

Outcome of Four Layered Bandaging in Venous Leg Ulcer due to Varicose Veins

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ABSTRACT

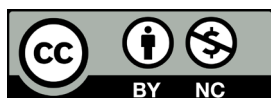
Introduction: Venous ulcer is the late sequelae of venous diseases like varicose veins, deep vein thrombosis. Four layered bandaging (4LB) is a multicomponent elastic bandaging technique used for the treatment of venous ulcer. However, the efficacy of this treatment in our context hasn't been well studied. The main aim of this study was to know the outcome of 4LB bandaging in venous ulcer due to varicose veins in patients presenting to university hospital of Nepal.

Methods: This cross-sectional study included patients with venous ulcers secondary to varicose veins presenting to the Vascular Unit outpatient department at Dhulikhel Hospital from January 1, 2021, to October 31, 2022. All eligible patients were treated with four-layer bandaging (4LB). Patients with concomitant arterial disease (ankle-brachial index <0.8 with symptoms such as claudication, ischemic ulcer, or gangrene) were excluded. Ulcer area and stage were recorded before 4LB application and reassessed at 7 days and 30-day follow-up. Data were analyzed using IBM SPSS Statistics version 13.0. Continuous variables were compared using the independent sample t-test and categorical variables using the Chi-square test. A p value <0.05 was considered statistically significant.

Results: Four layer bandaging for venous ulcer was done in a total of 46 participants. Among them, 31 were male and 15 were female. The mean age of the participants was 46.8 years. 36 participants had the first occurrence of ulcer while the rest of them had recurrence. The duration of ulcer time was seven months with the mean area of ulcer 2.5cm². Following 4LB bandaging, the mean area decreased to 1.9cm² in 1 week and 1.2cm² in 1 month. 24 (54.4%) of them had healing of venous ulcers from Stage C6 to Stage C5 according to CEAP classification.

Conclusions: Newer bandaging techniques like 4LB is a recommended treatment modality for venous ulcer due to varicose veins. Once optimized these cases should undergo further treatment such as RFA and other adjunct procedures where applicable.

Keywords : Varicose Veins, Venous Ulcers, Compression Therapy



INTRODUCTION

A venous ulcer is an open skin lesion of the leg or foot that occurs in an area affected by venous hypertension. It is a late sequelae of venous diseases like varicose veins and deep vein thrombosis; and is associated with disabilities and prolonged morbidity.¹ It has significant economic, clinical and social burden affecting 1 % of the general population.²

The primary cause of venous ulcer is due to obstruction or retrograde flow resulting in venous hypertension thus leading to macro or micro vascular dysfunction.³

Heaviness in the leg, pruritus, pain, and edema that worsens during the day improving with limb elevation are the common symptoms whereas, signs like varicose veins, telangiectasias, lipodermatosclerosis and inverted champagne-bottle deformity of the leg may also be seen. The main goal for the treatment of venous leg ulcers is ulcer healing and compression therapy is the standard treatment. Multicomponent elastic compression therapies have been proven to be more effective than single layer and non-elastic components.⁴ One of the methods of multicomponent elastic compression therapies is a four layer bandage system.

Four-layer bandage (4LB) was developed to provide high compression because this pressure is required to achieve ulcer healing in case of chronic venous insufficiency.⁵ The four layers in 4LB are a plain stockinette, an orthopaedic bandage, a cotton compression bandage, a cotton and rubber elastic bandage and a cohesive bandage as shown in Table 1. Prior to applying the 4LB, the ulcer is dressed using alginate, silver or normal saline dressing. Tapes are avoided as they can cause peeling of skin during removal. 1 Figure 1 shows different steps and layers employed while applying 4LB.

Figure 1: Showing different steps in 4LB population



Although 4LB is an established treatment for venous ulcer, in Nepal only a few studies on its utility have been done. Therefore, this study is done to study the outcome of 4LB in venous ulcer due to varicose veins in patients presenting to our hospital.

Table 1: Table mentioning the layers in 4-LB Bandage.

Layers	Functions
Plain Stockinette	For securing the wound dressing.
Orthopaedic Bandage	For absorbing exudate and redistributing pressure around limb.
Cotton Compression Bandage	For flattening the padding layer and aiding absorbency of the orthopaedic bandage.
Cotton and Rubber Elastic Bandage	Providing higher pressure at the ankle, with decreasing pressure exhibited at the calf to help improve upward blood flow.
Cohesive Bandage	For providing higher level of compression (sub-bandage pressure approximately 23 mm of Hg) & must not be over-extended.

METHODS

This study is a cross-sectional study of patients with venous ulcer due to varicose veins who presented to the Outpatient Department of Vascular Unit of Dhulikhel Hospital from January 1st 2021 to 31st October 2022. This Study was approved by the Institutional Review Committee (IRC) of Kathmandu University School of Medical Sciences (KUSMS). All the patients were treated with four layer bandaging. Baseline data like age, gender, duration of varicose veins, duration of ulcer and size of ulcer were taken. If patients had venous

ulcers in both the limb, data was entered separately as two patients. To calculate the surface area of the ulcer greatest length and width of the ulcer was taken. As the shape of the ulcer is irregular, the greatest length and width of the wound were multiplied and recorded.⁶

Patients with concomitant arterial disease (ankle brachial index of less than 0.8 along with symptoms of arterial disease like claudication, ischemic ulcer, gangrene), were not advised for 4LB and thus not included in the study. The patients with venous ulcer were seen by at least one vascular surgeon of the two vascular surgeons in the department (with nine and three years experience in management of venous ulcer). The patients were counseled by one of the vascular surgeons in relation to the application, prior considerations, potential benefits, expected results, and possible issues with 4LB, as well as the estimated duration of use of 4LB and planned followup times.

The application of 4LB was done by medical officers, trained nurses or physiotherapists under supervision by a vascular surgeon. Dyna 4LB multilayer compression bandage (Dynamic techno medicals) was used with Agfix Ultramax silver dressing (Dynamic techno medicals). Following the application of 4LB, the bandage was not taken off for six days. The patient was asked to be followed up on the seventh day. On the day of follow up, the 4LB was removed and details on area of ulcer, presence of granulation, presence of epithelization, whether the ulcer is healed and possibility of radiofrequency ablation were recorded. Granulation of ulcer is defined as presence of red, bumpy tissue which is highly vascular.⁷ Epithelization of ulcer is defined as regenerated epidermis over the wound surface.⁸ Healing of ulcer is defined as presence of scar which completely covers previous ulceration site.⁷ Possibility of RFA and other adjunct treatment is decided once there is improvement of the wound in terms of reduction of size, absence of discharge, absence of features of cellulitis. The patient and patient party were re-taught the application of 4LB and under supervision, they were asked to apply 4LB on the patient. Then they were asked to remove 4LB on the seventh day and reapply after a break of around 6 hours. This was repeated for two more weeks and they were asked to follow up in a month (from day 1 of 4LB bandage). During follow up, information as in the one-week follow up was collected and recorded. The patients who were eligible for radio frequency ablation and other adjunct treatment of varicose veins were subsequently treated with the procedures. The database was created in Microsoft office access 2021 (Microsoft). Data was analyzed in SPSS 13.0 (IBM, SPSS Inc). Nominal variables were expressed

in terms of frequency. Scalar variables were expressed as mean, standard deviation and range. Comparison of two variables was done by independent sample t-test. Comparison of nominal variables was done by Chi-square test. P value of less than 0.05 was considered significant.

RESULT

Four layer bandaging for venous ulcer was done in a total of 46 participants. Among them, 31 (67.4%) were male and 15 (32.6%) were female. Base line characteristics as well as details on ulcer are mentioned in table 2. The mean age of the participants was 46.8 years. 36 participants had the first occurrence of ulcer while the rest of them had recurrence. The mean duration of ulcer time was seven months with the mean area of ulcer before application of 4LB was 2.5cm².

Table 2: Details on the demographic and clinical characteristics.

Variables	Subgroups	Value
Gender	Male	31 (67.4%)
	Female	15 (32.6%)
Age	Mean	46.8 years
	SD	13.7 years
	Range	22 years to 72 years
Ulcer status	First	36 (78.3%)
	Recurrent	10 (21.7%)
Ulcer duration	Mean	7.0 months
	SD	4.0 months
	Range	1 month to 24 months
Ulcer area (cm ²) before 4LB	Mean	2.5 cm ²
	SD	1.6cm ²
	Range	1 cm ² to 8 cm ²

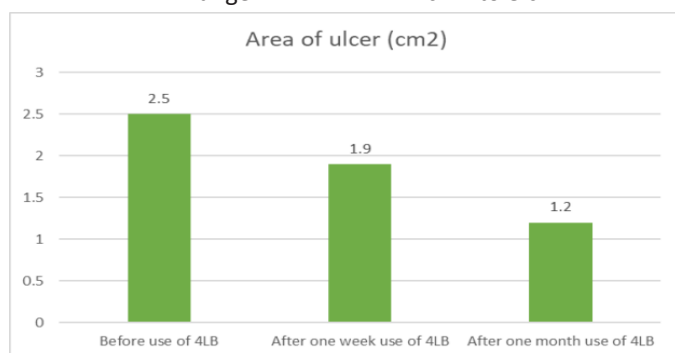


Figure 2: Bar diagram showing ulcer area before 4LB, after one week of 4LB and after one month of 4LB

Table 3: Details on ulcer area, presence of granulation, presence of epithelization, possibility of RFA in one week and one month.

Variables	One week	One month	Remarks
Presence of granulation	40 (87%)	46 (100%)	p<0.01
Presence of epithelization	22 (47.8%)	37 (80.4%)	p<0.01
Number of ulcers healed	1 (2.2%)	24 (52.2%)	p<0.01
Possibility of RFA	21 (45.7%)	30 (65.2%)	p<0.01

Following use of 4 LB bandage, presence of granulation, presence of epithelization, number of ulcer healed and possibility of performing RFA are shown in table 3. Presence of granulation tissue was present in 40 patient (87%) after one week of use of 4LB. Following use of 4LB for a month, presence of granulation tissue was noted in all the patients. Following 4LB for a week presence of epithelization was noted in 22 (47.8%) patients which increased to 37 (80.4%) after use for a month. Following use of 4LB for a week, only one ulcer (2.2%) was healed while that increased to 24 (52.2%) after use for a month. Following use of 4LB for a week, RFA was possible in 21 (45.7%) patients. After use for a month, RFA was possible in 30 (65.2%) patients. Following 4LB bandaging, the mean area decreased to 1.9cm² in 1 week and 1.2cm² in 1 month as shown in figure 2 (p value <0.01). Pictures of representative case is shown in figure 3.



Figure 3: Ulcer area before 4 LB and after 1 week of 4 LB bandaging

DISCUSSION

The most common strategies for compression therapies in venous ulcers are compression bandages, compression stockings, and pneumatic compression devices along with multilayer compression modalities like four layer bandages. All of these techniques are examples of high level compression (35-40 mm hg) which are contraindicated in case of concomitant arterial diseases.

A randomized control trial comparing use of 4LB compared to usual treatment for venous ulcer found 4LB to provide better quality of life in areas of physical activity and social functioning.¹⁰ A Cochrane review done in 2015 showed statistically significant results in ulcer healing with 4LB bandages when compared with short stretch bandages.¹¹ Although 4LB and other compression strategies help in healing of venous ulcer, they tend to recur if the primary problem is not addressed or patient compliance to use of 4LB or other compression strategies decreases.¹² In case of venous ulcer due to varicose veins, management of primary disease in form of radiofrequency ablation, ligation of perforators or saphenopopliteal junction, phlebectomy, sclerotherapy are necessary so as to prevent the recurrence. Wherever possible, RFA is a commonly preferred intervention owing to it being a minimal invasive procedure. In indicated cases, other adjunct procedures are also done concomitantly.¹³

In a study, median time for ulcer healing when 4LB was used was 62 days compared to 77 days when short stretch bandage was used. Ulcer recurrence in 4LB group in the study was 10.1% while that in short stretch bandage group was 13.3%.¹⁴ Seventy-seven percent of the ulcers with an initial ulcer area less than or equal to 5 cm² healed as compared with 33% healed for the ulcers with initial ulcer area greater than 5 cm².^{15,16} Our study has also found significant reduction in ulcer size after 4LB when seen in a week and a months time.

Venous ulcerations usually follow a chronic course, and either heal slowly or never heal. This can be attributed to the pathway of healing of these ulcerations, which do not follow an orderly clinical course. The disease therefore remains hyperactive in the inflammatory phase with an accelerated level of MMPs which damages the components ECM like fibronectin, causing a delayed wound healing.^{17,18} The treatment should aim at stopping the inflammatory response and escalating the healing response. A molecular study demonstrated the histological changes in the bed of the venous ulcer

pre and post compression therapy. The result showed a markedly increased migration of epidermal cells over the ulcer bed and the margins, which was revealed by increased fibronectin staining in those areas.¹⁹ Following granulation, in favorable circumstances epithelization starts. In our study, in the followup of a week, granulation was present in 87% while epithelization was present in 47.8%. After a month granulation was seen in all the cases while the rate of epithelization doubled. A review on wound care in venous ulcer mentioned that type of dressing does not influence much on the granulation and epithelialization as proper compression is key for that.

Previous studies have shown beneficial effects of RFA alongside foam sclerotherapy in patients with active venous ulcers. A randomized controlled trial done in 2018, they found that the healing rate of ulcer accelerates when endovenous interventions are performed promptly.²⁰ Another study done by Sermsathanasawadi showed promising results with the ulcer healing rate at 56.2% in 6 months and 65.9% in a 1 year following RFA. RFA with concomitant ultrasound guided foam sclerotherapy of pathologic perforating vein should be considered in addition to compression therapy in patients with active VLU. The rate of recurrence of venous ulcer was also was 7.7% at 1 year, 14.3% at 2 years, and 23.4% at 3 years.²¹

In contrast to our study, we did endovenous ablations only when the venous ulcer was an improvement of the wound in terms of reduction of size, absence of discharge, absence of features of cellulitis. One reason for doing RFA after improvement in ulcer is to reduce the chances of infection and patients will be better optimized for intraoperative risks and postoperative outcome. Adaptive compression therapy devices are gradually being used for the treatment of venous ulcer with efficacy similar or even better than 4LB.²² But the recent treatment modalities requires sophisticated devices with costs much more than 4LB.²²

CONCLUSION

Newer bandaging techniques like 4LB is a recommended treatment modality for venous ulcer due to varicose veins for preoperative optimization in terms of improvement in ulcer healing. Once optimized these cases should undergo further treatment such as RFA and other adjunct procedures where applicable.

REFERENCES

1. O'Meara S, Tierney J, Cullum N, et al. Four layer bandage compared with short stretch bandage for venous leg ulcers: systematic review and meta-analysis of randomised controlled trials with data from individual patients.
2. Lal BK. Venous ulcers of the lower extremity: Definition, epidemiology, and economic and social burdens. *Seminars in Vascular Surgery* 2015; 28: 3–5.
3. Robles-Tenorio A, Lev-Tov H, Ocampo-Candiani J. Venous Leg Ulcer. In: *StatPearls* [Internet]. StatPearls Publishing, 2022.
4. Bonkemeyer Millan S, Gan R, Townsend PE. Venous Ulcers: Diagnosis and Treatment. *Am Fam Physician* 2019; 100: 298–305.
5. Four-layer bandaging: from concept to practice. Part 1: The development of the four-layer system, <http://www.worldwidewounds.com/2004/december/Moffatt/Developing-Four-Layer-Bandaging.html>
6. Jørgensen LB, Sørensen JA, Jemec GBE, et al. Methods to assess area and volume of wounds – a systematic review. *Int Wound J* 2016; 13: 540.
7. Ren S-Y, Liu Y-S, Zhu G-J, et al. Strategies and challenges in the treatment of chronic venous leg ulcers. *World J Clin Cases* 2020; 8: 5070–5085.
8. Pastar I, Stojadinovic O, Yin NC, et al. Epithelialization in Wound Healing: A Comprehensive Review. *Adv Wound Care* 2014; 3: 445–464.
9. Shi C, Dumville JC, Cullum N, et al. Compression bandages or stockings versus no compression for treating venous leg ulcers. *Cochrane Database Syst Rev*; 2021. Epub ahead of print 2021.
10. Clarke-Moloney M, O'Brien JF, Grace PA, et al. Health-related quality of life during four-layer compression bandaging for venous ulcer disease: a randomised controlled trial. *Ir J Med Sci*; 174. Epub ahead of print April 2005. DOI: 10.1007/BF03169124.
11. De Carvalho MR, Peixoto BU, Silveira IA, et al. A Meta-analysis to Compare Four-layer to Short-stretch Compression Bandaging for Venous Leg Ulcer Healing. *Ostomy Wound Manage* 2018; 64: 30–37.
12. Vowden KR, Vowden P. Preventing venous ulcer recurrence: a review. *Int Wound J* 2006; 3: 11.
13. Karmacharya RM, Shrestha B, Singh A, et al. Short Term Outcome of Adjunct Foam Sclerotherapy for Varicose Veins in Patients Subjected to RFA at Dhulikhel Hospital, Nepal. *Int J Vasc Med* 2019; 2019: 4956437.
14. Harrison MB, Vandenkerkhof EG, Hopman WM, et al. The Canadian Bandaging Trial: Evidence-informed leg ulcer care and the effectiveness of two compression technologies. *BMC Nurs*; 10. Epub ahead of print 13 October 2011. DOI: 10.1186/1472-6955-10-20.
15. Millan SB, Gan R, Townsend PE. Venous Ulcers: Diagnosis and Treatment. *afp* 2019; 100: 298–305.
16. Partsch H, Damstra RJ, Tanzelaar DJ, Schuller-Petrovic S, Velders AJ, Roij MD, Lim Sang RT, Quinlan D. Multicentre, randomised, controlled trial of four-layer bandaging versus short-stretch bandaging in the treatment of venous leg ulcers. *Vasa*. 2001 May 1;30(2):108-14.
17. De Angelis B, Orlandi F, D'Autilio MFL, et al. Vasculogenic Chronic Ulcer: Tissue Regeneration with an Innovative Dermal Substitute. *J Clin Med Res*; 8. Epub ahead of print April 2019. DOI: 10.3390/jcm8040525.
18. Baum CL, Arpey CJ. Normal cutaneous wound healing: clinical correlation with cellular and molecular events. *Dermatol Surg*; 31. Epub ahead of print June 2005.
19. Herrick SE, Sloan P, McGurk M, et al. Sequential changes in histologic pattern and extracellular matrix deposition during the healing of chronic venous ulcers. *Am J Pathol* 1992; 141: 1085.
20. Gohel MS, Heatley F, Liu X, et al. A Randomized Trial of Early Endovenous Ablation in Venous Ulceration. *N Engl J Med* 2018; 378: 2105–2114.
21. Sermsathanasawadi N, Jieamprasertbun J, Pruekprasert K, Chinsakchai K, Wongwanit C, Ruangsetakit C, Mutirangura P. Factors that influence venous leg ulcer healing and recurrence rate after endovenous radiofrequency ablation of incompetent saphenous vein. *Journal of Vascular Surgery: Venous and Lymphatic Disorders*. 2020 May 1;8(3):452-7.
22. Mayrovitz HN, Partsch H, Vanscheidt W. Comparison of 4-Layer Bandages and an Adaptive Compression Therapy Device on Intended Pressure Delivery. *J Wound Ostomy Continence Nurs* 2015; 42: 468–473.