Edema Reduction Techniques: A Biologic Rationale for Selection

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KEY TERMS

Arteriole
Arteriole hydrostatic pressure
Collector lymphatics
Diaphragmatic breathing
Exudate edema
Filariasis
Hydrophilic
Indurated
Initial lymphatic
Interstitium
Lymph
Lymphatic bundles
Lymphatic capillary
Lymph nodes
Lymphangion
Lymphedema
Lymphorrhea
Lymphovenous anastomoses
Macrophages

Manual edema mobilization (MEM)
Manual lymphatic drainage (MLD)
Manual lymphatic treatment (MLT)
Oncotic pressure
Osmotic pressure
Phagocyte cells
Pump point stimulation
Starling’s equilibrium
Thoracic duct
Transudate edema
Venule
Watershed areas

Editors Notes: Before the importance of Sandra Artzberger’s work on the treatment of edema was recognized, the edema techniques that hand therapists were taught were not specific to the lymphatic system and sometimes even damaged this delicate and amazing part of the body. Artzberger has done much to delineate the anatomy and physiology of posttraumatic edema. She has changed our thinking and has overhauled the treatment
repertoire, creating an approach that is based on science. Her technique of manual edema mobilization has resulted in much-improved management of edema in clients with upper extremity injuries.

Unlike in the past, the treatment of hand edema no longer needs to be partly a guessing game. Modern treatment selections are more firmly grounded in anatomic and biologic principles and therefore are more successful. To treat edema effectively, the therapist must know the difference between the lymphatic and venous systems, including the role these systems play in edema reduction. It also is essential that the therapist understand the different types of edema. This chapter describes acute, subacute, and chronic edema. It reviews vascular and lymphatic anatomy and biology, and it describes appropriate interventions for edema, including the technique of manual edema mobilization (MEM). Special emphasis is placed on the clinical reasoning involved in selecting the appropriate treatment.

The lymphatic system originates in the interstitium with the smallest of the lymphatic vessels, called the initial lymphatic or lymphatic capillary, and culminates in the largest lymphatic structure, called the thoracic duct. The venous system has a continuous-loop pump system, but the lymphatic system does not (Fig. 3-2). Therefore the lymphatic system must be stimulated to activate a force pump, creating a vacuum and drawing the lymph proximally. Initial lymphatics, which are larger than venules, are finger-shaped tubes that are closed on the distal end and lined with overlapping, oak leaf-shaped endothelial cells. Anchor filaments extend from the endothelial cells to the connective tissue. Movement of the connective tissue pulls on the anchor filaments. This, in turn, pulls on the overlapping flaps (junctions) of the endothelial cells, and water and large molecules are admitted into the initial lymphatic. Large molecules also enter the initial lymphatic when a change in the interstitial pressure causes the junctions of the endothelial cells to spread apart. The initial lymphatic connection forms a netlike structure (Fig. 3-1).
The balance between fluid moving into and out of the vascular vessels on a cellular level, first described by Ernest Starling in the early 1900s, is called Starling’s equilibrium. This balanced movement of fluid functions as a gradient system from high to low pressure. On the capillary level, arteriole hydrostatic pressure (the pressure of the blood fluid exerted on the arteriole vessel wall) is 30 to 40 mm Hg, which is enough pressure to cause filtration of electrolytes, fluid, a few small plasma proteins, and other nutrients into the interstitium. The osmotic pressure (also called the oncotic pressure) in the interstitium is determined by the concentration of proteins in this intercellular space; this pressure is approximately 25 mm Hg. Tissue cells in the interstitium absorb the nutrients, electrolytes, and other substances filtered out of the arteriole. Of the remaining substances, 90% diffuse by osmosis into the venous system. The residual 10% of leftover substances are large molecules, which are absorbed by the lymphatic system. These large molecules consist of plasma proteins, minerals, ions, hormone cells, bacteria, fat cells, and fluid. Once the cells enter the initial lymphatic, they make up a substance called lymph (see Fig. 3-1).

ACUTE EDEMA RELATED TO THE VASCULAR ANATOMY

The venous and lymphatic systems have many pumplike structures that help propel the blood back to the heart. Because of the descending gradient of hydrostatic pressures from the arteriole capillary to the venule capillary, small-molecule substances diffuse easily and are reabsorbed into the venous capillary through its thin wall. Active muscle contraction acts as a pump as it compresses and empties the large deep venous vessels. As this blood is propelled proximally toward the heart, a negative pressure is created, which draws blood from the periphery into the deep veins.

Edema develops when the descending gradient of Starling’s forces are disrupted by an interruption and an imbalance. The cascade of events that occurs after tissue laceration is a good example. Initially, an outflow of water and electrolytes (transudate edema) into the wound occurs. The mast cells then release histamines, which greatly increase capillary permeability, and plasma proteins, phagocytic cells, and other substances leak into the area. Plasma protein fibrinogen is converted to fibrin, which plugs the endothelial cells lining the lymphatics. This prevents the lymphatics from temporarily removing the large molecules as the various phagocyte cells perform their “cleanup” function. Edema results when excess fluid and plasma proteins are trapped in the interstitium. Starling’s equilibrium is disrupted, because the trapping of excess proteins in the interstitium increases the osmotic pressure.

The immediate goal of treatment by physicians and therapists is to limit the amount of outflow into the wound bed, thereby preventing excessive swelling, accumulation of blood, and further tissue damage. After 2 to 5 days, the swelling begins to subside as the surrounding intact venous capillaries start to absorb the transudate and the lymphatic vessels absorb the large-molecule plasma proteins not phagocytized by the macrophages.

Reduction Techniques for Acute Edema

Bulky Dressing
Several techniques can be used to reduce excessive fluid outflow (edema). For example, a bulky hand dressing applied at the time of surgery gives counterforce to the outflow (filtration) by changing the tissue pressure. It is composed of appropriate wound care dressing, fluffy
gauge sponges, and rolled-on gauze. After soft tissue trauma, immobilization for up to a week in a bulky dressing or plaster splint facilitates healing of involved structures by preventing stress on fragile tissue, which could cause microscopic rupture of vessels with resulting edema. The therapist should check the dressing or splint to make sure it is not too tight and should contact the physician immediately if this is a possibility. A bulky dressing that is too tight causes vascular changes, temperature changes, increased edema, or severe, painful compression of the fingers and can lead to tissue breakdown. The capillary refill test can be used to check vascular status (see Chapter 5). The therapist also must teach the client that any vascular changes (i.e., changes in tissue color) or sensory changes must be reported immediately to the physician. Procedures such as tenolysis and flexor tendon repair involve minimal or no immobilization in a bulky dressing. However, even with these diagnoses, limited motion can increase edema, therefore early motion must be balanced with rest to prevent this. In an animal study, high-voltage pulse current (HVPC) used on very acute edema was reported to retard the high capillary permeability outflow. This finding has not yet been replicated in human subjects. (HVPC is discussed later in the chapter.)

Elevation
Elevation of the hand above the heart, if not contraindicated, also reduces outflow because it reduces the arterial hydrostatic pressure. Elevation in the acute stage facilitates lymphatic flow because hydrostatic gradient pressure is increased along the lymphatic trunks. Ideally, the involved extremity is elevated in a plus 45-degree “ski hill” position; this means that pillows are placed such that the elbow is above the shoulder, and the hand is above the elbow and wrist.

Keeping the arm elevated while sleeping can be difficult. Often clients use pillows on either side of them. A belt can be fastened around the pillows to keep them together. Also, the bed can be moved against the wall so that one set of pillows is pushed up against the wall, preventing them from falling. For clients with finger replantation, elevation no higher than the heart is recommended to avoid compromising arterial blood flow.

Precaution. Extreme elevation of the right arm must be avoided in stroke clients with right-sided heart weakness. Extreme upper extremity elevation may cause fluid to flow too quickly into the right side of the heart, because the right upper quadrant is drained by the right lymphatic duct that empties into the right subclavian vein.

Cold Packs
Cold packs, if not contraindicated for vascular and tissue ischemia reasons, cause vasoconstriction and thus reduce the outflow of fluid in the acute stage. However, the temperature of the cold pack is a consideration. Research shows that when the temperature is lower than 59°F (15°C), proteins leak into the interstitium from lymphatic structures. Excess proteins in the interstitium cause edema.

Precaution. To prevent “ice burn” to tissue, always place a dry towel between the skin and the cold pack. Cold packs should not be used on a client with a replanted hand or digit because of the effect of vascular compromise on tissue viability. A nerve repair may be injured by cold postoperatively. Clients should get explicit care instructions from their physicians, including precautions on the use of cold packs.

Retrograde Massage
Light retrograde massage with elevation facilitates diffusion of small molecules into the venous system. The elevation reduces capillary filtration (outflow) pressure, and the light pressure from the retrograde massage aids in venous absorption of the small molecules.

Precaution. The pressure is kept light to avoid damaging the single-cell initial lymphatic structures in the dermal layer of the skin.

Compression
Light compression, such as from an elastic glove, Coban lightly spiral-layered on a digit (see Fig. 3-6, A, on CD), or low-stretch finger bandage wraps (see Fig. 3-6, B, on CD), facilitates small molecule absorption by the venous system and absorption of large and small molecules by the lymphatic system. A loose but compressive glove generally is one in which the glove material can be pulled away from the hand and fingers at least ½ inch (see Figure 3-6, C, on CD).

Precaution. An elastic glove should be fitted to give some compression but should feel loose on the hand and fingers. If the compression is too tight, fluid flow is restricted, which increases edema.

Kinesio Tape also promotes absorption of the large and small molecules in the interstitium because it increases the space between the skin and connective tissue (see Fig. 3-6, D, on CD). Increasing this space creates a pull on the connective tissue anchor filaments attached to the endothelial cells of the initial lymphatics; this separates the planted endothelial junctions, thereby increasing lymph and fluid flow.

Indications for Manual Edema Mobilization
Many wonder why MEM is not started in the acute stage. In 1989, Hutzschenreuter and Brummer did a research study on this point using sheep. They compared the
results in two groups, one in which manual lymphatic drainage (MLD) was performed and one in which it was not, over a defined period (i.e., immediate postoperative to 3 weeks postoperative). They found that both groups showed minimal fluid reduction during the first week after surgery. However, after the first week, the MLD group had a significantly greater increase in fluid movement and edema reduction than the control group. 13 These results are not surprising because initially, acute edema is a transudate that is changing to exudate edema as the plasma proteins invade and are contained. Only the lymphatic vessels can remove excess proteins from the interstitium. MEM and manual lymphatic treatment (MLT)* programs are designed to activate lymphatic vessels. A multicenter study compared the results of retrograde massage with those of MEM in clients with subacute edema from a wrist injury 4 weeks after injury.14 The study found that both groups showed improvement, but the MEM group showed statistically greater improvement in all but one category.

**CLINICAL Pearl**

Remember, edema at 4 weeks is subacute and has a high protein content. To be successful in these cases, reduction treatment must stimulate the lymphatics.

Some physicians prescribe proximal active motion of an extremity or gliding of the involved structures, or both, during the acute stage of wound healing. Proximal trunk and shoulder motion is excellent. It decongests the lymphatic vessels and removes tissue waste products, resulting in better oxygenation to tissue and faster wound healing. However, movement must be balanced with rest of involved structures. This is done by progressively grading the exercise so as not to increase hand inflammation, pain, and swelling. Always respect the fragility of healing tissue and vascular structures. When moving the involved structures, start with limited movement and check for signs of increased pain, swelling, or redness. If edema increases, rest the involved hand for a day (consider applying a static splint). Resume activity, but do less than previously and gradually increase the exercise over the next treatment sessions. I usually begin with the rule of three or five: three (or five) repetitions of an exercise three (or five) times a day. If this does not increase swelling, gradually increase repetitions or frequency, or both. Remember, edema and pain limit motion and retard progress.

*Manual lymphatic treatment is the generic term used to describe the massage principles common to all schools of lymphatic drainage.15

### CLINICAL Pearl

Reduction edema is almost always the first priority; do this, and the client will gain motion.

In the early poststroke stages, hand and arm edema is a transudate swelling because fluid leaks into the interstitium as a result of lack of muscle pumping activity on the vascular vessels. Elevation, light retrograde massage, and light compression from an elastic glove or elasticized arm stockinette are effective treatments that promote diffusion of leaked electrolytes and water back into the venous system.

**Precaution.** When using an elasticized garment, observe two important precautions: (1) make sure it is not too tight (i.e., it does not cause color or temperature changes in the hand or digit) and (2) with elasticized stockinette, make sure it cannot roll down, causing swelling distally.

A body garment glue can be used to prevent the elastic stockinette from rolling down on itself, which can cause distal swelling. Keep in mind that some body garment glues are latex based, therefore always make sure your client does not have a latex allergy before using such a glue.

### Summary of Reduction Treatment for Acute Edema

- Bulky hand dressing (usually applied by the surgeon postoperatively)
- High-voltage pulse current (HVPC) (used only for very acute edema; benefit in humans not yet proven)
- Elevation
  - Lesser degree of elevation is needed for replanted digits and/or hands.
  - Extreme elevation is contraindicated if right-sided heart weakness is present (i.e., poststroke patient).
- Cold packs (used in the first 24 to 48 hours only as directed by physician)
  - Cold packs should not be used for replants because cold causes vasoconstriction.
  - Precautions should be clarified with physician if a nerve is involved.
- Light retrograde massage
- Loose elastic glove or elastic stockinette
- Coban (loosely placed on digit in spiral, distal-to-proximal pattern)
- Finger bandage wraps
- Limited active motion of uninvolved areas (excessive trunk/shoulder motion increases edema)
- Balance of activity and rest for all structures to prevent inflammation or increase in edema
SUBACUTE AND CHRONIC EDEMA RELATED TO THE LYMPHATIC ANATOMY

As mentioned earlier, the initial lymphatic capillary (initial lymphatic) is the lymphatic system’s smallest structure. The initial lymphatic is not connected to the venous or arterial system. As described previously, the initial lymphatic is composed of finger-shaped tubes that are closed on the distal end and lined with overlapping, oak leaf–shaped endothelial cells; these tubes are connected to each other in a netlike structure in the dermal layer of the skin (see Fig. 3-1). The lymphatic system is also a negative-pressure pump system that absorbs large molecules out of the interstitium ending in the venous system at either the right or left subclavian vein.

CLINICAL Pearl

The anatomic differences between the lymphatic and venous systems determine the anatomically based treatment of edema.

Exercise moves lymph faster through the collector lymphatics and increases the rate of lymphatic uptake from the interstitium.

Eventually the bolus of lymph moves into the afferent lymphatic pathways of the lymph nodes. Lymph nodes, which perform several immunologic functions, are composed of a series of complex sinuses and therefore often are considered “dams” or “kinks in the hose” in the movement of lymph. Excessive swelling distal to the lymph nodes does not increase their rate of filtration, but rather causes further congestion distally. Venous vessels do not connect to lymph nodes and therefore do not
reflect this slowing of fluid movement. Also, venous vessels do not carry bacteria or tissue waste products and therefore do not pass these substances through the lymph nodes for cleansing. Lymph nodes present significant resistance to the flow of lymph and must be massaged to facilitate a faster flow of the distal congested lymph. The MEM method of massaging healthy and uninfected nodes or uses MEM pump point stimulation, which is a method of simultaneously massaging two groups of nodes, bundles of lymphatic vessels, or watershed areas, which speeds up the movement of lymph through the nodes.

From the nodes, lymph can enter the venous system directly, through lymphovenous anastomoses (areas where the small vessels of the lymphatic and venous systems join), or it can continue on in the lymphatic vessels and empty into either the right lymphatic duct or the largest lymphatic vessel, the thoracic duct. The thoracic duct lies anterior to and parallel with the spinal vessels and empty into either the right lymphatic duct or systems join), or it can continue on in the lymphatic vessels and empty into either the right lymphatic duct or the largest lymphatic vessel, the thoracic duct. The thoracic duct lies anterior to and parallel with the spinal cord from approximately L2 and empties into the left subclavian vein. The right lymphatic duct terminates in the right subclavian vein.

The movement of lymph in the thoracic duct is affected by changes in thoracic pressure. Diaphragmatic breathing expands the abdomen, causing changes in thoracic pressure that move the contents of the thoracic duct more proximally. This action creates a vacuum, drawing lymph from the more distal vessels toward the thoracic duct. Treatments such as MEM, therefore, begin with diaphragmatic breathing and trunk exercise. This is analogous to removing the plug from a drain or a clog from a backed-up sink. The plug must be removed before the water can flow out. In terms of clinical application, the vacuum created by diaphragmatic breathing moves lymph more proximal in the thoracic duct, creating a space into which the more distal peripheral edema can move.

**CLINICAL Pearl**

The key to successful edema reduction is to “remove the plug” by starting proximally at the trunk with diaphragmatic breathing and proximal exercise.

Before they reach the thoracic duct, the deep lymphatic trunks share a common vascular sheath with the venous and arterial structures. Therefore exercise increases the rate of arterial flow and passively stimulates the lymphatic vessels, increasing the rate of lymph flow. Also, at least 200 lymph nodes are located centrally and around deep venous and arterial structures. Exercise of the abdominal muscles increases the pumping of blood, which stimulates the lymph nodes, moving lymph through them more rapidly.

“Exercise is key to lymphatic activation”—this is a frequently quoted statement. Yet therapists know that in most cases, simply exercising the edematous hand or arm in the subacute phase does not significantly or permanently reduce edema. Lymphatic structures can exceed 30 times their normal capacity before edema becomes visible; this means that proximal to the visible edema is the beginning of nonvisible edematous congestion.

Exercise and light massage significantly proximal to the visible edema create a negative pressure, drawing lymph proximally and thus removing the “clog.” The results of research by Pecking and colleagues present a strong argument for stimulating lymphatic absorption and conduction significantly proximal to visible edema. In these researchers’ study, MLD was performed exclusively to the contralateral, normal upper quadrant on 108 women with lymphedema caused by mastectomy; this resulted in a 12% to 38% lymph uptake in the hand, even without massage of the involved area. The contralateral massage created a negative pressure (vacuum), drawing the lymph from the involved to the uninvolved area, where it could be absorbed into the normal system.

If we synthesize these findings with the theory that changes in thoracic pressure move lymph proximally, and add the knowledge that muscle contraction stimulates lymphatic uptake on many levels, we arrive at a very strong rationale for beginning edema reduction at the trunk even if edema is visible only in the hand. Clinically, this means that therapists should not begin edema reduction treatment where edema is visible; rather, they must begin in a normal, uninvolved area significantly proximal to the visible edema. Appropriate treatments include diaphragmatic breathing, trunk stretching and muscle contraction exercises and activities, and MEM massage that begins in the area of the uninvolved axilla. (MEM is discussed in more detail later in the chapter.)

**Reduction Techniques for Subacute and Chronic Edema Based on the Lymphatic Anatomy**

To review, the lymphatic system is an independent pump system that works on a negative pressure gradient. When lymph vessels fill (high pressure is created), lymph moves to an area of lower pressure.

The two keys to activating the lymphatic system are as follows:

**CLINICAL Pearl**

The sooner lymphatic decompression occurs, even with non-visible edema, the less the chances of developing tissue and scar thickening, fibrosis, and contractures.
1. Proximal, uninvolved lymphatic structures must be stimulated (massaged), creating a lower negative pressure to draw the most proximal edema out of the involved area.

2. Molecules are absorbed into the lymphatics from the interstitium because only changes in the interstitial fluid pressure (low to high) cause the endothelial cells lining the lymphatics to open.

Key 1 is based on the theory that negative pressure causes a suction effect that moves the more distal lymph proximally in the trunk and extremities. Appropriate treatments to achieve this include MEM massage that starts at the uninvolved axilla, diaphragmatic breathing, trunk exercise, trunk exercise combined with breathing, proprioceptive neuromuscular facilitation (PNF) techniques combined with exhaling and inhaling, and easy yoga trunk stretching exercises.

Key 2 facilitates the uptake of lymph from the interstitium by creating changes in the interstitial pressure; by causing stretching of the anchor filaments attached to connective tissue; and by creating negative pressure, which causes the opening of lymphatics through lymphangion pumping. Appropriate treatments to achieve this include MEM, Kinesio Taping, gentle myofascial release (MFR), bombardment of tissue with fluidotherapy particles at a machine temperature higher than 98°F (36.7°C), continuous passive motion (CPM) machine therapy, and active and passive exercise. The movement and slight compression of a loose elastic glove or elastic stockinette causes interstitial pressure changes and lymphatic absorption. It is critical to absorption that the glove fits loosely. Kinesio tape provides light stimulation of tissue because it increases the space between the skin and connective tissue. Courses providing instruction in the use of Kinesio Tape are available.

Massage or compression on tissue must be light to avoid collapsing the single-cell initial lymphatics in the dermal layer. Miller and Scale reported that the initial lymphatics began to collapse at a pressure of 60 mm Hg and that they closed completely at 70 mm Hg. Eliska and Eliskova found that a 3-minute friction massage on edematous tissue at 75 to 100 mm Hg caused temporary damage to the endothelial linings of both the initial lymphatics and the collector lymphatics.

Contrast Baths
Some therapists use contrast baths to reduce edema, although currently no research is available that supports this practice. If contrast baths are to be used, research findings on temperature need to be considered. Kurz states that lymph flows best at temperatures between 71.6°F (22°C) and 105.8°F (41°C). For therapy purposes, the hot temperature should not exceed 98°F (36.7°C) to avoid increasing capillary permeability (which is enhanced by heat) and thus edema. With regard to the cold temperature, as mentioned earlier, research has shown that the initial lymphatics actually leak protein into the interstitium at temperatures below 59°F (15°C). Therefore, to avoid the leakage of more plasma proteins into the interstitium (potentially increasing edema), the cold temperature should not be lower than 59°F (15°C).

Precaution. To avoid worsening the edema, set the temperatures for contrast baths between 71.6°F (22°C) and 98.6°F (36.7°C).

Therapy with contrast baths commonly is performed by having the client immerse the hand in warm water for 3 minutes and then in cold water for 1 minute. This sequence is repeated four times, ending on cold.

High-Voltage Pulse Current
HVPC is also a consideration for subacute and chronic edema. Griffin and colleagues found that HVPC did not reduce pre-existing edema. However, a subsequent study by Stralka and coworkers on employees with cumulative trauma disorders provided new insights and raised more questions. In this study, both the control and experimental groups used a splint that incorporated HVPC. However, the device was energized only in the experimental group. According to the study’s findings, the experimental group showed a reduction in edema, whereas the control group did not. Considering that there are various types of edema, this raises the question of whether the members of the experimental group had a combination acute and chronic edema and, if so, which type the HVPC affected, or whether it affected both types.

Pneumatic Pump
If a pneumatic pump is used on subacute or chronic edema, two research-based guidelines must be considered. First, the maximum pressure should not exceed 40 mm Hg to avoid collapsing the initial lymphatics. Even though the initial lymphatics do not begin to collapse until 60 mm Hg, the 40 mm Hg level is recommended to account for any calibration or pump errors. Second, high pressure is not necessary, because the pneumatic pump only softens lymph, it does not cause protein uptake.

Continuous Passive Motion
CPM initially was designed to maintain gliding of tendons and joints after surgery. However, the movement of the CPM machine pulls on connective tissue. This means that the anchor filaments running from the initial lymphatics to connective tissue are stretched, which pulls apart the junctions of the endothelial cells lining the
initial lymphatics. In extremely edematous tissue, the motion may or may not stretch the anchor filaments because tissue expansion caused by the edema may already have ripped off the anchor filaments. Giudice used CPM on edematous hands more than 4 weeks after the injurious incident and found that although edema diminished initially, it returned to pretreatment levels once the CPM treatment stopped. I would conclude that because no proximal massage of the lymphatics was performed before the CPM technique was used, the fluid content of the lymph was merely pushed into adjacent areas. The hydrophilic plasma proteins (plasma proteins that attract the water molecule) remained congested in the interstitium and retracted the water molecules, causing edema to return. The CPM treatment might have had a more permanent effect if two full MEM treatment sessions, as well as the MEM pump point technique (discussed later in the chapter), had been done before the CPM was applied. Also, a short MEM home treatment program performed three or four times daily would continue to decongest the edema, aiding the anatomic lymphatic pump. A comparison of the use of CPM with and without MEM on subacute hand edema clients would be a valuable research study.

**Summary of Reduction Treatment for Subacute Edema**

- Diaphragmatic breathing
- Trunk stretches, trunk exercises, easy (appropriate) yoga trunk stretches
- MEM
- Kinesio Taping
- Gentle myofascial release
- Continuous passive motion machines
- Fluidotherapy machine (set at 98° F [36.7° C] or lower)
- Active and passive exercise (avoid excessive exercise, which can cause reinflammation of tissue)
- Loose elastic glove; loose elastic stockinette; cotton finger wrap bandages; Coban
- Pneumatic pump to soften lymph (set at 40 mm Hg maximum)
- Chip bags (see Fig. 3-7, A and B, on CD)

**CLINICAL Pearl**

Starting proximal at the trunk is the key to lymphatic decongestion; this is the first technique that must be done so that the other edema reduction techniques are effective.

### Reduction Techniques for Chronic Edema

Chronic edema is persistent edema that lasts longer than 3 months and is indurated (hard) and difficult to pit. As a result of the long-term entrapment of plasma proteins in the interstitium, the tissue becomes fibrotic. In part, treatment is the same as for subacute edema, but it includes softening of the fibrotic tissue to facilitate uptake by the initial lymphatics. Softening of indurated tissue can be accomplished with low-stretch bandaging, chip bags (convoluted foam pieces covered with stockinette), foam-lined splints, silicone gel sheets, and elastomer pads (see Fig. 3-7 on CD). Neutral warmth builds up under these inserts, causing an enzymatic reaction that softens the indurated tissue. The varying densities of the foam chips in a chip bag can result in tissue pressure differentiation, stimulating protein uptake.

#### Low-Stretch Bandaging

Low-stretch bandages are cotton, nonelastic bandages that have a 20% stretch because of the weave of the bandage. These bandages are rolled on rather than stretched on. Because of the low stretch factor, Dr. Judith Casley-Smith and Dr. John Casley-Smith call the bandages “high working, low resting bandages.” When a muscle contracts, it bulks up under the bandages. Because they stretch only 20%, they provide a light counterforce, which is not enough to collapse the initial lymphatics. When the muscle relaxes, the bandages only collapse 20%, again not enough to collapse the initial lymphatics. Thus variation in tissue pressure facilitates lymphatic uptake and prevents refilling of stretched tissue. Research has shown that use of a combination of low-stretch and foam bandages on the forearm, along with exercise, increases protein uptake.

Low-stretch finger wraps also soften lymph and facilitate lymphatic absorption. (see Fig. 3-6, B, on CD) These are often used when a client’s hand is so edematous that it does not fit into an elastic glove. Low-stretch finger wraps are not used to squeeze the edema out, because that would collapse the delicate lymphatic structures. The distal-to-proximal spiral pattern in which the wraps are applied, the neutral warmth maintained by the finger bandages, and the effect of finger movement all soften the indurated tissue, improving lymphatic flow and edema reduction.

#### Chip Bags

Chip bags vary in size, depending on the area they are to cover. They consist of stockinette bags filled with various densities and sizes of foam. The ends of the bag are either taped or sewn closed. Chip bags can be worn under low-stretch bandages, loose elastic gloves, or splints (see Fig. 3-7, C and D, on CD). Various types of com-
mercially fabricated chip bags made of foam or wheat hulls are also available for purchase.

**Coban**

Coban is used by many therapists on edematous fingers. When placed on the finger or digit circumferentially, it creates a squeezing effect, pushing fluid distal or proximal, or both. Lightly overlapping spirals of Coban distal to proximal down a digit facilitates the absorption and movement of fluid proximally (see Fig. 3-6, A, on CD). Coban also creates a buildup of neutral warmth. A small stockinette or powder can be put on Coban once it is on the finger so that the wrapped fingers do not stick together.

**CLINICAL Pearl**

For chip bags, Coban, or low-stretch bandaging to be successful, proximal MEM, or at least pump point stimulation (discussed later in the chapter), must be done first to decongest the lymph ("pull the drain plug") and move it proximal.

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**Summary of Reduction Treatment for Chronic Edema**

- All techniques listed for treatment of subacute edema
- Methods to soften indurated tissue (i.e., tissue that is hardening or already hard), including chip bags, convoluted foam in stockinette, elastomer and elastomer-type products, silicone gel sheets, foam-lined splints, low-stretch bandages, cotton finger wraps, and loose elastic stockinette and/or gloves (on CD, see Fig. 3-6, A to C; also Fig. 3-7, A to F).

**OTHER TYPES OF EDEMA AND APPROPRIATE TREATMENT**

**Lymphedema**

Lymphedema is a chronic, high-protein edema that results when a permanent mechanical obstruction of the lymphatic system creates a lymphatic overload. Permanently obstructed lymph nodes can be caused by surgical removal of the lymph nodes, irradiation of the nodes or skin, filariasis (an infestation of worms that destroys the lymph nodes), or a congenital deficit of the lymph nodes and lymphatic vessels. Clients with lymphedema must be treated with a full MLT program performed by a trained therapist. Treatment includes multiple rerouting of lymphatic flow patterns around deficit areas. MEM is not appropriate for these clients.

**Precaution.** MEM is a treatment for clients with an overloaded but intact lymphatic system.

Therapists working with hand clients may see a permanent deficit of the lymphatic system, resulting in persistent, sustained swelling. This is seen with circumferential scars, as with a replanted digit. It may also occur with circumferential skin grafting. Primary (congenital) or secondary lymphedema (e.g., from the removal of diseased nodes) causes lymphatic congestion (slow outflow of lymph) in the subcutaneous, epifascial tissue space, which means that only the superficial lymphatic vessels are affected. Therefore a client whose fingers are edematous as a result of this type of lymphedema does not develop joint contractures (Fig. 3-4). If surgical or traumatic invasion into the deeper lymphatic structures around joints has occurred, joint contractures may develop. Soft tissue contractures are caused by laceration of superficial and deep lymphatic capillaries, high capillary permeability that causes leakage of plasma proteins,
and prolonged congestion of plasma proteins around these joint and tendon structures.

Complex or Combined Edema

Complex or combined edema is initially a transudate edema, such as acute flaccid stroke hand edema. With flaccidity, no muscle pump facilitates vascular flow, and water and electrolytes leak into the interstitium, resulting in a transudate edema. The treatment is the same as for acute edema. During this phase, night splinting might be considered to prevent shortening of the extensor tendons. Three months later, the edema may have a viscous feel, but it is relatively fast to rebound and it does not significantly or permanently reduce with elevation and/or the use of an elastic glove. The edema now has an exudate component. At this point, the lymphatic system, which initially was aiding in the removal of the excess fluid (transudate edema), has reached its maximum capacity. The lymphatic system is overloaded and has slowed down, resulting in lymphatic congestion. The congested plasma protein content of the fluid makes the edema feel viscous. The treatment is the same as for subacute and chronic edema. Often a splinting program is needed to prevent or overcome joint contractures.

Precaution. Overexercising or forcing joints in a flaccid or hemiparetic hand can cause microscopic rupture of tissue, resulting in inflammation and increased hand edema. Therefore a balance must be attained between gentle, progressive motion and rest of structures.

Cardiac Edema

Cardiac edema occurs with a decline in the heart’s ability to pump blood completely through the circulatory system. As a result, fluid accumulates in the extremities, especially around the ankles. Often cardiac edema manifests as bilateral ankle swelling with a slight pinkish tone to the tissue. Hand therapists treating older adults need to look for this type of edema.

Precaution. MEM and many of the edema reduction techniques are contraindicated for clients with cardiac edema, because movement of more fluid can further overload the already compromised cardiac system.

Low-Protein Edema

Low-protein edema can manifest as extremity swelling caused by liver disease, malnutrition, or kidney failure (e.g., nephrotic syndrome). Edema results because too few plasma proteins are present in the interstitium to bond with the water molecule and bring fluid back into the vascular systems.

Precaution. Low-protein edema has a systemic cause and must be treated with medication. MEM and many of the edema reduction techniques are contraindicated because they may overload the kidneys or liver. Also, even if these edema control techniques are used, this type of edema will return because of its systemic cause.

EVALUATION OF EDEMATOUS TISSUE

Edema reduces range of motion (ROM) both actively and passively because it increases the size of the fingers or hand. This, in turn, can reduce functional use and coordination of the hand. Once the edema has been reduced, if decreased ROM persists, the therapist can effectively evaluate and treat joint and/or soft tissue limitations. The sooner the edema is reduced, the less the buildup of plasma proteins in soft tissue, the less the fibrosis of the tissue, and the less the thickening of scar tissue.

Precaution. Reducing edema does not reverse existing joint contractures.

By taking circumferential measurements, the therapist can determine where on the hand specifically the edema is prevalent. For consistency, always use the same measuring device; also, take measurements at the same time of day and after the same amount of hand activity.

Edema rebound tests (see Chapter 5) can help determine whether treatment has reduced some of the viscous congested edema. For instance, if the edema rebound time was 65 seconds before treatment and 40 seconds after treatment, this indicates that lymph was moved out. To make this subjective test more consistent, devise a protocol for how much pressure used and for how long it is applied.

Volumeters repeatedly have proved that they provide reliable, valid edema measurements. These measurements indicate whether volume reduction has occurred; they do not specify the location of the reduction.

The criteria for tissue quality assessment, another evaluation method, are as follows:

- Acute edema: Tissue pits deeply, rebounds rather quickly, and can be easily moved around.
- Subacute edema or early stage chronic edema: Tissue pits, is very slow to rebound, and has a viscous quality.
- Chronic edema: Tissue pits minimally and has a hard feeling.
- Severe edema: Tissue has no elasticity and is shiny, taut, and cannot be lifted.
- Lymphorrhea: Weeping of tissue occurs with an extremely congested edematous hand or arm. Lymph, a clear, yellowish fluid, escapes from the interstitium to the outside of the skin. Techni-
cally, weeping tissue is considered an open wound and must be treated as such. MEM techniques can rapidly decongest the lymph and stop the lymphorrhoea.

**Note:** Always perform the capillary refill test if the client’s hand has a bulky dressing or if the client is wearing finger bandages.

**Precaution.** *Color, temperature, and sensory changes may be signs of a problem. A purple color often indicates pooling of venous blood, and a whitish color means that arterial blood flow to the tissue is compromised. Immediately notify the physician of these signs.*

**CLINICAL Pearl**

Macrophages are less effective in edematous tissue because it has less oxygen; phagocytic activity therefore is diminished.8

The therapist must be able to distinguish between congestion and infection. With an open wound, the classic signs of infection are redness, warmth, pain to the touch, odor, and/or cloudy drainage. With a closed wound, the signs of a subclinical infection are a pinkish red color and slight warmth; also, the wound may be painful to the touch, odor, and/or cloudy drainage. With a closed wound, the signs of a subclinical infection are a pinkish red color and slight warmth; also, the wound may be painful to the touch and the tissue may be hard.30 This is often seen with a very edematous extremity or hand if the first course of antibiotics hasn’t fully resolved the infection. Extremely edematous hands often need a second course of antibiotics.

**Precaution.** If infection is suspected, MEM should not be started before a full course of antibiotics has been completed and the physician has assessed the status of the infection.

The signs of congestion frequently are the same as those of a subclinical infection. The client’s history can help determine whether the condition is congestion or infection (or both). Often congestion (and, possibly, infection) can be prevented if the therapist begins treatment of an uninfected extremity early, before visible edema is present, with the short version of MEM. Prolonged tissue congestion can lead to infection because congestion reduces oxygen delivery to tissue, diminishing the effectiveness of the phagocytic cells.

Both old and new scars can create a barrier to lymph flow. Check for proximal scars (e.g., on the shoulder, back, or axilla). Soften both old and new scars with gentle myofascial release techniques, silicone gel sheets, and/or Kinesio Taping. Instruct the client in MEM techniques to reroute edema around scars and to soften scars.

Sensory testing is very important for an edematous extremity because edema often reduces sensation. As edema is reduced, the degree of sensation usually improves. Sensory testing therefore becomes an objective test that shows limitations and improvements that can be related to function.

Coordination often is diminished by edema in the hand. A nine-hole peg test can become a repeated, scheduled test for assessing hand function. Reducing hand edema should improve coordination, unless an underlying problem exists.

Pain assessment is very important. As edema declines, pain usually diminishes. Clinically, pain reduction often is noticed before ROM shows improvement. Keep in mind that pain can have many sources. For example, in a client with a Colles fracture, edema reduction can relieve the pain caused by the pressure of edema on the nerve receptors; however, the client still may have chronic pain specifically related to the fracture site. Therefore other, appropriate methods must be used to reduce that pain, which differs from edema-related pain. Even during treatment for a different cause of pain, the client should follow a MEM home program twice daily to eliminate any new, not yet visible congested edema.

**MANUAL EDEMA MOBILIZATION**

MEM is an edema reduction technique for persistent edema in the hand, arm, or leg in which the lymph system is intact but overloaded. MEM specifically activates the lymphatic system to facilitate absorption of the excess and congested large plasma protein molecules, other large molecules, and small water molecules from the interstitium. This technique reduces both visible and not yet visible edema. It is a modification of MLT techniques used for lymphadenectomy and/or lymph node irradiation, primary (congenital) lymphedema, and lymphedema arising from filariasis. For those types of edemas, MLT very appropriately involves extensive rerouting of lymph flow around missing or permanently damaged nodes and lymphatic vessel areas.

I developed MEM after I became certified in lymphedema treatment and learned about the anatomic functioning of the lymphatic system. My study of anatomy and physiology led me to realize that the traditional treatments for upper extremity edema could be improved if they were based on this knowledge. I realized that the subacute edema I struggled to reduce in my surgical, trauma, and stroke clients with hand edema was a lymphatic overload edema. In these cases, because the lymphatic system, although overloaded, was still intact, extensive rerouting wasn’t necessary, just decongestion, starting at the trunk.
MEM is a significant modification of MLT in several ways: (1) it involves only one trunk rerouting technique; (2) it requires exercise after each segment is massaged; (3) it has its own light hand massage patterns; (4) it includes scar rerouting patterns; (5) it relies heavily on client follow through with a self-management program; and (6) it incorporates pump point stimulation, which is unique to MEM.

The full MEM program takes 30 minutes. The short version, consisting of trunk rerouting and pump point stimulation, takes 15 minutes. MEM can be combined with other edema reduction techniques, but it should be done before those techniques are performed. The reason for this is simple: MEM decongests the most proximal edema and moves that edema proximally, creating a space into which the more distal edema can move by means of a proximal negative pressure vacuum. The more traditional edema reduction techniques will be more effective after MEM, after there is space cleared to which the edema can be moved proximally.

### Principles and Concepts

MEM is grounded in the following principles and concepts:

1. Light massage is provided, ranging from 10 to 20 mm Hg, to prevent collapse of the lymphatic pathways and arterial capillary reflux.
2. When protocol allows, exercises are performed before and after the MEM session; these exercises are done in a specific sequence, starting proximal to the edematous area or in the contralateral quadrant if possible.
3. Massage is performed in segments, proximal to distal, then distal to proximal. Massage ends in a proximal direction (i.e., toward the trunk).
4. When possible, the technique includes exercise of the muscles in the segment just massaged.
5. Massage follows the flow of lymphatic pathways.
6. Massage reroutes around scar areas.
7. The method of massage and the types of exercise do not cause further inflammation of the involved tissue.
8. A client home self-massage program is devised that is specific to the pathologic condition of the hand.
9. MEM can be adapted to various diagnoses and stages of high plasma protein edema.
10. Guidelines are included for incorporating traditional edema control, soft tissue mobilization, and strengthening exercises without increasing in edema.
11. Specific precautions are observed.
12. When necessary, low-stretch compression bandaging or other compression techniques are used.
13. Pump point stimulation is used extensively.
14. MEM is beneficial in clients whose lymphatic vessels are intact but overloaded from congestion.

### Contraindications

The precautions and contraindications for MEM include those that are common to most massage programs and others that are specific to the movement of a large volume of fluid through the system. Always consult a physician if you are concerned about the client’s current or past cardiac and/or pulmonary status. For instance, if an 80 mL volumetric difference exists between the client’s two extremities, inform the physician that with MEM, that much fluid may be moved through the heart and lungs. Ask whether this would compromise the client’s cardiac status.

Therapists should not use MEM in the following circumstances:

- If infection is present, because the infection may be spread by the technique.
- Over areas of inflammation, because inflammation and pain may be increased; MEM should be performed proximal to the inflammation to reduce the amount of congested fluid.
- If a hematoma or blood clot is present in the area, because the clot may be activated (i.e., it may move).
- If active cancer is present. A controversial theory notes the potential for spreading cancerous cells. MEM should absolutely never be done if the cancer is not being medically treated. The therapist should always seek the physician’s advice.
- If the client has congestive heart failure, severe cardiac problems, or pulmonary problems, because the cardiac and pulmonary systems may be overloaded.
- In the inflammatory stage of acute wound healing, because theoretically the cellular cleanup process and the invasion of fibroblasts may be disrupted.
- If the client has renal failure or severe kidney disease, because the edema in these cases is a low-protein edema, and the renal system may be overloaded and/or the fluid may be moved to some other undesirable site.
- If the client has primary lymphedema or lymphedema arising from a mastectomy. Successful treatment of this condition requires a knowledge of ways to reroute lymph to other parts of the body, as well as specific techniques beyond the scope of this chapter.

### MEM Massage, Drainage, and Term Definitions

#### U’s Hand Movement Pattern

U’s are a pattern of hand movement that involves placing a flat but relaxed hand lightly on the skin. The hand
gently tractions the skin slightly distal and then circles back up and around, ending in the direction of the lymph flow pattern. The movement is consistently a clockwise or counterclockwise motion in a U, or teardrop, configuration. Very light pressure (10 mm Hg or less) is used to move just the skin, thereby stimulating the initial lymphatics. Clinically, this is taught by having the therapist first place the full weight of the hand on the client’s arm; then, while the entire palm and the digits remain in contact with the client’s skin, the hand is partly lifted so that only half its weight rests on the arm. MEM massage proceeds at this very light pressure, moving in a U while tractioning (pulling), not sliding, the skin. This is a "skin" massage—just enough pressure to make the skin move.

Clearing U’s Skin Tractioning Pattern
Clearing U’s is a pattern of skin tractioning performed in segments. It starts proximally and moves to the designated distal part of the trunk or arm segment (i.e., upper arm, forearm, or hand). A minimum of five U’s are done in three sections for each segment. The purpose is to create interstitial pressure changes that cause the initial lymphatics to take up lymph. The direction of “flow” movement follows the lymphatic pathways toward the heart (i.e., flowing proximally, not distally). If not contraindicated by the diagnostic protocol, active muscle contraction is done in each segment after it has been “cleared.” This increases the rate of lymphangion contraction, which moves the lymph out of the area more quickly.

Flowing U’s Lymph Movement Pattern
Flowing U’s is a pattern of sequential U’s that starts in the distal part of the segment being treated and moves proximally past the nearest set of lymph nodes. This could be described as “waltzing” up the arm. The process of moving one U after another from distal to beyond the node is repeated five times. After the final repetition is completed, the flowing U motion is performed all the way to the contralateral upper quadrant. The purpose is to move the softened lymph out of the entire segment and facilitate its eventual return to the venous system and the heart (Fig. 3-5).

Pump Point Stimulation
Pump point stimulation involves simultaneous, synchronous movement of the therapist’s two hands in a U pattern over areas of lymphatic bundles (groups of initial and collector lymphatics), watershed areas, and/or lymph nodes. Because nodes pose resistance to the flow of lymph, pressure from the full weight of the hand is used. Typically the therapist does 20 to 30 U’s in one area before proceeding to the next area of pump points. After pump point stimulation is performed in an area, exercise is done either in that area or proximal to it. Sometimes an MEM flow massage is done before the next area of pump points is stimulated (see Fig. 3-8, B, on CD).

Therapists should not attempt MEM unless they have been trained in the technique. Two- and 3-day courses are available and encouraged for any therapist who would like to use MEM as a course of treatment. The following case study is an example of the short version of MEM, which is presented here to offer the reader a sense of what the MEM program entails (see Fig. 3-8 on CD).

Case Study
This case study, presented by Karin Ronhoj, OTR, CLT, an occupational therapist in Denmark, is offered as a clinical reasoning tool to help readers synthesize the material in this chapter. This case represents the first time Karin used MEM. Her problem-solving approach is valuable for readers not already familiar with MEM. The answers to the six questions posed below can be found at the end of the case study.

HISTORY
An 84-year-old woman fractured the first (thumb) metacarpal bone of her left (L) hand when she hit a door with her hand. The client was treated in the emergency department (ED) with casting of the fracture. After 2 days this cast became too tight. She returned to the ED,
where a new cast was applied. At neither visit was the client instructed in any edema reduction techniques. During her third visit to the ED, 10 days after injury, the ED physician called in a hand surgeon. The surgeon immediately sent the client to Karin in occupational therapy (OT), knowing that she had expertise in edema reduction techniques (see Fig. 3-9, A and B, on CD).

1. What edema reduction techniques could the ED physician or nurse have advised the client to perform for this acute stage while wearing the cast?
   a. Elevation of hand above heart
   b. Use of ice/cold pack for 24 hours
   c. Use of hot pack first 24 hours
   d. Continue all activities, use hand as much as possible
   e. Restrict activities for first 24 hours, rest as much as possible with hand elevated above heart, move shoulder and elbow when arm is elevated

CLINICAL EVALUATION FINDINGS

• Social history: widow, lives alone in large house, responsible for all self-care and household chores; client is ambidextrous but prefers using L hand.
• Hematoma covering two thirds of the dorsum of the hand; multiple bruising of volar surface forearm and fingers; fingers pale and also purplish from bruising.
• Hand girth measured along descending angle of MCPs was 6.5 cm larger than same area on unaffected (R) hand. Proximal phalanges of index-small digits averaged 2 cm greater than on the right. Skin was taut, shiny, couldn’t be lifted, and felt viscous (spongy) when compressed.
• Sixty-second rebound time on index proximal phalanx, the most edematous digit.
• Average of 10 to 15 degrees of active and passive motion of all finger joints; thumb not measured.
• When client actively made a fist, distance to palmar crease ranged from 10 cm on index finger to 11 cm on small finger.
• Client reported extreme pain when the therapist touched her hand or when she moved it actively or passively.
• Client needed a replacement splint, to be made of thermoplastic material, for L thumb; hand surgeon had ordered the splint.
• Slight swelling of both ankles, but no heat or redness.
2. The type of edema the client had was subacute because
   a. The tissue had a viscous feel.
   b. The tissue was slow to rebound when pitted.
   c. The physician had given it that label.
   d. The patient had pain and decreased active and passive ROM.

3. The therapist must plan an edema reduction program 10 days after the injury. What types of treatment techniques should be considered?
   a. Ice packs
   b. Light retrograde massage
   c. Vigorous active and passive ROM of the entire upper extremity
   d. Intermittent elevation to reduce dependent edema
   e. Kinesio Taping to reduce the hematoma and swelling
   f. MEM
   g. Elevation of the arm/hand as much as possible
   h. Gentle, progressive active ROM of the arm, including the fingers but not the thumb
   i. Light spiral Coban wrapping of the digits
   j. Elastic glove on all fingers and the hand, including the thumb with the splint

4. Why wouldn’t you consider fluidotherapy for this client, even at 98.6° F (36.7° C)? Why wouldn’t you use contrast baths within the recommended range?

INITIAL TREATMENT

Karin’s treatment of this client for the first session consisted of fabrication of a thumb immobilization splint, MEM treatment to the upper trunk (diaphragmatic breathing, MEM exercises before and after treatment, upper trunk massage, active muscle contraction for the shoulders) and an activities of daily living (ADL) evaluation. The client borrowed appropriate assistive devices for temporary one-handed use.

5. Why didn’t Karin do MEM for the entire extremity or trunk and all pump points at the first session (MEM short version)?
   a. She ran out of time.
   b. It was contraindicated because of the extent of bruising on the arm and the hematoma on the hand.
   c. A potential cardiac problem was a concern because of bilateral ankle swelling.
   d. She wanted to go slowly with the client so that she could watch for contraindications and observe the rate of edema reduction.

CONTINUING CARE

The client was seen for a second therapy treatment 5 days later. Her entire medical chart was obtained and showed no cardiac problems. The bilateral ankle swelling was from venous insufficiency. The bruising was fading on
her arm, the color of the fingers had become more normal (i.e., less congestion), her pain had decreased, and she had some increase in ROM. Karin then did the entire MEM program and put low-stretch bandages on the fingers and forearm (see Fig. 3-9, C to E, on CD).

6. Low-stretch bandages were used to:
   a. Squeeze fluid out of the fingers and hand
   b. Prevent refilling of tissue with fluid after MEM massage
   c. Reduce indurated (hard) tissue

SUBSEQUENT CARE
Four days later, the client returned for her third hand therapy treatment. Edema continued to decrease slowly, pain continued to decrease, active and passive ROM of digits continued to improve, the client was successfully following her self-management exercise program, self-massage, and rebandaging wearing 23 of 24 hours daily. Karin noted that the edema was reducing slower than she had thought it would with the MEM method. At this point, she had done MEM massage only up to the wrist because of the contraindication for doing MEM on the area of a hematoma. Karin contacted me, and I advised her to do the Kinesio Taping hematoma/edema reduction method on the dorsum of the hand. She obtained the proper instruction for Kinesio Taping for hematoma/edema reduction. The Kinesio Tape was applied (see Fig. 3-9, F, on CD).

At the client's fourth therapy visit, 19 days after the start of treatment, she had reduced hand pain with a resulting increase in ROM, such that a composite fist was only 4 cm from touching the palm. Originally the fingers were 10 to 11 cm from touching the palm. This was 4 days after application of the Kinesio Tape, and the hematoma was almost gone.

RESULT OF CARE
Four weeks after treatment began, the thumb splint was discontinued. The next week Karin discontinued the low-stretch bandages and stopped performing MEM during clinic visits. The client continued her home MEM program for 2 more weeks. The client was discharged 2 months after treatment was initiated with a nonedematous, functional thumb and hand (see Fig. 3-9, G and H, on CD).

DISCUSSION
Q: If Karin had known Kinesio Taping methods for hematoma reduction before treating this client, could she have applied the Kinesio Tape at the first treatment session, 10 days after injury?

A: Yes, this would have reduced the hematoma, and the digit edema would have been reduced more quickly.

Q: If Kinesio Taping for hematoma reduction had been applied during the first treatment, could the same MEM trunk program been performed?

A: Yes. However, this was Karin’s first experience with using both MEM and Kinesio Tape. It is advisable not to do two new techniques at one time. It is best to observe the reaction and extent of edema reduction before applying the second technique. This gives a frame of reference for future application. In this case, it was especially important to do just one technique at a time and gradually add techniques because of the extent of bruising.

Q: Is there edema normally related to a healing fracture?

A: Yes, it is not uncommon to see moderate swelling during the first 2 weeks of the healing process. Usually the secondary edema in the surrounding tissue can be reduced during this time with MEM.

Q: Could two or three different treatment techniques have been used to reduce edema during those first three treatment sessions?

A: No. Currently, with subacute edema, MEM is the only method that follows lymphatic anatomy for proximal decongestion. This proximal decongestion must be done first so that the peripheral edema has a space into which it can move. Other techniques will be more effective after trunk MEM and a home MEM program have been done for a week. If edema isn’t reducing as quickly as you think it should, re-evaluate as Karin did.

CLINICAL PROBLEM SOLVING
What is the effect of the hematoma? Are there scars or old injuries proximal to the edema that are barriers to lymph flow? Does the client have fascial restrictions or ROM restrictions proximally? Is the client following through with an MEM home program and doing a light stroking massage? Add more treatment techniques according to your evaluation findings.

ANSWERS
1. A, B, E
2. A, B
3. D through H
4. Because the client must wear the thumb splint at all times. Also, heat would soften the splint.
5. B, C, D
6. B, C
Acknowledgment

I would like to thank Karin Ronhoj of Denmark for the case study and for her passion for MEM. Her dedication has prompted her to conduct an MEM research study (in progress) and to become an expert in the teaching of MEM. Her efforts doubtless will help to further develop this area of expertise.

References