A comparison of inferface pressures of three compression bandage systems

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Abstract

Objective: To measure and compare the interface pressures achieved with two compression bandage systems – a four-layer system (4LB) and a two-layer short-stretch system (SSB) – with a new two-layer system (2LB), which uses an etalonnage (performance indicator) to help achieve the correct therapeutic pressure for healing venous leg ulcers – recommended as 40mmHg. *Method*: 32 nurses with experience of using compression bandages applied each of the three systems to a healthy female volunteer in a sitting position. The interface pressures and time taken to apply the systems were measured. A questionnaire regarding the concept of the new system and its application in comparison to the existing two systems was then completed by the nurses. *Results*: The interface pressures achieved show that many nurses applied very high pressures with the 4LB (25% achieving pressures >50mmHg) whereas the majority of the nurses (75%) achieved a pressure of <30mmHg when using the SSB. A pressure of 30–50mmHg was achieved with the new 2LB. The SSB took the least time to be applied (mean: 1 minute 50 seconds) with the 4LB the slowest (mean: 3 minutes 46 seconds). A mean time of 2 minutes 35 seconds was taken to apply the 2LB. Over 63% of the nurses felt the 2LB was very easy to apply. *Conclusion*: These results suggest that the 2LB achieves the required therapeutic pressure necessary for the management of venous leg ulcers, is easy to apply and may provide a suitable alternative to other multi-layer bandage systems.

Key words: Bandage ■ Compression ■ Interface pressure ■ Tissue viability ■ Venous leg ulcer

Ulceration of the lower extremities are of venous origin in 45–60% of cases (Mekkes et al, 2003) and prevalent in approximately 1% of the adult population (Fowkes et al, 2001). Compression bandage therapy is the treatment advocated, with a strong evidence base, for the management of chronic venous ulceration. To achieve healing, however, it is essential for both patients and healthcare professionals, when using compression bandages, to ensure rigorous concordance to the chosen regimen over a long period of time. It has been documented that the proportion of patients whose ulcers heal can be directly related to concordance with bandage compression therapy (Moffat, 2004).

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To counteract the increased intravenous pressure caused by venous disease, the sub-bandage pressure provided by the compression bandage should exceed 40mmHg (Partsch and Partsch, 2005). However, it is generally considered that a pressure between 30 and 50mmHg at the ankle will ensure reduction of venous hypertension without causing undue discomfort to the patient or damage to the skin (Taylor et al, 1998). Therefore, a high level of applied compression is more therapeutically effective than light compression (Cullum et al, 2004).

Compression therapy systems include single or multi-layer bandages; short, medium, long-stretch; elastic or inelastic bandages and hosiery (Bello and Phillips, 1998). Their selection will depend on various parameters, including ease of use and application, patient concordance and acceptability for both the nurse practitioner and patient (Dale et al, 2004).

In recent years it has become common practice to treat venous leg ulcers using multi-layer compression bandage therapy, which provide the required recommended therapeutic pressures, recommended as 40mmHg (World Union of Wound Healing Societies, 2008), and good healing rates. However, some of these bandages (notably the four-layer system [4LB]) may cause discomfort due to over-compression, and lead to reduced patient concordance to the compression therapy system (Moffat et al, 1999; 2003; Partsch et al, 2001; Franks et al, 2004).

Long-stretch versus short-stretch: treatment modalities

Short-stretch and long-stretch bandages are designed to have different treatment modalities. Long-stretch or 'elastic' bandages have a stretch greater than 120% and are applied at 50% stretch, exerting a constant therapeutic pressure of approximately 40mmHg to the limb and the difference between the working and resting pressure is low. Short-stretch or 'inelastic' bandages have a stretch of less than 120% and are applied at 100% stretch, providing a low resting and high working pressure. Multi-layer bandages combine both short- and long-stretch bandages, donating a medium resting pressure, and are designed to maintain sustained compression over a period of 7 days.

A new two-layer bandage (2LB) compression system (KTwo® [Urgo Medical, Shepshed, Loughborough]) has recently been developed, in which the two layers are designed to spread the pressure. Following a non-comparative clinical study of the management of venous leg ulcers (Benigni et al, 2007), and

a randomized study on healthy volunteers to measure the pressure interface evolution over a period of 1 week wearing different compression therapy systems (Junger and Haase, 2007), a comparative test was undertaken among a panel of healthcare professionals. This evaluated the level of interface pressure applied by different multi-layer bandage systems on a healthy lower limb, the time taken to apply the bandages and the acceptability of these systems to the clinician.

Methods

Thirty-two nurses (nine tissue viability nurses and 23 district nurses) were asked to attend four different venues in the North and the Midlands in England (Liverpool, Wakefield, Birmingham and Leicester). Initial screening of the nurses was undertaken; inclusion criteria were nurses who had current, regular experience of applying venous leg ulcer compression bandage systems, specifically the 4LB and the short-stretch bandage (SSB).

Prior to the application of the third compression system (2LB), each nurse was instructed in the application technique. This took the form of a brief video explaining the protocol, as this product was not yet available for use in the UK and the nurses had no prior experience of it.

Each nurse taking part in the study applied the three bandages to the same healthy volunteer, a 28-year-old female with an ankle circumference of 21 cm, who attended all four venues. Each bandage system was applied to the volunteer while she was sitting with her leg slightly elevated and flexed; however, the pressures were measured with the volunteer sitting with her knee bent at a 90° angle and her foot flat on the ground, thus increasing the size of the calf-muscle pump and therefore increasing the sub-bandage pressure, depending on the resistance of the bandage.

Following application, measurement of the interface pressure achieved by each nurse was recorded with the volunteer sitting up-right; her leg bent 90° at the knee and her foot flat on the floor. The time taken by each nurse to apply each of the selected bandages to the leg was also measured. The sub-bandage pressures were measured using a Kikuhime pressure monitor (the same monitor in every circumstance), with the sensor placed at position B1, which is located 10 cm proximal to the medial malleolus (*Figure 1*) (Partsch et al, 2006). Having applied each of the three compression bandage systems, each nurse was asked to complete a qualitative feedback questionnaire regarding the three systems and the concept of the new 2LB.

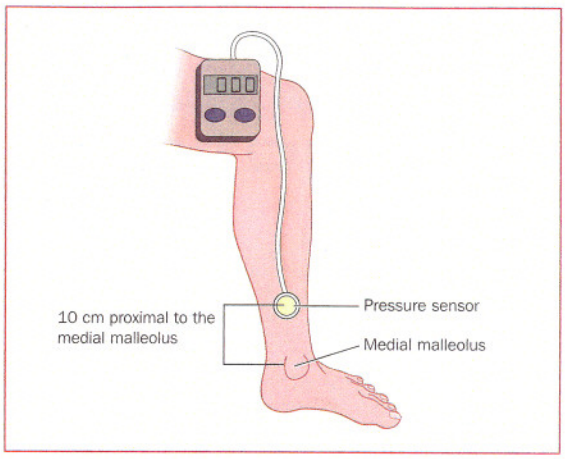
The systems were randomized with regard to the order of application to reduce potential bias. The 2LB was applied twice by each nurse to overcome any issues of unfamiliarity with it, as they had experience of using the other two systems.

Table 1. Interface pressure measurements (mmHg)

	4LB	SSB	2LB (1st test)	2LB (2nd test)
Mean	44.1	23.2	39.8	39.8
Standard deviation	12.4	9.5	11.2	10.1

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system; SSB = Actico two-layer short-stretch compression system

Figure 1. Kikuhime sensor placed at position B1, 10 cm proximal to the medial malleolus.



(This qualitative and quantitative research was undertaken by Stethos International, an independent pharmaceutical industry market research company.)

Tested compression systems

Three compression systems were selected and tested: the 2LB (KTwo®), the 4LB (Profore [Smith & Nephew, Hull]) and the SSB (Actico® [Activa, Burton-on-Trent]).

The 2LB

The 2LB is a multi-layer compression bandage system comprising two different bandages

- Layer 1: K-Tech®, a light compression, medium-stretch bandage (75%)
- Layer 2: K-Press®, a cohesive, long-stretch bandage (160%)

Each bandage is printed with an etalonnage (pressure indicator) to show when the product has been correctly applied, and together the two bandages achieve the required average pressure of 40 mmHg.

The 4LB

The 4LB system is a multi-layer compression system composed of four separate bandages:

- Layer 1: Profore 1 (Softban natural), a sub-wadding bandage, 100 % polyester
- Layer 2: Profore 2 (Softcrepe), a light, conformable, short-stretch bandage (60–70%)
- Layer 3: Profore 3 (Litepress), a light compression, long-stretch bandage (180%)
- Layer 4: Profore 4 (Coplus), a flexible, cohesive, long-stretch bandage (140%).

The four bandages of the 4LB system donate an ankle pressure of at least 40 mmHg when correctly applied.

The SSB

The SSB system is a multi-layer compression bandage system composed of two separate bandages:

- Layer 1: Flexi-Ban sub-wadding bandage, 100 % polyester.
- Layer 2: Actico, a short-stretch, cohesive bandage, composed of cotton, polyamide and elasthane.

Table 2. Distribution of the interface pressures achieved by the nurses (%)

Bandage system	Percentage of nurses achieving interface pressures					
	<29 mmHg	30–35 mmHg	36–44 mmHg	45–50 mmHg	51+ mmHg	% between 30–50 mmHg
2LB	6%	28%	44%	13%	9%	85%
4LB	6%	16%	34%	19%	25%	69%
SSB	75%	12%	13%	0%	0%	25%

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system; SSB = Actico two-layer short-stretch compression system

The SSB system gives a low resting pressure (i.e. when the patient is supine) and can donate a high working pressure of >80 mmHg.

Results

Thirty-two nurses participated in this evaluation; their mean time of qualification as a nurse was 9 years. The mean values of the interface pressure between the bandage and the skin are reported in *Table 1*. The two mean consecutive values documented with 2LB are at the expected therapeutic pressure level (40 mmHg), very close to the one observed with the 4LB (44.1 mmHg), but higher than the level documented with the SSB (23.2 mmHg). Despite taking the differing system modalities into account, it should be noted that the patient was not in the resting supine position, in which case a higher pressure would be expected for the SSB.

Of the nurses achieving the required therapeutic interface pressure (30–50 mmHg), 85 % were with the 2LB, 69% with the 4LB and 25% with the SSB (*Table 2*). Furthermore, while 25% of the nurses in the 4LB group applied a high pressure to the lower limb (>50 mmHg), 75% of those with the SSB applied a sub-therapeutic pressure.

The mean time to apply each compression bandage system was also documented during the test (*Table 3*). The shortest application time observed was with the SSB (1 minute 50 seconds), followed by the 2LB (2 minutes 35 seconds and 2 minutes 16 seconds) with 4LB taking the longest time to apply (3 minutes 46 seconds).

Responses to the questionnaire

Once the practical application of the bandages was completed, (including the measurement of the interface pressures and the time taken to apply the compression systems), the nurses were interviewed separately by a different person using a standard questionnaire schedule. They were asked to describe their experiences with the three different compression bandage systems and state the advantages, if any, they had experienced using the 2LB (*Table 4*).

The nurses were asked how the 2LB compared to the other two multi-layer bandage systems used in this evaluation. Eighty-eight per cent of the nurses judged the 2LB to be better than the SSB and 4LB systems, 6% said there was no specific difference when comparing the 2LB with the other two systems and 6% said they felt it was not as good. *Table 5* details the reasons given by the nurses.

The presence of the etalonnage was considered very helpful by 78% of the nurses and quite helpful by 19% of the nurses, while 3% felt that it had made no difference.

The nurses were then asked to rate the three tested compression systems on a scale of 1 to 10 (10 being the highest), for a number of different criteria. *Table 6* shows the percentage of nurses who rated each individual system between the values 8–10 (good to excellent).

The 2LB was appreciated for its ease of application and low bulk, and the nurses perceived that it would have higher levels of acceptability and comfort for the patients than the other two compression bandage systems. It was also considered that the 2LB had the same ability to remain in place over a week as the 4LB.

Table 3. Results of the timing tests (minutes/seconds)

	4LB	SSB	2LB (1st test)	2LB (2nd test)
Mean	03:46	01:50	02:35	02:16
Standard deviation	01:02	00:34	00:36	00:33
Range: minimum	02:00	00:53	01:22	01:07
Range: maximum	06:02	03:00	04:00	03:42

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system; SSB = Actico two-layer short-stretch compression system

Discussion

This comparative evaluation was undertaken by a panel of experienced nurses, to measure the level of interface pressure following the application of three different multi-layer bandage systems on a healthy volunteer; the time taken to apply each system and the acceptability of each system to the nurses involved in the evaluation.

In this evaluation, the new 2LB was the compression system most frequently applied within the normal range of pressures required for the treatment of venous leg ulcers, i.e. 40 mmHg ankle pressure, which is widely recognized as the gold standard for the 4LB, despite the differing modalities discussed previously. Eighty-five per cent of the nurses achieved a pressure of between 30–50 mmHg on first application which is considered to be a suitable range of pressures to provide a therapeutic effect (Taylor et al, 1998). It is notable that the mean pressure did not change between the two successive applications of this compression system; however, the range and standard deviation decreased. This may suggest that the nurses started to become familiar with the application and 'feel' of the new bandage and that the 2LB may be applied consistently by nurses unfamiliar with this new system to give the required therapeutic pressures on first application. This may be due to the construction of the bandages and the presence of the etalonnage performance indicator.

Table 4. Advantages of the 2LB compression system

Advantages	% of nurses mentioning these criteria
Indicators ensure correct interface pressure applied	56%
Quicker to apply than the 4LB	25%
Easy to use/easy to apply	25%
Reduced bulk	22%
Allows the wearing of normal shoes	16%
Soft first layer gives greater comfort	16%

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system

Table 5. Reasons given why the 2LB was considered better than the SSB and 4LB

Reason given	% of nurses mentioning these criteria
Less bulky/lighter for the patient	28%
Circles – good guide to pressure level	25%
More comfortable for the patient	16%
Patients can get shoes on	13%
Easier to apply	16%
Quicker to apply	13%

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system; SSB = Actico two-layer short-stretch compression system

In this evaluation, the documented pressures showed that the majority of the nurses achieved a high pressure with the 4LB (25% achieving pressures >50 mmHg) whereas 75% of those applying SSB were unable to achieve 30 mmHg, which would be expected had the volunteer been in the supine position.

Furthermore, the measurement of the interface pressures of the 2LB, when compared with the same 4LB and SSB systems, has been reported, through a randomized clinical trial on healthy volunteers, to maintain a level of sub-bandage pressure similar to the 4LB and slightly better than the SSB, with a better comfort profile versus the two other compression therapy system (Junger and Haase, 2007).

Table 6. Percentage of nurses rating each bandage system good to excellent with regard to each parameter

Criteria	2LB	4LB	SSB
Ease of application	63%	47%	22%
Low Bulk	72%	3%	47%
Comfort	69%	13%	31%
Expected patient compliance	63%	13%	31%
Expected ability remaining in place	56%	56%	25%

2LB = KTwo two-layer compression system; 4LB = Profore four-layer long-stretch compression system; SSB = Actico two-layer short-stretch compression system

There is evidence to suggest that compression therapy increases the percentage of venous leg ulcer healing rates with a beneficial effect on the reduction of leg ulcer recurrence (Vin et al, 2004), and that a high degree of compression is more effective than light compression (Cullum et al, 2004). Obtaining this therapeutic pressure level may explain the efficacy reported with the 2LB in leg ulcer management, where investigating physicians in a clinical trial considered that 85% of the selected venous ulcers had improved or healed following a 6-week period applying the 2LB compression system (Benigni et al, 2007).

The level of interface pressure is also considered to be a factor that affects patient concordance. A very high pressure may result in damage to the skin and possible removal of the bandages by the patient due to discomfort, which was also experienced by healthy volunteers (Junger and Haase, 2007). Therefore, the lower resting pressure of the SSB may facilitate increased patient concordance.

The management of clinical risks is an important aspect of healthcare and these results demonstrate that the 2LB system, with the etalonnage, is able to prevent the adverse risk of tissue damage, or necrosis, caused by inappropriate application. Sub-therapeutic pressures are also considered a risk, in terms of delayed healing of venous ulceration and increasing both treatment times and the associated costs.

With regard to the time taken to consistently apply the three compression bandage systems, the SSB was the quickest, with a mean time of 1 minute 50 seconds and the 4LB the slowest with a mean time of 3 minutes 46 seconds. The time taken to apply the 2LB was between 2 minutes 16 seconds and 2 minutes 35 seconds. It should be noted that the nurses were initially unfamiliar with the application technique relating to the 2LB, despite their experience in bandaging with the other two compression bandages. However, the short training application video and the use of the etalonnage may have had some affect on the time of application, specifically the second time around.

To achieve good patient concordance to a compression bandage therapy system, special attention has to be paid to the need to avoid bandage creases, particularly for patients presenting with venous ulceration or oedema. The presence of stretch and pressure indicators on the bandages can help to reduce unsatisfactory application and the risk of bandage related damage (Vin et al, 2004).

When considering the acceptability of the three tested compression bandage systems, the nurses felt that the 2LB system offered advantages in terms of consistency of pressure application, due to the presence of the etalonnage, and that the product was quick and easy to apply (over 63% of the nurses felt the 2LB was easy to apply with a score of 8–10 (noted as good or excellent on the given scale (0 = very difficult to apply; 10 = very easy to apply), while only 22% and 47% felt this for the SSB and the 4LB systems respectively.

Following evaluation of the new 2LB system, it was felt by the nurses that the patients would benefit from the reduced bulk of bandage layers, the softness and comfort offered by the first layer and the ability to wear their normal footwear. These opinions had already been documented in a clinical trial involving patients with venous leg ulcers (Benigni et al, 2007), when it was considered that the sensation of pain,

heat and itchiness decreased for the patient when wearing the 2LB system, and that the patient found it easier to wear their normal shoes. Fifty per cent and 40% respectively reported that general comfort during the day and at night was better than with their previous compression system.

Conclusion

The evaluation of three compression bandage systems among experienced nurses showed that the new 2LB system provides the required therapeutic pressure of 40 mmHg when applied to the lower limb of a healthy volunteer with an ankle circumference of 21 cm, when in a sitting position. The achieved pressure level suggests good performance of this system in the management of trophic disorders of venous origin, while also offering ease of application, consistent pressure application with the etalonnage for the clinician and less bulk and greater comfort for the patient than traditional multi-layer systems.

KEY POINTS

- A consistent sub-bandage pressure of 40 mmHg is recognized as the required pressure necessary to treat venous leg ulcers.
- 85% of the nurses using the two-layer bandage (2LB) system achieved the required therapeutic pressure (30–50 mmHg) with a mean of 39.8 mmHg on first application, despite no prior experience of this particular system.
- Nurses applying the four-layer bandage took longer than when applying the short-stretch bandage or 2LB.
- 63% of nurses applying the 2LB found it easy or very easy to apply.
- The etalonnage on the 2LB aids the application of correct compression, therefore reducing the potential risk of pressure damage.
- The nurses perceived that less bulk (bandage layers) increased patient comfort and concordance to compression therapy bandaging.

Further clinical work should be undertaken to confirm these findings, although previous clinical data suggest that the 2LB may be considered a suitable alternative to other compression bandage systems enabling an overall improvement to the patient's quality of life. BJN

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