



# Staged arthrodesis using the Masquelet technique for osteomyelitis of the finger with articular destruction: a report of two cases

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Received: 17 February 2019 / Published online: 15 May 2019  
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## Abstract

Osteitis of the fingers is a serious infection that needs early diagnosis and appropriate surgical debridement and antibiotic treatment of the infected bone. If the effects of treatments are insufficient, long-term antibiotic treatment and repeated operations could be required. In worst cases, some patients may have to undergo amputation. Recently, the usefulness of the Masquelet technique in extensive traumatic bone defects has been reported. We herein describe two cases of immunocompromised patients with purulent osteitis involving joint destruction of the finger treated by two-stage arthrodesis using the Masquelet technique. They obtained good infection control and better function of the finger than before the operation. Moreover, there was no recurrence of the infection. The Masquelet technique could be an alternative technique for osteitis with high risk of amputation.

**Keywords** Phalangeal osteitis · Masquelet technique · Two-stage arthrodesis · Antibiotic treatment · Immunocompromised host

## Introduction

Osteitis of the fingers is a serious infection that needs early diagnosis and appropriate treatment. The causes of infection are trauma (especially after penetrating trauma), operation, and spread from contiguous soft tissue and other infection sites [1]. In addition to oral or intravenous antibiotic treatment, surgical treatment is the cornerstone of an adequate therapy. However, if the effect of treatment is insufficient, long-term antibiotic treatment and repeated operations could be required [1]. Patients with vascular disease or immunodeficiency whose infection was caused by drug-resistant bacteria have an increased risk of being refractory to therapy and developing serious infection. In the worst-case scenario, some patients may have to undergo amputation [1, 2]. Even when an infection is well controlled, extensive bone defects

and joint destruction caused by the infection can induce severe dysfunction of the hand.

Recently, the usefulness of the Masquelet technique in extensive traumatic bone defects has been reported. The Masquelet technique is also used in the reconstruction of traumatic bone defect of the upper limb. However, reconstruction of bone defects in the hand, especially the fingers, using this technique is uncommon [3–7], and there are only a few reports on the use of this technique for bone defects of the fingers caused by infection [8, 9]. We herein report two immunocompromised patients with purulent osteitis involving joint destruction of the finger.

## Case report

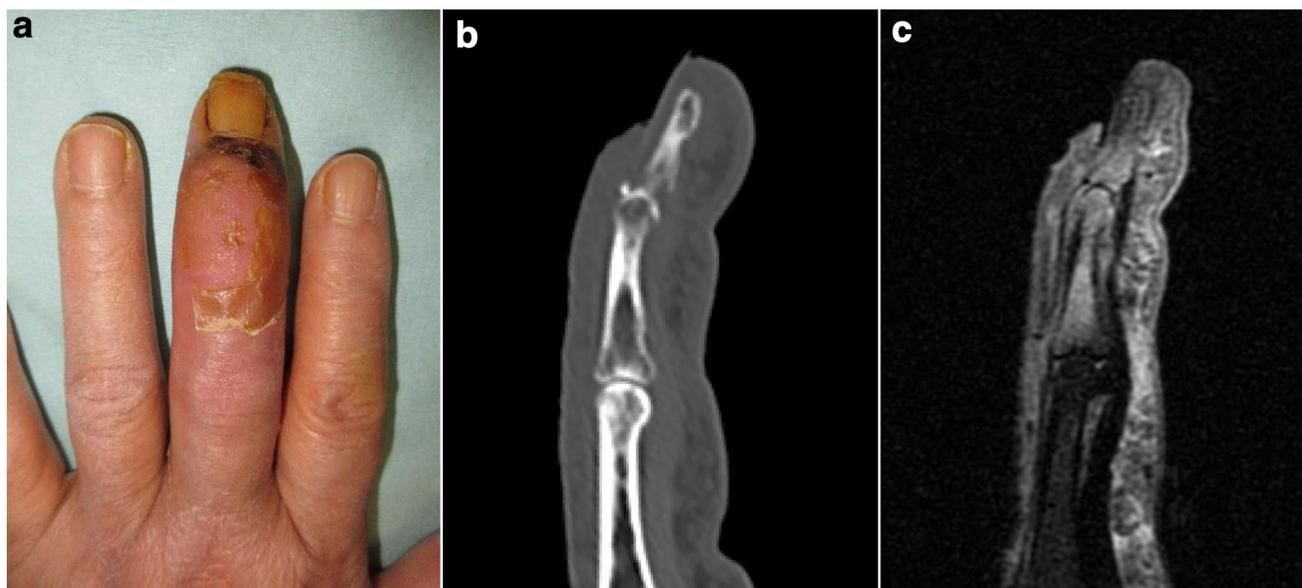
### Case 1

A 72-year-old woman with type 2 diabetes mellitus had a recurrent ganglion at the left distal interphalangeal (DIP) joint of the middle finger, which she punctured herself several times. The patient sustained swelling and pain of the middle finger and was referred to our department 4 weeks after the onset (Fig. 1a). Computed tomography (CT) and

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**Fig. 1** **a** Appearance of the middle finger of case 1 before the first operation. Note the swelling of the finger caused by osteitis. **b** Lateral computed tomography of the middle finger. Note the destruction of

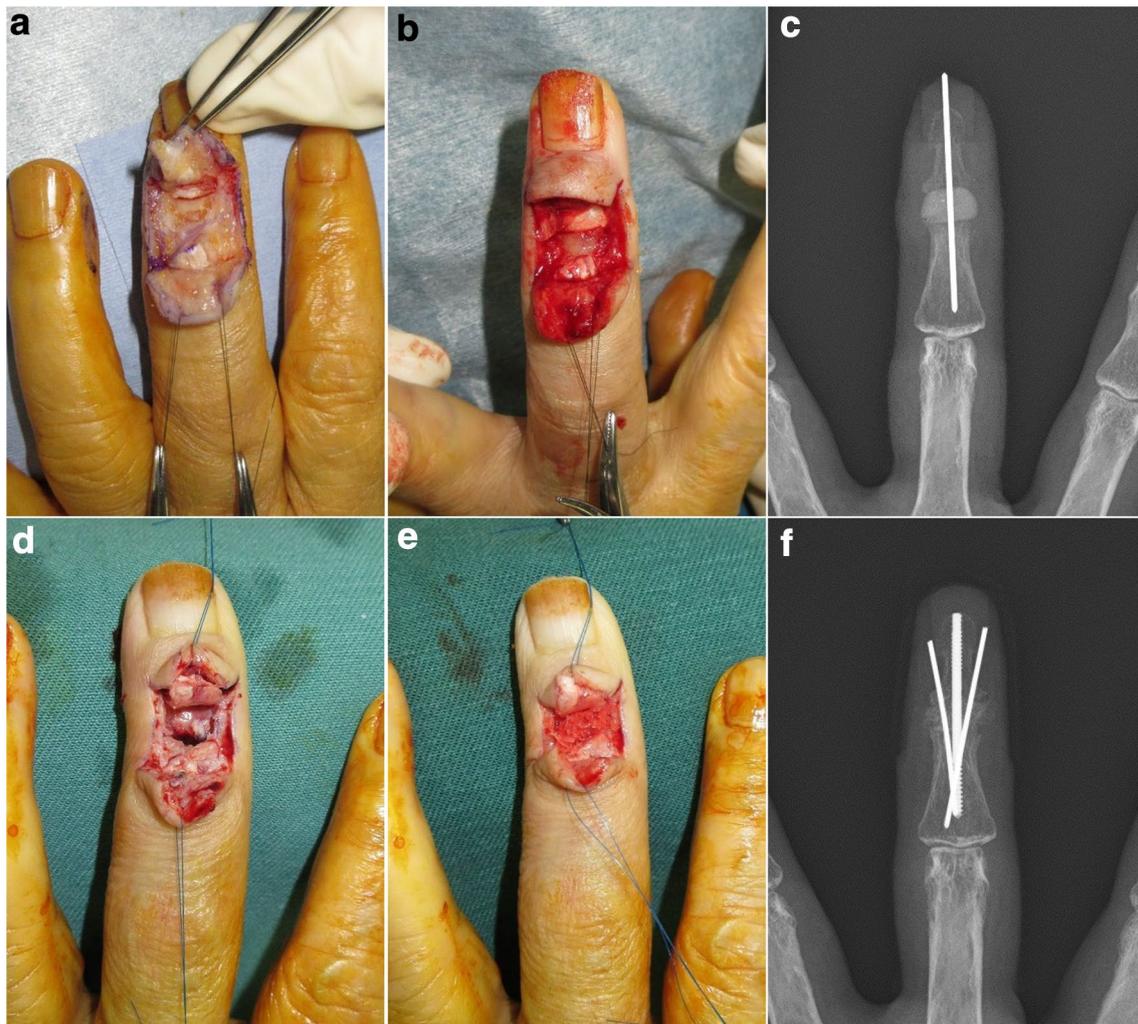
the distal interphalangeal joint. **c** Lateral magnetic resonance imaging of the middle finger. There is a high-intensity area in the distal and middle phalanges, suggesting osteitis of these bones

magnetic resonance imaging (MRI) demonstrated destruction of the DIP joint of the left middle finger and inflammation of the distal and middle phalanges (Fig. 1b, c). At the first operation, the DIP joint was noted to be destroyed and replaced by granulation tissue from the infection (Fig. 2a). The infected granulation and bone tissues were removed, and the joint space was filled with vancomycin (VCM)-impregnated polymethylmethacrylate (PMMA) cement spacer (PMMA 10 g + VCM 1 g); the finger was immobilized with 1.1-mm C-wire (Fig. 2b, c). Based on the results of the preoperative bacterial culture of the joint fluid and the intraoperative bacterial culture of the granulation and bone tissues, the patient was diagnosed with methicillin-resistant *Staphylococcus aureus* (MRSA) osteitis. After the first operation, the finger was immobilized with a thermoplastic splint and intravenous anti-MRSA drug treatment (teicoplanin for 2 weeks and daptomycin for 4 weeks) was performed. At 6 weeks after the first operation, a second operation was performed. After the removal of the cement spacer, an autogenous bone graft from the distal radius was secured to the defect, and arthrodesis of the DIP joint was performed with a 1.8-mm headless compression screw (PercuFIX; Stryker) and two 0.7-mm C-wires (Zimmer) (Fig. 2d–f). Bone union was achieved at 2 months after the operation. She had irritation from the wires, which were thus removed. At 14 months after the second operation, the ranges of motion (ROM) of the middle metacarpophalangeal (MP) and proximal interphalangeal (PIP) joints were 16° of extension and 76° of flexion and –12° of extension and 84° of flexion, respectively. The DIP joint was fixed at 0° of extension. The grip

strength of the affected hand was 15.3 kg, which was 105% of the contralateral side (14.6 kg). The patient had no pain in the affected finger or relapse of the infection (Fig. 3a–c).

## Case 2

A 72-year-old man, who was undergoing hemodialysis due to diabetic renal failure, sustained a wound at the dorsal PIP joint of the left index finger with a machete and was treated at a nearby hospital. Three weeks after the injury, he complained of swelling and pain in the affected finger and was given oral antibiotic treatment. However, there was no improvement of the symptoms, and he was thus referred to our department at 4 weeks after the injury. CT and MRI demonstrated destruction of the PIP joint of the left index finger (Fig. 4a–c). At the first operation, the destroyed PIP joint of the index finger was filled with pus and replaced by infected granulation tissues (Fig. 5a). Debridement of the bone sequestrum and intramedullary curettage of the proximal and middle phalanges were performed, followed by implantation of a VCM-impregnated PMMA cement spacer (Fig. 5b, c). Although bacterial culture was negative due to preoperative antibiotic treatment, intraoperative findings strongly indicated osteitis. Therefore, postoperative oral antibiotic treatment with minocycline and levofloxacin was performed for 6 weeks. Ten weeks after the first operation, a second operation was performed. An autogenous bone graft from the ilium was secured into the defect and arthrodesis of the PIP joint was performed with a 2.0-mm locking plate (Variable Angle Locking Hand System; DePuy



**Fig. 2** Intraoperative pictures at the first operation of case 1. **a** The distal interphalangeal (DIP) joint was destructed and replaced by granulation tissue. **b** The DIP joint is filled with antibiotic-impregnated cement spacer. **c** Postoperative radiograph of the first operation of case 1. Intraoperative pictures of case 1 at the second operation.

After the removal of the cement spacer (**d**), an autogenous bone graft was secured into the defect space (**e**). **f** Postoperative radiograph of the second operation of case 1. Arthrodesis was performed with PercuFIX  $\varnothing$  1.8 mm and two 0.7-mm C-wires according to the procedure of Spies et al. [14]

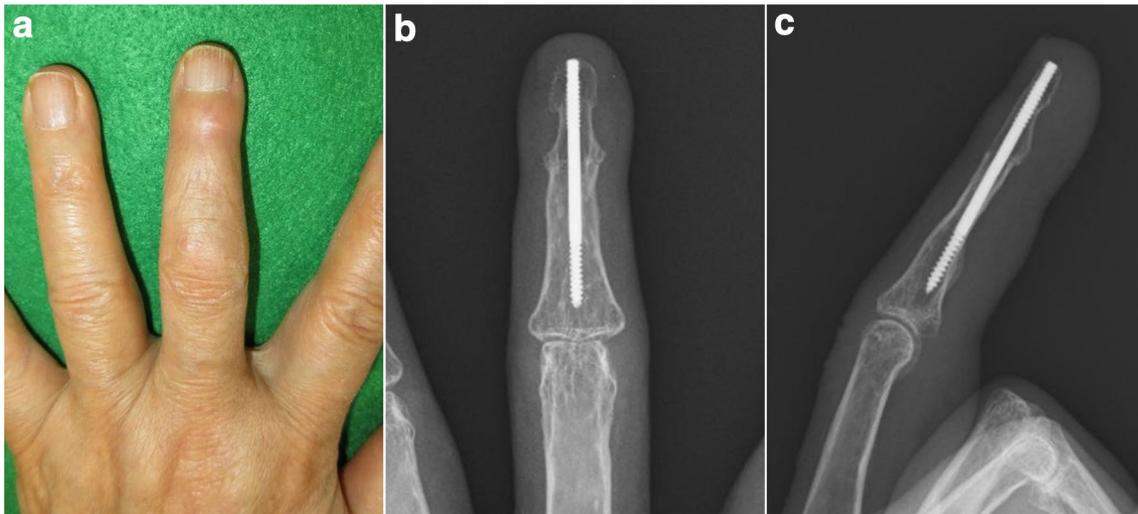
Synthes) (Fig. 5d–f). Bone union was achieved at 2 months after the operation. At 12 months after the operation, the ROMs of MP and DIP joints of the index finger were 0° of extension and 75° of flexion and 0° of extension and 45° of flexion, respectively. The PIP joint was fixed at 30° of flexion. The grip strength of the affected hand was 20 kg, which was 80% of the contralateral side (25 kg). There was no pain in the affected finger or relapse of the infection (Fig. 6a–c).

## Discussion

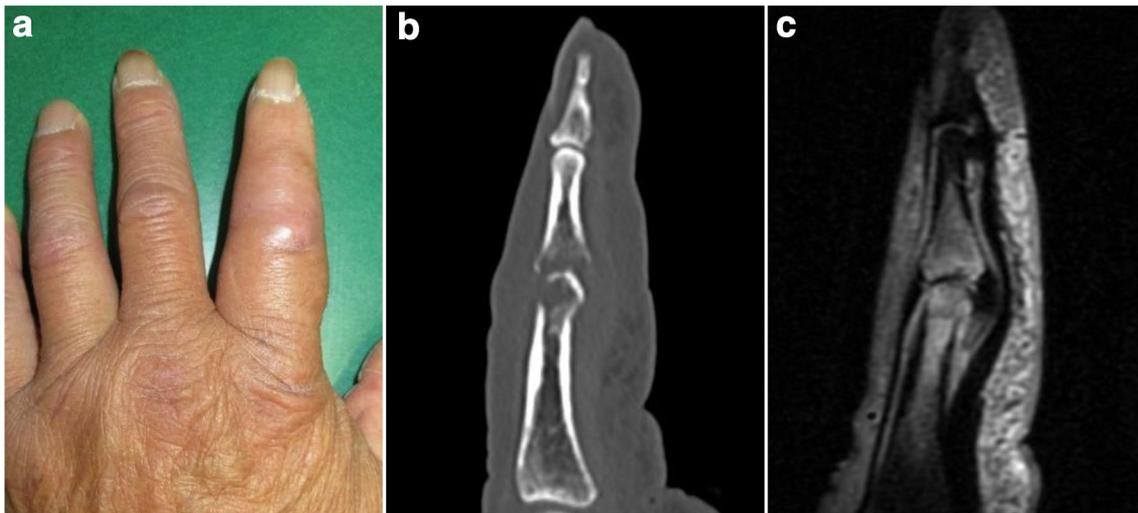
The incidence of metacarpal or phalangeal osteitis has been reported to be 1.1–10% of hand infections [1]. Generally, effective management of osteitis depends on early diagnosis

and adequate antibiotic and surgical treatment. Although there is no recommended duration for adequate antibiotic therapy for phalangeal osteitis, 6 weeks is the most frequent duration [10]. Poor prognostic factors of osteitis are vascular disease, immunodeficiency, drug-resistant bacteria, and delayed diagnosis [1, 2]. Reilly et al. [1] reported that the rate of amputation for phalangeal osteitis was 39%, and especially in cases of post-traumatic osteitis, the rate was 54%. Considering such evidence, it could be extremely difficult to preserve good finger function for patients with such comorbidities.

Our two patients had increased susceptibility to infection, which had poor prognostic factors (case 1, diabetes and MRSA; case 2, diabetes and hemodialysis), and developed osteitis after trauma. At the initial visit, they had already



**Fig. 3** **a** Appearance of the middle finger of case 1 at 14 months after the second operation. There were no signs of infection. Anteroposterior (**b**) and lateral (**c**) radiographs of the middle finger of case 1



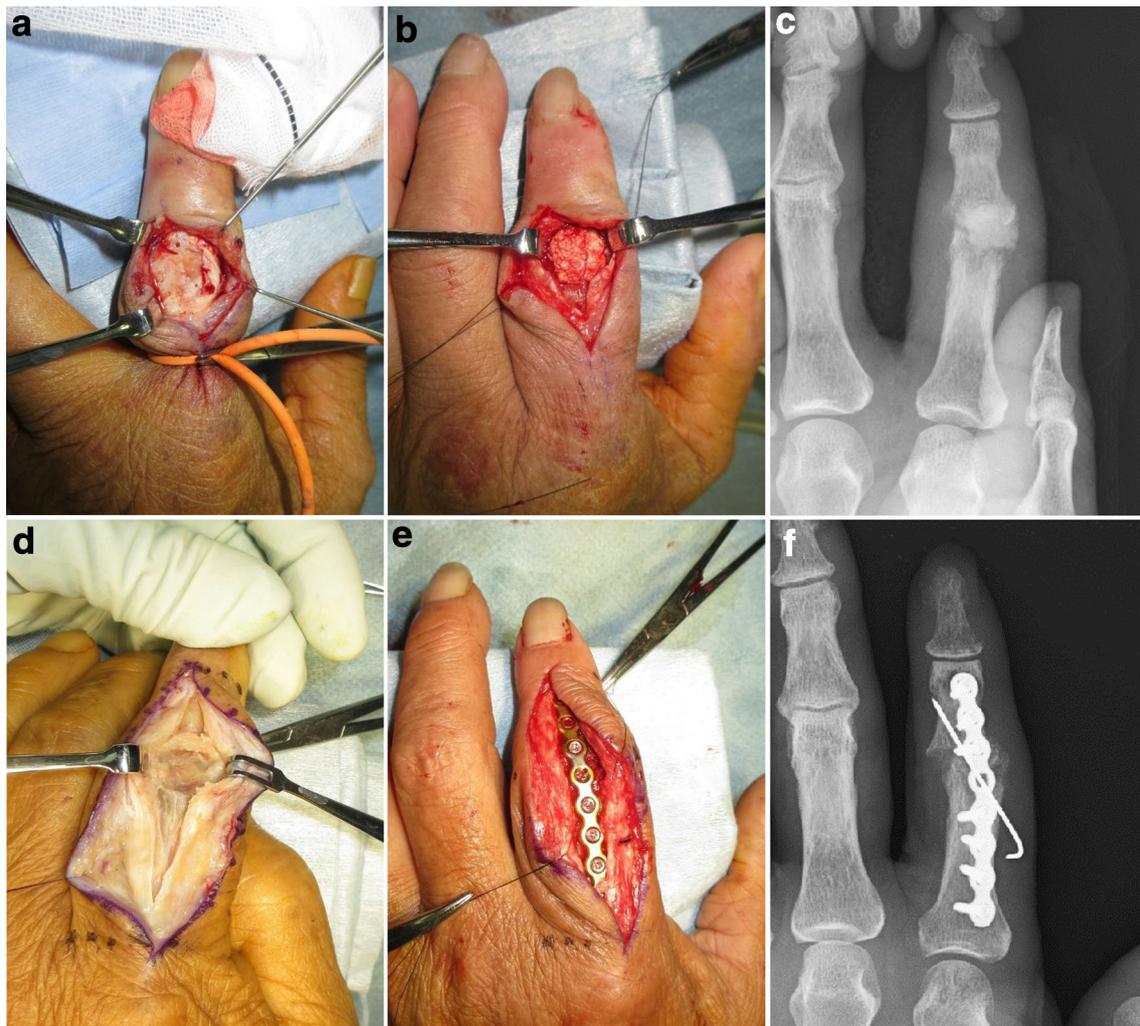
**Fig. 4** **a** Macropicture of case 2 before the first operation. Note the swelling around the proximal interphalangeal (PIP) joint of the index finger. **b** Lateral computed tomography of the index finger. Note the

destruction of the PIP joint. **c** Lateral magnetic resonance imaging of the index finger. There is a high-intensity area in the middle and proximal phalanges, suggesting osteitis of these bones

presented irreversible joint destruction in more than half of the joint surface; therefore, we performed two-stage arthrodesis by the Masquelet technique.

We believe that this technique has strong advantages in securing a well-controlled infection and reconstruction of finger function even in patients with high risk of amputation. A few studies have reported the treatment of phalangeal osteitis by the Masquelet technique. Proubasta et al. [9] reported the case of a 50-year-old man with MRSA osteitis after an open mallet fracture. They performed debridement and gentamycin-impregnated cement spacer placement as the first operation, followed by arthrodesis with headless

compression screw and corticocancellous bone graft as the second operation at 4 weeks after the first operation [9]. In addition, Hara et al. [8] reported the case of a 38-year-old man with osteitis of the PIP joint caused by  $\alpha$ -*Streptococcus* and *Prevotella* after a human bite injury. The patient was treated with a panipenem/betamipron-impregnated cement spacer, followed by arthrodesis with T-plate and iliac cancellous bone graft after 4 weeks [8]. Similar to our cases, their cases achieved bone union and well-controlled infection. Moreover, as compared with normal arthrodesis, two-stage arthrodesis by this technique of placement of a cement spacer into the space resulting from thorough debridement of



**Fig. 5** Intraoperative picture of case 2 at the first operation. **a** The proximal interphalangeal (PIP) joint is filled with pus and replaced by infected granulation tissues. **b** Debridement was performed, and the PIP joint was filled with an antibiotic-impregnated cement spacer. **c** Postoperative radiograph of the first operation of case 2. Intraopera-

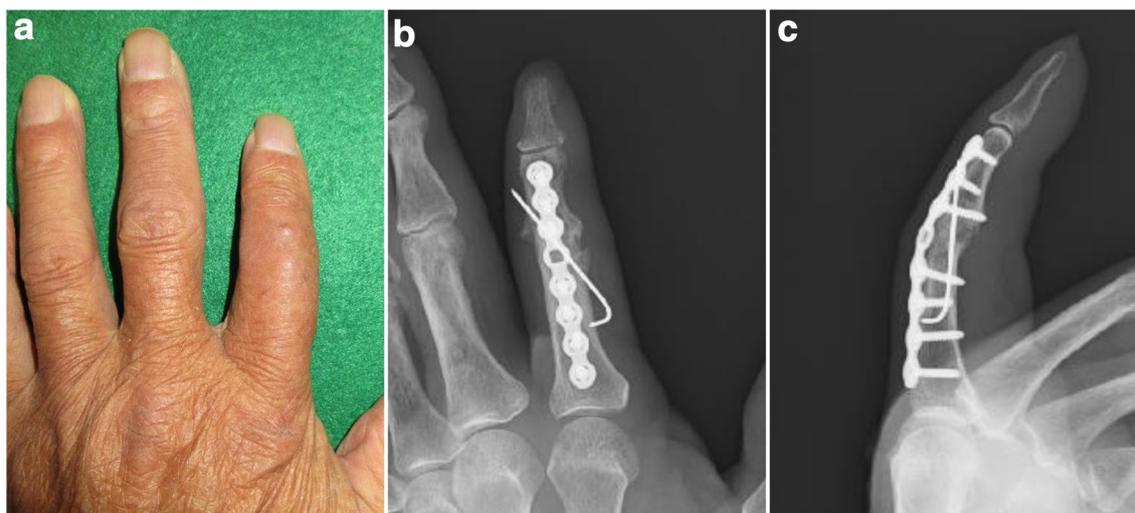
tive pictures of case 2 at the second operation. After the removal of the cement spacer (**d**), an autogenous bone graft was secured into the defect space and arthrodesis was performed with a 2.0-mm locking plate (**e**). **f** Postoperative radiograph of the second operation of case 2

the infected joints has the benefit of maintaining the length of the finger. Unglaub et al. [11] reported the use of PMMA chain placement and external fixation after joint resection. We believe that the indication and effectiveness of the aforementioned technique are similar those of ours; however, a cement spacer with buried wire fixation or a cement spacer alone with splint immobilization can be less expensive and reduce the risk of additional infection through the pin sites.

The disadvantage of this technique is the need for some restriction and protection of the affected fingers for approximately 3 months during the period from cement-spacer implantation to bone union. Compared with external fixation, our technique provides less stability of the operated joint. Therefore, good patient compliance is necessary to prevent breakage of the cement and operated joints,

especially in patients with poor bone quality. Aimé et al. [12] reported good outcomes of 13 patients with phalangeal osteitis using one-stage surgery by permanent antibiotic-impregnated cement spacer placement. Compared with our method, their technique has the advantages of short treatment period and easy postoperative therapy. However, this technique has a potential risk of loss of alignment and secondary arthritis caused by loosening or breakage of the cement spacer, especially in the case of workers performing hard labor and long-term follow-up patients. Hence, the operative procedure should be selected depending on the patients.

The limitation of our report was that we did not elucidate the necessity and appropriate period of systemic (intravenous or oral) antibiotic treatment in the Masquelet technique for



**Fig. 6** **a** Macropicture of the index finger of case 2 at 12 months after the second operation. There was no recurrence of infection. Anteroposterior (**b**) and lateral (**c**) radiographs of the index finger of case 2

osteitis. Hara et al. [8] and Proubasta et al. [9] used antibiotic-impregnated cement spacer without systemic antibiotic treatment, whereas we performed systemic administration of antibiotics for 6 weeks in addition to local antibiotic treatment with VCM-impregnated cement spacer according to the treatment regimen for lower extremity and forearm osteitis using the Masquelet technique by Wang et al. [13] and Walker et al. [5]. In the future, we need to accumulate experience regarding this technique for phalangeal osteitis and elucidate the necessity and appropriate period of systemic administration of antibiotics.

In addition, the fixation of the joint filled with cement after the first operation should also be a subject of future study. Generally, stabilization of the affected joint is important to obtain good infection control. In case 2, cement placement with thermoplastic splint immobilization could not stabilize the PIP joint sufficiently, and some spacer displacement was observed during antibiotic treatment. In case 1, cement placement with C-wire fixation provided sufficient stability of the DIP joint. Of note, this technique has a potential risk of spread of bacteria along the wire. Therefore, if we use the wires, radical debridement of infected bone would be necessary and the wire should not be placed in intact phalangeal bones without osteitis. An external fixator could be a safer option without a higher risk of bacteria spread; however, we should be careful of additional pin site infection when using it.

## Conclusion

Osteitis of the finger is challenging to treat, especially in immunocompromised patients. We reported the cases of two immunocompromised patients with potential risk of

amputation who were successfully treated with two-stage arthrodesis using the Masquelet technique. This technique could be a useful treatment option for osteitis of the finger.

**Acknowledgements** The authors report no benefits, grants or assistance from any party.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical consideration** This article does not contain any studies with human participants or animals performed by any of the authors.

**Informed consent** Informed consent was obtained from the patients.

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