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CME ARTICLE

Compression therapy in dermatology

Joachim Dissemond[1] | **Kerstin Protz**[2] | **Markus Stücker**[3]

[1]Department of Dermatology, Venerology and Allergology, University Hospital Essen, Essen, Germany

[2]Competence Center for Health Services Research in Dermatology (CVderm), Institute for Health Services Research in Dermatology and Nursing (IVDP), University Medical Center Hamburg-Eppendorf (UKE), Hamburg, Germany

[3]Department for Dermatology, Venerology and Allergology, Ruhr-University Bochum, Vein Center of Dermatology and Vascular Surgery, Bochum, Germany

Correspondence
Joachim Dissemond, MD, Department of Dermatology, University Hospital Essen, Hufelandstrasse 55, 45122 Essen, Germany.
Email: joachim.dissemond@uk-essen.de

Joachim Dissemond
Finanzielle Interessen: Von einer anderen Institution
Erklärung zu nicht-finanziellen Interessen: ICW, WundDACH, AGW, DGPL

Kerstin Protz
Finanzielle Interessen: Nein
Erklärung zu nicht-finanziellen Interessen: ICW, EWMA, DGPL, ICC

Markus Stücker
Finanzielle Interessen: Von einer anderen Institution
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Summary

Compression therapy is a conservative therapy that can be used in many patients with dermatological conditions, especially those associated with edema. In addition to its well-established use in venous and lymphatic disorders, there is increasing evidence that compression therapy supports the healing of inflammatory dermatoses. The presence of edema, regardless of its etiology, is an indication for the use of compression therapy.

Nowadays, a variety of materials and treatment options are available for compression therapy, each with their own advantages and disadvantages. Often, compression therapy with low resting pressures is sufficient for effective therapy and is better tolerated by patients. The main contraindications to compression therapy are advanced peripheral arterial disease and decompensated heart failure.

Individual factors and economic considerations should be taken into account when deciding on compression therapy with the patient. Patient self-management should be encouraged whenever possible. This requires education and support tools.

KEYWORDS
compression therapy, dermatological diseases, edema, self-management

INTRODUCTION

Compression therapy has been an essential component of the conservative treatment of people with phlebological and lymphological diseases for many decades.[1,2] In recent years, both the different materials and the indications for compression therapy have become more sophisticated and diverse. Diseases that were once considered strict contraindications, such as erysipelas and peripheral arterial (occlusive) disease (PAD), have now been thoroughly reevaluated and may even be regarded as indications for compression therapy under specific circumstances. This article therefore focuses on the latest findings in compression therapy of the lower extremities, particularly in the field of dermatology.

PHYSICAL AND PHYSIOLOGICAL BASICS

The effectiveness of compression therapy is influenced by the pressure applied, the type of compression garments

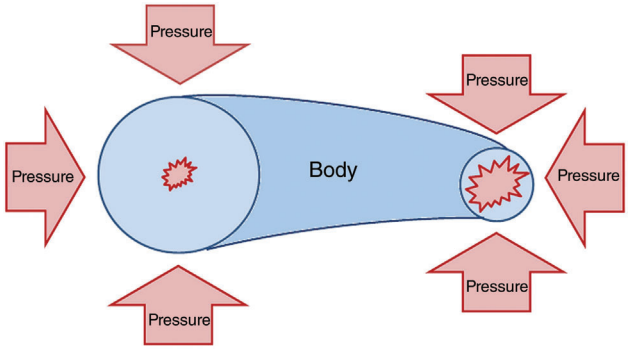

FIGURE 1 Scheme of the pressure effect according to Laplace (J .H. Timm, Hamburg).

used and the number of overlapping layers of compression material.[3]

In terms of pressure, a distinction must be made between resting pressure and working pressure.

Resting pressure is the pressure in a supine position. A typical measurement point for determining resting pressure is the so-called measuring point B just proximal to the medial malleolus. This resting pressure is typically used to classify the compression classes of medical compression stockings. When changing position from prone to upright and also during muscle activity, the pressure increases - the resulting pressure values are called working pressure. The difference in pressure between standing and supine position is defined as the static stiffness index (SSI). The more elastic and extensible a material is, the lower the SSI; the more inelastic and inextensible a material is, the higher the SSI. The higher the stiffness, the greater the massage effect during movement.[4]

According to Laplace's law, the external pressure (P) is directly proportional to the tension (T) of the compression material and inversely proportional to the radius (r) of the compressed limb (P = T/r), as illustrated in Figure 1. In practice, this implies that structures with a smaller radius, such as the tibial edge or the edge of the foot, will experience higher pressure values than structures with a larger radius, such as the back of the foot or the thigh.[3]

Compression therapy has been demonstrated, primarily through experimental studies, to have a beneficial impact on various outcomes across different conditions (Table 1). The most extensively investigated effects include the reduction of edema and the influence on veins through constriction of their lumens, leading to a decrease in venous blood volume in the leg. Edema should always be diagnosed and treated based on its underlying cause. In patients with chronic venous insufficiency (CVI), compression therapy can help to prevent capillary hypertension, which is a significant hemodynamic factor contributing to the development of skin complications.[5] For dermatological applications, the discussed effects of compression therapy on microcirculation and inflammation are particularly relevant. Thus, compression therapy can result in a modification of shear stress, leading to an improvement in microcirculation.[6] Capillary perfusion is partially regulated by viscous blood flow. Viscous solutions induce shear stress on the surface of the endothelium. This mechanical stimulus results in the release of nitric oxide (NO) and prostacyclin. This in turn leads to vasodilation in the downstream microvascular bed, improving capillary perfusion. Under compression therapy, capillary density increases and capillary diameter decreases.[7] Additionally, it has been observed that compression therapy promotes the release of anti-inflammatory mediators from endothelial cells.[8] For example, there is an increase in nitric oxide synthase 3 and a decrease in interleukin-6 and P-selectin with compression therapy.[9]

TABLE 1 Effects of compression therapy (modified according to Partsch and Partsch 2016).

Edema reduction	Restriction of the capillary filtrate
	Fluid shift to non-compressed areas
	Promotion of lymphatic drainage
Veins/vein constriction	Increase in venous flow velocity
	Reduction of venous pooling
	Amelioration of the muscle pumping function
Microcirculation	Increase in shear stress
Inflammation	Release of anti-inflammatory mediators
Arteries	Increase in arterial flow through intermittent as well as continuous compression therapy with moderate pressure.
	Reduction of arterial inflow when the compression pressure exceeds the perfusion pressure

TABLE 2 Indications for medical compression therapy.[10]

- Chronic venous diseases, such as chronic venous insufficiency and venous leg ulcers
- Thromboembolic venous diseases, such as venous thrombosis and post-thrombotic syndrome
- Edema, such as lymphedema and postoperative edema
- Nausea, dizziness, and congestion symptoms during pregnancy
- Burns
- Scars
- Inflammatory dermatoses of the leg

INDICATIONS FOR COMPRESSION THERAPY

The current AWMF guideline of the German Society of Phlebology (DGP) lists the indications for medical compression therapy (Table 2).[10]

TABLE 3 Selection of dermatologic conditions that potentially benefit from compression therapy.

- Erythema induratum
- Erythema nodosum
- Lichen ruber
- Necrobiosis lipoidica
- Perifolliculitis capitis abscedens et suffodiens
- Pigment purpura
- Psoriasis
- Purpura pigmentosa progressiva
- Pyoderma gangrenosum
- Vasculitides
- Vasculopathies
- Circumscribed scleroderma

Compression therapy for inflammatory dermatoses

Inflammatory dermatoses of the legs are not further addressed in this guideline. Although there are very few publications in the literature on compression therapy for inflammatory dermatoses of the legs, there are numerous expert recommendations on compression therapy for many dermatological conditions in current textbooks[11] and guidelines.[10] However, the underlying evidence is very limited, primarily consisting of case reports or expert opinions (Table 3).

On the lower legs, some of the generalized inflammatory dermatoses are much more persistent and pronounced than on other anatomic regions. For example, psoriatic plaques on the lower legs are often particularly refractory to treatment compared to other affected areas of the body. The precise reason behind the impaired healing of psoriasis plaques on the lower legs is not yet fully understood. However, it has been hypothesized that the inflammation leads to an increased tendency for edema, so that the healing of the inflammatory reaction is slowed by stasis.[13] The support of psoriasis healing by compression therapy has only been described casuistically. A patient with psoriasis on both extensor surfaces of the knees was fitted with a compressive knee brace for osteoarthritis. This side healed significantly better than the previously comparable other side with otherwise identical local therapy. This case report discusses the occlusive effect of the dressing in addition to local pressure.[14] In another patient, stage III lymphedema was the trigger for psoriasis vulgaris. Here, too, the psoriasis plaques healed under compression therapy without further treatment measures.[16]

Psoriatic plaques on the lower legs are often more resistant to treatment compared to other affected areas of the body.

Until now, erysipelas has been considered a contraindication to compression therapy according to many expert recommendations and guidelines.[17] However, a paradigm shift is taking place. A retrospective study evaluated the outcomes of 56 hospitalized patients with lower leg erysipelas. All patients received compression therapy in addition to systemic antibiotic therapy from the start. None of the patients experienced clinical deterioration or sepsis while undergoing compression therapy. The authors discussed that patients with erysipelas sometimes have massive edema, which is reduced by compression therapy. This reduction in edema may lead to fewer complications, such as tension blisters, and potentially may improve the penetration of antibiotics into the inflamed tissue. Although this study did not show faster healing due to the lack of a comparison group, it does demonstrate that compression therapy can be safely used in patients with erysipelas.[18] There is considerably better evidence for fewer recurrences in patients with recurrent erysipelas and leg edema [19] with the use of compression therapy in addition to education on erysipelas prevention As a result, there are now initial recommendations from professional societies for the use of compression therapy in erysipelas.[20]

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In a retrospective, monocentric analysis, the clinical course of a total of 31 patients with various forms of cutaneous vasculitis was studied. All patients received compression therapy with short-stretch bandages in addition to systemic therapy. No relevant side effects were observed in this study. Although no comparison group was included, the authors discussed the potential improvement in therapeutic response and potential reduction in systemic immunosuppression associated with compression therapy.[21] Since thrombotic occlusion of skin vessels occurs in livedo vasculopathy, the current AWMF guideline recommends compression therapy not only to promote healing but also to prevent recurrence based on expert recommendations.[22] The current german AWMF guideline for pyoderma gangrenosum acknowledges the lack of scientific studies on the benefits of compression therapy. However, experts agree that patients with lower extremity pyoderma gangrenosum benefit from anti-inflammatory compression therapy.[23] The first published case reports on compression therapy for necrobiosis lipoidica are almost 50 years old.[24] Since then, despite the lack of studies, it has been textbook opinion to use compression therapy supportively in necrobiosis lipoidica.[11,25] It therefore has a firm place in the hitherto otherwise poorly standardized treatment approaches.[26] Casuistic descriptions are also available for erythema induratum,[27] erythema nodosum,[28] lichen ruber (verrucosus),[25] perifolliculitis capitis abscedens et suffodiens,[29] progressive pigmented purpura,[30] or scleroderma circumscripta.[31]

Especially due to the frequently challenging pain symptoms, compression therapy in inflammatory dermatoses can be initiated with low resting pressure values of about 20 mmHg.

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TABLE 4 Criteria for compression therapy after burns.[87]

- Resting pressure ranging from 18–32 mmHg
- Custom-made and interchangeable trimmings
- Bi-elastic flat-knitted, woven, and knitted fabrics
- Recommended wearing time of at least 23 hours per day for 24 months or until scar maturation
- Removal only for body care, scar massage, or lymph drainage

TABLE 5 Contraindications of compression therapy.[10]

- Advanced peripheral arterial disease
- Decompensated heart failure
- Phlegmasia coerulea dolens
- Septic phlebitis

20 mmHg.[32] This approach usually results in effective edema reduction and is better tolerated by patients.

Scars

A completely different example of the effectiveness of compression therapy in non-edematous pathological skin conditions is scar therapy. In the case of pathological scars, a distinction is made between hypertrophic scars and keloids. For both conditions, early implementation of compression therapy, possibly prophylactically, is recommended.[33] Hypertrophic scars can develop in up to 90% of individuals affected by burns.[34] Although the underlying pathophysiology is not fully understood, it is known that compression therapy in scars leads to reduced capillary perfusion and affects fibroblast differentiation and proliferation, resulting in a decrease in type I and type III collagen.[35–37] Compression therapy can additionally be combined with silicone sheets and pressure pads. Studies have shown that combination therapy leads to significant pain reduction and improvement in scar extensibility within 2–4 months.[38] A crucial factor in the development of pathological scarring is chronic inflammation in the reticular dermis.[39] The positive therapeutic outcomes of compression therapy therefore also indirectly point to the anti-inflammatory properties here. Today, compression garment therapy is the gold standard in the prevention and treatment of pathological scars of any genesis, especially after burns (Table 4).[10,33]

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CONTRAINDICATIONS FOR COMPRESSION THERAPY

There are fewer and fewer contraindications to the basic implementation of compression therapy (Table 5). However, certain conditions may present specific risks, such as severe extremity paresthesias or intolerance to compression materials. In such cases, the decision regarding therapy should be made after careful consideration of the benefits and risks and selection of the most suitable compression device.[10] Close clinical monitoring is generally recommended in these situations.

TABLE 6 Advanced PAVK exists if at least one of the following parameters is present.[10]

- ABI < 0.5
- Ankle artery pressure < 60 mmHg
- Toe pressure < 30 mmHg
- tcpO2 < 20 mmHg dorsum of foot

Abbr.: ABI, ankle-brachial index; tcpO2, transcutaneous partial pressure of oxygen measurement

Advanced peripheral arterial disease

In peripheral arterial disease (PAD), blood flow to the arteries supplying the extremities is restricted by stenosis or occlusion. The disease progresses in different stages. Although well palpable foot pulses argue against advanced PAD, they are not conclusive.[40] Therefore, it is recommended that the ankle brachial index (ABI) be obtained as a minimum requirement before initial application of a compression device. The only contraindication to compression therapy is advanced PAD, also known as critical ischemia (Table 6).[41] The majority of patients treated for PAD have mild PAD. If the ABI is > 0.5 and/or absolute occlusion pressures are > 60 mmHg in the legs, compression materials with resting pressures up to 40 mmHg can be used.[42] This is particularly important in patients with mixed etiology leg ulcer, as the primary clinical concern in leg ulcer is usually the CVI and the often less pronounced PAD is only a comorbidity and not a contraindication to compression therapy.[43]

Advanced PAD, also referred to as critical ischemia, is the sole contraindication for compression therapy.

Decompensated heart failure

Heart failure is the reduced physical capacity due to a dysfunction of the heart ventricles. The most common causes are coronary artery disease (CAD), arterial hypertension, and atrial fibrillation. Clinical symptoms include dyspnea, fatigue, dry cough, and nocturia. Decompensated heart failure is a major contraindication to compression therapy. Decompensated heart failure is usually defined as class III or IV according to the classification of the New York Heart Association (NYHA). In NYHA Class III, physical capacity is significantly impaired, but there are typically no symptoms at rest. Even mild physical exertion can cause fatigue, arrhythmias, shortness of breath, or angina. In NYHA Class IV, symptoms are present with all physical activities and at rest. Most patients are bedridden.[3]

TABLE 7 Pressure values of phlebological compression bandages.[46] These resting pressure values refer to the medial B1 area (transition of the tendon into the calf muscle) in the supine position.

- Mild: < 20 mmHg
- Medium: ≥ 20–40 mmHg
- Strong: ≥ 40–60 mmHg
- Very strong: > 60 mmHg

Decompensated heart failure is a major contraindication to compression therapy.

However, most of the predominantly elderly patients with lower-extremity edema are diagnosed with NYHA Class I or II compensated heart failure, which may be treatable with medications. In these cases, compression therapy is not contraindicated. In clinical practice, compression therapy in patients with cardiac edema is usually initiated with resting pressures around 20 mmHg and/or elevation of the legs above heart level. If clinical symptoms worsen, such as dyspnea, compression therapy should be discontinued immediately.[44]

APPROPRIATE USE OF COMPRESSION THERAPY IN DIFFERENT THERAPY PHASES

The choice of compression material depends on the phase of therapy and should consider the needs and physical capabilities of the individual. Compression therapy can be divided into different phases.[45] Since leg circumference decreases rapidly with adequate compression therapy, the decongestion phase uses materials that can be individually adjusted to the loss in circumference. In this phase, compression therapy reduces edema.[46,47] Studies show that in patients with venous leg ulcers (VLUs), a phlebological compression bandage (PCB) with a resting pressure of 40–60 mmHg provides the best results (Table 7).[3,47] With adequate compression care and patient compliance, the decongestion phase should be completed in approximately 4 weeks.[48] In the subsequent maintenance phase, the goal is to maintain the achieved decongestion. If there is hardly any further decrease in leg circumference, then the maintenance phase no longer requires complex and bulky bandaging with compression bandages. (Ulcer) stocking systems are then used. After healing, preventive measures are implemented to prevent recurrence.

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Short-stretch bandages

Short-stretch bandages are still the most commonly used treatment option in Germany.[49,50] They are considered inelastic as their extensibility is less than 100%.[47] The low-stretch material of short-stretch bandages generates counterpressure during muscle contraction. This results in a high working pressure during movement and a low resting pressure. Phlebological short-stretch bandages are used primarily in mobile patients and should be applied with a strong resting pressure (Table 7). However, with the slightest movement and edema reduction, they quickly lose both resting and working pressures, causing them to slide over each other.[51,52] The PCB loses its shape, becomes ineffective, and can cause constrictions and must therefore be renewed daily during the decongestion phase. In addition, there are considerable deficits in the proper application of the bandage in daily care. Phlebological short-stretch bandages are often applied incorrectly and do not generate therapeutically relevant resting pressure (Figure 2).[53] There are a variety of bandaging techniques such as Pütter, Sigg, Fischer, Schneider or figure-eight wraps. However, there is no evidence for the superiority of any one technique.[3] It is important that principles of compression bandaging are observed (Table 8). To protect the skin from indentations and pressure points, additional padding materials such as

FIGURE 2 Improper phlebological compression bandaging with short-stretch bandages (A. Winter, Kiel).

TABLE 8 Basics of phlebological compression bandaging with short-stretch bandages.

- Skin protection with cotton tubular bandage. This is measured to be 2.5 times the length of the lower leg and pulled up below the knee.
- Underpadding to prevent skin damage.
- The width of the bandage is selected according to the shape and diameter of the body part.
- At least two bandages are required.
- To prevent equinus deformity, the foot is placed in dorsiflexion during bandaging.
- It is important to apply adequate and even pressure from the start. Loose turns, such as in the forefoot area, can lead to edema formation.
- Bandage rolls are unrolled directly on the leg under constant tension.
- Bandages are applied towards the heart and not brought back towards the feet.
- The bandages are not pulled away from the body to avoid intermittent pressure spikes, pain, or constriction.
- The bandage is secured with adhesive tape at the end.
- In case of forefoot edema or lymphedema, the toes are also compressed.

FIGURE 3 Underpadding and upholstery with cotton bandages and pads on the lower leg for a phlebological compression bandage with short-stretch bandages (K. Protz, Hamburg).

cotton, foam bandages, or pads should be used. They can compensate for irregularities or protrusions (Figure 3). Additionally, they support an even distribution of pressure.[54]

The low-stretch material of short-stretch bandages generates counterpressure during muscle contraction. This results in a high working pressure during movement and a low resting pressure.

Long-stretch bandages

Long-stretch bandages are considered elastic bandages because their extensibility is greater than 100%, usually in the range of 140% to 200%.[55] Phlebological compression bandages with long-stretch bandages create a high resting pressure and a low working pressure. During muscle contraction, long-stretch bandages offer little resistance and achieve only a limited effect on promoting venous return. Their use in immobile patients should be viewed critically, as they can cause pressure damage due to the high resting pressure during longer periods of rest. Therefore, PCB should not consist solely of long-stretch bandages. However, long-stretch bandages can be part of multi-component systems.[56]

Phlebological compression bandages with long-stretch bandages create a high resting pressure and a low working pressure.

Zinc paste bandages

Zinc paste bandages are barely stretchable, inelastic bandages with an extensibility of less than 10%. The PCB with zinc paste bandages generates a very high working pressure with a low resting pressure, resulting in rapid decongestion in mobile patients. However, these pressures decrease as the volume decreases. They are applied wet. Zinc paste bandages can be bi-elastic, simultaneously transversely and longitudinally elastic, or inelastic, more or less hardening depending on the material properties. Zinc paste bandages that have not fully hardened may leave residues on the patient's clothing and environment. Since zinc paste bandages are relatively rigid, they restrict the mobility of the upper ankle and thus the function of the venous pumps. Applying zinc paste bandages requires a good knowledge of materials, proper application and practical experience. Because zinc paste compression bandages are relatively rigid, they restrict mobility in the upper ankle and therefore affect the function of the venous pumps. Good knowledge of materials, proper application techniques, and practical experience are required to apply a zinc paste compression bandage.[56,57]

The PCB with zinc paste bandages generates a very high working pressure with a low resting pressure, resulting in rapid decongestion in mobile patients.

MULTI-COMPONENT SYSTEMS

A modern and often more effective alternative to the aforementioned PCBs are multi-component systems.[54,58] They are available as ready-to-use sets of one to four bandages. They include several components such as padding bandages, short-stretch bandages, long-stretch bandages, special foam bandages, some of which contain zinc and/or calamine, as well as cohesive fixation bandages or combinations thereof.[55] Unlike short-stretch bandages, the application of multi-component bandages does not require knowledge of complex bandaging techniques. In addition, the application is less time-consuming.[59] In some systems, special stretching techniques or visual markers provide an indication of the resting pressure generated and ensure proper fitting (Figure 4). The adhesive properties of individual components stabilize the PCB and prevent rapid dislodgement. Properly applied, multi-component systems achieve and maintain pressures of ≥40 mmHg for several days. Many manufacturers of multi-component systems also offer "lite" versions that, when used properly, produce a resting pressure of approximately 20 mmHg. Multi-component systems are not washable or reusable, but can be left on the lower leg for up to seven days, depending on the decongestion situation. Compared to reusable short-stretch bandages, however, they are more cost-effective because decongestion is achieved more quickly, resulting in lower staffing and material costs.[60]

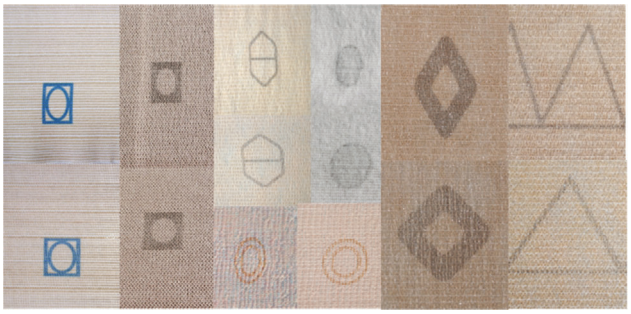

FIGURE 4 Examples of pressure indicators on multicomponent systems (K. Protz, Hamburg).

FIGURE 5 Application of a medical adaptive compression system (K. Protz, Hamburg).

A modern and often more effective alternative to the aforementioned PCBs are multi-component systems.

Many manufacturers of multi-component systems also offer "lite" versions that, when used properly, produce a resting pressure of approximately 20 mmHg.

Medical adaptive compression systems

Medical adaptive compression systems (MACs), also known as adjustable compression wrap bandages, produce resting pressures of 20–60 mmHg, depending on the system, when applied correctly. In some MACs, the resting pressure generated can be visually controlled by markings or specifically adjusted by stretching techniques (Figure 5). For application, reusable cuffs are placed around the limb to be compressed and closed with small velcro techniques. Depending on the system, the bands of the cuff can overlap or run parallel to each other. If the leg circumference decreases due to edema reduction, the closures can be readjusted.[3] This allows some patients or their families to take responsibility for their own MACs, which promotes self-management and treatment adherence.[3,46] Some of the MACs have been approved as medical devices in Germany since 2022 (Table 9).

In some MACs, the resting pressure generated can be visually controlled by markings or specifically adjusted by stretching techniques.

Ulcer stocking systems

Ulcer stocking systems are approved as medical devices in Germany and include two stockings. Depending on the manufacturer, the understocking provides a resting pressure of 17–22 mmHg, holds the wound dressing in place, and serves in some products as a gliding aid for the overstocking. It is usually available in german compression class (CC) II. When superimposed, the pressure values add up to CC III.[3] The overstocking can be removed at night, while the understocking should be worn day and night, if possible. Patients or their family members are often able to apply these systems themselves, which encourages self-management. In addition, unlike compression bandages, these stocking systems are less bulky and provide better ankle mobility. They maintain a constant level of pressure and are less prone to slipping.[61]

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The overstocking can be removed at night, while the understocking should be worn day and night, if possible.

Medical compression stockings

In principle, medical compression stockings (MCS) are suitable for long-term therapy. They can be taken off overnight and put on in the morning before getting up. MCS can be prescribed and reimbursed as medical devices and are available in four CC according to the RAL (German Institute for Quality Assurance and Certification) quality mark (Table 10). There is no strict assignment of compression classes to clinical findings.[3] Medical compression stockings are available as ready-to-wear and custom-made products, as well as in circular knit and flat knit. Patients can choose from a variety of colors, patterns, and decorative weaves. Compression stockings are available in different lengths and designs. Compression stocking applicators and removal aids must be prescribed separately in addition to the MCS. The prescription should include the appropriate indication, such as age-related loss of strength, morbid obesity, joint disease, or paralysis.[3] Donning and doffing aids are available in various designs. Frames are particularly suitable for patients with limited mobility (Figure 7). Sliders are much easier to handle and require less space than frames (Figure 6). However, patients still need sufficient mobility. Donning and doffing aids facilitate the handling of compression stockings, improve self-management, and protect the stocking material.[63] Since there is a wide range of models, individualized advice should be given.

TABLE 9 Characteristics of different compression therapies.

	Short-stretch bandages	Multi-component systems	Medical adaptive compression systems	Ulcer stocking systems	Medical compression stockings
Features	Inelastic bandages with low extensibility capacity < 100% combined with padding materials	Pre-packaged sets of 1–4 bandages of different components: e.g., padding, short-stretch, long-stretch, fixation bandage	Ready-made product available in up to 3 leg lengths (short, normal, long) and in different sizes depending on ankle and calf circumference	Ready-made products available in 3 leg lengths (short, regular, long) and in various sizes, knits (circular/flat knit depending on the company), and compression classes (depending on ankle and calf circumference).	Ready-to-wear and individually made-to-measure available in three leg lengths (short, normal, long) in different knits (circular/flat knit), compression classes and designs (e.g., forefoot cushion, lower leg sock, thigh sock, trousers)
Replacement intervals	Mostly daily	Up to 7 days possible	Application before getting up and removal in the evening while in bed; can also be worn overnight	The liner sock remains on overnight; the outer sock is worn over it during the day	Daily
Attachment	Large number of possible techniques	No knowledge of complex techniques required; technique according to manufacturer's specifications	Technique according to manufacturer	The liner sock also serves as an aid for donning the outer sock	More or less complex depending on knitting technique and compression class
Slipping	They lose their compression and shift against each other after just a few minutes	Hardly any slippage due to cohesive fixation bandage	Hardly any slippage, as they can be readjusted when circumference is reduced	No slippage with adequate measurement	No slippage with adequate measurement
Therapeutically relevant application pressure	Difficult to ensure, as not estimable	Partially equipped with pressure indicators/stretching techniques	Partially equipped with pressure indicators/stretching techniques	Ensured through ready-to-wear products	Ensured through ready-to-wear products
Wearing comfort/mobility	Low(er) due to thicker bandaging	Better/higher due to thin(er) bandaging	Good, as medical adaptive compression systems start above the ankle	Good, hardly noticeable; good mobility in the ankle joint	Good, hardly noticeable; good mobility in the ankle joint
Self-management	Application by patients or relatives is not recommended	Application possible by trained relatives	Self-application or application by relatives after training is possible	Self-application or application by relatives after training is possible; if necessary, the use of assistive devices for donning and doffing may be helpful	Self-application or application by relatives after training is possible; if necessary, the use of assistive devices for donning and doffing may be helpful

TABLE 10 Classification of medical compression stockings in Germany into compression classes (CC) corresponding to the pressure values according to RAL GZG 3872.2.6 at rest on the ankle area (RAL).

CC	Intensity	Pressure (mmHg)	kPA
I	Mild	18–21	2.4–2.8
II	Moderate	23–32	3.1–4.3
III	Firm	34–46	4.5–6.1
IV	Extra firm	≥ 49	≥ 6.5

Abbr.: CC, compression class

FIGURE 6 Examples of donning and doffing aids as sliders (K. Protz, Hamburg).

FIGURE 7 Examples of donning and doffing aids as frames (K. Protz, Hamburg).

FIGURE 8 Example of the use of an intermittent pneumatic compression therapy (K. Protz, Hamburg).

Compression classes are not strictly assigned based on specific clinical findings.

Intermittent pneumatic compression therapy

Intermittent pneumatic compression therapy (IPC) for passive activation of the muscle pump can be used in all phases of compression therapy. These are complex systems in which an electronically controlled pump generates a defined resting pressure between 12 mmHg and 200 mmHg in one to twelve air chambers over the entire leg (Figure 8). A more recent innovation in German-speaking countries are devices that target compression solely at the feet or thighs. In these cases, compression is achieved in part by intermittent pulse compression, with pressure build-up occurring in less than one second. In addition to thrombosis prophylaxis, an improvement of arterial inflow has been claimed.[64] By repeatedly building up and releasing pressure, IPC promotes venous and lymphatic drainage and decongests edema.[65] Intermittent pneumatic compression therapy is used as an adjunct to the aforementioned compression therapies and can be prescribed and reimbursed as an assistive device, especially for partially immobile or immobilized patients (Table 11). In addition to devices for clinics and physicians' offices, there are also home devices that can be prescribed on a temporary or long-term basis and used independently by patients or their relatives. The duration of application is 30–60 minutes and should be repeated up to three times a day. The success of the treatment should be regularly monitored.

By repeatedly building up and releasing pressure, IPC promotes venous and lymphatic drainage and decongests edema.

Future perspectives

Currently, the first hybrid systems are already being used on patients in the form of compression cuffs on the lower

TABLE 11 Therapy options by therapy phase.[88–90]

Therapy phases	Therapeutic options of compression therapy for venous leg ulcers		
Decongestion	Compression bandages Multi-component systems	Short-stretch bandages Long-stretch bandages Zinc paste bandages Padded bandages Cohesive bandages	Intermittent pneumatic compression therapy
Maintenance	Medical adaptive compression systems Medical compression stockings/ulcer stocking systems		
Prevention	Medical compression stockings	Circular knitted Flat knitted	

leg. Integrated electronic controls allow the compression pressure to be precisely adjusted and modified pneumatically or hydraulically.[65,66] Otherwise, as in many areas of medicine, it will be intelligent systems that represent a future evolution of current treatment options. Sensors can be integrated into compression materials to continuously measure pressure values without contact via a smartphone. These values can then be transmitted to the patient's caregivers, for example, and evaluated by algorithms. If the pressure levels are no longer appropriate, an alarm function can be activated to indicate this.[65] New materials for compression therapy, such as those with shape memory or automatic contour adaptation, are also being developed.[67]

RELEVANT ASPECTS FOR CLINICAL PRACTICE

Deep vein thrombosis and post-thrombotic syndrome

Patients with acute deep vein thrombosis (DVT) suffer mainly from pain and swelling in the affected limb. Both symptoms are significantly reduced by the prompt initiation of compression therapy.[68] In addition to providing acute symptom relief, early initiation of compression therapy for deep vein thrombosis (DVT) decreases the incidence of venous occlusion and subsequent post-thrombotic syndrome (PTS).[69] With immediate initiation of modern drug anticoagulation and simultaneous compression therapy, the thrombus in DVT often regresses completely or to such an extent that patients are symptom-free within 3–6 months. The indication for continued compression therapy should be reassessed 3–6 months after the diagnosis of DVT. This is done based on clinical complaints and/or by functional diagnostics for venous return. Patients who do not experience symptoms such as edema, heaviness, or skin changes at the end of compression therapy usually do not develop PTS.[70] Therefore, the duration of compression therapy after DVT can be individualized and lifelong compression therapy after DVT is not necessary for all patients.[70,71]

In addition to providing acute symptom relief, early initiation of compression therapy for deep vein thrombosis (DVT) decreases the incidence of venous occlusion and subsequent post-thrombotic syndrome (PTS).

Varicose veins

In cases of varicose veins, compression therapy is utilized for both conservative and post-interventional treatments. Purely conservative management of chronic venous diseases, such as varicose veins, should be considered in the following situations:

- When intervention is not indicated, not desired, or not possible,
- To serve as a temporary measure until an intervention can be performed,

When symptoms persist following intervention, such as in cases where varicose veins have been eliminated but deep venous insufficiency of the major veins persists, or in instances of functional CVI due to obesity.[72]

After undergoing invasive therapy for varicose vein, one week of compression therapy is usually sufficient.[3] Following endovenous thermal ablation, compression therapy can help reduce pain and improve quality of life in the first few days after the procedure. However, post-interventional compression therapy has no impact on more severe complications such as thrombosis.[73]

After undergoing invasive therapy for varicose vein, one week of compression therapy is usually sufficient.

Lymphedema

Compression therapy is a crucial component of the complex physical decongestive therapy (CPDT) for patients with lymphedema.[74] The decongestion phase with compression bandages is followed by long-term, often lifelong, therapy with MCS. In addition to flat knit MCS, which are particularly indicated for large caliber changes or deep skin folds, round-knit MCS, especially those with increased stiffness, are also used for less pronounced lymphedema.[75]

Compression therapy is a crucial component of the complex physical decongestive therapy for patients with lymphedema.

Which therapy phase is present?

According to the description of VLU, for each indication it is necessary to consider whether the patient is in the decongestion phase, the maintenance phase, or the prevention phase. The appropriate compression therapy is then selected individually (Table 11).

Ready-to-wear or custom-made?

For compression stockings to work optimally, a good fit is essential. Therefore, each limb that requires a MCS must be individually measured. If the measured circumferences and lengths correspond to standard measurements, a standard compression stocking should be selected. Custom-made compression stockings are only necessary if there are significant discrepancies. It is important to measure the MCS on an extremity that is free of edema, whether it is a ready-to-wear or custom-made stocking.[3]

Circular knit or flat knit?

When prescribing MCS, circular knit stockings are considered the standard of care. Significantly more expensive flat-knit compression stockings should only be prescribed in special situations. These include severe circumferential changes of an extremity or conically shaped extremities and/or deepened tissue folds as may be seen in severe CVI, pronounced lymphedema and obese patients, among others. The assignment of circular and flat knitted fabrics is not diagnosis-based, but findings-based.[3]

When prescribing MCS, circular knit stockings are considered the standard of care.

The assignment of circular and flat knit fabrics is not diagnosis-based, but findings-based.

Medical compression stocking with closed or open toe?

The provision of closed toe compression stockings is considered standard care and offers the following advantages: no pressure from any cuffs on the foot, no need for a second stocking in cold weather, well tolerated even in the presence of hallux valgus, and providing compression in the forefoot and toe area as well.[3] Although the closed toe prevents the foot part from sliding up, it can also put uncomfortable pressure on the big toenail, which may possibly increase the discomfort of an unguis incarnatus. An open toe stocking may be prescribed as a special fitting if the MCS needs to be a little airier in the summer, if hammertoes are present, or if the stocking needs to be more variable in terms of donning aids.

The provision of compression stockings with a closed toe is considered standard care.

Which compression class?

A strict assignment of compression classes I–IV to individual medical conditions is not meaningful.[3] The lowest effective CC that provides symptom relief should be preferred, as therapy adherence is promoted by lower compression classes. Compression class I is often sufficient. In this context, it should be noted that compression stockings of all classes are reimbursable in Germany and that home nursing can be prescribed for assistance with donning and removing compression stockings of all classes.

The lowest effective compression class that provides symptom relief should be preferred.

Duration of compression therapy?

After interventional treatment of varicose veins, a compression therapy of 1–2 weeks is usually sufficient. After an acute DVT, compression therapy should be initiated immediately and carried out for at least 6 months. Subsequently, if there are no symptoms, an attempt to discontinue compression therapy can be made. In cases of clinically manifest PTS and chronic lymphedema, long-term, often lifelong compression therapy is indicated.[3,75]

After an acute DVT, compression therapy should be initiated immediately and carried out for at least 6 months.

Care of compression materials

To ensure adequate compression with proper care, manufacturers generally recommend a service life of 6 months for MCSs and MACs. Short stretch bandages often lose their elasticity and become ineffective for compression after 10–15 washes. The effectiveness of any compression material depends not only on the stress it is subjected to during donning and doffing, but also on how well it is cared for. Patients therefore need to know how to properly care for reusable compression stockings in terms of washing temperature, detergent, and drying procedures.[59]

Short stretch bandages often lose their elasticity and become ineffective for compression after 10–15 washes.

Skin care and allergies

Compression therapy can cause itchy, irritative skin reactions in up to 50% of patients.[76] It is therefore important

to avoid direct contact of the compression materials with the skin. Cotton tubular bandages, for example, offer adequate protection.[55] In addition, these tubular bandages can increase the stability of the phlebological compression bandage, for example, when putting on shoes.[3]

Under compression therapy, the occurrence of eczema is common. These eczemas are usually irritant or asteatotic in nature and not caused by contact allergies.

Under compression therapy, the occurrence of eczema is common. These eczemas are usually irritant or asteatotic in nature and not caused by contact allergies.[75] In case of doubt, an epicutaneous test should be carried out. It should be noted that the formerly common term "rubber stockings" is misleading and factually incorrect. Modern compression materials no longer contain rubber. Components such as polyamide, elastane, cotton, viscose, or microfibers are used instead.[77] Therefore, the term "rubber stockings" should no longer be used.[78] Allergological testing, such as with the Thiuram Mix, is only useful in rare instances. However, in individual cases, sensitizations to dyes or the adhesive band of compression stockings have been described.[79,80] In addition, cohesive bandages may contain latex, depending on the manufacturer. In cases of known allergy or clinical symptoms, these should be replaced by latex-free products.[81]

To reduce the risk of developing irritant or asteatotic eczema, patients should be encouraged to perform daily skin care routines. Care must be taken to ensure that the skin care product has fully absorbed into the skin before applying the compression garment, otherwise the compression material will not slide optimally over the skin.[78]

To reduce the risk of developing irritant or asteatotic eczema, patients should be encouraged to perform daily skin care routines.

Self-Management

With an aging population and a decreasing number of healthcare professionals, self-management is becoming increasingly important. Through an individually tailored education, patients are able to assess therapy (awareness), they gain competence (empowerment), and their health-related self-management is promoted.[82–84] Compression therapy particularly requires the patient's cooperation. Nonadherence increases the risk of recurrence and prolongs the duration of treatment.[85,86]

Through an individually tailored education, patients are able to assess therapy (awareness), they gain competence (empowerment), and their health-related self-management is promoted.

CONCLUSIONS FOR PATIENT CARE

The following basic principles can be formulated for the use of compression therapy in dermatology:

- Start compression therapy immediately after diagnosis and exclusion of contraindications.
- Compression therapy supports healing in many inflammatory dermatoses of the legs.
- Neither diabetes mellitus nor PAD are contraindications per se for compression therapy. The clinically important contraindications are decompensated heart failure and advanced PAD (critical ischemia).
- The presence of edema, regardless of its etiology, is an indication for the use of compression therapy within its approved scope.
- Compression therapy with low resting pressures around 20 mmHg is often sufficient and better tolerated by patients.
- For most indications, but especially for edema prophylaxis and after deep vein thrombosis, compression therapy up to the knee is sufficient.
- Medical compression stockings should only be fitted to decongested extremities.
- Enhance therapy adherence through joint selection of an appropriate compression device.
- Whenever possible, patient self-management should be encouraged. This requires education and supportive tools.
- With compression therapy, the patient's quality of life should be better than without compression therapy.

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CONFLICT OF INTEREST

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[CME QUESTIONS / LERNERFOLGSKONTROLLE]

1. Was ist heute **keine** Indikation für eine medizinische Kompressionstherapie?
   a. Postoperative Ödeme
   b. Verbrennungen
   c. Narben
   d. Tinea corporis
   e. Entzündliche Dermatosen der Beine

2. Was ist heute eine Kontraindikation der Kompressionstherapie?
   a. Dekompensierte Niereninsuffizienz
   b. Immobilität
   c. Floride Stauungsdermatitis
   d. Insuffizient eingestellter Diabetes mellitus
   e. Dekompensierte Herzinsuffizienz

3. Wann sollte bei Patienten mit peripherer arterieller Verschlusskrankheit (PAVK) **keine** Kompressionstherapie durchgeführt werden?
   a. Ankle-Brachial-Index > 1,3
   b. Ankle-Brachial-Index < 0,9
   c. Knöchelarteriendruck > 130 mmHg
   d. Knöchelarteriendruck < 60 mmHg
   e. Die PAVK stellt per se eine Kontraindikation dar

4. Welche Ruhedruckwerte sind mit einer Bandagierung am Unterschenkel mit phlebologischen Kompressionsverbänden bei einem Ulcus cruris venosum ohne klinische relevante PAVK anzustreben?
   a. < 20 mmHg
   b. 20–40 mmHg
   c. 40–60 mmHg
   d. 60–80 mmHg
   e. > 80 mmHg

5. Wann sollte man von Bandagierungen der Beine der Patienten mit Ulcus cruris venosum mit phlebologischen Kompressionsverbänden auf medizinische Kompressionsstrümpfe (MKS) umsteigen?
   a. Wenn das Ulcus cruris venosum abgeheilt ist.
   b. Nach drei Monaten
   c. Wenn die Exsudation moderat ist.
   d. Wenn die Beine entstaut sind.
   e. Nie

6. Zu Lasten welches ärztlichen Budgets sind Kompressionsbinden verordnungs- und erstattungsfähig?
   a. Hilfsmittel
   b. Arznei- und Verbandmittel
   c. Sprechstundenbedarf
   d. Heilmittel
   e. Es sind grundsätzlich Selbstzahlerleistungen.

7. Nach welcher Zeit sind Kurzzugbinden bei täglichem Wechsel und Waschen neu zu verordnen?
   a. Nach 2 Wochen
   b. Nach 1 Monat
   c. Nach 1 Woche
   d. Nach 3 Monaten
   e. Nach 6 Monaten

8. Was gilt für die optimale Auswahl der Kompressionsklasse?
   a. Patienten mit postthrombotischem Syndrom müssen mindestens mit medizinischen Kompressionsstrümpfen der Klasse III versorgt werden.
   b. In der Schwangerschaft dürfen maximal Kompressionsstrümpfe der Klasse I eingesetzt werden.
   c. Häufig ist die Versorgung mit medizinischen Kompressionsstrümpfen der Klasse Ix ausreichend.
   d. Medizinische Kompressionsstrümpfe der Klasse I werden von den Krankenkassen in Deutschland nicht erstattet.
   e. Der ambulante Pflegedienst darf zu Lasten der Krankenkassen medizinische Kompressionsstrümpfe erst ab Kompressionsklasse II und höher an- und ausziehen.

9. Was gilt für den Einsatz von rundgestrickten und flachgestrickten medizinischen Kompressionsstrümpfen?
   a. Patienten mit Lymphödem müssen immer mit flachgestrickten medizinischen Kompressionsstrümpfen versorgt werden.
   b. Flachgestrickte medizinische Kompressionsstrümpfe dürfen ausschließlich für Selbstzahler verordnet werden.
   c. Rundgestrickte medizinische Kompressionsstrümpfe sind bei Lymphödem kontraindiziert.
   d. Flachgestrickte medizinische Kompressionsstrümpfe kommen bei großen Umfangänderungen der betroffenen Extremität und bei vertieften Gewebefalten zum Einsatz.

e. Rundgestrickte medizinische Kompressionsstrümpfe kommen nur in Sondersituationen zum Einsatz.

10. Was gilt für die Therapiephasen der Kompressionstherapie?
    a. In der Entstauungsphase sollten medizinische Kompressionsstrümpfe eingesetzt. werden
    b. Medizinische adaptive Kompressionssysteme können insbesondere in der Entstauungsphase eingesetzt werden.
    c. Medizinische Kompressionsstrümpfe sind beim Ulcus cruris venosum kontraindiziert.
    d. In der Phase der Prävention sollten standardmäßig flachgestrickte medizinische Kompressionsstrümpfe verordnet werden.
    e. Die intermittierende pneumatische Kompressionstherapie ist für keine der Therapiephasen indiziert.

Liebe Leserinnen und Leser,
der Einsendeschluss an die DDA für diese Ausgabe ist der 30. November 2023.

Die richtige Lösung zum Thema "Lokaltherapie der Psoriasis vulgaris" in Heft 6/2023 Lösung: 1d, 2a, 3d, 4a, 5c, 6c, 7c, 8e, 9b, 10a

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