

Basic Principles of Compression Therapy for Lymphedema

Heeyoune Jung, MD

Department of Rehabilitation Medicine, National Traffic Injury Rehabilitation Hospital, Yangpyeong, Korea

The effectiveness of compression therapy in lymphedema is well recognized, and methods of external compression include multi-layered lymphedema bandaging, compression garments, and intermittent pneumatic pump. External pressure applied to tissue reduces excessive fluid accumulation and facilitates lymph drainage. Consistent compression may have effect on fibro-sclerotic tissue degradation. Whereas compression therapy give benefit in lymphedema management and prevention, inadequate use of the compression may trigger worsening of lymphedema or other adverse effect that clinicians must put effort to educate patients and observe any sign of improper wear of compression device. Ideal feature of compression is low resting pressure and high working pressure, and gradient pressure, higher distally. Details of three compression methods and issues to be considered in prescribing and applying the each method are described.

Key Words: Lymphedema compression • Compression therapy • Compression bandage • Compression garment • Compression pump

INTRODUCTION

External compression is a major element of the complex decongestive therapy, the comprehensive and multidisciplinary approach for the management of lymphedema. It is an essential treatment tool that plays important role in both the acute phase and maintenance phase of treatment. The purpose of external pressure applied to the skin is to reduce the interstitial tissue fluid formation and to assist the removal of already accumulated lymph from the tissue. Fibrotic skin due to chronic lymphedema may also degrade by a specific type of compression garment.

Compression is cost effective and gives good outcome, but without accurate knowledge of component characteristics and proper use of the specific compression methods, the therapy may fail and even cause worsening of edema. Clinicians should understand the

compression garment material construction and its diverse application to provide optimal and effective treatment of lymphedema as well as to promote patients' comfort and long-term compliance.

Three methods of external constant compression, multi-layered bandaging, compression garments and intermittent pneumatic compression are discussed in this article. The review provides the overview of the backgrounds of compression therapy of lymphedema and the appropriate use of each compression methods.

Effect of Compression to a Limb

By decreasing excess fluid formation and facilitating lymph fluid drainage, compression controls lymphedema. These effects of compression therapy are through several mechanisms as described below.

1. Vascular mechanism

Pressure through the external compression to the skin brings indirect transmission of pressure to the underlying vascular system. It has effects on venous and arterial circulation.

The pressure enhances valvular function of veins and increases blood flow velocity. The blood volume also

► Received: March 8, 2016, ► Accepted: April 20, 2016
Address for correspondence: **Heeyoune Jung**, MD, PhD
Department of Rehabilitation Medicine, National Traffic Injury Rehabilitation Hospital, 260 Jungang-ro, Yangpyeong-eup, Yangpyeong-gun, Gyeonggi-do 12564, Korea
Tel: +82-31-580-5551, Fax: +82-31-580-5208
E-mail: heeyounejung@gmail.com

decreases due to the reduction of the diameters of the vessels [1]. Therefore, the amount of lymph formation from extra-vascularisation is reduced. When inelastic compression material is applied, the muscle activity while moving the limb assists the compression to improve the blood flow. These effects can be achieved by inelastic material with about 40-60 mmHg pressure in lying position [2].

External compression can cause tissue ischemic damage if pressure exceeds arterial pressure. Doppler exam or ankle-brachial pressure index (ABPI) should be considered to evaluate arterial function especially in patients with arterial occlusive diseases.

2. Increased interstitial tissue pressure

Increased interstitial pressure overcomes hydrostatic pressure of vessels that fluid filtration to interstitial tissue is reduced.

The pressure change to the interstitial tissue by external compression varies depending on the circumference of the limb according to the law of Laplace and tissue compliance [3]. This matter needs to be considered when applying compression therapy.

3. Lymphatic flow

Improvement of lymphatic drainage through lymphatic channels is achieved by external compression. Increased interstitial pressure may compromise small lymphatic vessels, which has lower pressure, yet improvement of clearance of tissue fluid was observed in several studies [4,5].

Compression garment with inelastic material reflects the pressure caused by muscle contraction during activity, which may cause compression to lymphatic valve hence improves lymph flow. There is still a lack of evidence of the exact effect of compression to lymphatic system.

4. Effect on tissue

Tissue fibro-sclerotic change can be observed in chronic lymphedema and softening of the fibrotic tissue is observed with compression therapy. Bandages or garments made of recently developed textile with numerous small compressible capsules imbedded are supposed to create pressure gradients in adjacent tissue promoting the constant mobilization of tissue fluid and break down of the fibrotic tissue.

Constant compression also supports overstretched skin

and helps to restore the shape of the limb.

Pressure Generated by Compression

The pressure generated to the tissue by external compression varies depending on the tension force of the compression hosiery, fit between the garment and the limb, application technique, limb circumference and shape, and tissue compliance [6]. According to the Laplace's law, the sub-bandage pressure is also determined by number of layers and bandage width in multi-layer bandaging.

Direction of the blood and lymphatic flow needs to be respected and the pressure should be applied in graduated manner, higher distally and lower proximally. If the limb circumference varies at different points of the limb due to edema, compression applied with caution that the greater pressure is always remain distally.

To ensure the precise control of the pressure exerted, the bandages with tension indicating markers are developed.

Another desired feature of the compression therapy is high working pressure and low resting pressure. The bandaging provides constant low pressure at rest, but during activity the muscles contract and press against the inelastic bandage and create higher pressure. This facilitates lymphatic flow during activity.

Multi-Layer Lymphedema Bandaging

Multi-layer lymphedema bandaging serves as the essential intensive therapy for acute lymphedema or often the supplement to compression garment for chronic lymphedema or for palliative care. The systemic review revealed multi-layer bandaging is effective in volume reduction in lymphedema patients [7]. It is superior to compression garments in limb distortion or skin changes like hyperkeratosis.

Multi-layered bandaging is difficult to apply by patients and inappropriate application may cause worsening of the lymphedema. Trained specialists must apply the bandaging until the patient or a caregiver learn and demonstrate good technique of bandaging [8].

Before bandaging the skin should be cleaned and any skin lesion should be inspected. Individual fingers or toes are bandaged with smaller inelastic bandages in spiral pattern from distal to proximal, without impeding hand function. Then apply cotton tubular bandage to the whole arm to provide protection of skin from bandages. For focal skin thickening or vulnerable bony

prominence, dense foam padding may be applied.

Synthetic wool foam wraps around entire arm for extra padding then spiral bandaging with inelastic bandages. Bandaging always starts from distally to proximally and with elbow or knee extended. Use overlap of bandages to achieve the desired pressure and minimize creases at joints. After applying the bandaging, the patient should feel comfortable and any pain or sensory change should be assessed. The patient is encouraged to use the limb as usual even with bandaging applied to warrant pumping action of the limb muscles.

The multilayer bandaging should be changed daily to ensure the sufficient pressure especially in acute stage treatment.

Bandaging is contraindicated in vascular compromised patients like severe arterial occlusive disease, uncontrolled heart failure, acute DVT and the limb of severe neurological deficit. Bandaging may be applied with precaution in patients with advanced disease for palliative care.

Compression Garments

For long term maintenance use after stabilization of the limb size by intensive therapy, compression garment in proper size is applied.

There are two types of fabric material for compression garment, circular knit and flat knit. Circular knit produces seamless tube which is thinner and more cosmetically acceptable. Flat knit material is thicker and knitted as a flat piece that is used for custom made garments. Flat knitted garments can accommodate distorted shape or large limb [9].

Compression garments must be designed to provide graduated pressure, greatest at distal end and lesser proximally. The garment material in different level of pressure is available and according to the sub-garment pressure, the compression garment classified from class I to class IV. For lymphedema treatment, class II-III (30-50 mmHg) compression garments are used generally.

To ensure tight fit for adequate compression, proper measurement of limb size is important. Measurement is performed once acute edema is minimized and limb shape distortion is optimized. Compression gloves should be considered if hand edema is observed.

Cost and patients' tolerance level need to be reflected when prescribing the garments. The level of patients' cognition, dexterity of the upper limbs, and shape and positioning of the affected limb should be counted.

Patients should be educated for frequency and dura-

tion of garment use. Longer consecutive hours of garment use gives better edema control [10] but undressing the garment once a day for skin inspection is advised. Garment wear during exercise or high level activity is emphasized.

Patients must be well-acquainted with the accurate technique of the garment application avoiding over stretch or folds, and proper garment care. The garment loses elasticity after using every day for 3-6 month then it should be replaced.

Intermittent Pneumatic Compression

Pneumatic compression is administered to the edematous limb by inflation and deflation in cycle of air chambers attached to a pump. Multi-chambered pneumatic pump supposedly provides sequential gradient compression and propels tissue fluid proximally. The effect of intermittent pneumatic compression in lymphedema management [11] is still controversial and the recommendation of the numbers of chamber, the mode of sequential compression, or the degree of gradient pressure is not established yet. Manual lymphatic drainage performed beforehand the pneumatic compression may give more benefit [12].

Proximally displaced lymphatic fluid may accumulate at genital area and cause fibrosclerotic ring creating further obstruction of lymphatic flow that close observation of the proximal area is needed [8].

CONCLUSION

Compression therapy for lymphedema is a key element throughout from the acute to maintenance phase and the effect of compression therapy in volume reduction and symptoms alleviation is well established. Three types of compression have different roles in lymphedema management and understanding the characteristics and physiology of each method is important for proper use. The application of compression is eventually carried out by patients in long term and health care providers are responsible to deliver adequate information, education and support.

REFERENCES

1. Foldi E, Junger M, Partsch H. The science of lymphoedema bandaging. European Wound Management Association (EWMA) Focus Document in practice. MEP Ltd, London;

- 2005.
2. Patrsch B, Partsch H. Calf compression pressure required to achieve venous closure from supine to standing positions. *J Vasc Surg* 2005;42(4):734-738.
3. Mann R, Yeong EK, Moore M, Colescott D, Engrav LH. Do custom-fitted pressure garments provide adequate pressure. *J Burn Care Rehabil* 1997;18:247-249.
4. Adams K, Rasmussen J, Darne C. Direct evidence of lymphatic function improvement after advanced pneumatic compression device treatment of lymphoedema. *Biomed Opt Express* 2010;1(1):114-125.
5. Lentner A, Wienert V. Influence of medical compression stockings on venolymphatic drainage in phlebologically healthy test persons and patients with chronic venous insufficiency. *Int J Microcirc Clin Exp* 1996;16(6):320-324.
6. Carati C, Gannon B, Piller N. Anatomy and physiology in relation to compression of the upper limb and thorax. *J of Lymphoedema* 2010;5(1):58-67.
7. McNeely ML, Peddle CJ, Yurick JL, Dayes IS, Mackey JR. Conservative and dietary intervention for cancer-related lymphedema: a systematic review and meta-analysis. *Cancer* 2011;117:1136-1148.
8. The diagnosis and treatment of peripheral lymphedema: 2013 Consensus document of the international society of lymphology. *Lymphology* 2013;46:1-11.
9. Clark M. Compression bandages: principles and definitions. In: European Wound Management Association (EWMA) Position Document: Understanding compression therapy. MEP Ltd, London; 2003.
10. Bertelli G, Venturini M, Forno G, Macchiavello F, Dini D. Analysis of prognostic factors in response to conservative treatment of postmastectomy lymphedema. *Surg Gynecol Obstet* 1992;175(5):455-460.
11. Feldman J, Stout N, Wanchai A, Stewart B, Cormier J, Armer J. Intermittent pneumatic compression therapy: systemic review. *Lymphology* 2012;45(1):13-25.
12. Szolnoky G, Lakatos B, EKskeny GT, Varga E, Varga M, Dobozy A, et al. Intermittent pneumatic compression acts synergistically with manual lymphatic drainage in complex decongestive physiotherapy for breast cancer treatment related lymphedema. *Lymphology* 2009;42(4):188-194.