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ORIGINAL ARTICLE

Operative treatment of metacarpal and phalangeal fractures in athletes: early return to play

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Abstract
Background Evaluating the outcomes of operative treatment for metacarpal and phalangeal fractures in athletes returning early to play and discussing the more effective methods that permit rapid early return to athletic activity.
Methods We retrospectively identified a total of 105 metacarpal or phalangeal fractures in 105 athletes with conservative or operative treatment in our department. Of these, 20 athletes required an early return to sport because of a pending important game in their competition within 1 month after injury. Therefore, they underwent surgical treatment with open reduction and internal fixation of metacarpal or phalangeal fractures in an attempt to achieve an early return to their chosen sport at their usual competitive level. The patients included 6 rugby football players, 2 soccer goalkeepers, 3 American football players, 3 handball players, 2 baseball players and 4 who participated in other sports. The clinical records of preoperative and postoperative radiographs were available for all patients, and clinical outcome was evaluated by total active motion (TAM).
Results The patients were followed up for a mean of 27 (24–43) months. At the latest follow-up examination, bone union was obtained in all cases. In cases with metacarpal and phalangeal fractures, the average TAM was 263° (range 240°–270°).
Conclusion We consider that an early comeback to training and competition can be permitted exclusively for patients with metacarpal and phalangeal fractures. It is important for the attending physician to administer such treatment after obtaining informed consent and develop a trusting relationship with the patient and other related individuals while paying attention to their hope of quick recovery.

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Introduction

Metacarpal and phalangeal fractures are the most common injuries in the hands [1–5]. They are also common injuries in athletes between the ages of 10 and 40 years [6–8]. Metacarpal and phalangeal fractures comprise one quarter to one third of all fractures that occur during athletic competition, and they occur predominantly in ball handing and contact sports [9–11].

Metacarpal and phalangeal fractures can significantly affect an athlete's career, particularly when they occur during the playing season, and also can significantly affect the athlete's training when these injuries occur in the off season. The majority are managed nonoperatively with protective bracing and rapid return to play [11, 12]. Achieving early range of motion is important regardless of whether nonoperative or operative management is selected. However, indications for surgical treatment are somewhat different in athletes than in the general population because of the need for optimal hand function and early return to competition [13]. Stable fixation is generally indicated in athletes with displaced and unstable fracture patterns. However, it is especially difficult for the physician to determine whether the athlete can participate in a pending important game in their competition during the short-term period after injury.

The purpose of the present study was to evaluate the outcomes of surgical treatment for metacarpal and

phalangeal fractures in relation to athletes participating in a pending important game in their competition around 1 month after injury. It also discusses a more effective and straightforward method to permit a rapid and effective early return to athletic activity.

Methods

The present study was undertaken after receiving approval from our institutional review board. We retrospectively identified a total of 105 metacarpal or phalangeal fractures in 105 athletes with conservative or operative treatment in our department. We initially chose conservative treatment for undisplaced or minimally displaced hand fractures. However, we chose open or closed reduction with internal fixation or percutaneous pinning for hand fractures with displaced, unstable or comminuted fractures. The treatment algorithm for metacarpal and phalangeal fractures at our department is shown in Fig. 1. Of these patients, we focused on 20 athletes requiring an early return to sports because of a pending important game in their competition within 1 month after injury. For them, we considered which surgical treatment would be necessary to achieve open reduction with internal fixation, which is advantageous for fracture healing and rehabilitation in order to return early to a normal competitive level. Of the 20 athletes, 18 were male and 2 were female; their mean age was 20 years (range 16–31 years). They included 6 rugby football players, 2 soccer goalkeepers, 3 American football players, 3 handball players, 2 baseball players and 4 who participated in other sports (jockey, judo, softball and volleyball). The dominant hand was involved in 12 of the patients. Twenty fractures occurred in the 20 patients, including 8 metacarpal and 12 phalangeal (proximal 6, middle 6) fractures. The average duration between injury and the next scheduled competition was 3.4 weeks (range 1–4 weeks).

Operative technique and postoperative management

The operation was performed under local anesthesia (digital block) or an upper arm block on the day of surgery. Metacarpal fractures were treated surgically through a midline dorsal skin incision and exposure of the fracture site while avoiding the extensor tendon. Spiral and oblique shaft fractures were generally fixed with mini-screws. Mini low-profile plates were applied to transverse and comminuted fractures. Phalangeal fractures were treated surgically with mini low-profile plates or only mini-screws through the lateral or dorsal approach. Plate fixation was applied in transverse or comminuted fractures. In turn, mini screw fixation was applied in unicondylar fractures and simple shaft fractures. The volar approach was used to obtain secure joint surface reduction and stability of the fracture site for cases such as fracture-dislocation of the PIP joint.

Postoperative management

Following the operation, the patients were prohibited from returning to working out or training using the

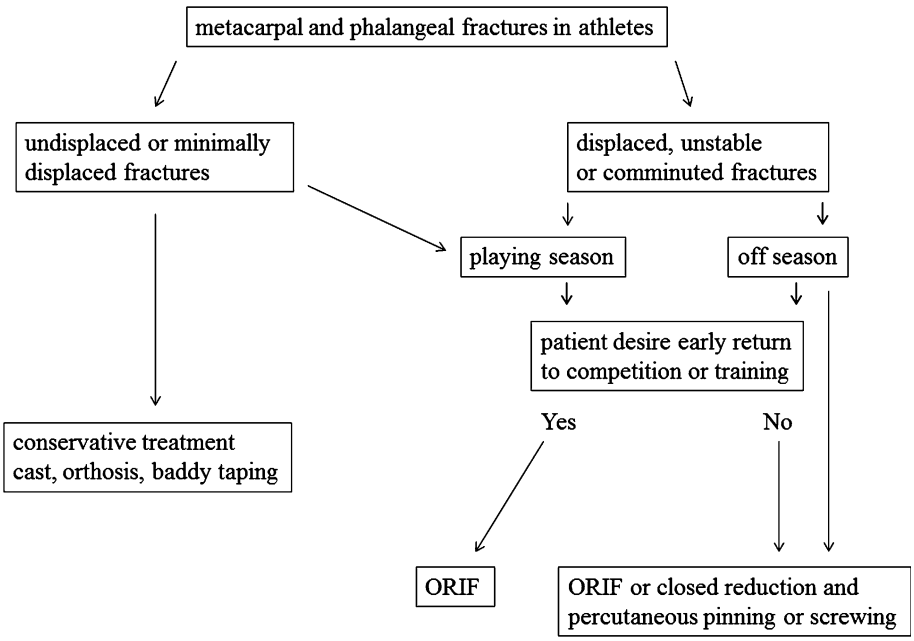

Fig. 1 Treatment algorithm for metacarpal and phalangeal fractures in athletes at our department. The indication for surgical or conservative treatment should be determined according to both the type of fracture and the need for an early return to competition. According to this algorithm, a physician should always decide the best treatment for the athlete considering the athlete's career, time period before the game, significance of the game, degree of expected functional recovery until the game and intent of others related to the athlete (family, coaches)

involved hand and wrist for 1 week. For metacarpal and phalangeal fractures, active finger motion exercises were started immediately after surgery with external immobilization. In the second week, the patients were allowed to resume easy training with a protective orthotic and buddy taping to the adjacent finger. They started easy contact play or ball sports with a protective orthosis. In the metacarpal fractures, the plastic self-removal cast is molded to the contours of the hand and wrist to perform handling keeping full digital flexion and extension. In phalangeal fractures, the injured finger is buddy taped tightly to the adjacent finger and molded by the plastic self-removal cast while playing. In the third week, the patients returned to technical training in earnest. We continued to examine them for local pain and swelling of the injured hand every few days after the operation. After resumption of training, swelling was controlled with retrograde massage, proper elevation and icing immediately after therapy by the hand therapist. Resolution of local tenderness, pain and local signs of injury was checked carefully for at least 4 weeks.

Patient evaluation

The mean follow-up period was 27 months (range 24–43 months). The clinical records as well as preoperative and postoperative radiographs were available for all patients. Clinical outcome was evaluated by total active motion (TAM) for metacarpal and phalangeal fractures at the last examination prior to the first competition after surgery and at the latest follow-up examination. At the latest follow-up, patient satisfaction was evaluated based on five grades: very satisfied, satisfied, neutral, dissatisfied and very dissatisfied. Data for all patients are summarized in Table 1.

Table 1 Overall patient data

Case	Age	Sex	Sports	Fracture site	Fracture pattern	Internal fixation	Duration	TAM	Satisfaction
1	22	M	Handball	Proximal phalanx, right little finger	Transverse	Plate	4 (weeks)	260	Very satisfied
2	21	M	American	PIPj fracture-dislocation, left middle finger	Comminution	Plate + artificial bone	3	270	Very satisfied
3	16	M	Rugby	Right 2th metacarpal	Displaced, rotation	Plate	1	270	Satisfied
4	18	M	Soccer (goal keeper)	Right 4th metacarpal	Oblique	Mini-screw	2	270	Very satisfied
5	21	M	Rugby	Proximal phalanx, right index finger	Comminution	Plate	4	265	Very satisfied
6	17	M	Baseball	Middle phalanx, left ring finger	Unicondylar	Mini-screw	3	250	Satisfied
7	20	M	Soccer (goal keeper)	Left 4th metacarpal	Displaced	Plate	4	270	Very satisfied
8	16	M	Judo	Right 5th metacarpal	Displaced, rotation	Plate	4	270	Very satisfied
9	31	M	Jockey	Proximal phalanx, left thumb	Displaced	Plate	2	125	Very satisfied
10	23	M	Rugby	Middle phalanx, right middle finger	Unicondylar	Mini-screw	4	240	Very satisfied
11	16	F	Volleyball	Proximal phalanx, right little finger	Transverse	Plate	4	270	Very satisfied
12	31	M	Rugby	Right 4th metacarpal	Spiral	Mini-screw	4	270	Very satisfied
13	21	M	American	Right 4th metacarpal	Comminution	Plate	4	270	Very satisfied
14	24	M	Rugby	Middle phalanx, right middle finger	Unicondylar	Mini-screw	3	250	Very satisfied
15	18	F	Softball	Middle phalanx, left ring finger	Oblique	Mini-screw	4	260	Satisfied
16	22	M	Handball	Left 5th metacarpal	Displaced, rotation	Plate	3	270	Very satisfied
17	19	M	American	Proximal phalanx, right thumb	Transverse	Plate	4	120	Satisfied
18	23	M	Handball	PIPj fracture-dislocation, right index finger	Comminution	Plate + artificial bone	3	250	Satisfied
19	22	M	Baseball	Left proximal phalanx, little finger	Transverse	Plate	4	255	Satisfied
20	17	M	Rugby	Left 4th metacarpal	Displaced, rotation	Plate	4	270	Very satisfied

Duration time between the injury and the next scheduled competition, *TAM* total active motion, *plate* mini low-profile plate, *PIPj* proximal inter-phalangeal joint

Results

At the last examination just prior to the first competition after surgery, callus formation developed in 12 cases, which included 4 transverse fractures, 1 commination, 2 oblique, 4 displaced and 1 unicondylar fracture. Local swelling and pain were gradually reduced from 2 to 4 weeks after the operation. In 15 cases, the patients developed a full grip 4 weeks after surgery. All athletes were able to participate in the next competition as desired. Re-fracture or breakage of the plate and screw due to early return to competition were not noted at all. After returning to competition, displacement, delayed union and nonunion of the fractures did not occur in any of the cases. Finally, bone union on radiographic findings in all cases was achieved within 3 months after surgery. However, the operative wound re-opened in two patients (rugby football players) as a complication. They had immediately returned to play the day after the operation without keeping their agreement with the surgeons not to return to their sport for 1 week, and they were treated by re-suturing.

At the latest follow-up examination, all athletes had neither angulation nor rotational deformity. In cases with metacarpal and phalangeal fractures, the average TAM was 263° (range 240°–270°). In those with a phalangeal fracture of the thumb, the average TAM was 123°. Removal of the plate was performed in nine cases with low-profile plating. The satisfaction scores were very high, and all patients were satisfied with their participation in their competitions (Table 1).

Representative case presentation

A 21-year-old male university student suffered a fracture-dislocation of the PIP joint of the long finger during participation in an American football game 3 weeks before the national university championship. As the patient was a wide receiver and important player on the team, we had the goal of returning him to the playing field as soon as possible. After receiving informed consent, surgery was performed 2 days after the injury. Bone collapse and defects were observed on the PIP articular surface; thus, artificial bone grafting and low-profile plate fixation were performed under the digital block. The patient resumed training 1 week after the operation and participated in the championship game 3 weeks after surgery, which resulted in no complications regarding finger function. TAM was 270° (Fig. 2a–d).

Discussion

Most hand fractures in athletes are minimally displaced and only require protection and rehabilitation during healing [12]. Universal hand fracture management principles are applied to athletes. Therefore, treatment is designed to maintain or restore skeletal alignment and reestablish normal hand function. Stable fixation is often recommended for athletes with displaced and unstable fracture patterns as well as for traditional patients. However, surgical treatment is sometimes recommended for athletes who desire an early return to competition or training, minimizing the lost playing time, even though conservative treatment is indicated for stable fractures (Fig. 3a, b). Longer plate fixation is occasionally indicated for the purpose of rigid fixation (Fig. 4a, b). In phalangeal fractures, except unicondylar and simple shaft fractures, plate fixation allows for immediate stability and an active range of motion [14–16]. As Geissler reported [11], plate fixation is an option for the contact athlete who desires an early return to competition or in case of a comminuted fracture pattern. In this instance, it is recommended that the plate be placed on the radial or ulnar border of the phalanx to avoid scarring from the closely adhered extensor tendon on the dorsal aspect of the phalanx [11, 16, 17]. In the representative case, plate fixation was performed for an American football player. For traditional patients, intramedullary reduction and external fixation may be indicated as a surgical option (Fig. 5a, b). However, plate fixation is the better option for athletes wanting to return early to competition. In metacarpal fractures, plate fixation is better tolerated with a decreased risk of stiffness compared with the phalanges. Therefore, plate fixation allows for an immediate return to competition with protective bracing and is recommended for athletes who desire an early return to competition or training [7–9, 12, 13]. It is also suggested for contact athletes who have a long spiral fracture, transverse fracture or comminuted fracture.

It can be difficult to determine the optimum therapeutic strategy for athletes in mid-season as they are eager to resume participation in their sport as soon as possible, but a level-headed and prompt medical judgment needs to be made by the attending physician. The pros and cons of surgery need to be considered. Unlike the leg joints, the hand joints are not subject to load-bearing forces. Accordingly, athletes with hand joint injuries can return to activity relatively early thanks to advances in surgical techniques and external immobilization. However, attending physicians are unsure about approving early participation in games compared to early training as there is no specific protocol for treatment of athletes with such external injuries who are aiming to have an early return to competition. Singletary et al. [7] reported that the desires and motivation of the player, coach and parents may pressure the physician to return the patient to play more quickly than is safely possible. Accordingly, it is considered that the decision should be made in a comprehensive manner by taking into consideration such conditions as the

Fig. 2 Representative case. **a** A 21-year-old male university student suffered a fracture-dislocation of the PIP joint. The patient resumed training 1 week after the operation and participated in the championship game 3 weeks after surgery, which resulted in no complications regarding finger function. TAM was 270° at the latest follow-up. **b** Anterior-posterior and lateral radiograph before surgery. **c** Anterior-posterior and lateral radiograph the day after participating in the game. **d** Anterior-posterior and lateral radiograph after surgery at the latest follow-up (24 months after the operation)

time period before the game, significance of the game, kind of sport activity, positioning of the athlete in the sport, site of fracture, hand dominance, background of the athlete in the activity, degree of expected functional recovery until the game, intent of others related to the athlete (family, coaches) and the potential of the athlete.

The therapeutic policy of our department is as follows. After informed consent has been obtained from the athlete and/or guardians, surgery is performed for patients who anticipate playing in a game in the next 2 weeks or later and who are expected to gain restoration of function to some extent during the early postoperative period. Because of the nature of the injury, some athletes must give up their hope of participating in an upcoming competition in accordance with the type of sport activity, the site and form of the fracture.

During the postoperative period, we frequently observe the affected site while the athlete is training for the game [18]. Swelling and pain are inevitable just after surgery, especially in the affected site. Rehabilitation is planned in accordance with the severity of the injury. Notably, when an excessive load is exerted on the affected site during the initial 2 weeks after surgery, inflammation and swelling will not disappear, causing a delay in functional recovery. Therefore, we prohibit training for up to 1 week and observe the affected site twice a week until participation in the competition, including radiography to provide guidance for the degree of training and rehabilitation. The athletes with metacarpal, phalangeal fractures can manage an early comeback with adequate taping and protection of the affected site after surgery and an experienced hand therapist can design a functional brace that allows for the athlete's specific needs, enabling athletic participation within weeks of surgery [12, 13, 15, 18].

Treatment is designed to maintain or restore skeletal alignment and reestablish normal hand function while

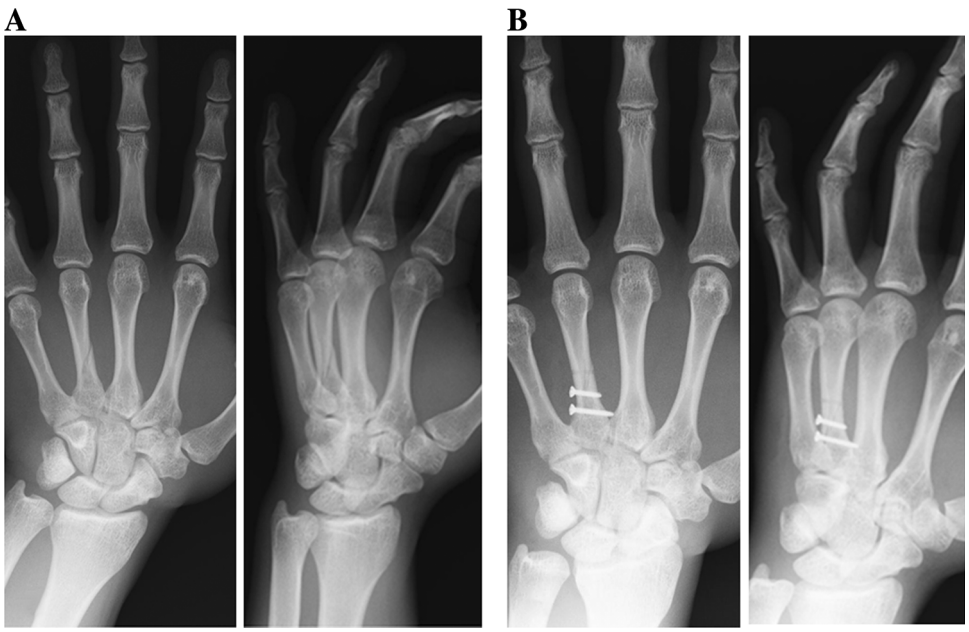

Fig. 3 Case 12. Surgical treatment is occasionally recommended for athletes who want to return early to competition or training, minimizing lost playing time, even though conservative treatment is indicated for stable fractures. **a** Anterior-posterior and lateral radiograph before surgery. **b** Anterior-posterior and lateral radiograph after surgery

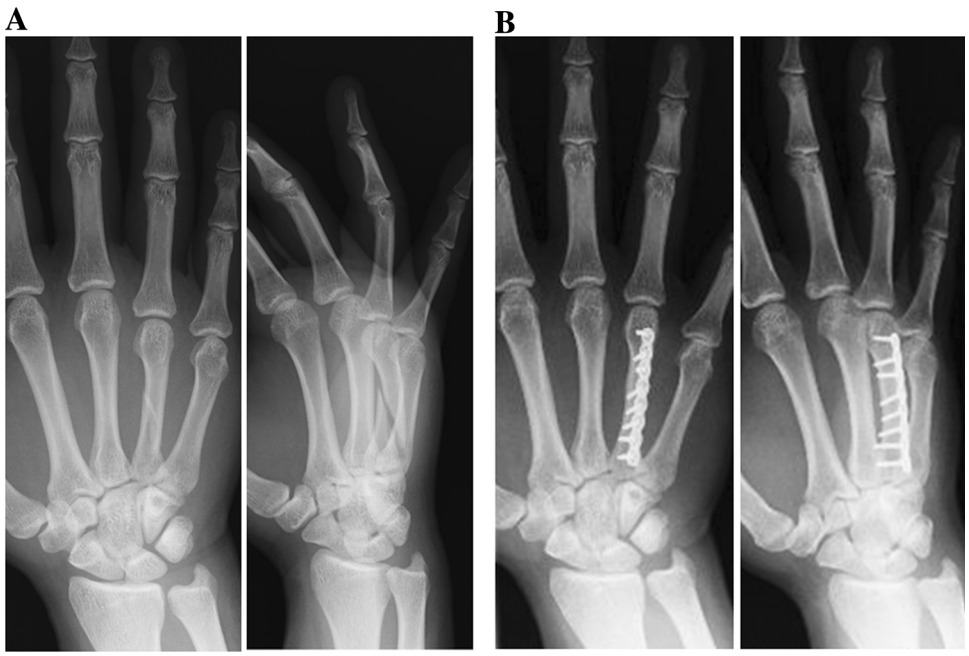

Fig. 4 Case 20. Longer plate fixation is occasionally indicated for the purpose of rigid fixation for athletes to return early to competition or training, even though screw fixation is indicated. **a** Anterior-posterior and lateral radiograph before surgery. **b** Anterior-posterior and lateral radiograph after surgery

minimizing lost playing time and altered performance. No matter what the level of play, the injured athlete may press to return to normal competitive levels and expect the physician to be able to restore immediate or early functional excellence. Therefore, the treatment of hand fractures in athletes can be a challenge for both surgeons and patients. Because of their special needs and the issue of returning to play, athletes often pose a unique challenge in the management of hand fractures. Surgeons should consider treatment and hand therapy without complications, including stable fixation and techniques that avoid or limit additional soft tissue damage.

This study had several limitations. First, it was a retrospective study and small case series. Second, it did not have a control group undergoing conservative treatment for metacarpal and phalangeal fractures in athletes desiring an early return to play because of a pending important game in their competition within 1 month after injury.

The present 20 athletes were able to obtain bone union and recover favorable function after surgery without functional

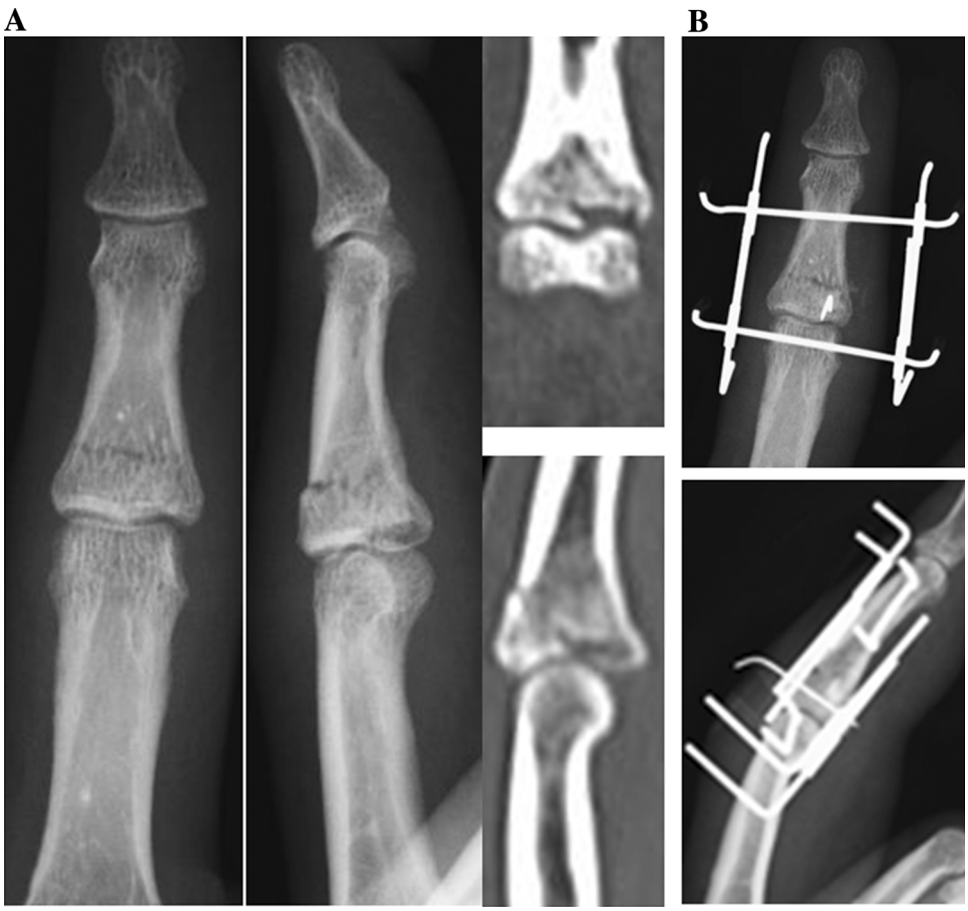

Fig. 5 These figures show middle phalangeal intra-articular fracture of the PIP joint. Intramedullary reduction and external fixation may be indicated as a surgical option for traditional patients. **a** Anterior-posterior, lateral radiograph and computer tomography before surgery. **b** Anterior-posterior and lateral radiograph after surgery

disturbance caused by making an early comeback to the sport activity. However, for early comeback cases, especially those within 1 month after surgery, there are always potential complications. Therefore, it is important for the attending physician to administer such treatment after obtaining informed consent and develop a trusting relationship with the patient and other related individuals while paying attention to their hope of quick recovery. The physician should make treatment decisions that keep the patient's overall athletic career and future hand performance in mind.

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

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