












## The Foot

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Original Article

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

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## Highlights

- A new technique for treating calcaneal osteomyelitis.
- 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.
- Offers the advantage of local delivery of antibiotic for at least 30 days.
- The Silos, apart from storage of antibiotic acts also as a scaffold for bone formation decreasing the risk for a fracture.
- Infection was eradicated in all 12 patients with a single stage procedure following a bone preserving technique.
- The early results are promising.

## Abstract

### Background

Chronic osteomyelitis necessitates 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.

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## 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], [4], [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 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.

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## Section snippets

### 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 inâ€¦

### 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 tunnelsâ€¦

### 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 *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* respectively. *P. aeruginosa* with *S. aureus* was more common in polymicrobial infection (25% or 3 patients). In 3 patients (25%) the cultured microorganisms were resistant to gentamycin using the EUCAST breaking points [14].

After theâ€¦

### Discussion and conclusion

Osteomyelitis of the hindfoot is particularly difficult to treat considering that the skin is thin with little only subcutaneous tissue for coverage of the bone. Amputation is not infrequently the more viable choice [15]. In the case of osteomyelitis of the tubercle of the calcaneus a partial calcanectomy can treat the infection salvaging the foot. The aim is to remove all the infected bone and decrease the size of the ulcer. Most of these infections start as pressure ulcers of the heel fromâ€¦

### Ethics and declaration of conflicting interests

The research was performed in accordance with the 1964 Declaration of Helsinki ethical standards. The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.â€¦

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It is worth noting that changes of the infection causing microorganism occurred at a rate of 50.0% in the reinfected patients after stage one treatment. This might be attributable to superinfection during surgery or to a failure in microbiological identification [21], which may be responsible for the high infection persistence rate. New bone formation often occurs in parallel to bone resorption in chronic bone infection [22,23].

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Two studies completed the calcaneal resection with external fixation [24,30]. Local antibiotics were used in 2 studies [25,31]. Flaps were used in few cases.

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However, local antibiotic delivery yield very high local concentrations of antibiotics in targeted areas, especially in the presence of osteomyelitis: this approach maybe especially useful in poorly perfused tissues and ‘hard-to-reach’ locations. For example, the Silo technique, describes debridement delineated by MRI, drilling of bone tunnels and injection of antibiotic-loaded bio-ceramic, allowing infection control.<sup>34</sup> There is a current focus on biodegradable vehicles.

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