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CASE REPORT

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NPWT AVELLE™ A NOVEL SYSTEM FOR TREATING ULCERATIONS ASSOCIATED WITH CHARCOT FOOT SYNDROME – A CASE REPORT

NOWATORSKI SYSTEM NPWT AVELLE™ W LECZENIU OWRZODZEŃ STÓP CHARCOTA – OPIS PRZYPADKU

ABSTRACT: Diabetic neuroosteoarthropathy, also known as Charcot joint, is a rare and severe complication occurring in patients with diabetes. The evolution of this process results in bone and joint destruction and recurrent foot ulcers. It leads to total malfunction of the affected joint level. The aim of this case report is to emphasise, that successful wound therapy as well as therapy of osteomyelitic changes are essential before deciding on further reconstructive treatment.

KEY WORDS: neuroarthropathy Charcot, NPWT Avelle™ system, ulceration

STRESZCZENIE: Cukrzycowa neuroosteoartropatia, zwana potocznie stawem Charcota, jest rzadkim, lecz poważnym powikłaniem występującym w przebiegu cukrzycy. Rozwój choroby skutkuje destrukcją aparatu kostno-stawowego oraz powstawaniem nawracających owrzodzeń, prowadzących do całkowitej utraty funkcji zajętego piętra stawowego. Celem niniejszej pracy jest podkreślenie, iż przed podjęciem decyzji o dalszym leczeniu rekonstrukcyjnym niezbędna jest skuteczna terapia powstałych owrzodzeń oraz zmian osteolitycznych.

SŁOWA KLUCZOWE: neuroartropatia Charcota, owrzodzenie, system podciśnieniowy Avelle™

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INTRODUCTION

Charcot neuroarthropathy (CN), despite being the rarest form of diabetic foot syndrome (DFS), is associated with twice as many major amputations, compared to other forms of DFS [1]. The incidence is estimated at 0.1–29% and prevalence at 0.08–13%. However, those numbers may be underestimated due to the fact, that it is often very difficult to distinguish primary from secondary neuroarthropathy in a patient presenting with an advanced ulcer penetrating to the bone and causing its destruction.

Neuroartropathy, which is diagnosed too late, becomes the cause of loss of supportive functions of the foot and the occurrence of difficult-to-heal ulcers. Foot ulcers develop in almost 34–50% of patients with CN [2, 3]. Their consequences are often osteomyelitis, which may result in aggravation of destructive changes in the ligamentous apparatus. This may lead to life-threatening infections and, consequently, the need for emergency amputation of the lower limb.

We are looking for methods that accelerate the rate of ulcer healing in DFS. This is particularly important in the case of people with CN who are waiting for an orthopedic correction of the deformity. It is the deformity that constantly increases the risk of ulcer recurrence.

Depending on the surgical technique used in a given center, an external or internal fixation is used alternatively in patients with CN. Internal fixation is the preferred method in most centers and the condition for its implementation is ulcer healing.

This case report presents a complicated course of treatment of a patient with CN, eventually concluded with the preparation of a patient for orthopedic reconstruction using the NPWT Avelle™ system.

CASE REPORT

A 68-year-old woman with a 30 year history of type 2 diabetes mellitus (DM), complicated by both microangiopathy

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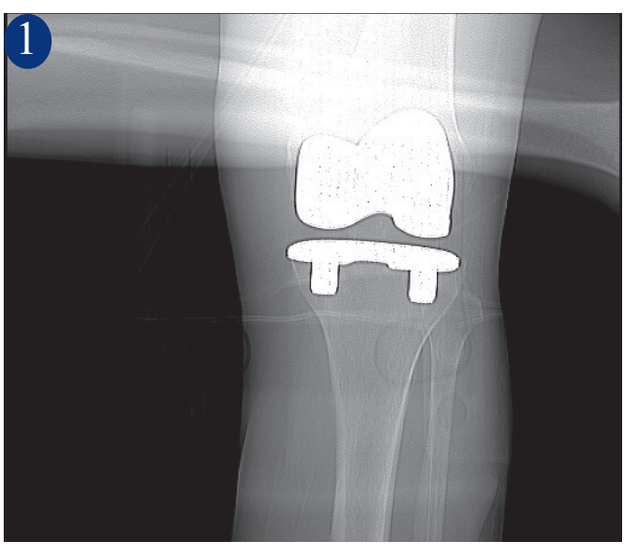
(diabetic retinopathy, neuropathy) and macroangiopathy (coronary disease, previous myocardial infarction, atherosclerosis of lower limbs), was admitted to the hospital due to a non-healing ulcer on the plantar surface of her left foot. The ulcer first appeared 5 month earlier. Additionally, the patient was also diagnosed with CN in the same foot. Two months before admission, the patient underwent surgical drainage of an abscess which developed in the same foot.

On admission the patient had clinical symptoms of infection. The patient presented with hyperthermia (38 Celsius degrees), oedema of the left lower extremity from the knee down and ulceration located on the plantar surface of the midfoot penetrating to the bone. Those features were present despite double-agent antibiotic therapy (clindamycin + ciprofloxacin) two weeks before hospitalization. There was suspicion, that face numbness, which the patient reported, were due to an allergic reaction against one of those medications, however there were no systemic signs of anaphylaxis present. It must be strongly emphasized, that this patient was prone to allergies. Laboratory diagnostic tests showed the following: inflammatory markers were raised (CRP – 69.8, WBC – 15.8). Samples from the wound were taken for microbiological assessment and antibiotic therapy was changed to intravenously administered imipenem and metronidazole according to the antibiogram. Professional wound debridement was performed.

Diagnostic imaging of the affected tissues, including the bones, was necessary. However, due to metal elements present in the right foot, the patient was dismissed from MRI (Fig. 1–3).

Ultrasound revealed oedema and inflammatory infiltration of soft tissues, without presence of fluid.



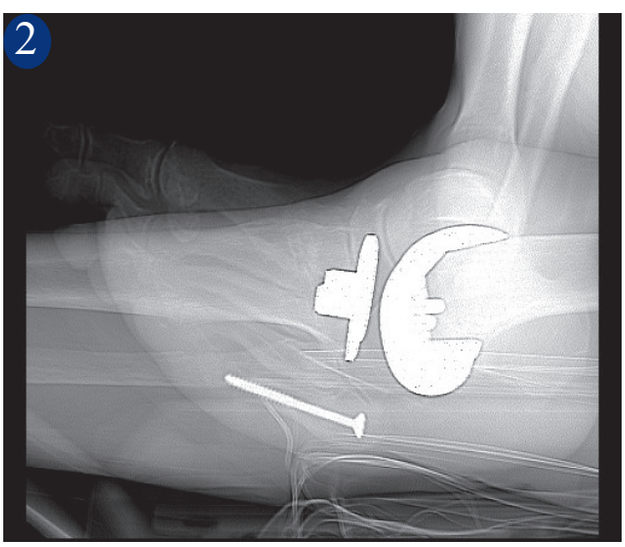


Fig. 1, 2. CT scan showing metal knee prosthesis.

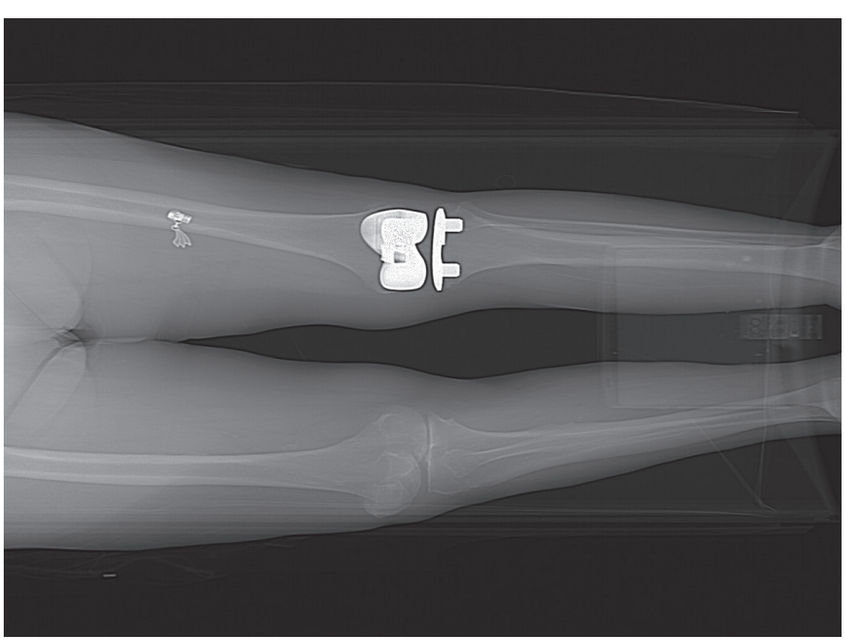


Fig. 3. CT scan showing metal knee prosthesis.

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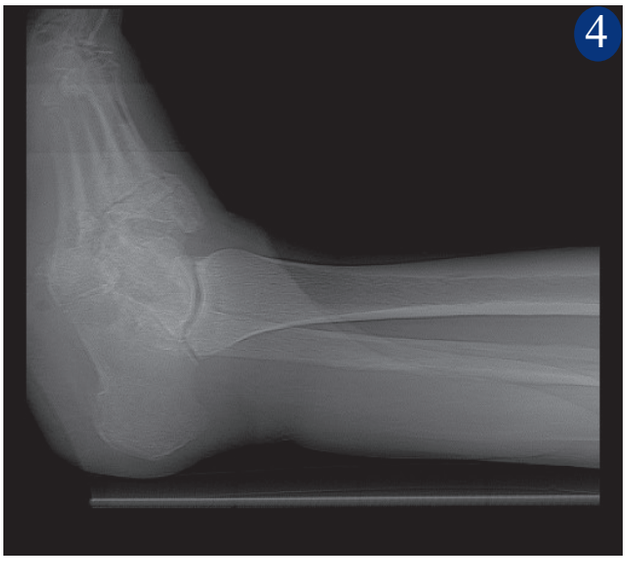

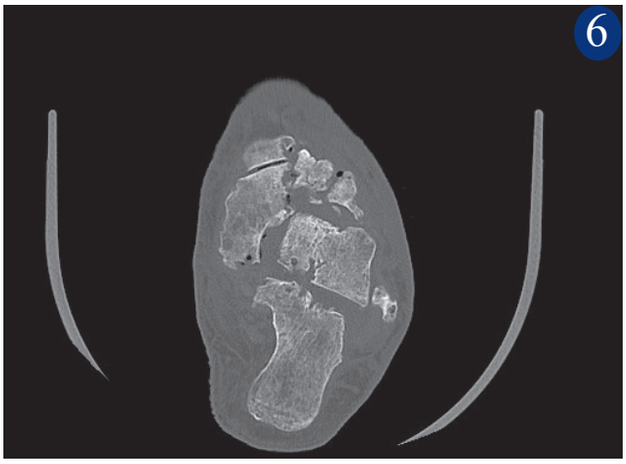

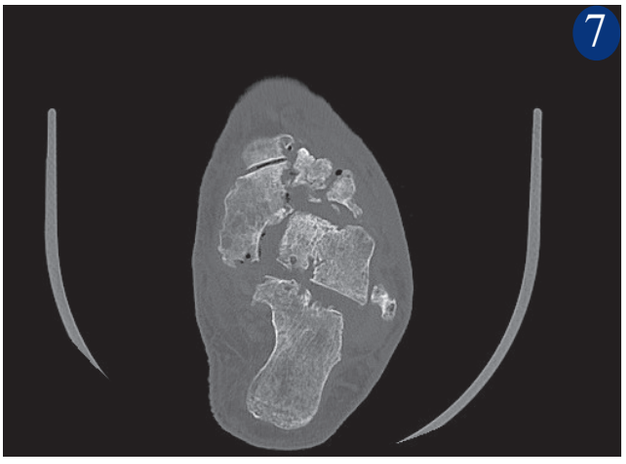

Fig. 4–7. CT scan, signs of inflammation.

X-ray of left foot unveiled features of fresh osteolysis in the lateral part of the head of the proximal phalanx of the second digit, gas in soft tissues of the second and third digit, as well as in the projection of the second and third metatarsal bones plus tarsus, in Chopart's joint progression of Charcot-type destruction compared to an X-ray from 2 months prior (Fig. 4).

CT scan showed an ulcer penetrating from the plantar surface of foot towards the cubic bone, signs of inflammation, oedema and gas bubbles around the ulcer; in the tarsal bones and affecting both the Lisfranc and Chopart joints, strongly aggravated features of bone destruction with numerous free bone pieces were present in Lisfranc and Chopart joints, a number of disseminated, differentiated osteolytic outbreaks in the tarsal bones (mainly in the head of the talus, but also in the calcaneus), likewise around base of all the metatarsals (Fig. 5–7).

The patient still had increased body temperature which was highest in the afternoon. After 2 days of hospitalization, the patient reported 5 loose stools. Due to suspicion of *Clostridium difficile* infection, oral metronidazole was administered. The patient's feces tested positive for both *C. difficile* surface antigen and toxins. Due to lack of clinical improvement, vancomycin therapy was proceeded and the patient responded positively. Diarrhea stopped on the following day and the patient finally reached normothermia.

On the 10th day of hospitalization microbiological examination of the samples from the wound revealed *Acinetobacter baumannii* sensitive to colistin. Antibiotic therapy was modified – colistin was introduced, vancomycin continued and imipenem discontinued. The consulting orthopedist did not find any indications for surgery and advised continuation of conservative treatment. It was necessary to find an alternative wound treatment method, that would accelerate the process of healing.

The decision to put a V.A.C. dressing was made after 12 days of hospitalization. NPWT is a non-invasive method of wound treatment which has been in use worldwide for the last 25 years. Its functionality is based on the use of continuous or intermittent sub-atmospheric pressure (negative pressure), which is achieved by using a suction pump to remove

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air from a superficially sealed wound. This leads to removing fluid from the extravascular space which results in stimulation of granulation and healing processes. There is a significant number of evidence-based reports confirming clinical benefits of this method. Firstly, NPWT reduces postoperative wound complications, such as surgical site infection, reduction in incidence of dehiscence, as well as reduces scarring [4]. It causes molecular changes in the wound (stimulation of cell proliferation leads to tissue granulation and faster wound healing), through dilation of arterioles which increases blood flow to the wound bed, reduces the oedema of the wound and promotes immune responses [5].

Due to suspicion, that the patient may develop an allergic reaction to materials used in wound dressings, a decision has been taken to use the new Avelle™ V.A.C. system. Its dressings consist of 5 layers. The most external layer is a waterproof film, which provides barrier bacteria and viruses, but also permits evaporation. Right underneath it there is a special foam, which allows negative pressure to distribute evenly across the dressing. In the middle there is a Hydrofiber® core gel, which special channel construction absorbs exudate from the wound and locks it away. The first layer put directly on wound is another type of Hydrofiber® gel, which is meant to maintain dressing integrity on removal. The last, fifth layer, is made of silicone. Being put around the wound, it settles the dressing in place, but does not cause any allergic reaction (Fig. 8).

Dressing changes were conducted every 3 days. After the first cycle of NPWT prominent decrease of wound size was observed (surface and depth), which enabled covering the surface of the bone.

After 11 days of colistin therapy, laboratory tests revealed deterioration of kidney function manifesting itself in increased creatinine levels (1.63 mg/dl, GFR – 32 ml/min). The patient was treated with intravenous fluid therapy. Apart from reducing colistin doses, previous treatment was continued. Control laboratory tests ran, on the following two days showed further deterioration of kidney function (creatinine – 1.87 mg/dl, GFR – 27 ml/min, then – 18 ml/min). Fluid therapy was continued and intensified (1500–2000 ml 0,9% NaCl per day). Due to acute kidney failure both colistin and vancomycin were discontinued. Because of the lack of possibility of continuation of targeted antibiotic therapy and positive effects of NPWT therapy, the latter was continued.

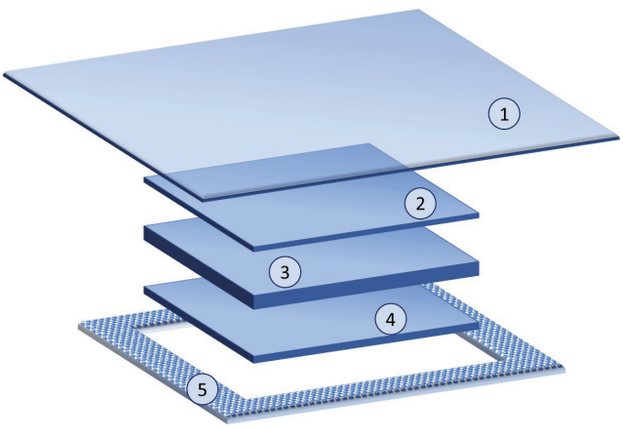

Fig. 8. Scheme of Avelle™ dressing. 1. Waterproof film layer. 2. Foam. 3. Hydrofiber® core gel. 4. Hydrofiber® contacting gel. 5. Silicone pad.

Fig. 9, 10. Bone penetrating ulceration on the day of admission.

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Fig. 11. Ulceration, condition at the beginning of ambulatory treatment.

Fig. 12. Ulceration, condition at the end of ambulatory treatment.

Thanks to gradual improvement in kidney function, the patient was dismissed from the Clinic and referred to continue NPWT in ambulatory conditions.

After almost complete closure of the ulcer, the patient was referred to the orthopedic clinic in order to determine further reconstructive treatment (Fig. 9–12).

DISCUSSION

The priority in taking care of a patient with DF is to heal the first ulcer appearing in life. Each subsequent episode carries the risk of longer ulcer healing than the first one [6]. As much as 85% of amputations are preceded by the presence of the ulcer [7]. It has been shown that most of them could be prevented by identifying and removing direct causative factors. Risk factors leading to infection of the foot tissues are: bone penetrating wound, duration of ulcer over 30 days, recurrence of ulceration, wound resulting from an accident and the presence of peripheral vascular disease [8].

It was shown that the chance of healing of ulcers during the 20-week treatment negatively correlates with the size of the wound, the degree of its severity and the time of appearance of the ulcer before treatment [9].

Studies show that 2.7% of patients with CN are at risk of amputation and a 12-fold increase in the risk of ulceration [10]. Foot ulcer may be present in 34–50% of patients with NC, which further increases the risk of amputation in this group of patients [2, 3].

Apart from the benefits for the patient and the healing team, it is worth noting that the financial outlays allocated for the treatment of ulcers and/or amputations cause reimbursement of costs and even bring savings in healthcare [11].

Clinical experience and basic science studies show that negative pressure wound therapy is a promising, yet still under-used, treatment method for patients with DFS.

NPWT finds its application in DFS. Diabetes significantly impairs the process of wound healing. It lasts much longer, creating a risk of complications such as osteoarthritis, sepsis, the necessity of resection of the necrotic tissues, as well as amputation of the limbs or death of the patient [12, 13]. This method, using physical phenomena, including negative pressure in the wound bed, promotes the reversibility of the pathophysiological mechanisms underlying the formation of

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ulcers. The essence of the treatment of negative pressure is to maintain the balance in the wound moisture and stimulate the growth of granulation tissue, which is achieved by reducing excess of exudate and reducing the pressure exerted on microcirculation vessels, improving their perfusion [14]. In addition, microorganisms that are a direct infectious agent are removed using NPWT.

Pursuant to the guidelines of the NPWT-EP expert group published in 2011, the aim of using NPWT in DFS should be to completely heal the wound or prepare the wound for further treatment stages leading to wound closure, e.g. skin graft implantation [15]. Few existing studies describe the use of NPWT for patients with ulcers in the course of CN, qualified for surgical reconstruction surgery.

In patients with CN, NPWT systems with instillation (V.A.C. instill) may be used during active osteomyelitis. During the termination of active bone infection, acceleration of wound healing may involve the use of traditional negative pressure wound therapy devices. In Polish conditions, NPWT therapy is rarely used in patients undergoing reconstructive surgery. As a rule, it is proposed to first treat bone inflammation with simultaneous treatment of ulceration, followed by orthopedic reconstructive treatment consisting mostly of the so-called internal fixation. In non-Polish centers, external fixation is more often used (the so-called Ilizarowa apparatus), which does not have to be connected with the need to heal the wound. In the presented case, the decision about a possible further reconstructive treatment of neuroartropathy depends on the healing of the ulcer and thus the resolution of the features of osteoarthritis and bone marrow. Clinical practice, however, indicates the possibility of healing ulceration in a patient with good blood supply to the arterial bed, while fragments of bones covered by osteolysis may remain beneath the layer of healed skin. Persistent anemia with low iron concentration is clinically manifested. In this case, a surgical removal of the osteolytic focus is recommended. A 6-week period of targeted antibiotic therapy is allowed, provided that the material for microbiological assessment is a bone fragment covered by inflammated tissue. After this period, the above-mentioned therapy or a decision about reconstructive treatment should be considered. If peripheral blood count parameters improve, which is an indirect indicator of the proper healing of osteoarthritis, the prognosis regarding the possibility of reconstructive surgery is positive. We are looking for specific methods that could in a non-invasive manner confirm or exclude features of osteoarthritis. NMR is one of the most sensitive and increasingly available methods of assessing the state of the bone-joint structure. However, it gives false positive results, which may cause the wrong therapeutic decision, including the possibility of amputation.

The gold standard used to confirm or rule out bone inflammation is a percutaneous bone biopsy (probe-to-bone test – PTB-TEST). Unfortunately, this method is rarely used in European centers, while in the United States it is the method of choice used in this indication [16].

NPWT by closing the access of infectious agents to the bottom of the wound reduces the risk of persistence of osteomyelitis traits. Any reduction in wound size in the DFS reduces the risk of amputation. NPWT meets this task perfectly. In our study, it was shown that larger wounds heal much more effectively using negative pressure wound therapy compared to traditional methods than wounds of initially smaller size [17]. The wound healing time in DFS often exceeds many months. It has been observed that the use of NPWT reduces the incidence of wounds, which heal over the year by 34–35% compared to traditional methods [18].

This also confirms the cost-effectiveness of NPWT in healing DFS [19–21].

CONCLUSIONS

Treating foot ulcers may be a challenging process, but there is a variety of treatment methods that may be highly useful, implemented independently or combined. NPWT is one of the means of effective wound healing, allowing to perform reconstructive treatment, which altogether reduces the risk of amputation. Ulcerations in Charcot neuroarthropathy need special attendance due to the highest risk of amputation and mortality among patients with DF. Due to this fact, NPWT should be considered in each patient with DFS.

CONFLICT OF INTEREST: All Authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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