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CASE REPORT

# Surgical outcome of the patient with open proximal phalangeal fracture with bone defect due to dog bite injury treated with vascularized bone graft: a case report

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**Abstract**
A dog bite injury involving joints and bones has poor prognosis. We described a case of open proximal phalangeal fracture with bone defect of the left index finger due to dog bite injury. The patient was treated successfully with a pedicled second metacarpal vascularized bone graft based on the second dorsal metacarpal artery following debridement and external fixation. Subsequently, extensor tendon tenolysis wrapped with adipofascial flap based on the first dorsal metacarpal artery was performed. After obtaining supple joint of the finger, flexor tendon tenolysis was performed. The postoperative course was uneventful, without infection. Nineteen months after the last operation, there was slight pain in the finger at power grip, but no disability in activities of daily life and work. The total active motion of the left index finger was 245°, and plain radiography showed bony union without osteoarthritic change. Good clinical outcome was obtained through a combination of staged surgery.
Level of evidence: Level V, therapeutic study.

**Keywords** Dog bite · Vascularized bone graft · Second metacarpal bone · Open fracture

## Introduction

Dog bite injuries to the hand are often seen in clinical settings. Bite wound involving a joint, tendon, or bone causes severe infection, osteomyelitis, and poor prognosis [1–3].

Vascularized tissue transplantation can offer resistance to infection by maintaining vascularity, and vascularized bone graft can provide structural support and additional blood supply to the recipient site [4–6].

Some reports and meta-analyses showed that application of vascularized bone graft for bone defect after infection offered resistance to infection and led to good clinical results [7–9].

The purpose of this report was to describe the case of injury to the left index metacarpophalangeal (MP) joint and open comminuted proximal phalangeal fracture with bone defect due to dog bite. This injury has a high risk of infection, and the case was treated successfully with a pedicled second metacarpal bone graft following debridement and external fixation, extensor tendon tenolysis with a pedicled adipofascial flap, and flexor tendon tenolysis.

Level of evidence: Level V, therapeutic study

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## Case report

The patient provided written consent for the publication of this case report. A 32-year-old right-handed woman, a dog trainer, had a dog bite injury while she was attempting to separate her two dogs, German shepherd, that were fighting. The wounds were over the dorsal left MP joint of the index finger and on the first web. The wound was sutured, and an oral antibiotic was given by another doctor. She was referred to our hospital for further treatment the next day.

Initial examination showed a 2.5-cm-long wound on the dorsal second MP joint accompanied by remarkable redness and swelling (Fig. 1a). Plain radiography of the left hand showed comminuted intra-articular fracture of the proximal phalanx of the left index finger (Fig. 1b).

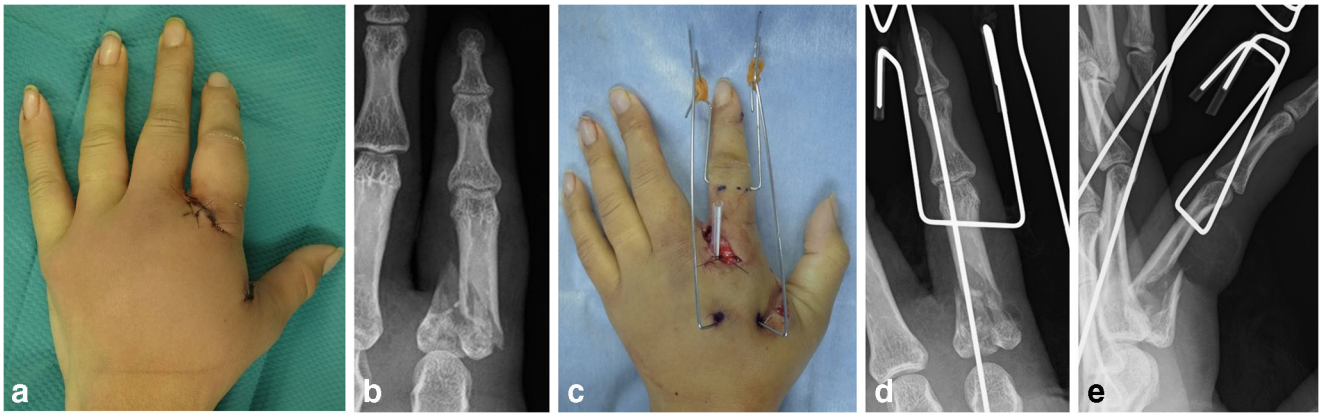


**Fig. 1** Macroscopic findings and plain radiography at the initial presentation and after debridement and external fixation. Macroscopic photograph (**a**) and plain radiography (**b**) at the initial presentation. Macroscopic photograph (**c**) and anteroposterior (**d**) and lateral plain radiography (**e**) after debridement and external fixation

Blood tests revealed a white blood cell (WBC) count of 9400 cells/μL and C-reactive protein (CRP) level of 3.45 mg/dL. On the same day, debridement was performed to remove the contaminated soft tissue, partially ruptured extensor tendon, and bone stripped off the periosteum, followed by external fixation with 1.2-mm Kirschner wires (Fig. 1c–e). Removed tissues were cultured for bacteria. Postoperative intravenous antibiotics, 1.5 g sulbactam/ampicillin, were administered three times per day, and the swelling and redness decreased in a week. A second look of the wound was performed at 4 days after operation. There seemed to be no active infection, and the cultures were negative.

Because no remarkable infection symptoms in the physical examination and laboratory data (WBC count, 5300 cells/μL; CRP, 0.19 mg/dL) were found, open reduction was performed at 8 days after the first operation. Because this patient had an allergy to titanium material, we used Kirschner and soft wires for bone fixation. After bone fixation using wires, a 10 × 4 × 5-mm bone defect was found on the dorso-ulnar side of the proximal phalanx (Fig. 2a). The second dorsal metacarpal artery between the MP joint of the index finger and metacarpophalangeal joint was patent, as assessed by ultrasonography. The bone defect was repaired with a pedicled second metacarpal-base bone graft based on the sec-

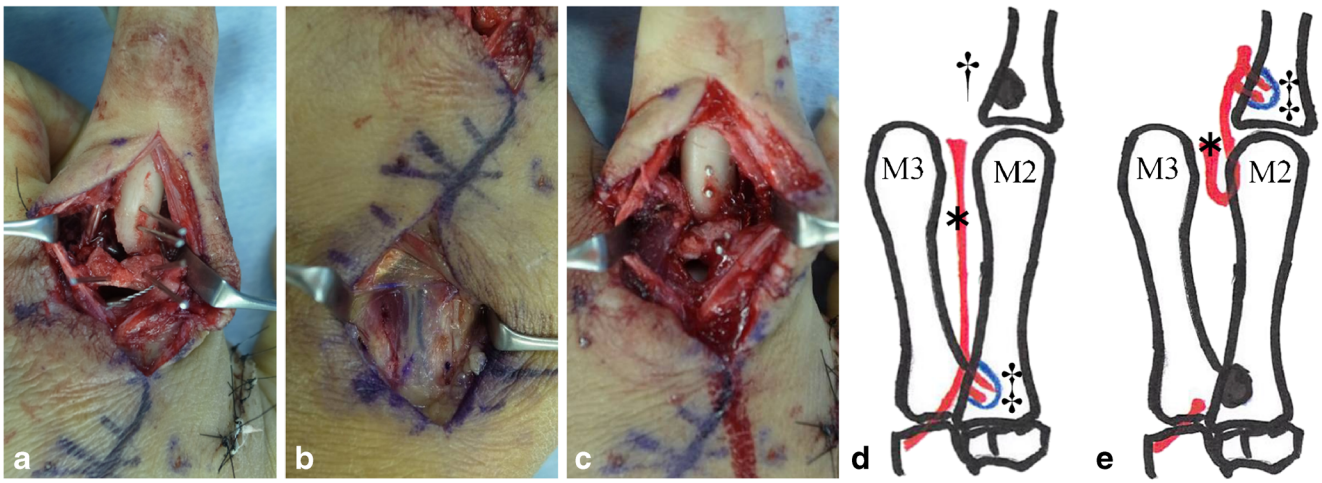


**Fig. 2** Intraoperative image and scheme of the procedures at the second operation. **a** Bone defect was found on the dorso-ulnar side of the proximal phalanx after fracture fixation. **b** The second dorsal metacarpal artery at the base of the second metacarpal bone. **c** The pedicled base of the second metacarpal bone graft was filled into the bone defect and fixed. **d**, **e** Scheme of the procedures. Bone defect of the proximal phalanx (cross) was repaired with a pedicled second metacarpal-base bone graft (double cross) based on the second dorsal metacarpal artery (asterisk) in retrograde flow. M2, second metacarpal bone; M3, third metacarpal bone


**Fig. 3** Plain radiography at the second operation. Anteroposterior (**a**) and lateral (**b**) plain radiography of the proximal phalanx of the index finger

ond dorsal metacarpal artery in a retrograde flow (Figs. 2b–e and 3a, b). The proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of the index finger were mobilized at 2 days, and the MP joint of the index finger was mobilized at 2 weeks after the operation. The fracture was united at 2 months after surgery without infection. The active extension/flexion range of motion of the index finger at 4 months after operation was as follows: MP joint, 15°/60°; PIP joint, −10°/40°; and DIP joint, 0°/20°.

In the third operation at 4 months after osteosynthesis, we removed the wires, released the contracture of the MP joint, and performed tenolysis of the extensor tendon. After checking the patency of the first dorsal metacarpal artery by ultrasonography, the extensor tendon was wrapped with a pedicled adipofascial flap based on the first dorsal metacarpal artery in a retrograde flow to prevent adhesion of the extensor tendon (Fig. 4a–e). The extension/flexion range of motion of the index finger at 6 months after extensor tendon tenolysis was as follows: active: MP joint, 20°/70°; PIP joint, − 5°/60°; DIP joint, 0°/30°; passive: MP joint, 20°/75°; PIP joint, − 5°/95°; DIP joint, 0°/75°. In the fourth operation, we performed flexor tendon tenolysis from the palm to the DIP joint, keeping the A2 and A4 pulleys. Nineteen months after the last operation, she felt slight pain on power grip, but there was no disability in activities of daily life and work. There was scar formation on the dorsal aspect of the hand (Fig. 5a). The grip strength was 31.3 and 22.4 kg for the right and left hands, respectively. The active extension/flexion range of motion of the index finger was as follows: MP joint, 25°/75°; PIP joint, − 5°/95°; and DIP joint, 0°/55° (Fig. 5b). Plain radiography showed bony union (Fig. 5c, d). Ultrasound (SONIMAGE HS1, KONICA MINOLTA JAPAN, Inc., Tokyo, Japan) image showed good excursion of the extensor tendon surrounded by fat, indicating that the vascularized adipofascial flap

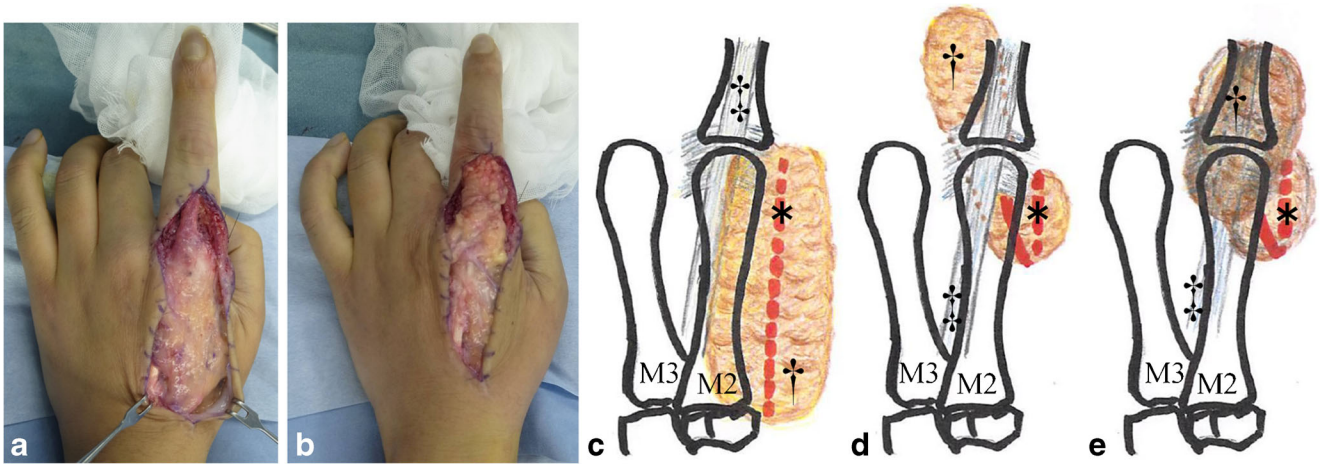


**Fig. 4** Intraoperative image and scheme of the procedures at the third operation. **a** Dorsal adipofascial flap. **b** After releasing the MP joint and the extensor tendon of the index finger, the extensor tendon was wrapped with adipofascial flap based on the first dorsal metacarpal artery. (**c**–**e**) Scheme of the procedures. Extensor tendon of the index finger (double cross) was wrapped with a pedicled adipofascial flap (cross) based on the first dorsal metacarpal artery (asterisk) in a retrograde flow. M2, second metacarpal bone; M3, third metacarpal bone

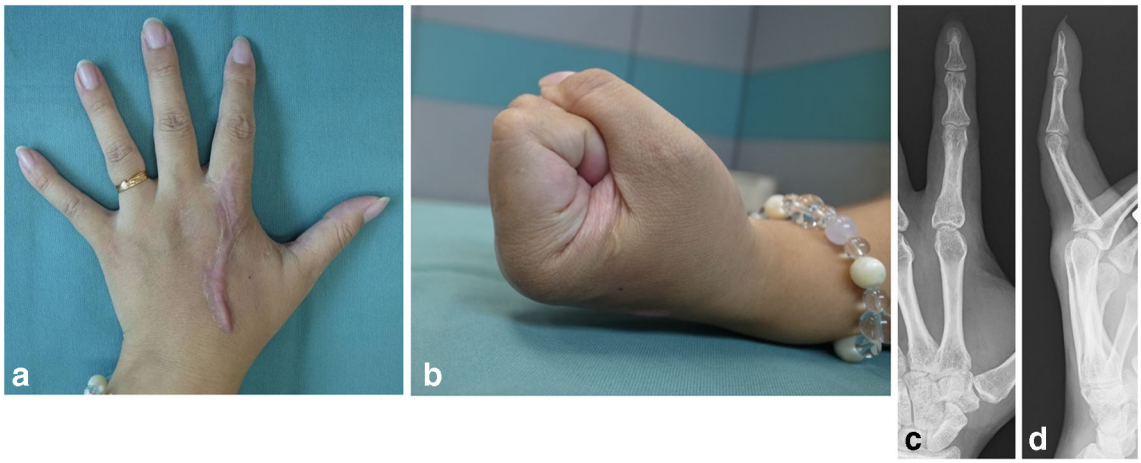


**Fig. 5** Macroscopic findings and plain radiography at last follow-up. Dorsal (**a**) and lateral views (**b**) of the left hand. Anteroposterior (**c**) and lateral (**d**) plane radiography of the proximal phalanx of the index

was viable and prevented adhesion of the tendon (Fig. 6a, b) The Disabilities of the Arm, Shoulder, and Hand score was 0.8.

## Discussion

We have presented a case of an open comminuted proximal phalangeal fracture with bone defect due to dog bite injury, which, under high suspicion of infection, was treated successfully by pedicled second metacarpal bone graft based on the second dorsal metacarpal artery following debridement and fixation using an external fixator, extensor tendon tenolysis wrapped with vascularized adipofascial flap based on first dorsal metacarpal artery, and flexor tendon tenolysis. Although the prognosis of the bite injury over the joint was reported to be poor, we obtained a good clinical result through four-stage surgery [3].

Surgical debridement of contaminated wound of the hand is important and can reduce the bacterial load [10]. However, hand wounds and patients with delayed presentation must be checked for infections even with the debridement [11]. Our case was complicated by involvement of bone and joint, and thus, the patient presented to our hospital the day after the injury. Vascularized tissue transplantation increases local phagocytosis and antibiotic delivery and decreases bacterial counts by maintaining vascularity [5]. Moreover, vascularized bone grafts can help repair the bone defect with viable cells, which provide structural support, additional new blood supply to the recipient area, and high rate of union [6]. It is more difficult to eradicate bone and joint infection than that of the soft tissue. These are the reasons why we chose vascularized bone grafting as the reconstructive method for bone defect

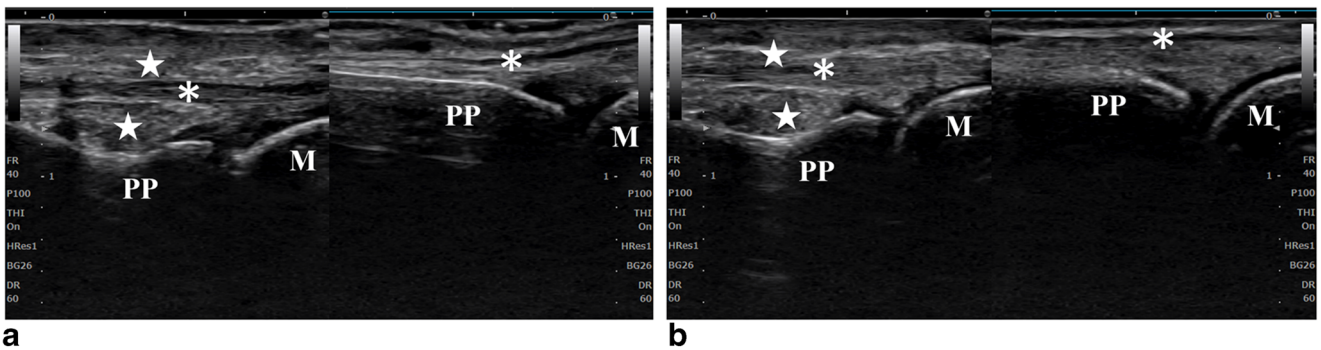


**Fig. 6** Ultrasound evaluation of the extensor tendon of the index finger. **a** Ultrasound image in long axis at extension of the finger. Left side is the operated side and right side is the healthy side. **b** Ultrasound image in long axis at flexion of the finger. Left side is the operated side and right side is the healthy side. Asterisk, extensor tendon; white star, vascularized adipofascial flap; PP, proximal phalanx; M, metacarpal bone

after dog bite injury over than artificial bone graft or nonvascularized bone graft. Although the Masquelet technique is also effective for bone defect, one more procedure is required, i.e. cement spacer placement at the initial procedure and cancellous bone grafting at the second procedure [12].

The base of the second metacarpal bone was selected as the donor site of the bone graft. Pedicled second metacarpal bone graft based on the second dorsal metacarpal artery was used for bony reconstruction of the carpal bone (scaphoid nonunion, Kienbock disease), the distal and proximal phalanx of thumb, and the distal to proximal phalanx of index finger in previous reports [13–15]. Furthermore, it is less invasive, as pedicled vascularized bone graft does not need vascular anastomosis. When the second metacarpal artery was not available due to bite injury or is used for the pins of the external fixator, we could use the third metacarpal artery as a pedicle.

After obtaining bone union, we removed the wires and performed capsulotomy of the MP joint and extensor tendon tenolysis as second-stage operation. To prevent adhesion of the extensor tendon in scar tissue, we wrapped the extensor tendon by the adipofascial flap based on the first dorsal metacarpal artery. The usefulness of the free adipofascial flaps after tenolysis was reported previously, and we used that concept by pedicled flap [16]. Good result was also obtained in our case.

At the third-stage surgery, we performed flexor tendon tenolysis because of the remaining flexion lag of the finger. Yamazaki et al. [17] reported the clinical outcomes of flexor tendon tenolysis after phalangeal fracture, demonstrating that the finger motions were improved by surgery and the results correlated significantly to the total passive range of motion preoperatively. We could obtain good active range of motion by flexor tendon tenolysis after passive range of motion was supple. Flexor tendon tenolysis after phalangeal fracture was effective, as previously reported.

The limitation of this case report is the number of operations (four times) and prolonged treatment period. Because the patient had an allergy to titanium material, we could not use titanium plate or screws for strong fixation of fracture. If rigid fixation was obtained, early range of motion exercise might have reduced the adhesion of the tendon and the joint contracture.

Good clinical outcome was obtained in this case of open comminuted proximal phalangeal fracture with bone defect due to dog bite injury through a combination of staged surgery, vascularized bone graft to the bony defect, extensor tendon tenolysis with vascularized adipofascial flap, and flexor tendon tenolysis.

**Funding** None.

## Compliance with ethical standards

**Conflict of interest** Koichi Yano, Yasunori Kaneshiro, Ryosuke Iio, and Hideki Sakanaka declare that they have no conflict of interest.

**Ethical approval** This case report was approved by the institutional review board.

**Informed consent** Written consent for the publication of this case report was obtained from the patient.

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