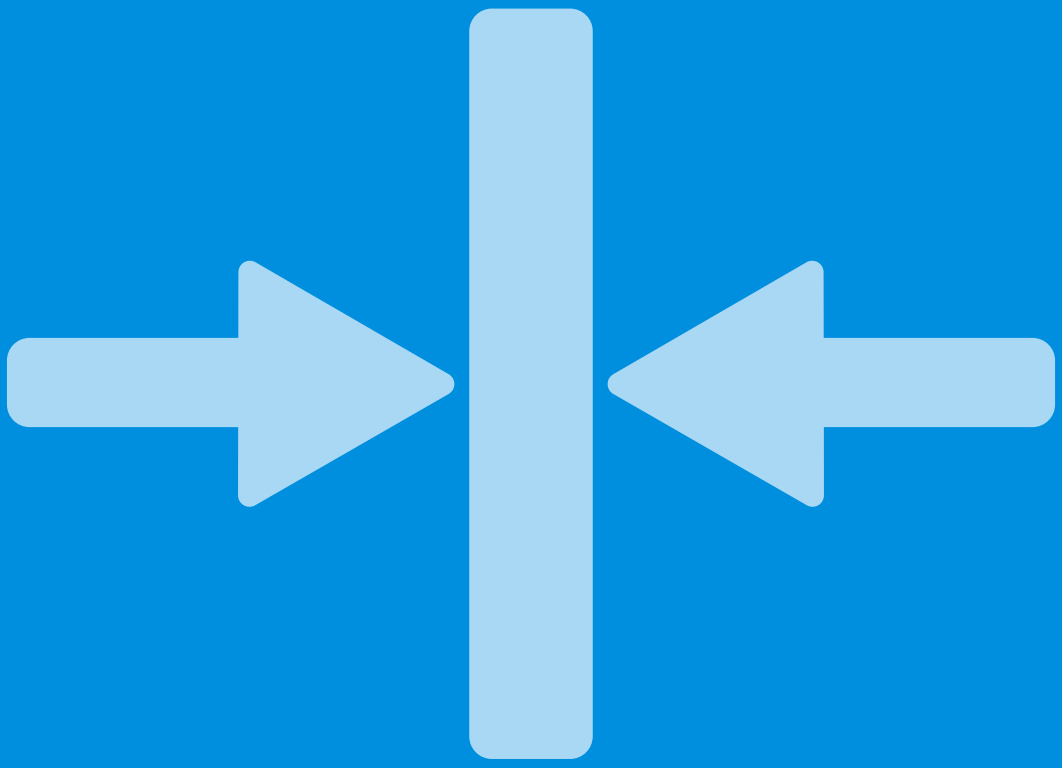
Adjustable compression wraps



Background, evidence and case studies on use in lymphatic and venous disease

JWC journal of wound care

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Project editor: **Benjamin Wakefield**
Project manager: **Angela Shaw**
Associate publisher: **Tracy Cowan**
Heads of projects: **Camila Fronzo and Chris Beck**
Design: **Veesun Ho**
Managing director: **Anthony Kerr**
anthony.kerr@markallengroup.com

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To discuss partnering on case series documents, contact Anthony Kerr on +44 (0)7979 520828
anthony.kerr@markallengroup.com

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Foreword

Rebecca Elwell, Macmillan Lymphoedema Advanced Nurse Practitioner and Team Leader, University Hospitals of North Midlands NHS Trust

Lymphoedema – failure of the lymphatic system, which gives rise to swelling, skin and tissue changes and a predisposition to infection[1] – is still poorly recognised, and awareness is low among both patients and healthcare professionals.[2] People with lymphoedema often report delays in obtaining referral to specialist lymphoedema services, leading to feelings of frustration and anxiety, as well as possible avoidable complications of lymphoedema, such as cellulitis.[3]

There is a lack of specialist lymphoedema services in the UK. Some services restrict referrals to only those patients whose lymphoedema is a result of cancer treatment, and some services exclude patients with a wound. Many wound-care practitioners have had to learn to become expert in the management of chronic oedema, including the adaptation of techniques for compression therapy to manage oedema.

Compression therapy aims to reduce oedema by shifting tissue fluid from the compressed part to the non-compressed parts of the body or limb. By this mechanism, compression can reduce pain and other symptoms, as well as reduce the chance of infection and progression of lymphoedema, by promoting lymphatic drainage.[4]

There are several types of system for delivering compression therapy, including bandages and adjustable wraps. Adjustable compression wraps allow supported self-management and offer the wearer the opportunity to undertake skin hygiene and moisturisation, as well as continue to participate in daily activities. Adjustable-wrap technology has evolved from the early prototypes with interlocking rigid systems, with innovations including to cut-to-fit options, as well as neoprene or thick fabrics that are better tolerated by patients, although bulkier and less conforming. Easywrap (Haddenham Healthcare) adjustable wraps have the advantages of a low profile, durability and the unique opportunity for users to wear their own clothes and shoes.

The ongoing VenUS-6 trial should establish the efficacy of compressive wrap systems in the management of leg ulceration, including their impact on healing compared with compression bandaging. This multicentre randomised controlled trial will randomise 675 participants into three groups: 225 to evidence-based compression, 225 to two-layer bandage and 225 to compression wraps. The primary outcome will be time to wound healing. The associated costs of these treatments to the NHS will also be evaluated. The proposed end date of the trial is January 2024.[5]

Until this time, choice of compression system relies on holistic assessment of the patient, with consideration of oedema level, wound type, wound position and patient tolerance.[6] Where possible, compression should be individualised with respect to the limb's shape and size and the patient's build and gait. Gait is an important metric that may be altered by bulky bandages, oedema and badly fitting footwear that restricts ankle mobility and presents a risk of falls.[7] With any compression system, ongoing review and adaptation are essential to promote wound healing, to reduce exudate and oedema and to support the patient and meet their needs.

This supplement includes a clinical review of lymphatic insufficiency and stiff compression in venous leg ulceration; the results of a study comparing easywrap with six other adjustable wraps by variation in pressure, stiffness and elasticity; and seven case studies on the use of easywrap in venous leg ulceration. It is hoped that this supplement will guide clinical decision making in the selection of the most appropriate adjustable compression wrap for the patient's needs.

Note: Rebecca Elwell is a trustee of the British Lymphology Society

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Lymphatic insufficiency and stiff compression in venous leg ulceration

Julie Stanton, Director of Nursing, Community Telehealth, Pioneer, Sussex Wound Healing and Lymphoedema Centres

Suboptimal management of leg ulcers is a growing burden on the NHS's nursing and financial resources.[1,2] There is a common pattern where failure to establish a leg ulcer's underlying aetiology leads to inappropriate treatment.[2] Such a misdiagnosis may follow an assumption that most leg ulcers are predominantly caused by venous insufficiency. However, this assumption is based on data that are over 25 years old,[3-5] and it misses more recent evidence linking leg ulcers to both lymphatic and venous insufficiency, such that their aetiology should be described as lymphovenous (*Table 1*).[6-8]

In the majority of guidance and best-practice statements on leg ulcers, the relevance of lymphatic insufficiency is not mentioned in any detail.[9,10] However, to improve outcomes for patients with leg ulceration, clinicians need to recognise the interconnected nature of the venous and lymphatic systems. Effective management of leg ulcers requires an understanding of how the lymphatic system functions, how lymphatic insufficiency can affect the wound healing process and the role of oedema.

Pathophysiology

Lymphatic system

The lymphatic system is a network of nodes and vessels that produce and transport lymph, a clear fluid with roles in the immune and circulatory systems. The lymphatic system's circulatory function is to absorb the fluid that leaks into the tissue and return it back into the venous system.[11] This continuous flow of lymph is also needed to fight infection, as white blood cells drag bacteria and toxins through the lymphatic vessels to the lymph nodes, which in turn triggers an immune response.

Lymphatic insufficiency

Damage to or alteration of the free flow of lymph (lymphatic insufficiency) has pathological effects on circulation (lymphostasis) and immune response (lymphatic immunopathy).[11] Such damage can be a primary congenital issue or secondary to trauma, obesity, surgery, immobility, infection or obstruction.[12] Lymphostatic changes are associated with advanced chronic venous insufficiency (CVI), because higher pressures in the veins increase filtration into the interstitial spaces, eventually overloading the lymphatic system and increasing oncotic pressure, which is the mechanism whereby fluid is pulled back into the vessels. Lymphatic immunopathy involves dysfunction of chemical modulators, resulting in a delayed immune response.[11]

Lymphatic insufficiency affecting the skin (lymphostatic dermopathy) leads to reduced oxygenation, tissue breakdown and loss of skin integrity.[11] This compromises the skin's essential immune functions, rendering it vulnerable to a high bioburden and recurrent superficial and chronic infections, including cellulitis. Lymphostatic dermopathy can also trigger subcutaneous fibrosis (lipodermatosclerosis), which affects the nerves, causing pain and discomfort.

Should this inflammatory cycle become chronic, the risk of recurrent and/or chronic ulceration is significantly increased. Moreover, damage to local or regional lymphatic vessels in the area of a wound can significantly decrease its ability to heal and increase its size and bioburden.[8,11]

Lymphatic insufficiency typically manifests as lymphoedema (*Box 1*). Patients with unrecognised or improperly treated lymphoedema will typically progress through stages leading to loss of skin integrity and challenging wounds.

Oedema

The under-recognition of lymphovenous disease is due in part to the misdiagnosis of chronic oedema – swelling caused by the abnormal accumulation of extracellular fluid in tissue.[7,13] Oedema may be attributed to venous insufficiency, where incompetent valves in the deep, perforating or superficial veins lead to failure of the calf muscle pump to return blood back up the leg.[14] CVI can cause oedema, which in turn increases the risk of ulceration due to trauma or skin breakdown due to the underlying disease. However, lymphatic insufficiency is present in most, if not all, patients with CVI of at least Clinical-Etiology-Anatomy-Pathophysiology (CEAP) stage 3, the stages characterised

Table 1. Understanding key terms

Prefix/suffix	Adjective	Noun	Description
Lympho-	Lymphatic	Lymphatic system	Vessels and nodes that circulate lymph
-edema	Oedematous	Oedema	Abnormal accumulation of fluid
Phlebo-	Venous	Veins	Vessels that circulate deoxygenated blood

Box 1. Staging of lymphatic insufficiency and lymphoedema[12]

0.	Swelling not present, despite impaired lymph transport
I.	Early presentation with visible swelling that is soft and pitting and may subside with elevation
II.	Increased swelling; elevation alone rarely reducing oedema; tissues becoming firm; pitting only being possible with strong sustained pressure
III.	Lymphostatic elephantiasis: severe swelling with changes in skin and tissue texture; tissues increasingly fibrotic, no pitting; deep skin folds; may be hyperkeratosis and/or papillomatosis

by the presence of oedema (*Box 2*).[6-8,11] A revision of Starling's law (filtration and reabsorption balance) supports that all oedema is representative of lymphatic insufficiency (lymphoedema).[13-15]

As such, chronic oedema associated with venous insufficiency will also be associated with lymphatic insufficiency, and so it can be characterised as phlebolymphoedema. Phlebolymphoedema results when chronic venous hypertension causes increased capillary filtration and overloads the lymphatic system.[16] It may present with a combination of lymphatic and venous characteristics (*Box 3*).[12,17-19] While oedema associated with venous disease is initially watery and low in protein, lymphoedema and phlebolymphoedema involve extracellular fluid that is higher in protein due to the activation of inflammatory cytokines, making the oedema harder.[8]

Compression therapy

Mechanism of action

Venous and/or lymphatic insufficiency can be effectively treated with compression therapy (*Box 4*).[20] The ideal treatment for CVI would achieve both a decrease in capillary filtration and an improvement in lymphatic function. The right application of pressure improves venous circulation by reducing venous hypertension reflux, improving venous return and maximising the calf muscle pump. It promotes healing of venous leg ulcers by reducing elevated levels of matrix metalloproteinases (MMPs). Meanwhile, in the lymphatic system, an enhanced muscle pump increases the frequency and amplitude of lymph-collector contractions. Opposing fluid filtration from blood capillaries into the tissue decreases the lymphatic load and so reduces formation of excess interstitial fluid. Fluid is shifted into areas with better lymphatic function, where it can be drained. Lymphatic reabsorption is increased, lymphangion contractions are stimulated and fibrosclerotic tissue is broken down.[15] Compression contains the oedema and softens and stimulates lymphatic flow, therefore 'decongesting' the limb.[21]

Compression is the most important part of complex decongestive therapy (CDT), the gold-standard treatment for lymphoedema.[22] CDT aims to reshape and soften the oedematous limb by removing protein-rich extracellular fluid from the congested tissues to areas with better lymphatic function.[17,18,22,23] CDT is a holistic approach, and it should also involve skin care, exercise programmes, psychosocial support and education.

Strength

Compression therapy is delivered at different levels of strength, also referred to as dosage (*Table 2*).[10] In practice, the leg is a dynamic system, and the actual strength of compression at a given time (interface pressure) varies depending on the patient's position and activity. For example, the interface pressure changes whenever the

Box 2. Clinical-Etiology-Anatomy-Pathophysiology (CEAP) staging of venous insufficiency[11]

- C0. No visible or palpable signs of venous disease
- C1. Telangiectasias or reticular veins
- C2. Varicose veins
- C2e. Recurrent varicose veins
- C3. Oedema
- C4. Changes in skin and subcutaneous tissue secondary to chronic venous disease
- C4a. Pigmentation or eczema
- C4b. Lipodermatosclerosis or atrophie blanche
- C4c. Corona phlebectactica (ankle flare)
- C5. Healed
- C6. Active ulcer
- C6r. Recurrent active ulcer

Box 4. Impact of compression therapy

Lymphatic system

- Breakdown of fibrosclerotic tissue
- Decreased fluid filtration from capillaries into tissue
- Decreased formation of excess interstitial fluid
- Decreased lymphatic load
- Enhanced muscle pump
- Increased frequency and amplitude of lymph-collector contractions
- Increased lymphatic reabsorption
- Increased stimulation of lymphangion contractions
- Shifting of fluid into areas with better lymphatic function

Venous system

- Improved venous return
- Maximised calf muscle pump
- Reduced elevated matrix metalloproteinase levels
- Reduced venous reflux
- Reduces venous hypertension

Box 3. Characteristics of phlebolymphoedema[12]

- Moderate-to-severe hyperkeratosis
- Oedema rarely reducing at night
- Lipodermatosclerosis
- Oedema to the toes and foot
- Mild or thickened skin folds
- Positive Stemmer's sign

Table 2. Compression therapy by strength

Strength	Pressure
Mild	<20 mmHg
Moderate	20–40 mmHg
Strong	40–60 mmHg
Very strong	>60 mmHg

shape of the leg changes with contractions of the muscle, such as when pressure is intermittently increased by expansion of the calf muscle. A compression system's ability to resist calf muscle expansion is known as its dynamic stiffness index (DSI). Standing pressure is directly related to resistance to stretch; it is the pressure dynamic that produces the 'micro massage' effect to stimulate a positive impact on lymphatic, venous and arterial circulation.[9,10,21,24–27] Interface pressure can also be affected by a variety of patient and clinician variables (*Box 5*).[10,22,23,28,29]

Dynamic profile (elasticity or stiffness)

Compression systems vary in their dynamic profile, also known as elasticity or stiffness. This affects the system's performance and produces different haemodynamic effects.[13,30,31] The dynamic profile is determined by measuring the difference between the interface pressures when the patient is supine (lying pressure) and standing or walking (standing pressure). This can be calculated as a static stiffness index (SSI). An elastic system will be yielding and give way when standing or walking, with a narrow dynamic profile and relatively modest difference between resting and standing pressures.[32] Conversely, a stiff system will have a broad dynamic profile, with a relatively high difference between resting and standing pressures.[31] This makes stiff compression systems better suited to containment, as the fabric is resistant to stretching, which would not allow the oedema to come back into the limb.[21,27,33] Stiffness can be valuable when standing or walking, as the higher standing pressure can compensate for increased pressure on the vessels (hydrostatic load). It is also valuable during rest, especially bed rest, as a lower lying pressure is more comfortable and thus better tolerated.[21,27,31]

Compression systems should be classified according to the stiffness of the final application, rather than by the elastic behaviour of the constituent materials, which are often used in combination.[21,34] In practice, this might mean classifying compression systems according to their ability to generate and maintain a predetermined level of compression at the ankle on an 'average' leg, referring to the typical limb of a person of average height and weight without overt disease present.

Compression systems

Compression therapy can be applied with a variety of systems, including both dynamic pneumatic pumps and static systems, such as bandages, hosiery and adjustable wraps, all of which have different advantages, disadvantages and dynamic profiles (*Table 3* and *Figure 1*).[31] Bandaging systems include short-stretch bandages and multilayer kits of elastic bandages, which become stiffer when used in two, three or four layers. These stiff and elastic bandages can be used in combination for a high standing pressure that is suitable for less mobile patients. The interface pressure provided by compression bandages decreases over time, due to a combination of slippage, material fatigue and oedema reduction.[28,29] Compression hosiery, which includes stockings and socks, comes in removable two-layer kits that are suitable for self-management but are relatively elastic and also liable to lose strength over time.

Adjustable wraps—also known as adjustable Velcro devices—create a semi-rigid compression system that provides resistance to tissue movement, enabling

Box 5. Variables affecting pressure

Patient variables

- Limb circumference and shape distortion
- Soft tissue covering of the leg (bony prominences)
- Activity levels of the patient
- Underlying pathology
- Type and texture of oedema

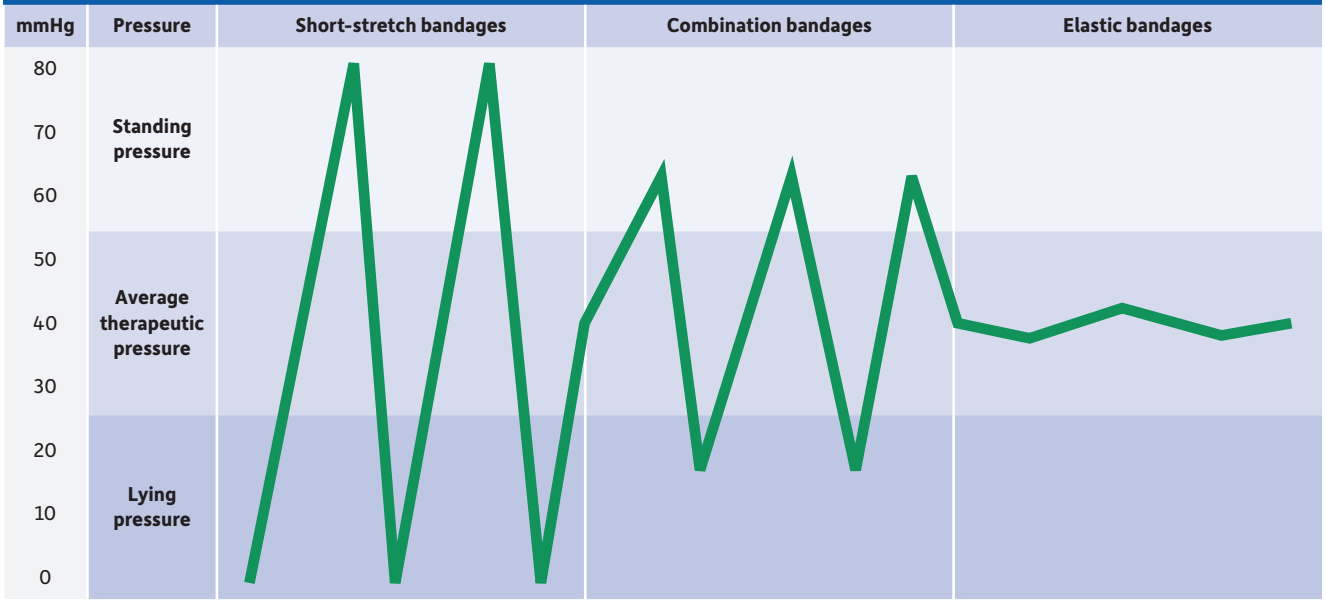
Clinician variables

- Poor bandaging techniques (inconsistent tension, overlap)
- Inappropriate knowledge (compression classes, application and types, as well as patient abilities, such as movement and exercise)
- Fear of causing harm
- Lack of training and education

Table 3. Compression garments

Type	Advantages	Disadvantages	Dynamic profile
Short-stretch bandages	▪ High standing pressure ▪ Low lying pressure	▪ Low lying pressure (higher pressure requires movement) ▪ Loss of pressure over time	Stiff
Multilayer bandage kits	▪ Consistent standing pressure ▪ Suitability for less mobile or immobile patients ▪ Greater combined stiffness provided by use of elastic bandages in 2–4 layers rather than individually	▪ Loss of pressure over time ▪ Inability to reach higher peak pressure ▪ Potential discomfort due to consistent pressure	Individually elastic; stiff in multiple layers
Combination elastic/inelastic bandages	▪ High standing pressure ▪ Suitability for less mobile patients	▪ Lower lying pressure than full inelastic short-stretch bandages	Stiff
Adjustable wraps	▪ Suitability for self-management	▪ Removability ▪ Loss of compression dosage due to fabric fatigue	Stiff
Two-layer hosiery kits	▪ Ability to reapply to achieve consistent pressure ▪ Suitability for self-management	▪ Removability ▪ Loss of pressure with improper application	Relatively elastic

Figure 1. Dynamic profiles of different compression systems



pressure variations within the tissues, thereby promoting both lymphatic and venous function.[30] Adjustable wraps provide a low lying pressure and high standing pressure, and they have been shown to achieve interface pressures and SSIs that are similar and in some cases higher than short-stretch bandages.[35,36] Compression systems, including bandages, can lose their pressure over 24 hours following application, so adjustable wraps can be adjusted throughout the day to keep the level of compression consistent.[29,31] However, this consistency depends on the patient having the dexterity and concordance to reapply the adjustable wrap throughout the day.[37] Compared with compression bandages, adjustable wraps are less bulky, reducing restrictions on mobility. They are also easier to apply for both clinicians and patients, potentially saving costs from nursing time and making them especially suited to aid self-management.[24,35,36,38-40] Many adjustable wraps are designed to mimic the standard 50% overlap of traditional bandaging systems, allowing for greater comfort.[39] All of this can make adjustable wraps an effective alternative to either compression bandages or hosiery.

Indications

Compression therapy is the most important therapeutic procedure for leg ulceration caused by venous and/or lymphatic insufficiency and should usually be the first-line treatment.[13,20,31,41] There are several different compression systems available, and the choice of system should be matched to the following individual patient factors:

- Activity level
- Ankle circumference
- Dexterity
- Disease pathology
- Lifestyle
- Mobility
- Skin texture (hard or soft)
- Wound size, duration and complexity.[13,24,26,31,33,42]

A compression system needs to achieve several goals (*Box 6*).[31,32] The chosen system should provide the ideal interface pressure on the affected leg, as well as the system's comfort and tolerability necessary for continued adherence. Its ability to achieve these goals will be determined by the following features:

- Compression strength
- Consistency of pressure over time
- Durability
- Dynamic profile (elasticity or stiffness)
- Ease of application
- Slippage
- System type.

In general, strong compression (>40 mmHg) is recommended for the treatment of leg ulcers.[20,31] Stiffer systems with higher standing pressures are better at promoting healing in wounds with lymphovenous aetiologies.[21,29,32,34] A more significant haemodynamic effect with better healing results can usually be achieved with compression systems with multiple layers or a single stiff layer than one with a single elastic layer.[26,31]

This choice should be guided by evidence of the system's clinical efficacy in a comparable indication. However, research comparing the

Box 6. Goals of an ideal compression system

- Adapt to cope with limb distortion
- Allow the patient to wear appropriate clothing and footwear
- Avoid causing allergic reactions (non-sensitising)
- Deliver sufficient active pressure for standing and walking
- Deliver tolerably low lying pressure
- Encourage safe, accurate and consistent application
- Enhance calf muscle function
- Last for up to 7 days
- Stay in place until next application
- Permit the patient to mobilise

healing outcomes of different compression systems is limited, and additional studies are needed to draw and conclusions on their relative superiority.[28,31,34]

Practical issues

Underuse

Compression therapy remains underutilised in the management of leg ulcers, despite the evidence of its efficacy in ulcers of various aetiologies.[43] There are a variety of reasons for this. The perception of compression therapy as uncomfortable or painful can discourage clinicians from attempting it, especially in patients with painful ulceration. This fear of causing injury to the patient is often misplaced, and correctly applied compression therapy can relieve pain associated with venous or lymphatic disease, as well as numbness and poor range of movement.[44] Clinicians who are willing to use compression may be under financial pressure or lack the necessary organisational support and resources, such as a formulary limitations without the full range of compression options.[44-48] Not all clinicians have the level of professional competency needed to correctly apply compression therapy, especially bandage systems. These variations in clinician education and experience can be addressed by making training more widely available.[44-47] Overcoming these barriers and increasing use of compression can improve patient outcomes and quality of life.[45]

Adherence

Patients with leg ulcers do not always adhere to prescribed compression therapy.[45] Compression can be uncomfortable or painful, especially shortly after it has commenced before it takes full effect. Patients may object to the cosmetic appearance of a compression system, or they may find compression therapy difficult to fit in with their lifestyle.[45,49] However, non-adherence can delay healing, worsen symptoms and lead to disease progression and further complications, resulting in poor outcomes and higher management costs.[50]

Clinicians should avoid citing non-adherence as an excuse for poor outcomes and instead aim to ensure patients are in concordance with their treatment plan.[45] Clinicians should improve their professional knowledge and develop patient-centred compression therapy pathways and formularies. This will allow clinicians to recommend the most appropriate compression options to maximise results and minimise discomfort.[45,51,52] These positive experiences of compression will encourage continuing adherence. Adherence can also be improved by supporting patient choice and self-care.

Patient choice

The outcomes and experience of care can be improved by supporting active patient involvement in their treatment.[49,51] Patients can be empowered to make an informed decision between a range of appropriate compression systems, selecting the one best suited to their clinical presentation and personal preferences. Participation and engagement in management decisions has been shown to have clinical and holistic benefits for patients.[52,53] This does require clinicians to be knowledgeable about the compression systems available, the theory behind how they work and how they are best applied, as well the patient's clinical presentation, lifestyle and personal preferences.

Self-care

Patient participation can also mean supporting patients to independently manage aspects of their condition where appropriate. A 2020 study found that 50% of all new patients with wounds assessed in a community setting were eligible for a self-care pathway which ultimately released nursing time.[54] Self-care releases nursing time, reduces costs and contributes to sustainability of healthcare systems.[54] However, self-care needs to maintain pressure and comfort, and so it relies on clinicians delivering effective patient education on how to apply compression correctly and when to seek professional assistance.[51-55] To achieve this, wound care and tissue viability services can build on the self-care initiatives set up during the COVID-19 pandemic.

Conclusions

Clinical knowledge about the lymphatic system is continuously expanding, and clinicians involved in wound care need to overcome the assumption that most leg ulcers are predominantly venous in aetiology, when many of these chronic, complex wounds also involve lymphoedema as a component.

Therefore, clinicians participating in the management of patients with leg ulcers need to be able to recognise the clinical presentation of lymphatic, venous and lymphovenous insufficiency and accurately identify lymphoedema in its early stages. Following this, it is necessary to develop and implement treatment plans and modalities for lymphovenous aetiologies that address venous and lymphatic insufficiencies in parallel and optimise both venous and lymphatic haemodynamics.[8,56] This should promote effective healing and improve patient outcomes.

Those treating patients with leg ulcers should deepen their understanding of the dynamics of compression, going beyond strength level alone to consider the stiffness or elasticity of a system's dynamic profile and how this affects the venous and lymphatic systems. This understanding can be used to select the most appropriate compression system for the patient's needs. The outcomes of compression can be improved by addressing underuse and non-adherence and promoting patient choice and independent self-care. A more personalised and evidenced-based approach to compression therapy will improve concordance, cost efficiency and patient outcomes.

As identified by the Legs Matter campaign, NHS services across the UK need to improve the quality of care when it comes to the treatment of leg ulceration.[49] Managing the increasing demand for wound care will require structural changes. Services should be integrated, rather than operating in silos, in order to improve patients' assessment and access to the right care at the right time.[57] Meanwhile, nurses need to be adequately trained and given the resources to apply effective compression to the right individual at the right time, while increasing awareness of the impact of lymphoedema.

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Comparing the variation of pressure, stiffness and elasticity achieved in seven adjustable wrap systems including easywrap strong

Natalie Phillips, Clinical Manager (Lymphoedema), Haddenham Healthcare, and **Tom Wright**, Managing Director, Haddenham Healthcare

Background: Existing information provided by manufactures and evidence does not always offer clear guidance of why to select the most appropriate product for a suitable patient. When selecting, terms such as short-stretch or inelastic are used to describe adjustable wrap properties, and generally wraps are indicated as an alternative to traditional compression bandages. Metrics such as variation in pressure, stiffness and elasticity can be applied to adjustable wraps and could be used to assist selection.

Aims: To determine whether easywrap strong (Haddenham Healthcare) had a lower standard deviation (SD) in lying pressure, greater static stiffness index (SSI) and/or a greater mean elongation ratio than six other adjustable wraps.

Methods: In this preliminary exploratory study, seven adjustable wraps were tested in vivo 20 times each (140 tests in total), on 20 people (with a variable number of readings per participant), to give the SD in lying pressure and mean SSI. The same wraps were tested in vitro five times each to give the mean elongation ratio.

Findings: Of all seven adjustable wraps, easywrap strong had the second lowest SD in lying pressure at 5.9 mmHg, compared with 8.9 mmHg overall; the highest mean SSI at 13.2 mmHg, compared with 9.5 mmHg overall; and the highest mean elongation ratio at 137.0%, compared with 107.1% overall.

Conclusions: These metrics suggest that theoretical principles and tests used in compression bandages are applicable to easywrap strong by demonstrating a low variation in lying pressure, suggesting consistent application of pressures within intended therapeutic levels. Higher SSI indicates greater resistance to stretching, which is linked to improved venous function and oedema reduction. Higher elongation ratio demonstrates greater tensile strength, which should maintain therapeutic pressure for longer without readjustment.

This article presents the results of a novel comparative study of seven different adjustable wraps available in the UK, using methods established in compression bandages. These two types of compression system, bandages and wraps, were introduced in the previous article in this supplement, which explored the pathophysiology of venous and lymphatic insufficiency and how these conditions can be treated with compression therapy.

Background

The benefits of using adjustable wraps are detailed in several case studies published in peer-reviewed journals.[1] Research has shown that stiff adjustable wraps may be more effective than inelastic compression bandages in healing venous leg ulcers, although statistical significance was not established.[2] At the time of testing, there were seven adjustable wraps listed in the lymphoedema category of the NHS Drug Tariff system that could deliver compression levels of 40 millimetres of mercury (mmHg) to the limb. However, there is no clear guidance or comprehensive comparative evidence to help clinicians select between adjustable wraps. This leaves health professionals to rely on their clinical experience and individual preference to choose the most appropriate option for their patients.[3]

In contrast, there is a wealth of scientific research supporting the use of compression bandages to manage lymphoedema, chronic oedema and venous leg ulcers.[4,5] Likewise, appropriate product selection can be assisted by published standards and recommendations[6] detailing the practical aspects of classifying compression bandages – some of which form part of German testing standards (DIN 61632:2009-12).[7] There are established theoretical principles that underpin the manufacture, testing and use of compression bandages. According to these principles, the ability of a compression system to consistently apply the appropriate level of therapeutic pressure – and thus improve the condition of a leg in clinical practice – is indicated by three main variables: lying pressure, stiffness and elasticity.

Lying pressure indicates how much force a compression system exerts on the limb (interface pressure) when the person is lying in a supine position. Interface pressures are measured in mmHg at the medial point of B1, where the Achilles tendon meets the gastrocnemius muscle, as research suggests this is the point that will show the greatest difference between lying and standing pressures.[6] In clinical practice, minimal variation in lying pressure is preferable, suggesting greater consistency in applied pressure on the limb and thus greater likelihood of it being within the intended therapeutic levels.

Stiffness indicates a compression system's dynamic profile or resistance to stretching. Stiffness is calculated as a static stiffness index (SSI), which is the difference between the lying pressure and standing pressure (when the person is upright). Stiffness in

this context has been theoretically defined as the increase in interface pressure per centimetre increase in leg circumference.[6] In clinical practice, higher stiffness is preferable, suggesting a relatively lower lying pressure that is more comfortable and thus better tolerated at rest and a relatively higher standing pressure that can better compensate for increased pressure on the vessels (hydrostatic load) and prevent oedema returning to the limb. According to Mosti et al,[10] greater stiffness is linked to improved venous function in people with venous insufficiency. According to Partsch et al[6] and treatment guidelines,[11] a compression system that is sufficiently stiff to reduce oedema should have an SSI of at least 10 mmHg.

Elasticity indicates a compression system's tensile strength, which can be understood as the length the material returns to after being stretched. Elasticity is calculated as an elongation ratio, which is the elongated length minus the residual length, divided by the elongated length minus the initial length, expressed as a percentage. In clinical practice, greater tensile strength is preferable, suggesting different material properties that are able to return to their original length (or smaller) without losing pressure over time.[12]

Adjustable wraps are often indicated as an alternative to compression bandages and have a similar mechanism of action. Therefore, it would be reasonable to suggest that lying pressure, stiffness and elasticity could be as relevant to adjustable wraps as they are to compression bandages, and evidence should be collected to test this.

Aims

Haddenham Healthcare conducted a study to see if the theoretical principles used in bandaging were applicable to wraps by testing and comparing the characteristics of wraps used to treat lymphoedema, and to see if conclusions could be drawn in relation to easywrap strong (Haddenham Healthcare) using the parameters of lying pressure, static stiffness and elasticity. The primary aim was to determine whether easywrap strong had lower variation in lying pressure than the other six wraps. The secondary aim was to determine if easywrap strong had greater stiffness and elasticity than the other six wraps.

Methods

The study included seven of the adjustable wraps listed in the NHS Drug Tariff at the time of testing that could achieve a pressure on application of 40 mmHg. All wraps, except easywrap strong, were anonymised in the results due to this being an industry-sponsored publication.

The adjustable wraps underwent in vivo testing, undertaken in house over a period of 4 days. A convenience sample was recruited of 20 healthy adults who did not have a diagnosis of lymphoedema, venous disease or lipoedema, nor any contraindications for graduated compression. Participants were recruited from the office base of the researchers. All participants were given detailed written information on the study aims and gave their written informed consent. Their age, sex and ankle circumferences were recorded.

Each participant first rested in the supine position on a treatment couch, where their ankle circumference and calf circumference were measured. First, a pressure monitor (PicoPress, Microlab) was calibrated and placed on one of the participant's legs and fixed in place with a liner. Then the selected adjustable wrap was applied to the limb as per application guidelines, by a clinician experienced in the use of all the devices tested. After 5 minutes of resting, with the participant still supine, the reading from the pressure monitor was recorded, giving the lying pressure. This was used to calculate the standard deviation as a measure of variability in lying pressure. The participants were then asked to stand up, and, after 1 minute, the reading from the pressure monitor was recorded, giving the standing pressure, and thus the SSI was calculated. To minimise bias, the pressure monitors were covered while the adjustable wraps were applied, and the readings were not revealed or documented until a further minute had gone by. This formed baseline measurements.

After each adjustable wrap was tested, the pressure monitor was recalibrated to ensure the pressure within the bladder was zero, according to the manufacturer's instructions. This process was repeated 20 times for each adjustable wrap, equating to 140 readings in total. The number of readings taken per participant varied due to the compatibility of their ankle size.

The adjustable wraps underwent in vitro tensile testing of elasticity, which was undertaken externally. Seven adjustable wraps were cut into ≈30 cm length x 8 cm width bands, labelled and sent to an independent laboratory commissioned by Haddenham Healthcare. Each 5 cm end of the fabric samples were placed between the clamps of a tensile testing machine, and the length between was stretched under a force of 1 N per centimetre. The lengths before, during and after being stretched were measured, and calculated to give three percentage values:

- Elongated length, the length during stretching at 1 N/cm as a percentage of the initial length
- Residual length, the length 2 minutes after being relaxed following stretching at 1 N/cm as a percentage of the initial length
- Elongation ratio, the elongated length minus the residual length, divided by the elongated length minus the initial length.

This was performed five times for each wrap.

The adjustable wraps were described as single-layer and double-layer, to enable grouping of the wraps into two groups, to allow for analysis of the data obtained during testing. The authors recognise that this is not an agreed industry definition. (*Figure 1*): single-layer wraps, applied as a single

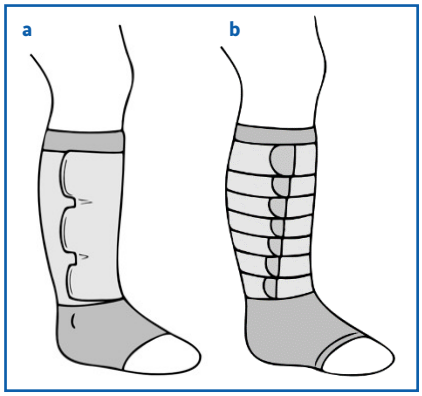

Figure 1. Adjustable wrap types: single-layer wrap (a) and double-layer wrap (b)

non-overlapping piece, which may itself contain multiple layers of fabric, applied as bands of fabric that overlap each other by around 50%.[6]

Results

In the in vivo test, the average age of participants was 43.5 years (standard deviation (SD) 15.2 years), and 55% (n=11) were male. The average circumference of their ankle was 22.4 cm (SD 1.3 cm) and calf was 38.9 cm (SD 3.3 cm).

The SDs in lying pressures are given in *Table 1*. The wraps with the lowest SD in lying pressure were wrap 1 at 5.2 mmHg, wrap 5 (easywrap strong) at 5.9 mmHg and wrap 2 at 7.0 mmHg, compared with 8.9 mmHg across all seven wraps.

The mean SSI per wrap is given in Table 1. The wraps with the highest mean SSI were wrap 5 (easywrap strong) at 13.2 mmHg, wrap 7 at 11.7 mmHg and wrap 4 at 9.7 mmHg. This compares with an overall mean SSI of 9.5 mmHg.

The results of in vitro tensile testing of elasticity are given in *Table 1*. The wraps with the highest mean elongation ratio were wrap 5 (easywrap strong) at 137.0%, wrap 6 at 111.0% and wrap 7 at 105.0%, compared with an overall mean elongation ratio of 107.1%.

Of the seven adjustable wraps, three were single-layer wraps and four were double-layer wraps, including wrap 5 (easywrap strong). Mean SSI was greater in double-layer wraps than in single-layer wraps (10.5 vs 8.1 mmHg). Variation in lying pressure was lower in single-layer wraps than in double-layer wraps (SD 6.5 vs 7.3 mmHg), which was because of wrap 1 having the lowest mean lying pressure and lowest variation in lying pressure of all the wraps, an outlier in the single-layer group. Average elongation ratios were greater for double-layer wraps compared with single-layer wraps (124.1% vs 100.3%), which is discussed in the limitations section.

Discussion

Among all adjustable wraps tested, wrap 5 (easywrap strong) achieved the lowest variation in lying pressure, with an SD of 5.9 mmHg, demonstrating the greatest consistency of pressure on application.

The mean SSIs of five specific adjustable wraps and all adjustable wraps together (9.47 mmHg) were below the 10 mmHg threshold in Partsch et al.[6] Only 65 of 140 applications achieved an SSI of at least 10 mmHg. Only wrap 5 (easywrap strong) and wrap 7 achieved an average SSI of greater than 10 mmHg.

Wrap 5 (easywrap strong)'s greater consistency of lying pressures and higher stiffness as measured by SSI may have been the result of differences in its specific components and how these components were combined in the manufacturing process. Wrap 5 (easywrap strong) is made from a knitted fabric, while wrap 6 is made from sewn layers of fabric and all other wraps are made from laminated layers of fabric.[9] One hypothesis is that knitted rather than laminated or sewn construction may be better able to maintain structure, shape and function when stretched. However, this would need further independent testing to confirm.

The specific components of each adjustable wrap, and the way in which it is constructed, are likely to influence the interface pressure, stiffness and other aspects of how it performs. Like compression bandages, adjustable wraps could be described as either single-component (comprising a single piece of foam or bandage) or multicomponent kits (applied with a liner underneath or having an inbuilt liner). All adjustable wraps were made from a mix of different synthetic fibres, such as polyamide, nylon and polyurethane, which differ in their breathability and ability to stretch.[9] However, clinicians generally only need to know what materials a compression system is made from to be aware of potential patient allergies or sensitivities.[6]

Rigid (inelastic) compression bandages have very vertical stress-strain curves, meaning changes in stretch produce relatively pronounced changes to the pressure applied to the limb, and this could be applicable to adjustable wraps.[13] Wraps could be described as having a lockout similar to bandages. When describing easywrap strong, although classified as an inelastic wrap, is designed with an inherent lockout that means it does not operate on a very vertical part of the stress–strain curve. Consequently, an adjustable wrap with elastic properties that is correctly sized and re-adjusted as the limb reduces should deliver therapeutic pressure, even below lockout tension, and should require less reapplication. This also means that the straps do not have to be applied with absolute precision to achieve the correct tension.

Double-layer wraps applied a greater mean lying pressure and are theoretically significantly stiffer than single-layer wraps, suggesting that double-layer wraps are likely to be the more clinically effective option. However, larger independent studies could solidify these data.

The Partsch[6] testing standards for bandages are not fully applicable to adjustable wraps. For example, this study diverges from Partsch et al[6] by not giving maximum stretch (at 10 N/cm), as such high pressures are not likely to occur in practice and thus

Table 1. Variation in pressure, stiffness and elasticity of seven adjustable wraps

Wrap	Standard deviation of lying pressure (mmHg)	Mean static stiffness index (mmHg)	Mean elongation ratio (%)	Layers
Wrap 1	5.2	6.7	97.1	Single
Wrap 2	7.0	9.5	96.6	Single
Wrap 3	7.4	8.1	101.0	Single
Wrap 4	8.3	9.7	101.0	Double
Wrap 5	5.9	13.2	137.0	Double
Wrap 6	7.9	7.6	111.0	Double
Wrap 7	7.1	11.7	105.0	Double

have little clinical relevance. The Partsch standards[6] did not clearly define parameters for elongation, and, although testing was carried out in line with DIN standards,[7] the suggested parameters of 90% for elongated length and 70% for elongation ratio are only relevant to crepe cotton bandages. All these testing methods refer to bandages that are overlapped at 50%, which is not applicable to adjustable wraps that do not have an overlap. It is important to be aware that there are different testing standards globally, including testing methods that use lower force.

To inform clinical practice, it is valuable to know how reliably the interface pressures applied by different adjustable wraps fall within therapeutic ranges for specific indications, as well as within manufacturer recommendations and patient tolerance. For example, guidelines recommended therapeutic compression levels for healing and maintenance of venous leg ulcer of at least 40 mmHg, within manufacturer recommendations, while the recommended compression for reduction of lymphoedema is the highest level tolerated up to 60 mmHg.[4,5] The distribution of lying and standing pressures for each adjustable wrap is illustrated in *Figures 2* and *3*. The wraps included in this study differed in how consistently they applied pressure within these ranges.

Limitations

This study has some limitations. Although every care has been taken to reduce researcher bias, it was conducted by the manufacturer of one of the tested adjustable wraps and so is not independent. The in vitro laboratory tests could not show whether interface pressures would be affected by variations in the size and shape of limbs, muscles and tissues. The methods in which the wraps were prepared for testing could have impacted test results. Meanwhile, in vivo testing presented the risk of user error, such as potential incorrect placement of pressure monitors or adjustable wraps. Likewise, the pressures exerted by each adjustable wrap on human subjects could be impacted by many variables, such as an underlying condition that the researchers were not made aware of during the consent process.

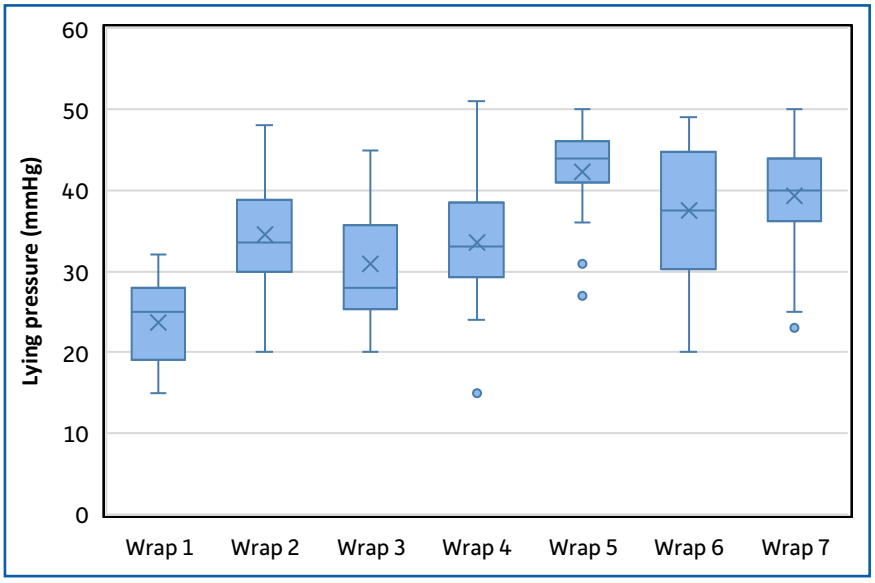

Figure 2. Distribution of lying pressures of seven adjustable wraps (mmHg)

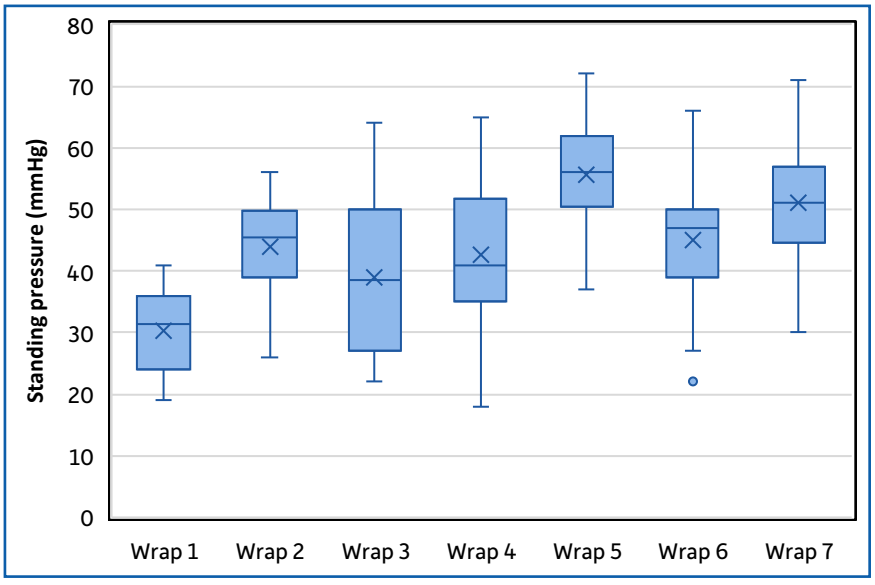

Figure 3. Distribution of standing pressures of seven adjustable wraps (mmHg)

Furthermore, as these tests were conducted on healthy adults, ankle circumferences were at the smaller end of what is seen in clinical practice, and while the appropriately sized wrap was fitted to the limb, the smaller ankle circumferences could have resulted in higher pressures documented on application. However, this was not the case for wrap one; the smallest wraps available fitted all test subjects and did not achieve its stated 40 mmHg pressure.

In the authors' experience, clinicians typically use the terms stiffness and elasticity interchangeably to mean the same thing. However, the metrics adapted from Partsch et al[6] for this study record stiffness and elasticity separately: stiffness as an SSI, calculated from the difference between interface pressures measured in vivo, and elasticity as elongated length, residual length and elongation ratio, calculated from tensile testing measured in vitro.[14] The distinction between these concepts

is not straightforward, and this could be problematic and cause confusion for clinicians using compression systems.

The number of readings taken per participant varied because of the compatibility of their ankle size with the wraps being tested, meaning that some wraps were tried on the same participant more than once and not all wraps were tried on all participants. This is likely to have introduced some clustering of data.

Conclusions

Clinicians providing compression therapy to treat lymphatic and/or venous disease need to be able to determine how different compression systems are likely to perform in clinical practice. This makes it possible to select the most appropriate option for an individual patient's needs. The metrics of stiffness could be applicable to all wraps; however, this should be confirmed by each industry partner. The metrics of elasticity may not be a suitable testing method for all wraps, although they could be more applicable to those wraps that are designed to be applied as overlapping devices. This should also be confirmed by industry partners individually. In the case of easywrap strong, these metrics are applicable.

With the second lowest standard deviation in lying pressure at 5.9 mmHg, the highest mean SSI at 13.2 mmHg and the highest average elongation ratio at 137.0%, easywrap strong likely has clinical advantages over the other six adjustable wraps in terms of wound healing and oedema reduction, which is demonstrated in case studies within this suppliment. However, large scale clinical research should be conducted to improve the body of evidence to demonstrate this. Furthermore, industry standards should be developed to enable robust testing of wraps in the laboratory. These results suggest that easywrap strong may apply therapeutic pressures more consistently, improve venous function and maintain therapeutic pressure for longer without readjustment.

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Case study 1. Highly exuding venous leg ulcers with gross oedema and varicose eczema

Sylvie Hampton, Independent Tissue Viability Consultant Nurse

A 69-year-old man, John, presented at the specialist wound clinic with several small leg ulcers that had been non-healing for 9 weeks, as well as serous fluid weeping from his legs.

Background

John had been experiencing recurrent venous leg ulceration ulcers for the past 2 years. He had a history of bilateral varicose eczema, oedema and treated atrial fibrillation, as well as obesity that was increasing as a result of diabetes, poor nutrition and lack of mobility.

John was mobile but slept in his riser recliner chair at night and spent a great deal of the day in the chair as well, rarely mobilising, all of which contributed to his chronic oedema. He reported feeling more comfortable in the chair than in bed. He lived alone in assisted-living accommodation, although his son stayed with him several nights a week.

John's wounds were being dressed with a foam dressing (Biatain, Coloplast), which he found to be comfortable. His flare-ups of eczema were treated with short courses of a strong topical corticosteroid cream (clobetasol), as weaker corticosteroids had not been effective. He had also been prescribed compression hosiery for venous insufficiency, but had been unable to independently remove his hosiery and relied on the nurses to do so weekly, and he was consistently non-concordant.

Presentation

On presentation, John had four wounds, the largest measuring 5 cm by 3 cm and the others measuring no more than 3 cm at the widest point (*Figure 1*). The wounds were all very shallow, with some maceration at the wound edges as a result of the excessive exudate. There were no clinical signs of infection. The wounds were highly exuding, and the serous fluid weeping from John's leg was soaking his dressings and slippers, as well as causing other problems. John's legs were grossly oedematous, with measurements given in *Box 1*. Eczema was present on the surrounding skin.

Treatment

Wound care was continued per local practice, with the wounds being cleaned with a wound irrigation solution (Octenilin) to prevent infection and then dressed with the same foam dressing (Biatain) used before the evaluation. His eczema was again treated with corticosteroid cream. However, John had his compression system changed to easywrap (Haddenham Healthcare)adjustable wraps, to enable him to independently remove and reapply them for showering. He would attend the wound clinic weekly for review.

John was advised by the diabetic team and the tissue viability consultant nurse to make lifestyle changes to reduce his weight. He was also advised to stop sleeping in a chair, as this had a negative effect on his lower legs.

Follow-up

Within 2 weeks, the exudate had stopped, and the wound had healed. After two applications of corticosteroid cream, his varicose eczema had significantly improved. By day 52, John's legs showed a marked improvement (*Figure 2*) and his oedema had reduced in size (*Box 1*). Therefore, he would no longer need to attend wound clinic regularly and would instead ask for an appointment if concerned.

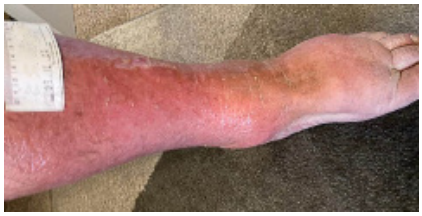

Figure 1. Presentation

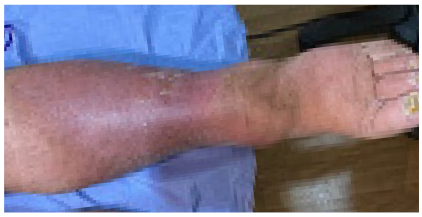

Figure 2. Day 52

Box 1. Leg size (cm)

Measurement	Day 0	Day 52
Left ankle	32.5	31.5
Left midcalf	48.5	48.5
Right ankle	33	31
Right midcalf	49.2	47.5

Despite advice, John's weight had continued to increase, and he was still sleeping in a chair day and night. He acknowledged that he had made an informed choice in this.

Discussion

John felt easywrap had certainly improved his quality of life, especially as his slippers were no longer soaked by his oozing legs. He reported finding easywrap simple to apply and remove and that this allowed him to manage extremely well independently.

Case study 2. Venous leg ulcers, eczema and hosiery that had not been changed for 2.5 years

Sylvie Hampton, Independent Tissue Viability Consultant Nurse

A 62-year-old man, Charlie, presented to his GP with venous leg ulceration and compression hosiery that had not been changed for 2.5 years.

Background

Charlie had experienced recurrent venous leg ulceration over a 4-year period. He also had varicose eczema related to venous insufficiency, which recurred when there was no one to care for his legs appropriately at that time. He had no other medical history and was fully mobile.

Charlie's venous insufficiency was being treated with class 3 compression hosiery, and his eczema was being treated with light hypoallergenic stockings (DermaSilk) worn against the skin which assists in managing the symptoms of eczema. However, he was unable to apply this hosiery himself, owing in part to anxiety, and he had no access to NHS care while his leg ulcers had healed. To overcome this, he had arranged for weekly visits by a private home carer to wash his legs and apply his hosiery for him.

However, these carer visits stopped in 2020 because of the COVID-19 restrictions, and over the following 2.5 years Charlie did not once remove his hosiery. Neither Charlie nor his carer informed the GP that he was without help and was not removing his hosiery, as Charlie believed that the COVID-19 restrictions meant no one was permitted to visit him at home. During that 2.5 years with his hosiery never removed, his skin did not deteriorate, while the wounds that had developed during the maintenance had almost closed in that time, and several had healed. He continued to have difficulty applying the provided compression hosiery after the 2.5 years once he had the hosiery removed.

Presentation

At the GP wound clinic, Charlie's hosiery had to be removed by cutting it off. There were large clumps of damp skin cells that fell away as the hosiery was removed, but there was no odour.

Charlie then underwent a lower-limb assessment. In both limbs, his ankle brachial pressure index (ABPI) was 0.9, his capillary refill was 2 seconds and his Doppler sounds were biphasic and clear. The skin on his legs was in a fair condition, dark red in colour and very fragile as a result of the eczema (*Figure 1*). There were also signs of hyperkeratosis, haemosiderin staining and oedema. There was no gross oedema of the lower limb (likely because the hosiery had been in place), but the thigh was large above where the hosiery ended. His leg measurements are given in *Box 1*.

There were two small, very shallow wounds on the right leg, measuring 3 cm by 3 cm and 1 cm by 4 cm. These wounds were clean, with no signs of infection.

Within a few days of removing the hosiery, Charlie developed blisters around his ankles. However, these quickly resolved and were thought to have resulted from the release of the continuous pressure after 2.5 years.

Treatment

Charlie was prescribed and agreed to a new course of treatment (*Figure 2*).

Box 1. Leg size at presentation (cm)

Measurement	Left	Right
Ankle	24	23
Midcalf	27.5	30
Proximal calf	33	37

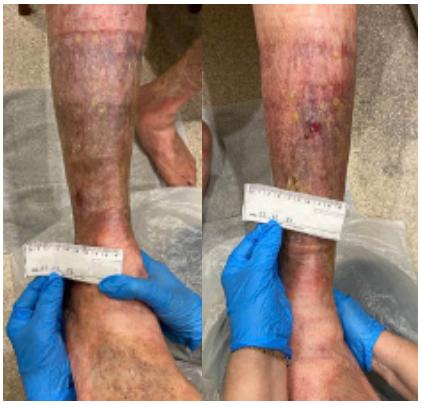

Figure 1. Presentation: right (a) and left leg (b)

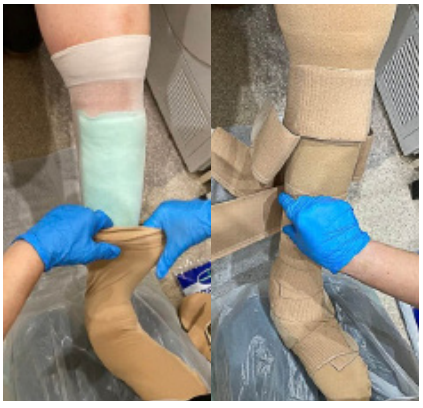

Figure 2. Treatment: hypoallergenic stockings and pad in situ (a) and applying easywrap (b)

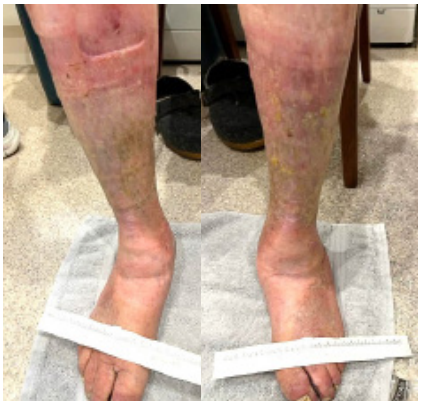

Figure 3. Week 8: right (a) and left leg (b)

Each week, his legs were to be washed in a bucket of warm tap water, and an appropriate emollient cream would be applied to improve skin integrity. He would continue to wear light hypoallergenic stockings against the skin to treat his eczema and hyperkeratosis. As Charlie's ankle circumference was below 18 cm, it was agreed that he would need additional padding over the bony prominences of the shin and ankle to protect against any pressure. This was provided with a hypoallergenic absorbent dressing pad (Zetuvit, Hartmann), with orthopaedic wool avoided because of the risk of exacerbating any eczema that may occur.

After trialling a short-stretch compression bandage for 2 weeks, it was recommended that Charlie's compression system be changed to easywrap (Haddenham Healthcare) adjustable wraps, as these would be easy to apply and remove independently. Easywrap thigh extensions that would deal with the oedema in his thighs would be ordered once the eczema was under control and he was comfortable with using easywrap.

Charlie was very distressed that he had been left so long without assistance, and so he was reassured that he would have assistance with washing his legs and applying compression. For the first month, Charlie would attend clinic weekly to be monitored and be cared for by the tissue viability consultant nurse. After that, if he was comfortable with the idea, a private carer would visit him at home. His wounds all healed and the eczema was also controlled over a 3-week period.

Follow-up

At week 8, the small wound at the top of Charlie's shin had fully healed, but his legs had not decreased in size (*Figure 3*). At this time, he presented with an episode of weepy varicose eczema at his heel, which meant that the case study was discontinued. The eczema episode has since resolved.

Discussion

At the end of the evaluation, Charlie reported that he was continuing to wear easywrap and continuing to notice improvements. He indicated that he preferred not to change the wraps during the week, as he lacked confidence in doing so. However, he was happy to adjust the wraps if he needed some respite from the pressure, and this reassured him that he had control over them. Charlie felt that the wraps were aesthetically pleasing when worn. Moreover, he was happy that, unlike the bandaging previously used, the wraps were not bulky and were thin enough to allow him to get his shoes on, even with foot pieces in situ.

Charlie's carer, who had previous experience of applying different types of wraps, considered easywrap to be one of the easiest to apply.

Case study 3. Venous ulceration and oedema in the left anterior lower leg

Sian Davies, District Nurse with Specialist Interest in Chronic and Complex Wounds, Hywel Dda University Health Board

A 61-year-old man, Everett, presented to the leg ulcer clinic with two wounds on his left lower leg that had been present for 6 weeks following a traumatic injury.

Background

Everett had no history of previous ulceration and/or oedema, chronic conditions or other medical issues. He had a healthy body mass index (BMI) and walked his dog daily. He was not taking any regular medication (except oral antibiotics and paracetamol).

Before presenting, Everett had been to his GP surgery, where his wounds were cleansed with saline and treated with an iodine-based primary dressing, absorbent padding and stockinette to secure these. The high exudate levels from the wounds had required daily dressing changes. He was taking oral antibiotics prescribed by the GP, as was standard practice at the surgery for wounds that fail to heal, as well as paracetamol. A wound swab had not been taken before commencement of oral antibiotics. No compression had been applied before attending the clinic.

Presentation

Both wounds were on the medial aspect of Everett's left lower leg, one above the other (*Figure 1*). The upper wound bed measured 7 cm long, 3 cm wide and 0.5 cm deep, and it was covered with 70% slough and 30% granulation tissue, with high levels of straw-coloured serous exudate. The lower wound measured 2 cm long, 2 cm wide and 1 cm deep, and it was covered with 50% slough and 50% granulation tissue. The edges of both wounds showed healthy granulation tissue and were sloping in appearance.

A full holistic limb assessment was performed following the health board's leg ulcer pathway. Everett's calf circumference was 36 cm on the left leg and 33 cm on the right, while his ankle circumference was 27 cm on the left leg and 26cm on his right ankle. His left leg showed localised oedema, which was warm and tender to touch, but there was no oedema in the right leg. Both legs showed haemosiderin staining and ankle flare. Everett's ankle brachial pressure index (ABPI) was 1.0, with triphasic waveforms bilaterally. These findings suggested that both legs were showing signs of venous hypertension.

When asked to score his pain using a numeric rating scale from 0 (no pain) to 3 (worst pain ever), Everett reported that his pain levels would often be 3, which made it difficult to sleep and perform his normal day-to-day tasks. He was only taking paracetamol, because he did not like the drowsy feeling other analgesics gave him.

Everett felt that the leg ulcers were ruining his life. The fear of leaking legs and malodour were causing social isolation. Moreover, the daily dressing changes and clinic appointments were preventing him from spending quality time with his wife, who was disabled and he had recently taken early retirement to care for.

Treatment

The clinical team explained to Everett that his oedema and high exudate levels were possibly causing the delay in wound healing and so the best way to facilitate healing would likely be compression therapy. He agreed, and a treatment plan option was discussed. This plan had to be compatible with Everett's busy lifestyle caring for his wife, who needed to attend medical appointments several times a week. Compression bandages would require him to attend the leg clinic several times a week to have the bandaging changed. As an alternative, Everett was offered easywrap (Haddenham Healthcare), which would allow him to change the primary and secondary dressings himself at home before reapplying the adjustable wrap, and he agreed that this would be a more suitable option.

The wounds were dressed as per local wound formulary guidelines and Trust policy. An emollient was prescribed according to the condition of the surrounding skin. Hydrogel was applied to the sloughy areas on the wound bed, and a non-adherent dressing was applied to the granulation tissue in the upper wound. A superabsorbent pad was applied over the primary dressing, and a stockinette was applied to secure the dressings. Everett was offered a British standard class one hosiery for his right leg to prevent any oedema and potential ulceration in the leg, which he agreed to wear to reduce the risk of venous leg ulceration in the future. Everett was shown how to apply and remove all of these dressings and wraps, and he felt he would be able to do so himself competently.

To reiterate all this, Everett received a patient information booklet on self-care of wounds. This covered everything from application, removal and disposal of dressings to leg washing, hand hygiene and emollient application. He was reviewed daily for the following 5 days to support with the independent changing of wraps and dressings. After this, an improvement was noted in the wound healing process, and his clinic appointments were reduced to twice weekly over the following 6 weeks.

Follow-up

Week 6

At week 6, the upper wound measured 4 cm long, 3 cm wide and 0.3 cm deep, while the lower wound measured 1.5 cm long and 1.5 cm wide, with superficial depth and 100% granulation tissue (*Figure 2*). The exudate levels had decreased, only requiring twice weekly dressing changes. There were no signs of inflammation and no complaints of pain.

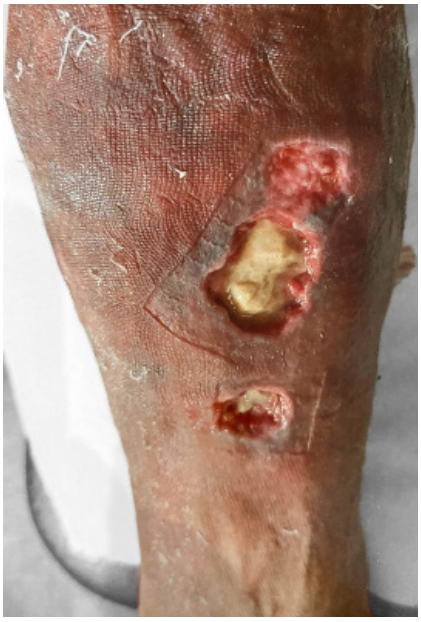

Figure 1. Left anterior lower leg at presentation

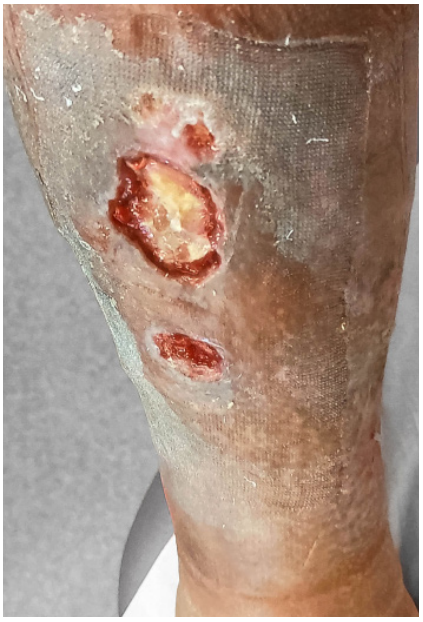

Figure 2. Left anterior lower leg at week 6

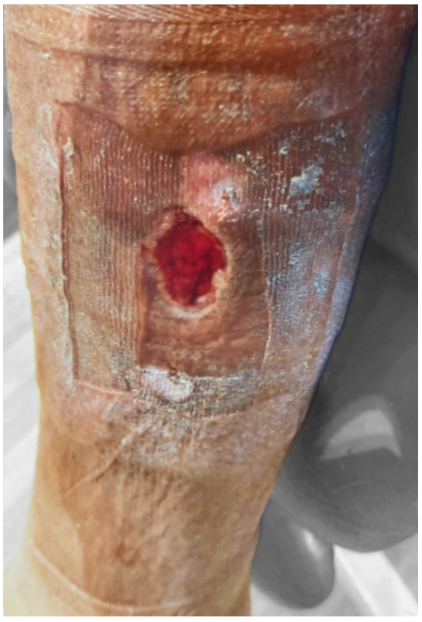

Figure 3. Left anterior lower leg at week 12

For the next 6 weeks, treatment continued with easywrap over a hydrocolloid sheet on the upper wound and a non-adherent dressing on the lower wound.

Week 12

At week 12, the upper wound measured 1 cm × 1 cm and was 100% covered with granulation tissue, while the lower wound had completely healed (*Figure 3*). The surrounding skin was intact but very dry, and Everett was reminded to apply emollient daily. His left calf circumference was 33 cm, with a reduction of 3 cm, and his ankle was 25.5 cm, with a reduction of 1.5 cm. He remained pain-free.

For the next 8 weeks, treatment continued with a non-adherent wound dressing, dressing pad and stockinette to secure, together with easywrap. Everett's leg clinic appointments were reduced to monthly, and he would change his dressings as required, usually every 3–4 days. At that point, he was removing easywrap at night and reapplying it in the morning when he woke up.

Week 20

At week 20, the upper wound had also completely healed. Everett was still using a dressing pad over the area for protection, and he felt that he did not want to cause any trauma to the site and have the wound reoccur. It was discussed with Everett that compression was a lifelong intervention and that, when he felt ready, he could then wear the British standard class 3 hosiery on his left leg to prevent reoccurrence. Everett agreed but wanted to keep wearing easywrap for another month, just to make sure the wounds would not reoccur.

Discussion

From week 6, Everett would often state that he could not believe the improvement in the wound and amount of leakage. He said he found applying, removing, washing and drying easywrap to be easy. He found that easywrap was comfortable to wear and that his mobility had greatly improved, so that he was able to take longer walks with his dog. He also appreciated being able to shower regularly and that his trousers fitted over easywrap without it appearing bulky. Most importantly, he felt greatly empowered by being able to manage the dressing changes himself at home at a time that suited him, so he did not need to attend the leg clinic as often. This had reduced a great deal of stress and enabled him to spend quality time with his wife.

Case study 4. Lymphorrhoea and venous ulceration in chronic bilateral lower-limb oedema

Sian Davies, District Nurse with Specialist Interest in Chronic and Complex Wounds, Hywel Dda University Health Board

A 57-year-old man, William, presented to the leg ulcer clinic with two wounds and lymphorrhoea (abnormal lymph fluid flow) in the left leg that had been present for 3 weeks.

Background

William had had chronic bilateral lower-limb oedema for several years, but he reported never previously experiencing leaking or ulceration. He had a high BMI (>50kg/m^2) and a history of heart failure, hypertension and hyperlipidaemia. He did not exercise and had a high-calorie, high-fat diet. He did not smoke but drank alcohol occasionally.

William had been having treatment in his GP surgery, which consisted of an ichthammol paste bandage, padding and a stockinette to secure these. A health professional at the GP surgery had advised him not to shower, which made him feel frustrated. Before attending the leg clinic William was cleansing his leg with gauze and warm tap water, without ever washing it.

Presentation

The left lower leg had one wound to the anterior aspect and one wound to the posterior aspect. Both wounds measured 1 cm long and 2 cm wide, with 100% slough (*Figure 1*). The surrounding skin was macerated, likely as a result of the very high uncontrolled exudate levels, which meant that the two superabsorbent pads he was using required changing two or three times a day. There was a full circumferential area of redness with uneven skin. There was also haemosiderin staining, indicative of venous insufficiency.

William underwent a holistic lower-limb assessment according to the health board's leg ulcer pathway. On examination, William's calf circumference was 56 cm and ankle circumference was 44 cm bilaterally. Mild fibrosis was noted, with no pitting oedema to legs or feet and no oedema to the toes. His ankle brachial pressure index (ABPI) as 1.2, with biphasic waveforms bilaterally. He had no ischaemic rest pain intermittent claudication, a capillary refill of less than 3 seconds, and a limb that was warm to touch. These findings indicated that William had venous insufficiency, and this was the likely cause of his oedema, lymphorrhoea and ulceration.

William reported a great deal of discomfort in his legs as a result of the high volume of lymphorrhoea causing excoriation and burning. When asked to score his pain using a numeric rating scale from 0 (no pain) to 3 (worst pain ever), he reported that it was at least 1 all the time, going up to 2 if he had been walking.

The discomfort had reduced William's mobility and left him feeling isolated. The high exudate levels had been making his footwear wet and uncomfortable, causing him to take time off from the catering business he ran and where he usually worked as a chef.

Treatment

The clinician assessing William discussed his lifestyle choices at length, as well as self-care treatments that could be adopted to improve his health. As William stated that he tended to stand all day at work, he was encouraged to walk more. Advice was provided regarding the activation of the foot and calf pump to aid venous return and reduce oedema. He was advised to adopt healthier eating habits to facilitate weight loss and so reduce the pressure on his heart and lymphatic system, as well as reduce the risk of other chronic conditions. However, he declined a referral to a dietician and has shown little interest in adopting healthy eating choices.

Compression therapy was identified as the gold-standard treatment for reducing lymphorrhoea in lower leg oedema caused by venous hypertension. Given William's history of heart failure, the safety of applying compression therapy was first discussed with the heart-failure nurse. The heart-failure nurse agreed that, as William's symptoms were stable, he could undertake compression therapy with close monitoring. Therefore, the benefits of compression therapy were communicated to William, who agreed to trying it.

However, William was reluctant to use compression bandages that would need to be regularly changed in clinic, when his work commitments meant he could not attend clinic appointments more than once a week. He was very keen for an alternative compression system that would allow him to self-manage, and so he was offered the easywrap Strong (Haddenham Healthcare) adjustable wrap for his left leg. Both William and his wife – who was present at the consultation and happy to support with the therapy – were eager to try easywrap Strong.

Therefore, a care plan was agreed in which William could remove the dressings and dispose of the waste accordingly, as well as shower and wash his leg as often as he felt he could, but at least twice a week. As well as easywrap, William was provided with a hydrocolloid dressing for the sloughy wounds, a barrier film to protect the

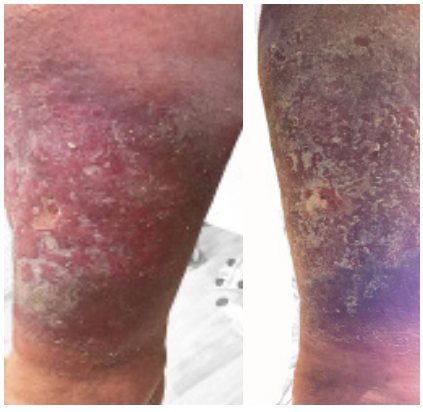

Figure 1. Presentation: left anterior (a) and posterior (b) lower leg

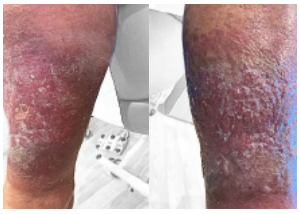

Figure 2. Week 6: left anterior (a) and posterior (b) lower leg

periwound skin, and an antimicrobial cream with a non-adherent dressing to protect and prevent trauma to the skin affected. He also received gloves and an information leaflet on leg care during dressing changes. William and his wife were shown how to apply and remove easywrap and the dressings and given advice on hand and leg-washing hygiene, such as cleaning the shower after use and washing towels after they had been used to dry the leg. William was delighted that he would be able to shower and wash his leg independently, reducing any exudate present on the skin, and that he would be able to manage the leg-care regimen himself between clinic appointments.

William was also offered flat-knit hosiery (RAL Class 1) for his right leg. He was informed that this would reduce oedema and the chance of complications associated with venous hypertension, such as ulceration and lymphorrhoea. However, he declined this offer.

Follow-up

Week 6

Following 6 weeks of using the easywrap Strong, William reported that his exudate levels had reduced and that this meant the padding only had to be changed once a day, compared with two or three times a day before.

His skin had softened to touch, and both the calf and ankle circumferences had reduced by 1 cm. His pain score had reduced, occasionally reaching 1, such as when he had been walking up stairs or driving. Otherwise, William felt that his quality of life had improved significantly, because he was able to mobilise better without pain and he no longer felt he had to worry about exudate leaking into his shoes or on the bedding.

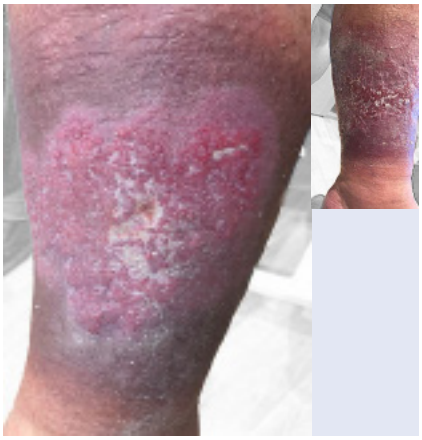

Figure 3. Week 12: left anterior (a) and posterior (b) lower leg

Both wounds remained 1 cm long and 2 cm wide, but the slough was lifting away from the wound bed during cleansing with a gauze (*Figure 2)*.

William admitted that he did sometimes forget to apply easywrap Strong. Sometimes – around two or three times a week – he would not wear them until late afternoon and take then off for bedtime. The clinician reassured William that he could take the wraps off at night when in bed but reiterated importance of wearing them all day every day, and so he promised to do so.

Week 12

Following 12 weeks of using easywrap Strong, the exudate had reduced further, with the padding only needing to be changed every 2 or 3 days. William's left leg was less painful, more often than not scoring 0 and only occasionally scoring 1. The anterior wound had reduced in size to 1 cm long and 1 cm wide and comprised 100% granulation tissue (*Figure 3)*. The posterior wound had healed. The periwound skin was even softer to touch. His calf and ankle circumferences had reduced by 3 cm and 2 cm respectively in total over the 12 weeks.

Discussion

William felt much more optimistic since using easywrap Strong. He found that it was comfortable to wear, did not increase his pain levels and allowed him to see positive results, such as exudate reduction and pain reduction, fairly quickly. Despite initially worrying that it would be complex, his wife had found easywrap to be easy to apply and remove. They both felt that it was a better alternative to bandaging for them as it reduced the need for clinic appointments so that they could concentrate on their businesses. William reported that being able to take care of his own leg between clinic appointments had made a major difference to his life.

From a healthcare perspective, these positive patient outcomes were down to the holistic assessment that William underwent on his first appointment to the leg clinic.

This assessment identified the leg ulcer's aetiology and barriers to healing, as well as the patient's treatment goals and priorities. This allowed the timely selection and implementation of an evidence-based care plan that was agreeable to the patient and resulted in good healing outcomes. Moreover, by potentially reducing the wound healing time, dressing costs and nurse time, it was cost-effective.

Case study 5. Left medial malleolus ulcer

Jo Holloway, Lower Limb Specialist Nurse, Wye Valley NHS Trust

A 61-year-old man, Gary, presented with a 3-month history of static left medial malleolus ulceration that had required multiple courses of oral antibiotics for recurrent infection. His pain score could be as high as 9/10 or at best 3/10. This had been resulting in poor sleep, low mood and reduced activity and social engagement.

History

Gary was obese and had type 2 diabetes, which was controlled with metformin. He experienced sleep apnoea and hypertension, for which ramipril was taken. He also had a history of deep vein thrombosis and total hip replacement on the left leg.

Gary had a sedentary job that required him to stand or sit for long periods, with limited opportunities to elevate his legs. He was well engaged with healthcare professionals and was adherent with maintaining a good skincare regimen. However, his attendance at appointments was variable as a result of availability of appointments that fitted around his work commitments. This often resulted in dressings being changed once per week, where twice weekly would have been optimal.

Gary had initially self-treated the ulcer at home. After around 4 weeks, he presented to a service that was not commissioned to provide leg ulcer management. There he was provided immediate and necessary care as per the National Wound Care Strategy Programme (NWCSP)[1] and then referred to the local leg clinic team. After a delay in access because of capacity issues, the leg clinic clinicians assessed for red flags as per the NWCSP[1] and referred the patient into the complex lower limb service for a timely assessment.

Over this period, the wound was cleansed using normal saline and treated with a range of primary dressings, including silver, iodine and alginates, with a secondary adhesive foam dressing. Gary was also commenced on a circular knit 20 mmHg reduced compression garment liner. Despite this treatment, the wound remained static.

Assessment

A full lower limb assessment was performed by the lower limb specialist. Visual signs of venous hypertension were identified, with good biphasic pedal wave forms and a toe brachial pressure index (TBPI) of 0.81. TBPI was selected over ankle-brachial pressure index (ABPI) because the patient was diabetic and the ulcer too painful to tolerate a blood pressure cuff. It should be noted that the normal parameters of TBPI differ from those of ABPI. Gary was referred to the vascular department for consideration of endovenous ablation, as per recommendations from the National Institute for Health and Care Excellence (NICE).[2]

The wound measured 1.8 cm×1.1 cm, with a depth of 0.1 cm (*Figure 1* and *Table 1*). The wound bed was covered with 100% slough. The exudate level was moderate, and the pain level was 6/10.

Table 1. Wound healing outcomes by week

Week	Length	Width	Depth	Slough	Granulation	Exudate	Pain
Week 0	1.8 cm	1.1 cm	0.1 cm	100%	0%	Moderate	6/10
Week 2	1.7 cm	1.0 cm	0.1 cm	93%	7%	Moderate	4/10
Week 3	1.3 cm	1.0 cm	0 cm	60%	40%	Low	2/10
Week 4	1.2 cm	0.7 cm	0 cm	22%	78%	Low	2/10

Intervention

The lower limb specialist discussed compression options with Gary, focusing on what was important to him. It was agreed to try an adjustable compression wrap system, specifically the easywrap Strong with an easywrap Fusion Liner. These were selected as they would enable him to continue wearing his usual footwear and allow for shared self-care, without disrupting dressing placement when donning and doffing.

Easywrap was implemented as part of a new dressing regimen. First, Gary's leg was cleansed in a lined bucket of warm water using an emollient and debridement pad, before being soaked in a wound irrigation solution for 10 minutes and dried with a sterile drape. Then the wound was dressed with a barrier film to the wound edges, a primary honey dressing and a secondary silicone foam dressing. Emollient was applied to the rest of the leg, before fitting the easywrap Strong and easywrap Fusion Liner.

Gary was also prescribed a course of topical steroids. Betamethasone 0.1%

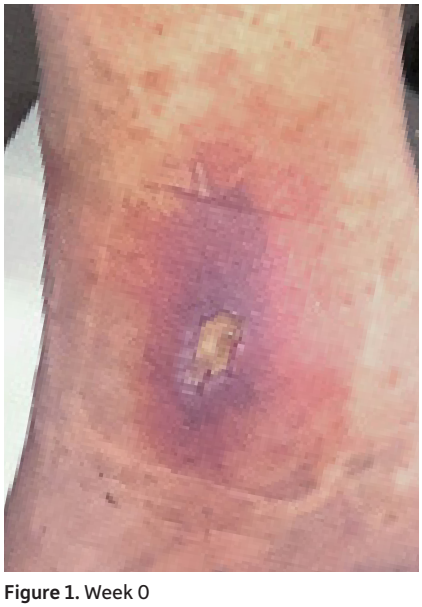

Figure 1. Week 0

was applied to the periwound area twice weekly at dressing changes until the surrounding erythema/eczema had settled at week 4 (more frequent application was not possible given the dressing change regimen). The patient was shown how to change his dressings and was given all of the appropriate dressings, this enabled a shared self-care approach. The patient would change the dressing himself once per week and would be reviewed by the lower limb specialist once per week. He was able to manage donning and doffing of the Haddenham Healthcare easywrap Strong independently and reported the garment was comfortable and enabled him to continue wearing his usual footwear.

Follow-up

At week 2, the wound measured 1.7 cm×1.0 cm, with a depth of 0.1 cm (*Figure 2*). The wound bed was covered with 93% slough and 7% granulation tissue. The exudate level was moderate, and the pain level was 4/10.

At week 3, the wound measured 1.3 cm×1.0 cm, with no depth (*Figure 3*). The wound bed was covered with 60% slough and 40% granulation tissue. The exudate level was low, and the pain level was 2/10.

At week 4, the wound measured 1.2 cm×0.7 cm (*Figure 4*). The wound bed was covered with 22% slough and 78% granulation tissue. The exudate level was low, and the pain level was 2/10. The surrounding erythema and eczema had settled, and so steroids were discontinued.

By week 6, the wound had entered the maturation stage of healing (*Figure 5*).

Discussion

Complete healing of a previously static venous leg ulcer was achieved within 6 weeks of commencing easywrap Strong, suggesting that this was an effective method of delivering compression. The patient was able to continue working, showering and wearing his usual footwear, and his pain score was reduced, all of which enabled him to adhere to the recommended care plan.

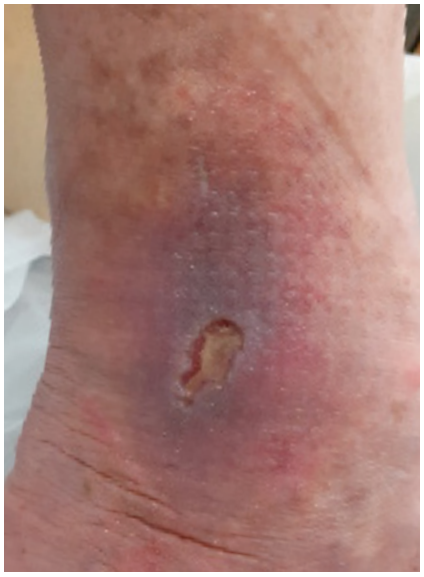

Figure 2. Week 2

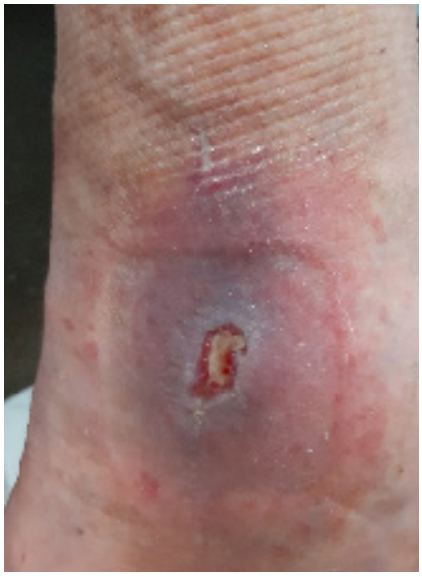

Figure 3. Week 3

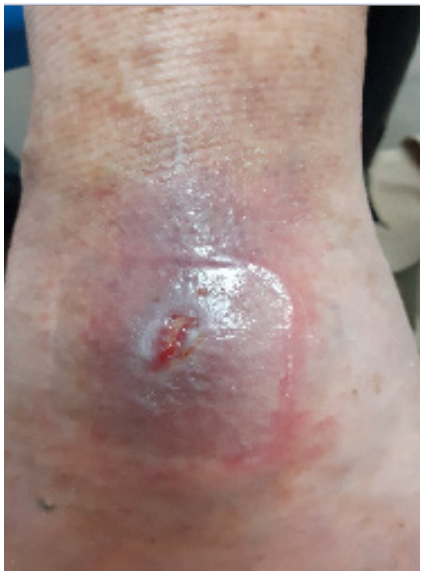

Figure 4. Week 4

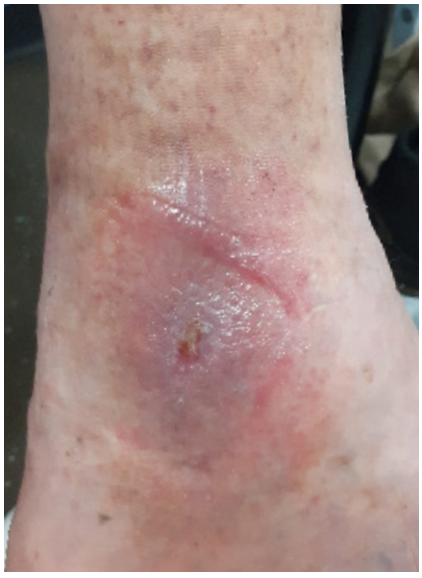

Figure 5. Week 6

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Case study 6. Bilateral venous leg ulcers with high exudate

Shannon Hanson, Tissue Viability Clinical Nurse Specialist, Lincolnshire Community Health Services NHS Trust

A 57-year-old woman, Joan, was referred for specialist tissue viability input for bilateral hard-to-heal venous leg ulcers (VLUs) with high exudate levels.

Background

Joan had had hard-to-heal venous leg ulceration for 28 months. Her comorbidities included hypothyroidism, chronic kidney disease (stage 3), obesity with BMI of 49kg/m^2 and chronic venous insufficiency, and her medical history included previous pulmonary embolism, sepsis and COVID-19.

Joan had limited mobility as a result of her VLUs and obesity. She worked full time at a desk job, with her legs remaining dependent for around 9–10 hours a day. She slept in a bed at night but was unable to mobilise long distances and relied on her husband's assistance for shopping and household chores. She had poor calf-muscle strength a result of the wound-related pain that she experienced.

For the 28 months since developing VLUs, Joan had been seeing the practice nurse for twice-weekly dressing changes. Throughout that time, her treatments had included wound care with mechanical debridement (Debrisoft, L&R), enzyme alginogel (Flaminal Forte, Medical Dressings), protease-modulating pads (UrgoStart Plus, Urgo) antimicrobial silver dressings (Aquacel AG, Convatefc), antimicrobial binding dressings (Cutimed Sorbact, Essity), hydrodesloughing silver dressing (UrgoClean AG, Urgo), and non-adherent iodine dressings (Inadine, Acelity).

A variety of compression systems had been trialled, including compression bandaging (Actico, L&R) and adjustable compression wraps (ReadyWrap, L&R). However, Joan's wounds and limb shape showed no signs of improvement. Despite being applied correctly, the compression systems trialled did not reduce her oedema, and there was frequent bandage slippage, likely because of the limb shape and size.

Presentation

On presentation, Joan had three leg ulcers. The right leg had a large pre-tibial ulcer measuring 7.7×4.8 cm, with 85% sloughy tissue and 15% granulation tissue (*Figure 1a*), as well as a scaly oedematous periwound area. The wound was leaking a large amount of serous exudate, which was not contained within the dressings by the next appointment 3–4 days later. There was a further patchy area of ulceration to the posterior, lateral side of the same leg, with minor ulcerations and general excoriation. There were no obvious signs of active spreading infection within these wounds at that time; however, signs of biofilm, such as slough, friable granular tissue and malodour, were present.

The left leg had two defined VLUs to the latero-posterior calf. The largest of these measured 7.4×3.6 cm and showed 100% sloughy tissue (*Figure 1b*). There was induration to the periwound, signifying prolonged inflammatory response, and scaly skin to surrounding area. Again, there were no clinical signs of infection. However, both wounds were extremely painful to cleanse, resulting in the occasional use of topical 5% lidocaine and/prilocaine cream (Emla) to numb the areas before wound-bed preparation.

The main issues affecting both legs were high levels of exudate, poor pain control and poor healing, likely linked to persistent biofilm and recurrent bacterial colonisation of the wound beds. There were also ongoing issues with the compression systems slipping, and causing indentations and pain, which meant that the system often had to be removed before the next routine appointment.

Intervention

A plan was developed with the specialist tissue viability nurse (TVN), and both legs were treated by the practice nurse, with a new wound-care regimen.

First, a gauze soaked with irrigation solution (Prontosan, B Braun) was placed on the wound bed for 10 minutes, and a barrier film (Cavilon, 3M) was applied to the periwound areas to prevent maceration. Then, all wounds were dressed with a protease-modulating pad (UrgoStart Plus, Urgo) and a superabsorbent pad (Kerramax, 3M). After this, Joan was commenced on a new adjustable compression wrap with liners to trial an alternative compression system (easywrap).

Joan also began to undertake regular calf-muscle exercises to improve her venous return and was actively trying to lose weight to reduce the pressure on her limbs and ulcers. She also took the initial 3 weeks off work to enable her to elevate her legs as much as possible. Wound progress and efficacy of the regimen was reviewed regularly by the TVN. After an initial delivery delay, the full system was applied 5 weeks after presentation.

Follow-up

After 1 week of using the compression wrap system, the VLU on the right pre-tibia measured 7×4 cm, a reduction of 1 cm, and showed 90% granulation tissue (*Figure 2a*). The VLU on the left calf measured 6.7×3 cm, a reduction of just under 1cm, and showed 50% granulation tissue, an improvement in the tissue distribution within the wound, showing less slough than before (*Figure 2b*). Joan reported a significant reduction in the amount of exudate and that she was tolerating the wraps very well, as well as feeling an improvement in her general leg pain. However, Joan was still not able to tolerate a mechanical debridement of the

biofilm within the wound bed as a result of wound pain.

By week 5, there appeared to be a reduction in wound size, but no measurements were recorded, although photos were taken (*Figure 3*). There had been a further reduction in exudate, but the signs of persistent biofilm remained, including sloughy tissue, friable granular tissue and a mild malodour. Joan had also recently been treated for a local wound infection. To reduce the level of slough and risk of infection, it was decided to swap her primary dressing to a hydro-desloughing silver dressing (UrgoClean AG, Urgo). Joan also restarted using topical lidocaine (Emla) to facilitate better weekly wound-bed cleansing and preparation.

By week 8, the VLU on the right pre-tibia measured 7×3 cm and showed 90% granulation tissue (*Figure 4a*). The pre-tibial wound was much healthier, with only mild maceration to the periwound and an overall improvement in the surrounding skin. The VLU on the left calf measured 6.2×2.2 cm and showed a mixture of 50% granulation and 50% slough to the wound bed (*Figure 4b*). Joan appeared better able to tolerate a more thorough cleansing and wound-bed preparation of each wound, which at first had not been achievable because of the pain.

Discussion

Throughout the trial, Joan reported feeling that easywrap was more comfortable than any other compression system that she had tried, because it did not roll down her leg, and the leg did not feel 'suffocated' by many layers of padding. She remarked that she was able to tolerate easywrap fully and felt that the system improved her overall leg condition. She felt it allowed her to change her dressings if she needs, as the wrap was accessible without waiting for a clinician. With easywrap, she felt in control of her wounds and was able to tighten and loosen the wraps as required.

In Joan's case, the use of easywrap for active ulceration proved successful where other compressions systems had failed, with an overall improvement in her wounds and no severe indentation arising from slippage of the compression system.

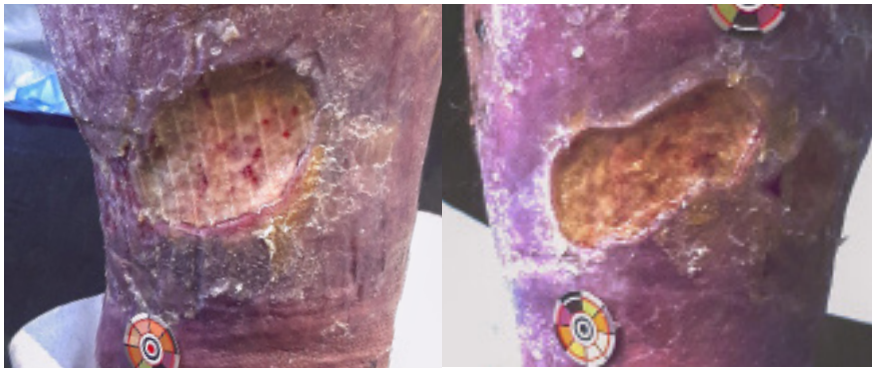

Figure 1. Presentation, right shin (a) and left calf (b)

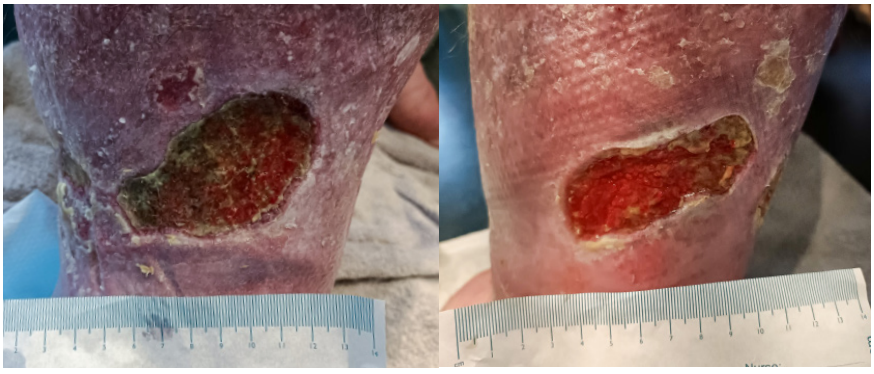

Figure 2. Day 7, right shin (a) and left calf (b)

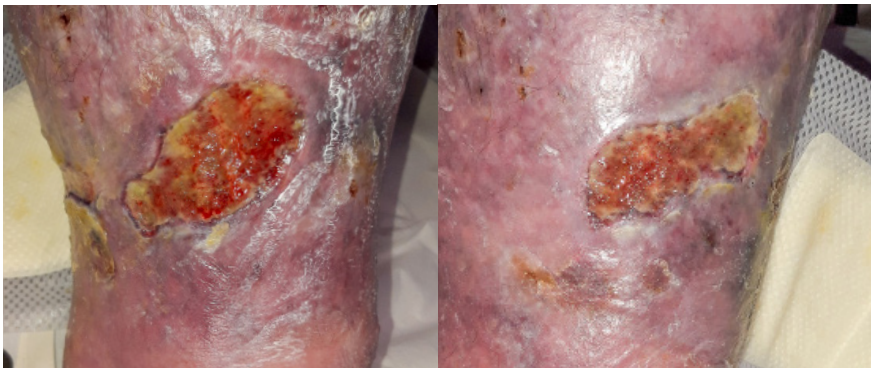

Figure 3. Week 5, right shin (a) and left calf (b)

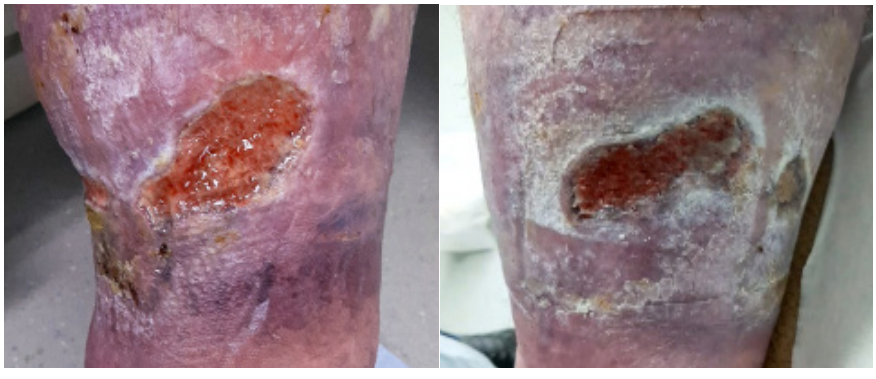

Figure 4. Week 8, right shin (a) and left calf (b)

Case study 7. Four venous leg ulcers

Shannon Hanson, Tissue Viability Clinical Nurse Specialist, Lincolnshire Community Health Services NHS Trust

A 63-year-old woman, Jean, presented to the community nursing team with several small venous leg ulcers (VLUs) and serous fluid weeping from her legs.

Background

Jean had had constant bilateral chronic secondary lymphoedema due to venous insufficiency and limb dependency for 4 years. Her comorbidities included hypertension, hypothyroidism, osteoarthritis and obesity, with a history of depression. Her regular medications included amitriptyline, citalopram, furosemide, lansoprazole, levothyroxine and naproxen. The arthritis affected her hips, for which she required hip-replacement surgery, but her BMI and presence of VLUs made her ineligible.

The combination of lymphoedema, arthritis and obesity severely limited Jean's mobility, meaning that she was housebound. She mobilised around her home in an electric wheelchair and used a walking frame at times but could only walk short distances. Although Jean was somewhat mobile, she spent a great deal of the day in the wheelchair, rarely mobilising, all of which contributed to her venous insufficiency and lymphoedema to her feet and lower limbs. She was able to transfer independently to a chair and bed, but she had difficulty getting into bed because of pain in her hips, so she occasionally slept in her recliner chair and only slept in her bed three or four nights a week. She lived alone with her two dogs in a house but was only living in the downstairs of the property.

Around 3 years after developing lymphoedema, Jean developed recurrent venous leg ulceration with high levels of exudate and cellulitis in her legs. She was referred to the community nursing team, and her wounds were dressed with an antimicrobial dry swab (Cutimed Sorbact Dressing Swabs, Essity) and superabsorbent padding (Kerramax, 3M), alongside various compression systems, which are further explored below. With this treatment, the VLUs began a cycle of healing and then breaking down again afterwards.

Jean also experienced venous eczema, which was periodically treated with a topical steroid cream (Eumovate, GSK).

Jean first received compression therapy with K-Plus (Urgo) mild compression bandages before an ankle-brachial pressure index (ABPI) measurement; however, these would not stay up correctly and constantly slipped, which was likely the result of the irregular swelling of her legs and the amount of exudate. Therefore, she was swapped to Actico (L&R) short-stretch compression bandages, but the exudate levels remained so high that she was being seen by the team 2–3 times a week. After 5 months, she was referred to the lymphoedema team, who saw her 5 months later because of the length of their waiting list. She was prescribed Juzo (Juzo) adjustable compression wraps, but Jean refused to have these applied until her wounds (which were healing slowly) had healed, which took a further 2 months (no rationale was recorded). Within a month of using Juzo (Juzo) adjustable compression wraps, Jean's legs began to deteriorate again, so she was switched back to Actico (L&R) short-stretch compression bandages, which she used for the 5 months before presentation in this case, 20 months after first ulceration.

Presentation

On presentation (to the same lymphoedema team), Jean had unmanaged oedema of both legs. She was unable to use her calf muscle effectively as a result of her arthritis, which would have contributed to her dependent lymphoedema. The circumference of her left leg was 61 cm at the calf and 33 cm at the ankle, and her right leg was 57 cm at the calf and 31.5 cm at the ankle. Her left leg also showed four VLUs:

- Lower-posterior wound, measuring 2×2 cm
- Upper-posterior wound, measuring 2.5×2.5 cm
- Medial wound, measuring 3×2.5 cm (*Figure 1a)*
- Lateral wound, measuring 3×3 cm *(Figure 1b*).

All four wounds were covered with 90% slough, in a thin shiny layer indicating possible biofilm presence,[1] and 10% granulation tissue. There was maceration evident to the periwound, and all wounds

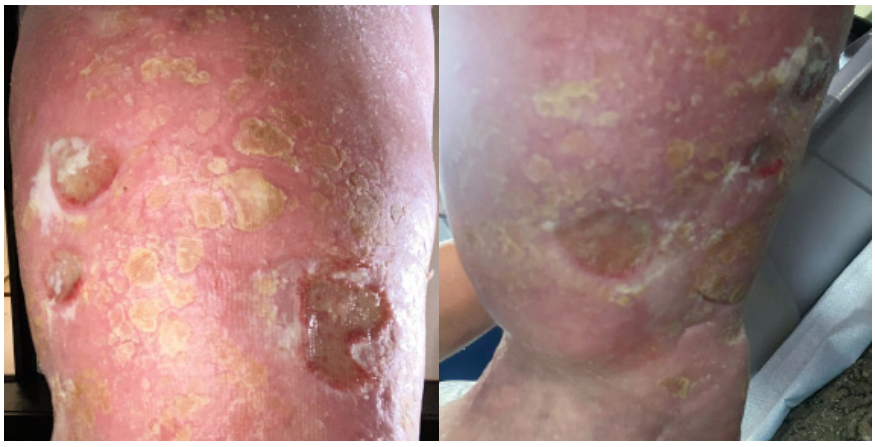

Figure 1. Presentation, lower-posterior, upper-posterior medial (a) and lateral (b) wounds

were exuding a moderate amount of serous fluid, but no odour. A wound swab completed around the time of presentation showed mixed enteric flora.

Intervention

A plan was developed by the specialist tissue viability nurse (TVN) that was consented to by Jean and carried out by the community nursing team. The goals of the plan were to effectively manage the ongoing bioburden and oedema in both of Jean's legs, which it was hoped would not only heal the ulcerations but also prevent their recurrence.

First, the VLUs were soaked with wound irrigation solution (Prontosan), then thoroughly cleansed with a mechanical debridement cloth (UCS Debridement Cloth, Medi UK); this method was to both disrupt and remove any debris and biofilm. All four wounds were dressed with an antimicrobial binding gel (Cutimed Sorbact, Essity), instead of the dry swab, to lift away newly forming biofilm, before being covered with a superabsorbent pad (Kerramax). Jean was then commenced on the easywrap adjustable compression wrap system with liners. Jean's mobility issues and osteoarthritis meant that she was unable to manage the wrap system independently, so she was assisted by the community nursing team. Although Jean had previously refused to use wraps until her wounds had healed, the education given to Jean during the initial assessment gave her the confidence to trial the new wrap system.

Follow-up

By week 2, the two smaller posterior wounds had healed. The medial wound was narrower, measuring 3×1.5 cm, and was covered with 20% slough and 80% granulation tissue (*Figure 2a*). The lateral wound had increased in size to 4.4×4 cm but was covered with 100% granulation tissue (*Figure 2b*). The periwound appeared healthy, and there were no clinical signs of infection. The general leg oedema had reduced, but there was a build-up of dry skin to the surrounding leg, so it was agreed to add soap substitute (Dermol 500) into the regimen, for its antimicrobial benefits as well as hydration.

By week 4, the medial wound had again reduced in size to 2×2 cm and was covered with 75% epithelial tissue, 20% granulation and 5% slough. The lateral wound measured 4×2.5 cm and was covered with 70% granulation tissue and 30% epithelial tissue, which was migrating from the front edge of the wound (*Figure 3*). The exudate level was low, and there remained still no signs of re-infection. Jean reported that she was very happy with the way that her legs were healing. This had given her hope that her legs would be healed in a few weeks, and, therefore, she had made an appointment to speak to the surgeon about a hip replacement.

By week 7, all wounds to Jean's left leg were fully healed and her oedema was much improved.

At week 8, the circumference of Jean's legs were again measured. The left leg had reduced by 25 cm to 36 cm at the calf and by 6.5 cm to 26.5 cm at the ankle. The right leg had reduced by 21 cm to 36 cm at the calf and by 3.5 cm to 28 cm at the ankle.

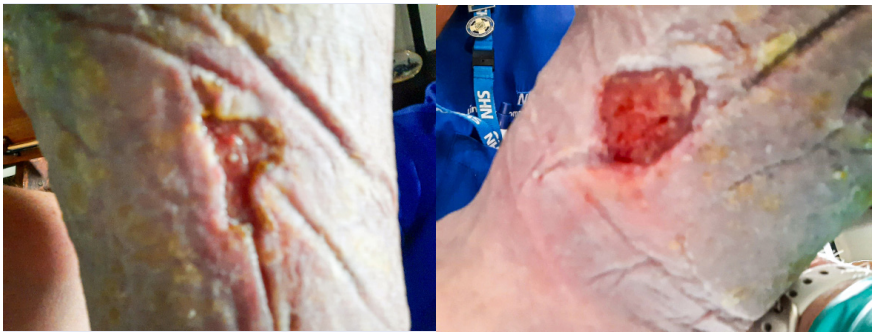

Figure 2. Week 2, medial (a) and lateral (b) wounds

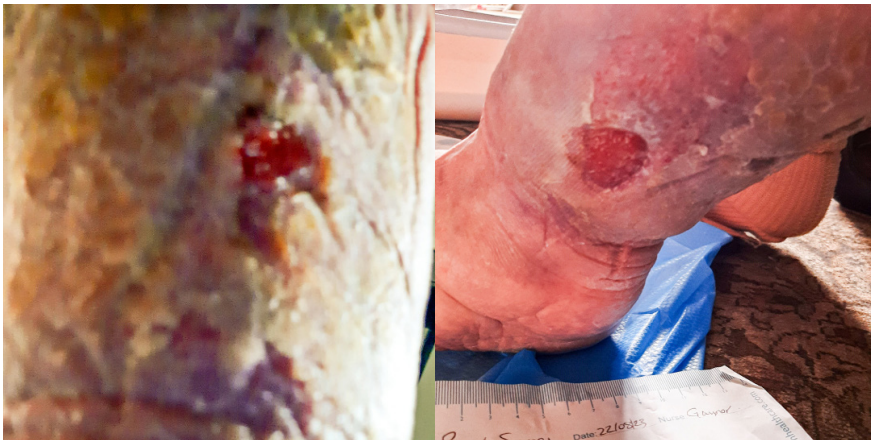

Figure 3. Week 4, medial (a) and lateral (b) wounds

Discussion

Within 2 months of undertaking a new combined regimen of wound care with thorough biofilm management and compression therapy with easywrap adjustable wraps, the chronic oedema to both of Jean's legs had significantly reduced, and she was feeling positive about the long-term management of her legs. She hoped that this progress would help her become eligible for hip surgery. The community nurses' feedback on easywrap was also positive, and they remarked on the speed and ease of application compared with other compression systems, such as bandaging.

References

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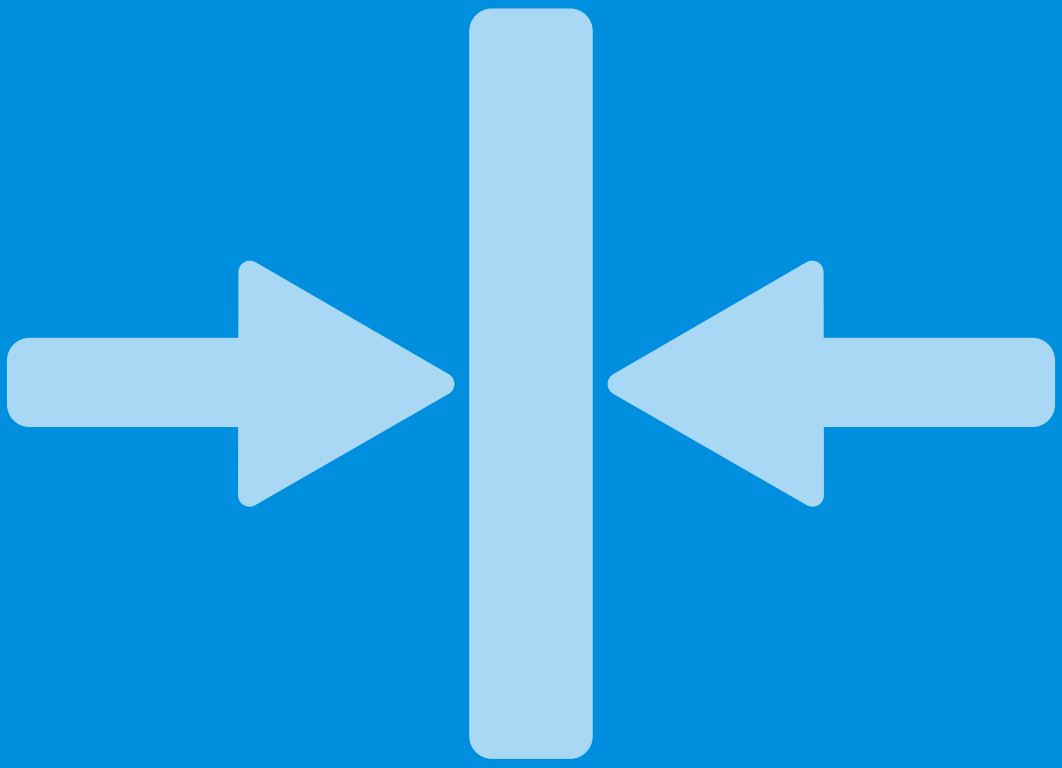

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