CHAPTER **46**

THE JONES COMPRESSION CAST AND DRESSING: Review and Clinical Applications

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INTRODUCTION

Dorland's defines edema as the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body; usually applied to demonstrable accumulation of excessive fluids in the subcutaneous tissues. Edema may be localized, due to venous or lymphatic obstruction or to increased vascular permeability, or it may be systemic due to increased heart failure or renal disease. Edema is a clinical sign, a symptom of disease and not the cause of disease itself. There are many pathologic processes, which can result in edema. (Table 1)

Chronic edema associated with congestive heart failure or venous insufficiency can result in lower extremity ulcerations. Acute edema associated with fracture-dislocations of the foot and ankle is inflammatory in nature and accompanied by redness and pain. It contributes significantly to the pain of the injury and not infrequently results in trauma blisters. Such blisters indicate a disruption of normal physiologic mechanisms responsible for the control of such edema. Their occurrence should be a rare event, but unfortunately it is not.

Excessive postoperative edema, also quite inflammatory in nature, contributes to wound complications such as dehiscence and can possibly contribute to the development and propagation of a postoperative infection particularly if it obstructs circulation. Significant edema is usually present in patients with postoperative pain greater than anticipated for the procedure performed. Likewise, when patients have a very uneventful course postoperatively, it is common to find minimal to no edema about the surgical site. The resolution, control, and prevention of edema are desirable by physicians treating disorders of the lower extremities. Regardless of its etiology, edema is rarely, if ever, desirable or beneficial. Its mere presence indicates a disturbance of normal homeostatic mechanisms, or a disease state or disorder. Rarely is edema idiopathic in origin, although it can be physiologic after long

Table 1

Pathologic Processes Which Can Cause Edema

I. Increased Capillary Pressure
   A. Excessive kidney retention of salt and water
   B. High venous pressure
      1. Heart failure
      2. Local venous block
      3. Failure of venous pumps
         a. Paralysis of muscles
         b. Immobilization of parts of body
         c. Failure of venous valves
   C. Decreased arteriolar resistance
      1. Excessive body heat
      2. Paralysis of sympathetic nervous system
      3. Effects of vasodilator drugs
II. Decreased Plasma Proteins
   A. Loss of proteins in urine (nephrosis)
   B. Loss of protein from denuded skin areas
      1. Burns
      2. Wounds
   C. Failure to produce proteins
      1. Liver disease
      2. Serious protein or caloric malnutrition
III. Increased Capillary Permeability
   A. Immune reactions that cause release of histamine and other immune products
   B. Toxins
   C. Bacterial infections
   D. Vitamin deficiency - especially vitamin C
   E. Prolonged ischemia
   F. Burns
IV. Blockage of Lymph Return
   A. Blockage of lymph nodes by cancer
   B. Blockage of lymph nodes by infection, especially with filaria nematodes
   C. Congenital absence or abnormality of lymphatic vessels

periods of inactive dependency such as after a long airplane ride.

Numerous techniques have been described and advocated for the control of edema including the use of pharmacological agents such as diuretics and certain NSAIDs, various physical therapy modalities such as muscle stimulation and mechanical pumps, and a variety of compression stockings and socks. Of particular benefit is the ability to apply a specific dressing to control and resolve edema within a controlled time frame following trauma or reconstructive surgery of the foot and/or ankle. The purpose of this paper is to review the basic physiology of edema and to provide a detailed description of a time-proven technique that the senior author has found to be beneficial. Although modifications have been made over the years, the basic principles and materials have not changed.

HISTORICAL REVIEW

Sir Robert Jones is credited as being the first physician to recommend a specific technique to control edema of the upper and lower extremities especially those associated with wartime injuries. He described the use of multiple layers of bulky cotton wool covered by calico bandage. Although compression dressings had been used for many centuries prior to his writing, no one has published a reliable, easy to apply technique. Charnley was the first to describe the importance of the "Robert Jones Bandage" and provide a complete description of the technique. Three layers of wool and three layers of domette bandage were applied "gently but firmly" six inches above and below the joint to a thickness of two inches.

Few reports in the literature have addressed the mechanism by which external compression controls the formation or facilitates the resolution of peripheral edema. Matsen et al. looked at tibial fractures in rabbit models and concluded externally applied compression bandages limit swelling in the injured tissue, but warned that the compression must be uniform to prevent untoward effects such as compartment syndrome. The ongoing debate revolves around whether external compression improves venous outflow or impedes vascular inflow to a degree, which is beneficial to the recovery of the injured tissues. Most agree that the formation of edema is detrimental to the recovery of traumatized tissues. Charnley and Smillie postulated that the compression cast provides firm support while still providing for small amounts of joint movement. This reduces postoperative stiffness. In addition, the Jones cast accommodates initial swelling while subsequently providing for even compression to reduce pathologic edema.

Not all clinicians support the use of the Jones compression cast. Critics argue compression is not maintained for a significant amount of time. At an AO Conference in 1983, Rosen and Schatzker reported on the use of pressure transducers beneath a compression dressing and found initial pressures were only maintained for five minutes or less. The specific technique they employed is not known. Smillie showed, however, that initial pressures were maintained for approximately forty-eight hours depending on the skill of the surgeon.

Brodell et al. utilized a slit catheter to measure intracompartmental pressures in the anterior compartment of the lower extremity under a compression dressing after knee arthroplasty. Compartment pressure measurements were obtained at fifteen-minute intervals. At four hours, pressures were maintained. Subsequently, pressures were measured at two-hour intervals for twenty-four hours. Once again, pressures were maintained and removal of the compression dressing resulted in a decrease in the intracompartmental pressure. The results of this study clearly demonstrate that compression is maintained for extended periods of time after skillful application of a Jones dressing. The technique employed by Brodell consisted of sterile gauze over the wound, followed by thick cotton wool from a roll. Each layer overlapped the previous layer by one-half. This resulted in 2 inches of thickness. This was followed by additional cotton wool covered by an elastic bandage pulled quite snugly from distal to proximal.

Raj et al. found pressures to drop after 6 to 8 hours employing a bandage consisting of two 15-cm. Bandages followed by padding and finished with tubigrip material. This technique was effectively used in the Varicose Vein Clinic of Nottingham General Hospital in England.

Other modalities have been used successfully to reduce peripheral edema. Continuous cryotherapy and intermittent pulse compression were compared in a study by Stockle et al. They found both treatments to significantly reduce edema particularly in the post-traumatic and postoperative situations.

Table 2

Physical Forces Acting Across the Capillary Wall

(approximate values in mm Hg)

Causing Fluid to Move Out		**Causing Fluid to Move In**	
Intravascular hydrostatic pressure (average)	23	Osmotic pressure of Plasma proteins	25
Osmotic pressure of tissue proteins and mucopolysaccharides	10	Hydrostatic tissue pressure	1-4
	~ 33		~26 to 29

PHYSIOLOGY OF EDEMA

The formation of peripheral edema is an alteration or disturbance in the delicate relationship between the intravascular and interstitial fluids. The forces that regulate the movement of fluid in and out of the vascular space consist of the intravascular hydrostatic pressure and the interstitial colloid osmotic pressure. A large volume of literature suggests the forces tending to move fluid out of the vascular space into the interstitial space are consistently greater than the forces acting in the opposite direction.(Table 2)

The main contributing factor in the formation of peripheral edema is an increase in vascular permeability. This phenomenon begins early, following traumatic injury or surgical insult. The initial increase in permeability is a result of the release of histamine and histamine-like substances acting on the venular side of the capillary network allowing leakage of electrolytes and more importantly plasma proteins into the tissues. This process upsets the balance of forces favoring net accumulation of fluid in the subcutaneous tissues. This, however, should be a short-lived process lasting from fifteen to thirty minutes. The other mechanism contributing to tissue accumulation of fluid is direct vascular injury. This can occur following surgical dissection or major blunt trauma resulting in leakage of blood and its constituents into the tissue spaces. This again favors tissue swelling and continues until vascular injury is repaired or plugged by thrombus.

APPLICATION TECHNIQUE

Table 3 lists the materials required for a Jones compression bandage. A stockinet is applied, if desired, but is rarely necessary. If reconstructive surgery has been performed, the compression bandage is applied after application of the sterile surgical dressing. Several rolls of Johnson & Johnson 4-inch Specialist Cast Padding are applied from distal to proximal beginning just distal to the first and fifth metatarsophalangeal joints.(Fig. 1) The cast padding is applied in a manner that will create a pressure gradient from distal to proximal. The first several rolls are applied with less compression; subsequent rolls are applied with greater compression. It is important that the first several rolls

Table 3

LIST OF MATERIALS

Johnson & Johnson Specialist Cast Padding (J&J Product #9044)
1 roll — 4" Webril Undercast Padding (Kendall Product #3175)
2 or 3 6" Ace Bandages
2 sets — 5" X 30" Fast Setting Plaster Splints (J&J Product #HRI 8137-007395) or 2 rolls synthetic casting material of choice
1 roll Self Adherent Elastic Wrap (Coban — 3M Surgical Division Product #1584)
Lamb's wool or Cotton Balls (optional)
Stockinette (optional)

are applied with minimal compression, as this will permit swelling to increase temporarily, should it be necessary.

After several rolls have been applied from the toes to the tibial tuberosity, an ace bandage is applied. (Fig. 2) The 6-inch ace bandage is typically applied from distal to proximal in such a manner that it too will create a compression gradient from distal to proximal. The application begins at the level of the first and fifth metatarsophalangeal joints. It should not be applied distal to these joints, especially in neuropathic patients as pressure ulcers can result on the adjacent sides of the digits. In cases where the edema is severe enough to warrant concern of interdigital ulcerations, lambs wool or cotton balls can be placed in the interdigital spaces

The process is then repeated with 3 to 4 additional rolls of 4-inch Johnson & Johnson Specialist Cast Padding and another 6-inch ace bandage. (Fig. 3) These subsequent materials are applied with increased tightness, compared to the previous layers of the same materials with focus on maintaining the compression gradient effect. In effect, each and every layer of material has been applied with greater pressure distally and lesser proximally; and each subsequent layer is applied with slightly greater tension than the preceding layer.

If additional support or splinting of the extremity is desired, the entire bandage is covered with one layer of Webril; plaster rolls; or two sets of 5" x 30" splints (5 to 10 open splints per set) or if preferred, synthetic splints or rolls are applied

Figure 1 Application of 3 to 4 rolls of 4" J & J Specialist Cast Padding to create a pressure gradient from distal to proximal with minimal tension which will permit swelling to increase if necessary.

Figure 2. Application of the first 6" Ace bandage.

Figure 3. Appearance following the repeat application of several additional rolls of J & J Specialist Cast Padding with slight increase in tension. Compression is greater distally and less proximally reinforcing the pressure gradient phenomenon.

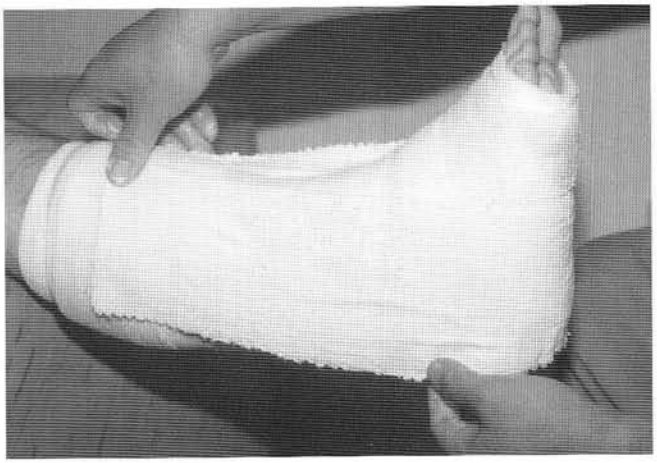

Figure 4. Application of the first of two sets of splints to provide additional immobilization, support and protection of the extremity. One layer of Webril cast padding has been applied between the splints and second ace bandage. Note the splints do not encircle the posterior aspect of the leg but rather are applied in a stirrup configuration.

last.(Fig. 4) These materials provide a more rigid splint to the extremity when necessary. Unless a specific position is critical to the procedure (i.e. TAL, gastrocnemius recession or tendon transfer) the authors' preference is to use two sets of 5" x 30" plaster splints; one set is applied as a stirrup around the sides of the leg and ankle crossing the inferior aspect of the heel, the other across the plantar distal aspect of the foot and crossing in front of the ankle and lower leg.(Fig. 5) Once the splints have been crudely molded and contoured, additional Webril and a 6" ace bandage are applied to mold the splints and maintain their position.(Fig. 6) This ace bandage is left in place until the first dressing change is performed. Table 4 summarizes the layer sequence for the Jones bandage.

Table 4

TECHNIQUE OF APPLICATION

Layer 1 — 3-5 rolls of J&J Specialist Cast Padding
Layer 2 — One 6" Ace Bandage
Layer 3 — 3-5 rolls of J&J Specialist Cast Padding
Layer 4- One 6" Ace Bandage
Additional (Optional) Layers
Layer 5 — 4" Webril (one or two rolls)
Layer 6 — 2 sets J&J 5" X 30" Plaster Splints
Layer 7 — One 6" Ace Bandage OR
Layer 8 — Synthetic or Plaster rolls

Figure 5. Application of the second set of splints to the distal aspect of the foot. This set of splints crosses over the anterior ankle and distal leg.

Figure 6. Application of a somewhat snug 6" Ace bandage which results in molding of the two sets of splints as they set and cure. The extremity is now effectively immobilized in a compression cast.

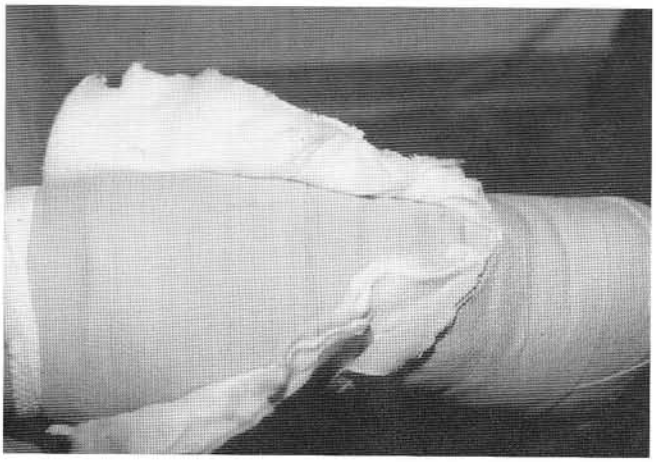

Figure 7. Technique of removal of the plaster splints without the use of cast cutters. The ace bandage and cast-padding layer are split down the posterior aspect of the leg to the second ace bandage. This will allow the splints to be removed easily from the anterior aspect of the leg, ankle and foot.

Figure 8. Appearance of the splints following removal. Pulling the eggshell splints apart at their posterior edge and then gently pulling and lifting the entire set of splints from the underlying ace bandage facilitates removal. The remaining two ace bandages can be removed intact and reapplied as part of the dressing if desired. New cast padding, however, will be required.

The Jones compression dressing is usually changed within 5 to 7 days and a second application performed if additional edema requires resolving prior to application of a cast. If plaster splints were applied, the entire dressing can be removed without the need for a cast cutter. The ace bandage and single layer of Webril are split down the posterior aspect of the leg and the splints, ace bandage and Webril layer removed as a single unit by pulling them forward from the front of the leg and dorsum of the foot.(Figs. 7, 8) If plaster or synthetic fiberglass rolls were applied, a cast cutter will obviously be required.

In some cases, because of the concern over recurring edema while in a standard cast, such as in a patient with Charcot arthropathy, a modification is made which incorporates some components of the Jones Compression Dressing. Following application of the standard stockinet, several layers of the specialist cast padding are applied followed by an ace bandage. A roll of Webril is applied, and finally the standard desired casting materials.

DISCUSSION

The cumulative effect of this multiple layer type dressing is a powerful technique to resolve edema, prevent edema, or permit limited swelling to occur if necessary. All this can be accomplished without the need to "split" or "remove" any of the dressing while still attempting to control the edema process. (Figs. 9-15) This is in stark contrast to an Unna's boot type dressing which does not create a pressure gradient effect; in fact such dressings are not uncommonly restrictive in nature and require removal by the patient or physician when the edema process continues. Unna boot type dressings only attempt to prevent, not resolve further edema by their constrictive or restrictive nature.

The modified cast technique virtually eliminates the need to remove the cast, which becomes "too tight" one or more weeks after its application. The modification for a cast described previously has allowed the senior author to leave lower extremity casts intact for periods of up to 12 to 16 weeks without any significant concerns for cast-induced ulceration even in patients with significant peripheral sensory neuropathy. This includes patients with acute onset diabetic neuroarthropathy where the edema can be quite profound, and wax and wane during the course of treatment. In these patients, the standard Jones compression dressing is employed to resolve the initial edema, followed by prolonged cast immobilization employing the modification described previously.

The senior author has employed the Jones compression dressing routinely following reconstructive foot and ankle surgery; this includes simple forefoot surgery as well as major reconstructive cases where postoperative edema is of concern. The dressing can be easily modified to meet the individual needs of each patient. For example, following an Austin bunionectomy procedure, the author applies materials up to the first ace bandage. To keep the ace bandage secure, one roll of a self-adhering elastic wrap (e.g. Coban) is applied; tape can also be used if preferred by the surgeon. The full application is made in patients who have undergone more extensive forefoot or rearfoot procedures (multiple osteotomies,

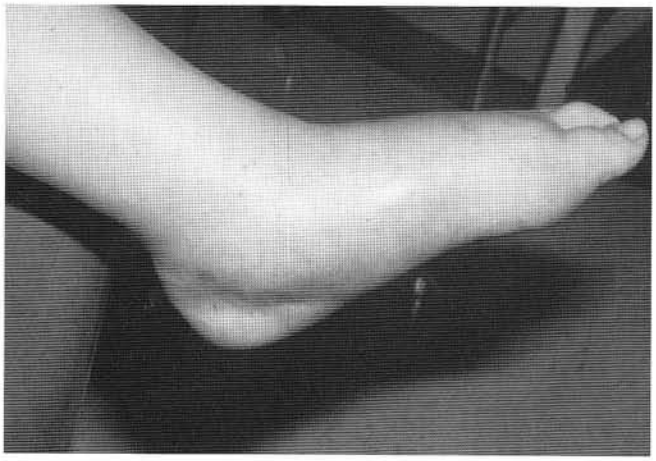

Figure 9A. Initial clinical appearance of a patient with an acute diabetic Charcot arthropathy process.

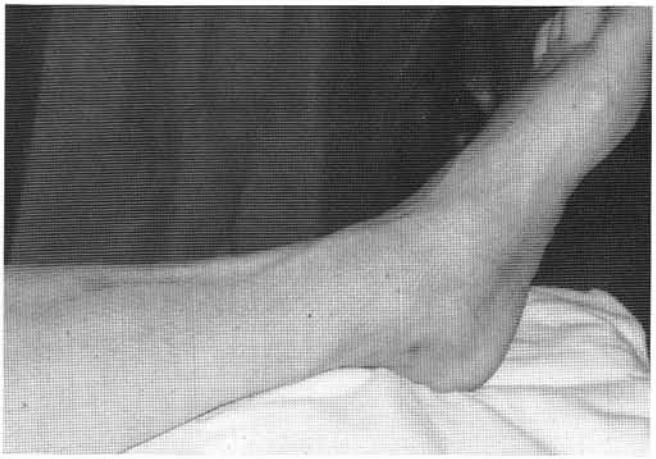

Figure 9B. Appearance after application of a Jones Compression Dressing for one week.

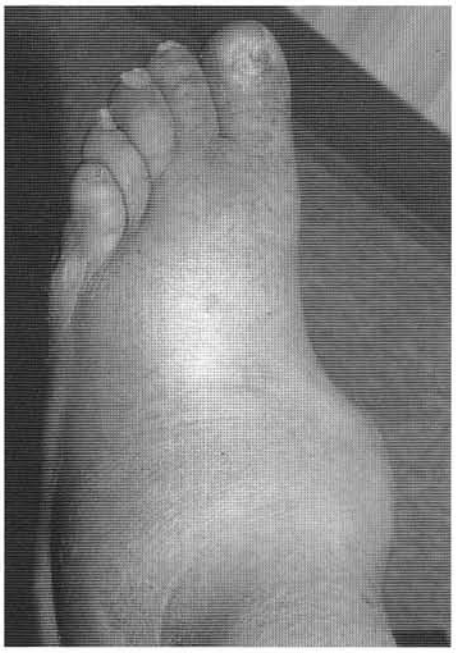

Figure 10. Clinical appearance of a patient with severe diabetic Charcot arthropathy of a chronic nature. Patient had recurrent ulceration over talar head. Chronic changes of the skin as a result of the edema over two years are readily appreciated. Patient also had a chronic healing ulcer over the talar head area.

Figure 11. Dorsoplantar radiograph of the same patient shown in Figure 10. Note the frank subtalar dislocation with complete destruction of the navicular bone.

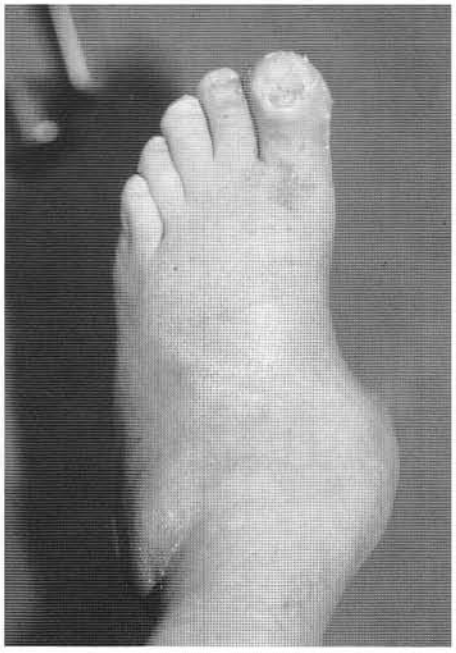

Figure 12. Clinical appearance following the application of a Jones Compression Dressings for one week. There has been an impressive reduction of the chronic edema. This technique, in addition to non-weight bearing resulted in rapid resolution of the ulcer as well without any special wound care measures.

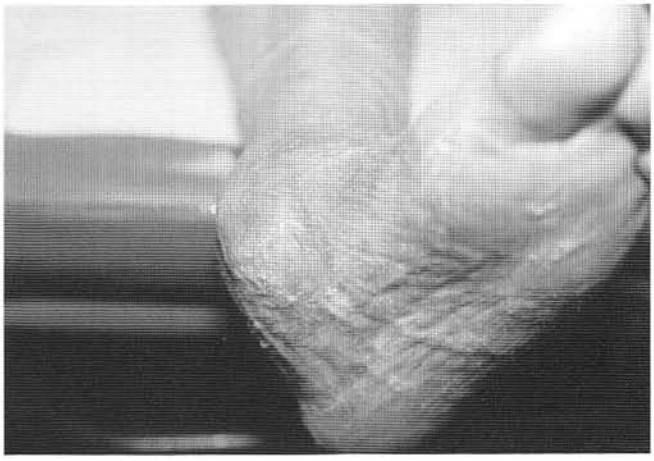

Figure 13. Clinical appearance of the foot approximately 6 weeks later with continued non-weight bearing and repeated applications of a modified Jones bandage to further resolve edema prior to surgical reconstruction that was undertaken.

Figure 14. Clinical appearance of an insulin dependent diabetic patient with severe edema, which was initially attributed to deep vein thrombophlebitis. The correct diagnosis was acute Charcot arthropathy of the midfoot. A Jones Compression cast was applied for 2 weeks to resolve the edema before instituting definitive treatment.

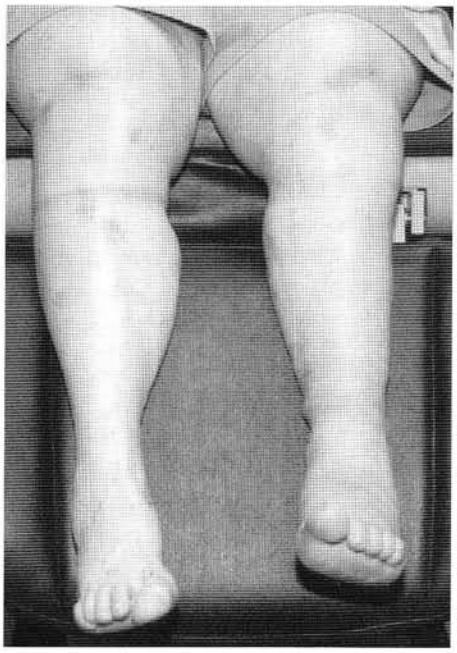

Figure 15. Appearance after treatment with the Jones Compression Cast.

pan metatarsal head resection with digital arthrodesis, extensive digital surgery, single, double or triple joint arthrodesis or osteotomy, flatfoot or cavus foot reconstruction, Charcot foot reconstruction, etc.). When combined with sound surgical technique and patient compliance, the clinical results at the first dressing change are usually quite impressive to both physician and patient alike.

The Jones compression dressing/cast is also routinely employed in patients who have sustained trauma to the foot or ankle where significant edema is of concern. This includes injuries such as fracture-dislocations of the foot and ankle, and major sprains, as well as patients who are awaiting surgery for those injuries. In patients who have sustained major fracture-dislocations, the dressing is immediately applied in the emergency department setting to control and minimize edema while awaiting operating time to perform open reduction with internal fixation; whether surgery is delayed for hours or days, the ability to minimize edema is invaluable. Fracture blisters, not uncommonly encountered following trauma to the rearfoot or ankle are virtually eliminated. When the edema is kept to a minimum, surgery is enhanced by better visualization of the tissues, and patient discomfort and pain are lessened. In addition, less wound complications and infections can be expected postoperatively. In essence, the environment for healing is optimized.

Finally, the Jones compression dressing is also useful to resolve edema caused by systemic problems such as chronic venous insufficiency, lymphadema, or other illness or disease which result in lower extremity swelling. However, caution should be exercised when employing this technique to control edema. Its application without consideration of its effect on the patient's cardiorespiratory function could potentially be devastating. Consideration should be given to consulting the patient's primary caregiver or specialist first.

SUMMARY

Edema can have many adverse effects on the human body. Rarely is it a desirable physiologic event. Likewise, when edema can be controlled without concern for compromise of the overall patient health status, it is very beneficial. The control of lower extremity edema following surgery or

trauma of the foot and ankle is very beneficial to both patients and physicians. It results in less pain, less peri-operative complications and a more favorable environment for patient healing and recovery. Use of the Jones compression dressing and cast is an effective technique to resolve and control edema regardless of its etiology. This compression bandage/cast is not a substitute for meticulous surgical technique. It is a time-honored, effective, cost-efficient technique that has undergone minimal modification over the years. The principles of Sir Robert Jones continue to have a significant influence on the science and art of surgery nearly 100 years later and are an example of the profound influence one person can have on the entire practice of reconstructive and trauma surgery of the foot and ankle.

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