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Original Articles

Single stage treatment of diabetic calcaneal osteomyelitis with an absorbable gentamicin-loaded calcium sulphate/hydroxyapatite biocomposite: The Silo technique

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ABSTRACT

Background: Chronic osteomyelitis necessities appropriate infected bone and soft tissue excision. The authors describe the Silo surgical technique for the treatment of calcaneal osteomyelitis using a new antibiotic-loaded absorbable calcium sulphate/hydroxyapatite biocomposite.

Methods: The Silo method involves debridement of the dead bone and local delivery of antibiotic in drilled tunnels using the biocomposite. It is combined with multiple sampling and culture-specific systemic antibiotic treatment guided by a multidisciplinary team.

Twelve consecutive diabetic patients with heel ulcers and calcaneal osteomyelitis were treated with the above method. All had comorbidities (Cierny–Mader (C–M) Class B hosts). The mean age was 68 years (range 50–85). A retrospective review of radiographs and electronic medical records was conducted.

Results: Patients were followed up until clinical cure of the ulcer for a mean of 16 weeks (range 12–18). Infection was eradicated in all 12 patients with a single stage procedure following a bone preserving technique. One patient required a subsequent flap operation and six vacuum-assisted closure (V.A.C.). There was also one case of prolonged wound leakage and no calcaneal fractures.

Conclusions: The Silo technique is an effective method of local delivery of antibiotics and can be effectively implemented into the single-stage treatment of calcaneal osteomyelitis offering increased bone preservation and local delivery of antibiotic, decreasing the need for a major amputation.

Level of evidence: Level IV- case series.

1. Introduction

Calcaneal osteomyelitis is a serious complication in a diabetic foot leading often to amputation [1]. Once it is established it is rarely eradicated without any surgical intervention. The principle is that the infected bone must be resected and the surrounding soft tissue extensively debrided. Insufficient bone resection will lead to recurrence of the osteomyelitis but on the other side there is a need to preserve as much bone as possible in order not to jeopardize stability of the residual foot. Furthermore soft tissue coverage is a crucial determinant of success. In the case of calcaneal tuberosity osteomyelitis, it is functionally desirable to retain as much of the bone as possible but the exact adequate level of resection to eradicate the infection is arbitrary intra-operatively and depends on surgeon's experience.

Local delivery of antibiotics in the treatment of osteomyelitis has been applied extensively during the last decades and is considered both safe and effective [2]. Calcium sulphate (CAS) materials loaded with antibiotics are used for bone defects after excision of infected bone but bone formation is not reliable and pathological fractures have been reported in up to 5% of patients [3–5].

Recently, the combination of CAS and hydroxyapatite (HA) in a synthetic and injectable mixture has been introduced as "the new era bone substitute" [6]. The above combination has also been loaded with antibiotics (175 mg gentamycin in 10 ml CAS/HA: Cerament G; Bonesupport, Lund, Sweden). It has been shown that the Cerament G biocomposite is highly effective for dead space management in cases with chronic osteomyelitis [7].

The authors present the Silo technique for single surgical treatment

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of chronic calcaneal osteomyelitis using Cerament G. The proposed method offers the advantage of limited bone resection and local delivery of antibiotic into the deep bone to eradicate microscopic foci of infection.

2. Operative technique

A single-stage protocol treatment of chronic osteomyelitis is applied [8]. A thigh tourniquet is used when possible with the patient under general anesthesia and prone or (if anesthetic concerns) in a lateral recumbent position with a vacuum beanbag on a radiolucent table [9]. A longitudinal posterior incision continues onto the inferior surface of the heel and then to the ulcer or can split the Achilles tendon. The Achilles tendon if needed is sharply reflected off the bone and the ulcer in the soft tissue debrided and excised in an elliptic shape to facilitate closure. Multiple operative samples are taken, using an established method [10].

All patients had MRI scan of their foot pre-operatively. Based on the MRI findings, the extension of the heel wound, the presence of sepsis and the general health condition of the patient decision is taken weather operative treatment with the Silo technique is adequate. Intra-operatively bone resection includes all the infected and non-viable bone. A few millimeters of bone covering the hypointense (on T1-weighted images) and hyperintense (in T2-weighted images) nidus of osteomyelitis is aimed (Fig. 1a and b). If possible, the posterior subtalar joint is preserved. In order to deliver locally antibiotic and treat microscopic foci of infection multiple Silo type tunnels (four to five) are drilled into the os calcis using a 3.2 mm drill bit. Drilling is done under X-ray guidance towards the posterior subtalar joint at least 0.5 cm short of full length (Fig. 2). Then, the area is irrigated with hydrogen peroxide and dried. The dry Silo tunnels are filled with 5 ml of Cerament G using the provided extender tips (Fig. 3). The wound is either closed primarily (Fig. 4) or left open for wound care and dressings and the vacuum-assisted closure (V.A.C.) can also be applied. After healing of the wound, a custom-made ankle foot orthosis (AFO) can be applied.

With regards to the suitability of a patient with chronic calcaneal osteomyelitis for the Silo technique, involvement of the posterior subtalar joint (PSJ) is an absolute contraindication. The drilled tunnels reach 1 cm short of the PSJ and an arbitrary minimal length of 2 cm is chosen in order to contain the biocomposite so infection infected bone at a distance of less than 2.5 cm from the PSJ is considered as a contraindication for the Silo technique. Based on the above all patients excluded deemed unsuitable for the debridement process were excluded pre-operatively

Antibiotic treatment as per protocol is stopped at least two weeks before surgery, provided it is safe for the patient [6]. Intra-operatively the patient is given intravenous gentamicin (2 mg/kg continued as one dose every 24 h initially) and teicoplanin (400 mg and continued as every 24 h initially) after taking samples and modified according to the microbiology results for a total of 6–12 weeks.

3. Patients and methods

The patients were informed on the nature of the procedure and gave their consent to proceed. Our ortho-plastic team has a wide experience on the local application of Cerament G for treatment of chronic bone infections with or without associated metalwork [11]. The effectiveness of the Cerament G biocomposite is also supported from the literature [7]. Based on the above and on the fact that our technique is practically an enhancement of the traditional partial calcanectomy with drilled tunnels filled with the biocomposite we offered the Silo treatment to the patients.

Twelve consecutive diabetic patients with ulcer associated with chronic calcaneal osteomyelitis were treated with the Silo technique. Their physiological status was determined as either Cierny–Mader (C–M) Class A (no comorbidities), Class B^{L} (local compromise in the affected limb), Class B^{S} (systemic compromise) and Class B^{LS} (local and systemic compromise) [12]. All had comorbidities and were classified as C–M Class B^{LS} hosts. A multidisciplinary team including orthopaedic and plastic surgeons, an infectious disease physician, podiatrists and physiotherapists were involved in the treatment. The definition of chronic osteomyelitis was made for symptomatology of at least six months with radiological, microbiology and clinical findings [13].

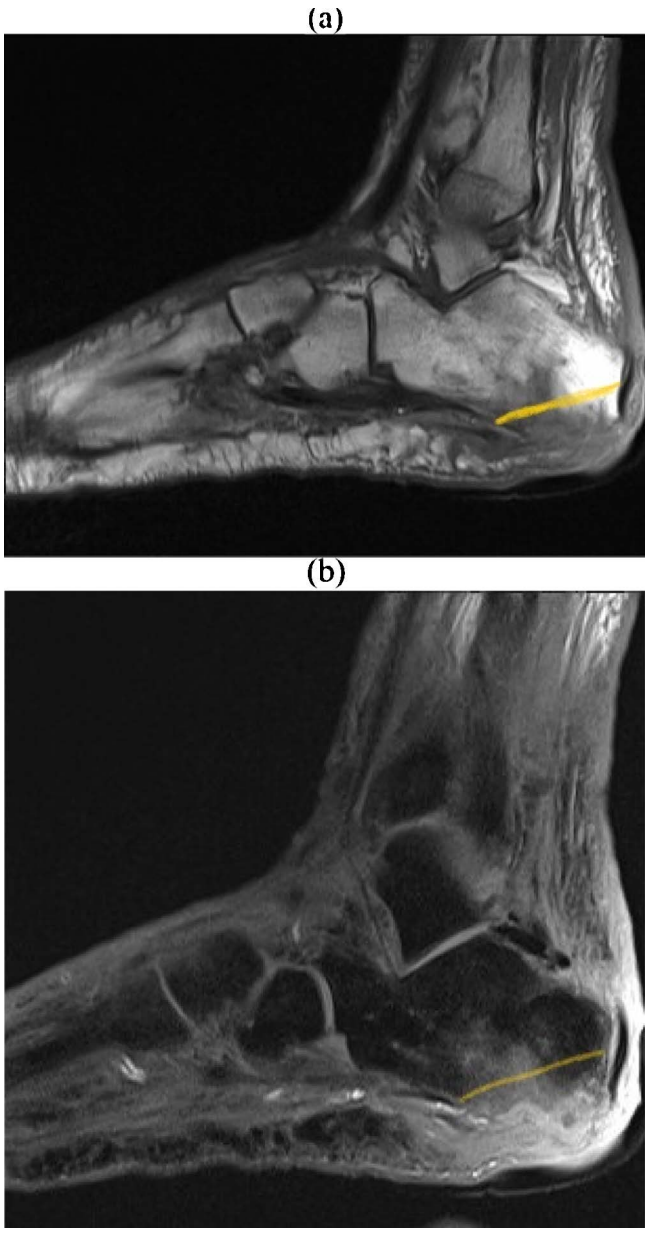

Fig. 1. Calcaneal osteomyelitis on sagittal T1-weighted (a) and T-weighted (b) magnetic resonance imaging sections with the planned resection level (yellow line). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

A retrospective review of radiographs and electronic medical records was conducted. The average age was 68 years (range 50–85) including 8 male and 4 female patients.

4. Results

Patients were followed up until wound healing was achieved for a mean of 16 weeks (range 12–18). The frequency of isolated pathogens was 33% (4 patients), 25% (3 patients), 17% (2 patients) for