Phase-specific wound management of venous leg ulcer

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Phase-specific wound management of venous leg ulcer
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Preface

Venous alterations and venous diseases are among the commonest impairments of health and well-being, and it is estimated that about two million citizens of the Federal Republic of Germany are affected by a lower leg ulcer of venous origin. This statistic illustrates the social and socio-economic relevance of this medical condition, but does not adequately describe the loss in quality of life suffered by persons with a chronic ulcerative disease.

Many ulcer patients have a decades-long history of suffering because of inadequate and failed attempts at therapy and ultimately often resign themselves fatalistically to the apparently unavoidable. However, modern diagnostic procedures involving little stress for patients, combined with appropriate therapeutic concepts, now mean that venous leg ulcers can be effectively brought under control. Undoubtedly, this requires an adequate knowledge of the complex medical problems involved and the physician’s ability to motivate patients to take upon themselves a sometimes protracted program of therapy. The very fact that rapid ulcer healing occurs only in very few cases causes problems. Both physicians and patients may lose patience, and the unscientific use of multiple medications is not infrequently substituted in place of consistently practised compression therapy.

This HARTMANN medical edition presents therapeutic concepts involving conservative management of these conditions in the light of pathophysiological knowledge. These approaches are based on the use of compression bandaging as basic therapy and illustrate the possibilities offered by phase-specific wound management with hydroactive wound dressings, since moist wound treatment has proved especially effective in the treatment of chronic ulcerations.
Causes of venous leg ulcer

Venous leg ulcer is an expression of an extremely severe metabolic derangement in the cutis and subcutis resulting from chronic venous insufficiency. Understanding the underlying pathomechanism requires a knowledge of the anatomy of the leg vein system and the athophysiological processes involved.

Anatomy of the leg veins

The leg vein system is divided according to anatomical criteria into the superficial or suprafascial and the deep or subfascial venous system. The two regions are connected by the communicating veins to form a single functional unit.

The suprafascial veins are located in the cutis and subcutis, i.e. outside the fascia, a binding layer of connective tissue surrounding the muscles. They are connected by a network of numerous lateral branches and take the form of extensive venous plexuses which drain the superficial blood into the deep veins, but because of their high storage capacity also have functions in regulating blood volume. The superficial veins collect in the two main superficial veins, the great (vena saphena magna) and small (vena saphena parva) saphenous veins. The small saphenous vein empties into the popliteal vein (vena poplitea) in the hollow of the knee, while the large saphenous vein passes into the deep femoral vein (vena femoralis) below the inguinal ligament.

The subfascial veins run as larger vessels inter- and intramuscularly within the fascia and are paired with the corresponding arteries. They serve as blood collectors and
transport the blood back to the heart and are thus also known as deep or transport veins. The lower leg veins, the anterior and posterior tibial veins, unite to form the popliteal vein, which continues on towards the heart as the femoral vein.

The interconnections within a venous system, e.g. only in the suprafascial system, are provided by the communicating veins (venae communicantes). The interconnections between the supra- and subfascial venous system, on the other hand, are created by numerous perforating veins (venae perforantes) which “perforate” the fascia for this purpose. Main groups are Cockett’s veins above the ankle, Boyd’s veins below the knee joint and Dodd’s veins in the thigh.

Almost all veins have more or less numerous venous valves that serve as volume regulators. They make sure that the blood flows only in one direction, namely towards the heart or from the superficial to the deeper levels.

Physiology and pathophysiology of venous return
The return transport of the blood to the right ventricle of the heart requires the presence of various physiological driving forces and assistive mechanisms to overcome the high total hydrostatic pressure which acts on the leg vein system when the body is upright. The principle of communicating tubes with postcapillary residual pressure, variations in respiratory pressure in the thoracic and abdominal space and the elastic aspiration of the heart provides the necessary mechanisms. The most effective factor, however, is the functional unit of the calf muscle pump.

During movement of the legs, the deep veins are compressed with every muscular contraction. This forces the blood out towards the heart and the venous valves prevent the blood from pooling back into the veins. When the muscles relax, the deep veins expand to create a negative pressure which results in blood being aspirated through the perforating veins from the more distally located venous segments and the suprafascial venous plexuses. The alternating compression-suction effect of the muscle pump is complemented by similar mechanisms in the joints and the firm resistance surface provided by the fascia which ensures that the pressure that builds up during the contraction also acts in an inward direction.

The interplay of these mechanisms results in the blood being raised towards the heart through several consecutive and coordinated levels on a kind of “paternoster” principle from the foot, through the ankle, through the calf, the hollow of the knee, the thigh and the groin, while simultaneously being withdrawn through the perforating veins from the suprafascial plexus. The blood therefore flows from the more superficial to the deeper levels and from distal to proximal; the venous pressure falls.
The severity, localization and duration of the outflow disorder and the degree and duration of stress on the leg vein system determine the variable clinical presentations which appear gradually and with inexorably increasing severity. This complex of clinical signs is subsumed under the general term chronic venous insufficiency (CVI) and is usually assigned to three grades of severity according to the Widmer classification.

Grade I chronic venous insufficiency is characterized by a collection of dilated venules (corona phlebectatica) and edema around the ankles and above the arch of the foot, and by ankle edema.

Grade II manifests as hyperpigmentation of the skin, lower leg edema and dermatoliposclerosis. The skin is then firmly bonded with the lower leg fascia, cannot be raised in folds and has a more pronounced sheen than usual. An extreme form of dermatoliposclerosis is atrophie blanche (also known as capillaritis alba or white

The earliest recognisable consequence of this disordered condition is edema, which leads to further increases in pressure and accumulations of fluid and thereby further exacerbates the already compromised metabolic situation. Further consequences are fibrotic, degenerative and inflammatory processes associated with trophic skin alterations. Finally, obliterative inflammatory processes in the venules and arterioles lead, initially in regions with unfavourable venous hemodynamics, to the development of venous leg ulceration as the now visible sign of decompensated venous hypertension.
atrophy), which occurs almost exclusively as a consequence of CVI. Characteristic signs of this skin alteration are white, atrophic focal lesions ranging in size from a coin to the palm of the hand, and are found mainly in the ankle region or around scars of healed ulcerations.

Grade III manifests as a florid or healed venous leg ulcer. Its site of predilection is the perimalleolar region (Bisgaard region), but it can also occur elsewhere on the lower leg. Ulcerations can also spread to cover the entire lower leg in a circular pattern resembling a gaiter.

Pathophysiology of CVI
Chronic venous insufficiency can either be the result of primary varicosis or a consequence of a postthrombotic syndrome; the anatomical localization of the flow obstacle is the factor that determines the clinical prognosis.

Suprafascial venous insufficiency / primary varicosis
The most important disease of the superficial leg vein system is primary varicosis or varicose veins. Varicose veins are abnormally and irregularly swollen veins with a typically tortuous course visible below the skin. They can be caused by valve agenesia (congenital absence of venous valves), but more often it is hereditary or age-related loss of elasticity of the venous walls that leads to vascular dilatation and valve incompetence. This congenital predisposition is promoted by factors such as hormonal influences during pregnancy, lack of exercise or inflammatory processes. If lumen enlargement and valvular insufficiency occur in the large superficial leg veins (great and small saphenous vein), the disease is known as saphenous varicosity. Lateral branch varicosis is present when the lateral branches of the saphenous vein are affected by these changes, while varicose extensions of the communicating veins are known as reticular varicosis.

Since only about 10% of the venous blood is returned to the heart through the superficial veins, a functional disorder of individual venous segments can usually be compensated without much difficulty by blood being diverted to other venous plexuses or by the intact deep communicating veins assuming the transport functions. The clinical situation undergoes a serious change, however, when lumen enlargement and valve incompetence also begin to affect the perforating and subfascial veins. The direction of venous flow is then reversed, leading to disorders of physiological return and retrograde flow conditions.
The drop in pressure caused by the calf-muscle pump during walking is reduced or completely absent (venous hypertension), and the functional capacity of the venous valves is progressively impaired. The effects manifest as chronic venous insufficiency, characterized by the pathophysiological disorders of microcirculation in the cutis and subcutis already described, which can culminate in the formation of a venous leg ulcer.

When the valvular apparatus is still sufficient in primary varicosis, however, ulcerations can also develop as a result of injuries, blunt traumas or varicose ruptures. Their prognosis is correspondingly more favourable.

Subfascial venous insufficiency / postthrombotic syndrome

Insufficiency of subfascial veins can also occur in a primary form consecutive to valve agenesis or congenital underdevelopment of the venous valves, but in most cases appear as the secondary form after deep leg vein thrombosis (phlebothrombosis).

Thrombosis of the deep veins not treated immediately by thrombolysis or thrombectomy usually heals leaving a defect. The thrombus becomes organised like connective tissue, and this collagenous remodelling results in scar formation. Incomplete obstruction of the venous volume may often be followed by recanalisation, but because of the scar formation the vein loses elasticity and can no longer adapt to the variable blood volumes. The venous valves also can no longer fully perform their closure function and often create additional flow obstacles which promote turbulence of the blood. The alterations in the lumen due to scarring in the deep veins create new dead space for the calf-muscle pump, with the result that sufficient blood can no longer be withdrawn and the intravascular pressure increases. The continuous build-up of back pressure in turn results in metabolic derangements in the peripheral skin areas, and in the worst case to ulceration. Moreover, the increased pressure stress not infrequently leads to leakage of the valves of the perforating veins, causing blood to flow back from the subfascial into the suprafascial system.

The consequences are secondary varices and edematous infiltration of the cutis and subcutis with the known secondary complications. Postthrombotic syndrome (PTS) is the commonest cause of venous leg ulcer (postthrombotic venous leg ulcer).
Clinical presentation and diagnosis of venous leg ulcer

About 90% of leg ulcers develop as a result of venous hypertension secondary to severe chronic venous insufficiency. About 6% of venous leg ulcers are attributable to reduced peripheral arterial blood supply and about 4% to specific skin diseases. An exact diagnosis is therefore essential. This requires taking a detailed medical history, a clinical and instrumental examination and differential diagnostic procedures to rule out non-venous etiopathological factors.

Medical history
The medical history concentrates on familial or personal risk factors, vascular risks (varicose veins, symptoms of CVI, deep vein thrombosis, hypertension, arteriopathies, claudication), lifestyle habits (occupation, sedentary lifestyle, little exercise etc.), medication use, alcohol and tobacco consumption, type of onset and development of the ulcer (e.g. after injury or blunt trauma), but also previous local or systemic treatments.

Localization and form of the ulcers
Venous ulcers preferentially develop at the ankle (Bisgaard region) and allow a “prima vista” diagnosis. In about 20% of cases, however, they also develop at other sites on the lower leg, a situation which always requires differential diagnostic clarification. The shape and size of the venous ulcer are variable, and the ulceration can spread to cover the entire gaiter area of the lower leg.

1) Typical localization of venous ulcers, with postthrombotic ulcer as an example
2) Ulcerations resembling gaiters enclosing the lower leg
3) and 4) mixed venous leg ulcer due to CVI and pAOD
**Nature of the wound floor**
The wound floor of purely venous ulcers has at the most a coating of yellowish or whitish, fibrinous necrotic slough, and the ulcer usually produces hardly any exudate. Black necrotic tissue at the wound margins also indicates a disorder of arterial perfusion. This is classified as a mixed ulcer. A bloody-serous, purulent wound floor indicates the presence of infection.

**State of peri-ulcer zone**
Due to the venous and lymphatic stasis and the resulting skin alterations, patients with chronic venous insufficiency are predestined to develop stasis dermatitis and contact eczema. Stasis dermatitis, also known as varicose eczema, develops on peri-ulcer skin and is not infrequently encouraged by the use of greasy ointments. Contact eczema also develops as a reaction to sensitizing substances, such as topical antibiotics.

**Edema formation**
For more pronounced edema, comparative girth measurements are indispensable to assess the effect of compression therapy by monitoring the reduction in edema.

**Symptomatology/pain**
Ulcerations associated with primary varicosis usually cause less severe symptoms — and in these cases the edema is also less pronounced — than those developing as a result of CVI of postthrombotic origin. Especially the small ulcers developing in the region of a capillaritis alba can cause the patient considerable difficulties and pain. In general, however, ulcers with arterial involvement are much more painful than purely venous ulcers.

**Orthopedic abnormalities**
It is important — also in regard to the effectiveness of compression bandages — to check the mobility of the large joints, taking particular care to detect incipient stiffening of the ankle joints. Postthrombotic patients often exhibit talipes and rarely ankyloses of the upper ankle as a sign of ulcer disease already existing for several years, with cicatricial strictures resulting from frequent relapses.

**Recording of arterial status**
It is also essential to establish the arterial blood flow situation. Useful evidence is provided by the temperature of the extremity (cold when arterial perfusion is reduced) and palpation of the foot pulses. In patients with long-standing diabetes, however, palpation of the foot pulses cannot be used as a clinical criterion because considerable microcirculatory disorders may already be present due to pronounced media sclerosis despite well-filled pulses, and the ulceration is therefore of mixed arterial and venous origin. Furthermore, diabetics may lack the typical clinical signs of intermittent claudication because of diabetic neuropathy. Peripheral pressure measurement by Doppler ultrasound is also of little value in elucidating the arterial situation because excessively high pressure values are measured as a result of the media sclerosis. The only technique which can provide further diagnostic information in this situation is acral oscillography or possibly colour duplex sonography.

**Recording of venous status**
It is supremely important for therapeutic purposes to exactly localize the disorder of venous return within the venous system. The diagnosis is based on clinical and instrumental examinations. Doppler ultrasound especially is now a reliable routine diagnostic procedure for precisely determining the presence and extent of extrafascial
Clinical presentation and diagnosis

1) Before an ulcer of arterial origin develops, trophically altered nails, mycoses, erythema, marbling and loss of hair may be noticed.

2) Arterial leg ulcer on the extensor side of the lower leg with exposed anterior tibial tendon.

Further, similarly non-invasive methods are venous occlusion phlethysmography (VOP), used to measure venous outflow and venous capacity, as well as light reflection rheography (LRR), although the evidential value of this technique is greatly restricted by insufficient reproducibility.

Phlebography as an invasive imaging procedure involving the use of contrast media is now used with greater caution, but is still indispensable in many cases to establish indications for surgery, especially in relapses following venous surgical interventions.

Recording of general condition
The physician should always search for signs of latent or overt right ventricular failure. Clinical laboratory tests should include postprandial blood glucose, hemoglobin, red blood count, erythrocyte sedimentation rate, C-reactive protein and, when appropriate, hematocrit.

Differential diagnostic clarification
Although, as already mentioned, about 90 % of leg ulcers are the consequence of chronic venous insufficiency, leg ulcers of non-venous origin must always be included in differential-diagnostic deliberations. Possible causes may include:

Obstruction of larger and smaller arteries by peripheral arterial occlusive disease (pAOD), which can lead to arterial leg ulcer or necrotising vasculitis. The localization of arterial ulcers corresponds to the sites on the lower leg which tend to be most exposed to mechanical injuries, e.g. the anterior edge of tibia. Typical signs are black skin necroses, and subfascial structures such as tendons, muscles and bones may be visible. In vasculitis, pea- to coin-sized, occasionally extensive multiple ulcers are usually present. Depending on the localization of the vasculitic vascular lesions, these ulcers are superficial (superficial vasculitis) or have a deeper, punched-out appearance (deep vasculitis).

Macro-and microangiopathies and peripheral neuropathies associated with diabetes mellitus may result in angioopathic (diabetic gangrene) or neuropathic ulcers (perforating disease). Because of their commonest localization — acral and on the sides of the feet when of angioopathic etiology and on the sole of the foot under the metacarpophalangeal joints when of neuropathic etiology — identifying these ulcers is unlikely to present any problems.

Hematological diseases such as sickle-cell anemia, spherocytic anemia, thalassemia or essential thrombocytosis, may be associated with an ulcer as a concomitant symptom. Infections, such as ecthymas caused by staphylococci or erysipelas caused by streptococci are also possible.
Clinical presentation and diagnosis

Ecthymas have the appearance of punched-out, sharply defined ulcers and tend to occur mainly on the lower leg. Erysipelas presents as an extensive erythema which, if left untreated, becomes necrotic and can lead to ulcerative degeneration of relatively large areas of skin.

Traumatic events such as physical, chemical or thermal damage are further potential causes of leg ulcers, although artefacts (self-damage) should also be included in the physician’s deliberations.

Neoplastic diseases such as basaliomas, spindle-cell carcinomas, soft-tissue sarcomas or malignant lymphomas and melanomas, with relevant localization, lead to neoplastic leg ulcer. In view of the anticipated increase in HIV-positive patients, a growing incidence of Kaposi sarcomas is to be expected. The possibility of a malignant etiology should particularly be borne in mind when dealing with therapy refractory “problem ulcers”. The diagnosis is established histologically, and the importance of taking biopsy samples at an early stage is to be emphasized. Biopsy samples should be collected from several sites — at the edges and in the middle of the ulcer.

Examples of leg ulcers of non-venous origin
1) Ulcers due to very severe arterial blood flow insufficiency, frequent localization: lateral edge of foot and heel
2) Ulcer due to diabetic macroangiopathy on the lower leg
3) Neuropathic ulcer associated with diabetes mellitus “perforating disease”
4) Venous leg ulcer caused by chemotherapy for primary thrombocythemia
5) Hemorrhagic-bullous erysipelas
6) Necrotising erysipelas
7) Leg ulcer caused by a basalioma
8) Venous leg ulcer resulting from spindle cell carcinoma
Management of venous leg ulcer

Venous leg ulcer is a chronic wound with a poor or absent healing tendency. Especially the often extensive ulcers associated with severe chronic venous insufficiency and pronounced sclerosis of the cutis and subcutis can become a therapeutic crux medicorum requiring protracted treatment and characterized by frequent relapses. Nevertheless, today’s knowledge of the pathophysiological mechanisms implicated in causing venous leg ulcers generally allows the application of effective therapeutic concepts.

Therapeutic activities are concentrated on the following aspects: The venous hypertension underlying the ulcer must be remediated as effectively as possible in order to improve the nutritive situation in the damaged area of skin. An ulcer can only heal when the edema has subsided and venous outflow in the leg has been restored to a compensated state (Hach). These therapeutic objectives can essentially be achieved by means of compression treatment and, when appropriate, using invasive therapeutic methods (surgery and/or sclerotherapy).

Local ulcer therapy is based on appropriate wound management adapted to match the different phases of healing. Wound management should also eliminate as far as possible all the factors which generally compromise wound healing, such as infections, concomitant diseases and side effects of other treatments or negative psychosocial factors.

Compression bandaging as basic therapy

“There is no phlebology without compression therapy”. This dogma applies unreservedly for the management of venous ulcer, because the effect of the compression bandage intervenes causally in the disease process. It surrounds the leg with pressure firm enough to compress the dilatated veins. This restores and/or a certain degree substitutes the valvular function, reduces venous reflux from subfascial to suprafascial and increase the flow velocity of the venous blood. At the same time, compression causes an increase in the tissue pressure and thereby enhances absorption in the terminal vessels and the lymph vessels. The microcirculation is locally improved, which decisively improves the healing tendency of venous leg ulcer.
The compression bandage also acts as a firm resistance surface which helps to restore at least partially the function of the calf-muscle pump and improve its effectiveness. When compression therapy is carried out in the proper manner, relief of pain and initial signs of healing are observed within a short time, which is seen as an encouraging sign by patients and can motivate them to persist with the often protracted course of treatment. The mode of action of compression therapy, important information on bandaging materials and bandaging techniques for compression bandages as well as contraindications are described in detail from page 70 onwards.

**Invasive therapeutic procedures for compensation of chronic venous insufficiency**

In modern phlebology, sclerotherapy and surgery are mutually complementary therapeutic approaches. Which method is to be used ultimately depends on the anatomical localization of the disorder of venous return and the degree of chronic venous insufficiency.

In primary varicosis, remediation may possibly be achieved by sclerotherapy of peri-ulcer varicose veins, surgical treatment of saphenous insufficiency or sclerotherapy of lateral branch varices. Compression treatment, performed initially using a compression bandage and later with a compression stocking, must always be continued until complete healing of the ulcer is achieved.

In secondary varicosis and when there is severe venous hypertension in the suprafascial venous system, permanent closure of insufficient perforating veins supplying the ulcer is rarely successful. The temporary sclerotic process induced by the sclerotherapy, however, provides temporary hemodynamic relief and greatly improves the healing tendency. This applies especially to the varicose veins passing through the ulcerated area and the procedure – when carried out by an experienced and skilled sclerotherapist – often results in rapid healing.

Sclerotherapy within or close to areas of atrophie blanche must remain the exception. If sclerotherapy is unavoidable, a much lower concentration of sclerotic agent must be used than would be indicated for an area of healthy skin.

If the chronic venous insufficiency cannot be compensated on the basis of functional diagnostic criteria, after the ulcer has healed at least the surrounding perforating veins should be ligated to provide hemodynamic relief.

**Surgical treatment of ulcers**

For obstinate, therapy refractory ulcers, a surgical intervention proximal from the ulcer in the scar-free skin areas may be required. Procedures with good success rates include especially Hach’s paratibial fasciotomy and its more advanced form, Hauer’s endoscopic perforator ligation.

Hach’s procedure is based on the notion that splitting the muscle fascia along the entire edge of the shinbone allows capillaries to grow from the well perfused muscle tissue into the ulcer region, thereby promoting tissue neo-genesis. With Hauer’s method, hemodynamic aspects pre-dominate in the presence of insufficient Cockett’s perforating and simultaneous insufficiency of the deep vein system.
Adjuvant medicinal therapy
Systemic treatment of venous leg ulcer with the various pharmacological venotherapeutic agents is mainly of an adjuvant nature and is intended to support the decongestion induced by the compression therapy. Three groups of substances are used: diuretics, vasoactive (venotonicising) drugs and edema-protective agents.

Diuretics may be indicated for short-term use especially in the initial phase of treatment to mobilise local, reversible edema. Under no circumstances, however, should they be used to provoke a potent diuretic effect. Contraindications are high-protein edema and lymphedema.

Venotonicising drugs are reported to cause a reduction in the venous cross-section while simultaneously increasing blood flow velocity and reducing blood viscosity. The therapeutic objective of edema-protective agents is to influence the capillary vessel walls in order to reduce the extravasation of fluid into the tissue. Both medication groups include synthetic and purely plant-derived substances such as horse-chestnut, boxholly and sweet clover extracts in single-agent or combination preparations. Although the efficacy of the various pharmacological agents has been increasingly demonstrated in recent years, they are by no means capable of replacing compression therapy.

Identification of wound healing disorders
Although the course of healing of venous leg ulcer may be expected to be irregular in view of its etiopathologic origins, a variety of systemic and local influences can also be expected to induce further disorders which delay healing of the ulcer for months or even years. It is therefore important to identify and eliminate possible disorders.

Systemic disorders of wound healing mainly involve factors that are generally relevant to the healing process of chronic wounds, and thus also for venous leg ulcers. Primary factors are the patient’s age and nutritional status, certain basic diseases and also medication related effects.

Findings generated in clinical research allow the conclusion that physiological aging delays wound healing processes because of the generally reduced cellular activities, which may ultimately also be reflected in a reduction in the quality of the wound healing outcome. Serious disorders of wound healing, however, are usually an expression of the effects of age-related multimorbidity.

Wound healing requires a sufficient supply of protein, vitamins (especially C and A) and minerals (especially iron, copper and zinc). Because of inadequate nutrition, disorders of absorption or the effects of concomitant diseases, elderly patients frequently exhibit protein and vitamin deficiency states which should be diagnosed and treated. If zinc replacement appears useful, this should not be done externally with zinc ointments but by prescribing suitable oral zinc supplements.

Besides the vascular disorders which increase with age and which, as already described, create the basis for the various leg ulcers, other diseases that compromise wound healing are connective tissue diseases (e.g. rheumatic diseases), endocrinopathies (e.g. thyroid, adrenal) and metabolic disorders (e.g. diabetes mellitus), but also all diseases which influence the affected person’s immune status, such as malignancies, infectious diseases or hematological disorders.
The influence of medications is also to be evaluated. Various pharmacologic agents exert directly deleterious effects on wound healing, especially immunosuppressants, cytostatics, anti-inflammatories (mainly glucocorticoids) and anticoagulants.

The patient’s psychosocial situation also plays a not inconsiderable role. The management of chronic wounds always requires a high level of compliance from the patient because treatment is not confined to local procedures but also requires the consistent and conscientious application of causal therapies such as compression treatment. The patient is to be adequately informed about the purpose of and necessity for the individual elements of treatment, otherwise compliance will be partially or completely lacking.

Local interfering factors usually have their origins in incorrectly practised wound management. The use of multiple topical therapeutic preparations is especially to be mentioned in this respect. Such practices can not only greatly compromise the wound healing process, but also drastically increase the risk of local and systemic allergies. Especially those patients who all too readily resort to the use of "miracle cures" in their understandable wish to hasten the healing of their ulcer should be persuaded of the risks involved.

**Pain management**

Anaeesthetic topical therapeutic agents are contraindicated due to the risk of contact allergies. The following procedure is therefore recommended for severe pain: apply compresses immersed in ice water or cool the ulcerated area with ice packs at intervals during the 20 to 30 minutes before bedtime. In most cases the pain subsides relatively quickly with correctly applied compression therapy. An analgesic can be given to control nocturnal discomfort in the initial phase.
Phase-specific wound management of venous leg ulcer

Chronic wounds like venous leg ulcer also heal in a phase-specific manner. However, the progression of these phases through the correct sequence is frequently disturbed by many different systemic and local interfering factors; often, the cleansing phase persists for an unphysiologically protracted period. Proper wound management will therefore be based on the premise of meeting the specific requirements of the disturbed wound healing phases as exactly as possible.

Regardless of the type of wound and the extent of tissue loss, every wound healing process proceeds in phases which overlap in time and cannot be separated from each other. Classifications into three or four phases of wound healing are usual; the system postulating three basic phases will be used in the following presentations:

- The inflammatory and exudative phase serves to stop the bleeding and cleanse the wound, mainly by phagocytosis.
- In the proliferative phase, blood vessels and replacement tissue, known as granulation tissue, are produced to fill the defect.
- The differentiation phase is characterized by maturation of the new tissue, its epithelisation and the concluding scar formation.

In practice, the three phases of wound healing are known for short as the cleansing, granulation and epithelisation phase.

Schematic diagram of the time course of the wound healing phases:

Inflammatory phase: Cleansing
Proliferative phase: Fibroblast migration and formation of granulation tissue
Differentiation phase: Maturation and increasing wound contraction/epithelisation
This physiological wound healing cascade, which always requires the cells involved in repair to appear in the chronologically correct order, only occurs spontaneously when certain basic requirements are fulfilled:

▪ The cell metabolism must be assured by an adequate supply of blood and oxygen.
▪ A physiologically balanced, moist wound environment with an adequate pH must be present in the wound to promote the cellular activities.
▪ All inhibiting factors together, such as microbial colonization and toxic degradation products of bacteria and tissue, must not exceed the autolytic capabilities of the wound.

If these conditions are not present due to the influence of various deleterious factors (inadequate blood supply with tissue hypoxia, drying out of the wound floor, wound infections etc.), more or less pronounced disorders of wound healing and, without timely intervention, a chronic wound will develop: Cells die, necrotic tissue forms to an extent that can no longer be compensated by endogenous cleansing mechanisms. At the same time, toxic degradation products of bacteria and tissue infiltrate the peri-wound area, giving rise to further tissue necrosis and maintaining the chronicity of the wound.

The problems associated with the chronic wound become more severe if the ulcer has developed due to microcirculatory and metabolic disorders in the cutis and subcutis, as is the case with venous leg ulcer. In contrast to an acute wound, in which the preconditions for the wound healing cascade to proceed in the proper sequence are created in the inflammatory-exudative phase, with ulcers of ischemic origin the repair activities of the cells have to be initiated in an area of skin with highly compromised metabolism, which makes a properly regulated process of wound healing impossible from the outset.

The pathophysiological situation existing in venous leg ulcer, however, also indicates the kind of measures that need to be taken to achieve ulcer healing:

▪ As a causal measure, the hemodynamics in the leg vein system and the microcirculation in the wound area are to be improved by the methods already described, such as compression therapy and, if necessary, invasive procedures such as surgery and / or sclerotherapy.
▪ Locally, the chronic wound is to be transformed as far as possible into the state of an acute wound by means of adequate treatment. This offers the opportunity for the processes necessary for healing to be re-initiated in the physiologically correct cellular and temporal sequence and to proceed in a regular manner.

Which activities have proved beneficial in which phases of wound healing is described below. Moist wound treatment has proved particularly successful; its principles will therefore now be explained.

**Moist wound treatment**

“A dry wound is a dead wound”. Based on this recognition, the principle of moist wound healing has become the established approach to the management of secondary healing wounds, i.e. wounds in which granulation tissue has to be formed, and for epithelial wounds. The benefits of this method of treatment, which is based on studies by G. D. Winter (1962, first published in “Nature”), the underlying scientific principles of which have been scientifically validated in general terms, are well known, and have effects on all phases of wound healing:
During the cleansing phase, moist wound dressings achieve a thorough cleansing of the wound and render possible mechanical debridement without damaging cells. Inactivation of immunocompetent cells can also be avoided by the moist environment (Seiler).

During the granulation phase, a physiological microclimate similar to a cell culture medium is created within the wound, which encourages cellular proliferation and consequently the formation of granulation tissue. Turner/Beatty et al (1990) have reported that permanent moist therapy causes a significantly more rapid reduction in the wound area and a larger amount of granulation tissue.

In the epithelisation phase, the conditions for mitosis and migration of epithelial cells improve under moist dressings. This generally results in more rapid epithelisation with better cosmetic results.

Patients frequently report that their pain is relieved under moist wound treatment. In addition, the dressing change itself is atraumatic and causes less pain because modern dressings, as used for moist wound treatment usually do not adhere to the wound, i.e. have atraumatic properties. At the same time, this “nonstick” effect eliminates the stripping off of cell layers when the dressing is changed – the undisturbed state of the wound so important for healing is preserved.

However, the success of moist wound treatment depends on a critical prerequisite: the wound requires a permanent, uninterrupted, balanced supply of moisture. If at any stage drying out is allowed to occur, the cells inevitably die as a consequence. Further necroses develop and can even eventually deepen the wound.

The most basic type of moist wound dressing is the traditional gauze dressing, moistened with normal saline or Ringer’s solution. However, this is also the type of dressing most liable to create problems. Gauze dressings dry out rather quickly and stick to the wound, an unfortunate property that causes freshly formed cells to be torn away with the dressing as the latter is changed. Moreover, ensuring a permanent supply of moisture to the compress is time-intensive, not easy to manage and is difficult to reconcile with compression therapy.

The so called hydroactive wound dressings, in comparison, are an innovation that represents a major advance, not only in regard to efficacy but also practicality. They include the gel forming calcium alginate dressing Sorbalgon, the wound pad dressing TenderWet, the hydroactive foam dressing PermaFoam, the absorbent hydrocolloid dressing Hydrocoll and the transparent hydrogel dressing Hydrosorb. With these dressings, wounds can be kept permanently moist without difficulty. Moreover, the differentiated physical principles of action of the various wound dressings ensure that the specific requirements of many different wound conditions can be selectively fulfilled.

**Wound management in the cleansing phase**

Experience has shown that this initial phase demands great patience and will need more time to complete the longer the ulcer has existed. This is because the deranged metabolic situation in the area of skin which is responsible for the venous ulcer not only maintains the chronicity of the wound but also greatly hinders the self-cleansing mechanisms. The vicious cycle can only be broken by adequate treatment: compression therapy is indispensable to improve the hemodynamics and selective cleansing procedures are also of major importance.
Surgical removal of necrotic tissue
If the patient’s medical situation allows, surgical debridement should be performed to remove necrotic and inadequately perfused tissue and fibrinous necrotic slough as completely as possible. This results in a “fresh”, bleeding wound. Wound healing can then commence, as in an acute wound, with hemostasis followed by the release of growth factors and migration of sufficient inflammatory cells into the wound, and can then reorganise itself into the chronologically correct sequence of events. This approach should be considered especially for therapy-refractory ulcers; after wound conditioning, there may be an indication for wound closure by split-thickness skin grafting.

For care of the surgically debrided ulcer and subsequent wound conditioning, wound coverage with the Sorbalgon calcium alginate dressings, whose principle of action is described from page 49 onwards, should be performed.

Cleansing by moist wound treatment
If surgical debridement is impracticable, physical debridement by moist wound treatment may be substituted. Hydroactive wound dressings with different modes of action are available for this purpose and are to be used selectively depending on the condition of the wound.

For ulcers with pronounced fibrinous and/or slimy coats (infected or non-infected), moist therapy with TenderWet 24 active is recommended. The principle of action of this “absorbent-rinsing dressing” is described from page 44 onwards. TenderWet is especially suitable in cases in which the ulcer environment is extremely sensitive due to eczematous lesions.

Particularly suitable for treatment under compression bandages is the hydroactive foam dressing PermaFoam. This dressing has a high vertical wicking effect for rapid regulation of wound exudate as well as high retention for reliable fluid binding, thereby protecting the wound margins and minimising the risk of maceration. Detailed product description from page 50.

For moderately exuding ulcers which still have a relatively intact peri-ulcer area, the absorbent hydrocolloid dressing Hydrocoll or, alternatively, the hydroactive ointment dressings Hydrotull can be used, because of the hydrocolloid characteristics are particularly effective in supporting wound healing. The principle of action in Hydrocoll and Hydrotul are described in detail starting on page 53 or 55.

Infection prophylaxis and control
The problem of infection prophylaxis and control is most likely to arise in the cleansing phase, which is often fraught with uncertainties. In most cases, the ulcer can be assumed to be colonized with microorganisms, although the contamination — especially in the case of purely venous ulcers — relatively rarely leads to a clinically overt infection. The rather low susceptibility to infection generally observed with older wounds thus also seems to apply to venous leg ulcers. Prophylactic disinfection of the ulcer or topical antibiotic therapy is therefore not advisable in most cases, especially considering the potential of many of these substances to inhibit wound healing and the high risk of sensitization.

One treatment option for infected and infection-prone wounds is the silver-containing ointment dressing Atrauman Ag. It has a broad spectrum of action and a sustained bactericidal action combined with proven good tissue tolerability and only low toxicity. Details about Atrauman Ag from page 62.
Atrauman Ag can also be used when systemic antibiotic treatment becomes necessary for severe infections with markedly elevated C-reactive protein. It may be useful to carry out a microbial identification and antibiotic sensitivity test to optimize the antibiotic therapy.

**Wound management in the granulation phase**
If the wound floor is clean, granulation tissue can form provided that the hemodynamic disorder underlying the ulcer continues to be compensated by compression therapy.

The nature of the granulation tissue is an important indicator of the quality of the repair process. Granulation tissue itself reacts with extreme sensitivity to exogenous influences and interfering factors and should therefore be treated as gently as possible. Fresh red granulation tissue no longer requires to be cleaned and irrigated and needs no ointments or powders to promote its growth. However, granulation tissue must be kept permanently moist with suitable hydroactive wound dressings. If the wound is allowed to become dry, cell necrosis again results in tissue death. Granulation tissue also has to be protected against mechanical irritation caused by stripping of cells when changing the dressings.

This is because granulation tissue has an extremely adhesive quality because of the high-protein exudate and the large number of superfine capillaries. Chronic ulcers frequently show a constellation in which part of the wound is already granulated, while other parts are still in the cleansing phase. If wound disinfection is required and during mechanical debridement, the granulation tissue should be spared.

A hydroactive wound dressing that meets the requirements of the granulation phase particularly well is the transparent hydrogel dressing Hydrosorb. Its gel structure has a high water content, allowing it to deliver moisture independently to the wound over prolonged periods without itself drying out. Especially when the formation of granulation tissue is stagnating, a therapy trial with the hydroactive foam dressing PermaFoam may be useful. The specific mode of action of Hydrosorb is described from page 57 onwards.

**Peri-ulcer eczema**
Venous leg ulcer is frequently accompanied by eczema. The eczema may be due to colonization of the damaged skin with bacteria and fungi (microbial eczema) or may be a contact allergy to topical medications.

The treatment is based on the general principles of eczema therapy. The acute, weeping eczema is treated by moist therapy, for example using moist tulle dressings with astringent or disinfectant solutions. The skin, however, should be prevented from drying out.

Subacute or chronic eczema should be treated in a differentiated manner, but using only non-allergic ointment bases and substances. Zinc paste (Pasta zinci) and cold cream (Unguentum leniens) in equal parts has proved a successful therapy in such cases. Long-term therapy with corticoid-containing topical preparations, however, should be avoided due to the risk of skin atrophy.
Wound management in the epithelisation phase

Well-developed granulation tissue offering the epithelial cells a moist gliding surface is the prerequisite for the mitosis and migration of epithelial cells. The most important function of the dressing is therefore to ensure that the wound also remains moist during the epithelisation phase. The ideal products for this purpose are the hydroactive ointment dressings Hydrotul, the hydrogel dressing Hydrosorb or the hydrocolloid dressing Hydrocoll thin, which was developed especially for already epithelised wounds.

An ulcer with a good healing tendency can be recognized from the fact that epithelisation is proceeding inwards from the ulcer margin or enlarging islands of epithelial tissue are spreading over the ulcer floor.

Certain topical therapeutic medications which induce scabbing of the ulcer can bring about a type of “spurious healing”. In most cases these encrustations can easily be detached again from the ulcer margin. The yellowish coatings underneath also have to be removed, and only then is a prognostic evaluation of the cleansed ulcer floor possible.

Because of the protracted course of healing, the wound margins of chronic ulcerations sometimes tend to epithelise and protrude inwards. Since no further epithelisation can then take place from the wound margin, the wound margins should be refreshed by trimming with a scalpel or sharp scissors.

Like all chronic wounds, venous ulcers also sometimes exhibit a poor tendency to spontaneous epithelisation. If the wound floor has been sufficiently conditioned, wound closure by split-thickness skin grafting (mesh graft) or the Reverdin method may be considered in these cases, especially for larger wound surfaces. In the Reverdin procedure, the flaps of epidermis applied onto the granulation tissue form islands from which epithelisation can proceed. Another possibility is the grafting of autologous and in vitro cultured keratinocytes. These keratinocyte cultures are prepared by isolating keratinocytes from a piece of the patient’s skin.

Therapy-refractory ulcers

If the ulcer refuses to heal despite all endeavours, the therapeutic concept should be reviewed. The following check list may assist in identifying possible causes of therapy-refractory ulcers:

- Is the compression therapy being adequately performed? If appropriate, change from temporary to permanent bandages, use stronger compression etc.
- Are the lesions being treated mixed arterial-venous ulcers?
- Doppler sonographic evaluation of peripheral blood circulation, further angiographic diagnostic imaging if required
- For arterial hypertension (Martorell ulcer): treat the hypertension
- Is there latent or overt right ventricular failure (edema in healthy leg)?
- Additional outflow disorders due to secondary lymphedema?
- Arthrogenic stasis syndrome in knee or hip arthrosis?
- Lack of exercise (“rather run and lie down, sitting and standing are bad”, obesity)?
- Erysipelas, mycotic and/or bacterial superinfection (clinical symptomatology)?
- Ulcer of other etiology?
- Therapy-refractory accompanying eczema: Allergy testing.
- Poorly managed diabetes mellitus (determine HbA1c).
TenderWet – wound pad with super absorber

TenderWet is an extremely effective wound dressing for quick cleansing, debriding necroses, reduction of microbes and wound bed sanitation particularly of chronic and infected wounds. This high efficiency is attributable to a special mode of action which allows continuous “rinsing” of the wound.

TenderWet is a multilayered dressing pad containing super-absorbent polyacrylate (SAP) as the central component of its absorbent core. The active agent-free super absorber is activated before use with an appropriate quantity of Ringer’s solution which is then released continuously into the wound for hours. The constant delivery of Ringer’s solution softens, detaches and rinses away necrotic tissue (1).

At the same time, however, microbially contaminated wound exudate is absorbed and bound into the wound dressing pad. This exchange – Ringer’s solution is delivered and proteins are absorbed - functions because the super absorber has a greater affinity for the protein-containing wound exudate than for the sodium-containing Ringer’s solution (2) and so the wound exudate displaces the solution from the wound pad. As soon as the factors inhibiting wound healing are removed, i.e. the wound has been cleansed of necrotic tissue, detritus and coatings, the conditions necessary for the buildup of granulation tissue are present: proliferative cells can migrate into the wound area and capillary ingrowth is possible (3). The moisture and the electrolytes contained in the Ringer’s solution, such as sodium, potassium and calcium, contribute to the cell growth.

TenderWet has no contra-indications and can also be used on infected wounds. In certain cases, there is an apparent increase in the size of the wound during the initial cleansing phase with TenderWet. This means that with this method devitalised tissue which was not recognisable as such was removed. In the case of deep wounds, TenderWet should be packed in loosely to ensure direct contact necessary for fluid drainage. The physical characteristics of the super absorber in combination with the outer covering of knitted fabric on the wound pad give TenderWet the necessary packing characteristics. With extensive wounds, the TenderWet wound pads should be applied with a slight overlap.

TenderWet comes in a range of variants and is available in round and rectangular shapes to meet differing application requirements.

For greater ease of use, TenderWet and TenderWet 24 are supplied in already activated form as TenderWet active cavity and TenderWet 24 active. These active wound pads are saturated ready to use with Ringer’s solution and can be applied immediately. This dispenses with time consuming preparations. Another advantage of the already activated wound pads is that a much greater volume of Ringer’s solution can be introduced into the absorbent core than is possible with manual impregnation. As a result, the wound can be kept moist longer.

Moreover, the pads are soft and easy to shape, especially in case of TenderWet active cavity, which can be used to pack even cavernous wounds without difficulty. In contrast, TenderWet 24 active should not be packed into the wound because of its moisture-repellent protective backing layer.
Phase-specific wound management [46.47]

The classical TenderWet must be saturated with Ringer’s solution before use. How much Ringer’s solution is required to activate the dressing depends on the size of the compress and is indicated on the packing accordingly. For easy activation of TenderWet (and also of TenderWet 24), TenderWet solution is supplied in ready to use vials. The composition of the sterile, pyrogen-free and isotonic solution corresponds to that of Ringer’s solution.

TenderWet 24 active and TenderWet 24 are designed so that the absorbing and rinsing effect is sustained for up to 24 hours. To protect the dressing from strike through, moisture-repellent layer is integrated inside the dressing on the side facing away from the wound. The side of the compress with the integrated protective layer is identified by the presence of parallel coloured strips to allow secure positioning of the wound pad. Because of this protective layer, TenderWet 24 should not be packed into the wound.

The following applies generally to all TenderWet wound dressing pads: They are not self-adhesive and require adequate fixation, e.g. complete-cover dressing retention with elastic non-woven sheet dressings (e.g. Omnifix) or elastic conforming bandages (e.g. Peha-crepp, Peha-haft).

Approximately 70-year-old patient with recurrent venous leg ulcer since 1992 (Case study B. Kowollik, Neuss)

1) 7 November 02, Status of venous ulcer after 5 days’ treatment with TenderWet 24, the wound is increasingly clean.

2) 15 November 02, all three phases of wound healing are visible: in the upper third epithelium, in the left third well-conditioned granulation tissue, in the right half the wound is still in the cleansing phase.

3) After 12 weeks the wound area is about two thirds reduced in size.

4) 28 February 03, the rapid course of wound healing has slowed down greatly.

5) To influence the perforating vein insufficiency, which was identified as the obstacle to healing, the pressure was increased in the ankle region by fitting a support pad.

6) Finished compression bandage

7) 14 May 03, increasing the compression was successful, the ulcer had decreased in size by one half.

8) 18 June 03, completely healed ulcer
76-year-old patient with a venous leg ulcer on the left lower leg for 30 years, with slimy coating, torpid granulation (Case study Prof. H. Winter, Berlin)
1) Ulcer status on admission.
2) Start of wound treatment with TenderWet 24. In the initial phase activated with local antiseptic (Lavasept).
3) Therapy continued with TenderWet 24 combined with compression treatment (short-stretch bandages).
4) Clean wound conditions with formation of abundant granulation tissue 4 weeks after wound treatment with TenderWet 24.
5) Split-thickness skin graft (mesh graft technique).
6) Result one year after grafting.

Sorbalcon – calcium alginate dressings with excellent conformability
Sorbalcon is the wound dressing ideally suited for cleansing and for supporting the build-up of granulation tissue in superficial and deep infected and non-infected wounds. By virtue of its excellent packing characteristics, Sorbalgon also provides effective cleansing and conditioning in deep wounds.

Sorbalcon is a non-woven dressing made of high-quality calcium alginate fibres which are introduced in the dry state into the wound (1). As they absorb sodium salts, present for example in blood and wound exudate, the fibres start swelling and undergo transformation into a moist absorbent gel which expands to fill out the wound (2). Since Sorbalgon adapts closely to the wound surfaces, microorganisms are also absorbed deep inside the wound and are reliably absorbed into the gel structure (3). This provides efficient microbial reduction and helps avoid recontamination. Wounds are swiftly cleansed, and Sorbalgon has therefore proved especially successful in the treatment of chronic and infected wounds.

Very good wound healing properties of Sorbalgon are among the other things due to type of suction properties of calcium succinate fibres. They absorb 10 ml exudates per gram of weight and thus have very high absorption capacity. On the other side, the absorption capacity is not achieved mainly among the fibres as by gauze, but the wound fluid penetrates intracapillary into the fibres and the microbes are safely trapped while transforming the liquid to gel. With its gel-like consistency, Sorbalgon unlike the semiocclusive wound dressings also acts as a moist dressing that has regulative effect on exudates and prevents the wound from drying out.
Sorbalgon’s gel-forming properties prevent it from sticking to the wound and dressing changes are painless. However, complete gelatinisation of the calcium alginate fibres requires the presence of sufficient exudate. Moistening of Sorbalgon with Ringer’s solution is advisable when ragged wounds with low exudation must be packed. Eventually remaining fibres can be removed from the wound by tweezers.

In the wound cleansing phase, 1 to 2 dressing changes daily may be required depending on the amount of exudation. Later, as granulation tissue forms, a dressing change every two to three days may be sufficient. Sorbalgon is available in three sizes as square dressings. Sorbalgon T is available in band form.

**PermaFoam – hydroactive foam dressing**

The foam dressing PermaFoam is indicated for non-infected wounds with moderate to heavy exudate in the cleansing phase and during the granulation phase. Its therapeutic action is based on its special pore structure.

PermaFoam is a combination of two differently structured foams that are connected with each other by a special form of lamination. The absorbent layer of PermaFoam consists of hydrophilic polyurethane polymers that can store up to nine times their own weight of liquid in their polymeric chains. The polyurethane matrix has a unique pore gradient: the large pores on the wound-facing side become progressively smaller in the direction towards the top layer, which produces strong vertical capillary action. The top layer of PermaFoam consists a flexible, close-porous polyurethane foam and is semipermeable, which means impermeable to germs but permeable to water vapour.

This material combination and design result in product characteristics which can counteract the maceration problems often observed with chronic wounds: via the strongly marked vertical wicking effect, the microbial contaminated wound exudate is quickly drawn up to underneath the outer layer. The large foam pores on the wound side ensure that viscous exudate and detritus can be also absorbed without blocking the pores. When absorbing the wound exudate, the polyethylene foam swells slightly which ensures the contact necessary to draw off discharges from the wound floor.

The absorbed wound exudate then spreads out laterally under the outer layer. In this regard, it is also important that PermaFoam has – mainly due to the special pore structure – has a high retention capacity for fluids. Even when pressure is applied from outside by, for example, a pressure bandage, the exudate is retained in the foam. Also relevant is the fact that the absorptive capacity of PermaFoam is only slightly reduced even under the pressure of a compression bandage. For example, under a pressure of 42 mmHg, the absorptive capacity is reduced by only 12 % compared with the pressure-free condition.

Taken together, all these characteristics result not only in the desirable rapid regulation of exudation, but also protect the wound margins from maceration because the absorbed wound exudates are not pressed back into the wound again. In addition, the high permeability of the outer layer to water vapour ensures a well-balanced moist microenvironment for the wound, which further
PermaFoam is atraumatic, sticking to the wound and growth of tissue into the foam structure are minimised. Due to the high absorptive capacity and the very good retention, PermaFoam can – even with profuse exudation (when no complications exist) - remain on the wound for several days.

PermaFoam is soft and flexible and therefore clings well to the wound contours. The dressing is held in place with elastic conforming bandages (e.g. Peha-haft) or over the entire area with elastic non-woven sheet dressing for dressing retention (e.g. Omnifix elastic). For easy fixation, PermaFoam has a adhesive border around the edges and the adhesive is kind to the skin. PermaFoam is available in a variety of versions and sizes.

Hydrocoll – absorbent hydrocolloid dressing

Hydrocoll is a self-adhesive, absorbent hydrocolloid dressing for cleansing and conditioning non-infected wounds with moderately severely to severely secretion.

The term “colloid” comes from the ancient Greek and means a substance which is integrated in a very finely dispersed form in a matrix. Hydrocoll therefore consists of hydrocolloids capable of absorbing and swelling and are incorporated in a self-adhesive elastomer. A semipermeable layer serves to prevent bacterial and moisture penetration.

The central feature of the mechanism of action of Hydrocoll is the hydrocolloids incorporated in the carrier layer. On absorbing wound exudate they swell to form a gel which expands into the wound and maintains a moist wound environment. The gel remains absorbent until the hydrocolloids are saturated. During the swelling process the absorbed wound exudate, which is always contaminated with detritus, bacteria and their toxins, is securely retained within the gel structure.

The adhesive power of the elastomer allows Hydrocoll to be applied to the wound like an adhesive plaster. When the gel forms, the adhesive power on the wound surface disappears, leaving Hydrocoll fixed only on the intact periwound area in a manner atraumatic to the wound.
Hydrocoll is manufactured using hydrocolloids with especially good absorptive and swelling properties, and which also have the characteristic of retaining a compact gel structure. Although Hydrocoll expands into the wound, in the gelatinised state it can be removed from the wound as an entirely intact dressing. Hardly any gel remnants remain in the wound, making it only exceptionally necessary to irrigate the wound to remove gel residues of pus-like consistency. This makes dressing change easier and more pleasant. Moreover, a reliable wound assessment can be made immediately.

The mode of action of Hydrocoll is effective in all the phases of wound healing: Since microbially contaminated wound exudate is quickly taken up into the hydrocolloid structure of the dressing by the absorbent and swelling process, the wound is rapidly and effectively cleansed. As general studies have shown, the microcirculation in the wound area also improves with progressive cleansing. The body’s own cleansing mechanisms are reactivated especially in chronic wounds in which the cleansing process is stagnating. During the granulation phase, the moist wound environment maintained by Hydrocoll stimulates the formation of granulation tissue. With Hydrocoll, the balanced moist wound environment can also be maintained without difficulty over prolonged periods and the granulation tissue is reliably prevented from drying out. In the epithelisation phase, the cell-friendly moist wound environment promotes mitosis and migration of the epithelial cells. In addition, undesirable scab formation which could delay healing is prevented. The impermeable to bacteria and liquid top layer forms a reliable barrier against microorganisms and protects the wound from dirt and moisture. Mobile patients can shower with the dressing in place.

Hydrocoll is available in different sizes and shapes, e.g. “concave” for the treatment of wounds on elbow and heel or the “sacral” for the treatment of decubital ulcers in the sacral region. In the rectangular standard version is also available for smaller wounds. The “Hydrocoll thin” version is specially suited for already epithelising wounds.

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**Hydrotul – hydroactive impregnated dressing**

By development of the hydroactive impregnated dressing Hydrotul, the beneficial properties of traditional ointment impregnated tulle dressings with the state of the art hydrocolloid technology have been combined. This opens a wide field of application for the hydroactive ointment dressings. Hydrotul is suitable for the treatment of superficial, both acute and chronic wounds; especially during the granulation and epithelization. Results of various studies have implied, that the hydroactive impregnated dressing Hydrotul promotes the wound healing process particularly by wounds where the previous therapies failed. The presence of infection is not contraindicated because unobstructed exudate drainage is possible.

For improved efficiency in wound healing and atraumatic properties of Hydrotul the hydrocolloid particles incorporated in polyamide fabric (1) are crucial. These carboxymethylcellulose granules absorb the wound exudate and create the moist wound environment like the known hydrocolloid dressings, stimulating the wound healing in...
all phases. Another benefit of the hydrocolloids is creating moist environment in the wound base and thus Hydrotul can remain on the wound for longer time than the conventional wound dressing without risk of drying out.

Additionally, an effect has the impregnation of the carrier polyamide lattice tulle by hydroactive non-medicated ointment mass based on triglycerides (2). The ointment mass prevents the dressing from sticking to the wound surface, enhances the atraumatic properties of the hydrocolloid component, keeps the wound margins soft and supple, thus preventing maceration. Moreover, with the ointment mass based on triglycerides the adipic component has been developed, which does not leave any displeasing residues which could decompose in the wound. Thus state of the wound can be always easily assessed. This is important for treatment of nearly all wounds, but special importance is for burns, where reliable wound assessment must be possible to reveal any changes that may worsen in time. Hydrotul should be used on third-degree burns only when ordered by the attending physician.

Sufficient mesh aperture of the polyamide carrier of Hydrotul (3) provides for an unobstructed drainage of wound exudate. Application of the Hydrotul on the burned wound shows, how Hydrotul keeps the wound surface moist and supple (see photo below).

Hydrotul is available as ointment dressing in the sizes 5 x 5 cm, 10 x 12 cm and 15 x 20 cm sterile and individually sealed.

**Hydrosorb – transparent hydrogel dressing**

Hydrosorb is particularly suitable for keeping granulation tissue moist and stimulation of epithelium regeneration and is thus the optimum wound dressing for phase-adapted further treatment after wound treatment with TenderWet, Sorbalgon or PermaFoam.

Hydrosorb is from the physical viewpoint, a three-dimensional network made of a ready-to-use gel dressing made of hydrophilic and absorbent polymers where 60% of water is incorporated. Despite of this high water content, Hydrosorb can absorb additional considerable amounts of fluid, owing to the presence of hydrophilic groups, without losing its gel structure. These properties imply the specific use of Hydrosorb for the wound treatment: Hydrosorb represents from the beginning the fully functional, moist compress, which does not need, unlike the
calcium alginates or hydro colloids, any wound exudate for transformation to gel form. Hydrosorb thereby provides the wound with moisture for several days from the start (1). At the same time, Hydrosorb absorbs excessive microbial contaminated secretions which are then held in the gel structure. Then with absorption of exudates the cross links in the polymer chains expand, creating space in the macromolecule for the foreign matter like microbes, detritus and odour molecules from which they cannot leak anymore. This exchange ensures the optimum moisture level for wound healing, thus promoting the production of granulation tissue and epithelialisation (2). The surface of Hydrosorb is impermeable to water and bacteria to protect against secondary infections.

However, it should be noted, that the hydrogels show other absorption characteristics than textile materials or calcium alginates. The hydrogels cannot absorb liquids spontaneously; their fluid absorption capability occurs only after certain time period and increases only slowly. But then the hydrogels like Hydrosorb have the capability of continuous lasting absorption capacity. Hydrosorb prevents the dressing from sticking to the wound and can be removed even after prolonged periods on the wound without the risk of wound irritation. Hydrosorb can be removed in its entirety as the gel sheet structure does not

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**A)** Particular macromolecules with their deposited water molecules create polymer chains through special cross links.

**B)** Exudate absorption.

**C)** The cross links are expanded and create space for secure trapping of microbes, exudates and odour molecules.

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**Case study - 79-year-old patient with venous leg ulcer**

1) Start of treatment with TenderWet active in December 21st, 2004; re-dressing every 24 hours.
2) After one week treatment with TenderWet active change-over to wound conditioning on foam dressing PermaFoam; re-dressing every 3 or 4 days.
3/4) Under PermaFoam quick build-up of granulation occurred.
5) For stimulation of epithelisation the treatment continued with the hydrogel dressing Hydrosorb.
6/7) The further progression without complications under treatment by Hydrosorb or compression is shown on the photos.
8) After two months of treatment, again according to the phase specific application of TenderWet active, PermaFoam and Hydrosorb the ulcer is healed.
break down because of the absorbed secretions. No residues remain in the wound and the condition of the wound can be assessed without prior irrigation.

In addition, the transparency of Hydrosorb, which is maintained even after prolonged use is particularly useful in practice. It allows inspection of the wound without changing the dressing. This ensures the non-disturbance of the wound, very important for healing, as well as being highly cost-efficient because of the longer intervals between dressing changes.

Hydrosorb is available in two versions as Hydrosorb and Hydrosorb comfort. Hydrosorb does not have an adhesive edge and is secured with adhesive tape, a dressing bandage or a compression bandage. Hydrosorb comfort is surrounded by a hypoallergenic adhesive film border for bacteria-proof fixation.

Hydrosorb Gel – for dry wounds rehydration
Hydrosorb Gel is a transparent, viscous and sterile gel based on carboxymethylcellulose, Ringer’s solution and glycerine, providing immediately a moist wound environment helping to promote wound healing to deep and ragged wounds which are dry or in danger of drying out. The ingredients of Hydrosorb Gel ensure continuous and sufficient moisture for dry wounds with the following therapeutic applications: fibrinous and necrotic sloughs are softened and removed. Hydrosorb Gel thereby absorbs exudates contaminated by microbes and detritus, where a small amount of exudate is present. The endogenous physical debridement is thereby stimulated efficiently and the physiological secretion necessary for wound healing can be renewed. In the wound conditioning phase with granulation, the tissue electrolytes build up contained in the Ringer’s solution like sodium, kalium and calcium promote cell proliferation.

The dry wounds or wounds in danger of drying out exist particularly due to the long existing, chronic Ulcera cruris and decubital ulcers. In second degree burns, the Hydrosorb Gel cools and soothes pain with its moisture. Application on infected wounds can be performed only under the supervision of attending physician.

Hydrosorb Gel is available in convenient dosing syringes of 15 g and 8 g ensuring easy application under all wound conditions: Through a long discharge, the Hydrosorb Gel can be applied also to deep, ragged wounds directly and cleanly. This safe application is promoted by the gel consistency. The gel is sufficiently packed to prevent immediate escape and soft sufficiently to adapt to the wound base.

The dosing syringe can be easily handled by one hand, and the gel can be dispensed exactly. Moreover, the Hydrosorb gel syringe can be effectively emptied unlike tubes, where gel often remains. An exact amount, necessary for wound treatment, can be dispensed from the syringe. Clear indication of volume in ml on the syringe is also advantageous. It enables to determine at a glance, how much gel has been applied to the wound. The introduced gel quantity can be used to determine the wound
Atrauman Ag – silver-containing ointment dressing for infection control

The germicidal action of silver-containing wound dressings has long been known. The silver-containing ointment dressing Atrauman Ag is a successful attempt to create a product with reliable bactericidal activity but only low cytotoxicity so that wound healing is not compromised.

The support fabric for Atrauman Ag is made of an open-weave hydrophobic textile made from polyamide. It is coated with metallic silver which is chemically bound, i.e. firmly fixed, to the support fabric. The silver-coated support fabric is impregnated with a hydrophilic ointment. The complete system is highly permeable to air and water vapour. This design offers decisive advantages: When in contact with wound exudate, the silver-containing ointment dressing releases silver ions from its metallic surface. The majority of these ions remain in the immediate vicinity of the dressing — only very few enter the wound itself — adhere to the surface of bacteria and reliably destroy them. The wound exudate together with the dead bacteria and endotoxins produced by this process are absorbed into the secondary dressing.

The fewer silver ions that are released into the wound and into the cell tissue, the lower the toxicity of the dressing containing silver. The low toxicity of Atrauman Ag has been demonstrated in studies with the human keratinocyte cell line HaCaT. The bactericidal spectrum of action of Atrauman AG is extremely broad and includes gram-positive as well as gram-negative bacterial strains. The effective bactericidal action persists not only briefly but for a prolonged period. The ointment impregnation, finally, protects the wound margins and minimises adhesion.

Another aspect of practical importance is that Atrauman Ag can be combined with many different wound dressings as a secondary dressing without loss of effectiveness, allowing the continuation of treatment with methods in accordance with the indication. Combinations are possible with, for example, PermaFoam hydroactive foam dressing, the calcium alginate dressing Sorbalgon, the wound pad TenderWet or traditional wound dressings like ES compresses.
<table>
<thead>
<tr>
<th>Products for dry wound treatment</th>
<th>TenderWet</th>
<th>Sorbalgon</th>
<th>PermaFoam</th>
<th>Hydrocoll</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product characteristic</strong></td>
<td>wound pad dressing with super absorber polyacrylate with unique absorbing and rinsing effect, activated before use with the Ringer’s solution and this is then brought to the wound and exchanged for the wound exudate.</td>
<td>non-medicated calcium alginate dressings with excellent conformability, transformed in the presence of wound exudates to the wet gel, whereby the microbes are safely trapped in the gel structure</td>
<td>hydroactive foam dressing made of variously structured foamed material with high vertical wicking effect as well as high retention for reliable fluid binding, microbe-proof cover layer</td>
<td>self-adhesive hydrocolloid dressing with particularly absorbent and expandable hydrocolloids, in combination with semipermeable microbe- and water-proof cover layer</td>
</tr>
<tr>
<td><strong>Properties and use</strong></td>
<td>through continuous supply of the Ringer’s solution and simultaneous extraction of microbial contaminated exudates (= absorbing and rinsing effect) quick active wound cleansing and promotion of tissue cells proliferation, for treatment of infected and non-infected wounds during the cleansing phase and at the beginning of the granulation phase</td>
<td>high absorption capacity with efficient cleansing action, keep the wounds wet after transformation to gel, stimulates granulation build-up; due to excellent conformability ideal for cleansing and conditioning of deep and ragged, infected and non-infected wounds also after surgical débridement</td>
<td>rapid regulation of wound exudate, protects the wound margins and minimises, particularly suitable for treatment of venous leg ulcers in combination with the treatment by compression, for treatment of burn ups up to the grade IIa, for deep wounds, difficult difficultly treatable problematic zones the appropriate specific shapes are used</td>
<td>cares for good cleansing, improves microcirculation in the wound area, promotes build-up of granulation tissue, prevents from sticking to the wound and can be removed from the wound in one piece, suitable especially for conditioning of non-infected wounds with moderately severe to severe secretion</td>
</tr>
<tr>
<td><strong>Presentations</strong></td>
<td>TenderWet 24 active, steril, Ø 4, Ø 5,5, 4x7, 7,5x7,5, 10x10 und 7,5x20 cm; TenderWet active cavity, steril, Ø 4, Ø 5,5, 4x7, 7,5x7,5 und 10x10 cm; TenderWet 24, steril, Ø 4, Ø 5,5, 7,5x7,5 und 10x10 cm; TenderWet, steril, Ø 4, Ø 5,5, 7,5x7,5 und 10x10 cm</td>
<td>Sorbalgon, steril, 5x5, 10x10 und 10x20 cm; Sorbalgon T Tamponadestreifen, steril, 1g/30 cm und 2g/30 cm</td>
<td>PermaFoam, steril, Ø 6, 10x10, 10x20, 15x15, 20x20 cm; PermaFoam comfort, steril, 8x8, 11x11, 10x20, 15x15, 20x20 cm; PermaFoam sacral, steril, 18x18, 22x22 cm; PermaFoam concave, steril, 16,5x18 cm; PermaFoam cavity, steril, 10x 10 cm; PermaFoam tracheostomy, steril, 8x8 cm</td>
<td>Hydrocoll, steril, 5x5, 7,5x7,5, 10x10, 15x15 und 20x20 cm; Hydrocoll sacral, steril, 12x18 cm; Hydrocoll concave, steril, 8x12 cm; Hydrocoll thin, steril, 5x2,5, 7,5x7,5, 10x10 und 15x15 cm</td>
</tr>
</tbody>
</table>
### Products for dry wound treatment

<table>
<thead>
<tr>
<th>Product</th>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
<th>Image 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrotul</strong></td>
<td><img src="image1.png" alt="Hydrotul" /></td>
<td><img src="image2.png" alt="Hydrotul" /></td>
<td><img src="image3.png" alt="Hydrotul" /></td>
<td><img src="image4.png" alt="Hydrotul" /></td>
</tr>
<tr>
<td><strong>Hydrosorb</strong></td>
<td><img src="image1.png" alt="Hydrosorb" /></td>
<td><img src="image2.png" alt="Hydrosorb" /></td>
<td><img src="image3.png" alt="Hydrosorb" /></td>
<td><img src="image4.png" alt="Hydrosorb" /></td>
</tr>
<tr>
<td><strong>Hydrosorb Gel</strong></td>
<td><img src="image1.png" alt="Hydrosorb Gel" /></td>
<td><img src="image2.png" alt="Hydrosorb Gel" /></td>
<td><img src="image3.png" alt="Hydrosorb Gel" /></td>
<td><img src="image4.png" alt="Hydrosorb Gel" /></td>
</tr>
<tr>
<td><strong>Atrauman Ag</strong></td>
<td><img src="image1.png" alt="Atrauman Ag" /></td>
<td><img src="image2.png" alt="Atrauman Ag" /></td>
<td><img src="image3.png" alt="Atrauman Ag" /></td>
<td><img src="image4.png" alt="Atrauman Ag" /></td>
</tr>
</tbody>
</table>

#### Product characteristic

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrotul</strong></td>
<td>Hydroactive ointment dressing with hydrocolloid particles deposited in open-weave carrier polyamide and non-medicated ointment impregnation based on triglycerides</td>
</tr>
<tr>
<td><strong>Hydrosorb</strong></td>
<td>Transparent gel dressing made of absorbent polyurethane polymers where as much as 60% of water is incorporated, in combination with semipermeable microbe- and water-proof cover layer</td>
</tr>
<tr>
<td><strong>Hydrosorb Gel</strong></td>
<td>Clear, viscous and sterile hydrogel based on carboxymethylcellulose, Ringer’s solution and glycerine</td>
</tr>
<tr>
<td><strong>Atrauman Ag</strong></td>
<td>Silver-containing ointment dressing with a bactericidal action; the metallic silver is permanently bonded to the backing material made of hydrophobic lattice tulle is additionally impregnated with non-medicated ointment mass</td>
</tr>
</tbody>
</table>

#### Properties and use

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrotul</strong></td>
<td>Provides optimally moist wound environment for quick healing, prevents from sticking to the wound, protect against traumatization by re-dressing, keeps the wound margins soft and supple, thus preventing maceration, for treatment of superficial acute and chronic wounds in the granulation- and epithelisation phase</td>
</tr>
<tr>
<td><strong>Hydrosorb</strong></td>
<td>Supplies the wound with moisture from the beginning, due to transparency allows inspection of the wound without a change of dressing (= high cost-effectiveness because of the longer intervals between dressing change), ideal for keeping moist environment of granulation and epithel after therapy with Tender-Wet, Sorbalgon or PermaFoam</td>
</tr>
<tr>
<td><strong>Hydrosorb Gel</strong></td>
<td>Rehydrates the deep and ragged wounds which are dry or in danger of drying out, fibrinous and necrotic sloughs are softened and removed, promotes efficiently the autholytical débridement, through electrolytes contained in Ringer’s solution promotes cell proliferation, easy to use by virtue of dosing syringes</td>
</tr>
<tr>
<td><strong>Atrauman Ag</strong></td>
<td>For treatment of infected wounds and wounds endangered by infection, the broad spectrum of bactericidal spectrum grampositive/negative, long-lasting bactericidal action, proven good tissue tolerability and low cytotoxicity, the ointment impregnation cares for the wound margins, shall be applied with absorbing secondary dressing</td>
</tr>
</tbody>
</table>

#### Presentations

<table>
<thead>
<tr>
<th>Product</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrotul</strong></td>
<td>Steril, 5 x 5 cm, 10 x 12 cm und 15 x 20 cm</td>
</tr>
<tr>
<td><strong>Hydrosorb</strong></td>
<td>Steril, 5x7,5, 10x10 und 20x20 cm; <strong>Hydrosorb comfort</strong>, steril, 4,5x6,5, 7,5x10, 12,5x12,5 und 21,5x24 cm</td>
</tr>
<tr>
<td><strong>Hydrosorb Gel</strong></td>
<td>Steril, Dosierspritze à 15 g und 8 g</td>
</tr>
<tr>
<td><strong>Atrauman Ag</strong></td>
<td>Steril, 5x5, 10x10 und 10x20 cm</td>
</tr>
</tbody>
</table>
Options for phase-specific wound management of venous leg ulcer

<table>
<thead>
<tr>
<th>Wound cleansing</th>
<th>Granulation</th>
<th>Epithelisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necrosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrin coating</td>
<td></td>
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</tr>
</tbody>
</table>

Necrosis
- TenderWet 24 active (if needed in combination with Atrauman Ag)
- PermaFoam (in infected wounds only under medical supervision)
- PermaFoam concave
- Pre-damaged peri-wound area

Infection
- TenderWet 24 active
- PermaFoam concave
- Pre-damaged peri-wound area

Fibrin coating
- TenderWet 24 active
- PermaFoam concave
- Pre-damaged peri-wound area

Exudate ++
- TenderWet 24 active
- PermaFoam comfort
- PermaFoam concave
- Pre-damaged peri-wound area
- PermaFoam

Exudate +
- TenderWet 24 active
- PermaFoam comfort
- PermaFoam concave
- Pre-damaged peri-wound area
- PermaFoam

Compression therapy

Permanent bandage:
- Varolast

Temporary bandage:
- Pütter bandage

Compression stocking:
- Saphenamed ucv

Fixation

Normal skin:
- Omnifix elastic, Omniplast, Omnisilk, Peha-haft*, Stülpa-fix

Sensitive skin:
- Pehalast, Omnipor, Peha-crepp

Extremities:
- Peha-haft*, Pehalast, Stülpa-fix, Stülpa

Joints:
- Omnifix elastic, Stülpa-fix

* Caution: As a cohesive dressing retention bandage Peha-haft is to be used with care in patients with blood circulation disorders and should not be applied too tightly!

** As primary dressing in combination with absorbent wound dressings

*** For wounds with almost no exudate
Compression bandaging as basic therapy

The exactly fitting compression bandage is recommended both for acute and initial treatment and for maintenance therapy of all phlebological conditions. Many patients can be successfully treated by this method alone. The decisive factor for therapeutic efficacy, however, is that the various available compression materials such as bandages and stockings should be used in accordance with therapeutic needs.

Compression bandaging is to be regarded as the basic therapy for all venous leg ulcer conditions because it intervenes causally in the disease process. Compression applied to the leg causes
- narrowing of the suprafascial veins with at least partial restoration of valve function
- closure of incompetent perforating veins and thus prevention of reflux from sub- to suprafascial, as well as abolition of harmful “shear effects” accompanying muscle contraction
- when using a suitable technique, reduction of the lumen of the deep and muscle veins and thus a decrease in the dead space, acceleration of blood flow velocity and, to a certain extent, substitution or restoration of valve function when valves or valve remnants are still preserved
- an increase in tissue pressure and an associated increase in reabsorption in the terminal vessels and the lymph vessels
- reinforcement of the fascia as a resistance surface for the muscles and hence an improvement in the joint muscle pump and self massage of the tissue during movement
Acceleration of the blood flow velocity also has antithrombotic effects and, in combination with the resulting decongestion, has anti-inflammatory efficacy.

Moreover, the low resting pressure especially of bandages with a high working pressure allow the small vessels to be aerated during muscle relaxation and thus to be refilled with arterial blood; during muscle contraction they are squeezed out again by the high working pressure. This interplay of forces increases the blood circulation in the nutritive vascular segments of the terminal vessels, thereby substantially improving the metabolic performance.

Compression therapy is therefore indicated in disease states characterized by a tendency to edema, in thrombophlebitis, deep thrombosis, postthrombotic syndrome, primary varicosis without and with perforator incompetence and in venous leg ulcer of any etiology.

The effectiveness of a compression bandage essentially depends on the physical properties of the compression material used in terms of its force-stretch behaviour, and on the application technique employed. However, it should always be remembered: A compression bandage can only be fully effective combination with active movement!

Certain constellations also place limitations on the use of compression therapy: Although pAOD is not considered an absolute contraindication, in these patients compression therapy may only be used with a thorough knowledge of the arterial pressure conditions (caution: arterial ankle pressure below 70 mmHg).

Diabetic patients with media sclerosis are at particular risk in this respect, since sonographic pressure measurements are of little diagnostic value in these cases. If neuropathy is also present, the patient feels no pain and this “warning signal” is also missing.

In patients with latent heart failure, the sudden increase in venous return induced by the compression can cause right heart decompensation.

Finally, a compression bandage is almost ineffective if ulcers that have been present on the ankle for decades and frequent relapses have resulted in stiffening due to dermatofibrosis.

**The bandaging materials**

In compression bandage treatment, different clinical situations require the use of bandage material with differing force-stretch behaviour which may be described as the ratio between working pressure and resting pressure.

The working pressure results from the resistance presented by the bandage to the expansion of the muscles during muscle contraction. This pressure is always measured on the extremity while it is moving and is higher the less the bandage material can be stretched.

The resting pressure essentially corresponds to the application pressure, i.e. the force used to stretch the bandage when it is applied, but is also influenced by the individual restoring force of a bandage. Restoring force is the tendency of elastic material to slowly contract when relieved of loading. The resting pressure is therefore measured on the unmoved extremity. It is lower, the less stretchable the bandage material.
Of all the compression bandages, the semi-rigid, unyielding zinc paste bandage provides the greatest decongestion of deep venous regions. Two-way-stretch bandaging materials, such as the Varolast zinc paste bandage, also allow less experienced persons to apply effective zinc paste bandages.

Based on the criteria described, the materials available for bandage therapy can be divided into:
- rigid zinc paste bandages exerting the highest working pressure and lowest resting pressure;
- relatively inelastic, short-stretch bandages with high working pressure and low resting pressure;
- in two part stocking compression systems like the Saphenamed ucv, exerting relatively high working pressure and relatively low resting pressure, intended for acute phase of treatment;
- in medical compression stockings of various compression grades, used particularly in the after treatment.

As regards application techniques of compression bandages, a distinction is made between permanent bandages which remain in place for prolonged periods, and temporary bandages.

In addition, the occurrence of venous statis and other clinical images have to be considered when selecting which compression methods to use. In the acute phase, a compression bandage consisting of zinc paste or short-stretch bandages is always used, since they can respond more effectively to the variations in leg circumference. After decongestion, for continuation treatment is suitable a two part compression stocking system Saphenamed ucv, particularly in case of symptoms of the chronic venous insufficiency CEAP class C4-C6 (CEAP = clinic – etiology – anatomy – pathophysiology). If the leg is permanently decongested and the ulcer has fully healed, however,
treatment can be continued by using individually fitted compression stockings.

It should always be remembered that the compression bandage – regardless of the material and application technique – can only be fully effective when the patient is engaged in physical movement. It is also important to note that only one type of bandage should be used at once; for example short- and long-stretch bandages should never be combined in a single layer.

Zinc paste bandages
After application, zinc paste bandages produce semi-rigid, unyielding bandages. Because of their non-elastic nature, among all the bandaging materials these are the ones which can offer the greatest resistance to the working muscles and exert a working pressure so intense that it extends deep into the subfascial regions and rapidly reduces swelling. The correspondingly low resting pressure assures a good aeration effect, so that blood circulation in the nutritive vessels is promoted, especially during stagnation due to lacking withdrawal of blood by the deep veins.

The zinc paste bandage is therefore indispensable for rapidly reducing the leg swelling and removing stubborn edema especially on the back of the foot which resist treatment with temporary short-stretch bandages or permanent plaster bandages. Since the bandage cannot adapt to changes in leg circumference after the edema has subsided, however, it has to be changed frequently in this first phase of therapy.

Local ulcer care during the cleansing phase presents some difficulties. A daily change of bandage is often required, and is more easily accomplished by using temporary, short-stretch bandages. If appropriate, however, rapid decongestion with the zinc paste bandage may have to be attempted; wound cleansing can then be commenced. The zinc paste bandage can be indicated as a substitute for temporary bandages if the bandage is liable to manipulation or if dressing change on schedule is not always possible.

Short-stretch bandages
Short-stretch bandages are characterized by relatively low stretch, which causes the bandage to exert high compression with a high working pressure and low resting pressure. Since these pressure conditions are still sufficient to influence the deeper regions, the mode of action of such bandages corresponds to that of zinc paste bandages, although they do not have their high efficiency. On the other hand, short-stretch bandages have the advantage compared to zinc paste bandages that they adapt better to changes in leg circumference. When a good application technique is used, this means that they can be left in place for about three days, except in the acute, highly edematous stage.

Short-stretch bandages are suitable for all forms of chronic venous insufficiency and are the treatment of first choice for initiating or continuing treatment until the ulcer is completely decongested and epithelised.

Short-stretch bandages are available in a range of versions made possible by textile technology. Their stretch can range from about 50 % to a maximum 90 % to achieve the required high working pressure and low resting pressure. The type of yarns used and the design determine the typical use characteristics.

If bandages derive their elasticity from over-twisted, i.e. highly plied cotton chain-link threads, they are known as textile elastic. The best known and most commonly used bandage of this type is the classical "Ideal" type bandage, textile elastic bandage, but the Pütter bandage is
also textile elastic and is made from a somewhat stronger fabric resembling the “Ideal” type bandage.

Bandages are classified as permanently elastic if they derive their elasticity from fully synthetic chain-link threads. Crimped polyamides are mainly used for this purpose, and their degree of elasticity can be made suitably low by texturising in order to meet the physical requirements of a short-stretch bandage.

General principles of bandaging technique

Compression therapy with bandages supports the joint muscle pump, but only reaches its full effectiveness in combination with active movement. Consequently, this treatment should usually be carried out on an outpatient basis. Bed rest should also be avoided. Prolonged sitting, however, is even more unfavourable than lying. The following principles should be observed when applying the bandage:

▪ A good bandage should firmly enclose the leg all round,
▪ be applied with a pressure gradient decreasing continuously from proximal to distal
▪ and not press or pinch at any point.

Every bandage that meets these requirements is correct and beneficial regardless of the technique used. A guiding principle is that the bandage should adapt to the leg, and not the leg to the bandage. This is only achieved, however, if both edges of the bandage are always tensioned with equal force and the bandage is closely moulded onto the leg. To achieve this, the bandage must always unroll directly on the skin of the lower leg and should only be pulled tight in the direction of application. The gaps that are initially left open should be closed later.

Depending on the circumference of the leg, bandages with a width of 8 cm or 10 cm are most suitable. The bandage should be held in the hand such that the rolled-up part of the bandage is uppermost and faces outwards. Only in this way can it be unrolled on the leg. If, on the other hand, the roll of bandage is lifted off the skin, it cannot be guided properly, strangulating constrictions can form and the correct pressure gradient decreasing from proximal to distal will be jeopardised.

To apply the bandage, the ankle is placed at a right angle and the lower leg is flexed at about 90°. Application of the compression bandage begins at the metatarsophalangeal joints, taking care to include the heel. The skin of the toes becomes slightly cyanotic during this procedure. During walking, however, it becomes anaemic with every step only to fill with blood again when relieved. The pump action of the bandage can thus be observed directly at this site.

These rules must be followed if treatment is to be successful:
1) Compression treatment can only be effective if the correct pressure gradient is applied. The pressure is highest at the ankle and decreases continuously towards the knee.
2) The bandage must be held properly in the hand ...
3) ... because only in this way can it be unwound on the leg. If the roll of bandage is lifted from the skin, it cannot be guided properly, constrictions inevitably develop and the continuous pressure distribution is jeopardised. Too weak compression at the ankle and strong compression around the calf, however, congests even more than a stocking garter.
4) To apply the bandage, the ankle should be held at a right angle.
1) The heel is bandaged with the ankle joint in mid position at 90°. 
2) To increase the local pressure, recesses and hollows should be filled with firm padding elements.

The pressure exerted by a bandage is higher the greater its curvature. Bony prominences (ankles) or edges over the shin bone and the Achilles tendon should be padded at the sides to compensate the greater prominence at this site and reduce the local compression. Conversely, the local compression can be intensified if the curvature is increased by incorporating rigid padding. Hollow areas like Bisgaard’s region should not merely be loosely filled, but padded out with firm support elements so that the bandage can be applied over them with a slight prominence. The effect of the compression bandage should be increased over the ulcer itself by using pads which markedly overlap the ulcer margins.

To prevent the bandage chafing in the hollow of the knee, it should end about two finger breadths below the hollow of the knee. For this reason, the lower leg should also be flexed at a right angle when applying the bandage. It may be useful additionally to protect the hollow of the knee with soft, air-permeable padding material.

Bandages generally hold better if a second bandage is applied in the opposite direction and crossing over the first one, resembling the Pütter crossover bandaging technique.

A properly applied bandage gives the patient the feeling of having a firm support and is perceived as agreeable. Pain subsides. If pain worsens or if new pain develops which does not disappear on walking, the bandage must be removed immediately. Every bandaging technique can be taught and learned.

Each practitioner will gather their own experience and introduce modifications into their individual bandaging technique.
Short-stretch bandage

The bandaging technique illustrated here is a modified Pütter bandage consisting of two short-stretch bandages applied in the counter-rotating technique. This technique ensures high strength and better durability of the bandage.

The first turn of bandage begins at the metatarsophalangeal joints, moving from inside outwards (1). The foot is held at a right angle.

After 2-3 circular or "ear of corn" turns around the midfoot, the next turn encloses the heel and runs over the medial malleolus and back to the instep (2).

Two further turns are applied to additionally fix the edges of the first turn. The bandage first runs over the upper edge around the ankle (3) and then over the lower edge into the arch of the foot (4).

After a further circular turn over the midfoot, the bandage is taken over the ankle flexure back to the ankle (5), where following the contour of the leg it encloses the calf in steep turns (6).

The bandage runs from the hollow of the knee over the fibula head and back to the calf and then, following the contour of the leg, is again taken downwards (7) to close the gaps in the bandage.

The second bandage is applied in the opposite direction from outside to inside on the ankle (8) and its first turn runs over the heel back to the dorsum of foot.

Two further turns fix the upper (9) and then the lower edge of the heel turn.

The bandage is then taken once again over the midfoot and then, in the same manner as the first one, sharply upwards (1) and then back again. The finished bandage (11) is secured with adhesive tape.
Bandage made from Varolast zinc paste bandages

An opposing bandaging technique is not necessary for any of the zinc paste bandages because the fixation by the zinc paste mass provides the necessary strength and permanency of the bandage.

For bandages made from the two-way-elastic Varolast zinc paste bandage, in contrast to conventional zinc paste bandages continuous bandaging is possible. Cutting of bandages to shape is unnecessary. The two-dimensional stretch of the Varolast is only present during application.

The zinc paste bandage begins in the same manner as described on the previous pages from inside to outside (1).

After the corresponding turns around the midfoot, the bandage should be reinforced by repeating the turns around the heel (2) because a second bandage is not applied in the opposite direction.

The bandage is then taken around the lower leg as for the low-stretch bandages already described (3).

Finally, the Varolast zinc paste bandage is covered with a Stülpa tubular bandage for protection (4).

This technique begins with a circular fixation turn on the ankle running from inside to outside, then the bandage is taken across the inside of the heel to the hollow of the foot (1).

It encloses the midfoot (2), runs across the instep to the Achilles tendon (3) and over the lateral malleolus like the one to the sole of the foot (4). After lifting the arch of the foot, the bandage rolls, if a crosswise bandage is to be applied, in steep turns upwards. If a zinc paste bandage is applied using only one bandage, however, the additional heel and fixation turns described on page 74 are to be executed in the ankle region (5).

All further turns are executed as described on page 74 and 75 (6).
Bandages for compression therapy

Varolast
two-way elastic zinc paste bandages, ready to use: the two-dimensional deformability of the connective tissue also allows the bandage to be applied exactly without slitting and cutting at anatomically difficult transitional regions, which improves the continuous pressure gradient from proximal to distal; well tolerated by the skin and quick-drying.

Lastobind
permanently elastic, short-stretch bandages, elasticity about 50 %; very high, intense working pressure with low resting pressure; particularly suitable for permanent bandages – the working pressure also remains therapeutically effective during protracted use; aging resistant, washable up to 60°; skin-tone. Lastobind is also available as Lastobind-Duo in a double economy pack with 8 cm and 10 cm width bandages; especially suitable for the Sigg bandaging technique.

Pütter bandage
very strong, textile elastic short-stretch “Ideal” type bandages, elasticity about 90 %; high working pressure with low resting pressure; a sustained compression effect also when used for permanent bandages, boiling and sterilization proof; skin tone. The Pütter bandage is available in the form of two 10 cm width bandages for the classical reverse bandaging technique.

Lastocomp
Short-stretch foam rubber bandages laminated with “Ideal” type bandage fabric, elasticity about. 60 %, 3 mm thick; good massage effect on superficial venous blood flow; suitable as supplementary compression dressing on the thigh; breathable and well tolerated by the skin; particularly hard-wearing due to the lamination; hand washable; skin-tone.

HARTMANN “Ideal” type bandages
classical, textile elastic short-stretch bandages, loop-edged according to E DIN 61632-1B, elasticity 90 %; high working pressure with low resting pressure, can also be worn at rest; boiling and sterilization proof; the elasticity of the bandages, which decreases with wearing, can be restored by washing.

Idealhaft
cohesive, textile elastic short-stretch bandages, elasticity about 60 %; latex microdot coating on both sides for non-slip fit; very high working pressure with low resting pressure, can also be worn at rest; breathable; hand washable for multiple use, skin-tone.

Hypolastic
elastic, hypoallergenic short-stretch plaster bandages, elasticity about 60 %, very high working pressure with low resting pressure; non-slip and non-displaceable due to very good adhesive strength, the stability of the bandage is preserved even during prolonged wear, well tolerated by the skin due to hypoallergenic polyacrylate adhesive, can be applied without skin protection and removes painlessly; especially suitable for patients with pre-damaged skin; thermostable, sterilization-proof.

Stülpa
seamless knitted tubular bandage with high two-way-stretch; easy to apply without additional fixation; non-crease fit; used as a protective cover for zinc paste bandages, prevents soiling of underwear by the adhesive consistency of the zinc paste during the drying phase.
The Saphenamed ucv two part compression stocking system

Saphenamed ucv consist of two stockings for the lower leg with different compression tasks: The white, closed understocking (1) produces initially the compression pressure of approx. ca. 18 mmHg, in the UCV area, where the ankle area is situated, sensitive to incidence of ulcers. The foot will not be compressed, therefore there is no uncomfortable pressure on the toes. The understocking is worn day and night.

The flesh-coloured overstocking (2) is pulled on the understocking. By means of its special design in the ankle area, the overstocking produces additional compression pressure of 23 to 25 mmHg in the tied area, while good mobility is maintained. Moreover, the special knitting method ensures that the understocking and overstocking lock together after pulling them on. These catchments reduce elasticity of the particular components, whereby the working pressure increases up to 55 mmHg, thus a good support is provided for the calf musculature by movement. The overstocking is worn only during the day.

With regard to the pressure values, Saphenamed ucv is particularly suitable for treatment of the symptoms of chronic venous insufficiency of CEAP classes C4-C6, by varicosis with tropical skin changes, varicosis with healed ulcerations and varicose with florid ulcus.

The Saphenamed ucv is manufactured by using of patented „SeaCell pure“ textile fibres. These fibres contain seaweed, rich in substances like various minerals, carbohydrates, lipids, amino acids and vitamin E with positive effects to the skin. The „SeaCell pure“ fibres activate metabolism of the skin cells, remineralise the skin through contained sea salts and act as anti-inflammatory and are soothing to the skin. Moreover, the fibres with seaweed content are thermo regulating. The understocking can be washed in temperatures to 60 °C, the overstocking to 30 °C, the effects of seaweed remain preserved.

Practical use of the two part compression stocking system is versatile: One of the most important advantages is, that Saphenamed ucv provides for an effective compression and, at the same time, its application is easy. Risks of faulty bandage application like lace furrows or incorrect pressure dosing are eliminated.

Patients with venous leg sickness or, eventually with florid Ulcus cruris venosum are often elderly people, who need appropriate help for correct application of bandages. The Saphenamed ucv facilitates considerably the necessary compression therapy, often performed in own responsibility, particularly for this group of patients. The stocking system can be applied simply and effortlessly and is safely handled. Finally this promotes the patient compliance, which is very important for successful treatment.
When the venous ulcers are present, they are very often linked with skin problems on the lower leg: on one side by skin dryness caused by age and on the other side by blood circulation disorders and skin tissue nutrition disorders. The textile fibres „SeaCell pure“ in Saphenamed ucv act here anti-inflammatory and promote healing.

Lastly, the compression stocking system Saphenamed ucv, facilitates the tasks of outpatients and hospital health-care staff by treatment of patients with venous diseases. Additionally to the known advantages like compression safety and easy handling of the systems, there is also the aspect of time saving, which is important.

In a study on 10 patients could be shown the effectiveness of the compression therapy with Saphenamed ucv by treatment of chronic venous ulcers.
1) Lower leg with 14 month old Ulcus cruris venosum.
2) After application of the Saphenamed ucv understocking the resting pressure of 17 mmHg was achieved.
3) After application of the overstocking the pressures added to the resting value of 37 mmHg.
4) Ulcus after 2 month of compression therapy.

**Glossary and index of key terms**

A

- Acral → relating to the body and limbs (acra = extreme ends of the body, e.g. fingers, toe digits)
- Ankyloses → joint stiffness (bone adhesions) due to disease processes inside the joints, e.g. in chronic polyarthritis
- Arterial status, recording of
- Atrauman Ag (silver containing ointment dressing)
- Bandaging techniques
- Causal → originating
- Causes → 6 f
- Chronic venous insufficiency (CVI) → 11
- Chronic wound → 34
- Cleansing by moist wound treatment → 35
- Clinical presentation and diagnosis → 16 f
- Compensate → make up for (a weakness or dysfunction)
- Complaints → 18
- Compression bandage → application technique → 68
- Compression bandage → bandaging material → 73
- Compression bandage → 25
- Compression bandage, mode of action → 71

B

- Bandaging techniques → 82

C

- Causal → originating
- Causes → 6 f
- Chronic venous insufficiency (CVI) → 11
- Chronic wound → 34
- Cleansing by moist wound treatment → 35
- Clinical presentation and diagnosis → 16 f
- Compensate → make up for (a weakness or dysfunction)
- Complaints → 18
- Compression bandage → application technique → 68
- Compression bandage → bandaging material → 73
- Compression bandage → 25
- Compression bandage, mode of action → 71

D

- Decompression → the derangement/failure of the body’s natural compensatory mechanisms in response to functional disorders
- Differential diagnostic clarification → 20
- Dilatation → widening/distention of hollow organs or blood vessels by pathological processes, or instrumental for diagnostic-therapeutic purposes
- Disorders of wound healing → 28
- Distal → far from the body, further away from the middle of the body

E

- Edema formation → 18
- Edema-protective agents → 28

G

- General status, recording of → 20

H

- Hemodynamics → Science of the movement of blood flow in the vessels and the forces responsible
- Hydrocoll (absorbent hydrocolloid dressing) → 53
- Hydrosorb (transparent Hydrogel dressing) → 57
- Hydrosorb Gel → 61
- Hydrotul (hydroactive impregnated dressing) → 57
- Hypertension → high blood pressure

I

- Infection prophylaxis and control → 39
- Insufficiency → inadequate function or performance of an organ or organ system
- Invasive therapeutic procedures → 26

M

- Media sclerosis → calcium deposits in the middle layer (media) of the vessel wall of the
large arteries, e.g. frequently in diabetes mellitus
Medical history → systematic (patient) interview → 17
Medicinal therapy → 28
Moist wound management → 35
Multimorbidity → simultaneous presence of several diseases in one patient

O
Obliteration, obliterating → closure of the lumen of a body cavity, congenital, acquired through inflammatory processes or surgical, e.g. in vein ablation
Option → possibility to choose
Orthopaedic abnormalities → 19
Overt → evident, clear, med.: the manifestation of a disease by the corresponding symptoms

P
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Pathophysiology → composite term from pathology = science of disease-related changes in the body and physiology = science of the function of the body
Perforator ligation → 27
Peri → around something
Peri-ulcer area, state → 18
Peri-ulcer eczema → in the area around the ulcer → 41
Perivasular → in the area around blood and lymph vessels
PermaFoam → (hydroactive foam dressing) → 50
Polypragmasy → uncritical trying out or use of numerous medications and methods of treatment in the same patient
Postthrombotic syndrome → 14
Predisposition → special tendency/susceptibility, inherited or acquired, to develop certain diseases
Prognosis → reasoned forecast that under certain conditions certain events will occur, med.: prediction of the probable course and outcome of a disease
Proliferation → increase in tissue due to abnormal growth resulting from inflammatory processes, e.g. following the inflammatory phase of wound healing
Proximal → located closer to the centre of the body
Pütter bandage → 82

R
Relapsing → occurring repeatedly, med.: recurrence of a disease after it has healed
Relaxation → relief of tension, physiol.: relaxation of contractile tissue after active tensioning
Retention → holding back

S
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Short-stretch bandage → 77
Site of predilection → parts of the body preferentially affected by a certain disease process
Sorbalcon (calcium alginate dressings with packing ability) → 49
Stülp (seamless knitted tubular bandage) → 87
Subcutis → underskin, consisting of fatty tissue, next to leather skin (dermis)
Sufficient → adequate, enough (opposite: insufficient)
Surgical debridement of necrotic material → 38

T
TenderWet (wound pad with super absorber) → 44
Therapy → 24 ff
Therapy-refractory a disease no longer responds to the (usual) treatments
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U
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V
Valve agenesia → Agenisia = lacking formation or development of a part of the body, congenital, here: absence of venous valves
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