—Case Reports—

Two Cases of Flexor Digitorum Profundus Avulsion due to Enchondroma of the Distal Phalanx

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Abstract

Avulsion of the flexor digitorum profundus tendon with fracture of the distal phalanx is rare. Moreover, enchondroma is less frequent in the distal phalanx. We report two unusual cases of avulsion of the flexor digitorum profundus tendon at its insertion in combination with pathological fracture of the distal phalanx due to enchondroma. Curettage and bone grafting were performed for an enchondroma of the distal phalanx. The flexor digitorum profundus tendon and the avulsed bone fragment were reinserted through the bone graft into the distal phalanx using the pull-out technique. With Strickland's criteria, the clinical results were evaluated as excellent in both cases. At the final follow-up examinations, there were no symptoms and no recurrence of the bone tumor. In the present cases, three-dimensional computed tomography imaging was useful for diagnosing the flexor tendon avulsion, determining the preoperative identification the location of a ruptured tendon stump, and planning the operation to minimize the surgical wound. The recommended treatment for avulsion of the FDP tendon due to enchondroma is curettage, bone grafting of the resultant cavity, and reattachment of the tendon to ensure sufficient structural strength to permit secure fixation and early mobilization and, especially, to prevent flexion contracture of the finger because the stump of the flexor digitorum profundus is buried in the cavity of the distal phalanx.
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Key words: flexor digitorum profundus, avulsion, enchondroma, tendon rupture, three-dimensional computed tomography

Introduction

Avulsions of the flexor digitorum profundus (FDP) tendon are well-known injuries[1–3] that have been classified into 3 types according to the extent of tendon retraction[3]. Type III injury, involving a bone fragment that is avulsed by the tendon and is caught at the level of the A4 pulley, is rare, and only a few cases have been described so far[4]. Moreover,

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Fig. 1 Initial radiographs of left fifth finger: posteroanterior view (a) and lateral view (b). Initial radiographs of left little finger shows a translucent lesion at the base of the distal phalanx with thinned cortex, and an avulsion fracture of the base of the distal phalanx located on its palmar side of the middle phalanx 5 mm proximal to the DIP joint, and simultaneous fracture of the shaft of the distal phalanx.

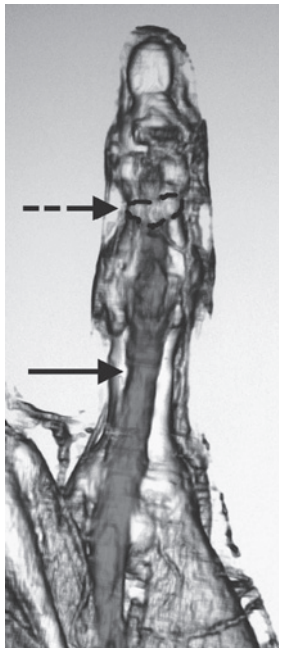

Fig. 2 3D-CT imaging with the volume rending technique of left fifth finger: posteroanterior view.
3D-CT demonstrates the avulsed bone fragment attached to the FDP was caught at the level of the distal A4 pulley

enchondroma is common in the bones of the hand[5] but are less frequent in the distal phalanx[6]. Furthermore, avulsion injury of the FDP tendon due to enchondroma of the distal phalanx is extremely rare[7–13]. The present report describes 2 cases of FDP avulsion due to enchondroma of the distal phalanx. The diagnosis and treatment of this injury are also discussed.

Case Reports

Case 1

A 35-year-old man sustained an injury of the left fifth finger when he held onto the handle of his bag while another train passenger pulled it away forcefully. Physical examination revealed swelling and tenderness of the palmar surface of the distal interphalangeal (DIP) joint of the fifth finger and an inability to flex the joint. Initial radiographic and computed tomographic (CT) studies showed a translucent lesion at the base of the distal phalanx with thinned cortex, an avulsion fracture of the base of the distal phalanx located on its palmar side of the middle phalanx 5 mm proximal to the DIP joint, and a fracture of the shaft of the distal phalanx **(Fig. 1a, b)**. Three-dimensional computed tomography (3D) CT, which can demonstrate the flexor tendon with the volume rendering technique, showed an avulsed bone fragment attached to the FDP was caught at the level of the distal A4 pulley **(Fig. 2)**. Seven days after injury, surgical exploration confirmed that the FDP tendon with a small fragment of bone had been avulsed at its insertion, as had been shown with 3D-CT **(Fig. 3)**. The fragment was caught by the A4 pulley. Curettage of the distal phalanx and grafting to the defect of bone from the olecranon were performed. The FDP tendon with the avulsed bone fragment was reinserted through the bone graft into the distal phalanx using the pull-out technique **(Fig. 4)**. The transverse fracture of the distal phalanx was fixed with a Kirschner wire. Histological examination confirmed the diagnosis of enchondroma. Early mobilization of the metacarpophalangeal (MP) joint

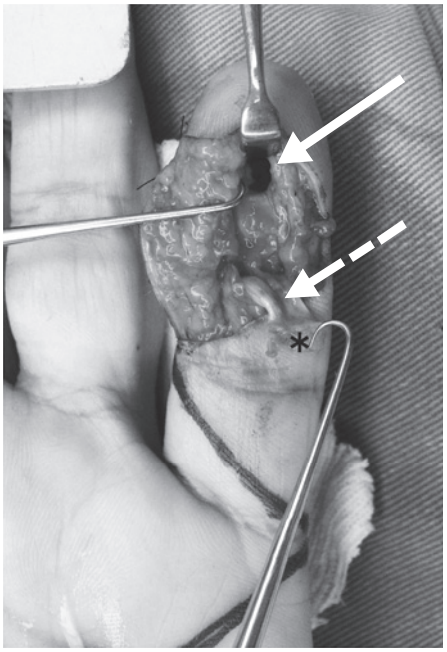

Fig. 3 Intraoperative photograph showing an avulsed FDP tendon with a bone fragment.
(a) Arrow: bone cavity of the distal phalanx.
(b) Arrowhead: an avulsed FDP tendon with a bone fragment. (*) Asterisk: an avulsed bone fragment.
Surgical exposure shows that the FDP tendon with a small fragment of bone is avulsed from the distal phalangeal cavity, as 3D-CT reveal had shown.

Fig. 4 Postoperative radiographs of left fifth finger: lateral view.
Postoperative radiographs of the left fifth finger shows curettage with bone grafting of the resultant cavity and reattachment of the tendon using the pull-out technique.

with 90-degree flexion was performed with a dorsal splint but without fixation of the DIP or the proximal interphalangeal (PIP) joint to allow active movement immediately after surgery. The splint was removed after 3 weeks. Six weeks after surgery the bone had healed satisfactorily, and the Kirschner wires and the pull-out wire were removed. At the 2-year follow-up evaluation, the patient had no symptom **(Fig. 5)** and no recurrence of the bone tumor. The ranges of motion of the affected fifth finger were 0° to 50° at the DIP joint and 0° to 90° at the PIP and MP joints. Percent total active motion (TAM) of the fifth finger was 96% (affected TAM 230°/unaffected TAM 240° × 100). According to Strickland's criteria, the clinical result was evaluated as excellent.

Fig. 5 Postoperative radiographs of the left fifth finger: lateral view.
Postoperative radiographs of the left little finger shows satisfactory bone healing and no recurrence of the bone tumor 2 years after surgery.

Case 2

A 36-year-old man sustained an injury of the fourth finger by falling down while walking.

Fig. 6 Initial radiographs of right fourth finger: lateral view.
Initial radiographs of the right fourth finger shows a translucent lesion at the base of the distal phalanx with thinned cortex, and an avulsion fracture of the base of the distal phalanx located on its palmar side of the middle phalanx.

Fig. 7 Postoperative radiographs of the right fourth finger: lateral view.
Postoperative radiographs of the right fourth finger show satisfactory bone healing and no recurrence of the bone tumor 2 years after surgery.

Examination showed marked swelling and tenderness of the fourth finger, particularly on the palmar aspect of the DIP joint, and no active flexion at the DIP joint. Initial radiographic examination showed a translucent lesion at the base of the distal phalanx with thinned cortex, and an avulsion fracture of the base of the distal phalanx was located on its palmar side of the middle phalanx **(Fig. 6)**. Ten days after injury, surgical exploration revealed complete avulsion of the FDP tendon with an attached fragment of bone from its insertion. The avulsed bone fragment was caught at the level of the distal A4 pulley. Curettage of the distal phalanx and grafting to the defect of bone from the olecranon were performed. The FDP tendon with the avulsed bone fragment was reinserted through the bone graft into the distal phalanx using the pull-out technique. Histological examination confirmed the diagnosis of enchondroma. The postoperative course was uneventful. Early mobilization of the MP joint with 90-degree flexion was performed with a dorsal splint but without fixation of the DIP and PIP joints to allow active movement immediately after surgery. The splint was removed after 3 weeks. Six weeks after surgery the bone had healed satisfactorily, and the pull-out wire were removed. At the 2-year follow-up evaluation, the patient had no symptoms **(Fig. 7)**. The fourth finger showed a full range of motion. There was no reccurence of the bone tumor. According to Strickland's evaluation, the clinical result was evaluated as excellent.

Discussion

Avulsion of the FDP tendon at its insertion is a well-recognized injury that has been classified by Leddy and Packer into 3 types[3]. In type I, the tendon avulses from the distal phalanx and retracts into the palm without a bone fragment. In type II, the most common type, the tendon retracts to the level of the PIP joint with or without a bone fragment. In type III, the least common type, the tendon avulses along with a bone fragment that is caught at the distal (A4) pulley, preventing proximal

retraction beyond the pulley. In addition, Smith has suggested that avulsion of a bone fragment from the distal phalanx and associated avulsion of the tendon from the fragment with subsequent retraction of the tendon should be classified as a type IV injury[14]. Only a few cases of type III injury have been described[4]. The present cases were classified as type III.

Incidentally, enchondroma is common in the hand[5], accounting for 15.0% of bone tumors there. Enchondromas arise most often in the proximal phalanges and metacarpals and less often in the distal phalanges[6].

Avulsion injury of the FDP tendon at its insertion in association with pathological fracture of a distal phalanx due to enchondroma is extremely rare[7–13]. Ogunro reported the first such case in 1983[11]. Subsequently, only 7 cases have been reported, indicating that this injury is rare.

In cases of FDP tendon avulsion, identifying the location of the ruptured tendon stump is useful for preoperative planning and to minimize the surgical wound. Trumble et al[15] have reported that of 9 cases diagnosed as type III on the basis of radiographs, 6 cases had misleading radiographs and were actually type IV injuries in which the tendon had become separated from the bone fragment at the time of exploration. Therefore, deteremining preoperatively whether the FDP tendon has retracted into the tendon sheath or the palm with or without a fragment of bone is difficult by means of radiographs alone. Ultrasonography and magnetic resonance imaging (MRI) are valuable diagnostic methods in this situation. However, the diagnostic accuracy of ultrasonography is very much dependent upon the examiner[16], and MRI cannot demonstrate the complete course of a flexor tendon in the hand with just a few images[17].

On the other hand, 3D-CT imaging of the extremities is used to visualize the structure and disorders of bones and joints. Moreover, 3D-CT with the volume rendering technique can demonstrate the relationship between bony structures and flexor tendons in the hand and wrist[18]. Sunagawa et al have reported that flexor tendon ruptures could be visualized with 3D-CT in all 21 cases examined[18]. Furthermore, all diagnoses based on imaging findings were the same as those based on operative findings, namely, the tendon stumps were found at the same level as demonstrated with imaging studes. In the present cases, tendons with bone fragments were clearly shown with 3D-CT imaging and volume rendering. Thus, 3D-CT imaging can be useful for diagnosing flexor tendon avulsion, especially, for distinguishing type III and type IV, and can be helpful in surgical planning.

The standard treatment for FDP tendon avulsion with a bone fragment due to enchondrma has been reattachment of the tendon to the distal phalanx using the pull-out technique, curettage, with bone grafting. In contrast, some authors have suggested that bone grafting is unnecessary for enchondroma of the hand. However, most authors recommend filling a curetted bone cavity with a bone graft, usually harvested from the iliac crest or olecranon, or a bone substitute. The reason for bone grafting is to minimize the volume of the bone defect, to maintain bone strength, and to encourage new bone formation and the early acquisition of bone strength. Incidentally, the most important points in the treatment of this injury are rigid attachment of the avulsed FDP tendon and early mobilization. In case of this enchondroma with the avulsed FDP tendon, curettage alone might leave dead space and weak bone, and the stump of the FDP with the thinned bone fragment might become buried in the cavity of the distal phalanx. Consequently, simple curettage without bone grafting may lead to flexion contracture of the DIP joint. Therefore, for avulsion of the FDP tendon due to enchondroma it is recommended that both curettage with bone grafting of the resultant cavity and reattachment of the tendon be performed so that structural strength is sufficient to permit secure fixation and early mobilization.

References

1. Boyes JH, Wilson JN, Smith JW: Flexor-tendon ruptures in the forearm and hand. J Bone Joint Surg 1960; 42A: 637–646.
2. Carrol RE, Match RM: Avulsion of the flexor profundus tendon insertion. J Trauma 1970; 10: 1109–

1118.
3. Leddy JP, Packer JW: Avulsion of the profundus tendon insertion in athletes. J Hand Surg 1977; 2A: 66–69.
4. Shabat S, Sagiv P, Stern A, Nyska M: Avulsion fracture of flexor digitorum profundus tendon ('Jersy finger') type III. Aech Orthop Trauma Surg 2002; 122: 182–183.
5. Campbell DA, Millner PA, Dreghorn CR: Primary bone tumours of the hand and wrist. J Hand Surg 1995; 20B: 5–7.
6. Gaulke R, Suppelna G: Solitary enchondroma at the hand long-term follow-up study after operative treatment. J Hand Surg 2004; 29B: 64–66.
7. Canovas F, Nicolau F, Bonnel F: Avulsion of the flexor digitorium profundus tendon associated with a chondroma of the distal phalanx. J Hand Surg 1998; 23B: 130–131.
8. Chen DB, Yee DG: Flexor digitorium profundus tendon avulsion through a recurrent enchondroma—a case report. Hand Surg 2001; 6: 125–126.
9. Froimson AI, Shall L: Flexor digitorium profundus avulsion through enchondroma. J Hand Surg 1984; 9B: 343–344.
10. Gollapenne RP, Anwar M, Jacobs L: Flexor digitorium profundus avulsion through an enchondroma of the distal phalanx. J Hand Surg 2007; 32E: 596–597.
11. Ogunro O: Avulsion of flexor profundus, secondary to enchondroma of the distal phalanx. J Hand Surg 1983; 8A: 315–316.
12. Vaz FM, Belcher HJ: Rupture of the tendon of flexor digitorium profundus in association with an enchondroma of the terminal phalanx. J Hand Surg 1998; 23B: 548–549.
13. Yamauchi T, Yoshii T, Sempuku T: Flexor digitorium profundus avulsion of the left little finger through enchondroma of the distal phalanx: pull-out wire technique treatment without bone graft. Hand Surg 2008; 13: 17–20.
14. Smith JH: Avulsion of a profundus tendon with simultaneous intraarticular fracture of the distal phalanx: Case report. J Hand Surg 1981; 6A: 600–601.
15. Trumble TE, Vedder NB, Benirschke SK: Misleading fracture after profundus tendon avulsions: a report of six cases. J Hand Surg 1992; 17A: 902–906.
16. Hoglund M, Torai P, Engkvist O: Ultrasonography for the diagnosis of soft tissue conditions in the hand. Scand J Plast Reconstr Hand Surg 1991; 25: 225–231.
17. Drape JL, Silbermann-Hoffman O, Houvet P, et al.: Complications of flexor tendon repair in the hand: MR imaging assessment. Radiology 1996; 198: 219–224.
18. Sunagawa T, Ochi M, Ishida O, Ono C, Ikuta Y: Three-dimensional CT imaging of flexor tendon ruptures in the hand and wrist. J Comput Assist Tomogr 2003; 27: 169–174.

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