Differential diagnosis of leg ulcers

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Leg ulcers are one of the most common pathological conditions affecting lower limbs. They are easy to be diagnosed with the naked eye. Chronic leg ulcer, also known as chronic lower limb ulcer, is a chronic wound of the leg that shows no tendency to heal after 3months of appropriate treatment or is still not fully healed at 12 months. Approximately 1% of the worldwide population will suffer from leg ulceration at some point in their lives. Leg ulcers represent a significant burden for patients, their caregivers and families, clinicians, and the whole health care system. Leg ulcers can cause social isolation, family lives, and affect a person's ability to work because of pain, treatment requirements, and frequent health care appointments. To treat a patient with chronic wounds is a considerable burden for the whole society. A correct diagnosis is essential to focus on appropriate management and to avoid inappropriate treatment that may delay wound healing, cause deterioration of the wound, or harm the patient. According to studies, the most common type of leg ulcer is a venous ulcer, the others being neuropathic ulcers and arterial ulcers. These three kinds of ulcers account for almost 90 % of cases of lower-leg ulceration. Rest 10 % are due to other vascular diseases, vasculitis ulcers, malignant ulcers, traumatic ulcers, chronic lymphedema, and a few rare medical conditions. The proper diagnostic is a critical factor in successful management. Ankle brachial pressure index (ABPI) measurement and duplex ultrasound of arteries and veins are essential in diagnostic vascular workup. Measurement $TcPO_2$ (transcutaneous oxygen tension measurement) is helpful additive method in diagnostic and decision making regarding adequate management.

Key words: chronic ulcers, venous and arterial ulcers

Diferenciálna diagnostika vredu predkolenia

Vredy predkolenia patria medzi najčastejšie patologické stavy zasahujúce dolné končatiny. Dajú sa ľahko diagnostikovať voľným okom. Chronický vred predkolenia, označovaný aj ako chronický vred dolných končatín, je chronická rana, ktorá nemá tendenciu na hojenie po troch mesiacoch adekvátnej liečby alebo nie je úplne zahojená ani po 12 mesiacoch. Približne 1 % celosvetovej populácie bude mať vred predkolenia niekedy v priebehu svojho života. Vredy predkolenia predstavujú významné bremeno pre pacientov, ich ošetrovateľov a rodiny, lekárov, ako aj celý zdravotný systém. Vredy predkolenia môžu spôsobovať sociálnu izoláciu, ohrozovať rodinný život a ovplyvňovať pracovnú schopnosť pre bolesti, časté liečebné procedúry a návštevy u lekárov. Liečba pacientov s chronickými ranami predstavuje záťaž pre celú spoločnosť. Správna diagnostika je základom pre adekvátny manažment a vyvarovanie sa nesprávnej liečbe, ktorá môže oddialiť hojenie, spôsobiť zhoršenie rany a poškodenie pacienta. Najčastejším typom vredu predkolenia je venózny vred, po ňom nasleduje neuropatický a artériový vred. Tieto tri druhy vredov predkolenia predstavujú 90 % prípadov vredov lokalizovaných na dolných končatinách. Zostávajúcich 10 % vredov je spôsobených inými cievnymi chorobami ako vaskulitídami, malígnymi ulceráciami, traumatickými vredmi, chronickým lymfedémom a inými zriedkavými príčinami. Presná diagnostika je kritická z hľadiska úspešnej liečby. Meranie parciálneho tlaku kyslíka ($TcPO_2$), určenie členkovo-brachiálneho tlakového indexu (ABPI) a duplexná sonografia sú základnými diagnostickými metódami, ktoré umožňujú správny terapeutický postup.

Kľúčové slová: chronické ulcerácie, venózne a artériové vredy

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Introduction

Ulcers are one of the most common pathological conditions affecting lower limbs. They are easy to be diagnosed with the naked eye. Chronic leg ulcer (CLU), also known as chronic lower limb ulcer, is a chronic wound of the leg that shows no tendency to heal after 3months of appropriate treatment or is still not fully healed at 12 months (1). Approximately 1% of the worldwide population will suffer from leg ulceration at some point in their lives (2). The incidence of ulceration is rising as a result of the aging population and increased risk factors for atherosclerotic occlusion, such as smoking, obesity, and diabetes. Ulcers of the skin can result in complete loss of the epidermis and often portions of the dermis and even subcutaneous fat. Since numerous factors lead to lower leg ulceration, health professionals must adopt an interdisciplinary approach to the systematic assessment of the individual to ascertain the pathogenesis, a definitive diagnosis, and optimal treatment required. Wounds represent a significant burden for patients, their caregivers and families, clinicians, and the whole health care system. Unfortunately, the human and financial costs of chronic wounds are not fully appreciated. Leg ulcers can cause social isolation, family lives, and affect a person's ability to work because of pain, treatment requirements, and frequent health care appointments (3, 4).

A correct diagnosis is essential to focus on appropriate management and to avoid inappropriate treatment that may delay wound healing, cause deterioration of the wound, or harm the patient (5-7). According to most of the Western and European studies, the most common type of leg ulcer is a venous ulcer, the others being neuropathic ulcers and arterial ulcers (8, 9). These three kinds of ulcers account for almost 90 % of cases of lower-leg ulceration. Venous diseases cause approximately 70 % of the limb ulcers. Rest 30 % are due to vascular diseases, diabetic, malignant ulcers, traumatic ulcers,

Table 1. Different causes of chronic ulcers

Vascular
• venous • arterial • mixed
Neuropathic
• diabetic • tabes dorsalis • syringomyelia
Metabolic
• diabetes mellitus • goat • prolidase deficiency
Hematological
• sickle cell anemia • cryoglobulinemia
Trauma
• pressure • injury • burns
Tumors
• squamous cell carcinoma • basal cell carcinoma • melanoma • sarcoma
Infection
• bacterial • fungal • protozoal
Others

Table 2. CEAP classification of chronic venous disease (Source: Adapted from the 2011Clinical Guidelines of Society for Vascular Surgery and American Venous Forum)

Clinical Classification (C)		Etiologic Classification (E)	
C_0	No visible/palpable signs of venous disease	E_c	Congenital
		E_p	Primary
C_1	Telangiectasias or reticular veins	E_s	Secondary (postthrombotic)
C_2	Varicose veins	E_n	No venous etiology identified
C_3	Edema	**Anatomic Classification (A)**	
C_{4a}	Pigmentation and/or eczema	A_s	Superficial veins
		A_p	Perforator veins
C_{4b}	Lipodermatosclerosis and/or atrophy	A_d	Deep veins
C_5	Healed venous ulcer	A_n	No venous location identified
C_6	Open venous ulcer	**Pathophysiologic Classification (P)**	
		P_r	Reflux
	Subscript	P_o	Obstruction
A	Asymptomatic	$P_{r,o}$	Reflux and obstruction
S	Symptomatic	P_n	No venous pathophysiology identifiable

chronic lymphedema, and a few medical conditions (9). Proper diagnostic is the key factor in successful management.

Epidemiology and etiopathogenesis

The incidence of ulceration is rising as a result of the aging population and increased risk factors for atherosclerosis, such as smoking, obesity, and diabetes, along with negative lifestyle habits. The prevalence of leg ulceration rises dramatically with age. However, ulcers can occur in quite young people, and there are records of people suffering from venous ulcers for up to 60 years (10). Chronic leg ulcers affect 0.6–3% of those aged over 60 years, increasing to over 5% of those aged over 80 years. CLU is a common cause of morbidity, and its prevalence in the community ranges from 1.9% to 13.1% (7). One of the studies reflects that venous leg ulcers were overall more likely to occur in women than in men. However, the overall difference in incidence between men and women probably reflects higher longevity of women as compared with men. Thereby increasing the overall rate for women (10). Family history of venous ulceration, obesity, phlebitis, deep venous thrombosis, and leg injuries are a significant risk factor in various studies (11). Today, venous ulcers are the most common of all ulceration, followed by arterial and mixed variety. With the increase in the incidence of diabetes, more and more diabetic foot ulcers will be more prevalent.

Leg ulcers have always been a challenge for clinicians in terms of diagnosis and understanding of its pathophysiology. Ulcers related to venous insufficiency constitute 70%, arterial disease 10%, and ulcers of mixed etiology 15% of leg ulcer presentations (12). The remaining 5% of leg ulcers result from less common pathophysiological causes, and this latter group comprises considerable challenges in diagnosis, assessment, and management (13). Table 1 is showing the causes of CLU in detail.

It is useful to divide leg ulcers into those occurring in the gaiter area and those occurring in the forefoot because the aetiologies in these two sites are different. Venous ulcers most commonly occur above the medial or lateral malleoli. Arterial ulcers often affect the toes or shin or occur over pressure points. Neuropathic ulcers tend to occur on the sole or over pressure points (14, 15). Patients with reduced mobility or obesity may develop ulceration in the gaiter area because of venous hypertension resulting from inadequate functioning of the calf muscle pump. Chronic kidney disease (CKD), hypertension, and myocardial ischemia may also be associated with increased risk of developing foot ulcers, including severe ulcers that necessitate amputation. Additionally, there are reports of higher rates of malnutrition and deficiencies of vitamins and minerals such as zinc in patients with chronic venous leg ulcers compared to the general population.

Venous ulcers

The association between ulceration at the ankle and venous disorders of the lower limbs has been known for more than 2000 years. Venous circulation of the lower extremities progresses from the superficial to perforating to deep veins, with valves in each system to ensure unidirectional blood flow. As the calf muscles contract, the pumping action causes the blood to flow from the deep veins into the inferior vena cava. The disorder of these pathways results in permanently increased venous pressure. This continuing venous hypertension, with all its consequences, is defined as chronic venous insufficiency. The pathophysiology of Chronic Venous Disease (CVD) is complex and involves genetic susceptibility and environmental factors. In general, it is a result of two critical hemodynamical faults; reflux due to the valvular incompetence or obstruction due to the chronic thrombus or external compression. Clinical, etiologic, anatomic and pathophysiologic classification of CVD is in table 2.

Figure 1. a.) Limb with normal venous pump, effects of exercise on calf volume and venous pressure, b.) Same effect in a patient with the post-thrombotic syndrome and venous hypertension

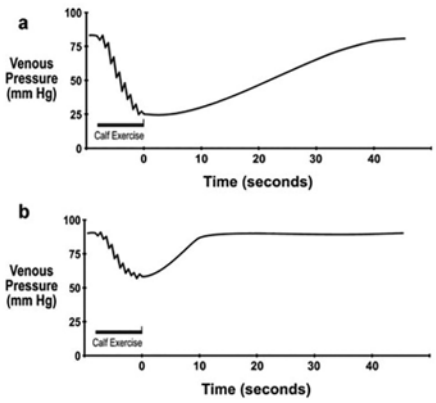


Figure 2. Venous ulcer

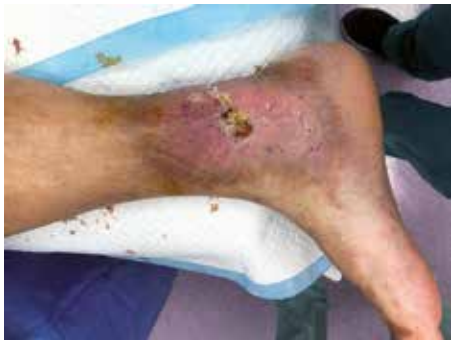
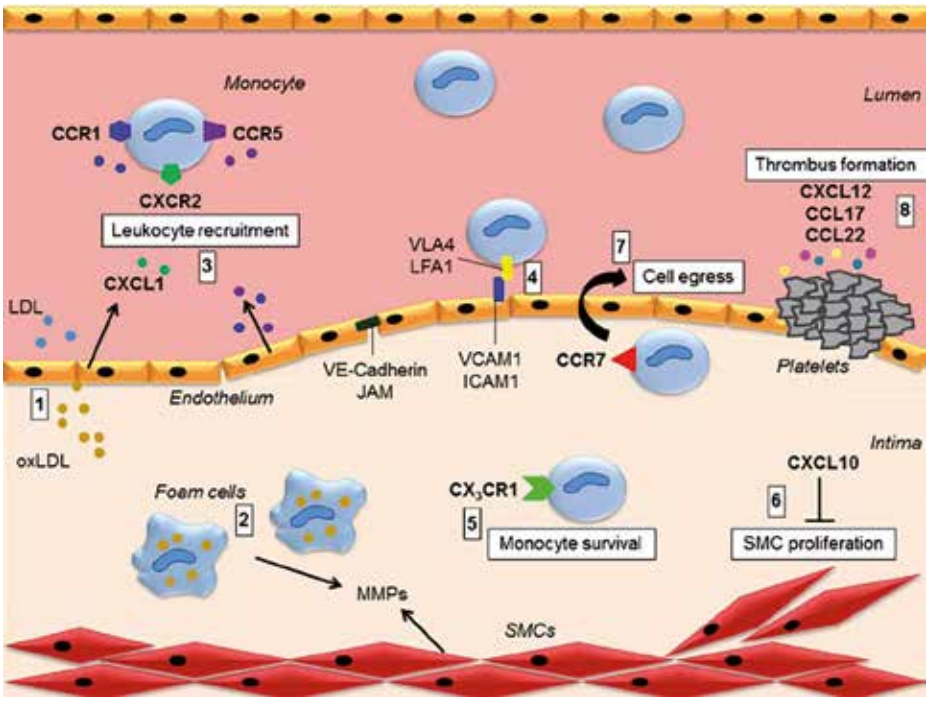


Figure 3. Pathophysiology of atherosclerosis (adapted from 19)



The various symptoms presenting in CVD and the observed clinical signs indicate that there is inflammation, secondary to venous hypertension (Fig. 1) and it leads to several inflammatory pathways that become activated. The endothelium and glycocalyx via specialized receptors are critical at sensing changes in shear stress, and the expression of adhesion molecules allows the activation of leukocytes leading to endothelial attachment, diapedesis, and transmigration into the venous wall/valves resulting in venous wall injury and inflammatory cells in the interstitial tissues. There is a complex of cytokines, chemokines, growth factors, proteases and proteinases, produced by activated leukocytes, that are expressed and unbalanced resulting in an environment of persistent inflammation with the clinical changes that are commonly seen, consisting of varicose veins to more advanced presentations of skin changes and venous ulceration (16).

Venous ulcers typically occur on the lower medial leg in the so-called gaiter area (Fig. 2). but they can be seen nearly anywhere on the lower leg or dorsum of the foot. They may be single or multiple, painful, and shallow with a red granulating floor. Usually, there is a zone of stasis dermatitis and brown-to-black hemosiderin deposits called lipodermatosclerosis. Edges may be clear-cut or irregular, and they extend onto the dorsum, up the leg, or become circumferential. If present, the ulcer will be found within this hyperpigmented area. Venous ulcers can be found on the lateral aspect of the dorsum as well, especially when there is severe saphenopopliteal reflux into the short saphenous venous system (17). Venous ulceration is a chronic disease characterized by periods of exacerbation and remission. Venous ulcers often take a long time to heal, which results in physical and psychological discomfort and negatively affects a patient's functional status (18).

Arterial ulcers

Arterial leg ulcers occur as a result of reduced arterial blood flow and subsequent tissue perfusion. In the vast majority of the patients, the arterial insufficiency is a result of the progressive narrowing of the arteries in the lower extremities as a result of the Peripheral Arterial Disease (PAD) due to atherosclerosis (19, 20). Pathophysiology of atherosclerosis is still not clear, but we consider it to be a chronic immunoinflammatory, fibroproliferative disease of large and medium-sized arteries fueled by lipids (Fig. 3). This involves physiological processes at the cellular and molecular levels, which are resulting in tissue loss and ulcerations (19).

There are three mechanisms involved in the pathophysiology of ischemic leg ulcers: (1) extramural strangulation (2) mural thickening or accretion, and (3) intramural restriction of blood flow. There is often considerable overlap, and the exact pathogenesis can not always be well defined. Most acute forms of vasculitis and some subacute and chronic forms are likely to cause leg ulceration due to tissue hypoxia and exudation of fibrin-like substance (21). Etiology of arterial ulcers is summarized in the table 3.

Arterial ulceration typically occurs over the toes (Fig. 4), heels, and bony prominences of the foot. The ulcer appears „punched-out" with well-demarcated edges and a pale, non-granulating, and necrotic base (21). They tend to be painful and they are usually dry and crusted and devoid of granulation tissue (22).

Some arterial leg ulcers may not be included in the category of chronic critical limb ischemia; however, they are unlikely to heal with conservative measures. Generally, they can be treated by conservative means using local therapy. Wound care must be supplemented by active wound debridement. Tissue blood

Table 3. Etiology of arterial ulcer

Arterial occlusion	atherosclerosis diabetes mellitus arterial thrombo-embolism thrombangiitis obliterans arteriovenous malformation trauma, fibromuscular dysplasia
Microcirculatory disorder	Raynaud syndrome scleroderma arterial hypertension increased blood viscosity blood transfusion reaction
Vasculitis	small, medium size and large vessel
Hematological disorders	sickle cell anemia thalassemia spherocytosis thrombocythemia…

supply must be improved by percutaneous transluminal angioplasty (PTA), or infrainguinal arterial bypass (23).

Mixed arterial and venous ulcers

The mixture of venous and arterial disease is likely to be the second most common etiological factor leading to leg ulcers (24). Combined arterial and venous insufficiency (CAVI) accounted for the second-largest group of patients with leg ulcers. In a study assessing 689 chronic leg ulcers, 14.5 % were of mixed origin as compared with those of an utterly venous origin 72 % (25). Elderly patients in this category may also have some degree of venous reflux giving rise to a „mixed" arteriovenous origin of the ulcers.

Clinically these patients can be difficult to diagnose due to the mixed symptoms and clinical signs with which they present. They may have some characteristics of arterial disease that may far overwhelm the venous picture such as a cold, dry dorsum of the foot, decreased pedal pulses, small ulcers on digits or dorsum of the foot, „hammer toes", with lipodermatosclerosis at the medial malleolar area leading an inexperienced clinician to think this may be a form of gangrene and ignore the venous component.

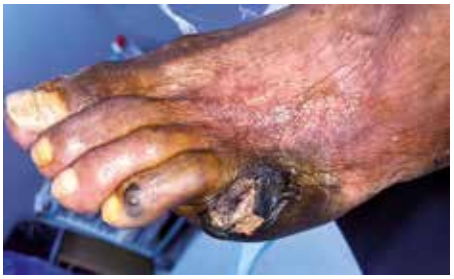
Alternately, a large medial malleolar ulcer typical of venous insufficiency may be accompanied by cutaneous gangrene of the covered toes or merely a dry withered foot with an absent dorsalis pedis pulse and loss of cutaneous hair on the lower leg but an excellent popliteal pulse. To the casual observer, this is a venous disease, and the fact that the patient has diabetes or an ex-smoker of a pack a day before admission may be lost to an inexperienced medical officer.

Ulcers may develop anywhere on the foot or calf in mixed disease, and patients need the eye of an experienced clinician to assess and manage the patient properly. Patients with a previous history of previous deep vein thrombosis (DVT) of the calf or thigh vessels complicate not only the diagnosis, but subsequent treatment since these mixed ulcers are unlikely to heal (26).

Diabetic/neuropathic/ neuroischemic ulcers

Diabetes mellitus patients may have a whole host of pathologies, some of which have the greatest effect on the foot. Ulceration of the foot is the commonest major endpoint in diabetic complications. Diabetic neuropathy and peripheral arterial disease are the main players in foot ulceration alone or with other factors such as mechanical issues (poor footwear, deformities with points of increased pressure), limited joint mobility, microvascular disease, and infections (Table 4). Neuropathic ulcers are usually at the site of repeated trauma as in the area at the metatarsal heads where a high pressure exists or dorsal surface of the „hammertoes" or the distal-most portion of these hammer toes where there is flexion at the interphalangeal joint (IPJ) of these „clawed" toes. The foot is warm, well-perfused, and pulse bounding. A foreign body may get lodged in the footwear, or a sharp object like a nail can penetrate the shoe or slipper. The presence of callus continues to impede ulcer healing since wounds heal from margins or edge, and epidermal cells from this area are prevented from so doing by the position of the callus. The pure ischemic ulcer is rare, and most are neuroischemic occurring at the medial aspect of the first metatarsal head, the heel, and the digits. There is no callus present, but there is a ring of hyperemia, with or without a necrotic center. Ulcer formation is preceded by mild trauma and the tight or poorly fitting usually „under"-sized shoe in women and the hard boot in the industrial areas.

Figure 4. Arterial ulcer



Diabetic neuropathy affects approximately 30–50 % of patients. Patients with diabetes then suffer from another source of ulceration, namely, those of a neuropathic origin which tends to be typically small, shallow, and painless and lies in relation to the digits and the plantar surface of the hallux at the metatarsal-phalangeal joint (MPJ) (Table 5). The ulcers in diabetics could be ischemic, neuropathic, or mixed neuroischemic. These account for the majority of ulcers seen in the practice of clinical vascular medicine at the emergency room, clinic, or long-stay „sepsis ward." However, they are not by any means the only etiology of ulcers encountered in practice of vascular medicine, and, indeed, there are more striking, chronic, and lethal forms of ulcers encountered on the legs and feet of patients (27, 28).

Assessment of the ulcer and leg vascularity

Clinical assessment

The first step toward the diagnosis of any leg ulcer is to compile a comprehensive history and assessment of the patient. This should include general health status, social and occupational

Table 4. Pathophysiology of pressure ulcers

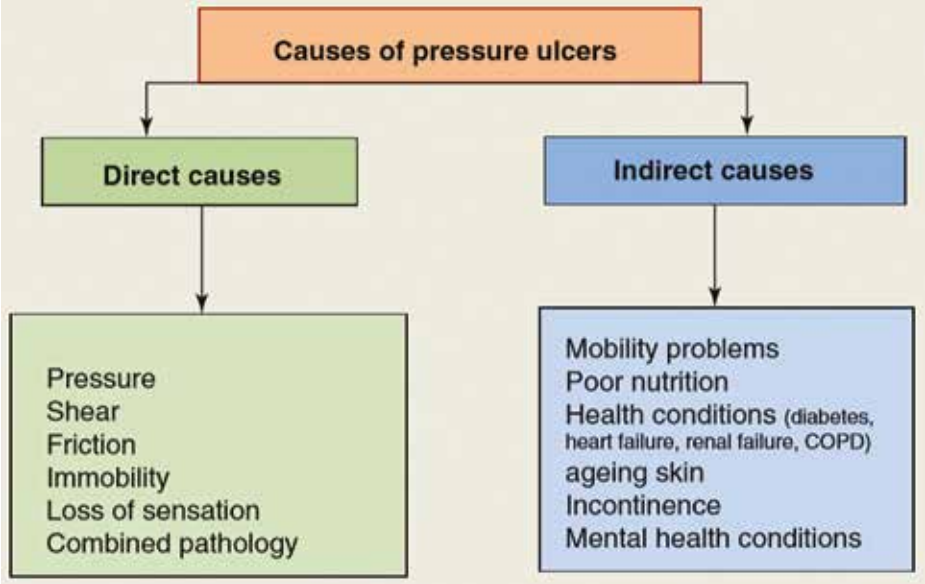


Table 5. Characteristics of neuropathic versus ischemic foot ulcers

Neuropathic ulcer Ischemic ulcer
painless painful
normal pulses absent pulses
regular margins, punched-out appearance irregular margins
often on plantar surface often on toes, glabrous margins
presence of calluses calluses absent
loss of sensation, reflexes, vibrations variable sensory findings
increased blood flow decreased blood flow
dilated veins cold foot
dry, warm foot pale bluish appearance
bony deformity no bony deformities

Table 6. PAD severity based on ABPI values

ABPI value	Severity of pad
0,91-1,20	normal
0,70-0,90	mild
0,40-0,69	moderate

situation, past and current medical history of relevant diseases (such as deep vein thrombosis, diabetes mellitus, autoimmune disorders, inflammatory bowel disease, and connective tissue disease), condition of the skin, current vascular status, limb size and shape, and history and status of the ulcer. The patient should give a history of lower extremity pain, paresthesia, anesthesia, and claudication. It is important to determine the duration of ulceration and whether it is a first episode or recurrent. Pain is a major problem for patients with leg ulcers unless there is a neuropathic component. Lack of pain, therefore, suggests a neuropathic etiology. Patients' mobility must also be addressed and documented (14, 15).

Examination

The examination of the leg should include palpation of pulses and a search for the signs of venous hypertension, including varicose veins, haemosiderin pigmentation, varicose eczema, atrophie blanche, and lipodermatosclerosis. The ulcer examination should include site, size, appearance, wound base, exudates level, and surrounding skin (14).

Investigations

1. Blood investigations such as complete blood count, erythrocyte sedimentation rate, blood sugar, lipid profile, renal function tests, and liver function tests are essential in patients with chronic leg ulcers.

2. Clotting test and laboratory screening tests for vasculitis

3. Investigations always center on a careful clinical examination, including bedside ankle-brachial pressure index (ABPI). Ankle pressures are crucial in the determination of the pathway management should follow and are required even concerning the venous component since it allows estimation for the degree of compression allowed in the patient. ABPI testing is very important for the diagnosis of an ischemic ulcer. Brachial and ankle blood pressure determination measured with the help of handheld Doppler measured after 10 min rest. The cuff is placed above the malleoli. The maximum cuff pressure at which the pulse can be heard with the probe is recorded and divided by the systolic blood pressure measured at the brachial artery. For the purposes of excluding peripheral artery disease, it is sufficient to perform only one ABPI measurement, i.e. by dividing the systolic pressure detected at a single posterior tibial artery by the systolic brachial pressure of one arm (see below). The diastolic pressure is not measured and is not required when measuring the ABPI.

The normal ABPI value is 0.9–1.1 (average 1). ABPI values below 0.9 suggest peripheral arterial occlusive disease (Table 6). If the vessels are calcified as in atherosclerosis and diabetes, ABPI can be inaccurate or invalid because the arteries may be hard to compress due to calcification. Pressure above 1.3 suggests calcified vessels and is an indication of the diseased vessel. If the ABPI is 1.3 or more, then a toe pressure is measured as it is most often spared from calcification. ABPI testing can be performed before and after exercise to uncover mild peripheral arterial atherosclerosis that presented with normal values at rest (29).

4. Color duplex ultrasound scanning (Fig. 5) which is becoming the *de facto* standard for evaluation of venous obstruction is also used to assess the location and extent of reflux in venous ulcers. Ultrasound is indicated also as first line imaging method to confirm peripheral artery lesions.

5.Venography (Fig. 6) may be considered as an investigational procedure in case of suspicion of venous obstruction. Lower extremities arteriography is indicated in patients with ischemic rest pain, intolerable claudication, impending gangrene, or the presence of non-healing ulcers of suspected arterial origin (14).

6. Plethysmography and venous pressure data are important in determining the need for surgical bypass or valve replacement. Quantitative data on venous obstruction, calf muscle pump

Figure 5. Venous ultrasound

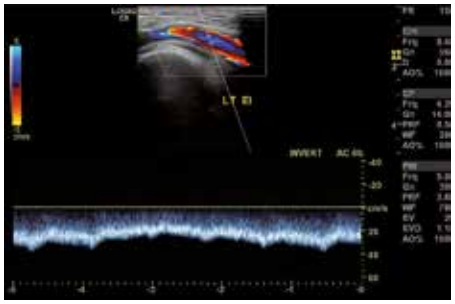


Figure 6. Venography imaging

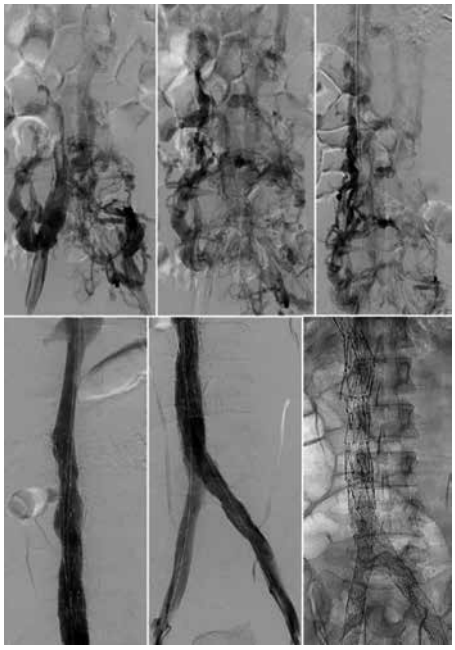


Figure 7. $TcPO_2$ measurement using 3 probes

ejection fraction and reflux are provided by air plethysmography, whereas venous pressures to diseases the physiological importance of anatomic obstruction because the collaterals may or may not provide adequate compensation for an obstructed pathway (30).

7. A quantitative bacterial culture is more specific and should be performed once a wound infection is suspected. This is performed by curetting or biopsying the bed of the ulcer. The quantitative biopsy is the current gold standard for assessing the quality and quantity of microbial pathogens within wound (31).

8. Ulcer biopsy is important in making a correct diagnosis and to rule out malignancy as these ulcers are prone to malignant transformation (32).

9. The clinical application of gene variant analysis and evaluation in patients with venous leg ulcers implies that the high-risk minority of patients could be identified in advance utilizing a simple blood test that would act as a genetic screening device (33).

Transcutaneous oxygen tension: a useful predictor of ulcer healing

Transcutaneous oxygen tension (pressure) measurement ($TcPO_2$) is non-invasive monitoring of the oxygen tension in the skin. The monitoring is performed by placing a Clark-type electrode on the skin so that it heats up the skin and provides $TcPO_2$ values.

$TcPO_2$ is a direct indication of the microvascular function. As opposed to pressure and volume assessments, $TcPO_2$ maps the actual oxygen supply available for the skin tissue cells. $TcPO_2$ also responds to macrocirculatory events, e.g., change in blood pressure and provocation maneuvers. In ESC Guidelines on th Diagnosis and Treatment of Peripheral Arterial Diseases published in 2017 defined objective criteria for the diagnosis of critical limb ischemia as ABPI < 0.3 , ankle pressure <50mmHg, or toe pressure < 30mmHg, or transcutaneous oxygen tension ($TcPO_2$) < 30mmHg (34). Factors influencing ulcer healing include local skin macro- and microcirculation and tissue oxygenation surrounding the ulcer.

Peripheral pulse examination and ankle-brachial pressure index (ABPI) measurement are commonly used in assessing limb macrocirculation. Furthermore, ankle pressure measurement is not easily achievable in patients with poorly compressible tibial arteries, such as those with diabetes mellitus or chronic renal failure and medial arterial calcification. In some cases, both tibial arteries may be occluded, making ankle pressure assessment impractical. While toe blood pressure measurement can be used with calcified tibial arteries, its use is limited in patients with gangrenous toes (35 - 39).

In contrast, it is much easier to measure the $TcPO_2$ at the dorsum of the foot in patients with critical limb ischemia (Fig. 7). This can assess both local arterial blood flow and skin oxygenation (40). At present, there is no consensus on the $TcPO_2$ value that should determine whether healing is likely to occur or whether revascularisation is indicated, with a range of 25–40mmHg being used (39, 41).

Found out that using peripheral pulses or ankle or toe pressure measurements alone to predict ischaemic ulcer healing has limitations. This has led to numerous efforts to find a complementary technique that would allow for more accurate predictions (41 – 45). Ruangsetakit and colleagues suggest that $TcPO_2$ values of 20–40mmHg are clinically useful in predicting healing outcomes in patients with critical limb ischemia (46).

ABPI measurement is a simple, non-invasive, and reproducible test for evaluating the severity of PAD (47, 48). However, its use is limited in patients with calcified or distally occluded tibial arteries. Furthermore, it may fail to unmask the underlying problem in high-grade aortoiliac stenosis, or where an occlusion has a rich collateral network. Therefore, ABPI is not sufficient when deciding ulcer healing. At present, a variety of $TcPO_2$ values are used to predict whether or not an ulcer will heal (36, 38, 40).

In TASC II, it is stated that a $TcPO_2$ of <30mmHg was a clear sign of a non-healing ischaemic ulcer. Kalani et al. (35) proposed that the probability of ulcer healing was low when $TcPO_2$ was < 25mmHg. In addition, they found that all patients with a $TcPO_2$ of > 38mmHg showed improved ulcer healing, and none with a $TcPO_2$ of < 13mmHg improved. Another study concluded that a $TcPO_2$ of <34 mmHg indicated the need for revascularization (38). Fife et al. (41) demonstrated that a $TcPO_2$ of < 40mmHg was associated with a reduced likelihood of amputation healing.

Most patients with critical limb ischemia will be at increased operative risk because of diabetes mellitus, coronary heart disease or chronic renal fai-

lure. Nevertheless, some are suitable for revascularization, and this has to be done with no delay (49). Surgical or endovascular revascularization is not obligatory in all patients, especially in patients with a $TcPO_2$ > 40mmHg. Conservative treatment in this group is not only cost-effective but also free of the risks of intra- or postoperative complications. However, patients with a $TcPO_2$ of < 20mmHg should receive either surgical or endovascular treatment, depending on patient status and severity of PAD (50–53).

They are also a significant limitation of TcPO2 measurement is that it takes significantly longer to do, compared with time needed for ABPI. Also, cellulitis or significant foot edema may confound the accuracy of $TcPO_2$ measurement.

Conclusion

The etiology of the lower limb ulcers can be heterogenous, as we explained above. For the successful management and healing of the skin defect is crucial to diagnose it properly since the treatment is different for each of etiology.

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