

SELECTION, MEASUREMENT AND APPLICATION OF GRADUATED COMPRESSION HOSIERY

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Compression hosiery has an important role to play in the prevention and treatment of venous leg ulcers (Bennett, 2000). Some patients may be non-concordant with compression bandaging and an alternative could be the use of below-knee graduated compression hosiery (Johnson, 2002). This article seeks to inform the clinician of how to overcome some of the hazards, problems and pitfalls associated with the selection, measurement, fitting and application of below-the-knee compression hosiery.

Graduated compression has been found to be successful in the management of venous ulceration (Negus, 1991).

Graduated compression hosiery, layer hosiery kits with liners, socks, stockings of thigh or below knee length (with an open or closed toe) and tights are worn for a variety of reasons (*Table 1*).

Technological advances have led to sophisticated developments in hosiery production, making it easier to apply and use. There has also been an improvement in colour ranges and textures, which has made the hosiery more acceptable to the user.

To prevent venous ulcer recurrence, patients require life-long graduated compression therapy (Marston and Vowden, 2003). Indeed, compression is the most important component in the conservative treatment and prevention of recurrence of venous

Table 1

Reasons for wearing graduated compression hosiery and accessories

To reduce venous hypertension in the leg veins by supporting the superficial veins and counteracting raised capillary pressure

To aid venous return of blood to the heart

To reduce oedema (swelling) of a limb

To aid healing of venous leg ulcers

To prevent venous leg ulcer recurrence following the initial healing of a wound

As primary prevention of leg ulcers where varicose veins are present

As prevention of deep vein thrombosis (DVT), and prevention of complications following DVT

For the reduction of lymphoedema

From: Tornngren, 1980; Mayberry, 1991; Badger, 2001; Fasiadis, 2002; Wounds UK, 2005

leg ulcers, and the management of lymphoedema (Jefferis, 1998). The physiological basis for compression therapy is well documented and established (Moffatt, 2003).

Research into leg ulceration has been primarily directed to developing effective treatment strategies, with impressive healing rates being demonstrated (Blair et al, 1988). However, recurrence remains a problem (Jones and Nelson, 1998).

Therefore, it is important when using hosiery that the correct selection, limb measurement, application, removal and evaluation of effectiveness is undertaken, documented and monitored. This process must always take into account the patients' preferences.

Contraindications

The use of compression hosiery is contraindicated in limbs with arterial insufficiency, since compression should never be allowed to impede arterial inflow (Parsch, 2003). In addition, over-tight bands of pressure caused by poorly fitting compression

Table 2

British classification of compression hosiery (community)

Class I: 14–17 mmHg

Light, mild support: indicated for superficial or early varices during pregnancy

Class II: 18–24 mmHg

Medium to moderate support: indicated for moderate varices or severe varicose veins, prevention of ulceration/recurrence, mild oedema and varices during pregnancy

Class III: 25–35 mmHg

Strong support: indicated for gross varices, post-phlebitis limb (following an inflammation of the vein), recurrent ulceration and lymphoedema

hosiery applied over oedematous tissue could induce ulceration. There is also a risk of heart failure, with excess fluid from the legs being forced back in to the central circulation causing the heart to be overloaded with fluid. Severe oedema of the lower limb caused by venous disease should be reduced by elevation or intermittent compression therapy before the application of compression hosiery, as oedema inhibits the microcirculation, preventing adequate perfusion and nutritional exchange (Cherry et al, 1996). Caution must also be taken with patients with diabetes and rheumatoid arthritis, as they may have small vessel disease; in these cases application of compression may result in pressure necrosis (Figure 1).

Classification of compression hosiery

Blood flow through the veins of the lower limb is improved when the greatest pressure is exerted at the ankle and gradually reduces to the knee. Compression

hosiery provides such graduated compression. Below-knee compression hosiery gives sustained graduated pressure at the ankle and the calf (Figure 2), and is graded into several classes dependant on where the hosiery is dispensed (Tables 2 and 3). It is standardised by measuring the compression at the ankle in mmHg. In order to achieve the correct compression, the hosiery must be applied according to the manufacturer's instructions. In the primary care setting (community), the British



Figure 1. Damage to the front of the ankle due to inappropriate size and fitting of hosiery.

classification is used to measure hosiery. In secondary care (hospital) the European classification is used; this classification gives higher levels of compression. The different types of classifications are described in Tables 2 and 3. Some hosiery kits come in two layers; the first layer is a liner stocking next to the skin, which gives 10 mmHg pressure. The second layer, the top stocking, slides on easily over the liner to give between 25–30 mmHg pressure. In combination, the two stockings achieve an overall pressure of 40 mmHg at the ankle.

Assessment

Care must be taken to ensure that the correct level of compression is chosen and

prescribed. Assessment is the key to the effective selection of hosiery as it will enable the identification of factors that influence which type of compression hosiery to use. It has been reported that patients with venous disease and leg ulceration often have complex diseases such as diabetes, which may effect the compression treatment (Nelzen et al, 1991).

The patient needs to be fully involved in the assessment process. Discussion must relate to past and current relevant medical and hosiery history, skin condition and allergies. The practitioner should also look for clinical signs of venous disease, and be aware of diagnostic test results, including vascular/Doppler ultrasound. Pedal (foot) pulses must also be palpated, Figure 3 demonstrates positions where foot pulses may be felt, although this alone is an inadequate method of assessing blood perfusion (Moffatt et al, 1994).

Doppler assessment

Failure to recognise arterial disease may result in unsafe

Table 3

European classification of compression hosiery (hospital)

Class I: 18.4–21.1 mmHg

Light, mild support: indicated for mild superficial effect

Class II: 18–24 mmHg

Medium to moderate support

Class III: 36.5–46.6 mmHg

Strong support: indicated for strong compression for combined superficial and deep effect

Class IV: 59mmHg +

Very strong compression for deep effect

application of compression therapy. Arterial perfusion should be evaluated using the hand-held Doppler ultrasound to calculate the ankle brachial pressure index (ABPI) (Vowden et al, 1996). For a detailed explanation on how to perform a Doppler examination see p. 54–60.

Doppler ultrasound assessment should always be used before applying compression with frequent reassessment to ensure that there is adequate arterial blood flow in the limb (Vowden et al, 1996; Anderson, 2002; Fowlkes et al, 1988).

Patients with a reducing ABPI will need to have regular checks as they may require lower classification or no hosiery (Wounds UK, 2005). The ABPI can change significantly in patients who previously presented with venous disease within normal limits. The Royal College of Nursing (RCN; 1998) states that ongoing Doppler ultrasound assessment may be determined by local protocols and recommends regular follow-up to monitor ABPI.

All patients found to have reduced pressure indices should be 're-Dopplered' at three monthly intervals or if symptoms change (RCN, 1998). Change can occur within a short period of time, and is affected by increasing age and other disease processes, patients with two or more arterial risk factors, diabetes and an initial ABPI of below 1.0 are likely to need closer monitoring. (Pankhurst 2004). Dowsett (2004) also suggests that any patient whose ulcer has not healed after 12 weeks, or

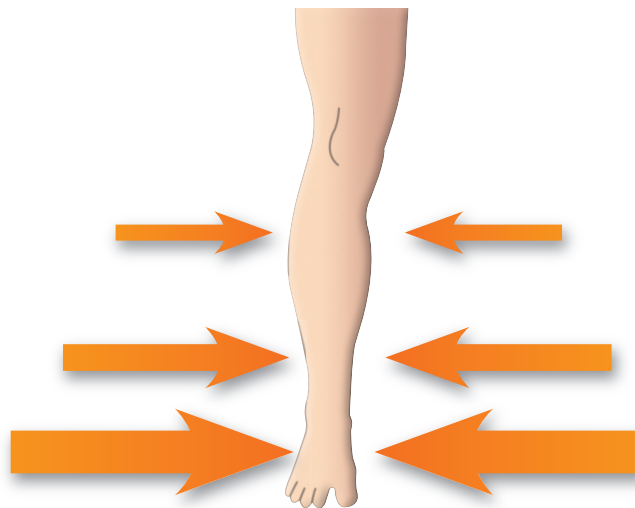


Figure 2. Compression hosiery is graduated with the greatest pressure at the ankle reducing as it goes up the leg.

if a new ulcer presents, should be re-Dopplered. An APBI must always be considered before repeat compression hosiery is prescribed.

Hosiery assessment

There are different varieties of hosiery available and therefore patients must be fully involved in the assessment of which type suits their individual needs. Factors that need to be taken into consideration are listed in *Tables 4 and 5*. In order to dispense hosiery, specific prescription details and information are required by pharmacist:

- ▶▶ Garment details (brand of hosiery)
- ▶▶ Colour of garment
- ▶▶ Class of hosiery
- ▶▶ Quantity required
- ▶▶ Length of garment
- ▶▶ Size required.

The assessment process must also include consideration of the risk factors of compression therapy. It is essential that these are considered before the application of any type of compression hosiery (*Table 6*).

For patients who prefer to take care of their own treatment, provided they have uncomplicated venous disease, (that is they have no other concurrent disease that is likely to influence healing), elastic compression hosiery which can be obtained on prescription can be used, particularly for those with smaller ulcerations that do not need a bulky primary dressing (Marston and Vowden, 2003).

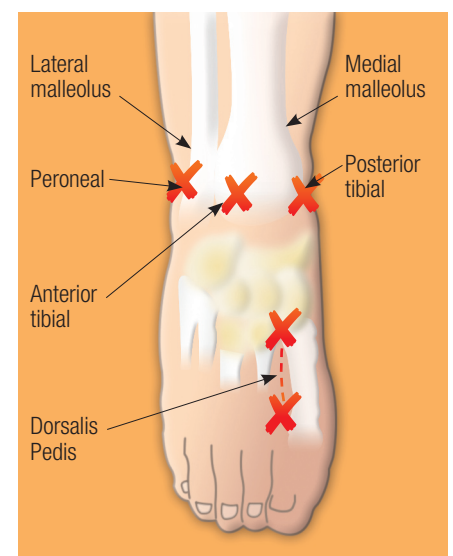


Figure 3. Various and approximate positions where the foot (pedal) pulses may be detected.

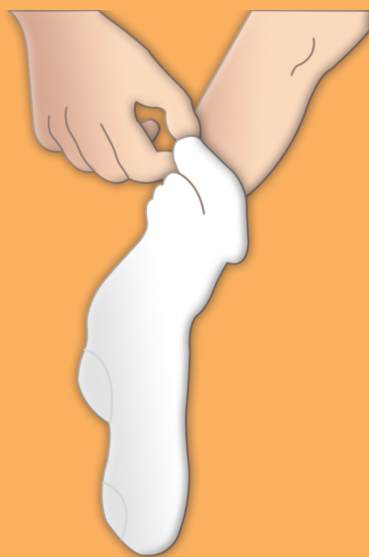


Figure 4. If the stockings are gathered together in the typical 'doughnut' fashion, the effect of the elastic material is multiplied many times and makes application difficult.

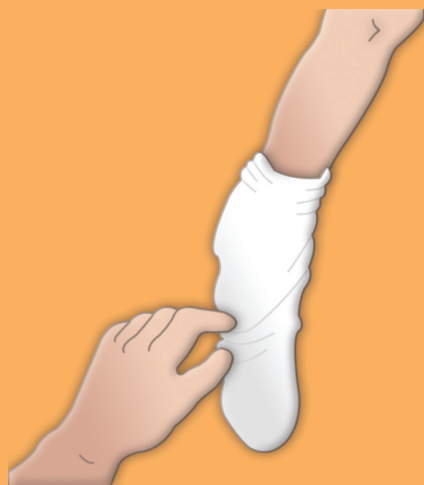


Figure 5. Insert the hand into the stocking as far as the heel pocket. Grasp the centre of the heel pocket and turn the stocking inside out to the heel area.



Figure 6. Carefully position the stocking over the foot and heel. Be sure that the heel is centred in the heel pocket. Pull the stocking up and fit it around the ankle and calf, working up to the final position. The top of stocking is positioned 1–2 inches below the back of the knee and bottom of the kneecap.

The documentation priorities of assessment for compression hosiery are:

- ▶▶ Past medical history
- ▶▶ Vascular assessment and reassessment, with diagnostic test results
- ▶▶ Skin condition, known allergies, sensitivity history
- ▶▶ Clinical signs of disease
- ▶▶ Any contraindications for hosiery
- ▶▶ Effect of hosiery on common skin conditions
- ▶▶ Time and date of each assessment (Wounds UK, 2005).

These should be recorded in the patient's case notes.

Measuring limbs for hosiery

Hosiery selection requires accurate measurement of the limb. Measurements should be taken either first thing in the morning or just after the bandages have been removed, as these are the times at which the limb will be least swollen. Limbs should be measured before each prescription is dispensed — most pharmacies will offer this service. Only staff who are competent should measure and fit appropriate hosiery for patients. Most patients will be suitable for standard sizes of hosiery (small, medium, large, extra large and extra, extra large). However, if these are not sufficient, made-to-measure garments are available, but this needs to be discussed with the pharmacist who will process the order through companies/suppliers, such as Credenhill Ltd, Derbyshire, which access made-to-measure hosiery.

Patients' feet should be flat on the floor while the measuring

procedure is performed. For below the knee hosiery, patients can be seated as long as their feet are flat. It is essential to use the right measuring guide for the correct make of hosiery as measurement sizes differ from make to make. The measurements should be recorded on the hosiery measurement chart. The measuring procedure is as follows:

- ▶▶ Use a tape measure to measure both legs, as each leg may be a different size.
- ▶▶ Record the circumference of the ankle at its narrowest point
- ▶▶ Record the circumference of the calf at its widest point
- ▶▶ Record the circumference of the thigh at its widest point (for thigh-length hosiery only)
- ▶▶ Record the length of the foot from the tip of the big toe to the heel
- ▶▶ Record the length of the leg from the heel to below the knee or groin for thigh length hosiery (In the latter case with the patient standing).

Application of compression hosiery

Compression stockings are not put on in the same way as ordinary hosiery. If the stockings are gathered together in the typical 'doughnut' fashion, the effect of the elastic material is multiplied many times and makes application difficult (*Figure 4*).

The patient/carer should be taught the application technique for their particular brand of hosiery since the manufacturer's application guidelines may vary. The first application should be supervised by a competent practitioner who has been trained to fit hosiery. Newly applied hosiery should be monitored

and checked after fitting with any difficulties and problems experienced being identified and addressed. There are a variety of suitable aids supplied by the hosiery manufacturers to help application, and these should be discussed with the patient. General tips on application techniques for open-toed hosiery include the use of silky slipperettes (Chinese slippers) or small plastic bags that can be placed over the toes, then the hosiery slid over the top. The slipperette or bag is then pulled through the toe hole when the stocking is in place. The use of rubber gloves may also aid application by improving the patient's grip (Edwards, 1996).

The correct method of application is outlined in *Figures 5* and *6*.

As stated earlier, two-layer hosiery treatment kits with liners are available and are easy to apply. Patients can be taught to self-care. *Figures 7–14* show an 82-year-old woman applying a two-layer hosiery system with a simple non-adherent absorbent dressing underneath (Cullum et al, 2001).

Patient education

Compression therapy or hosiery do not cure underlying venous disease, but temporarily restore venous function. Therefore, compression hosiery is a lifetime strategy for prevention of venous leg ulcer recurrence. General tips with regard to hosiery management for patients and the prevention of recurrence are highlighted in *Table 7*.

Conclusion

The application of compression hosiery initiates a variety of complex physiological and

biochemical responses in the leg, which can affect the venous, arterial and lymphatic systems. Wearing compression hosiery impacts on the venous dynamics (Hafner and Junger, 2000).

Selecting the correct grade and size of hosiery will ensure that a level of compression is provided that does not adversely

Table 4

Assessment for hosiery

- Hosiery type
- Colour (discuss with patient)
- Size
- Open or closed toe
- Grade
- Thigh length or below knee
- Leg measurements
- Document and record hosiery history
- Number of hosiery required
- Patient preference
- Material
- 'Off the shelf' or made to measure
- Variety
- Feel
- Previous experience of hosiery
- Patient's ability to apply and remove
- Consider hosiery for each leg, the ABPI may be different in either leg as one may have arterial disease and one venous disease

From: Kemp (1996); Jones (1998); Wounds UK (2005)

Table 5

Factors to consider when selecting hosiery

Correct measurement and fitting to ensure graduated compression without tight bands at or below the knee, across the front of the ankle, and around toes

Physical dexterity, especially the presence of arthritis in the hands which may make application of the garments more difficult

Joint deformities such as the hallux valgus (bunion) or crowded and deformed toes, may give higher pressures under the hosiery if it is not well fitting

Table 6

Risk factors to be considered before applying compression hosiery

Skin condition	Delicate skin can be friable due to recent healing
Shape of limb	The sub-hosiery pressure and the pressure gradient will be altered by the limb shape (in accordance with Laplace's law). Skin overlying exposed bony prominences may be subject to pressure damage
Presence of neuropathy /loss of sensation	Some patients may be unable to feel pressure or sensation in the lower limbs and the absence of this protective response increases the risk of pressure damage under the hosiery
Presence of cardiac failure	In patients with heart failure, rapid shifts of fluid from the surface cells in the legs to the deep system can be dangerous, as this may increase pressure in the already overloaded failing heart (Marston and Vowden, 2003)
Prevention of recurrence	All patients should receive an individualised prevention of recurrence of venous leg ulcers follow-up programme
Potential hazards	Pressure necrosis as a result of existing arterial disease Friction or pressure damage owing to poor fitting hosiery (Photo 1). Skin allergies or irritation (be aware of latex allergy) The hosiery may slip down the leg and twist causing a tourniquet affect in patients who cannot apply or remove hosiery Hosiery may be too short if not measured correctly and wrong size is prescribed, care must be taken to ensure hosiery is long enough
Risk areas	Tibial crest (shin bone) can be very 'sharp or knife edge like' and easily damaged Constricting cuffs, caused by ill fitting hosiery below or around the swollen arthritic knee joint Dorsum (top) of foot if the correct size for the foot is not measured Ankle deformity, most hosiery is designed for a full mobility of the ankle joint Bunion area, may be a cause of raised pressure from the hosiery Crowded/deformed toes may be a cause of raised pressure from the hosiery, consider open toe hosiery

From: Jones (1998); Wounds UK (2005)

affect arterial blood flow. By using the correct application techniques and the right hosiery, compression therapy can reduce oedema and pain, promote healing in the active ulcer and prevent recurrence.

As with any treatment, the practitioner must understand the indications for using compression hosiery in the individual patient, how compression hosiery works, and read the manufacturer's

instructions to ensure the products are used appropriately. **WE**

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Figure 7. Healing venous ulcer.



Figure 8. Liner turned back to heel pocket.



Figure 9. Easing the liner over the heel, holding the low adherent non-adhesive dressing in place.



Figure 10. Ensuring that the dressing is not wrinkled and lays flat to the wound bed.



Figure 11. Liner and dressing in place.



Figure 12. Top stocking is inverted to position the heel pocket.



Figure 13. Easing the hosiery over the heel and up the leg; the liner enables smooth application.



Figure 14. The liner and hosiery are in place, wrinkle free. The open toe can be fitted above or below the hallux (bunion area) according to patient comfort.

Table 7

Important general points on hosiery education for patient

- Inform patient/carer that hosiery should be cared for according to manufacturer's instruction, to maximise benefits and minimise risk during hosiery use. Hosiery with excessive wear, damage or defect should be replaced
- Ensure patient/carer is informed of the importance and the benefits of compression hosiery
- Information should be given to patients about renewal and replacement of hosiery
- Emphasise the importance of ensuring that care is used during application and removal of hosiery so that damage is prevented
- The amount of time the hosiery is worn should be assessed on an individual basis, but generally remove at night and reapply first thing in morning
- Check whether hosiery matches product selected/prescribed/recommended by assessing practitioner. A copy of the hosiery prescription should be kept by the patient
- Prevention of recurrence
 - Vascular investigation and surgery to varicose veins (if appropriate)
 - Reassess/re-Doppler patients every 6 months or 3 monthly for patients with complex medical problems (e.g. diabetes, rheumatoid arthritis, claudication)
 - Educate patients to avoid accidents/trauma and to keep legs and feet warm particularly if the patient has loss of sensation below the knee
 - Encourage mobility and teach exercises to improve calf muscle pump action to encourage the return of the venous blood in the lower limbs to the central system.
 - Advise on the benefits of elevating the affected limb when immobile (if venous disease present) this will enhance the return of the venous blood in the lower limbs to the central system.
 - Encourage access to well leg clinics where available
 - Advice should be given that compression hosiery needs to be worn for life

Sources: Wounds UK, 2005; Cullum et al, 2001; Fasiadis et al, 2002

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Key Points

- ▶▶ Graduated compression therapy has been found to be successful in the management of venous ulceration.
- ▶▶ To prevent venous recurrence, patients require life-long graduated compression therapy.
- ▶▶ Compression is the most important component in the conservative treatment and prevention of recurrence of venous leg ulcers and the management of lymphoedema.
- ▶▶ It is important when using hosiery that the correct selection, limb measurement, application, removal and evaluation of effectiveness is undertaken, documented and monitored.