MENTORS IN ORTHOPEDICS

THE CHALLENGE OF TREATMENT CALCANEAL OSTEOMYELITIS: SURGICAL OPTIONS AND OUTCOME OF A CASE SERIES

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SUMMARY

Background: Calcaneal osteomyelitis accounts for 3% to 10% of all bone infections and frequently results from trauma, surgical complications, or diabetic foot ulcers. Due to the high mortality rates associated with transtibial and transfemoral amputations, limb salvage through calcaneal preservation is prioritized. However, the anatomical complexity of the hindfoot and limited local soft tissue availability present significant challenges for skeletal and tegumentary reconstruction.

Objective: This study evaluates the surgical techniques and clinical outcomes of a consecutive case series involving 25 patients treated for calcaneal osteomyelitis using a combined bone and soft tissue management approach.

Key Points: Between 2005 and 2018, 25 patients underwent surgical intervention for calcaneal osteomyelitis, primarily following fracture-related infections (56%). Management involved a lateral L-shaped incision to facilitate thorough debridement or partial calcanectomy while preserving the Achilles tendon insertion and weight-bearing surfaces. Microbiological analysis identified Staphylococcus aureus (31%) and Candida albicans (17%) as the most prevalent pathogens. Soft tissue defects were addressed through primary closure, local rotational flaps, or skin grafting. At one-year follow-up, infection eradication was achieved in 88% of patients. Postoperative complications occurred in 36%, including wound leakage and a 12% recurrence rate requiring reoperation. Functional outcomes were favorable, with 88% of patients achieving unaided ambulation and 88% reporting a pain-free status.

Conclusion: Chronic calcaneal osteomyelitis requires a multidisciplinary strategy to ensure infection eradication and functional preservation. Single-stage partial calcaneal resection combined with targeted soft tissue reconstruction serves as an effective alternative to major amputation, maintaining high rates of limb salvage and patient mobility.

KEYWORDS

Osteomyelitis; Calcaneus; Limb Salvage; Debridement; Reconstructive Surgical Procedures

INTRODUCTION

Osteomyelitis represents one of the main and most devastating complication in orthopedics. Calcaneal osteomyelitis (CO) accounts for 3–10% of all bone infections, [1],[2],[3],[20]. Schildhauer et al. (2000) quantified the calcaneal rate of infections with 11% [3],[4]. CO usually happens after trauma, post-surgery, complication of the diabetic foot and through hematogenous spread in children. Overall, Staphylococcus aureus remains the most common causative bacteria in all age groups [2],[22].

The treatment principal includes early definitive diagnosis by culture, imaging studies, blood parameters, tailored systemic antibiotic coverage, wound irrigation, wide surgical debridement, curettage, partial or total calcaneal resection with or without soft tissue coverage. When it turned into a chronic phase, treatment procedures become more difficult [2],[10],[11],[23].

The preservation of the calcaneus and a functional foot anatomy is the main target during CO treatment. This is not always possible and depending on the local situation [3]. Surgical treatment of CO currently offers only a handful of curative options including bone debridement, partial or total calcanectomy as well as below-knee amputation [20]. Following major lower extremity amputation US Centers for Disease Control data show a 1-year mortality rate of 30%, a 3-year rate of 50%, and a 5-year rate of 70%, [24],[25]. Avoidance of transtibial and transfemoral amputations is important in regard to minimizing morbidity and mortality [24],[26]. Case reports advocate the use of partial calcanectomy as a viable alternative to below knee amputation [24]. According to Lehmann et al. (2021), and Bollinger M., Thordarson D.B. (2002) partial calcanectomy represents an alternative to lower leg amputation in cases of strictly local infection [5],[6]. The authors mentioned that partial calcaneal resection may be performed if the inflammatory process involves less than 50% of the heel [7]. In these circumstances, the sufficient hind foot blood supply seems to be the central problem [8],[9].

However, the reconstruction of the resulting skeletal and soft tissue defects is often complex. In contrast to the more proximal segments of the leg, the availability of soft tissue for the coverage of full-thickness defects with local or regional flaps is limited [12],[13]. Reconstruction of skeletal defects can be accomplished with bone grafting [14]. However, large defects require complex reconstructive procedures, such as distraction osteogenesis, vascularized bone grafting, or transfer of free flaps [10],[15],[16].

In this paper the technique and outcome of a case series of CO with the concomitant use of bone and soft tissue approaches for patients diagnosed with CO are described.

MATERIALS & METHODS

Twenty-five consecutive patients with osteomyelitis and open fractures of the calcaneus were included between 2005 and 2018. All patients were admitted to the Bone Infection Unit at our hospital under the responsibility of an orthopaedic surgeon (specializing in foot ankle surgery and bone infection surgery) who performed all operations. Patients demographics, cause of CO, previous treatment and comorbidities are summarized in table 1. Patients presented with pain (100%), swelling (100%) and purulent discharge from heels (80%). The most common causes of CO were fracture-related infection (14 patients), acute hematogenous osteomyelitis (6 patients), penetrating soft tissue trauma (2 patients) and complications after surgery (3 patients). All patients had received previous

antibiotics. Sixteen patients (64%) had already undergone previous operation elsewhere. Blood parameters for WBC, ESR and CRP were elevated. Radiographs of the calcaneus showed destruction in the lesion with sclerosis of the bone tissue around the lesion. Some patients had total sclerosis of the calcaneus. Chronic CO had been diagnosed with clinical and radiograph signs of osteomyelitis for minimum 2 months, and one of the following criteria: sinus, abscess, intraoperative pus, or positive microbiological cultures from deep surgical samples.

Sex, n (male/female)	19/6	
Age, y, mean; range	30.9 y; 5-77	
Cause no (%)	Fracture-related infection Haematogenous Penetrating soft tissue trauma Iatrogenic factor	14 (56%) 6 (24%) 2 (8%) 3 (12%)
Previous treatment no (%)	Previous antibiotics Previous surgery	9 (36%) 16 (64%)
Comorbidities no (%)	Peripheral neuropathy Peripheral vascular disease Tobacco smoker	4 (16%) 5 (20%) 13 (52%)

Table 1. Patient Demographics (n = 25)

After diagnosing CO all patients were planned for surgery under systemic antibiotic coverage. Postoperative antibiotics began empirical until appropriate bacterial culture and sensitivity results were available. The calcaneus was approached from lateral with an L shaped incision which allows good access to the infected bone and has the advantages of preserving the Achilles tendon attachment, the weight bearing surface of the calcaneus, and the overlying soft tissue. Any sinus tracts were excised and the subcutaneous and deeper soft tissues were debrided until healthy bleeding tissue planes. Thorough bone debridement or partial calcanectomy was performed and the infected bone was sent for cultures. The amount of bone debridement and excision was based on preoperative radiographs and until healthy bleeding bone remained, using curettes, cutters and osteotomes. The wound was closed either with local tissues or with one of the methods of plastic surgery. Intravenous antibiotics were continued for 1 week postoperatively followed by oral antibiotics for 1 month. All patients were seen regularly for the first 2 years after the operation, at 6 weeks, 3 months, 6 months, 1 year, and 2 years.

RESULTS

Cultures taken from the deeper aspect of the wound are summarized in Diagram 1. They included facultative anaerobe Gram-positive cocci: Staphylococcus aureus (31%), Staphylococcus epidermidis (7%), Streptococcus pyogenes (3.5%), Streptococcus agalactiae (7%); facultative anaerobe Gram-negative bacillus: Enterobactericeae family: Escherichia coli (10%), Proteus mirabilis (3.5%); Proteus vulgaris (7%); anaerobe nonfermentive Gram-negative bacillus: Pseudomonas aeruginosa (14%); form endosymbiotic fungi: Candida albicans (17%). All of the cultured microorganisms were sensitive to vancomycin and/or gentamycin (Diag.1).

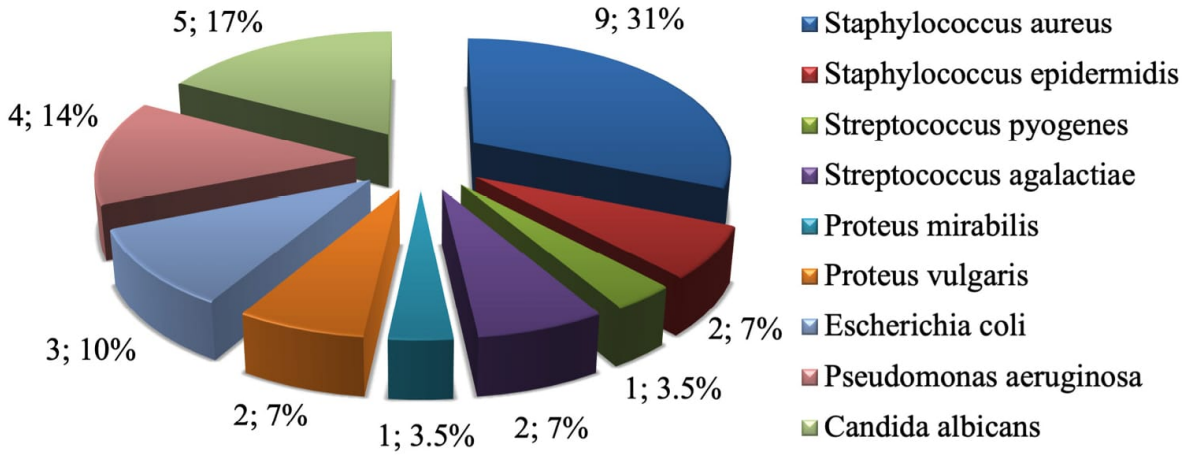

Diagram 1. Pathogens isolated from deep wound

All patients underwent surgery and type of bone and soft tissue management are summarized in (Table 2).

Surgical technique n (%)	Trepanation Sequestrnecrectomy Necrectomy Partial calcanectomy Ilizarov apparatus	5 (20%) 13 (52%) 11 (44%) 8 (32%) 3 (12%)
Soft tissue closure n (%)	Direct closure Free skin flap Local full-thickness flaps Full-thickness flaps (the Italian method of plastics)	16 (64%) 2 (8%) 4 (16%) 3 (12%)

Table 2. Surgical techniques used

Outcomes, complications, and clinical function are summarized in table 3. Infection was successfully eradicated in 22 patients at 1-year follow-up. Wounds healed by primary intention in 18 (72%) patients. Postoperative complications occurred in 9 patients (36 %) including wound leakage in 4 patients and recurrence of the osteomyelitis process occurred in 3 patients. All of them underwent successful reoperations with necrectomy. Wounds in the plantar surface of the heel developed in 2 patients after 6 months and was not associated with recurrent osteomyelitis. After conservative treatment they have healed.

Patients stayed in the clinic for 2-4 weeks. After that, patients began to gradually load the leg for 20-30 days followed by full weight bearing. Most patients (88%) were able to walk unaided, and 3 (12 %) needed crutches. 17 (68%) had a foot that comfortably fit into a regular shoe. Ordinary shoes with an insole were worn by 5 patients (12.5%), 3 patients wore a custom-made shoe (7.5%). Mild weight bearing pain was in 3 patients, 22 reported being pain free (Table 3).

Outcome	
Recurrence of bone infection	3 (12.5%)
The wound healed by primary closure	18 (72%)
The wound healed by secondary closure	7 (28%)
30-d postoperative complications no (%)	
Wound leakage	4 (16%)
Flap revision/reexplored	3 (12%)
Superficial ulcer	2 (8 %)
Mobility, no (%)	
Unaided	22 (88%)
Crutches	3 (12%)
Footwear, no (%)	
Regular shoes	17 (68%)
Normal shoe with a molded insole	5 (12.5%)
Orthotic custom shoe	3 (7.5%)

Table 3. Postoperative outcomes

CLINICAL CASE

A 59-year-old male patient was admitted with pain in the right calcaneus. More than 2 years ago, he had an open fracture of the right calcaneus with wound healing problems and a fistula one month after surgery.

Diagnosis: chronic post-traumatic osteomyelitis of the right calcaneus.

Operation: Longitudinal osteotomy of the right calcaneus, intralesional resection to healthy tissues. Primary wound healing and after 2 months full weight bearing. x-rays at 6 months show a healed bony lesion and no complaints (Figure 1).

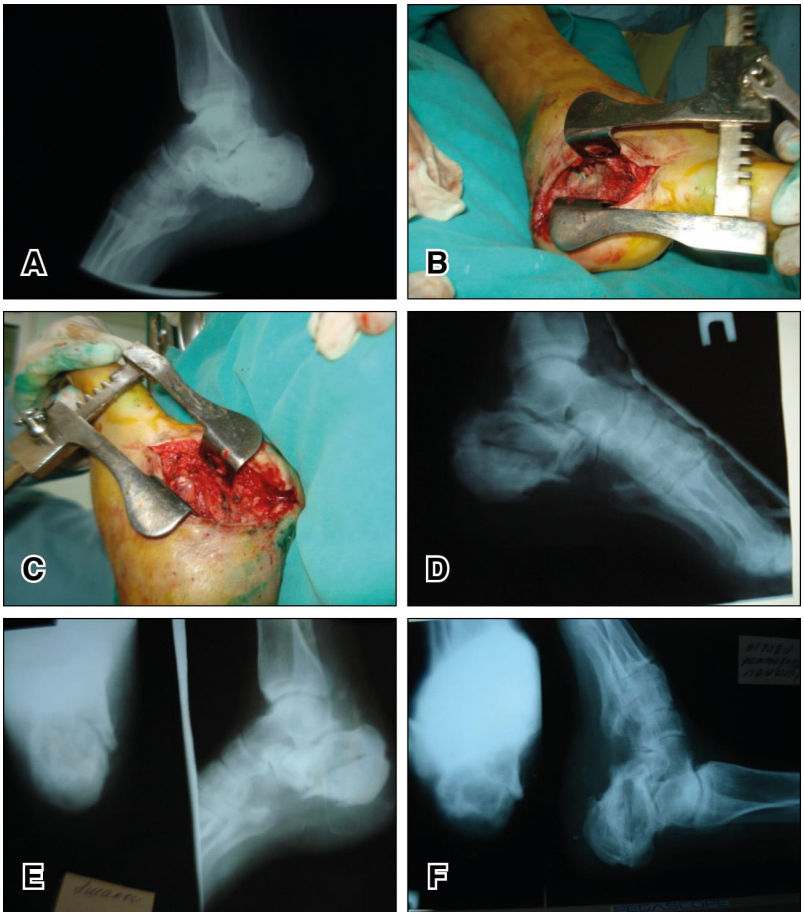

Figure 1: (A) X-ray of the right calcaneus before surgery. (B) intraoperative photographs after longitudinal osteotomy. (C) after intralesional resection. (D) x-ray after surgery. (E) x-ray after 2 months. (F) x-ray at 6 months-F.

DISCUSSION

Osteomyelitis of the calcaneus is a challenge for the patient and the surgeon. Generally, the goal of treatment includes eradication of infected bone, ensuring skeletal stability, adequate soft tissue coverage and preservation of function of the foot. Surgical management of CO includes local curettage or partial calcanectomy or total calcanectomy. In more severe cases of extensive calcaneal involvement, limited soft tissue coverage creates a challenge for the surgeon to allow for primary closure. Excision of devascularized infected bone risks destroying the weight bearing plantar cortex, detaching the Achilles tendon and disrupting the hindfoot complex. Moreover, in cases of osteomyelitis, the overlying plantar fat pad and skin are often compromised and limit soft tissue closure. Often below knee amputation has been recommended in these cases [20],[31],[36],[37],[38],[40],[41].

Only 3 (12.5%) patients in our study had a recurrence of bone infection which was similar to those of previous studies [40],[42],[43],[44]. Complications occurred in 9 cases (36%) including local ulcer, aseptic wound leakage and partial skin necrosis which needed 3 reoperations. Multiple further cohort series of partial, subtotal, and total calcanectomies have been published with varying results. One systematic review reports 80% healing rates, with better results occurring with partial rather than total calcanectomies [21],[27],[31]. Another systematic review found that 85% of patients receiving a partial calcanectomy maintained their mobility levels [31],[39]. Partial calcanectomy is a relatively simple procedure for chronic heel ulcers with limited calcaneal involvement. The amount of soft tissue compromise may allow for primary closure following partial calcanectomy [20],[31],[36].

Whether bone infection relapses after treatment is influenced by multiple factors, such as surgical strategies, pathogen species and virulence and finally, host immune status. The goal of operations is to remove all the devitalized infected tissues, leaving behind healthy vascularized bone. It is reasonable to understand that the protocols for CO treatment include partial and total calcanectomy, or even below-knee amputation. Although infection can be eradicated following such radical surgeries, the foot function may be more or less impaired [40], [45],[46].

If a primary wound closure is not possible it can be achieved by various plastic procedures including free muscle flaps (serratus anterior, gracilis), or local flaps (rotational flaps, abductor digiti minimi flap, neurocutaneous or fasciomusculocutaneous flaps). Skin grafting with a rotational flap using local tissues (Qarris and Saad method) was performed in 4 patients, wounds in 2 patients were closed with free split skin flaps. The reviewed studies showed no difference in the reinfection rate and failure rate of the flaps. However, the choice of soft tissue coverage should be based on the location and size of the soft tissue defect. Direct closure with the adjacent normal skin is preferable, but small defects may be reliably covered by local pedicle flaps [1],[47]. Disadvantages of free vascularized flaps are the need of microsurgery, long operation time, and prolonged hospital stay combined with higher costs. They are also usually insensate, producing a later risk of pressure ulceration. Regardless of which coverage is used, the applied procedure should guarantee an improved bone vascularization and a good dead space management to avoid haematoma formation [1],[48].

Despite the presence of various microorganisms in the formation of CO, gram-positive bacteria play a major role. In our study staphylococcus strains were the more common with 38 %. The majority were coagulasopositive Staphylococcus aureus with 31% which might occur in single and associative forms. Similar results were observed by many authors [2],[22],[31],[32].

Candida albicans were observed in 17 % which needed long term AB therapy. Patients without infection eradication may be caused by ineffective antibiotic therapy, difficulties in the surgical treatment and adverse effects. Other authors observed similar results [32],[33],[34],[35].

Seven pediatric patients (mean age 10.3 years, range 5-16) with chronic CO were treated with trepanation of the calcaneus with intralesional resection from the lateral incision.

A recurrence of the osteomyelitic process was observed in 1 patient. He underwent another successful necrectomy. Osteomyelitis in children is a potentially dangerous disease that requires early diagnosis and treatment in order to prevent the spread of infection to nearby joints, bone growth disorders and reduced quality of life [17],[19]. Nevertheless, acute osteomyelitis is not always easy to recognize since bone pain without systemic signs and symptoms, negative imaging and blood tests may confuse the clinician [18]. This is especially true when small bones, like the calcaneus, are involved. In this case, signs and symptoms may be even more subtle. Therefore, clinical experience and high index of suspicion are necessary for the emergency pediatrician to recognize and promptly treat these conditions [17].

CONCLUSION

Chronic osteomyelitis of the calcaneus is a disease that threatens the limb. Treatment of CO can be complex due to the poor soft tissue coverage and the nature of the stress on the calcaneus. CO is difficult to manage and requires a multidisciplinary approach involving orthopaedic surgeons, plastic surgeons and infectious diseases physicians. More than 30% of microbiological data showed the presence of staphylococcus aureus, which must be taken into

account in antibiotic therapy at the beginning of treatment. Our results also show that using a single-stage partial resection of calcaneum with primary closure of wound is a viable and useful technique in managing CO.

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