Understanding compression therapy to achieve tolerance

Compression bandage therapy may be poorly tolerated by patients and can be a frustration for both patients and practitioners. This article presents the view that practitioners need to increase their knowledge and assessment skills to enable patients to tolerate a rather difficult treatment. The use of compression bandages will be discussed in relation to their type, sub-bandage pressures, application technique and the role of the Ankle Brachial Pressure Index. It is hoped that some of the ideas presented will promote debate.

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KEY WORDS

Leg ulcers
Compression bandaging
Compliance
Sub-bandage pressure
Doppler ABPI

It has been firmly established that compression bandage therapy increases the healing rates of venous ulceration (Cullum et al, 2001). Compression therapy reverses the effects of venous hypertension. Venous blood velocity is increased through the reduction of superficial capillary and venous pressure (Mear and Moffatt, 2002), augmented by increasing the efficiency of the calf muscle pump (Partsch, 2003).

Multi-layer systems are more effective than single layer compression (Fletcher et al, 1997). It is also clear that practitioners vary in their techniques and the subsequent sub-bandage pressure being applied (Moore, 2002); thus consistency with any system is difficult to obtain. From the authors' experience, it appears that nurses can become fixed on which type of

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compression they use or is on offer to the patient. This was echoed in a study by Edwards (2003); she discovered that it was the patient's perception that they had to put up with the compression bandage on offer, despite their problems, because this was the treatment provided by the district nurse with little evident flexibility.

Yet if practitioners understand compression therapy, its role and how it can be achieved successfully through a variety of compression techniques, the practitioner's skill will be increased and thus also the tolerance of the patient for the therapy. Promoting tolerance is a complex interplay of issues and this article presents a few of them.

Knowledge of bandage type

The management plan must ensure a thorough assessment of the patient, limb, and ulcer history before compression therapy can be selected (Royal College of Nursing Institute, 1998; Scottish Intercollegiate Guidelines Network, 1998). Good knowledge about one compression system is not enough. It is the authors' experience that knowledge about the traditional four-layer system does not necessarily mean the nurse understands the key principles behind it or the individual properties of each bandage. It is essential that proficient practitioners know about all the differing types of compression bandages available if the

diverse needs of their patients are to be met. Yet, despite using a range of bandages, nurses appear generally unaware of bandage classification and where each bandage they use sits within this (*Table 1*).

There is also a confusion of terms used, e.g. long-stretch, elastic, inelastic or short stretch, compression or support. The British National Formulary's inclusion of Type 3a compression bandages in the section on support bandages adds to this confusion.

Classifying extensible bandages

Extensible bandages (also referred to as short-stretch, inelastic, long-stretch, elastic) have been classified

Table 1
Bandage classification
Type 1: Retention or conforming bandages
Type 2: Light support
Type 3: Compression bandages, pressure dependant on 18–25cm ankle
Type 3A: Light compression, 14–17mmHg
Type 3B: Moderate compression, 18–24mmHg
Type 3C: High compression, 25–35mmHg
Type 3D Extra high compression

based on their ability to safely apply and maintain a predetermined level of compression on limbs of known dimensions (Thomas, 1998). There are fundamentally two types of bandages.

Long-stretch or elastic bandages

Long-stretch or elastic bandages apply a predetermined amount of compression if applied following the manufacturer's instructions and to certain ankle widths. They change shape with the limb; when oedema is reduced, the bandage follows in on the limb. The sub-bandage pressure changes little when the patient is active or inactive. Elastic bandages are classified as type 3.

Short-stretch or inelastic bandages

Short-stretch or inelastic bandages do not have any elasticity; the stretch is caused by the weave only, thus forming an inelastic covering to the limb. This resists changes in the limb or calf muscle shape. Thus, when walking, the efficacy of the calf muscle pump is increased, with pressures being redirected back into the deep veins. This is described as a 'high working pressure' present on walking. However, when oedema reduces, the bandage cannot follow the limb in, becoming loose and thus this type of bandage requires more frequent application initially until the oedema has reduced. The advantage of this bandage is the 'low resting pressure' when supine. This may be useful for those who have particular problems with pain at night. Also, it is difficult to apply inelastic bandages with too much pressure, making it easy to teach patients or carers to apply. Inelastic bandages are classified as type 2 support bandages, yet when applied correctly they augment the calf-muscle pump thereby reversing venous hypertension.

Documentation of the bandages used and their proprietary name is essential, as is the rationale for choice. Practitioners also need to feel competent with the system that they are using and be aware of the cost implications of the different types of bandages, weighing up the bandage costs with nursing time, patient acceptability, and lifestyle.

Bandage properties have been discussed in detail elsewhere (Thomas, 1998) and it is important that practitioners are familiar with the various terms. They are clinically relevant and application of this knowledge will have a major impact on the tolerance of the therapy. For example, the bandage's density and extensibility govern its conformability. This is possibly why a type 3a bandage has better acceptability and comfort value than a cohesive bandage (type 3b); the latter has less extensibility and can be problematic for patients especially over the dorsum of the ankle where the bandage must be applied with care.

Sub-bandage pressure

Sub-bandage pressure (the pressure the limb receives from the bandage) is more than a theoretical concept and needs to be understood and utilised at assessment and evaluation. Practitioners need to understand its relevance. Laplace's equation can be 'used to calculate or predict sub-bandage pressures and hence the level of compression applied to the limb' (Thomas, 2003). This has been discussed and debated elsewhere (Mear and Moffatt, 2002; Clark, 2003; Thomas, 2003). Laplace's law reveals how the sub-bandage pressures are altered by the variables within the

law, i.e. number of layers, bandage tension, circumference of the limb, and bandage width. The equation is clinically relevant to the practitioner because it should affect their bandage choice and technique. Thus it is important to recognise that the following will increase the sub-bandage pressure:

▸▸ Smaller limbs
▸▸ Narrow bandage width. Thomas (2003) states that a 10cm bandage is applied with the same amount of force as a 5cm bandage, but the pressure is distributed over twice the area
▸▸ Bony or tendon prominence. This increase in pressure can be reduced with the use of sub-bandage wadding by increasing the width of the limb at that point and spreading the load
▸▸ Number of bandage layers. (A figure of eight application applies 1.5 times the pressure of a spiral technique [Barbenel et al, 1990], thus is only used in a type 3A bandage or for a short stretch in lymphoedema management.) Also, a strict 50% overlap will ensure only two bandages at any one point. A 66% overlap will ensure three bandages at that point (Thomas, 2003) and will contribute to compression intolerance and damage
▸▸ Increased bandage tension. Bandage guides will help prevent the excessive use of force.

The importance of limb circumference

A review by Cullum et al (2001) found that the aim is to achieve a sub-bandage pressure of approximately 35–45mmHg at the ankle. Graduated compression is the term used to describe the presence of greater compression at the ankle, reducing up the calf. This will be automatically applied if the bandage is applied with constant tension up the limb, as long as the limb is of a normal shape, i.e. narrower at the ankle and wider at the calf. If the shape is abnormal, i.e. lacking in calf bulk, then sub-bandage wadding must be used to restore a normal shape and reduce the likelihood of compression damage. Similarly where the calf muscle is reduced producing a long thin lower limb, varying the

Table 2

Multi-layer compression systems

Ankle width	Bandage layers
<18cm	X2 sub-bandage wadding, crepe, 3b bandage
18–25cm	Sub-bandage wadding, crepe, 3a bandage figure 8, 3b bandage
25–30cm	Sub-bandage wadding, 3c bandage, 3b bandage
>30cm	Sub-bandage wadding, 3a+3c+3b bandages

Figure 1. Guttering on the limb.

application technique of a type 3a bandage from a figure of eight to spiral, will allow for a better pressure distribution for the thin leg. A standard four-layer bandage, which takes no account of limb shape, may not be producing graduated compression.

Despite authors (Clark, 2003; Thomas, 2003; Moffatt, 2005) drawing attention to the need to measure the limb and choose bandages accordingly, from the authors' experience of reviewing patients within a tertiary referral unit, it seems that many nurses do not understand its significance. It is thus common for patients with very wide limbs not to receive the compression they require in order for healing to take place (*Table 2*).

Again, nurses need to have confidence in Laplace's law and be reassured that, by applying extra high compression, they will not cause damage to a limb with a 31cm ankle width. This knowledge will also ensure that the small limb (<18cm) will be protected from high sub-bandage pressure by the use of extra sub-bandage wadding. The use of compression therapy is about both competence and confidence. A recent study found nurses erred on the side of caution, fearful of applying incorrect compression (Field, 2004). This echoed work undertaken by Ruckley (2001) who found that reduced compression was often used, despite the presence of guidelines, when support for practitioners was lacking. Thus this points to the need for explicit referral pathways for specialist review and support.

While the development of the four-layer bandage system was based on the requirement for a sustained high compression at 40mmHg (Moffatt, 2004), there is debate about the precise levels required (Thomas, 1998). Practitioners would also recognise that for those with extensive venous disease, often a greater amount is required in order to prevent recurrent infection and aid healing.

One way of evaluating this requirement is through the presence of 'guttering' on the limb (*Figure 1*). The author has not been able to find this term described in the compression literature despite its recognition in clinical practice. Guttering can be described as longitudinal grooves down the gaiter and above, which are 3–5mm in width, revealing oedema reduction. Its presence demonstrates that the compression therapy is having a therapeutic effect on the limb. Thus guttering needs to be looked for when evaluating effectiveness. If it is not present and the wound is non-healing, then the supposition is that the compression therapy is not effective. The practitioner will need to review either the choice of compression system or the practitioner's technique. It is important that guttering is not confused with bandage creases that are transverse ridges that are red on their apex. These are brought about by poor application or slippage and need to be avoided.

When bulk or heat is a tolerance issue

Sub-bandage wadding must be used beneath any compression bandage, regardless of the compression levels applied, because of the risk this may pose to skin integrity. However, if footwear is a problem, driving is difficult or irritation a problem, one option is to modify and reduce its use with the proviso that the ankle width is wider than 18cm; the practitioner can do this safely if the rationale for its use is understood.

The sub-bandage wadding is used to protect the bony prominences and Achilles' tendon from excessive pressure by redistributing the high pressures away from these areas (Moffatt, 2005). It is also used for the absorption of exudate. By keeping these key principles in mind, bulk or heat can be minimised by reducing the amount of wadding over the base of the foot and up the calf: strips of wadding are applied down the tibial crest to the toes, and around the ankle, protecting the malleoli, the dorsum of the ankle, and Achilles tendon (*Figure 2*). Despite this suggestion appearing controversial, it is a simple measure that can produce a dramatic increase in tolerance for the bandage system and allow for more footwear choice.

The crepe layer can initially apply high pressures, but these reduce quickly over time. However, this initial high pressure must be recognised and the bandage applied with care. Again, it is important to remember that crepe is used for smoothing of the wadding and adding absorbency but can be considered the least effective layer (Moffatt, 2005). Thus the authors suggest that if bulk is causing intolerance, then the crepe layer can be omitted and the reason for this documented.

The significance of the application technique

When a compression bandage or system is not tolerated and thus removed, the patient is frequently described as non-compliant. They are thus dismissed as interfering with, or negating the effects of, this correct and beneficial treatment. This view is both detrimental to the patients' care and the therapeutic relationship. A patient

Figure 2. Bulk or heat can be minimised by reducing the amount of wadding over the base of the foot and up the calf: strips of wadding are applied down the tibial crest to the toes, and around the ankle, protecting the malleoli, the dorsum of the ankle, and Achilles tendon.

knows, if asked, which nurse they would prefer to apply the bandage. A patient in Edwards' (2003) study describes this well, making it clear that 'appropriate application of compression causes less pain and discomfort'. Thus, the technique used by the nurse and the bandage chosen must be the first point of review when a bandage is not tolerated.

While it is essential, as stated, to protect the prominent bony and tendon areas of the lower limb, one of the most common problems for the patient is tightness over the dorsum of the ankle. This cannot be tolerated and the bandage is often removed before any damage can be seen. The key reasons for this are:
» Too much compression too soon when pain management has not been instigated or is ineffective
» Too many bandage layers, that is, the bandage has not been applied utilising a 50% overlap
» Bandages applied with tension over the foot and ankle
» On application, the foot is in a relaxed or plantar-flexed position, so on walking there is bulking of the bandages.

These problems are easily prevented by ensuring that:
» The foot is dorsi-flexed when bandages are applied. The patient must learn the catch-phrase 'toes to your nose'

» No bandages are applied with tension until the turn coming out of the ankle
» Bandage layers are kept to a minimum.

This will also ensure that ankle mobility is not reduced, allowing the calf muscle to maintain its important function in promoting venous return.

If a patient has found the bandage system uncomfortable, the reasons for this needs to be investigated. Simply documenting that it was too painful is not adequate, and certainly is not enough to abandon a proven therapy. Mear and Moffatt (2002) discuss the importance of using the correct technique when applying a bandage. Practitioners need to be competent. A practitioner noticing the poor technique of a colleague is called to be an advocate for the patient and to identify and minimise risk (Nursing Midwifery Council, 2004). One way in which this can be dealt with is through adequate training of practitioners (RCN, 1998; SIGN, 1998).

Difficult-shaped legs often require a different application technique or bandage choice. Using a cohesive bandage as the top layer may prevent slippage. Charles et al (2003) describe the benefits of using a cohesive short-stretch bandage for the 'champagne bottle' shaped legs; they describe

utilising a combination of spiral and St Charles application technique with good effect, thereby preventing slippage. These techniques will need to be used by the specialists to help people in difficult circumstances.

Pain should not be tolerated
Pain is the main cause of abandoning compression therapy. Again, exactly what this means to the patient needs to be investigated. It is clear that most venous ulceration causes pain (Krasner, 1998; Persoon et al, 2004) thus new or additional pain is more significant. Most importantly, pain needs to be reduced through adequate analgesia, using opiates as necessary. Compression therapy cannot be tolerated if pain relief is not addressed. Some ulceration may be particularly painful and is not related to the size or depth of the ulceration but is caused by painful atrophe blanche. Oedema or lymphoedema can also be painful and debilitating.

The type of pain needs to be established and whether it is increased or changed with the compression therapy. It is imperative that the practitioner ascertains whether the pain is the result of ischaemia, neuropathy, infection or application technique. If ischaemic, symptoms would be pain or tingling in the toes, or claudication (cramping) pain; it is essential that patients are forewarned of these signs and know to remove their bandages.

Unresolved pain can also lead to hypersensitivity or hyperalgesia (Consensus document, 2004) and unfortunately this is poorly understood by practitioners leading to a lack of belief in the extent of a patient's pain. Understanding the pathophysiology of pain could have an enormous impact on a patient's quality of life (Briggs, 2005) and pain needs to dealt with actively, not with indifference. Having stated this, it appears that a common issue for the patient is simply that they lack belief that this therapy will not cause any adverse effects to their limb; they become worried, a worry made worse at night, resulting in them removing their bandage. Through discussion, the provision of analgesia and

the application of reduced compression, their confidence and tolerance is built up enabling them to progress onto high compression bandaging.

Attention to co-morbidities is also important. Paracetamol for a sickle cell patient or an intravenous drug user may be ineffective: the challenge is to find effective analgesia with sometimes 'imaginative' bandaging combinations that will be tolerated.

Role of the ankle brachial pressure index
The use of the Doppler ultrasound in providing a simple vascular assessment as part of determining leg ulcer management and therefore compression bandaging is advocated (SIGN, 1998; RCN, 1998). An ankle brachial pressure index (ABPI) is considered a reliable and reproducible measurement sensitive to arterial occlusive disease (Osmundson et al, 1985). The cut-off value for applying full compression has been based on evidence which places a normal ABPI value as being equivalent to or greater than one (Yao et al, 1969), with others locating it at 0.97 (Carter, 1969; Stoffers et al, 1996). Thus an ABPI of < 0.9 is taken to indicate a degree of arterial disease.

An ABPI of > 0.8 is therefore considered safe for the application of high compression therapy (SIGN, 1998) and Vowden and Vowden (2001) note how this has become the pivotal figure for determining high compression bandaging with a 'mixed ulcer' being defined at this point. An APBI of >0.8 allows the application of high compression. Light compression can be applied to a limb that has an APBI of 0.5 – 0.8. Practitioners need reminding of the benefits of reduced compression and the EWMA Position Statement on Compression Therapy (Marston and Vowden, 2003) has clarified this.

In a group of diabetics with venous disease, Bowering (1998) did not solely use the ABPI to determine the degree of compression to be used but evidence of peripheral arterial disease. Light compression was applied to limbs with an ABPI of 0.5–0.8 which produced positive results in this difficult

group. In addition, those who had an ABPI within a normal range (0.8–1.2), but also had evidence of some arterial disease, had light compression applied. As Bowering (1998) states:

'Although (ABPI of <0.8) are legitimate concerns, global avoidance of all levels of compression therapy in mixed venous and arterial ulcers [....] eliminates one of the best modes of venous ulceration treatment'.

Thus although cut-off values provide a useful tool perhaps they should not be seen as an end in themselves but part of the assessment, just as the ABPI is part of the process in determining leg ulcer management. Indeed using the ABPI as sole indicator of whether compression can safely be applied to the limb can limit the use of compression therapy and be detrimental to the patient. Relying upon the ABPI for compression decisions is also limiting if the patient is unable to tolerate the procedure: compression may be postponed in favour of a wait and see policy while the wound or condition deteriorates.

The ABPI is not a fixed phenomenon. Just as the pressure index varies with the systolic pressure it is also subject to a number of variables which influence the result and interpretation. Limitations to the Doppler method of measuring systolic pressure have been noted, particularly related to calcification of the arteries as in diabetes (Emanuele et al, 1981; Goss et al, 1989). Similarly the ABPI will not be helpful in microvascular or vasculitic conditions and hypertension and hypotension may also affect pressure ratios (Hugues et al, 1988; Carser, 2001) producing results which may lead to over or under compression.

The procedure for obtaining an ABPI is directly related to the accuracy of the results produced. Guidelines advise following a strict procedure and are well documented (Anderson, 1995; Vowden and Vowden, 1996; Stubbing et al, 1997). Any deviation produces results which should be

accounted for and recorded. Moreover the measurement and calculation is subject to practitioner competence and practice with inter-rater and intra-rater reliability creating a challenge (Fisher et al, 1996; Kaiser et al, 1999). This poses a question as to what training is available for nurses to facilitate them into competency in ABPI assessments and whether there enough guidance for complex assessments.

However, using the ABPI ratio is only one aspect of the Doppler ultrasound that should be used in decision making. The waveform output and pulsatile sounds are also important. Being able to differentiate the difference between tri-phasic, bi-phasic and monophasic sounds will help to assist the practitioner in discerning vascular status. The patient might have an apparently healthy ABPI of 1.0 but with a whooshy and monophasic pulse. This points to evidence of arterial disease and needs to be excluded with a Duplex Ultrasound. Any compression must then be reduced and applied with care. It also appears that in the authors' experience, some practitioners are reluctant to apply compression when an ABPI is greater than 1.2, fearing calcification, despite significant clinical need. Again, this does not account for the fit, younger patients with triphasic pulses for whom this ratio, or even above this, is normal.

Thus these points reveal the complexities of what is often considered a simple tool. Practitioners need to have courage and confidence to apply compression, but this is not the same as taking undue risks. Guidance regarding the ABPI and compression therapy is clear, and should be supported by specialist support and local referral pathways to vascular teams. These complexities are part of risk management within a clinical governance framework.

Not just for venous disease
With the classic definition of a leg ulcer being a loss of skin below the knee on the leg or foot, taking more than 6 weeks to heal (Dale, 1995), it appears that practitioners forget that

compression bandages are not just useful for treating venous ulcers. For pre-tibial lacerations, occurring in an area with poor vascular supply, healing can be slow, especially if complicated by oedema. While pre-tibial lacerations would benefit from compression therapy (Moffatt, 2005), the authors would contend that lower limb graft sites and suture lines from coronary artery bypass grafts would also heal faster with the application of light compression. Unfortunately, Stevens (2004) notes that some trusts are reluctant to allow practitioners to apply therapeutic compression for ulceration that is not venous. This can be limiting and will lead to some patients having ineffective treatment. The latter still require a full leg ulcer assessment and arterial assessment before compression therapy (RCN, 1998; SIGN, 1998).

Evaluation of compression therapy

Evaluation of compression therapy should occur on a regular basis. This involves assessment of comfort, toleration, efficacy (ulcer healing and oedema reduction), and sustainability. If the bandage is not staying secure for the allotted time, then time is being wasted on inefficient treatment and healing will be delayed. If a wound is non-healing despite adequate compression, then the original diagnosis of venous ulceration needs to be questioned and the patient referred for specialist advice. Consistent compression therapy is a key feature and needs to be appreciated by both practitioner and patient.

This article has not explored the complexities of non-compliance but has focussed on the need of practitioners to increase their skill and knowledge. It is clear that there will be a few patients for whom compression therapy cannot be tolerated. Yet, it is also evident that application varies widely (Moore, 2002) and practitioners need to review their knowledge and skills. When a practitioner understands the key principles of compression bandaging, the types and their properties, their ability to meet the patient's needs is enhanced. Practitioners need to listen to their patients and 'gain a better

understanding of their perceptions' (Edwards, 2003). This will allow the nurse to negotiate a treatment regime that is both comfortable and effective, thereby increasing tolerance with this difficult therapy. Creativity is essential or some patients will be left with little hope of healing (*Table 3*). Thankfully, with new materials and the recent addition of two-layer hosiery systems (Hampton, 2003), ingenuity should be less difficult to attain.

Conclusion

The complexities of compression bandaging are recognised and a good technique brings together the art and science of nursing. Practitioners require guidelines to follow that are evidence based and relate to local needs. Clear referral pathways are vital for wounds that are non-healing despite what is perceived to be correct management. Practitioners also need to know how to proceed when there is anxiety over Doppler results and associated interpretation.

With the increased knowledge and skills of practitioners, the classic venous leg ulcer often heals quickly, leaving the difficult to heal and those with complex aetiologies. While generalists still require clear guidelines in which to work, specialist practitioners are now working on the edge of what can be termed as evidence-based practice. In these circumstances we need to be creative in our craft, interpreting guidelines while holding on to key theoretical principles. Some readers may find several of the suggestions in this article worrying; others will recognise practices that they already carry out. It is hoped that by raising these challenging issues debate will be stimulated.**W**UK

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Table 3

Checklist for when compression bandaging is not tolerated

1. Check ABPI result is recent. What are the absolute values?
2. Has it ever been tolerated? If yes, when and who applied it?
3. Check application technique, especially over dorsum of ankle. Is there pressure damage or pain on walking?
4. Check where and when the pain occurs
5. Is the pain the result of arterial insufficency or is it based on fear/apprehension or claustrophobic feeling?
6. What type of compression has been tried?
7. Does the patient know immediately whether the bandage will be comfortable? If yes, then apply correctly and find out. If comfortable, then application technique needs to be addressed.
8. Does the patient/nurse ensure correct ankle position at application (toes to nose)?
9. Is footwear an issue? If yes, reduce sub-bandage wadding over base of the foot. Choose a single-layer bandage regime
10. Is the bandage slipping? Is this because of oedema reduction, shape of leg or application? Use cohesive bandage as a top layer or short-stretch technique that supports the calf

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