



Was Amputating the Foot the Best Therapeutic Option? Double Focal Compression Bandaging Technique

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Received: October 25, 2023

Published: December 22, 2023

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Abstract

This clinical case describes a complication in the removal of osteosynthesis material, implanted for a bimalleolar fracture of the right ankle. The importance of the case lies, in the therapeutic options indicated by the trauma and infectious diseases services, while hospitalised: Amputating his foot was the safest and best option, and although he initially accepted it, he later refused to go along with it, taking the risk himself. He decided to continue with the pharmacological treatment, as well as other therapeutic measures.

Months later, the patient started another treatment at our clinic. He was treated with a compression bandage and focused pressure on the wound bed. A technique that applies pressure to the wound, using only bandages and gauze. The result was incredibly good. He came in a wheelchair to have his ankle treated, and after compression therapy, he started using crutches, then walking sticks and later he was able to walk on his own. The patient was under our care for 2.5 years, then under the care of his general practitioner and other hospital specialists (traumatologist and internal medicine). During this time, he only came to our office for radiological monitoring, when we ordered it.

I have used this case to explain, based on pathophysiology, the clinical improvement in patients with congestive heart failure (NYHA I, II and III), when we applied compression bandages to them. I think physiological secretion of natriuretic peptides is the key.

Keywords: Natriuretic C Peptide; Wound Non-Healing; Focalized Compression

Introduction

The displacement of blood volume into the cardiac chambers, due to compression of the legs, causes an increase in cardiac preload. This causes an increase in pressure in the walls of the heart chambers. As a physiological compensatory mechanism, these walls secrete natriuretic peptides. Natriuretic peptides (NPTs) are peptide hormones with multiple functions, such as the regulation of blood pressure, water, mineral balance, and many metabolic processes [1,2]. Atrial natriuretic peptide (ANP) and B-type natriuretic peptide (BNP) are secreted by the atria and ventricles of the heart. ANP acts in an endocrine and paracrine manner, to reduce blood pressure and cardiac hypertrophy. BNP acts locally, to reduce ventricular fibrosis. C-type natriuretic peptide (CNP) primarily stimulates the growth of long bones but may also have unrecognized functions [3]. Studies in mice show that local production of CNP within the growth plate determines physiological endochondral bone growth [4]. On the other hand, patients with heart failure had increased levels of certain forms of ANP (proANP/ γ -ANP,

β -ANP) or BNP (uncleaved proBNP, mature BNP and N-terminal proBNP) compared with healthy controls [5]. In my opinion, it was the physiological secretion of natriuretic C-peptide, stimulated by the compression bandage on the right leg, that allowed the patient to walk without a cane.

Method

We use a simple compression bandaging technique to heal vascular leg ulcers (VLUs). I have called this technique "double focal compression bandaging", because we use two bandages. The first is an adhesive bandage used to fix the pad to the wound bed. This bandage concentrates compression on the wound bed. The second covers the first. It provides gradual external compression from the toes to 2 cm below the knee. Each turn of the tape covers 50-70% of the previous turn, in this way, the ulcer area receives pressure from 3 layers (pressure from the padding on the wound bed and the double effect of the external graduated compression bandage) [6] (Figure 1).



Figure 1: Double focal compression bandaging technique.

Why did we decide to use the technique on this patient?

This technique is based on pathophysiological principles such as arteriogenesis and angiogenesis, the formation of blood vessels. The pressure exerted by bandages on the wound bed stimulates arteriogenesis and angiogenesis. Angiogenesis is defined as the growth and proliferation of blood vessels from an existing vascular structure [7]. The remodelling of pre-existing collateral vessels is called arteriogenesis. In their normal state, these collateral vessels are narrow, high-resistance vessels. They provide little blood flow to their distal tissue bed. However, when a major vessel is blocked, blood flow is diverted through the collateral vessels, causing changes in the shear stress of the vessel wall. This haemodynamic stimulus causes an increase in the diameter and wall thickness of the collateral vessels. This is accompanied by proliferation of vascular cells and turnover of the vascular matrix [7-9]. Based on this knowledge, this hypothesis could explain how the use of the “double focal compression bandaging” for the healing of venous and arterial ulcers is achieved [10].

The patient had been diagnosed with a right ankle ulcer with bone exposure. I thought he could benefit from this technique. However, he would need to be in the clinic every day, for the first few weeks, for clinical monitoring of the wound.

Case Report

A 57-year-old man with the following underlying diseases: dyslipidaemia and enolism. I describe the chronological sequence of what happened to the patient.

On 02/29/2016, he had an open fracture of his right ankle, which resulted in a dislocation. A few days later, he had surgery for the implantation of osteosynthesis material. There were post-operative complications. These included necrosis of the skin on the medial malleolus and the external incision, which exposed the osteosynthesis material. Vacuum-assisted closure (VAC) was performed. Surgical debridement and removal of the osteosynthesis material with excision of the medial malleolus was performed. This choice was decided, because of the poor clinical evolution of the wound, with signs of infection. The patient had positive cell

cultures for months: Staphylococcus simulans, Staphylococcus aureus methicillin resistant (SAMR), Enterobacter and the last cell culture. During this time, he was treated with different antibiotics, but there was no positive response.

On 09/20/2016, the patient was admitted to the trauma/infection service, in another higher-level care hospital. He had a large ulcer on the medial aspect of the right ankle. There was purulent exudation and necrosis down to the bone. Complementary tests, cell cultures and X-rays, revealed: Pseudo septic arthrosis/Osteoarthritis of the ankle caused by enterobacteria (ESBL).

On 09/26/2016, according to a report from the trauma and infection services, as the infection could not be controlled with antibiotics, if the patient agreed, infracondylar amputation at the level of the tibia was considered. Four days later, the patient was informed. Amputation was the safest choice.

On 10/04/2016, after parenteral antibiotic treatment with high dose ertapenem, there was a significant improvement in pain, so he decided not to amputate, taking the risk of this decision. The doctors told him about the risk he was taking. He continued to take the antibiotics for another 4 weeks.

On 11/05/2016, the patient was discharged from the hospital. Ulcer treatment in a hyperbaric oxygen chamber, was part of treatment. The patient had 58 sessions by March 2017. There was no positive outcome.

On 09-04-2017, the patient arrived at the nurse’s office in a wheelchair, for wound care with antibiotic therapy. As the patient did not show any signs/symptoms of infection, he was referred for medical consultation. I asked for a wound culture and a chest x-ray. I told him about the chances of success with a “double focal compression bandaging”. He accepted the treatment. The culture was positive for Pseudomonas aeruginosa (Figure 2), and the thorax x-ray showed no alterations (Figure 8). This is how the wound was before the start of treatment.



Figure 2: Before application of "double focal compression bandaging". Positive cell culture for the presence of *Pseudomonas aeruginosa*.

The patient had no signs/symptoms of infection, so we stopped the antibiotics. We just put a double compression bandage on the leg with padding on the wound. In the first few months, we ordered cell cultures from the wound. These were positive for bacteria, but the patient had no signs or symptoms of infection (Figure 3).

Contamination does not mean infection. Focused pressure on the wound bed prevents infection [11]. Cell cultures were requested in the following months and showed bacterial contamination but no infection (Figure 4).



Figure 3: Positive cultures without clinical signs/symptoms of infection, on different dates. Around the ulcer there is increased vascularization.

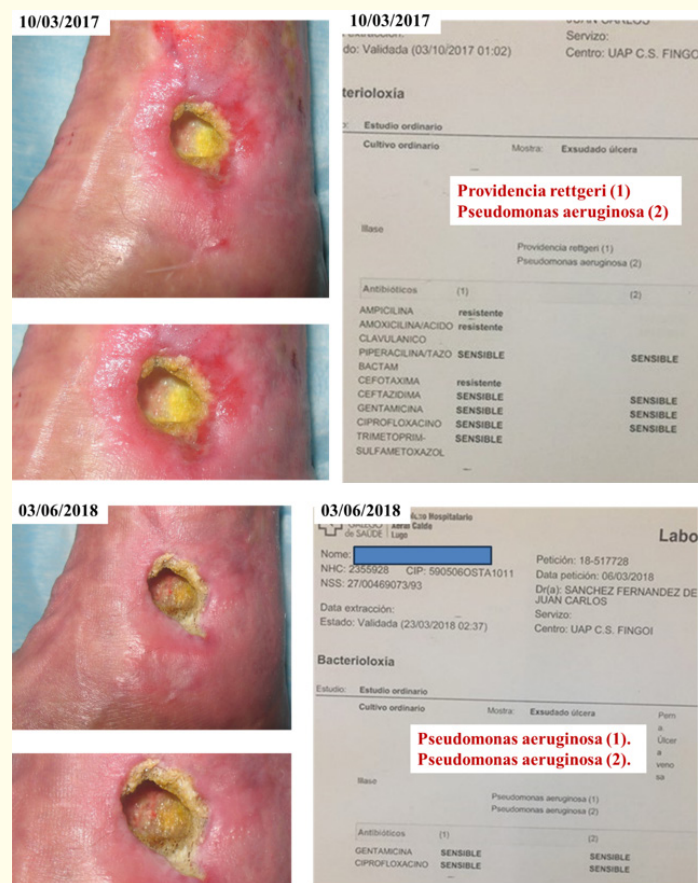


Figure 4: Bacterial contamination. No signs or symptoms of infection.

We educated the patient to recognize signs/symptoms of infection, such as fever and/or redness of the skin, in which case, he should come and see us as soon as possible. However, this was not necessary as it did not occur. We show the clinical progression of

the wound, from the time we treated the patient (04/09/2017), to the time the patient is under the care of their GP and other professionals. Significant bone growth can be seen, around the perimeter of the ulcer (Figure 5).

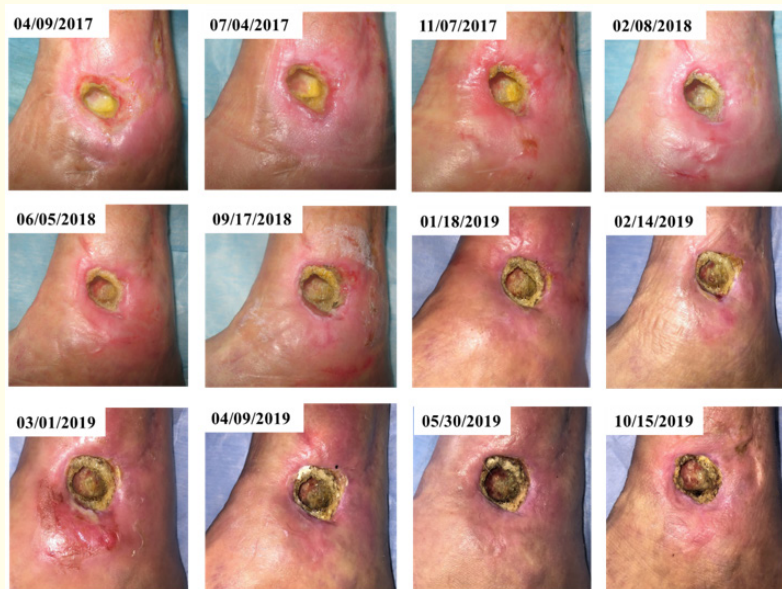


Figure 5: There is evidence of perilesional bone growth, although the ulcer has not closed.

Radiological findings

I asked for an x-ray of the ankle to check the condition of the wound, on the patient’s first visit to the clinic. A fracture is seen at the distal end of the fibula, with bone detachment at the distal

tibial end. We can also see the cavity formed by the ulcer. A follow-up ankle X-ray was then performed until June 2022. The X-rays shows bone growth. This has allowed him to walk on his own again (Figure 6).



Figure 6: Fracture of the distal end of the fibula. Detached fragment of the tibia. There is evidence of bone growth.

C-type natriuretic peptide (CNP) is a potent stimulator of long bone and vertebral development via endochondral ossification [12]. On the other hand, CNP stimulates osteoblastic proliferation [13]. In my opinion, compression in the legs triggers the physiological secretion of natriuretic peptides A, B and C. It is for this reason that, I have used this clinical case, to explain the clinic improvement in patients with congestive heart failure, when we apply double focal compression bandaging [14].

Discussion and Conclusion

Amputation of the foot was the safest therapeutic option, due to complications with the osteosynthesis material implanted in the right tibia. Given the difficulty of eradicating the bacteria, both the trauma and infectious disease services were in agreement. The patient initially accepted the proposal. A few days later, however,

he withdrew it, taking the risk of this decision. Further therapeutic measures were undertaken.

Before we took over his care, the patient was treated with antibiotics and had 58 sessions in a hyperbaric oxygen chamber. He was taken by ambulance, from his home to the referring hospital, about 150 km away, to receive the hyperbaric chamber sessions. He came to our office, in a wheelchair, to have the ulcer dressed with antibiotics, until the next session in the hyperbaric oxygen chamber. All of this comes at a considerable financial cost, without taking into account the amputation that had been indicated by doctors.

Given the clinical situation and the previous poor outcome, I thought that double focal compression bandaging might benefit the patient. So we applied it. It should also be noted that, no antibiotics

or antimicrobials were used, as there were no signs/symptoms of infection (cellulitis and/or fever), in the 2.5 years we treated him. Focalized pressure on the wound bed prevents infection [12].

In view of the good results with compression bandaging and the ineffectiveness of hyperbaric oxygen chamber sessions, these were discontinued. He was in our care for 31 months, then in the care of his GP and other specialists. The patient progressed from walking with crutches to walking unassisted, however, wound closure was not achieved.

Anecdotally, in order to apply for a job as a forest fire brigade leader in June 2021, the patient requested a medical report from his GP. We can conclude that, the patient had a very good level of mobility, to be able to apply for this job. Unfortunately, the patient died in August 2023, for reasons unknown to me.

This clinical case has been a reference for me, to explain the clinical improvement observed in patients with congestive heart failure (NYHA I, II, III) [15]. The patient had no signs or symptoms of heart failure, as confirmed by a chest X-ray (Figure 7). I attributed the growth of bone in the tibia to the secretion of natriuretic peptide C, induced by the pressure of the bandage on the leg. Compression bandaging of the legs causes an increase in cardiac preload. Is the secretion of natriuretic peptide the physiological response?

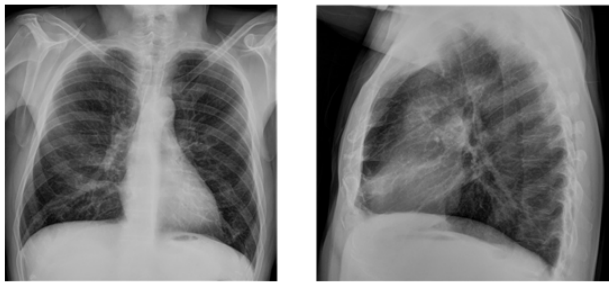


Figure 7: Chest X-ray.

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