Comparing the Effectiveness of Elastic Bandages and Shrinker Socks for Lower Extremity Amputees

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Twelve patients with below-knee amputations were assigned one of two methods for wrapping the residual limb: elastic bandaging and elastic shrinker socks. The limbs were measured over a period of four weeks to compare volumetric change. The results indicate the elastic shrinker sock to be more effective in decreasing residual limb volume.

Key Words: *Amputation stumps, Edema reduction, Physical therapy.*

Delaying prosthetic fitting because of inadequate shrinkage of the residual limb is detrimental to and discouraging for the amputee. The delay is especially frustrating when the patient displays the ability to wrap the limb well and is conscientious about following the treatment program. This study was designed to evaluate the comparative effectiveness of elastic bandaging and elastic shrinker socks in decreasing residual limb volume.

Early prosthetic application and the prevention of contractures are the foremost priorities in the rehabilitation of the amputee.[1] In order to begin prosthetic rehabilitation, the residual limb must be well healed and nonedematous. Adequate supportive bandaging during the postoperative period should 1) act as a dressing, 2) remain securely positioned despite movement of the limb, 3) hold tissue to control edema, and 4) mold tissues to facilitate prosthetic fitting. Optimum pressure gradients can be exerted that will control edema, support circulation, and minimize inflammatory reactions, all of which promote healing and are significant in the shaping of the residual limb.

Among civilians, the majority of lower extremity amputations are performed on elderly patients. Of these, 85 percent are secondary to ischemia produced by vascular disease.[1] The healing process in these patients is slow, and breakdown of the tissue further prolongs hospitalization and delays prosthetic rehabilitation.

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Swelling is common and, in a postoperative limb, inevitable. However, the presence of swelling and the failure of the swelling to subside unfavorably influence rehabilitation. Compression of tissues is desirable; one of the greatest problems is the unavailability of an efficient dressing that will support, compress, and protect the limb.

Four basic types of compressive bandaging have been investigated: 1) soft dressings, 2) pneumatic appliances, 3) semirigid dressings, and 4) rigid dressings. The elastic wrap bandage is a commonly used soft dressing. It is inexpensive and readily available. It has traditionally been used despite its inability to maintain continuous snugness and the difficulty encountered in applying the wrap. The usefulness of this type of dressing in amputation management is controversial. The patient's application of such a bandage often leads to poor results and may have negative effects such as compromised venous flow and thromboembolism. Other types of soft dressings have been studied. Dowie investigated the plastic vinyl chloride bag as a primary dressing.[2] Sher recommended the shrinker sock as a secondary dressing.[3]

Various types of pneumatic devices have been developed in recent years. A pneumatic device permits adjustment of externally applied pressure as well as accessibility of the operative site for inspection. These devices have been recommended as an alternative dressing for cases in which a rigid dressing cannot be applied.[3–5]

Semirigid dressings include the use of a gel-impregnated dressing[6] and supportive bandaging described by Puddifoot and associates.[7] The application of a rigid plaster dressing immediately after surgery is widely supported as a method that hastens residual limb shrinkage and shapes the limb for prosthetic fitting.[8]

Of primary importance when considering a compressive bandage is the amount of externally applied pressure possible without compromising vascular supply. Husni and associates found that maximal venous acceleration and minimal inflow obstruction were attained at pressures of 15 to 20 mmHg.[9] Kosiak demonstrated marked susceptibility of tissue to relatively low constant pressures for short periods of time.[10] He observed microscopic evidence of edema and cellular infiltration when 50 mmHg was exerted over a two-hour period. Furthermore, sustained pressures in excess of 25 mmHg are potentially harmful.[11]

Husni and associates found that pressures of elastic bandages greater than 10 mmHg simulated a major venous occlusion, whereas, with an air splint, pressures up to 20 mmHg could be safely applied. This result was attributed to the tourniquet-like effect produced by the elastic bandage.[9]

Several studies have compared the effectiveness of various bandaging methods. Mooney and associates found that the greatest delay in prosthetic fitting occurred among amputees who used elastic bandages rather than rigid plaster casts.[12] The failure rate (limbs requiring below-knee revision) for the elastic bandage group was 22 percent, compared with 6 percent for the plaster cast group. Isherwood and associates[11] attempted to ascertain pressure distributions beneath the elastic wrap, the bandage described by Puddifoot and associates,[7] and the pneumatic application. The elastic wrap exhibited the greatest range of pressures (23–72 mmHg) as well as the majority of highest readings. Elastic bandaging, therefore, is unreliable and potentially dangerous in terms of pressure and pressure distribution.[11]

METHODS

Subjects

The subjects were 12 amputees with below-knee residual limbs. The five men and seven women ranged in age from 12 to 88 years. The mean age was 56 and the median was 63. Four basic criteria for acceptance were developed: 1) a well-healed incision, 2) a score of 9 on a 10-point scale of proper wrapping technique (Fig. 1), 3) availability for weekly measurements for four consecutive weeks, and 4) not more than 2.25 kg (5 lb) of weight change over the four-week test period. The 10-point rating scale of wrapping technique was developed by the clinical staff therapists (Fig. 1). These 10 items were used to evaluate independence in wrapping procedures. During each week of the test period each item that the subject could perform independently was checked off. A total score was obtained by adding the number of checks recorded. The subjects were weighed at the beginning and end of the test period to ascertain maintenance of a stable weight throughout the four-week test period.

DATE				
1. Pressure decreases from distal to proximal				
2. Uses figure of 8 and oblique wraps only				
3. Even distribution of layers of wrap				
4. All areas are covered				
5. Wrap is secure and is properly anchored above the knee				
6. No wrinkling of bandage				
7. Re-wraps every 4 hours (patient report)				
8. No areas of highly concentrated pressure (redness)				
9. Pressure is <u>not</u> directed at the cut end of tibia				
10. Patient wraps independently				
TOTAL SCORE				

Fig. 1. Ten-point rating scale for evaluating independence in elastic bandage wrapping technique.

Of the 12 limbs, 10 (83%) had required amputation because of ischemia caused by diabetes mellitus or vascular disease. This proportion of amputations resulting from ischemic disease closely parallels the percentage previously reported in the general population.[1]

The subjects were randomly assigned to two groups. One group used elastic bandages wrapped above the knee, the other group wore elastic shrinker socks* that extended above the knee. Instructions given to each subject were uniform and consistent. Each subject using the wrapping technique was instructed to begin the wrap at the lateral side of the limb and proceed anteriorly to the medial, distal side of the limb (Fig. 2). All items on the 10-point rating scale (Fig. 1) were emphasized. The instruction session was concluded when the subject consistently performed the steps of proper wrapping technique. The subjects using shrinker socks were instructed in their proper application. Total contact and proper suspension were emphasized. All subjects were instructed to reapply the dressing at least every four hours, and more often if necessary.

* Truform, 3960 Rosslyn Dr, Cincinnati, OH 45209.

1. Begin at lateral side of limb.
2. Bring first wrap anteriorly to medial side of limb just superior to end of tibia.
3. Use figure of 8 wraps.
4. Anchor by continuing wrap above knee.
5. Re-wrap at least every 4 hours, and more frequently if wrap becomes loose.

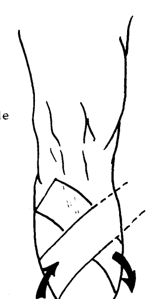

Fig. 2. Patient instruction sheet for wrapping procedures.

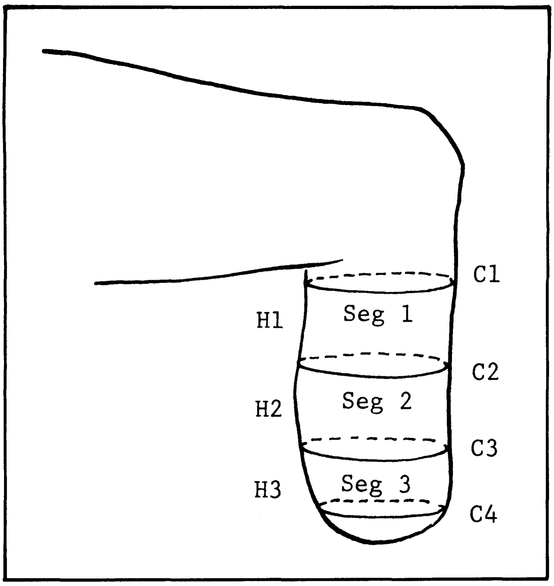

Fig. 3. Below-knee residual limb partitioned into truncated cones. Each cone is measured circumferentially at its top (C_1) and base (C_2). Height is defined as the distance between these two points. (Reproduced with permission of publisher.[13])

Procedure

An anthropometric technique designed to calculate segmental leg limb volume[13] was used to determine residual limb volume. The residual limb was partitioned into truncated cones (Fig. 3). The formula for volume of a truncated cone using circumference and height measurements is

$$\text{Volume} = h/12 \times [C_1^2 + C_2^2 + (C_1)(C_2)]$$

For each truncated cone, C_1 is the proximal circumference, C_2 is the distal circumference, and h is the height (Fig. 3).

TABLE 1
Demographic Description of Sample

	Bandage Group (n = 6)	Shrinker Sock Group (n = 6)
Sex		
Male	3	2
Female	3	4
Age (yrs)	50.5 ± 27.6[a]	62.0 ± 17.0[a]
Limb length (cm)	18.5 ± 5.5[a]	18.7 ± 3.8[a]
Disease		
Diabetes mellitus	3	3
Vascular insufficiency	1	3
Cancer	1	0
Congenital (revision)	1	0

[a] Mean ± standard deviation.

The total length of the below-knee residual limb was determined with a modified straight-edge ruler using the medial tibial plateau and the end of the tissue as the proximal and distal landmarks, respectively. These landmarks are easily palpable and correspond to those used to determine limb length for fabrication of a below-knee prosthesis.[8]

Circumferential measurements were recorded with Jobst† measuring tapes. The first tape was placed at the site of the medial tibial plateau. These tapes are spaced at a distance of 4 cm (1.6 in); therefore, the height of each truncated cone was 4 cm. If the height of the most distal cone was less than 4 cm, its height was then determined by subtracting the sum of the heights of the proximal cones from the total length of the limb. The tape for the distal circumference of this cone was placed as close to the end of the limb as possible. All measurements were taken while the subject was sitting with the knee relaxed and flexed to 90 degrees.

RESULTS

Table 1 presents the demographic description of both samples. Note that the shrinker group was older (although not significantly so) and had more vascular disease than did the bandage group. No difference in residual limb length was noted.

By summing the volumes of each truncated cone, a total volume for the limb was determined. Table 2 presents the average (± SEM) volume determinations (cm^3) for each wrapping method over the four-week test period. Note that there was an average increase (from week 1 to week 4) of 16.5 cm^3 ($t = 0.32$, NS) for the bandage method, whereas there was an average decrease bordering on significance of 63.6 cm^3 ($t = 1.67, p = .08$) for the elastic shrinker sock method. Comparing these two averages for the two methods revealed that the elastic shrinker method produced a significantly larger decrease in volume ($t = 2.10, p = .03$) after four weeks than did the bandage method.

DISCUSSION

This study indicated that the elastic shrinker sock method was significantly better than the bandage method in reducing residual limb volume (Tab. 2). This result appears not to be attributable to length of the residual limb, inasmuch as average limb lengths were equal in the two groups (Tab. 1). This result could be attributed, however, to the increased per-

† Jobst Institute, Inc, Box 654, Toledo, OH 43694.

TABLE 2

Residual Limb Volume Measurements for Each Wrapping Method Over the Four-Week Test Period

Week	Bandage Group (n = 6) (Mean ± SEM vol in cm^3)	Shrinker Sock Group (n = 6) (Mean ± SEM vol in cm^3)
1 (pretreatment)	1,357.7 ± 179.7	1,537.4 ± 142.4
2	1,386.2 ± 173.6	1,507.5 ± 205.2
3	1,457.2 ± 164.2	1,488.4 ± 190.7
4 (posttreatment)	1,374.2 ± 169.3	1,473.8 ± 153.5
Average change, weeks 1 to 4	+16.5 ± 50.8[a]	−63.6 ± 38.1[b]

[a] $t = 0.32$, NS against a one-sided alternative.
[b] $t = 1.67$, $p = .08$ against a one-sided alternative.

centage of ischemic disease in the shrinker sock group, inasmuch as this type of disease may create a greater potential for shrinkage. Assuming that younger patients might respond better than older patients to wrapping, it is indeed surprising that no change was observed in the bandage group despite the fact that it was composed of the youngest subjects in the sample.

These statistical results confirm our clinical observations noted during treatment of these and other patients not reported here. In general, we had believed that shrinkers were more effective; consequently we had substituted them for bandaging in many cases.

CONCLUSION

We recommend the use of an elastic shrinker sock as the method of choice in treating the below-knee amputee. In this study elastic bandaging was not effective in decreasing residual limb volume and, therefore, its use must be reevaluated, especially for patients with vascular disease.

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