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Case Report Open Access

A Case Report on the Treatment of Methicillin-Resistant Staphylococcus Aureus (MRSA) Infected Tibial Internal Fixation with Calcium Sulfate

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Abstract

The formation of biofilm is one of the main contributing factors for unsuccessful treatment of osteomyelitis. It is formed through bacterial adhesion to the fragments of dead bone. Poor perfusion or devascularization of an infected bone with changes in local pH further limits the diffusion of parenteral antibiotics.

Calcium Sulfate , a biocompatible and completely absorbable local carrier for antibiotics, has shown promising results in treating osteomyelitis. It is associated with less systemic effects and compliance issues when compared with conventional treatment of surgical debridement and prolonged systemic antibiotics.

Keywords: Calcium Sulfate; Ilizarov frame; Osteomyelitis; *Staphylococcus aureus*

Introduction

Despite gradual advances in surgical techniques and antimicrobial agents, the treatment of osteomyelitis remains a challenge. Its management is often difficult as it requires extensive surgical debridement and prolonged antibiotic therapy [1,2]. However, the relapse rate remains high; the primary contributing factor is the formation of a bacterial biofilm. Systemic antibiotics have poor penetration and often require three to four fold increase in concentration to achieve bactericidal activities [3]. Long-term systemic antibacterial therapy can become problematic due to compliance, drug toxicity and dead-space formation.

To counter these problems, systems that release antibiotics locally have been created. Stimulan (Biocomposities Ltd, Keele, UK) is a biodegradable synthetic calcium sulfate, which is completely absorbed and replaced by new bone. Biodegradable and absorbable carriers offer the advantage of avoiding the need for a second removal operation. Synthetic calcium sulfate with 100% purity was first introduced in 2000. This avoids potential toxicity associated with natural mineral sources of calcium sulfate [4].

Case Presentation

A 71-year-old man was referred to us with persistent osteomyelitis of his distal tibia fracture following an internal fixation in August 2013 (Figures 1 and 2). He was treated with an above knee backslab and sent home by emergency department after being diagnosed with closed injury to his right distal tibia and fibula fracture. His medical history included hypertension and a previous history of deep vein thrombosis, which had been treated with Warfarin. When he presented to fracture clinic ten days later, he had developed pressure ulcers over his left heel and medial malleolus.

Orthopaedic surgeons at the referring hospital decided to treat with an external fixator to allow soft tissue healing before definitive surgery. After three weeks of external fixation, the wound over his right medial malleolus had healed. Open reduction and internal fixation of his right tibia fracture was performed in September 2013 (Figures 3 and 4).

Seven weeks later, skin over the medial malleolus broke down again and left the distal part of tibial plate exposed (Figure 5). His tibia fracture failed to heal secondary to osteomyelitis.

Figure 1: AP radiograph of distal tibia and fibula fracture.

Investigations

Microbacterial culture from superficial wound swab grew MRSA. Intra-operative bone and deep tissue samples showed MRSA, enterococcus and E. coli. All isolates were sensitive to the combination of teicoplanin and gentamicin. Computed Tomography (CT) angiogram confirmed patient lower limb circulation.

Treatment

At referring hospital, he received eight weeks of intravenous teicoplanin and gentamicin with standard MRSA eradication therapy. Throughout the duration of his intravenous antibiotics, he stayed

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Figure 2: Lateral radiograph of distal tibia and fibula fracture.

Figures 3: Postoperative Lateral radiograph of internal fixation.

Figures 4: Postoperative AP radiograph of internal fixation.

Figure 5: Medical photograph showing skin breakdown over the medial malleolus with exposure of internal fixation in January 2014.

isolated in a side room. However, this failed to resolve his osteomyelitis and pressure ulcer over the medial malleolus. He was given the option of an above knee amputation, and referred to a foot and ankle specialist at University Hospital South Manchester for a second opinion with plastic surgery input.

In May 2014, his tibia non-union secondary to osteomyelitis was stabilised with Ilizarov frame. Calcium sulfate beads containing

gentamicin were applied to the fracture site and the medial malleolus (Figures 6 and 7). Internal fixation was removed during operation. Vacuum therapy was applied over the medial malleolus. Patient had two days of intravenous teicoplanin post-operatively before discharging home.

In theatre environment, Stimulan powder mixes easily and quickly with gentamicin liquid so there is no soaking required. This reduces unnecessary use of precious theatre time during mixing. Calcium sulfate from Stimulan kit can be modified in three sizes of bead (3 mm, 4.8 mm or 6 mm) or as a paste for injection to provide flexibility depending on the size of the defect. In this case, we applied 4.8 mm calcium sulfate beads at both the fracture site and the medial malleolus.

Outcome and follow-up

At six weeks follow-up, most of the calcium sulfate beads were absorbed which was shown radiologically (Figures 8 and 9).

Three months postoperatively, CT scan of lower leg demonstrated callus formation and fracture union (Figures 10 and 11). Further magnetic resonance imaging showed no signs of osteomyelitis.

Tissue viability nurses followed his pressure ulcers. The wound over the medial malleolus healed three weeks after the operation (Figure 12). The heel pressure ulcer was treated with dressings impregnated with surgihoney .

Discussion

In an attempt to overcome the issues related to the treatment of osteomyelitis, systems of local antibiotic release have been developed. One of the most commonly used materials is polymethylmethacrylate (PMMA) [5]. It is not biodegradable therefore a second operation is required for it to be removed once the antibiotic is released. If it is left in place, it will prevent bone ingrowth [6] and become a potential space for future infection [7].

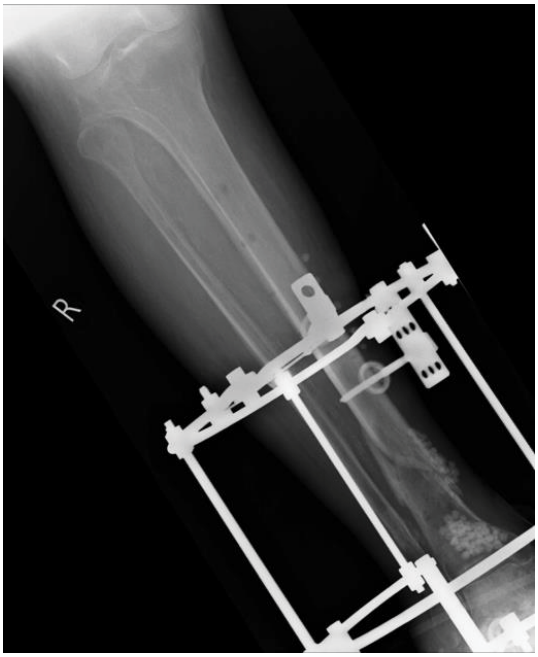


Figure 6: Immediate postoperative AP radiograph of Ilizarov frame in May 2014. Hyperdense areas in the tibia illustrated the areas where Stimulan was applied.

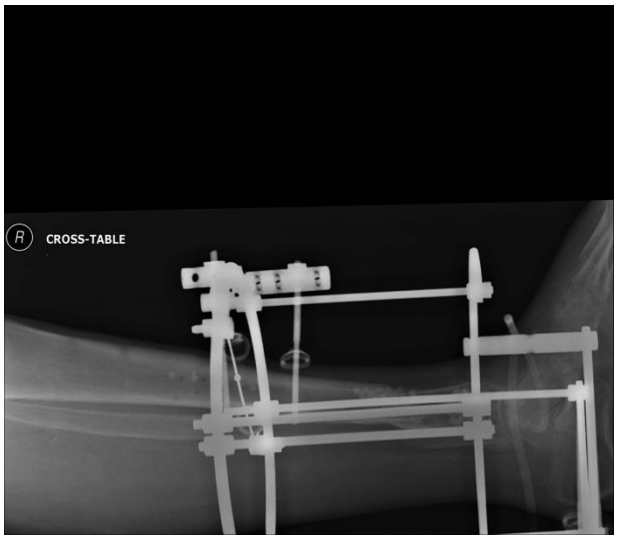
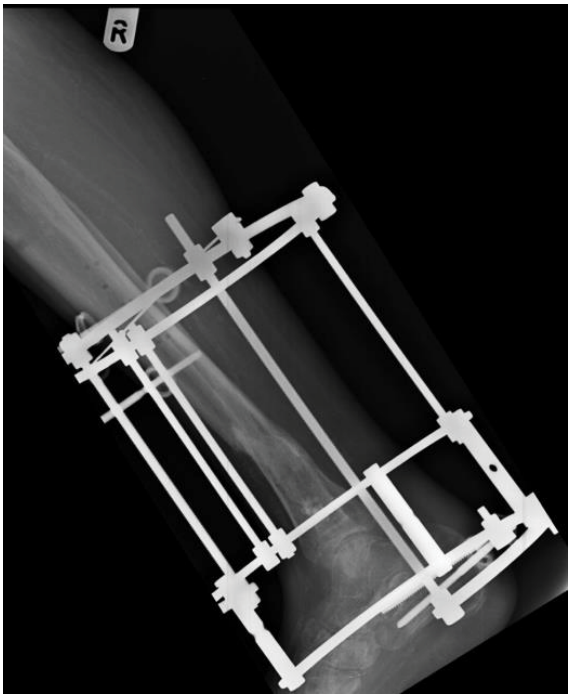


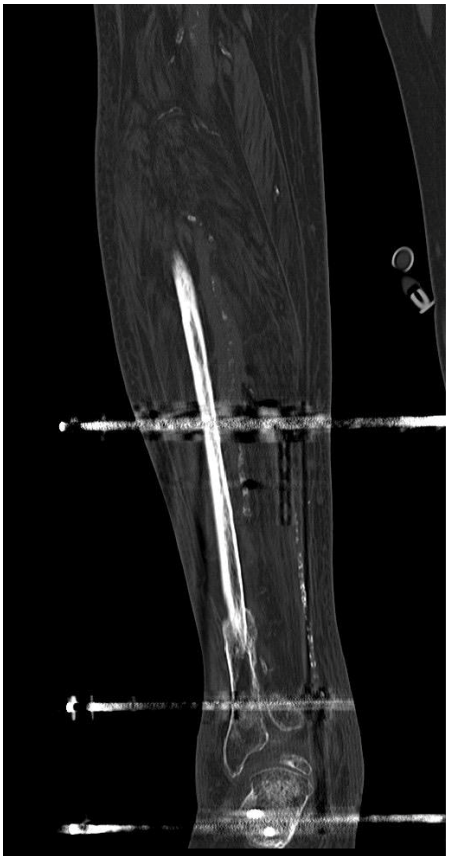
Figure 7: Immediate postoperative Lateral radiograph of Ilizarov frame in May 2014. Hyperdense areas in the tibia illustrated the areas where Stimulan was applied.

Figures 8: Six weeks postoperative AP radiograph.

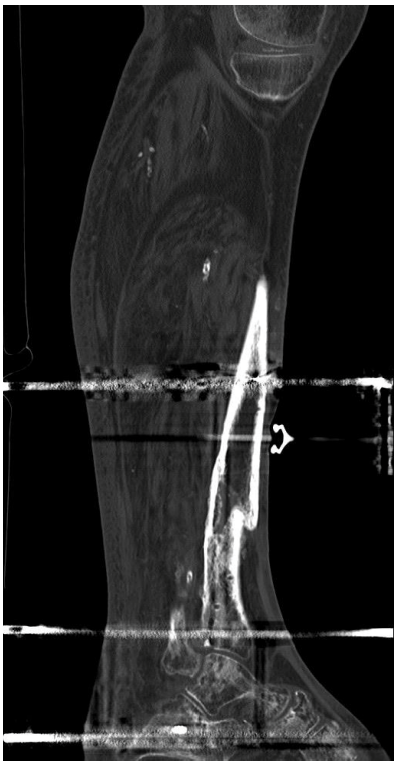
Over the last two decades, several biodegradable and absorbable carriers such as polylactic acid, hydroxyapatite, calcium phosphate and collagen materials have been developed [8]. The advantages of calcium sulfate include its biodegradability, predicable elution properties, osteconductivity, and ability to fill dead space [9]. Recent studies have shown that osteoblasts attach to and absorb calcium sulfate [10]. It provides an osteoconductive environment for vascular ingrowth. Calcium sulfate has the potential to release effective local antibiotic



Figures 9: Six weeks postoperative Lateral radiograph.



Figures 10: Coronal CT images showing union of the tibial fracture with Ilizarov frame still in situ in August 2014.



Figures 11: Sagittal CT images showing union of the tibial fracture with Ilizarov frame still in situ in August 2014.

Figure 12: Medical photograph showing skin healed over the medial malleolus.

concentrations for a period of at least forty-two days without affecting the chemical nature and antimicrobial efficacy [11]. Results *in vitro* have revealed that Stimulan admixed with 10% moxifloxacin was very

effective in achieving complete eradication of the causative pathogen in an experimental model of osteomyelitis caused by MRSA [12,13].

Calcium sulfate as a carrier is a new treatment option for osteomyelitis associated with internal fixation. In our experience it has less systemic effects, releases more effective antibiotic concentrations locally, reduces the length of parenteral antibiotic use and reduces the length of inpatient stay.

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