Journal of Hand, Upper Limb, and Microsurgery
JHUM
Journal of Hand, Upper Limb, and Microsurgery
Indonesian Orthopaedic Association for Upper Limb and Reconstructive Microsurgery

Functional Outcome After Central Slip Repair in Neglected Boutonniere Deformity: A Case Report

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Abstract
Injuries to the central slip of the extensor mechanism can lead to a Boutonniere deformity. Chronic central slip of the extensor tendon after penetrating trauma leads to a devastating burden, especially in the dominant hand. Repair of the central slip of the extensor tendon at the proximal interphalangeal (PIP) joint in boutonniere deformity is challenging due to its stiffness potential. The repair central slip with volar plate release procedure has been done in the middle phalanx. This study reports on the cases of neglected central slip defects treated after 1 month of injury. Clinical evaluations consisted of measuring the active range of motion in the PIP joint of the middle phalanx, QuickDASH, and Total Active Motion (TAM). At 6 weeks post-operation, the average active mobility, flexion, and extension of the third PIP joint measured 75 degrees and −5 degrees, respectively. And the functional outcomes were improved at the 4-month assessment, the third-finger PIP joint ROM had improved to 90 degrees flexion/−5 degree extension. In 4 months, the patient was able to work normally as a nurse. Various procedures such as tendon plasty, transfer, or graft have been described in the literature for boutonnière deformity. Proper rehabilitation is also needed to achieve satisfactory functional outcomes.

Keywords: Central slip; Extensor apparatus of fingers; Volar plate; Repair.

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INTRODUCTION

The anatomy of the extensor mechanism of the finger is complex The topographic classification for extensor mechanism injury developed by Verdan and Kleinert has eight zones (Kleinert, 1983). Zone II, IV, VI, VIII correspond to the regions located over a bone's diaphysis. Zone I, III, V, VII are located over the distal interphalangeal (DIP), proximal interphalangeal (PIP), metacarpophalangeal (MCP) and wrist joints (Fig 1). The total extensor tendon excursion varies linearly relative to the movement amplitude at the wrist, MCP and PIP joints. It is the largest for the middle finger (50 mm) and smallest for the fifth finger (35mm) (Bellemère, 2015).

The extensor mechanism in the PIP joint is the site where the central slip and two lateral bands split. Hence, properly balancing the length and tension between the central slip and lateral bands during reconstruction is very important (Lee and Ko, 2020).

The extensor tendon function to transmit tension from the muscle belly to the specific joint. Extensor tendons can be divided into intrinsic and extrinsic groups. The intrinsic muscles are located within the hand itself, whereas the extrinsic muscles are located proximally in the forearm and insert into the hand by long tendons. The extensor muscles are all extrinsic tendons except for the interosseous-lumbrical complex. All the extrinsic extensors are innervated by the radial nerve, which consists of 3 wrist extensors and a larger group of thumb and digit extensors (Griffin *et al*., 2012).

The neglected ruptured extensor tendon is the result of inappropriate initial acute treatment. This kind of injury presents various amounts of joint contractures, imbalances of intrinsic muscles, tendon retraction, and tendon callus lengthening. Manifestation of these injuries are closely related to the anatomy and physiology of the extensor mechanism (Bellemère, 2015). Extensor tendon injuries can cause serious functional impairment.

Unlike the flexor tendons, the extensor tendons in the fingers are anatomically thin and flat. Extensor tendon injuries are more frequent than flexor tendon injuries and are more common (61%) due to little protection from soft tissue and their superficial location. Extensors are particularly challenging for surgeons because of their reduced size compared with the flexors and their lack of collagen-bundle linkage. The flat tendon profile in the zone I to IV increase the surface area between the

repaired tendon and adjacent tissue, which makes it susceptible to adhesion formation (Griffin *et al*., 2012; Lee and Ko, 2020).

Zone III injury which involves tendons, bone, and joint, selection of an appropriate treatment presents a unique challenge. The authors of the present study achieved satisfactory outcomes through central slip repair with volar plate release in a patient with neglected ruptured extensor tendon left middle finger, Zone III central slip disruption (Boutonniere Deformity).

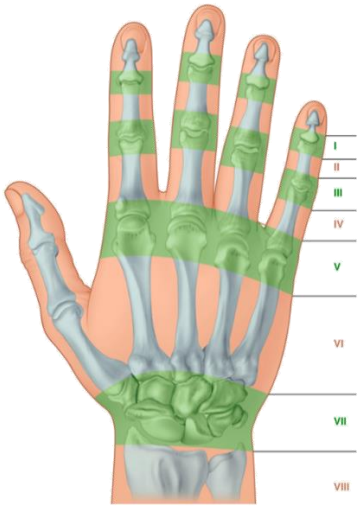

Figure 1 Topographic zones for extensor tendons

CASE REPORT

A 27 years old man presented with an isolated injury to the left third PIP joint after he accidentally cut his left middle finger with the knife a month ago. At the time of injury, the patient had his wound stitched in the ER. After healed, the patient was still unable to extend his left middle finger. Initial examination revealed swelling in his third left finger over the PIP Joint, tenderness over the dorsal surfaces, restricted movement, and Boutonniere Deformity (flexion of PIP joint and hyperextension of DIP joint).

Figure 2. Clinical picture of left Buttoniere Deformity

On physical examination we found scar at the dorsal side of left middle finger, and also Boutonniere Deformity (flexion of PIP joint and hyperextension of DIP joint). The active mobility of the MCP joint of the middle phalanx was 90 degrees flexion / 0 degrees extension, whereas the active mobility of the PIP joint of the middle phalanx was 90 degrees flexion / −30 degrees extension and the active mobility of the DIP joint of the middle phalanx was −5 degrees flexion / 10 degrees extension. Elson test was also found positive in the left middle finger.

Figure 3. Radiograph of the left third finger at the time of the patient's initial visit: there is no fractures involving the third middle phalanx base.

The diagnosis of a central slip injury (*Buttoniere Deformity*) was made based upon the loss of movement, and clinical presentation of PIP and DIP joint. The finger was initially performed central slip repair with volar plate release. Then the small wire was inserted through the PIP joint to maintain the joint extension. However, DIP joint active range of motion (ROM) was permitted after 2 weeks to stretch the oblique retinacular ligaments because the gliding of lateral bands during DIP joint flexion should not influence the volar plate or central slip. After 3 weeks, the wire was removed and the patient was advised to perform gentle active range of motion exercises every hour.

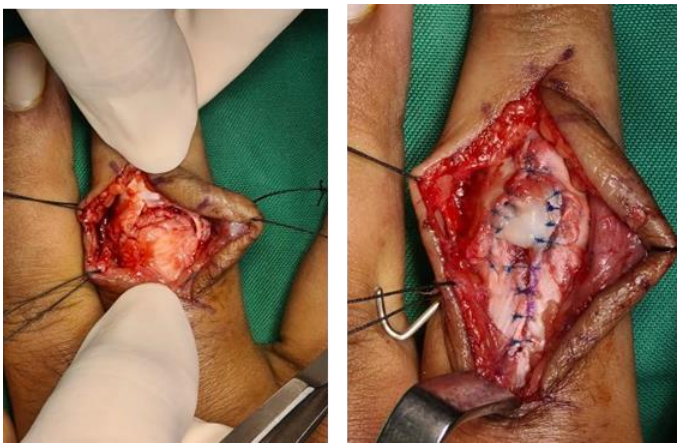

Figure 4. Clinical picture of left middle finger during operation. (a) Central slip repair and volar plate release (b) wire was inserted to fixated the PIP joint in extension

Within 3 weeks (6 weeks post operation), the active flexion and extension of the third PIP joint measured 75 degrees and −5 degrees, respectively (versus 100 degrees / −5 degrees contralaterally) and the active mobility of the DIP joint of the middle phalanx was 30 degrees flexion and −5 degrees extension. Total Active Motion within 6 weeks post operation was 185 degrees and TAM percentage was 82% (Good Result).

Figure 5. Radiograph of the left third finger after the operation procedure. (a) AP View (b) Oblique View

At 4-month assessment, the third-finger PIP joint ROM had improved to 90 degree flexion and −5 degree extension. The patient reported now using his left hand for activities of daily living without pain. Total Active Motion at 4 months follow up was 200 degrees, TAM percentage was 88% (Good Result) and QuickDASH score 0 (no disability).

Figure 6. Clinical picture of left middle finger after 4 months follow-up.

DISCUSSION

The proximal interphalangeal (PIP) joint extensor apparatus is anatomically complex and dynamic. It involves central slip, lateral bands, and intrinsic tendon. In this case, zone III injury, also known as boutonniere deformity is caused by central slip disruption at the PIP joint. As explained by the theory, boutonniere deformity in this case is formed 1 month after the first injury and in this case the author using wire instead of splinting in extension. (Griffin *et al*., 2012; Lee and Ko, 2020).

Even though conservative management is preferred for close zone III or boutonniere injuries, there are indications of surgical management. The indications include those with the evidence of displaced avulsion fracture at the base of middle phalanx, axial, and lateral instability of the PIP joint associated with loss of active or passive extension of the joint or failed of non-operative treatment (Griffin *et al*., 2012).

In this case, we operated the patient with the indication of loss of active extension of the joint. The loss of ROM was due to buttonhole deformity for central slip injury that was neglected over a month. In general, the objectives of surgical treatment include release the lateral slips and reduce volar disruption, reattach or reconstruct central slip, and make the PIP joint more flexible and wire insertion through PIP joint in extension position.

Operation of the extensor apparatus in the PIP joint can be repaired by a simple interrupted repair or the Silfverskiold cross-stich technique. This includes the central slip repair with the modified Becker and epitendinous cross-over methods after the denaturised soft tissue was removed. The PIP joint was fixed with transarticular K-wire (Lee and Ko, 2020). In specific manner, central slip repair was performed by debridement of the stump area, followed by tenolysis after fixing with the extended PIP joint with 1.0 mm K-wire, advancing the proximal stump, and repaired the area with modified Kessler technique and epitendinous cross-over repair. As explained by Griffin, Kirschner wire fixation of the PIP joint is maintained for around 14 days (Griffin *et al*., 2012).

In respect to subsequent central slip repair, Pratt (2002) stated that active joint motion of the PIP joint should not be initiated during the first 2 weeks, in 3rd week splint can be replaced with coil splint, which function to keep the finger at extension during rest, while PIP joint is allowed to flex adequately. Active extension of PIP joint and strengthening exercises can be initiated after 4-6 weeks (Pratt *et al*., 2002). In this case, we removed the K-wire after 3 weeks and physiotherapy was also started. Improvement of PIP joint of middle finger flexion and extension movement were found.

Satisfactory outcomes can still be achieved even though the treatment of an extensor injury in the PIP joint area is difficult. In this case Total Active Motion at 4 months follow up was 200 degrees, TAM percentage was 88% (Good Result) and QuickDASH score 0 (no disability). Even, in the case reported by Lee (2020) in which the extensor injury was neglected for over a year, the functional outcome was good after 12 months follow up and being treated with proper balance of length and tension between the central slip and lateral bands (Lee and Ko, 2020).

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