Applying Unna boot bandages with high pressure: Fischer bandages

Author:
Hugo Partsch

Unna boot bandages are still widely used around the world. They are popular, inelastic bandages, mostly applied with moderate or low pressure (20–30 mmHg). It is demonstrated that higher compression pressure (initially 50–70 mmHg in the resting position) has considerably stronger haemodynamic effects, making this so-called 'Fischer' bandage a suitable choice for patients with large ulcers in heavily congested legs but also with lymphoedema. These bandages have also pain-relieving properties in acute deep vein thrombosis, emphasised by Unna's pupil, Heinrich Fischer. The effectiveness of zinc paste bandages as the most inelastic compression material without any stretch relating to physiological consequences on venous, arterial and lymphatic flow in the lower extremity, is discussed in this article.

Hugo Partsch *is Emeritus Professor, Medical University of Vienna, Austria*

In 1885, the German dermatologist Paul Gerson Unna developed a zinc oxide paste that was applied to wet cotton bandages wrapped to the leg by using a brush. The zinc paste contained zinc oxide, linseed oil, wool fats and calcium carbonate, and had a drying, cooling, anti-inflammatory effect (Unna, 1899). Several companies have introduced ready-to-use zinc paste dressings to the market in recent years. Some Unna Boots also contain calamine lotion and glycerin. Usually, Unna boot bandages are applied with mild to moderate pressure (20–30 mmHg) to the leg (Zarchi and Jemec, 2014).

A pupil of Unna, Heinrich Fischer, reported excellent clinical effects when he applied Unna boot bandages to patients with deep vein thrombosis (DVT) with much higher pressures, probably more than 50 mmHg (Fischer, 1910).

In a publication from 1910, he wrote that the most amazing effect is the immediate pain relief in patients with acute DVT who barely tolerated the weight of the bed-cover as soon the bandage had been applied under very high pressure (Fischer, 1910). There is still a tradition in Germany of using such high-pressure zinc paste bandages, not only in patients with venous thrombosis, but also in venous leg ulcers, post thrombotic syndrome and lymphoedema, as this has been practiced by family members of Heinrich Fischer, summarised in a book edited by his grand-daughter and her husband, Helmuth Haid (Haid-Fischer and Haid, 1985).

However, since the technique of this special Fischer-bandage had been declared as being difficult to learn and to practice, its general use is still limited, although it offers an extremely effective alternative among inelastic compression modalities. Based on the author's lifelong experience and insights coming from clinical research (Haid et al, 1968; Partsch, 2001), some advantages of this technique will be covered in this article.

Material and handling

For a bandage covering the lower leg, it is advisable to use two 5 m (or one 10 m long) ready-made zinc paste bandages (e.g. Varicex F® (L&R), 10 cm x 10 m, or Gelocast® (BSN Medical), 10 cm x 9 m), cotton wool rolls (e.g. Cellona® rolls, L&R), one short-stretch bandage (e.g. Rosidal K®, L&R) 10 cm x 5 m, or Comprilan® (BSN Medical) 10 cm x 5 m) and tapes (Leukoplast®, BSN Medical) 2.5 cm x 5 m). Scissors to cut the zinc paste rolls and an apron for the bandager are important additional tools (International Lymphoedema Framework [ILF], 2012).

Application technique

After checking the arterial status by palpating the foot pulse and, in case of doubt, using a handheld Doppler instrument for measuring the ankle pressure, which should be more than 60 mmHg, the patient (in a sitting position) is asked to keep his/her foot dorsally extended (toes towards the nose), thereby protruding the tendon of the foot elevator. By putting some cotton wool over this area, the tendon is protected from high

Figure 1. Fischer bandage in situ.

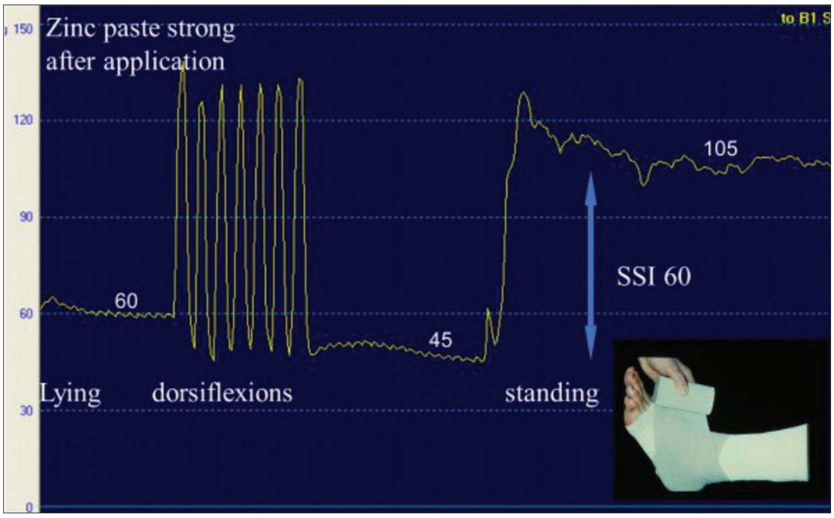

Figure 2a. Compression pressure registered at the B1 point under a firmly applied zinc-paste bandage ("Fischer bandage"): 60 mm Hg in lying position, pressure peaks up to more than 120 mmHg during dorsiflexion, resulting in a pressure decrease to.45 mmHg. Standing up the pressure rises to more than 120 mmHg, which slowly falls to 105mmHg. In the supine position arterial pulsations can be seen. Static stiffness index (SSI)=105-45=60.

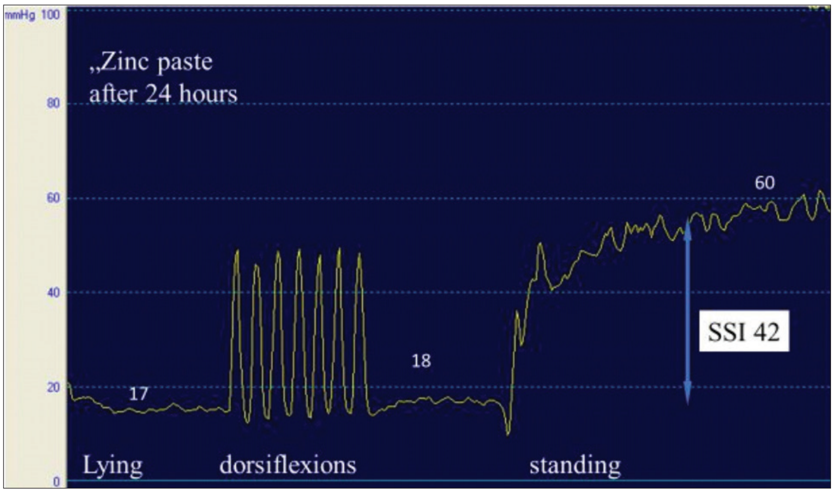

Figure 2b. After 24 hours resting pressure is 18 mmHg in supine position and rises to 60 mmHg after standing up. (SSI=42). Pressure amplitudes by dorsiflexion are still high ("massaging effect").

local pressure, which may otherwise hurt during walking or even create local pressure damage.

The first turn of the zinc past bandage starts between the heel and the protected tendon and back to the heel. Then the bandage is wrapped over the ankles and down to the mid-foot. In a mobile patient without oedema of the foot, it is not necessary to cover the foot down to the toes, in oder not to restrict ankle movement. If the foot is swollen, the bandage should go to the bases of the toes and, in lymphoedema, it is recommended that toes are wrapped using small stripes of gauze (ILF, 2012).

The wrap is then guided up to the ankle region with the role always pressing against the skin, and cut whenever the fibres of the gauze get twisted — the fibres of the bandage should always stay parallel to each other. While the bandage roll is pressed towards the leg, the bandage layers are guided up the leg in a figure of eight configuration, always trying to stay with the roll in tight contact with the leg, thereby molding the material to the irregularities of shape and consistency of the underlying tissue under considerable pressure. Whenever the fibres of the bandage material do not follow a parallel arrangement, the bandage is cut and application is continued in a new direction. Once half of the 5-metre bandage is applied, the second half is put on, again starting at the foot level.

The clinician should stop wrapping the leg at the tibial tubercle (about 2–3 cm below the knee). After the leg is wrapped, a smooth line without pits can be felt by touching the bandaged leg. The consistency of the bandage should feel like a firmly blown-up balloon.

The white zinc paste is then covered by applying a short-stretch bandage (e.g. Rosidal K, 2.5 m), again with full stretch, tightly towards the leg. The end of the bandage is secured with some tape. In order to prevent rolling of the material in the shoe, tapes are also attached over the heel and foot *[Figure 1]*. Rolling of the bandage can also be prevented by the application of an elasticated tubular piece (Tubigrip®, Mölnlycke) over the bandage.

Most patients will explain that the bandage is firm, but not painful. This is also the case in patients with venous ulcers, even when patients complain during bandage application that they would not tolerate this high pressure.

First time bandagers could use a pressure measuring device like Kikuhime® (TT Meditrade) or Picopress® (Microlab) and check the subbandage pressure, which should be between 50 and 60 mmHg. High intermittent pressure peaks can be very effective even in patients with additional arterial occlusive disease (Alvarez et al, 2015).

The patient should start walking immediately. For first-time patients, it is advisable to explain to them that they should start walking and come back in 15 minutes. It happens very rarely that the bandage needs to be removed because of heavy pain.

Table 1. Specific arguments for zinc paste bandages (Delos Reyes et al, 2014).
Haematologic: • Stimulation of fibrinolysis (reduction of plasminogen activator inhibitor-1) • Reduction of coagulation (tissue factor inhibitor, endothelial cells, F VII)
Haemodynamic: • Increase of flow velocity
Flow induced endothelial reactions: • Shear-stress induced release of vasoactive mediators from endothelial cells
Reduction of capillary filtration
Stimulation of lymph flow

It is essential to explain to the patient that this firm bandage requires regular walking exercises, because there will be an immediate oedema reduction, so that the high pressure will drop. Half an hour of walking is especially important for the patient after the application of a new bandage, as long as the material is still wet.

The patient cannot shower or use a bath tub while wearing an Unna Boot, unless the bandage is covered with a plastic bag.

Usually the bandage will stay in place for 1 week before requiring a change. Heavily oozing wounds will require more frequent bandage changes in the initial treatment phase. If the exudate penetrates the bandage, even daily change may be necessary in extreme cases. Usually, the initial heavy secretion will rapidly subside and the ulcer will dry out with increasing oedema reduction. In patients with lymphoedema, bandages will be reapplied as soon they come loose. Patients should be able to wear regular socks and shoes while wearing an Unna Boot dressing. They could also try wearing a wider shoe or slipper.

Bandage changes are undertaken by removing the tapes and by unwrapping the short-stretch bandage, which can be washed and reused again. The zinc paste can be cut down, which may be easy when the oedema of the leg is reduced. If this is not the case, it is wise to unwrap the bandage layers impregnated with zinc paste manually, to avoid injuries by cutting the skin of the leg.

Compression pressure: how high should it be?

The main difference between a Fischer bandage and Unna boot bandages is the high initial compression pressure after application. One can measure the bandage pressure at the so-called 'B1 point', which corresponds to the transition between the tendinous part and the muscular part of the medial gastrocnemius muscle using an air-filled pressure probe (Picopress). Pressure measurement is mainly conducted for scientific interest and for training purposes, but not for every routine patient.

As shown in *Figure 2a*, this high pressure starts to drop immediately in a healthy subject from 60 mmHg after application to 45 mmHg after seven dorsiflexions in the lying position (Partsch, 2017). By standing up, the pressure rises to more than 120 mmHg and falls to 105 mmHg, 20 seconds later. This pressure drop can be explained by an instant reduction of the leg volume and not by yielding of the compression material, as can be demonstrated by applying bandages to a bottle, which does not reveal a pressure drop within 2 minutes.

After 24 hours, the lying pressure has dropped to values lower than 20 mmHg but is still high during standing and walking *[Figure 2b]*. Despite the pressure drop in the resting position, the standing pressure and the pressure amplitudes stay quite high under the non-yielding zinc paste material, even 24 hours after bandage application. The difference between the standing and the resting pressure has been called 'Static Stiffness Index (SSI)', which correlates well with the pressure peaks during ankle movement, characterising the massaging effect of the compression material (Partsch et al, 2008).

Such immediate pressure loss demonstrating immediate removal of oedema cannot be seen if the bandage is applied with initial low pressure *[Figure 3]*. However, there is still a high pressure in the standing position and high-pressure peaks during walking, explaining the high degree of efficiency even up to 1 week after application (Mosti and Partsch, 2010).

In a study that revealed similar ulcer healing rates with zinc paste bandages compared to Coban 2™ (3M), the following pressures were reported by Mosti et al (2011) for the zinc paste in 50 patients applied using the Fischer-technique: post-application: (median and interquartal range); lying: 56.5 mmHg (54–59); standing: 79 mmHg (73–82); after 1 week: lying: 29.5 mmHg (27–31); standing: 53.5 mmHg (50–56). The pressure drop after 1 week was 48% in a supine and 32% in standing position.

Low versus high pressure

Low compression pressure may be effective in reducing, but also preventing oedema. This can be observed even by healthy persons every evening before going to bed when the socks are removed; there is a compression mark above the ankles showing that the pressure of the sock was able to

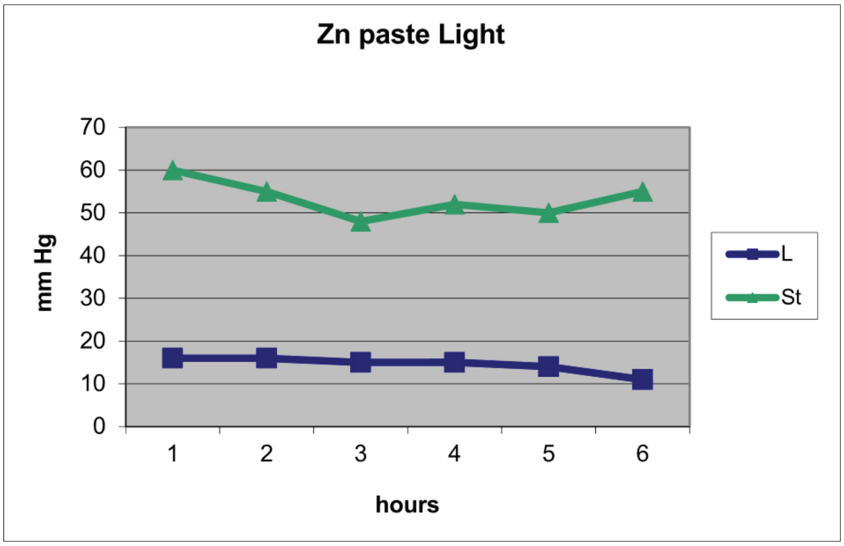

Figure 3. Unna boot bandage applied with a mild resting pressure (18 mmHg) shows standing pressures falling from initial values of 60 mmHg by 5–10 mmHg during the next few hours (L= Lying, St=Standing).

reduce physiologic evening oedema after 1 day spent in an upright position. Using Duplex and MRI studies, it could also be demonstrated that low pressure around 15 mmHg is able to narrow superficial and deep veins in the supine position, but not in the upright position (Partsch and Partsch, 2005; Partsch et al, 2010).

Investigations have shown that high compression pressure in the upright position, overcoming the local intravenous pressure, is needed to achieve an improvement of the venous backflow in ambulant patients. For patients with arterial occlusions, compression pressure should be reduced. It has been shown that inelastic compression with an initial pressure up to 40 mmHg will even improve arterial flow as long as the systolic ankle pressure is higher than 50 mmHg (Mosti et al, 2011). Patients with an ankle pressure lower than 50 mmHg (critical ischaemia) should not be treated with compression. Enhancement of arterial pulsatile flow under compression had been shown in a study by Mayrovitz in healthy people previously (Mayrovitz, 1998).

Measurement of ambulatory venous hypertension

Intravenous pressure can be measured by putting a needle into a dorsal foot vein. In the standing position, the pressure in the veins, corresponding to the weight of the blood column between the measuring point and the right heart, will increase in the lower leg to values between 60 to 90 mmHg, depending on the body-height. When a normal subject starts walking, the intravenous pressure falls to values lower than 30 mmHg, demonstrating a normal function of the calf pump due to the intact valves, which prevent retrograde refluxes. In case of valvular incompetence, refluxes will occur with every step that prevent the distal venous pressure to be reduced. This situation is called 'ambulatory venous hypertension', which is the main cause for skin changes and ulceration on the lower leg. It could be shown that this ambulatory venous hypertension can be reduced by applying strong, inelastic bandages exceeding a resting pressure of more than 50 mmHg (Partsch, 1984) *[Table 1]*. The resulting compression pressure during standing of more than 70 mmHg can achieve venous narrowing as can be shown by Duplex and MRI as a prerequisite for a haemodynamic action (Partsch and Partsch, 2005; Partsch et al, 2010).

Measuring the ejection fraction of the calf pump

The ejection fraction of the calf pump is another parameter characterising the quality of venous return in a walking subject. While in normal individuals 60–70% of the blood volume pooled in the calf muscle is pumped up towards the heart during walking, this ejection fraction, which can be measured using a plethysmographic method (Poelkens, 2006), is reduced in patients with chronic venous insufficiency, mainly due to refluxes. Strong compression in patients with chronic venous insufficiency is able to increase the amount of blood volume pumped up during walking significantly, in contrast to elastic material and compression stockings.

It could be shown that in patients with chronic venous insufficiency, reduced pumping function could be restored to normal values of ejection fraction only when the standing pressure was >60 mmHg, when SSI values exceeded 10 mmHg or when the pressures amplitudes were higher than 15 mmHg (Partsch, 1984; Mosti et al, 2008a; 2008b; 2010). Some of these mechanisms might explain the pain-relieving effect of a Fischer bandage in patients with acute deep vein thrombosis (Fischer, 1910; Partsch, 2014), which may be connected with a reduced risk for developing a post-thrombotic syndrome (Partsch et al, 2004; Amin et al, 2018).

Mechanically induced pressure changes in the tissue lead to very complex changes in the microcirculation, including cells and molecules involved in inflammatory reactions. In summary, firmly applied zinc paste bandages are haemodynamically effective, reducing venous reflux and improving venous pumping function during walking, leading to a rapid reduction of pain and oedema. Their main disadvantage is the fact that their application requires some training on behalf of the clinician. WINT

Declaration

The author has no conflict of interest, financial or otherwise. The submitted manuscript is the author's original work, has not been published before and is not being considered for publication by another publisher. Ethics approval was not required.

References

Alvarez OM, Wendelken ME, Markowitz L, Comfort C (2015) Effect of high-pressure, intermittent pneumatic compression for the treatment of peripheral arterial disease and critical limb ischemia in patients without a surgical option. *Wounds* 27(11): 293–301

Amin EE, Bistervels IM, Meijer K et al (2018) Reduced incidence of vein occlusion and postthrombotic syndromeafter immediate compression for deep vein thrombosis. *Blood* 132(21): 2298–304

Delos Reyes AP, Partsch H, Mosti G et al (2014) Report from the 2013 meeting of the International Compression Club on advances and challenges ofcompression therapy. *J Vasc Surg Venous Lymphat Disord* 2(4): 469–76

Fischer H (1910) Eine neue Therapie der Phlebitis. Med.*Klinik* 30: 1172–3

Haid H, Lofferer O, Mostbeck A, Partsch H (1968) Lymph kinetics in the postthrombotic syndrome under compression bandages. *Med Klinik* 63(19): 754–7

Haid-Fischer Freya, Haid H (1985) *Venenerkrankungen. Phlebologie für Klinik und Praxis* (5th edn.) Thieme: Stuttgart, New York

International Lymphoedema Framework (2012) *Best Practice: Compression Therapy: A Position Document on Compression Bandaging* (2nd edn.) Available at: https://bit.ly/2JRD69j (accessed 16.07.2019)

Mayrovitz HN (1998) Compression-induced pulsatile blood flow changes in human legs. *Clin Physiol* 18(2): 117–24

Mosti G, Crespi A, Mattaliano V (2011) Comparison between a new, two-component compression system with zinc paste bandages for leg ulcer healing: a prospective, multicenter, randomized, controlled trial monitoring sub-bandage pressures. *Wounds* 23(5): 126–34

Mosti G, Iabichella ML, Partsch H (2012) Compression therapy in mixed ulcers increases venous output and arterial perfusion. *J Vasc Surg* 55(1): 122–8

Mosti G, Mattaliano V, Partsch H (2008a) Influence of different materials inmulticomponent bandages on pressure and stiffness of the final bandage. *Dermatol Surg* 34(5): 631–9

Mosti G, Mattaliano V, Partsch H (2008b) Inelastic compression increases venous ejection fraction more than elastic bandages in patients with superficial venous reflux. *Phlebology* 23(6): 287–94

Mosti G, Partsch H (2010) Inelastic bandages maintain their hemodynamic effectiveness over time despite significant pressure loss. *J Vasc Surg* 52(4): 925–31

Partsch B, Partsch H (2005) Calf compression pressure required to achieve venous closure from supine to standing positions. *J Vasc Surg* 42(4):734-8.

Partsch H (1984) Improving the venous pumping function in chronic venous insufficiency by compression as dependent on pressure and material. *Vasa* 13(1): 58–64

Partsch H (2001) Therapy of deep vein thrombosis with low molecular weight heparin, leg compression and immediate ambulation. *Vasa* 30(3): 195–204

Partsch H, Clark M, Mosti G et al (2008) Classification of compression bandages: practical aspects. *Dermatol Surg* 34(5): 600–9

Partsch H, Kaulich M, Mayer W (2004) Immediate mobilisation in acute vein thrombosis reduces post-thrombotic syndrome. *Int Angiol* 23(3): 206–12

Partsch H, Mosti G, Mosti F (2010) Narrowing of leg veins under compression demonstrated by magnetic resonance imaging (MRI). *Int Angiol* 29(5): 408–10

Partsch H (2014) The role of leg compression in the treatment of deep vein thrombosis. *Phlebology* 29(1 suppl): 66–70

Poelkens F, Thijssen DH, Kersten B et al (2006) Counteracting venous stasis during acute lower leg immobilization. *Acta Physiol (Oxf)* 186(2): 111–8

Unna PG (1899) *Allgemeine Therapie der Hautkrankheiten*. Urban & Schwarzenberg, Berlin-Wien

Zarchi K, Jemec GB (2014) Delivery of compression therapy for venous leg ulcers. *JAMA Dermatol* 150(7): 730–6