Chapter 31
Intermittent Pneumatic Compression Therapy

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The use of intermittent pneumatic compression (IPC) devices in the therapeutic approach to lymphedema is perhaps the most controversial element of what is traditionally termed complex decongestive physiotherapy. In the United States, historically, pneumatic compression has been the mainstay of lymphatic therapy for decades.[1] IPC, preferably accomplished with multi-chamber pumps, effectively removes excess fluid from the extremity.[2-9]

Early enthusiasm for the benefits of IPC have been tempered by the theoretical concern that the pressures generated by these devices might damage skin lymphatics.[10,11] When used in lower extremity lymphedema, generation of genital edema is also a theoretical concern.[12] Development of a ring of fibrous tissue above the proximal margin of the device's sleeve has also been reported.[13]

Although IPC has this history of controversy surrounding its use, with the threat of incurred complications, the American Cancer Society Working Group on the Diagnosis and Management of Lymphedema designated intermittent compression pumps as a potential adjunctive component of decongestive lymphatic physiotherapy when used as an adjunct to the other components. Recognizing that pneumatic compression with lower pressures (≤40 mm Hg) had been suggested to be effective and to potentially court a lower risk of complications,[14] we undertook a prospective, randomized study to investigate the safety and relative efficacy of pneumatic compression therapy for the treatment of patients with breast carcinoma-associated upper extremity lymphedema when used adjunctively with compression bandaging and manual lymphatic massage.[15] Twenty-three previously untreated, patients were randomized to receive either decongestive lymphatic therapy (DLT) alone or decongestive therapy with daily adjunctive IPC. The addition of IPC to standard

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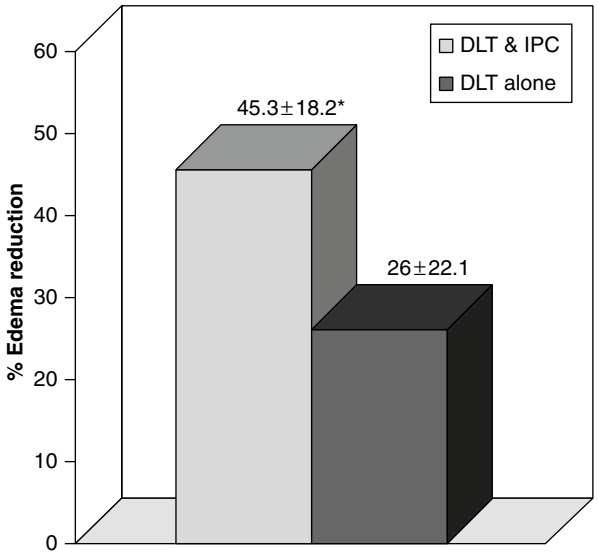

Fig. 31.1 The effect of adjunctive, intermittent pneumatic compression (*IPC*) on initial decongestive lymphatic therapy (*DLT*) in patients with breast carcinoma-associated lymphedema. The data depict the percentage reduction in volume of the limb attained after 10 days of daily therapy with either (1) DLT plus IPC or (2) DLT alone. The data are provided as the mean ± standard deviation for each group. The *asterisk* denotes a statistically significant difference ($p<0.05$)

DLT yielded additional mean volume reduction (Fig. 31.1). In 27 additional patients assessed during the maintenance phase of therapy, the addition of IPC to DLT enhanced the therapeutic response. In both the acute and maintenance phases of the study, IPC was tolerated well without detectable adverse effects on skin elasticity or joint range of motion.

Although the use of IPC in lymphedema has been hampered by individual reports of complications and lack of efficacy,[16] focused attempts to document the adverse effects, such as the study cited, do not seem to support the pejorative implications of IPC, particularly when the treatment modality is utilized in an *adjunctive* manner. The ostensible benefits of IPC correlate well with experimental physiological observations, in which the promotion of lymph formation by tissue compression is related to the number of compressions applied and the time interval between each compression. Thus, it would seem that the benefit accrues through centripetal emptying of the terminal lymphatics, such that the vessels refill after each compression is released.[17]

It is likely that continued refinement in the bioengineering and programmability of the pneumatic compression devices will enhance their efficacy in translating the physiological effects of intermittent compression to the therapeutics of lymphedema. As an example, quite recently, an adaptation of IPC has been introduced that purports to mechanically simulate the effects of manual lymphatic drainage. This device, the Flexitouch® System, delivers minimal, phasic external compression to both the affected limb(s) and the trunk in a programmable fashion. When prospectively examined for its role in patient self-management, the device has demonstrated

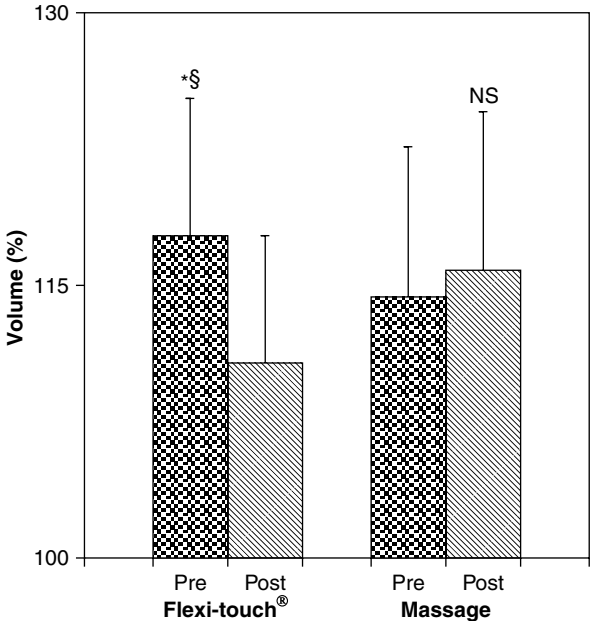

Fig. 31.2 A prospective, randomized, crossover study of maintenance therapy (Flexitouch® vs. Manual Lymphatic Drainage [MLD]) was performed in 10 patients with unilateral breast cancer-associated lymphedema of the arm. Excess volume of the affected arm is expressed as a percentage of the volume of the contralateral, normal arm. The effect of treatment on the percentage excess volume compared with the contra-lateral arm, was significant for Flexitouch™, but not for MLD (mean ± SD; $^{*}p = 0.0005$ compared with the pretreatment value; $^{\S}p = 0.003$ compared with response to MLD)

objectively demonstrable outcome benefits (Fig. 31.2).[18] Furthermore, in 155 lymphedema patients (93 with cancer-related lymphedema), before and after treatment assessment with the 12-item Short-Form Health Survey demonstrated significant improvement in all areas of perceived physical and emotional health.[19] Clearly, further evaluation of the role of such devices is warranted.

It has been advocated that IPC can be incorporated into a multidisciplinary, therapeutic program,[1,15,20,21] but the guidelines for patient and device selection continue to evolve. Several factors are involved in these therapeutic decisions, including simple versus advanced devices (the latter offering the option, in various combinations, of multi-chamber design, programmability, and advanced technologies to permit individual, lymphedema-specific therapeutics).[16] In addition, patient selection factors must determine not only the desirability of adding IPC to the treatment regimen, but also the choice of the specific device. These patient factors include severity of lymphedema; response to conservative therapies; lymphedematous involvement of the trunk, breast, or genitalia; presence of pain or open wounds; heterogeneous, regional variability in the severity of the edema; and/or the presence of complications that contraindicate the use of simple, non-programmable devices (Table 31.1).

Table 31.1 Intermittent pneumatic compression device selection

Patient considerations
• Severity of lymphedema
• Responsiveness to conservative therapies
• Lymphedematous involvement of the trunk, breast, or genitalia
• Pain
• Open wounds
• Complications that contraindicate the use of simple, non-programmable devices
Simple versus advanced design
• Multi-chamber design
• Programmability
• Advanced technologies to permit individuated, lymphedema-specific therapeutics

References

1. Brennan MJ, Miller LT. Overview of treatment options and review of the current role and use of compression garments, intermittent pumps, and exercise in the management of lymphedema. *Cancer*. 1998;83(12 suppl American):2821-2827.
2. Zelikovski A, Haddad M, Reiss R. The "Lympha-press" intermittent sequential pneumatic device for the treatment of lymphoedema: five years of clinical experience. *J Cardiovasc Surg (Torino)*. 1986;27(3):288-290.
3. Dittmar A, Krause D. A comparison of intermittent compression with single and multi-chamber systems in treatment of secondary arm lymphedema following mastectomy. *Z Lymphol*. 1990;14(1):27-31.
4. Walby R. Treatment of lymphedema in institutions. Two weeks of in-hospital intensive lymphatic drainage followed by maintenance treatment with a pulsator. *Tidsskr Nor Laegeforen*. 1990;110(24):3125-3126.
5. Wozniewski M. Value of intermittent pneumatic massage in the treatment of upper extremity lymphedema. *Pol Tyg Lek*. 1991;46(30-31):550-552.
6. Pappas CJ, O'Donnell TF Jr. Long-term results of compression treatment for lymphedema. *J Vasc Surg*. 1992;16(4):555-562; discussion 62-64.
7. Brunner U, Frei-Fleischlin C. Current status of combined physical decompression therapy in primary and secondary lymphedema of the legs. *Vasa*. 1993;22(1):8-14.
8. Bunce IH, Mirolo BR, Hennessy JM, Ward LC, Jones LC. Post-mastectomy lymphoedema treatment and measurement. *Med J Aust*. 1994;161(2):125-128.
9. Szuba A, Rockson SG. Lymphedema: classification, diagnosis and therapy. *Vasc Med*. 1998;3(2):145-156.
10. Eliska O, Eliskova M. Are peripheral lymphatics damaged by high pressure manual massage? *Lymphology*. 1995;28(1):21-30.
11. Foldi E. Massage and damage to lymphatics. *Lymphology*. 1995;28(1):1-3.
12. Boris M, Weindorf S, Lasinski BB. The risk of genital edema after external pump compression for lower limb lymphedema. *Lymphology*. 1998;31(1):15-20.
13. Casley-Smith J, Casley-Smith J. Other physical therapy for lymphedema: pumps; heating; etc. In: Casley-Smith J, Casley-Smith J, eds. *Lymphedema*. Adelaide: The Lymphedema Association of Australia; 1991:155-159.
14. Balzarini A, Pirovano C, Diazzi G, et al. Ultrasound therapy of chronic arm lymphedema after surgical treatment of breast cancer. *Lymphology*. 1993;26(3):128-134.
15. Szuba A, Achalu R, Rockson SG. Decongestive lymphatic therapy for patients with breast carcinoma-associated lymphedema. A randomized, prospective study of a role for adjunctive intermittent pneumatic compression. *Cancer*. 2002;95(11):2260-2267.

16. Rockson SG. Current concepts and future directions in the diagnosis and management of lymphatic vascular disease. *Vasc Med*. 2010;15(3):223-231.
17. McGeown JG, McHale NG, Thornbury KD. Effects of varying patterns of external compression on lymph flow in the hindlimb of the anaesthetized sheep. *J Physiol*. 1988;397:449-457.
18. Wilburn O, Wilburn P, Rockson SG. A pilot, prospective evaluation of a novel alternative for maintenance therapy of breast cancer-associated lymphedema [ISRCTN76522412]. *BMC Cancer*. 2006;6:84.
19. Ridner SH, McMahon E, Dietrich MS, Hoy S. Home-based lymphedema treatment in patients with cancer-related lymphedema or noncancer-related lymphedema. *Oncol Nurs Forum*. 2008;35(4):671-680.
20. Rockson SG, Miller LT, Senie R, et al. American Cancer Society lymphedema workshop. Workgroup III: diagnosis and management of lymphedema. *Cancer*. 1998;83(12 suppl American):2882-2885.
21. Leduc O, Bourgeois P, Leduc A. Manual lymphatic drainage: scintigraphic demonstration of its efficacy on colloidal protein reabsorption. In: Partsch H, ed. *Progress in Lymphology*. Amsterdam: Elsevier; 1988:551-554.