Effect of super-absorbent dressings on compression sub-bandage pressure

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Leg ulceration is a chronic condition affecting approximately 1–2% of the population (Graham et al, 2003); it is the most prevalent of chronic wounds in the Western world, accounting for 45-60% of all chronic leg ulcers (Mekkes et al, 2003). Compression therapy is proven to be an effective treatment for venous leg ulcers (O'Meara et al, 2009). Venous ulcers are the result of a complex chain of events resulting from venous valve incompetence and subsequent venous hypertension. Compression therapy aims to reduce the superficial venous pressure by exerting external pressure on the interstitial tissue. In 1969, Stemmer detailed that an external pressure of between 30–40mmHg pressure was required at the ankle to reverse chronic venous hypertension. Since then there has been much discussion on the precise optimum level of compression pressure required to reverse venous hypertension, but 40mmHg has been found to be clinically effective (Nelson, 1997). The achievement of graduated compression is a key component of any compression therapy, aiming to provide 40mmHg of pressure at the ankle with a gradual reduction in the pressure up the leg towards the knee. This graduated compression is achieved because of the natural increase in the circumference of the limb. Sub-bandage pressure can be calculated using Laplace's law (Thomas, 2003) which states the pressure produced beneath the bandage is directly proportional to the tension within the fabric, the number of turns applied but inversely proportional to the circumference of the limb. Therefore, the larger the limb, the more pressure from the bandage is required to affect the interstitial tissues.

ABSTRACT

Venous leg ulcers can be highly exuding and moisture management is often challenging. The emergence of super-absorbent dressings have been marketed as a tool to manage high levels of exudate, in combination with compression therapy, for the management of venous leg ulcers. Compression bandages are designed to give precise amounts of compression which is calculated by considering the circumference of the limb. Super-absorbent dressings contain a form of polymer that swells as it locks in moisture. This study was designed to evaluate the effects of super-absorbent dressings on sub-bandage pressure. A series of controlled tests were performed using four different super-absorbent dressings which were applied to a volunteer's limb beneath compression bandaging. Sub-bandage pressures were recorded as fluid was introduced to the super-absorbent dressing. The results identified that sub-bandage pressure increases and the pressure profile changes following the expansion of the super-absorbent dressing. Further research needs to be performed to assess whether the use of these super-absorbent dressings under compression could be detrimental to venous ulcer healing.

KEY WORDS

Compression bandaging ◆ Super-absorbent dressings ◆ Sub-bandage pressure ◆ Venous leg ulcers

Moisture management

Venous leg ulcers are often highly exuding and moisture management is challenging, requiring the use of absorbent dressings. Uncontrolled levels of exudate can lead to damage to peri-ulcer skin such as maceration or excoriation, and subsequent enlargement of ulcer size. The seminal work of Winters (1962) paved the way for the development of moist wound healing, the challenge being to maintain optimal moisture balance using appropriate dressings to absorb excess fluid or retain fluid in an otherwise dry wound, thus achieving a moist wound environment (Palfreyman et al, 2006; White and Cutting, 2006). However, it is well accepted that the type of dressing applied beneath compression does not affect healing rates significantly and that decisions regarding which dressing to use should be based on costs and patient and practitioner preferences (Palfreyman et al, 2006). Additionally, leg ulceration is known to have significant negative impact on many aspects of patients' quality of life (Flett et al, 1994; Franks and Moffat, 1998; Jones et al, 2008) and leakage of exudate has been identified as a major factor restricting social activities in patients with leg ulceration, resulting in social isolation (Hopkin, 2004; Hareendran et al, 2005).

Dressings consisting of polyurethane foam, alginate fibre and carboxymethylcellulose have been used to achieve adequate moisture control over a number of years. More recently there has been an emergence of new super-absorbent dressing which are designed to control large volumes of exudate (Flivasorb (Activa Healthcare); Ecylpse (Advancis Medical); KerraMax (Arc Therapeutics); Sorbion S (Sorbian) and DryMax Extra (Aspen), which have been marketed for the management of highly exuding wounds including the management of venous leg ulcers. The author has seen a steady increase in the use of these super-absorbent dressing in her local community.

These new dressings have a different action to traditional foams as they are designed to swell significantly in size as the dressing absorbs the exudate. Companies state that the products are safe to use under compression (Activa, 2010; Advancis Medical, 2010; H&R Healthcare, 2010), however, there is little evidence available to assess the effects of these dressings on sub-bandage pressure.

Arc Therapeutics (2010) claim KerraMax can be used in the management of venous leg ulcers under mild to moderate compression, however, they do not clarify whether the use is recommended under full compression. Interestingly Arc provide no rationale as to why KerraMax is not advocated under full strength compression. In order to explore whether significant increase in dressing size, especially owing to the width of dressing increasing when in contact with exudates, would alter sub-bandage pressure; a small scale study was designed aiming to evaluate the effects of the new generation of super-absorbent dressings on sub-bandage pressures.

Methods

An evaluation of four super-absorbent dressing was undertaken; Flivasorb, Sorbion S, KerraMax and Eclypse. All of these dressings contain polymers which expand as exudate is absorbed. All dressings chosen were 20cm x 30cm in size.

A series of controlled tests to measure any effects on the sub-bandage pressure were undertaken. Pressure measurement pads were applied to the medial aspect of a volunteer's leg at the level of the ankle (2cm above malleoli), mid-calf (19cm higher), and just below the level of the knee. The pads were secured in place to ensure consistency between tests. The left leg of a healthy volunteer was used in all experiments, ankle circumference was 24cm and calf circumference was 41cm. The Kikuhime monitor was selected to measure sub-bandage pressure and this was calibrated prior to testing. An experienced practitioner applied all the compression bandages within this test, a mixture of 4-layer and 2-layer bandages were used, which are all designed to apply 40mmHg pressure at the ankle gradually reducing to 20mmHg just below the level of the knee. All bandages were applied in a standard fashion as recommended by the supplier. Each hyper-absorbent dressing was applied to the lateral aspect of the limb; this was to ascertain whether the increase in the size of the dressing caused by fluid affected the general sub-bandage pressure, not just pressure directly below the dressing. Below the dressing a pipe was placed to allow later introduction of fluid. Over this, compression bandaging was applied. Prior to application of any fluid sub-bandage pressure were measured and the initial sub-bandage pressures were recorded. Water was then applied via the tube at a rate of 10ml per minute, to allow time for the dressing to absorb, sub-bandage pressures were recorded at one minute intervals for duration of 5 minutes. A total of 200ml were delivered over the 5-minute period for each dressing. From these measurements an average pressure increase was calculated. All measurements were taken with the volunteer standing. The test was repeated three times for each dressing to gain a mean pressure increase. There was evidence of fluid strikethrough in the 4-layer bandages with all of the dressing but on removal of the 4-layer bandages each of the absorbent dressing were found to be fully saturated.

Results

The results identified that sub-bandage pressures altered following expansion of the super-absorbent dressing under compression therapy in this small scale evaluation. *Figure 1* displays the mean percentage increase in sub-bandage pressure using 4-layer compression; *Figure 2* displays the mean percentage increase in sub-bandage pressure using 2-layer compression.

Results ranged from a 2.5% increase in sub-bandage pressure with Eclypse to a 21.8% increase in sub-bandage pressure with Flivasorb when used under 4-layer compression (*Figure 1*). Similar increases were seen when using 2-layer compression systems (*Figure 2*) ranging from a 0% increase with Eclypse to 24% with Flivasorb. Flivasorb affected sub-bandage pressures the most in both groups followed by Sorbion and KerraMax. Eclypse dressings had little effect on sub-bandage pressure with a 2.5% increase being seen with the 4-layer bandage and no effect under a 2-layer bandage kit.

Figure 3 displays the percentage change under a 4-layer bandage at the level of the ankle, mid-calf and just below the knee on standing.

The increase in pressure varied at the points of measurement, the greatest difference was seen at the level of the ankle raising 38% with the use of Flivasorb, 23% with Sorbian S, 8% with KerraMax and 2% with Eclypse.

Figure 4 represents the percentage increase in pressure with the use of super-absorbent dressings in combination with 2-layer bandage systems. The greatest percentage differences were seen at the mid-calf level. This raises the possibility that super-absorbent dressings can alter the pressure profile with possibility of causing reversed compression.

Discussion

There has been information published on the effects of compression on a dressing's performance (Thomas, Fram and Phillips, 2007) with Steinlechner, Rohrer and Abel (2008) suggesting that the polymer network structure retains liquids permanently inside the dressing and hardly releases them, even under compression, however, there is little information on the effect of the dressing on the compression profile. The four super-absorbent dressings chosen for this study are widely available to practitioners both within the UK and the international market and are marketed for the management of highly exuding venous leg ulcers with each company promoting that the dressings are suitable to be used under compression therapy

Results from this evaluation suggest that Eclypse had the least effect on sub-bandage pressures when polymers in the dressing expanded. The largest increase in sub-bandage pressure was seen when using Flivasorb which increased sub-bandage pressure by 38%. More rigorous

Figure 1. The mean percentage increase in sub-bandage pressure using 4-layer compression

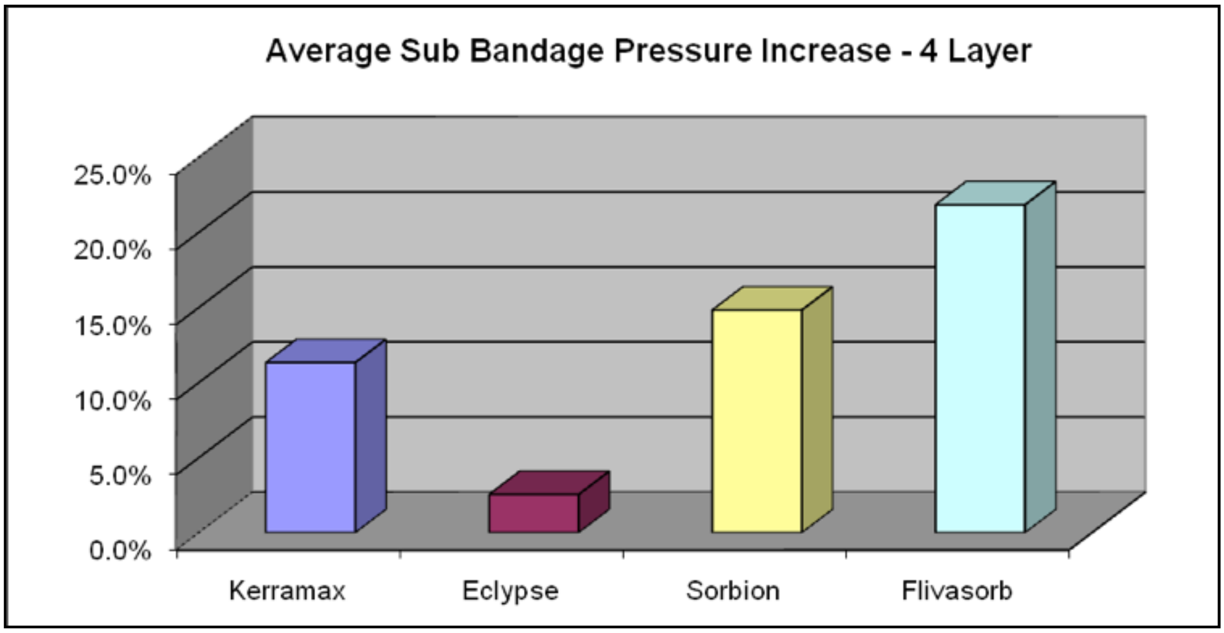
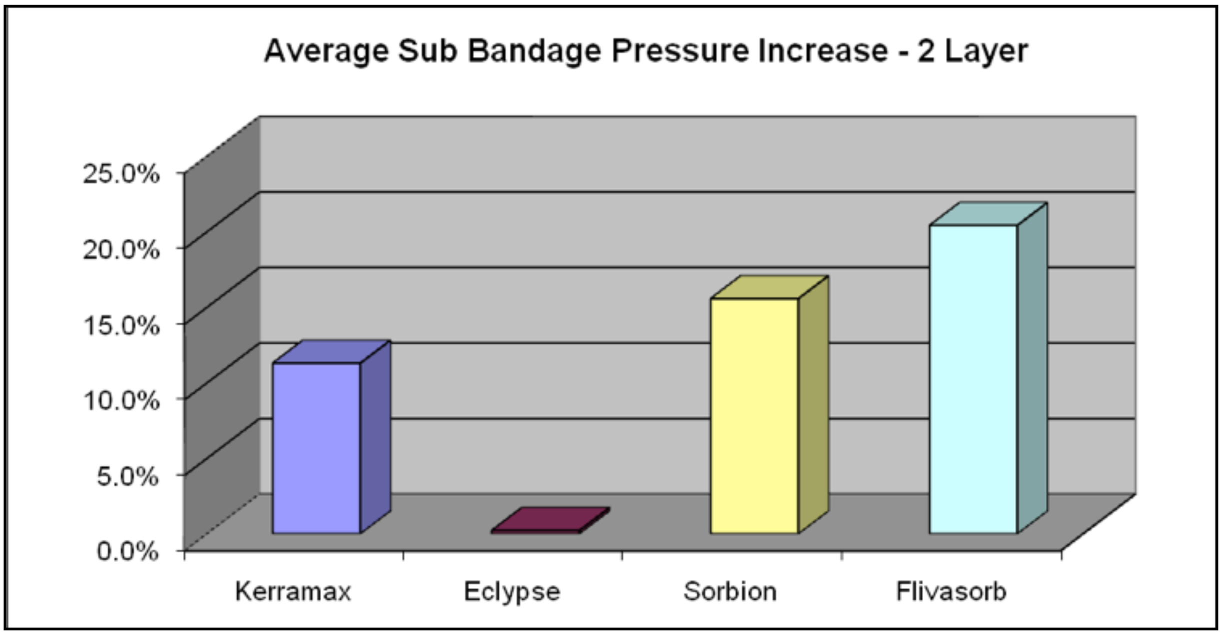


Figure 2. The mean percentage increase in sub-bandage pressure using 2-layer compression kits



studies are required to clarify these results. Furthermore, there needs to be research undertaken to explore if an increase in sub-bandage pressures does impact on the effectiveness of compression. The alteration of the sub-bandage pressure profile could have detrimental effects on ulcer healing, for example, causing a 'tourniquet' effect which may cause patient discomfort and bandage intolerance leading to poor patient compliance with compression therapy.

The results demonstrated that sub-bandage pressures are altered in the use of super-absorbent dressing but more research needs to be performed to see if these results are repeatable and to assess further the effects of altered compression profiles on wound healing.

Limitations

There are a number of limitations of this small evaluation including the reliability of sub-bandage pressure monitors. The efficacy of pressure monitors depends on a large number of intrinsic factors such as shape of limb, posture

Figure 3. The percentage change under a 4-layer bandage at the level of the ankle, mid-calf and just below the knee on standing

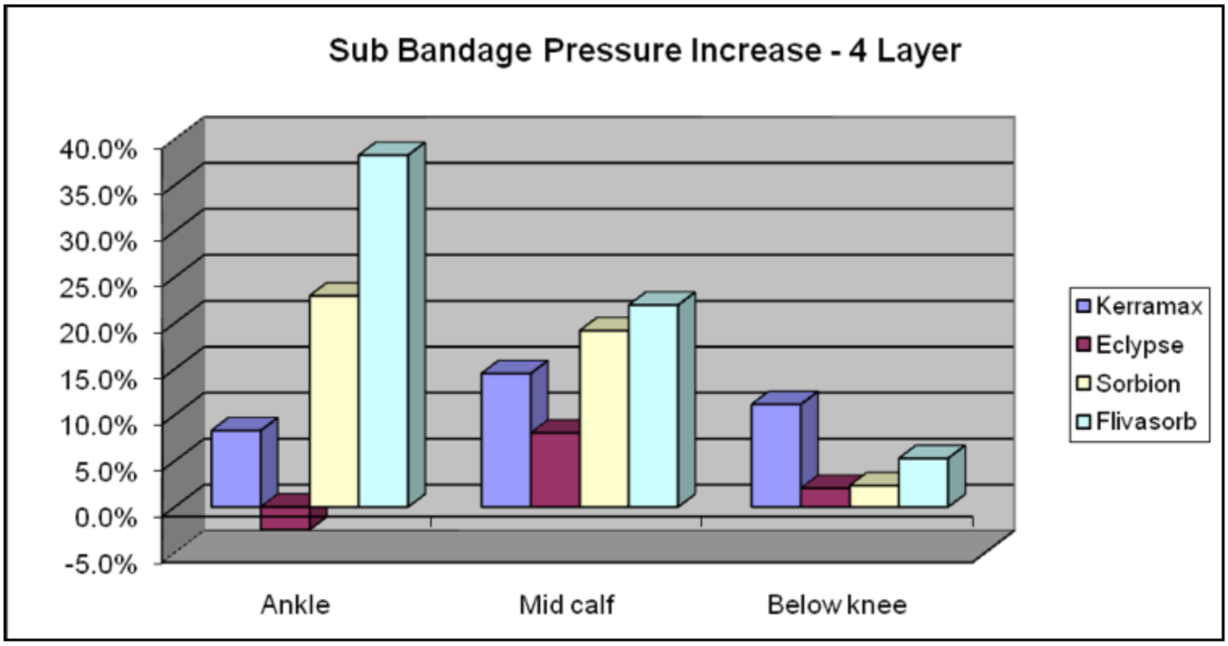
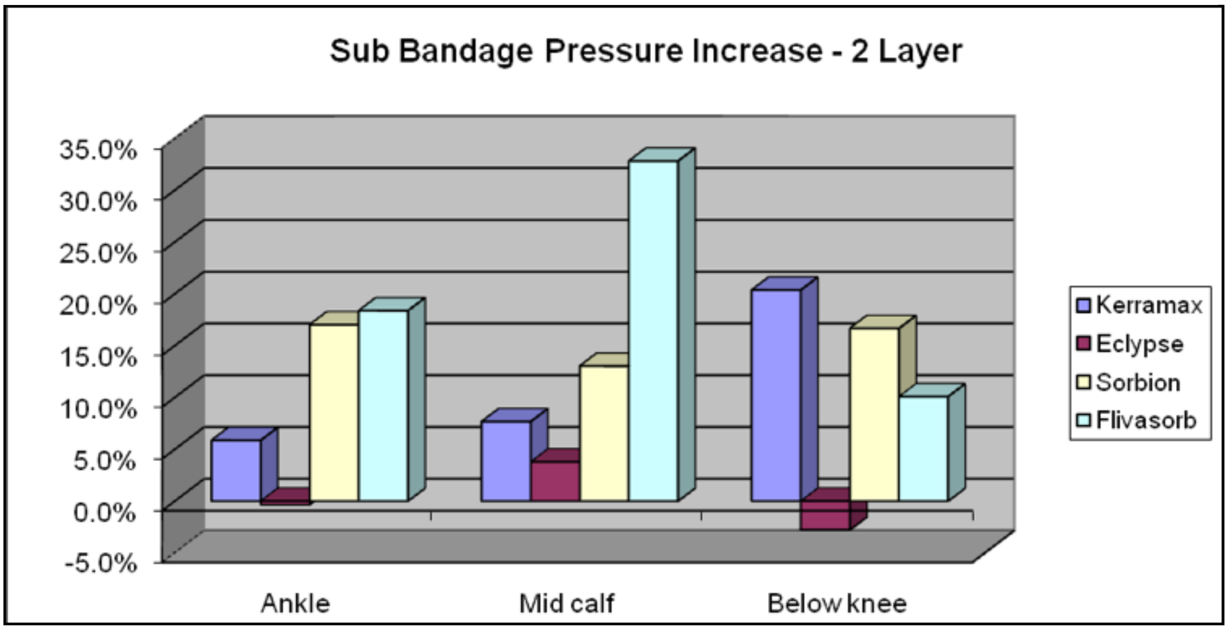


Figure 4. The percentage change under 2-layer bandage kits at the level of the ankle, mid-calf and just below the knee on standing



and extrinsic factors such as room temperature, calibration, application, surface and moisture (Barbenel, Sockalingham and Queen, 1990). Many other factors can also influence the pressures obtained, for example, type of bandage, experience of bandagers and patient characteristics. This study was designed to minimize the number of variables by using the same practitioner, the same limb and the same measuring device. It is also important to remember that interface pressure measurements only supply information on one aspect of the surface (O'Dea and Barnett, 1999) and provide no information on the changes this pressure causes in the body tissues.

In clinical situations, when treating heavily-exuding venous leg ulcers, it may be appropriate to consider the effects of an expanding absorbent dressing on the overall compression profile. Despite the poor scientific rigour to this evaluation it does raise concern that some of the super-absorbent dressings can significantly increase compression sub-bandage pressure and further research needs to be performed before companies can claim that it is appropriate to use such dressings under compression therapy.

Conclusion

This small scale evaluation has identified that sub-bandage pressure does increase with the use of super-absorbent dressings, but it is unknown whether this effect would be detrimental to healing rates. It is recognized that this is only an evaluation and lacks research rigour and validity, but does raise important questions that need to be further investigated. The most important being: does a rise in sub-bandage pressure have a detrimental effect on the healing process and can the results of this study be replicated in a controlled trial? **BJCN**

Conflict of interest

This evaluation was supported by an unrestricted educational grant from Advancis Medical

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