

Treatment of dorsal fracture dislocation of proximal interphalangeal joint by open reduction and internal fixation using titanium anchor: Novel technique

Ahmed Abdelazim Abosalem. MD and Ahmed Naser Elbarbary, MD.

Lecturers of Orthopaedic Surgery, Faculty of Medicine, Menoufia University, Shebin El-Kom, Menoufia, Egypt

Correspondence to: Ahmed Abdelazim Abosalem. MD

Postal Address: Department of Orthopaedic Surgery, Faculty of Medicine, Menoufia University, Shebin El-Kom, Menoufia, Egypt.

Email:

ahmed.abosalem@med.menofia.edu.eg

ORCID: 0000-0002-1957-2629

Telephone: +201064348989

The Egyptian Orthopedic Journal; 2022 supplement, December, 57: 44-49

ABSTRACT

Background:

Proximal interphalangeal joint (PIPJ) fracture-dislocations can be dorsal or volar. Dorsal dislocations of the PIPJ with volar lip fractures are the most common pattern. Treatment of such injuries especially with high comminution is challenging. Anatomical reduction of the volar lip fracture fragment with stable fixation and early range of motion (ROM) is paramount to obtaining good results. In this article, we report the results of the treatment of dorsal fracture dislocation of PIPJ by open reduction and internal fixation of the volar lip fragment and reattachment of the volar plate using a 2.8 mm titanium anchor.

Patients & Methods:

The present study was a prospective case series of patients who had dorsal fracture-dislocations of the PIPJ treated by open reduction and internal fixation of the volar lip fragment and reattachment of the volar plate using a 2.8 mm titanium anchor. Postoperative functional outcomes were evaluated after 6 months by assessment of the visual analog scale (VAS), Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) score. Postoperative complications e.g., infection, stiffness, and loss of reduction were recorded.

Results:

In this study, 23 patients were included, 19 (82.6%) males and 4 (17.39%) females. After a six-month follow-up fracture union was achieved in all patients with no joint subluxation. There was no infection or loss of reduction. The ROM of the PIPJs was stable. Postoperative ROM in 21 (91.3%) patients was 87.4 ± 11.2 degrees which was near the normal ROM of the same finger on the other hand ($p = 0.1$). The ROM in two patients was 60 degrees and painful. The mean postoperative VAS score was 2.5 ± 1.1 . The mean postoperative Quick Dash score was 8.3 ± 1.22 .

Conclusion:

Treatment of dorsal fracture dislocation of the PIPJ by open reduction and internal fixation with volar plate reattachment using titanium anchor provides anatomical reduction of the articular surface, stable fixation of the volar lip fragment, well reattachment of the volar plate and early range of motion with good functional outcomes.

Keywords:

Dorsal Fracture Dislocation PIP, Open reduction internal fixation, Volar plate Reattachment, Titanium Anchor.

INTRODUCTION

Dorsal fracture-dislocations of the PIPJ are usually caused by axial load over the PIPJ while the joint is held in a mild degree of flexion. The axial load causes the volar lip of the middle phalanx to shear off as it hits the head of the proximal phalanx. It also may result from hyperextension injury of the PIPJ that leads to failure of the volar plate resulting in rupture or avulsion of the middle phalangeal volar lip (1).

Dorsal fracture dislocation of the PIP joint can be classified into type I (stable): with involvement of less than 30 % of the articular surface, type II (tenuous): with involvement of 30–50 % of the articular surface, and type III (unstable): in which

more than 50% of the articular surface involved. The threshold for stability is about 40 % involvement of the articular surface of the middle phalanx base (2).

There are several methods to treat such injuries including extension block using a splint or through closed pinning (3), dynamic external fixations (4), open reduction and internal fixation using volar buttressing plating (5), volar plate arthroplasty (6), hemihamate autograft reconstruction (7), and arthrodesis in neglected and complicated injuries by osteoarthritis (8). Anatomical reduction of volar lip fracture fragment with stable fixation and early range of motion is paramount to obtain good results. The volar plate is also commonly disrupted

in dorsal fracture-dislocations and the failure to recognize and treat such injury will lead to a swan-neck deformity. Any delay in the diagnosis and/or treatment will lead to stiffness and later osteoarthritis of the PIP joint and will greatly affect hand function (1).

In this study, we report the results of the treatment of dorsal fracture dislocation of PIPJ by open reduction and internal fixation of the volar lip fragment and reattachment of the volar plate using a 2.8 mm titanium anchor.

PATIENTS AND METHODS

This study was a prospective case series of 23 patients with dorsal fracture dislocation of PIP joints who had been admitted to the Menofia University Hospital from January 2019 to February 2021 with a minimum of 6 months follow-up. A single-hand orthopedic surgeon performed all the operations. The study was approved by Menoufia University Institutional Review Board (IRB) and the ethical committee. Written consent about the procedure and possible complications was taken.

Inclusion criteria were (a) age was between 17 and 50 years; (b) Type II and III with involvement of more than 50 % of the articular surface of the base

of the middle phalanx (c) recent fractures in which surgical interference was done within one week from the onset of the injury.

Exclusion criteria were (a) highly comminuted (Pilon) fracture dislocation; (b) open fractures; and (c) history of prior surgical interference. Patients had to complete at least six months of follow-up to be considered for the study.

Preoperative evaluation

A detailed history was obtained for assessment of the mechanism of injury. The general and local examination was done for evaluation of the skin condition and associated injuries. Plain X-rays of the injured hand, anteroposterior and oblique views. A lateral X-ray of the injured finger was obtained, **Fig.1**. Laboratory investigations as preoperative assessment in the form of complete blood count, bleeding profile, liver function tests, kidney function tests, and random blood sugar. In all patients, a single prophylactic antibiotic was administered 2 hours before surgery in the form of a third-generation cephalosporin injection, and the dose was adjusted according to the weight of the patient.



Figure 1: Preoperative plain X-ray (lateral and AP views) of the twenty-five-year-old man with volar lip fracture and dorsal fracture dislocation of PIPJ of the right ring finger.

Surgical technique

The procedure was done with the patient in a supine position and the affected upper limb was placed on a radiolucent table. General anesthesia with digital block anesthesia using 10 ml (5 ml xylocaine 1%- and 5 ml bupivacaine 0.5%) was used. A pneumatic tourniquet was applied over smooth padding at the mid-arm. After sterilization and draping of the affected limb, a sterile Esmarch bandage was used to exsanguinate the limb followed by inflation of the pneumatic tourniquet to a pressure 100 mmHg more than the

systolic blood pressure. A trapezoidal-shaped skin incision was made over the volar aspect of the PIPJ with the elevation of the skin flap superficial to the neurovascular bundle. The flexor sheath between the A2 and A4 pulleys was sharply divided from one side and reflected with exposure of the underlying flexor tendons. The PIPJ was entered between the accessory collateral ligament and the volar plate. For proper exposure of the PIPJ, the volar plate was detached from the base of the middle phalanx (from the volar lip fragment) and the collateral ligaments were detached from

the proximal phalanx. The PIPJ was hyperextended with the displacement of the flexor tendons to one side for proper exposure to the fracture site, **Fig 2**. The volar rim fragment was reduced anatomically and fixed by the 2.8 mm titanium anchor and the reduction is checked under the C Arm image, **Fig 3**. The volar plate was reattached to the base of the middle phalanx utilizing the sutures of the titanium anchor, **Fig 4**. The collateral ligaments were proximally reattached by suturing them to the volar plate. The stability of the PIPJ was clinically and radiologically tested through a continuous range of motion under a C-arm image followed by skin closure. The patients were placed in a dorsal hand splint in the functional position.

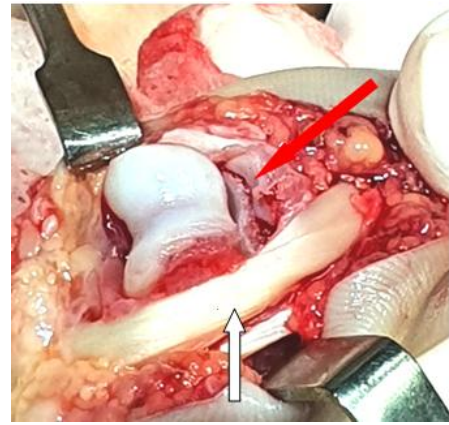


Figure 2: Intraoperative clinical image showing hyperextension of the PIPJ with exposure of the volar lip fragment (red arrow) and displaced flexor tendons (white arrow)

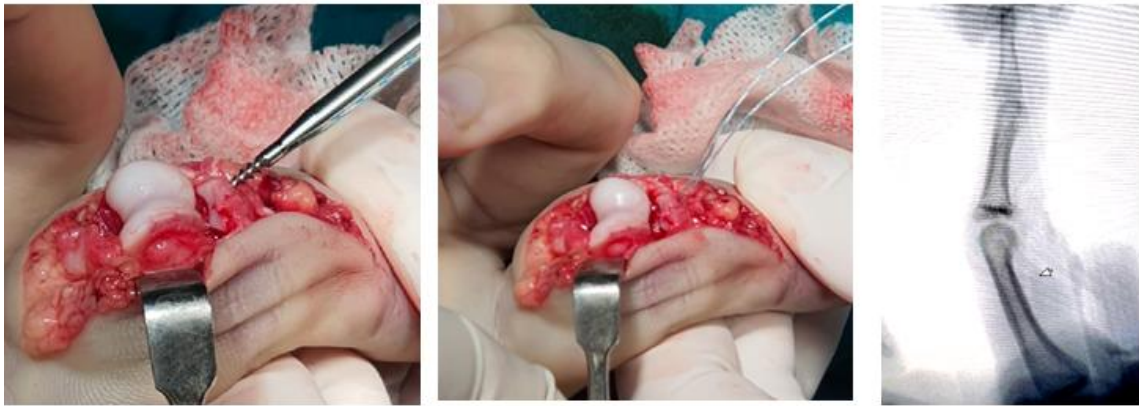


Figure 3: anatomical reduction of the articular surface and fixation using 2.8 titanium anchor



Figure 4: Volar plate and collateral ligaments reattachment

Postoperative care and functional evaluation

Plain X-rays of anteroposterior and lateral views were obtained on the first postoperative day. Two days postoperatively, follow up in outpatient

clinic for assessment of wound status and start active ROM of the PIPJ. Two weeks postoperatively, skin sutures were removed with the application of a removable splint with intermittent active range of motion. Four weeks postoperatively, the removal of the splint was done, and full passive ROM. Six weeks postoperatively, strengthening exercises were started. Three months postoperatively, return to full activity after ensuring complete radiological union of the fracture. Final clinical and radiological evaluation was done after six months follow-up, **Fig. 5**. Postoperative functional outcomes were evaluated after 6 months by assessment of the ROM of the PIP joints, the visual analog scale (VAS), and the quick disabilities of the arm, shoulder, and hand (Quick DASH) score. Radiological evaluation was done by assessment of the radiological union and joint congruity. Postoperative complications e.g., infection, stiffness, and loss of reduction were recorded.



Figure 5: Six-month postoperative lateral and AP plain X-ray with complete healing of volar lip fragment, anatomical reduction of the articular surface, and restoration of the joint congruity

Statistical analysis

At the end of the study, the data were collected, tabulated, and statistically analyzed by IBM SPSS (statistical package for social science) version 23. Qualitative variables were evaluated using the Chi-square test. The quantitative variables were compared with the opposite side using Mann-Whitney and T-tests. The significance level was set at P-values less than 0.05.

RESULTS

A total of 23 patients met the inclusion criteria for this study, 19 (82.6%) males and 4 (17.39%) females with an average age of 26.3 ± 8.2 (range, 19-45) years. The ring finger was injured in eleven patients, five middle fingers, four index fingers, and three little fingers.

Nine patients were of type II and 14 patients were of type III. The minimum follow-up period was six months. All the patients were done within one week from the onset of the injury. The mean duration from trauma to surgery was 3.3 ± 1.5 days.

At the final follow-up, the radiological union was achieved in all patients with no joint subluxation or incongruity. The mean duration of the radiological union was 5 ± 2.54 weeks. The ROM of the PIPJs was stable. Postoperative ROM in 21 (91.3%) patients was 87.4 ± 11.2 degrees which was near the normal ROM of the same finger on the other hand ($p = 0.1$). The infection happened in two patients with the stiffness of the PIPJs with painful and limited ROM (60 degrees). They were managed by daily dressing and antibiotic therapy. After the subsidence of the infection, arthrodesis of the PIPJs was done in those two patients. There

was no statistically significant difference between the type of injury (II or III) and the final ROM. The mean postoperative VAS score was 2.5 ± 1.1 . No pain in 14 patients, mild pain in seven patients, and severe pain in two patients. The mean postoperative Quick Dash score was 8.3 ± 1.22 . Twenty-one patients returned to their previous activity after four months. There was no loss of reduction or joint subluxation.

DISCUSSION

Dorsal fracture dislocation of the PIP joints of the fingers can markedly impair hand function if not early diagnosed and properly managed. Restoration of the joint congruity, stable fixation of the fracture, soft tissue repair, and early joint ROM are paramount to obtaining good results while treating such injuries (9).

Fractures that involve less than 30% of the articular surface are usually stable and can be treated with an extension block using a dorsally placed splint. Hamer et al in 1992 reported good results using this technique in 27 patients (10).

Fractures that involve more than 30% are usually unstable, and the use of a dorsal-blocking splint as a treatment method for these injuries has a poor outcome.

Several methods were used to treat such unstable dorsal fracture dislocation of the PIP joints. Waris et al. 2016 treated 41 fingers with unstable dorsal fracture dislocation of the PIP joints by closed reduction and extension block pinning with a mean follow-up period of 5.2 years. The mean range of motion of the PIP joints was 80° (range, 35° to 115°) with a mean extension loss of 6° (range, 0° to 50°) excluding 2 joints that were salvaged with arthrodesis. They reported recurrent subluxation of the PIP joints in 29% of the patients after hardware removal, which was associated with increased residual pain (11).

Closed reduction of the dorsally dislocated PIP joint can be achieved and maintained by a dynamic distraction external fixator that allows an early active range of motion as reported in the Ruland et al study but the anatomical reduction of the volar lip fracture fragment cannot be fully achieved using this method that can lead to malunion with an articular step of and limited painful ROM (12). Ruland et al treated 26 PIP fracture dislocations using a dynamic external fixator with a mean follow-up period of 16 months. The mean final range of motion of the PIP joints was 88° . They reported 23.5% superficial pin tract infection (12). The dynamic external fixation method using k wires and rubber bands may have possible complications such as over-distraction of the PIP joint leading to postoperative stiffness, pin tract

infection that may lead to osteomyelitis, and loss of reduction due to tear of the rubber bands.

Volar plate advancement arthroplasty provides resurfacing of the irregular volar articular surface of the middle phalanx besides providing a volar restraint to maintain the reduction of the PIP joint (13). This method has a rate of complication, especially in unstable types with involvement of more than 40 % of the articular surface such as flexion contracture of the PIP joint that may reach up to 77% as in the Meena¹³ study, re-dislocation or subluxation of the PIP joint that may reach up to (31%) as in Hastings and Carroll study¹⁴. (13-14) Hemi-hamate arthroplasty is another method that can be used to treat comminuted fracture dislocation PIP joint. Kato et al.¹⁵ treated 13 patients with unstable dorsal fracture-dislocations of the PIP joint with a modified technique of Hemi-hamate arthroplasty. They reported that the average ROM of the PIP joint was improved significantly to 71.3 degrees at the final follow-up. Union was achieved in all patients except one patient who showed mild graft absorption and three patients who showed a mild degenerative change of PIP joints. (15) Hemi-hamate arthroplasty is better used to treat comminuted dorsal fracture-dislocations of the PIP joint because of donor site morbidity and it is a technically demanding procedure.

Afshar et al. 2020 treated 21 patients with dorsal fractured dislocation of PIP joints using a volar buttressing hook plate. They reported that the mean postoperative ROM was 85.7 ± 13.2 degrees in 90.5% of the patients They reported that there were symptoms of plate irritation in 9.5% of the patients (16). Singh T et al. 2019 treated 11 patients using a volar four-hole buttress plate. The reported fixed flexion deformity (FFD) of the PIP joint in 63.3 % of the patients. The mean FFD of the PIPJ was 14 degrees. The mean Quick-DASH score was 13 (17). Watanabe K. 2019 treated 12 patients using a volar buttress plate. They reported that the mean final ROM of the PIP joints was 94.2 (range, 85-115) degrees of flexion and 0 (range, -15-5) degrees of extension (18).

In this study, 23 patients with dorsal fractured dislocation of PIP joints were treated using a 2.8 mm titanium anchor as a method of fixation of the volar lip fragment and for reattachment of the volar plate. After a six-month follow-up, fracture union was achieved in all patients with no joint subluxations. There was no infection, loss of reduction, or hardware irritation. The ROM of the PIPJs was stable. Postoperative ROM in 21 (91.3%) patients was 87.4 ± 11.2 degrees which was near the normal ROM of the same finger on the other hand ($p=0.1$). The ROM in two patients

was 60 degrees and painful. The mean postoperative VAS score was 2.5 ± 1.1 . The mean postoperative Quick Dash score was 8.3 ± 1.22 . The results of this study are comparable to the results of ORIF using the volar buttress plate but without hardware manifestations. This technique provides stable fixation of the volar lip fragment, restoration of the joint congruity, soft tissue repair, and early joint ROM without hardware irritation.

CONCLUSION

Using a titanium anchor for internal fixation of the volar lip fragment and volar plate reattachment is a safe and reliable method for the treatment of dorsal fracture dislocation of the PIP joint of the fingers with good functional outcomes.

REFERENCES:

- 1- Caggiano NM, Harper CM, Rozentel TD. Management of Proximal Interphalangeal Joint Fracture Dislocations. *Hand Clin.* 2018;34(2):149-165.
- 2- Kiefhaber TR, Stern PJ. Fracture dislocations of the proximal interphalangeal joint. *J Hand Surg Am.* 1998;23(3):368-380.
- 3- R. Maalla, M. Youssef, G. Ben Jdidia, C. Khimiri, H. Essadam. Extension-block pinning for fracture-dislocation of the proximal interphalangeal joint. *Orthop. Traumatol.: Surg. Res.* 2012; 98(5):559-563.
- 4- Sastravaha N, Limudomporn K, Tawewuthisub W. A Novel Technique for Dynamic External Fixation of Proximal Interphalangeal Joint Fracture-Dislocations. *J Hand Surg Asian Pac Vol.* 2020;25(4):427-433.
- 5- Cheah AE, Tan DM, Chong AK, Chew WY. Volar plating for unstable proximal interphalangeal joint dorsal fracture-dislocations. *J Hand Surg Am.* 2012;37(1):28-33.
- 6- Dionysian E, Eaton RG. The long-term outcome of volar plate arthroplasty of the proximal interphalangeal joint. *J Hand Surg Am.* 2000;25(3):429-437.
- 7- Yang DS, Lee SK, Kim KJ, Choy WS. Modified hemihamate arthroplasty technique for the treatment of acute proximal interphalangeal joint fracture-dislocations. *Ann Plast Surg.* 2014;72(4):411-416.
- 8- Millrose M, Gesslein M, Ittermann T, Kim S, Vonderlind HC, Ruettermann M. Arthrodesis of the proximal interphalangeal joint of the finger - a systematic review. *EFORT Open Rev.* 2022 Jan 11;7(1):49-58.
- 9- Bindra R, Colantoni Woodside J. Treatment of Proximal Interphalangeal Joint Fracture-Dislocations. *JBJS Rev.* 2015;3(12):e1.
- 10- Hamer DW, Quinton DN. Dorsal fracture subluxation of the proximal interphalangeal joints treated by extension block splinting. *J Hand Surg Br.* 1992;17(5):586-590.
- 11- Waris E, Mattila S, Sillat T, Karjalainen T. Extension Block Pinning for Unstable Proximal Interphalangeal Joint Dorsal Fracture Dislocations. *J Hand Surg Am.* 2016;41(2):196-202.
- 12- Ruland RT, Hogan CJ, Cannon DL, Slade JF. Use of dynamic distraction external fixation for unstable fracture-dislocations of the proximal interphalangeal joint. *J Hand Surg Am.* 2008;33(1):19-25.
- 13- Meena DK. Functional evaluation of volar plate advancement arthroplasty in fracture dislocation of the proximal interphalangeal joint. *J. Orthop. Trauma Rehabilitation.* 2018;10(1):13-18.
- 14- Hastings H 2nd, Carroll C 4th. Treatment of closed articular fractures of the metacarpophalangeal and proximal interphalangeal joints. *Hand Clin.* 1988;4(3):503-527.
- 15- Kato N, Koike T, Zakaria AF. Modified Hemihamate Arthroplasty With Oblique Osteotomy of the Middle Phalanx Base to Reconstruct the Proper Contour of the Articular Surface. *Tech Hand Up Extrem Surg.* 2020;24(2):79-84
- 16- Afshar A, Tabrizi A, Taleb H, Safari M. Results of fracture-dislocation of interphalangeal treatment with volar buttressing

hook plating techniques. Orthop Traumatol Surg Res. 2020;106(4):765-769.

- 17- Singh T, Jayawardhana R, Craigen M, Rajaratnam V.** Volar Buttress Plating for Unstable Dorsal Fracture-Dislocations of the Proximal Interphalangeal Joint. J Hand Microsurg. 2019 Aug;11(2):106-110.

- 18- Watanabe K.** Volar Buttress Plating for Dorsal Fracture-Dislocation of the Proximal Interphalangeal Joint With a Central Depressed Fragment: A Preliminary Report of 12 Cases. J. Hand Surg. Glob. Online 2019;1:101-104.