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A Comparative Study between Multi-Layer vs Single Layer Bandage of Leg Ulcer's Healing Outcomes

Rakibul Hasan[1], Md. Saif Ullah Khan[2], Mainul Mahmud[3], Samaresh Chandra Saha[4], Sourav Bhowmick[5]

[1]Assistant Professor, Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
[2]Associate Professor, Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
[3]Resident (MS Phase-B), Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
[4]Resident (MS Phase-A), Department of Vascular Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
[5]Indoor Medical Officer, Department of Thoracic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh.

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ABSTRACT

Background: Venous leg ulcers are a common and frequent chronic twisted caused by damage to the veins. In Bangladesh, chronic venous leg ulceration is a frequent physical disorder that comes across by vascular surgeons. Research has shown that the majority of ulcers can be induced to heal by the application of adequate levels of sustained graduated compression. Bandages vary significantly in their aptitude to provide sustained compression due to differences in their structure and the content of elastomeric yarns. Multi-layer systems were more effective than single-layer systems, and high compression was more effective than low compression. Objective: To find out a compression therapy (single layer crepe/short stretch bandage and multilayer/four-layer bandage) in patients with venous leg ulcers. **Methods:** This study was conducted on 180 patients within the last two years, January 2018 to January 2020 at the Department of vascular surgery, Bangabandhu Sheikh Mujib Medical University. In which 90 patients with venous leg ulcers were treated with a multi-layer bandage and another 90 patients with the same condition were treated with a single layer crepe bandage. The primary outcome was measured by the time duration of ulcer healing. Secondary outcomes included incidence and number of adverse events in every patient. **Results:** Healing time of venous ulcers was accessed with a periodic interval. The multi-layer bandage was associated with a significantly shorter time of healing. P-value reached from unpaired t-test. The primary outcome shows 68% of patients who received four-layer bandages achieved healing within one month. On the other hand, 12% of patients who received a single layer/crepe bandage did so. **Conclusion:** Multi-layer bandages heal venous leg ulcers more rapidly than the single-layer crape bandage. These data suggest that the benefits observed the consistent despite prognosis is different. Patients with large ulcers have poor healing prognosis regardless of their treatment modalities.

Keywords: Chronic venous disease, multi-layer bandage, single layer/crepe bandage.

INTRODUCTION

Among all ulcers in the lower leg, venous disease is responsible for 60-70%.[1] Venous ulcer is the most severe form of venous disease. Venous leg ulcers as a frequent chronic disease caused by damage veins and consequent high venous pressure.[2] The estimated lifetime prevalence for leg ulceration in developed countries is 1% and the point prevalence is 0.1-0.2. Prevalence increases with age and is higher among women.[3] The successful management of venous leg ulcers represents a big clinical problem and a serious drain on limited financial resources. Research has shown that the majority of ulcers can be induced to heal by the application of adequate levels of sustained graduated compression. Bandages vary greatly in their ability to supply sustained compression thanks to differences in their structure and therefore the content of elastomeric yarns.

Name & Address of Corresponding Author
Dr. Rakibul Hasan
Assistant Professor,
Department of Vascular Surgery,
Bangabandhu Sheikh Mujib Medical University,
Dhaka, Bangladesh
E-mail: optio_28@yahoo.com

Other factors, like limb circumference and shape, also will have a crucial influence on the pressure produced beneath a tourniquet. Bandages are grouped consistent with their function and performance, so as to facilitate the selection of an appropriate product. Leg ulcers are a lingering condition, which caused by a number of physiological and biochemical disorders, either individually or in combination, but approximately 70%, are associated with venous disease. The prevalence of venous ulceration increases with age and the condition is also more common in women than men. A significant number of ulcers (about 20%) are caused by some form of arterial disease. Depending upon the situation and severity of the matter, this might affect large parts of the leg or smaller localized areas of tissue. Other important causes of ulceration include diabetes and rheumatoid disease, although numerous other medical conditions also can cause ulcer formation. Ulcers that are caused by arterial disease should be referred to as a specialist vascular surgeon for assessment and possible surgery. Venous ulcers, however, can be managed by more conservative means, although surgery may subsequently be considered to correct

the underlying physiological disorder.[4] Venous leg ulcers are a common and recurring chronic wound caused by damage to the vein sand consequent high venous pressure.[5] The estimated lifetime prevalence for leg ulceration in developed countries is 1% and the point prevalence is 0.1-0.2%. Prevalence increases with age and is higher among women.[6] A substantial proportion of the costs is attributable to nursing time.[7,8] These ulcers are also associated with increased costs and reduced health-related quality of life for patients. Compression bandaging is thought to assist ulcer healing by reducing distension in the leg veins and accelerating venous blood flow.[7,9-11] A previous systematic review of published trial-level data concluded that compression was simpler in healing venous leg ulcers than no compression, multi-layered systems were simpler than single-layer systems, and high compression was simpler than low compression, but no clear differences in effectiveness were detected between different types of high compression.[12] The four-layer bandage and therefore the short stretch bandage are samples of high compression (defined as ankle sub-bandage pressure 35-40 mm/Hg). Such systems are deemed to deliver the optimum therapeutic effect in eligible patients but are contraindicated in people with clinically significant arterial disease. The four-layer bandage (an elastic system), the quality method within the UK, comprises orthopedic wool, crepe bandage, bandage, and a final cohesive retaining layer. All layers are applied from toes to the knee and normally require weekly renewal but can be changed more often if necessary. The short stretch system, used as a typical treatment in mainland Europe and Australia, is an inelastic bandage, meaning that it's minimal extensibility (or "give") when handled. An orthopedic wool layer is covered by the bandage at full stretch to create a rigid casing around the limb that generates resistance against calf muscles and other tissues with reapplication every few days. The short stretch bandage has the advantage of being washable and reusable.[13] The multi-layer bandage commonly available as a proprietary kit, designed to be discarded after a single-use. Leg ulcers are characteristic to be loss of epidermal and dermal tissues of leg and foot. Leg ulcers are most frequently caused due to venous insufficiency & arterial insufficiency, neuropathy due to diabetes and prolonged pressure.[14] Less common causes include; trauma, inflammation, malignancy, metabolic Conditions and due to Infections. Approximately 1% of the population suffers from a leg ulcer at some stage during their lives.[15] Venous leg ulcers are a consequence of chronic venous insufficiency.[16] The goals of non-operative treatment: for venous ulceration are to promote healing of the existing ulcer and prevent recurrences while allowing the patient to maintain a normal ambulatory status. Compression therapy remains the primary non-operative treatment for chronic venous insufficiency despite progress in both ablative and reconstructive venous surgery.[17] The compression pressure at least 30 mm/Hg to 40mm/Hg at the ankle should be utilized in the management of venous leg ulcers. All tourniquet systems must create a pressure gradient from ankle to knee. According to the law of Laplace, which mathematically relates bandage tension-compression pressure, the shape of the leg will create this gradient. Hence compression is going to be found maximum at the gaiter area just proximal to the ankle 30-40 mm/Hg and as we go up the foot decreases and at the knee it in 17-20mm/Hg. The recommended pressure for the treatment of venous disorder includes; ankle pressure of 14-17mm/Hg in superficial or early varicosity, 18-24mm/Hg in varicosity of medium severity or with ulcer treatment and prevention of mild edema and 25-35mm/Hg in gross varicosity, post-thrombotic syndrome, and gross edema. Ulcer treatment and prevention.[18]

Table1: Type of bandages.[19-21]

Dressing	**Functional Capacities of Dressing Layers**
First layer dressing	Gamgee applied from foot to above knee to absorb the discharge from ulcers and protect bony prominences.
Second layer dressing	Banding with cotton bandage to keep the 1st layer in place
Third layer dressing	Crepe bandage which applies the compression pressure
Four layer dressing	Micrepore/adhesive bandage to keep compression bandage in place
Layer of Bandaging	**A Short Brief**
Type 1	Light weight conforming stretch bandages. Which have simple dressing retention function, it has light weight elastomeric threads, which impart a high degree of elasticity but little power to the bandage.
Type 2	Light support bandages called short or minimal stretch bandages. Crepe type single bandage products of British pharmacopoeia. These have been used for the treatment of venous ulcer. They form an inelastic covering to the leg which tends to resist any change in the geometry of the calf muscle during exercise.
Type 3	Compression bandages, deliberate application of pressure to control edema and reduce swelling.
Type 3a	Light compression bandages maintain low level of pressure up to 20mm /Hg indicated in superficial or early varicosity and varicosity during pregnancy.
Type 3b	Moderate compression bandages, pressure of 30 mmHg the ankle, used in the treatment of varicosity during pregnancy, varicosity of medium severity.
Type 3c	Have pressure of 40mm/ Hg - Gross varicosity, gross edema, and post thombotic venous insufficiency and leg ulcers.
Type 3d	Extra high performance compression bandages have pressure of >50 mmHg used for most edematous limbs.

In order to realize the pressures described within the arrangement described above, it's assumed that the bandages in question are going to be applied within the kind of a spiral with a 50% overlie between

turns, effectively produce a double layer at on the limb. Different application techniques like a figure of eight bandages will produce larger numbers of layers at any one point and thus higher sub-bandage pressures. It is also important to recognize that the pressures quoted for the various types of bandages are intended only as a general guide. If a bandage was to be applied with constant tension to legs of various dimensions, the pressures achieved would even be very different. This variation is clearly demonstrated within the aim of the study is to match the healing rate and area of healing in chronic venous ulcer with the topical use of H-EGF beside with regular multi-layer compression bandaging as vs. multi-layer compression bandaging. The importance of leg geometry and application tension can't be overemphasized when selecting or applying a bandage to supply a selected level of pressure, so as to treat a particular clinical disorder. Applied too loosely, the bandage will be ineffective, too tight and it may cause tissue damage and necrosis.[22] In extreme cases, this may lead to amputation, particularly if the arterial disease is present.[23] Research has shown that the tension with which bandages are applied varies between practitioners. Although one individual may produce reasonably consistent results from patient to patient, major variations have been recorded in the pressures achieved by the different bandages.[24] In an attempt to overcome this problem, bandages are produced which have a geometrical design printed at intervals along their length which changes shape when the bandage is stretched to a predetermined level of tension.

Figure 1: Venous ulcer showing staining of surrounding skin.

Figure 2: Incorrectly applied bandage

Figure 3: Necrosis caused by incorrectly applied Bandage

MATERIALS AND METHODS

This study was conducted on 180 patients within the last two years in which 90 patients with venous leg ulcers were treated with a multi-layer bandage and another 90 patients with the same condition were treated with a single layer crepe bandage. Before the application of a bandage, the proper history of the patient was taken and a duplex scan was done. The primary outcome was measured by the time duration of ulcer healing. Secondary out included incidence and number of adverse events in every patient.

RESULTS

In [Table 1] shown that, according to gender wise total patients' distribution, male patients were 60% and female patients were 30% respectively of multi-layer and crepe single layer bandages. P value was 0.138.

Table 1: Distribution of the patients by gender (N=180)

Gender	Multi-layer bandage (n=90)		Single bandage (n=90)		P value
	n	%	n	%	0.138ns
Male	65	72.0	55	61.0	
Female	25	28.0	35	39.0	
Base	90	100.0	90	100.0	

ns= not significant

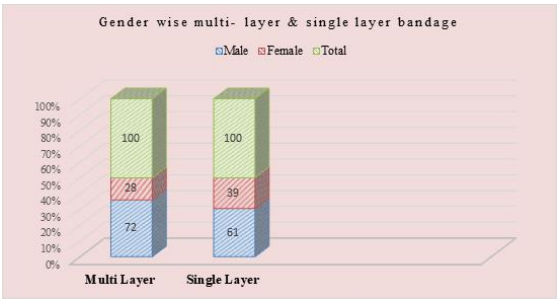

Figure 4: Gender wise patients'distribution-multi-layer& single bandages

In [Table 2] shown that, 41-50 age groups were highest 39% & 36% of multi- layers and crepe single bandage patients followed by immediate group 51-60 age group 22% & 24.5% respectively. The mean score was 42.5±13.2 & 44.3±11.7. P-0.308ns.

Table 2: Distribution of the patients by age (N=180)

Age group (years)	Multi- layer bandage (n=90)		Single bandage (n=90)		P value
	n	%	n	%	
21-30	7	7.5	9	10.0	
31-40	19	21.0	17	18.5	
41-50	39	43.5	36	40.0	
51-60	20	22.0	22	24.5	
>60	5	6.0	6	7.0	
Mean±SD42.5±13.244.3±11.70.308^{ns}					

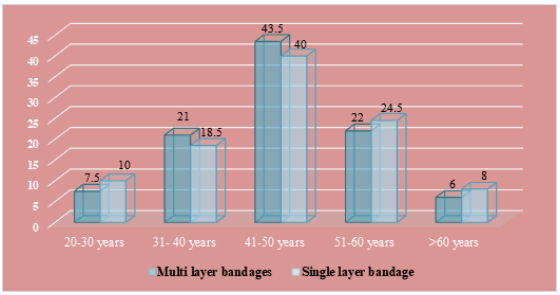

Figure 5: Distribution of patients by age wise of four layer &crepe layer bandages

In [Table 3] shown that, CVI were height of 68%& 61% in both multi- layer and crepe single layer bandage patients. P value - 0.282^{ns}

Table 3: Distribution of the patients by sex (N=180)

Duplex	Multi- layer bandage (n=90)		Single bandage (n=90)		P value
	n	%	n	%	0.282^{ns}
CVI	68	68.0	61	61.0	
Chronic DVT	22	22.0	29	29.0	

Table 4: Distribution of the patients by ulcer status (N=180)

Duplex	Multi-layer bandage (n=90)		Single layer bandage (n=90)		P value
	n	%	n	%	0.706ns
First	11	11.0	13	13.0	
Recurrent	79	79.0	77	77.0	

In [Table 4] shown that, recurrent were height of 79% &77.0% in both multi- layer and crepe single layer bandage patients. P value - 0.706^{ns}

In [Table 5] shown that, regarding ulcer duration of patients, 1-6 month were highest 31%& 41% both of multi- layer & crepe single layer bandage patients. Mean score were 5.7±2and 4.3±2.1. P value 0.001^{s}

Table 5: Distribution of the patients by ulcer duration (N=180)

Ulcer duration (months)	Multi- layer bandage (n=90)		Single layer bandage (n=90)		P value
	n	%	n	%	
<1	29	29.0	41	41.0	
1-6	31	31.0	41	41.0	
7-12	20	20.0	3	3.0	
>12	10	10.0	7	7.0	
Mean±SD5.7±2.64.3±2.10.001^{s}					

^{S}= significant

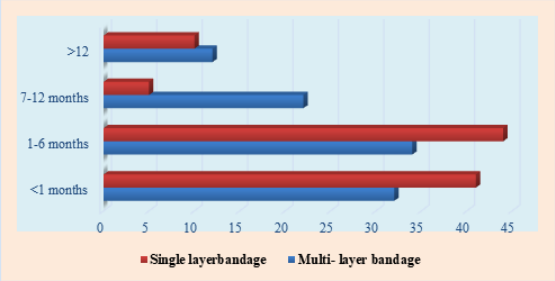

Figure 6: Distribution of patients by ulcer duration time of four layer & crape layer bandages

In [Table 6] shown that, presence of slough were height of 58% &54% in both multi- layer and crepe single layer bandage patients. P value 0.562^{ns}

Table 6: Distribution of the patients by presence of slough (N=180)

Presence of slough	Multi-layer bandage (n=90)		Single layer bandage (n=90)		P value
	n	%	n	%	0.562ns
Sloughy	58	58.0	54	54.0	
Nonsloughy	32	32.0	36	36.0	

In [Table 7] shown that, presence of granulation tissue were height of 74% &53% in both multi- layer and crepe layer bandage patients. And p value 0.001^{s}

Table 7: Distribution of the patients by presence of presence of granulation tissue (N=200)

Presence of granulation tissue	Multi- layer bandage (n=90)		Single layer bandage (n=90)		P value
	n	%	n	%	0.001^{s}
Granulating	74	74.0	53	53.0	
Non granulating	16	16.0	37	37.0	

In [Table 8] shown that, healing time of the patient was higher 63% of <1 month with multi- layer bandage whereas with single layer/crepe layer was 12%. Mean score were 1.1±0.8&5.7±2.2. P value 0.001^{s}

Table 8: Distribution of the patients by healing time (N=180)

Healing time (months)	Multi- layer bandage (n=90)		Single layer bandage (n=90)		P value
	n	%	n	%	
<1	63	63.0	10	10.0	
1-3	24	24.0	14	14.0	
3-6	2	2.0	25	25.0	
>6	1	1.0	41	41.0	
Mean±SD1.1±0.85.7±2.20.001[s]					

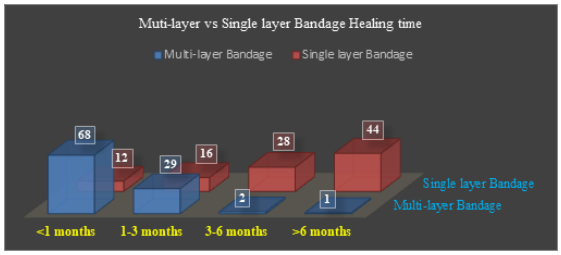

Figure 7: Distribution of patients by healing time of multi- layer &single layer bandages

DISCUSSION

The venous ulcers exact causes yet not very clear, but a common denominator is usually venous stasis may be the cause of chronic venous insufficiency.[25-27] Venous stability causes the pressure in veins to increase. The body needs the pressure gradient between arteries and veins so as for the heart to pump blood forward through arteries and into veins. When venous hypertension exists, arteries have higher pressure in veins and blood is not pushed effectively into the area. Venous hypertension may also stretch veins and allow blood proteins to outflow into the extravascular space, isolating extracellular matrix (ECM) molecules growth factors and preventing them helping to heal the wound. Outflow of fibrinogen from veins also as a lack in fibrinolysis can also reason fibrin to make up unevenly the vessels, preventing oxygen and nutrients from triumph cells. Venous deficiency may also cause white blood cells leukocytes to mount up in small blood vessels, releasing provocative factors and reactive oxygen species and further contributing to chronic wound formation.[28-31] It is in the crus that the classic venous stability ulcer occurs. Venous stability results from damage to the vein valvular system within the lower extremity and in extreme cases allow the pressure within the veins to be higher than the pressure in the arteries. These pressure significances in the transudation of stimulating intermediaries into the intravenous tissues of the lower edge and consequent breakdown of the tissue including the skin.

CONCLUSION

It is concluded that multi-layer (four layers) bandaging has better results in healing of venous ulcers as compared tosingle layer {crepe layer) short stretch bandage. Large size ulcers and chronic ulcers take long time to heal. Four layer bandaging is easy to apply in outpatient department (OPD) basis and leads to early healing of ulcers hence should be used in all patients of venous ulcers. Several different types of bandaging systems are available, each of which may have advantages over the others for particular applications. To this end, bandaging and advice on product selection should once again form a part of a nurse's training. Without proper care, the ulcer may get infected leading to cellulitis or gangrene and finally may need elimination of the part of a limb in the future.

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