Effect of manual lymph drainage after hindfoot operations

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ABSTRACT **Background and Purpose**. *Manual lymph drainage therapy is often prescribed following hindfoot operations. However, the relative efficacy of this treatment component has not yet been determined.* **Method.** *A two-group pre-test–post-test study design was used in this preliminary randomized clinical trial of 23 subjects who underwent hindfoot surgery. Patients were randomly assigned into two groups: an intervention group of 11 patients who received standard physiotherapy plus manual lymph drainage; and a control group of 12 patients who received standard physiotherapy but no lymph drainage. The main outcome measure was the percentage reduction in excess limb volume, measured by the water displacement method at the second post-operative day (t1) and at the day of discharge (t2).* **Results**. *Compared to the control group, a significant reduction in post-operative swelling was measured in the intervention group only* ($p = 0.011$). **Conclusions**. *Application of lymph drainage techniques after hindfoot operations, in combination with standard physiotherapy exercises, achieves greater limb volume reduction than exercise alone. The present study offers an insight into a treatment that may shorten rehabilitation and thereby control the cost of caring for post-operative treatment complicated by post-operative swelling.*

Key words: hindfoot surgery, manual lymph drainage, physiotherapy, post-operative swelling

INTRODUCTION

Manual lymph drainage is a well-established and widespread treatment used to prevent lymph oedema and cases of post-operative swelling (Schuchhardt and Vollmer, 2000). Several studies have shown the efficacy of this technique in relation to decreasing swelling and increasing perfusion (Franzeck et al., 1997; Francois et al., 1989; Hutzschenreuter et al., 1989; Balzer and Schönbeck, 1993). Francois et al. (1989) identified chronic oedema of the lower limbs by lymphoscintigraphic exploration. Patients underwent therapy involving eight days of manual lymph drainage combined with elevation of the limbs during rest periods. Manual lymph drainage increased lymph flow in 16 limbs (out of 25 limbs treated), implying that the oedema resulted from a functional lymphatic anomaly. In contrast, manual drainage did not increase lymph flow in nine limbs, suggesting a structural anomaly of the lymphatic system. The study by Boris et al. (1994) showed an average reduction of swelling of 88% after a daily treatment for 30 days. These authors included 18 patients with unilateral lower extremity lymphoedema and four individuals with bilateral leg oedema in their study. In addition to the manual lymph drainage Boris et al. (1994) gave some instructions for active exercises to their patients. Furthermore, application of a bandage for 23 hours was standard. In a clinical setting, Franzeck et al. (1997) studied the effect of manual lymph drainage and compression therapy in a population of 12 patients with primary and secondary lymph oedema. After two weeks' intensive manual lymph drainage and compression bandaging, micro-lymphatic hypertension was significantly reduced. Three months later, after continuing compression, lymph capillary pressure was still significantly reduced. Hence, the decrease of swelling following the implementation of lymph drainage techniques in these studies relates to primary and secondary lymph oedema. In this condition, oedema is caused by overproduction of lymph or is developed because of a problem in the lymphatic drainage system (Boris et al., 1994; Mortimer 1995). Hutzschenreuter and Ehlers (1986) report vagotonic reactions as a possible mechanism causing swelling as well.

In the acute orthopaedic clinic, post-operative swelling may be regarded as a common phenomenon causing variable lower extremity volumes. The cause of the swelling, however, remains a point of debate. Many different sources may contribute to the development of post-operative swelling, for example, the surgical technique used, the duration and type of operation, the type of tourniquet used and the tissues involved. Nevertheless, post-operative swelling differs from classic lymph oedema and should not be confused with a physiological wound oedema either.

Post-operative swelling, however, may cause complications similar to primary and secondary lymph oedema (for example, increased pain, prolongued soft tissue healing, increased local soft tissue pressure) (Hutzschenreuter and Brümmer, 1989). Swelling after surgery, possibly in combination with venous stasis, is one of the three components of Virchow's triad (vascular damage, abnormalities in flow and hypercoagulability) predisposing to thrombosis. Any technique which may decrease one of these risk factors is worthwhile.

Results from a single-case study infer that, in special cases, manual lymph drainage combined with standard physiotherapy modalities can enhance treatment effect (Dotterweich, 2000). Animal experiments on wound healing show that treatment without manual lymph drainage may cause several wound healing deceleration problems compared to treatment with manual lymph drainage (Hutzschenreuter and Brümmer, 1989). In an experimental study on rats and sheep, Hutzschenreuter et al. (1989) demonstrated by means of light reflexion rheography and laser doppler fluxmetry that manual lymphatic drainage therapy causes vessel narrowing followed by increased blood flow in the arterioles, capillaries and venulae of the skin as well as in peripheral arteries, and increased lymph flow in lymphatic collectors. A clinical pilot study on patients with obliterative arterial diseases who underwent eight lymph drainage treatments over a four-week period under clinical conditions confirmed this observation (Francois et al., 1989).

Classical complex lymphatic drainage represents a time-consuming and material-intensive form of physiotherapy. Guidelines for the provision of this treatment were developed and published by Földi and Kubik (1999). An important part of this therapy is the application of a compression hose or bandage after the manual drainage to support the effect of the decongestion manual techniques (Whitmore et al., 1972; Strössenreuther, 1989). However, post-surgical circumstances, such as wound condition, pain or impaired circulation, do not always allow the application of such a hose or bandage. Neither is it always possible to apply an intermittent impulse compression technique, although this method has been shown to be effective (Gardner et al., 1990; Hamzeh et al., 1993; Myerson and Henderson, 1993; Stöckle et al., 1996). Hence, the purpose of the present study was to investigate the potential relevancy of manual lymph drainage applied after hindfoot operations in a clinical population undergoing hindfoot surgery. The following research question guided the study: 'Do volumetric measurements of lower extremity result in a decrease in values of post-operative swelling for subjects treated with and without post-operative manual lymph drainage techniques after hindfoot operations?' For the reasons previously mentioned, all the subjects presented in this study received manual lymph drainage without application of collateral compression bandage treatment. Consequent elevation of the extremity involved was regarded as an important substitute for the compression bandage. The ends of patients' beds were raised 10°, provided that the status of patients allowed this.

METHOD

Study design

The study was conducted as a randomized clinical trial.

Subjects and experimental procedure

Balgrist University Hospital serves as an orthopaedic hospital and is located in the city of Zurich, Switzerland. All patients scheduled for hindfoot operation (n = 69), admitted to the hospital during the period from April 2000 to February 2001, were considered for inclusion in the present study. Exclusion criteria were patients with diagnosed contraindications for lymph drainage therapy (prior history of deep venous thrombosis, pulmonary embolus, current diagnosis of local infection, neuropathy, reflex sympathetic dystrophy or chronic venous stasis syndrome), previous operations or diseases of the lymphatic or blood vessel systems and traumatic causes for the operation. If patients' status did not permit elevation of the lower extremity they were excluded from the study. Inclusion criteria after surgery were:

- A clinically diagnosed post-operative swelling.
- Age between 18 and 75 years.
- Good overall physical condition.

Twenty-three subjects who underwent hindfoot surgery met the inclusion criteria and volunteered as subjects in this study. General descriptions and data of the two groups are summarized in Table 1.

TABLE 1: General descriptions and data

	Intervention group	*Control group*	p *value*
Number of patients	10	12	
Gender	3 male/7 female	9 male/3 female	0.03
Average BMI (range)	28.46 (22.8–37.1)	30.27 (23.7–38.8)	0.48
Average age in years (range)	49.1 (29–69)	52.5 (27–67)	0.62
Average change in swelling (% relative to initial value)	−6.4	−0.1	0.03
Average hospital stay since surgery in days (range)	5.1 (3–7)	5.25 (3–9)	0.82
Type of operation (all patients were not acute traumatic)	3 arthroplasties 2 arthrodesis 1 re-arthrodesis 3 double arthrodesis 1 triple arthrodesis	7 arthroplasties 3 arthrodesis 2 osteotomies	

Ten patients underwent surgery for arthroplasties consisting of a total prosthesis of the ankle joint. Arthrodesis of the ankle joint was performed in five cases. One patient had a re-arthrodesis of the ankle joint. Two patients received osteotomies of the calcaneus and three a double arthrodesis of the ankle joint and the subtalar joint. Furthermore, one triple arthrodesis had been carried out. Although the indications for these operations were always different, post-operative treatment for this group of subjects is comparable. The main aim of post-operative physiotherapy is to support patients in regaining their independence in daily living. This may be achieved through physical exercises, if post-operative circumstances permit, and by gait training. Application of additional manual lymph drainage to decrease post-operative swelling could offer a means to enhance this treatment goal. A description of the physiotherapy programme is given in the 'Protocol' below. All subjects underwent hindfoot surgery performed by the same physician. They were required to sign an informed consent document. The study was approved by the Balgrist University Hospital Review Board.

Protocol

Subjects were randomly assigned to either a control or intervention group. Patients were chosen on the basis of availability and represent a convenience sample. The intervention group consisted of 11 individuals (3 male/8 female; 52.5 (±15.2) years of age); the control group comprised 12 individuals (9 female/3 male; 49.2 (±16.2) years of age). All subjects participated in a pre-test on their second post-operative day and a post-test on the day of hospital discharge.

The rehabilitation programme for both groups consisted of a standard physiotherapy protocol for inpatients after hindfoot operations. The standard physiotherapy programme contained thrombosis prophylaxis instructions, active and passive ankle movements (if allowed) and daily gait training with elbow crutches and partial body weight support. Active exercises consisted of ankle movements (plantar and dorsal flexion) beginning from the second post-operative day. A Scotch cast®), which is easy removable for exercises, was immediately applied again after the therapy. Movements were carried out in a supine position, applying a small tube-shaped cushion under the Achilles' tendon. The standard number of exercise repetitions for all patients was 50 without resistance and 25 with light resistance in both movement directions. The exercises were always performed at the same time of the day and before the manual lymph drainage. If circumstances did not permit such exercises (for example, arthrodesis, re-arthrodesis, double- and triple-arthrodesis and osteotomy) patients did not receive an alternative exercise programme. The lower end of all the patients' beds were raised 10° in order to ensure a constant lower extremity elevated position.

The intervention group added a daily 30-minute manual lymph drainage treatment to the post-operative rehabilitation programme. The manual lymph drainage therapy applied in the present study is adapted from the technique of Földi and Kubik (1999). First, gentle manual pressure was applied to each of the dermal lymphotomes to direct lymph flow to the non-obstructed lymph nodal areas. A firm, sustained manual pressure was applied to the watershed areas of adjacent lymphotomes, with particular emphasis on the lymphoedematous region. This was carried out in a predetermined manner aimed at redirecting lymph flow by opening and dilating the collateral vessels across watersheds from the oedematous to the normal lymphotomes. The pattern of manual pressure was individual for each patient. A more detailed description of this method is described elsewhere (Strössenreuther et al., 1999). Treatment was performed by the same licensed physiotherapist for all sessions. The physiotherapist previously acquired the skills necessary to conduct manual lymph drainage techniques in specific training sessions. To account for diurnal variations of oedema formation, therapy was always performed at the same time each day.

One subject withdrew from the study because she developed a plaster allergy, causing tension blisters which prevented the necessary wound coverage. Furthermore, the blister volumes caused by the allergy would have biased the study results. The statistical analysis was performed with the remaining 22 subjects who completed the study.

Volumetric measurements

Patients were monitored from the second post-operative day (t1) by means of volumetric measurement using a water displacement technique. A second volumetric measurement was performed at the day of hospital discharge (t2). A polyurethane tank (dimensions 40 × 40 × 20 cm; Figure 1) with an overflow spout was filled with water until spillage from the spout no longer occurred. Patients were seated comfortably and the involved foot was fully submerged. Patients were always seated on the same chair, which was not removed during the study. They had to sit in an upright position and correct positioning was controlled by bony anatomical landmarks (for example, lateral malleolus/caput fibulae/trochanter major).

The angle of the knee joint was controlled by a goniometer and had to be 90° flexion. The water overflow was measured in ml, and the mean of three consecutive measurements was listed. Since it was not possible to eliminate the effect of diurnal variations on swelling, these determinations were made at similar times of the day for each patient. Water and room temperature were kept under stable conditions and amounted to 25° C (water) and 24°C (room), respectively. Furthermore, all patients were transported in a wheelchair to the measurement location.

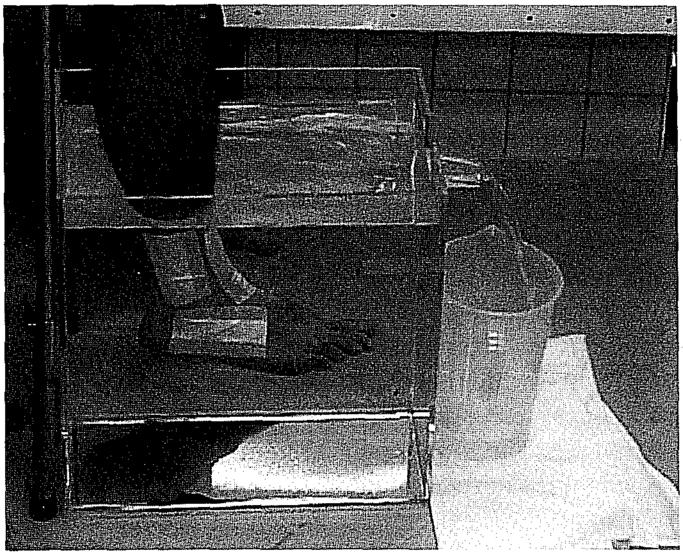

FIGURE1: Standardized water displacement technique.

Special instructions were given to patients to remain in their beds for 60 minutes before measurements.

Water volumetry is a simple test, the 'gold standard' of reference (Perrin and Guex, 2000). Reproducibility of the water displacement method in a clinical population has a reproducibility of 1.52% (day-to-day) and 1.76% (after a mean interval of 4–8 days) (Brijker et al., 2000).

During measurement, operation scars were covered with sterile plaster (Microdon™; 3M Health Care, D-46325, Germany) and an additional waterproof foil (OpSite Flexifix; Smith & Nephew Medical Ltd, Hull, UK). A study nurse applied a new bandage after each measurement session.

Statistical analysis

The mean of three volumetric measurements, expressed in ml, was used for each individual patient's measurement. Statistical analysis was performed by use of the SPSS statistical package running on a PC. Paired Student's *t*-tests were applied to detect significant differences in volumetric parameter between the two groups at time points t1 and t2, and between time points t1 and t2 (pre-test–post-test design) for both groups (Hicks, 1992; Altman, 1995). Results were considered significant at $p \leq 0.05$.

RESULTS

Of 23 patients who participated in the study, one was excluded owing to (involuntary) non-compliance and insufficient volumetric data. Table 1 above summarizes the general description and data for the selected group of patients.

All 22 subjects who completed the study underwent two volumetric measurements. The group difference in water displacement between the two measurements (second day post-surgery and at hospital discharge) was calculated as a percentage relative to the initial value of the measurements. Since there is inter-individual variation in anthropometrical size, volumetric measurements have been normalized to the first measurement value. This has been done so that volumetric changes between t1 and t2 may be compared readily.

The largest changes were observed in the intervention group. This change seemed to depend on the additional manual lymph drainage performed in this group. For the whole intervention group there was a mean decrease of 6.4%, whereas the control group showed a small decrease of 0.1%.

As expected, statistical analysis did not show a significant difference between the intervention and control groups at the time of the first measurement (t1). At time point t2 there was a statistically significant difference between the control group and the intervention group ($p = 0.032$; two-sided). At t2 the intervention group only showed a decrease in lower extremity swelling, which represents a statistically significant change ($p = 0.011$) compared to t1. Mean values (±SD) at t1 and t2 for the two groups are summarized in Figure 2.

DISCUSSION

The main finding of the present study was that patients who received manual lymph drainage complementary to standard post-surgery physiotherapy experienced a significant decrease in lower extremity swelling during hospitalization compared to patients receiving standard physiotherapy only. This result was reached without the use of additional compression bandaging techniques. Thus, the present study has shown that manual lymph drainage has potential to enhance recovery results after hindfoot operations. Patients treated with additional manual lymph drainage show significantly lower values. However, these

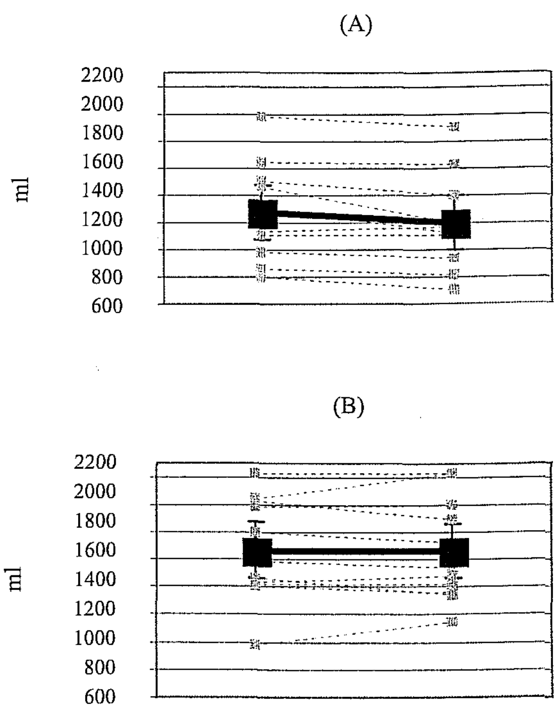

FIGURE 2: Foot volume: mean value for intervention and control groups at t1 and t2: (A) = intervention group; (B) = control group.

findings are based on small sample sizes and should remain preliminary in nature. Future research with bigger patient groups seems to be indicated and should consider clinical factors such as time to discharge, pain, wound healing problems and costs of care.

It has long been appreciated that early mobilization decreases the venous stasis which occurs during bedrest after an operation and can therefore help to reduce the risk of thrombo-embolic complications (Payling-Wright et al., 1951;Gibbs, 1957). During anaesthesia and subsequent periods of immobility, blood stagnates in the venous sinuses of the lower limbs since the muscle pumps are inactive. Most deep vein thromboses have been shown in the gastrosoleal plexi and many mechanical methods have been designed which aim to promote venous return by promoting the role of the redundant muscle pumps. One of the most popular methods is the A-V impulse system which is based on the discovery of the mechanism of the venous pump in the sole of the human foot (Gardner and Fox, 1983; Gardner et al., 1990). Following the discovery of the powerful venous pump in the foot that is activated by weightbearing, independently of muscular action, a pneumatic impulse device was developed to actuate this pump artificially. There is a general improvement in the microcirculation with the use of this system. However, the drawbacks of mechanical devices include the enforced bedrest and the expensive, specialized equipment necessary. The devices are often bulky or uncomfortable, leading to poor compliance (Sochart and Hardinge, 1999).

Sochart and Hardinge (1999) studied the relationship between movements of the foot and ankle and venous blood flow from the lower limb, to determine the optimum type of exercise for promoting venous return. They found that both passive and active exercise resulted in an increase in mean and peak blood velocities in the common femoral vein, but the active exercises produced greater changes. Another benefit of active movement is that the improvement in venous haemodynamics is maintained for up to 30 minutes after cessation of exercise (McNally et al., 1997). On the basis of the findings in the present study it may be speculated that manual lymph drainage techniques enhances this effect. Future studies into clinical populations should investigate the veracity of this hypothesis.

Patients with any kind of arthrodesis or osteotomies were not allowed to perform active ankle movements after their operations. An animal study on post-operative oedema (Taylor et al., 1992) demonstrated that muscle contraction (electrically induced in this case) actually contributed to post-traumatic oedema formation, by increasing circulation in the area and increasing intra-capillary pressures, thus increasing exudate formation in the interstitial tissues. Theoretically, this finding could have biased our results. However, since there were seven patients in the intervention group compared to five patients in the control group without an active post-operative exercise programme, it is considered that this factor did not influence our results. Furthermore, it seams questionable in how far the results of an animal study may be superimposed on patients. However, in future studies with larger groups, the influence of prohibited 'post-operative exercising' on the decrease of the post-operative swelling should be investigated. The present study did not estimate whether the observed results have any clinical significance. It is therefore not known if the observed effects from additional manual lymph drainage is sufficiently large to influence clinical practice. These issues must be considered in follow-up studies.

Post-surgery swelling, possibly in combination with venous stasis, is one of the three components of Virchow's triad (vascular damage, abnormalities in flow and hypercoagulability) predisposing to thrombosis, and any method which can decrease one of these risk factors is clearly worthwhile. A well-established manually applied massage technique which supports the aims of patients' active exercise programmes should be inexpensive and be readily incorporated into general post-operative rehabilitation. The implementation of active and passive ankle movements, combined with manual lymph drainage techniques, produced the greatest decrease in mean lower extremity volume and should therefore be considered rather than active exercises only.

IMPLICATIONS

Future research with bigger patient groups should be performed. This research should additionally consider clinical factors such as time to discharge, pain, wound healing problems and costs of care. Furthermore, whether application of manual lymph drainage in this patient population might influence clinical practice should be investigated. Future research should also consider alternative sampling techniques compared to the method used in the present study.

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