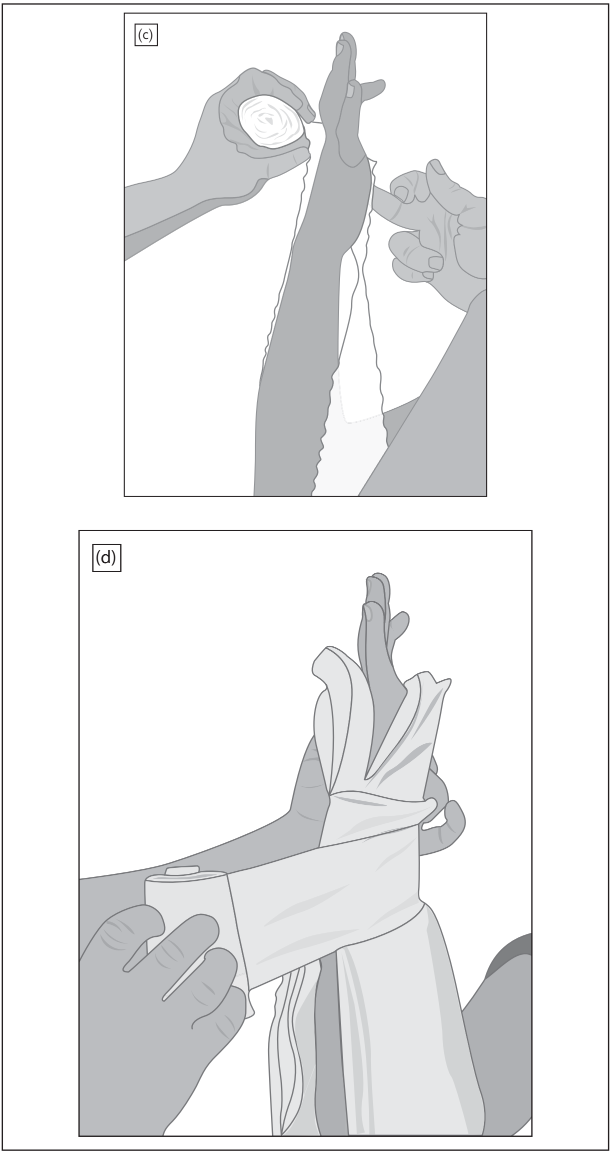

Figure 2.7 (Continued) c. Measuring the length of the plaster. d. Initial splint fixation with Sof-Roll.