A Case of Osteomyelitis after Calcaneal Fracture Treated by Antibiotic-Containing Calcium Phosphate Cements

Yoohak Kim,1 Fumiaki Inori1, Kiyotaka Yamanaka,1 Shouichi Murakami,1 Eri Narita,1 Kazumasa Yamamura,1 Hiroyuki Yasuda,1 Makoto Fukuda,1 Sadahiko Konishi,1 and Yukihide Minoda2

1Department of Orthopedic Surgery, JR Osaka Railway Hospital, Osaka, Japan
2Department of Orthopedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan

Correspondence should be addressed to Fumiaki Inori; inorin@flufe.ocn.ne.jp

Received 15 February 2018; Accepted 10 May 2018; Published 12 June 2018

1. Introduction

It was reported that calcaneal osteomyelitis (CO) accounted for 7%-8% of all osteomyelitis cases in adults [1]. In the literature, often, wound infection, soft tissue infection, and bone infection would not be differentiated. Schildhauer et al. quantified the calcaneal rate of infections to 11% [2]. Aseptic necroses of the wound edge especially after extended lateral approaches to the calcaneus were described in the literature between 2 and 27.3% [3–5]. Delayed healing or postoperative infection might occur up to 25% [6–11].

The clinical principal of treatment of this disease is antibiotic administration, irrigation, and debridement [12], whereas when it turned into a chronic phase, procedures of the treatment become difficult. Heier et al. postulated in 2003 that “the extent of soft tissue damage determines the therapeutical result” [13]. In this respect, the early soft tissue coverage plays an important role, so that early diagnosis and appropriate operative treatment are indispensable. The preservation of the calcaneus and thus a functional pedal anatomy is the main target during the infect sanitation. This is not always feasible. Depending on the local situation, the spectrum of surgical procedures includes partial calcaneal resection, calcaneectomy, and lower leg amputation.

According to Lehmann et al. and Bollinger and Thordarson, partial calcaneectomy is a decent alternative to lower leg amputation in cases of strictly local infection [14, 15]. The authors mentioned that partial calcaneal resection may be performed if the inflammatory process does involve less than 50% of the heel [16]. In these circumstances, the sufficient hind foot blood supply seems to be the central problem [17, 18]. Syme amputation may also be performed in special cases.

We report one case of calcaneal osteomyelitis arising after the pinning operation, and its remission was obtained by performing curettage of the infected cancellous bone of the calcaneal body and filling antibiotic-containing calcium phosphate cements (CPC) within its bone defect. This one-stage surgery is useful to treat calcaneal osteomyelitis.

2. Case Report

A 51-year-old female had an injured left foot by falling down from home stairs. The next day, she was admitted to our hospital and was diagnosed with closed tongue-type calcaneal fracture (Figure 1). Operation was performed using 2 pins of the Steinmann pin by the Westhues method (Figure 2). A fixed cast and 2 pins were removed at the same time on the 37th postoperative day, and there was no
potential for infection at that time. Nevertheless, she was admitted to our hospital with a complaint about heel pain and fever exceeding up to 40 degrees centigrade, after 9 days from the pin removal.

On the examination, skin redness, swelling, and pus-like discharge were observed around the surgical site (Figure 3). Plain X-ray showed hyperpermeability of the calcaneus, and magnetic resonance images confirmed a diagnosis of osteomyelitis of the calcaneus as well as an abscess formation (Figure 4). White blood cell count (WBC: $9.9 \times 10^3/\mu l$) and C-reactive protein (CRP: 10.06 mg/dl) were elevated. And methicillin-sensitive Staphylococcus aureus (MSSA) was cultured from the discharge.

Intravenous antibiotic therapy was administrated immediately (cefazolin $2 g \times 3$/day), and the next day, the patient underwent irrigation of the surgical site and surgical pus drainage. Fever fell down, and inflammatory aspects disappeared within few days; however, the discharge from the drainage continued on 7 postoperative days. MSSA was cultured again from the discharge, so that we can diagnose whether calcaneal osteomyelitis was not cured completely. 12 days after the 2nd surgery, the patient underwent radical debridement of the calcaneal bone marrow using Ollier’s lateral approach and irrigation with natural saline was performed. Subsequently, calcium phosphate cement (CPC) (Hoya Medical, Tokyo, Japan) with vancomycin was implanted at the defected site of the calcaneus (Figure 5). MSSA was also cultured positive from the bone marrow of the calcaneus. Intravenous antibiotic therapy was continued for 7 days, and it was changed to antibiotics per oral (minomycin $200 mg \times 2$, rifampicin $450 mg \times 1$) and continued for 30 days. CRP turned negative on the 10th postoperative day, and the pin tract’s fistula was completely closed on the 14th postoperative day. Osteomyelitis seemed to be controllable, and 1/3 partial weight bearing was started from 14 postoperative days. Weight bearing was raised every 1 week as 1/2 and 2/3, and full weight bearing had been completed on the 35th postoperative day. On the 6th postoperative month, fistula was completely closed and there was no recurrence of infection (Figure 6). The patient could walk normally without a cane, and we considered that complete remission of osteomyelitis was obtained.

3. Discussion
To treat CO, wide surgical debridement, skeletal stabilization, and administration of antibiotics are the main steps to eradicate sepsis [19, 20]. 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 [21, 22]. Reconstruction of skeletal defects can be accomplished with bone grafting [23]. However, large defects require complex reconstructive procedures, such as distraction osteogenesis, vascularized bone grafting, or transfer of free flaps [19, 24, 25]. Finally, toe or ray amputations and more extensive amputation procedures in cases of diffuse osteomyelitis can be a limb- and life-saving procedure in a certain group of frail patients [19].
To overcome these large bone defect problems, a cement spacer was considered a good candidate. Polymethyl methacrylate (PMMA) had been the first alternative as a bone filling cement spacer for bone defect. However, it did not have biodegradability; hence, 2nd-stage surgery such as removal and cancellous bone graft was demanded after the 1st-stage surgery [26]. CPC was developed as a bone filling cement spacer and used mainly in bone defects caused by bone tumor or bone fracture because CPC has the tendency to change its form easily to fix the filling part. Recently, the treatment method of osteomyelitis using antibiotic-containing CPC had started to be reported [27].

In this case, we selected 1-stage surgery using antibiotic-containing CPC because of the reasons stated below: the operation was performed within 2 weeks after the diagnosis of osteomyelitis, the patient was healthy without complications such as diabetes, and the detected organism was MSSA which had sensitivity for several antibiotics. With regard to this kind of 1-stage surgery technique, Nan et al. identified that calcium sulfate cement could induce the formation of the membrane in the same way as PMMA and suggested the possibility of 1-stage surgery owing to its degradability [28]. However, they finally removed calcium sulfate and reconstructed bone defect with cancellous bone graft for several reasons; our case accomplished 1-stage surgery with antibiotic-containing CPC.

Recently, investigations addressing the similarities and differences between PMMA and CPC as two types of cement spacer have drawn wide attention. CPC have proved to be a viable carrier of local antimicrobial agent allowing the prolonged release of gentamicin sulfate or tobramycin compared to the PMMA [29]. In an in vitro study, Yang et al. investigated the biological safety, biomechanics, and tissue compatibility of CPC and PMMA mixed in different ratios and concluded that CPC had excellent biological properties, whereas mechanical properties were inferior to those of PMMA [30].

Taken together, the previous and present studies have confirmed that calcium phosphate cement, as a novel delivery vehicle, possesses similar effectiveness as PMMA, but a clear characteristic of total biodegradability highlights its superiority over PMMA. However, it should be noted that calcium phosphate is less strong than PMMA.

4. Conclusion

CPC is very useful as a bone filling agent for bone defects because it could change its form freely. And it is also useful as an agent for the treatment of calcaneal osteomyelitis which failed to preserving treatment.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] E. H. Wang, S. Simpson, and G. C. Bennet, "Osteomyelitis of the calcaneum," The Journal of Bone and Joint Surgery, vol. 74-B, no. 6, pp. 906–909, 1992.
[2] T. A. Schildhauer, T. W. Bauer, C. Josten, and G. Muhr, “Open reduction and augmentation of internal fixation with an injectable skeletal cement for the treatment of complex calcaneal fractures,” *Journal of Orthopaedic Trauma*, vol. 14, no. 5, pp. 309–317, 2000.

[3] H. Zwipp, S. Rammelt, and S. Barthel, “Kalkaneusfraktur. Operative Technik,” *Der Unfallchirurg*, vol. 108, no. 9, pp. 749–760, 2005.

[4] M. Schofer, C. Schoepf, C. Rülander, and H.-R. Kortmann, “Operative und konservative Behandlung der Kalkaneusfrakturen,” *Trauma und Berufskrankheit*, vol. 7, Supplement 1, pp. S156–S161, 2005.

[5] J. R. Stephenson, “Treatment of displaced intra-articular fractures of the calcaneus using medial and lateral approaches, internal fixation, and early motion,” *The Journal of Bone & Joint Surgery*, vol. 69, no. 1, pp. 115–130, 1987.

[6] L. S. Levin and J. A. Nunley, “The management of soft-tissue problems associated with calcaneal fractures,” *Clinical Orthopaedics and Related Research*, vol. 290, pp. 151–156, 1993.

[7] R. Sanders, P. Fortin, T. Dipasquale, and A. Walling, “Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification,” *Clinical Orthopaedics and Related Research*, vol. 290, pp. 87–95, 1993.

[8] S. K. Benirschke and B. J. Sangeorzan, “Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures,” *Clinical Orthopaedics and Related Research*, vol. 292, pp. 128–134, 1993.

[9] S. K. Benirschke and P. A. Kramer, “Wound healing complications in closed and open calcaneal fractures,” *Journal of Orthopaedic Trauma*, vol. 18, no. 1, pp. 1–6, 2004.

[10] J. W. Folk, A. J. Starr, and J. S. Early, “Early wound complications of operative treatment of calcaneal fractures: analysis of 190 fractures,” *Journal of Orthopaedic Trauma*, vol. 13, no. 5, pp. 369–372, 1999.

[11] J. L. Howard, R. Buckley, R. McCormack et al., “Complications following management of displaced intra-articular calcaneal fractures: a prospective randomized trial comparing open reduction internal fixation with nonoperative management,” *Journal of Orthopaedic Trauma*, vol. 17, no. 4, pp. 241–249, 2003.

[12] D. Antoniou and A. N. Conner, “Osteomyelitis of the calcaneus and talus,” *The Journal of Bone & Joint Surgery*, vol. 56, no. 2, pp. 338–345, 1974.

[13] K. A. Heier, A. F. Infante, A. K. Walling, and R. W. Sanders, “Open fractures of the calcaneus: soft-tissue injury determines outcome,” *The Journal of Bone and Joint Surgery American*, vol. 85-A, no. 12, pp. 2276–2282, 2003.

[14] S. Lehmann, R. D. Murphy, and L. Hodor, “Partial calcaneectomy in the treatment of chronic heel ulceration,” *Journal of the American Podiatric Medical Association*, vol. 91, no. 7, pp. 369–372, 2001.

[15] M. Bollinger and D. B. Thordarson, “Partial calcaneectomy: an alternative to below knee amputation,” *Foot & Ankle International*, vol. 23, no. 10, pp. 927–932, 2002.

[16] J. F. Baumhauer, C. J. Fraga, J. S. Gould, and J. E. Johnson, “Total calcaneotomy for the treatment of chronic calcaneal osteomyelitis,” *Foot & Ankle International*, vol. 19, no. 12, pp. 849–855, 1998.

[17] D. G. Smith, “Principles of partial foot amputation in the diabetic,” *Foot and Ankle Clinics*, vol. 2, no. 1, pp. 171–186, 1997.

[18] S. B. Weinfeld and L. C. Schon, “Amputation of the perimeters of the foot,” *Foot and Ankle Clinics*, vol. 4, no. 1, pp. 17–37, 1999.

[19] M. J. Patzakis and C. G. Zalavras, “Chronic posttraumatic osteomyelitis and infected nonunion of the tibia: current management concepts,” *The Journal of the American Academy of Orthopaedic Surgeons*, vol. 13, no. 6, pp. 417–427, 2005.

[20] E. Zarutsky, S. M. Rush, and J. M. Schuberth, “The use of circular wire external fixation in the treatment of salvage ankle arthrodesis,” *The Journal of Foot and Ankle Surgery*, vol. 44, no. 1, pp. 22–31, 2005.

[21] S. Baumeister and G. Germann, “Soft tissue coverage of the extremely traumatized foot and ankle,” *Foot and Ankle Clinics*, vol. 6, no. 4, pp. 867–903, 2001.

[22] L. S. Levin, “Soft tissue coverage options for ankle wounds,” *Foot and Ankle Clinics*, vol. 6, no. 4, pp. 853–866, 2001.

[23] C. G. Zalavras, M. J. Patzakis, D. B. Thordarson, S. Shah, R. Sherman, and P. Holtom, “Infected fractures of the distal tibial metaphysis and plafond,” *Clinical Orthopaedics and Related Research*, vol. 427, pp. 57–62, 2004.

[24] J. F. Keating, A. H. R. W. Simpson, and C. M. Robinson, “The management of fractures with bone loss,” *The Journal of Bone and Joint Surgery British Volume*, vol. 87-B, no. 2, pp. 142–150, 2005.

[25] K. N. Malizos, C. G. Zalavras, P. N. Soucacos, A. E. Beris, and J. R. Urbaniaik, “Free vascularized fibular grafts for reconstruction of skeletal defects,” *The Journal of the American Academy of Orthopaedic Surgeons*, vol. 12, no. 5, pp. 360–369, 2004.

[26] A. C. Masquelet, F. Pitossi, T. Begue, and G. P. Muller, “Reconstruction of the long bones by the induced membrane and spongy autograft,” *Annales de Chirurgie Plastique et Esthétique*, vol. 45, no. 3, pp. 346–353, 2000.

[27] T. Niikura, S. Y. Lee, T. Ikawura, Y. Sakai, R. Kuroda, and M. Kurosaka, “Antibiotic-impregnated calcium phosphate cement as part of a comprehensive treatment for patients with established orthopaedic infection,” *Journal of Orthopaedic Science*, vol. 21, no. 4, pp. 539–545, 2016.

[28] N. Jiang, C.-H. Qin, Y.-F. Ma, L. Wang, and B. Yu, “Possibility of one-stage surgery to reconstruct bone defects using the modified Masquelet technique with degradable calcium sulfate as a cement spacer: a case report and hypothesis,” *Biomedical Reports*, vol. 4, no. 3, pp. 374–378, 2016.

[29] P. J. Papageopoulos, A. F. Mavrogenis, S. Tsiodras, C. Vlastou, H. Giarmarellou, and P. N. Soucacos, “Calcium sulphate delivery system with tobramycin for the treatment of chronic calcaneal osteomyelitis,” *Journal of International Medical Research*, vol. 34, no. 6, pp. 704–712, 2006.

[30] J. Yang, K. Zhang, S. Zhang et al., “Preparation of calcium phosphate cement and polymethyl methacrylate for biological composite bone cements,” *Medical Science Monitor*, vol. 21, pp. 1162–1172, 2015.