INTRODUCTION

Immobilization of injured bones, joints, ligaments, or muscles has been practiced traditionally, if nothing else, because of the comfort that immobilization provides. The types of methods and means of immobilization of fractures have expanded over the years. Early methods were limited to splints and traction. These methods were used worldwide for many generations, to be gradually replaced by plaster casts. Today many materials are available to fabricate casts, splints and braces (orthoses) including thermoplastic and fiber reinforced materials.

As a means of fracture immobilization, internal fixation became possible less than a century ago when anesthesia was invented and avoidance of infection became a reality. Internal plates and intramedullary nails, as well as external fixators, have gained enormous popularity. These advances have had positive effects in the management of the majority of fractures. Metallurgical improvements and new imaging techniques that facilitate surgery, particularly in the case of intra-medullary fixation of long bones, have solidify the definite place of surgery in the care of fractures.

Despite all the improvements in the surgical management of the skeletally injured patient, casting and bracing have a permanent place in the armamentarium of the orthopaedic surgeon. There is not as yet a single method of treatment, surgical or non-surgical, that applies to all fractures and under all circumstances.

In this Manual we attempt to summarize the most current techniques of casting and bracing of some of the most common fractures. Though it is generally perceived that casts, splints and braces “immobilize” fractures, the reality is that they do not. They simply “stabilize” them to different degrees. This “lack” of immobilization, rather than being a problem is a benefit, because rigid immobilization of fractures is unphysiological; it delays healing, produces a weak callus, and induces localized osteoporosis. If casts or braces were to rigidly immobilize fractured bones the incidence of nonunion, stiff joints and muscle atrophy would be far greater.

It was the realization that above-the-knee casts did not immobilize fractures of the tibia that inspired the birth to the concept of fracture bracing. The resulting introduction of freedom of the ankle joint resulted in the prevention of joint stiffness while allowing healing to take place uninterrupted.

In this Manual we devote space to the discussion of basic principles of a biological and physiological nature, which should be known to the practitioners of the art of casting and bracing of fractures. Though casting and bracing is used in the management of many musculoskeletal conditions, we have chosen to limit detailed discussion and the philosophy and techniques applicable to fractures of the distal radius, the humeral shaft, the isolated ulna and the tibial diaphysis.
1.3 Initial Treatment

1.3.1 Positioning of the patient and the limb.

Experience and clinical research has convinced us that Colles fractures are best stabilized in a position of relaxed supination of the forearm, rather than in the traditional position of pronation. We have extensively documented that the relaxed position of supination allows for better reading of radiographs, it reduces significantly the incidence of loss of reduction, maintains more securely the stability of the distal radio-ulnar joint and leads to more rapid restoration of wrist function.

The primary reason as to why loss of the achieved reduction of some Colles’ fractures is a common occurrence, is the fact that the only muscle capable of recreating the typical Colles’ deformity -radial shortening and dorsal angulation- is the brachioradialis. This muscle functions best when the wrist is in pronation and its deforming force is minimized when the forearm is in supination (Figure 1.4)).

In order to lessen the deforming force of the brachioradialis muscle, the arm must be stabilized initially in an above-the-elbow cast that holds the forearm in a relaxed attitude of supination, and the wrist in slight flexion and ulnar deviation. If the cast does not extend above the elbow, the forearm readily rotates into pronation, creating once again an undesirable physiological environment.

Figure 1.4. Schematic drawing illustrating the manner in which the contraction of the brachioradialis muscle creates the lateral and dorsal displacement of the distal radial fragment.

There are still a number of orthopaedists who adhere to the old traditional belief that pronation of the forearm is preferable.

We have documented that simple, transverse, nondisplaced Colles fractures that do not require manipulation do well in either long or short arm cast. Therefore the above-elbow cast in a relaxed position of supination should be reserved for these fractures.
Figure 1.7. a) The padded forearm is wrapped with casting material from the base of the metacarpals to just below the elbow. During this stage, the supinated forearm is flattened and the wrist held in an ulnar and volar position. b and c) Once the casting material has set, the wrapping continues to above the elbow, which is being held at 90 degrees of flexion. d) While the casting material is still in a soft stage, compression is applied over the medial and lateral distal arm. Care must be exercised not to compress over the bony prominences of the arm and forearm. e) Upon completion of the procedure, the elbow will be at 90 degrees of flexion, the forearm in a relaxed attitude of supination and the wrist in slight flexion and ulnar deviation.

1.4 Secondary treatment

1.4.1 Application of the below the elbow cast-Munster-like cast

The initial cast should be well padded to accommodate the additional swelling that will occur following the manipulation of the fragments. However, once the swelling and major discomfort have subsided significantly, a new cast is applied to prevent the possibility of displacement of the fractured fragments.

The new cast is applied in the same manner as the original one, but the amount of padding is reduced and the compression of the tissues increased. In order to maximize the degrees of function of the injured arm, a Munster-type of cast that we developed a number of years ago, permits some flexion and extension of the elbow, while preventing pronosupination.
In order to allow flexion and extension of the elbow, the anterior and posterior walls of the proximal cast are trimmed down. Anteriorly at approximately one inch below the elbow crease, and posteriorly just above the tip of the olecranon. In this manner the patient should be able to flex to approximately minus 20 degrees and extend the elbow to approximately 60 degrees. The abutment of the lateral wings against the distal arm prevents pronosupination (Figure 1.9).

Figure 1.8. a) and b) Illustrations of the firm molding of the distal arm.

Figure 1.9. a) and b) Illustration of the lines at which level the cast is to be trimmed. Anteriorly, approximately one inch below the elbow crease and posteriorly just above the tip of the olecranon.
Figure 2.11 – The patient is instructed as to how to adjust and to remove the brace. It can be left in place for bathing. Then immediately after, they can remove the brace using the hand on the uninjured side, by loosening the straps, removing the stockinette for laundering and replace it with clean, dry stockinette. Then the patient can reapply the brace and retighten the straps.

This slippage not only can produce irritation of the anticubital space, but results in loss of compression of the soft tissues. *This compression is essential for the maintenance of fracture alignment and stabilization of the fragments.* It is important, therefore to use adjustable braces. As swelling subsides and muscle atrophy experiences recovery, the need for frequent adjustment of the brace decreases. After the acute symptoms have subsided, the patient should be instructed to remove the brace for hygiene while bathing. The brace should be removed, the stockinet replaced with a clean one, and the brace reapplied, Figure 2.11.

*Under no circumstances should active elevation and flexion of the arm be instructed or encouraged prior to demonstration of intrinsic stability at the fracture site, as depicted by the presence of early callus, and the patient’s perception that motion at the fracture is no longer there.* Attempts to confirm clinical stability through manipulation at this time does more harm than good.
Figure 3.2. Stockinette is applied to the arm, extending over the hand and elbow, a). Holes may be necessary to allow for uniform expansion without wrinkles. Padding is wrapped from just below the elbow to the MP joints, b), and the stockinette reflected back on the padding. Next, casting tape is wrapped just short of the stockinette boarders with the forearm in neutral to relaxed supination, c) and d), flattening the soft tissues on the dorsal and volar sides, e), to separate the ulna from the radius. The forearm can be rotated slightly from supination to mild pronation, f), but the molding of the soft tissues will block the last few degrees of pronation as the radius tries to cross over the ulna. The web space between the thumb and fingers has a narrow, loose wrap to aid with suspension of the cast and control wrist position while allowing full use of the fingers, g).

3.3.2 Application of the prefabricated brace
Figure 4.7.  a) Upon completion of casting of the leg from the ankle to the level of the tibial tuberosity the patient’s heel should be placed on the lap of the applicator, and the patient’s quadriceps in a relaxed position. Patients must be frequently reminded of the need to maintain relaxation of the quadriceps. b) After applying a thin layer of cotton over the knee, casting material is wrapped to approximately two inches above the proximal pole of the patella. At this time, the proximal portion of the material is firmly flattened posteriorly.

Figure 4.8.  a) With the patient’s quadriceps relaxed, the lateral aspect of the femoral
APPENDIX

THE BASICS OF PRINCIPLES OF CASTING

A.1 Introduction
The following chapter assumes the reader has limited knowledge of orthopedic casting but previous medical experience such as Medical Assistant, Athletic Trainer, Radiologic Technologist, etc, and is in training to become an Orthopedic Technologist. This chapter describes the basic techniques in padding, synthetic casting tape application and molding that will apply for all casts included in this section of the manual and will not be repeated for each individual cast shown.

The most important elements in the casting application learning process is to start with the basics and through practice become familiar enough with different body types and injuries to adjust your technique to fit your particular patient’s needs. This manual will give you a good grounding in the basics. It is up to you to you to practice and improve.

A.2 The Cast Room
A well equipped cast room can make the casting process easier and safer for the patient as well as the caster. Having appropriate tools and keeping them maintained properly is the responsibility of the Orthopedic Technologist.

A.2.1 Safety Items
The same universal disease transmittal precautions you normally practice with your patients are also used in cast room. It is also necessary to have eye and ear protection available for you, the patient and anyone else involved in the cast removal procedure. Inexpensive eye and ear protection can be purchased at any hardware store. More elaborate ear protection for younger patients should also be available to help the cast removal process go more safely and smoothly. When using a cast removal saw the eyes of the cast saw operator and the patient should always be protected against flying fiberglass chards.

A.2.2 The Casting Table
A cast room should be large enough that a patient exam table can be accessed from all sides. An up & down motorized table will provide ergonomic help in safe patient transfers as well as provide the correct casting height for any situation. Some states have already passed patient lifting laws and require patient lifting mechanisms in hospitals and other medical environments. An up & down motorized table is not only safer for the patient during transfers from wheelchairs but will help reduce staff back injuries.

Make sure you purchase a table that can lower to 17 or 18 inches (wheelchair height) and raise to 34 inches. This will allow you to position short and tall patients at the best possible height for your casting procedures. Why lean over to reach the patient’s limb when you can raise the table to suit your own particular height and apply or remove a cast in a more ergonomic position. The federal government provides special tax advantages to encourage private medical practices to purchase these tables.
Using a 2” or 3” wide cast tape, starting at the wrist, cover the end of the Gumby as shown above and roll your cast tape round the wrist once or twice creating an anchor. Try not to stretch the tape.

The size of the cast tape used depends on the size of the patient and the experience level of the caster. Both 2” and 3” cast tape was used for demonstration purposes in these pictures.

As you roll the tape around the wrist start to swing it towards the hand to set-up your web space technique. Bring the tape far enough towards the hand to so that you also set-up your distal edge of the cast. How much coverage or how long or short a cast you apply to a particular patient is up to your supervising physician.
The proximal anterior mold is made by applying pressure with your palms on both sides of the anterior aspect of the cast. This relieves pressure on the tibial tubicle and will help prevent rotation within the cast.

The Achilles tendon mold is made by squeezing the area posterior to both ankle maleoli and medial/lateral of the Achilles tendon. This creates a deeper channel for the Achilles tendon.