Original article

Retrospective review on the effectiveness of compression therapy in venous leg ulcer healing at a wound care centre in Hong Kong

ABSTRACT

Introduction Venous ulcers are a serious clinical consequence of chronic venous insufficiency (CVI). The basis for successful management is compression therapy such as compression bandages, compression stockings and/or elastic tubular compression devices.

Aim The purpose of this study is to undertake a retrospective review on the effectiveness of compression therapies in a wound care nurse clinic in Hong Kong.

Method Patients in the clinic who presented with lower limb ulcers which showed either the signs and symptoms of CVI with an ankle brachial index >0.8 or where CVI was confirmed by Duplex scan were included in this study (Figure 1). The search period was from the start of treatment (Week 0) up to 24 weeks.

Results Time to heal was compared by using the log-rank test; 152 wounds healed within 24 weeks, with an overall healing rate of 93.3%. A total of 90.2% of wounds healed with compression bandages, 93.5% of wounds healed with compression stockings, and 98% of wounds healed with elastic tubular compression devices. The mean healing time was 10 weeks, 8 weeks and 9 weeks respectively.

Discussion In view of the various wound sizes between the three groups, there was relatively less difference in the overall wound healing rate among the three groups – relative risk (RR)<1. For ulcers sized >4cm^2 to ≤12cm^2, the difference in the wound healing rate between using compression bandages rather than compression stockings was found to be only 0.8% (RR=1.08).

Conclusion Taking into account the result from our study and considering both economic factors and patients' convenience, elastic tubular compression devices may be more suitable for our group of patients.

Keywords Venous ulcer, compression bandage, compression stocking, elastic tubular compression device

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INTRODUCTION

Venous ulcers are one of the most common wound problems in clinical practice and are a serious clinical consequence of chronic venous insufficiency (CVI). In the United States, it is estimated that around 500,000–600,000 people are treated for venous ulcers in wound centres annually[1]. In Australia, a study has shown that community nurses spend around 50% of their time treating venous ulcers[2]. Although the prevalence and incidence for people with venous ulcers in Hong Kong are not well documented, a study conducted in the community nursing services of one district (Kwun Tong) found that there were around 200 patients receiving wound care from community nurses each month, around 11% of these for leg ulcers[3].

The treatment of venous ulcers requires expensive wound dressing materials, compression therapy, pharmacological therapy, debridement and surgical interventions[4]. In 2002, it was estimated that Australia's national health system spent

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around A$114 a month for each patient on the management of their venous ulcers[4]. In the United States, Ma et al.[5] performed a cohort study on 84 patients within a period of 6 months and found the mean total cost of treating venous ulcers was US$15,732. This evidence shows that venous ulcers create a huge financial burden on the healthcare system.

The management of venous ulcers is not only a great burden to both the healthcare system and to the nurses, but it also adversely affects patients' physiological and psychosocial wellbeing, and also has a direct impact on the quality of life of elderly patients[6,7]. Physically, pain and immobility can impair their activities of daily living[8]. Psychologically, it is reported that venous ulcers can result in various problems such as feelings of helplessness, a loss of self-esteem, and increased stress and anxiety[6,9]. All of these negative impacts may impair the initial inflammatory responses, disturb the neuro-endocrine immune equilibrium and, finally, affect wound healing[10,11].

LITERATURE REVIEW

The basis for successful management of venous ulcers is compression therapy. It is believed the application of compression therapy to the limbs will lead to reabsorption of interstitial fluid, promote venous return, shift blood volume from peripheral to central circulation, reduce venous pressure, and prevent venous stasis[12-15].

The therapy consists of either a compression bandage system or elasticated compression stockings. Studies show that the mean healing time for using short-stretch (inelastic) compression bandages was around 12–24 weeks, while 50% of patients with wounds healed within 6 months when using long-stretch (elastic) compression bandages[16–17]. The effectiveness of compression stockings has also been demonstrated by various research. A study conducted by Dolibog et al.[18] shows the healing rate using compression stockings with pressure around 30–40mmHg over a 2 month timeframe to be 56.7%. When comparing the time for ulcer healing between a two-layer compression stocking (35–40mmHg) and a four-layer compression bandage (40mmHg), Ashby[19] observed the median time to ulcer healing for both were similar – 70.9% in 99 days and 70.4% in 98 days respectively. In addition, a meta-analysis conducted by Amsler, Willenberg & Blättler[20] reports that the healing of stockings (35–56mmHg) was greater than that of bandages (27–49mmHg) (62.7% vs 46.6%; p<0.00001) and that the average time to healing was 3 weeks shorter for compression stockings (p=0.0002). Mauck et al.[21] also performed a comparative systematic review and meta-analysis of compression modalities for venous ulcer healing. The review demonstrates there is no overall difference between compression stockings and compression bandages in ulcer healing, nor in time to ulcer healing.

Elasticated tubular compression devices are mainly used to help reduce lower limb oedema. In 2003, Bale & Harding[22] conducted a study using three layers of graduated Tubigrip (Mölnlycke) for patients with venous ulcers and found a 50% healing rate within 12 weeks. In addition, Weller[23] performed a randomised control trial on the wound healing rate of a graduated three-layer tubular device compared to inelastic compression bandages. Although the mean pressure was consistently at least 13mmHg higher in the inelastic bandage group, the result reflected a higher healing rate within the tubular device group in 12 weeks (74% vs 46%; p=0.05). However, further related studies on this area were limited.

METHODS

Study setting

The wound care nurse clinic in the hospital in this study aims to provide continuity care for patients with acute and chronic wounds. For patients with venous ulcers, our standard treatment regimen is to wash the lower limbs using soap and tap water, followed by application of hypoallergenic cream to moisturise the skin. Standard wound dressings for large amounts of exudate are Hydrofiber (ConvaTec), Gelfiber ((Durafiber) Smith & Nephew), or a foam dressing. Alginate dressings are normally for moderate amounts of exudate. For infected or severe colonised wounds, hypertonic sodium chloride dressings or Hydrofiber, Gelfiber or foam dressings containing silver are used.

In accordance with international guidelines, the majority of our patients are treated with compression therapy such as elastic (Setopress, Mölnlycke) or inelastic bandages (Pütter-Verband, Hartmann), compression stockings (Venosan 6002, Swisslastic Ag St. Gallen) or elastic tubular compression devices (Lastogrip, Hartmann) according to the patients' occupation, activities, age, and compliance. All nursing staff working in the wound clinic are trained to perform bandage application. However, due to some patients in our clinic not tolerating compression bandages, class 2 compression stockings are usually applied to provide medium support (23–32mmHg). With patients who are unable to tolerate either compression bandages or compression stockings, it is suggested that they use an elastic tubular compression device to control lower limb oedema. Pressure transducer (Kikuhime small probe, MediTrade) is used to measure the pressure on the medial aspect at the ankle. Normal dressing frequency is twice weekly unless required more frequently for excessive amounts of exudate.

Aim

The purpose of this study is to undertake a retrospective review on the effectiveness of compression therapies employed in the wound care nurse clinic of a university hospital in Hong Kong.

Inclusion / exclusion criteria

Patients were included who had lower limb ulcers with signs and symptoms of CVI with an ankle brachial index >0.8 or where CVI was confirmed by Duplex scan.

Patients were excluded if they met the inclusion criteria but refused to have any sort of compression nor elastic device. They were also excluded if they had recent deep vein thrombosis or

cardiac or respiratory problems for which compression therapy is contraindicated. In addition, patients with mixed ulcers or causes of ulceration other than venous disease were excluded from the study.

Patient recruitment

This is a retrospective design to perform a 6-year review (2011–2016) of all patients with venous ulcers who have undergone application of compression therapies in the clinic. A total of 217 patients were confirmed to have venous ulcers during the study period. Of these, 25 patients defaulted at follow-up, four were referred to community nurses or to a general out-patient clinic due to geographical reasons, two had operations performed, two passed away, and 13 patients refused any sort of compression or elastic device due to intolerance. Since the aim of our study is to review the effectiveness of compression therapies employed in our wound care nurse clinic, these patients were therefore excluded from our study, leaving an effective sample of 171. Of these, 82 were treated with inelastic bandages, eight with elastic bandages, 31 with compression stockings and 50 with elastic tubular compression devices. Due to insufficient number of patients treated with elastic bandages for data analysis (eight patients), this was excluded so the valid sample of this study was 163 (Figure 1). For patients with multiple ulcers over the lower limb, only the largest wound was included in this study. These 163 were then divided into three further groups.

Group A consisted of patients who were treated with two layers of inelastic compression bandages (Pütter-Verband, Hartmann). The bandages used were 15cm wide and either 5cm or 10cm long – according to limb circumference – with 100% stretch. The patients' affected limbs were wrapped with a tubular cotton gauze (Stulpa, Hartmann) without tension. The first layer of inelastic bandages was applied in a spiral motion with a 50% overlap in a clockwise direction with the patient in the recumbent or sitting position and the foot in dorsal flexion. The second layer was applied in the same method but in an anti-clockwise direction, creating an average total pressure of around 20–30mmHg over the two layers. A pressure transducer (Kikuhime small probe, MediTrade) was used to measure the pressure on the medial aspect at the ankle. Pressure was measured during the first application of compression bandages and then irregularly, such as when lower limb oedema was obviously reduced or there was deterioration in wound condition. The bandaging system was worn day and night and, normally, the wound dressing, together with the bandages, would be changed twice weekly. The bandages were washed by patients with water and soap and then reused. The bandages were renewed every 3–6 months or when damaged.

Group B consisted of patients who could not tolerate compression bandages, so class 2 compression stockings providing medium support (23–32mmHg) (Venosan 6002, Swisslastic Ag St. Gallen) were applied. The stocking size was determined for each patient according to the circumference of the leg as measured at the ankle and at the largest part of the calf; small, medium, large and extra-large sizes were available. The patients were taught about the application and removal of the stockings once soiled. The stockings were washed by the patients and were renewed every 3 months or when damaged.

Group C consisted of patients who were unable to tolerate neither compression bandages nor compression stockings; they were treated with elastic tubular compression devices knitted in tubular form (Lastogrip, Hartmann) to control

Figure 1. Patient recruitment process.

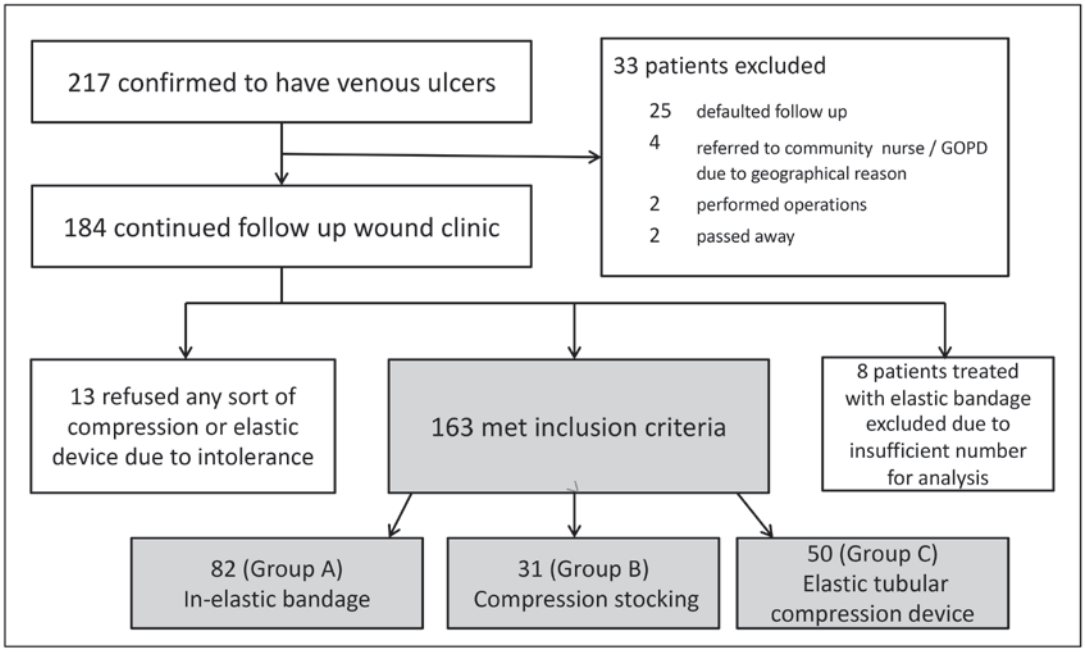

Figure 1 – Patient recruitment process

Table 1. Patient characteristics and study variables.

Variable*	Overall n=163	Group A n=82 (50.30%)	Group B n=31 (19.00%)	Group C n=50 (30.70%)	p value†
Age in years (range)	28–90	31–90	39–86	28–88	
Mean ± SD	70.03±13.62	69.06±12.30	69.00±13.57	72.28±15.60	0.378
Gender:					0.336
Male	101 (62.00)	51 (50.50)	16 (15.80)	34 (33.70)	
Female	62 (38.00)	31 (50.00)	15 (24.20)	16 (25.80)	
Risk factors:					
Diabetes mellitus	13 (8.00)	9 (11.00)	0	4 (8.00)	0.158
Hypertension	62 (38.00)	31 (37.80)	11 (35.50)	20 (40.00)	0.919
Heart disease	54 (33.10)	20 (24.40)	10 (32.30)	24 (48.00)	0.020
Deep vein thrombosis	16 (9.80)	8 (9.80)	2 (6.50)	6 (12.00)	0.717
Renal disease	4 (2.50)	0	0	4 (8.00)	0.010
Smoking	9 (5.50)	4 (4.97)	0	5 (10.00)	0.190
Alcoholism	5 (3.10)	2 (2.40)	0	3 (6.00)	0.281
Pulmonary disease	4 (2.50)	2 (2.40)	0	2 (4.00)	0.528
Ulcer location:					0.667
Shin	57 (35.00)	28 (34.10)	10 (32.13)	19 (38.00)	
Posterior gaiter area	6 (3.70)	1 (1.20)	1 (3.20)	4 (8.00)	
Medial gaiter area	18 (11.00)	9 (11.00)	5 (16.10)	4 (8.00)	
Lateral gaiter area	14 (8.60)	6 (7.30)	2 (6.50)	6 (12.00)	
Medial malleolus	45 (27.60)	26 (31.70)	9 (29.00)	10 (20.00)	
Lateral malleolus	17 (10.40)	10 (12.20)	2 (6.50)	5 (10.00)	
Anterior part of ankle	2 (1.20)	1 (1.20)	1 (3.20)	0	
Dorsum	4 (2.50)	1 (1.20)	1 (3.20)	2 (4.00)	

* Categorical data are expressed as number (%) and continuous data as mean ± standard deviation.
† Chi-square test for categorical factors, independent t-test for normally distributed continuous variables.

lower limb oedema. The size was determined for each patient according to the circumference of the leg measured at the largest part of the calf. The common sizes used were C (6.75cm in width), D (8cm in width) and E (8.5cm in width), with pressure varying from 10–15mmHg. Normally, one layer of elastic tubular compression device would be applied for wounds ≤2cm^2, with pressure around 10mmHg. For wounds >2cm^2, two layers were applied, with pressure around 12–15mmHg. Patients were taught about the application and removal of the tubular compression device once soiled. The tubular compression devices were washed by patients and were renewed every 2 months or when damaged.

Statistical analysis

All demographic data, patients' general assessment, wound assessment, wound treatment protocol, types of compression therapy and follow-up frequencies were obtained through the electronic records (clinical management system) of the study hospital. The search period was from the start of treatment (Week 0) up to 24 weeks. Healing rates at 24 weeks were calculated for Group A, Group B and Group C by using Kaplan–Meier survival analyses. Specific risk factors for ulcer healing – such as age, gender, ulcer location – were assessed using the Cox regression proportional hazards model. Hazard ratios and 95% confidence intervals (CI) were calculated. All analyses were performed using the statistical package for social sciences (SPSS) advanced statistical software (v. 10.0 statistical package).

Ethical consideration

The study was approved by the Institutional Review Board of the study hospital. All patients were under the same treatment team which comprised of six nurses who had completed a recognised wound care course and were trained in compression therapies.

RESULTS

A total of 163 patients with CVI met inclusion criteria in this study; 82 were treated with compression bandages (Group A),

Figure 2. Mean time to wound healing according to the Kaplan–Meier analysis.

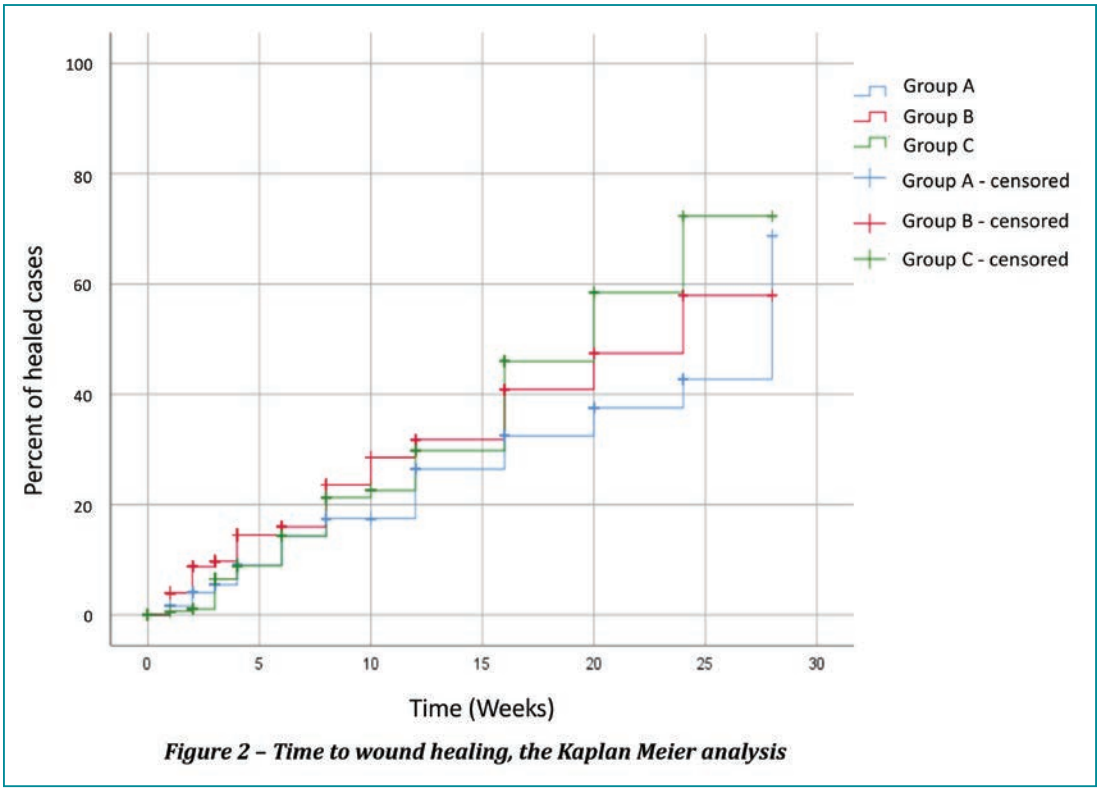

Figure 2 – Time to wound healing, the Kaplan Meier analysis

31 were treated with compression stockings (Group B) and 50 were treated with elastic tubular compression devices (Group C). Patients' characteristics, risk factors and ulcer locations are shown in Table 1, with categorical data expressed as number (%). There are no significant differences in gender nor ulcer locations between the groups. In risk factors and co-mortalities, there was also no significant difference except in heart and renal disease (p=0.020, p=0.010 respectively).

Overall wound healing

A total of 152 wounds healed within 24 weeks; an overall healing rate of 93.3%. By Kaplan–Meier survival analyses, the healing rates were 90.2% for Group A, 93.5% for Group B, and 98% for Group C at 24 weeks respectively. The mean healing time in Group A was 10 weeks, 8 weeks in Group B and 9 weeks in Group C (Figure 2).

Table 2. Predictor variables.

Variable	Hazard ratio	95% CI for healing rate		p value
		Lower	Upper	
Size of ulcer (cm^2)	0.829	0.770	0.894	0.0005
Age	0.983	0.970	0.997	0.378
Gender	0.907	0.623	1.320	0.34
Risk factor:				
Diabetes mellitus	0.857	0.448	1.639	0.16
Hypertension	1.014	0.654	1.572	0.92
Heart disease	1.143	0.729	1.791	0.02
Deep vein thrombosis	0.697	0.387	1.256	0.72
Smoking	1.212	0.697	2.108	0.31
Alcoholism	1.250	0.592	2.640	0.29

Table 3. Healing rate by group in regard to wound size.

Group / ulcer size	Group A		Group B		Group C		Relative risk of Group A vs Group B	Relative risk of Group A vs Group C
	Healed	*Non-healed*	*Healed*	*Non-healed*	*Healed*	*Non-healed*		
≤2cm^2	29 (100)	0 (0)	22 (95.7)	1 (4.3)	32 (97)	1 (3)	0	0
>2cm^2 to ≤4cm^2	14 (100)	0 (0)	2 (100)	0 (0)	4 (100)	0 (0)	0	0
>4cm^2 to ≤12cm^2	21 (87.5)	3 (12.5)	5 (83.3)	1 (16.7)	9 (100)	0 (0)	1.08	0.7
>12cm^2 to ≤ 24cm^2	5 (55.5)	4 (44.5	0	0	2 (100)	0 (0)	–	0.71
>24cm^2	5 (83.3)	1 (16.7)	0	0	2 (100)	0 (0)	–	0.71
Overall	74 (90.2)	8 (9.8)	29 (93.5)	2 (6.5)	49 (98)	1 (2)	0.9	0.67

Cox regression identified that different ulcer sizes were independent predictors of ulcer healing. Age, gender and risk factors were not associated with 24-week healing status except heart disease (Table 2).

Healing rate in regard to wound size

Table 3 shows the healing rate in regard to wound size of the three groups, with categorical data expressed as number (%). In Group A, all wounds ≤4cm^2 healed. However, for wounds with an area of >12cm^2 to ≤24cm^2, Group A had the least healing rate (55.5%). In Group B, the healing rate of wounds ≤4cm^2 was satisfactory (over 95%), but only obtained a 83% healing rate for wounds >4cm^2 to ≤12cm^2. There was no wound >12cm^2 in Group B. Group C achieved the overall highest wound healing rate (98%), with a 100% healing rate for wounds with an area from >2cm^2 to >24cm^2. Overall, for wounds ≤4cm^2, a 98% healing rate was achieved within 24 weeks (Table 3).

In view of the various wound sizes between the three groups, there was relatively less difference in wound healing rates among groups – relative risk (RR)<1. For ulcers sized >4cm^2 to ≤12cm^2, the difference in the wound healing rate between using compression bandages rather than compression stockings was found to be only 0.8% (RR=1.08).

DISCUSSION

The literature shows that people over 60 years old are particularly at risk for venous ulcers and around 2% of them are >80 years old[24,25]. This was reflected in our study population – the mean age was 70.03±13.62, with 24.5% over 80 years old. Our study also showed male patients accounted for 62% of our study population; this revealed a difference from other literature which showed women tended to develop venous ulcers more than men[26]. However, it may require further studies on the possibility of risk factors such as occupation or mobility level between genders.

Some research indicates the average healing time for venous ulcers was 24 weeks, with about a 45–70% healing rate in specialist clinics[27,28]. Our study showed that 93.3% of wounds healed within 24 weeks. The other related factors – such as dressing material used and frequency of wound dressing – were also investigated; however, there was no significant difference relating to the healing rate. The result reflected that the treatment regimen in our study population could meet international standards.

The literature also shows compression therapy heals more venous leg ulcers than not using compression therapy; however, there is insufficient evidence on the most effective degree of compression required to achieve ulcer healing[13,26,29]. A study performed by Milic et al.[29] suggests compression systems should be individually determined for patients according to their calf circumference. However, international consensus supports the optimum therapeutic effects of compression to be around 35–50mmHg of pressure at the ankle[13,30]. In our study population, the pressure applied was lower than the recommendations, with an average pressure of 20–30mmHg in Group A, 23–32mmHg in Group B and 10–15mmHg in Group C. Although we did not measure the sub-bandage pressure of different groups regularly, and cannot compare the pressure difference between these three groups during each visit to our wound clinic, the healing rate of elastic tubular compression devices is similar to compression bandages and stockings (Table 3).

However, the findings of our study differed from those in other studies. It is understood that there are many factors which affect the effectiveness of pressure, such as the skill and technique of the clinician, the stretch of the bandages applied, and the number of times bandages or stockings are washed since this will decrease the elasticity of the material[13,31]. Moreover, the effectiveness of various layers of elastic tubular compression devices is still limited. Therefore, it is difficult to accurately evaluate the effectiveness of these three groups of therapy. Further investigation to compare one to two layers of elastic tubular compression device with compression bandages and stockings is therefore suggested.

Furthermore, it should be noted that compression bandages tend to be bulky, require skilled application by trained staff, and may also induce footwear and mobility problems for some

patients[31]. In addition, because of humid and hot weather during spring and summer in Hong Kong, some of our patients cannot tolerate the bandaging system and prefer to change to other compression therapies. Compression stockings are less operator-dependent than bandages[32]. Patients can be taught about application and can change wound dressings themselves. However, elastic tubular compression devices are more economical and are more easily applied by the patients or their carers[33]. Moreover, these achieved a similar healing rate as the other compression therapies in this review. Taking into account the results from our study, and considering both economic factors and patients' convenience, elastic tubular compression devices may be more suitable for our group of patients. However, apart from wound healing and patients' convenience, clinicians should also consider other benefits and disadvantages when selecting the appropriate therapy for patients.

For example, lifestyle modification, calf muscle exercise and lower limb elevation are essential elements in venous ulcer healing. The literature reveals that exercise can improve calf muscle strength, mobility can improve calf muscle function, and leg elevation can promote changes in microcirculation and decrease lower limb oedema[17,32]. Although there is still no high level evidence which indicates their superior effect in venous ulcer wound healing, these are still recommended by various experts and in international guidelines[17,32]. In this review, our records did not detail patients' compliance on calf muscle exercise nor leg elevation, hence the analysis could not be performed.

Limitations

In this review, patients who refused compression therapies and defaulted on follow-up were excluded. It would have been more appropriate if these patients' wounds had been evaluated and compared to the healing rates with other compression therapies. In addition, it was found the majority of the large ulcers (15 patients) were treated by compression bandages (Group A); there were no large ulcers in Group B and only four in Group C. As such, the comparisons in healing rates may be affected by this factor.

Since this is a retrospective study to review our records, some information such as occupation, patients' calf circumference, body mass index, pain score, history of ulcers and recurrence rates are insufficient. In our clinic, there is also no guideline on the frequency of sub-bandage pressure measurement for these patients. Additionally, patients' compliance with compression therapy is not recorded in detail. This is an important issue since compression bandages may induce mobility problems for some patients. It may also affect their compliance with the therapy, and therefore negatively alter the outcome. Moreover, our study was only implemented in the wound care clinic of a university hospital, thus findings in this study cannot be generalised in other wound clinics in Hong Kong. Further multi-centre studies on this topic are therefore warranted.

CONCLUSION

Compression therapy is the gold standard in venous ulcer wound healing. As a general rule, high compression can achieve better healing than low compression, and some pressure is more beneficial than no pressure. In this review, although the sub-bandage pressure difference is not regularly measured between these three groups of patients, their wound healing rate is comparable. However, lifestyle modification, calf muscle exercise, lower limbs elevation and compliance with compression therapy are fundamental elements in venous ulcer healing. Clinicians should be reminded that patient education is also a significant issue for this group of patients.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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