

## Operative treatment of the Phalangeal neck fracture in hand

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### = Abstract =

It is generally accepted that displaced phalangeal neck fractures in hands accelerate the onset of degenerative changes, with increasing pain and stiffness of the affected joint. However, reports on the results of surgical treatment in phalangeal neck fractures are relatively few. We have followed sixteen patients, who had operations for phalangeal neck fractures. The average length of follow up was 13 months. The interval between injury and operation ranged from three days to six years, with a mean of 18 months. The second finger was the most frequently injured. The phalangeal neck had been displaced with rotation in 9 cases and slightly displaced without rotation in 7 cases. The most common surgical approach was a mid-dorsal incision. Of 16 cases, thirteen required open reduction and internal fixation with a K-wire, either for dorsal displacement and volar angulation of the head or for a 180 degree proximal rotation of the head. The pull-out wire technique was the second most common fixation method. Excellent and good results were noted in 10 cases(62%). Complications were found in seven cases and loss of motion was the most frequent. Late malrotation with angulation occurred in one case.

**Key Words :** Operative treatment, Phalangeal neck fracture

### INTRODUCTION

Injuries to the phalangeal neck in hand present unique diagnostic and therapeutic challenges

although most phalangeal neck fractures can be easily treated by closed reduction, and most heal without difficulty in three weeks. At the time of reduction of a phalangeal neck fracture, care must be taken to assure proper clinical alignment of the fingers. Operative treatment of phalangeal neck fractures, to our knowledge, have not been previously reported. We have assessed the functional

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outcome of surgical treatment in patients who had not previously had surgery and also reviewed the effectiveness of operative treatment in the phalangeal neck fractures.

## MATERIAL AND METHODS

Between March 1986 and March 1992, 16 patients who had 16 phalangeal neck fractures were followed. The ages of the 16 patients ranged from 3 to 52 years at the time of surgery. There were seven female and nine male patients (Table 1). The dominant hand was involved in 12 of the 16 patients. The duration of symptoms before the operation ranged from three days to six years, with a mean of 18 months (Table 2). The proximal phalangeal neck injury was most frequent (12 cases). There were four middle phalangeal fractures. There were 13 cases of phalangeal neck fractures and three cases of head fractures involved with the neck area. Before surgery, ten patients had received closed reduction and splint immobilization treatment at initial injury. The most common preoperative symptom of delayed cases were deformity of fingers and limit of motion at interphalangeal joints, although some patients also complained of a slight pain in inter-

**Table 1.** Age & sex distribution

Age	M	F
under 5	2	0
5 - 10	3	2
10 - 15	3	3
over 15	2	1
Total	10	6

**Table 2.** The interval between the operation & initial injury

Time	cases
3 days - 2wks	6
2 wks - 3mos	6
3 mos - 1yr	2
over 1 year	2
Total	16

phalangeal joints or a feeling of instability. These locations led to more obvious cosmetic deformity, which was the reason for referral.

Ten operations were carried out in an outpatient operating room. A fracture of the phalangeal neck was present in 16 patients, nine of whom had enough volar or dorsal angulation that the interphalangeal joint distal to the fracture was either dislocated or subluxated necessitating open reduction. The most common surgical approach was mid-dorsal incision. Of 16 cases, thirteen required open reduction and internal fixation with a K-wire. The pull-out wire technique was the second most common fixation apparatus (Table 3). Two patients had associated fractures of the upper limb or other fingers; none had a primary neurovascular injury. Active flexion of the interphalangeal joint of less than 90 degrees was found in three neglected displaced fractures. In all neglected cases the radiographs at review showed that the fragment had malunited by callus in the original displaced position. The mean active range of motion of all injured interphalangeal joints was 70 degrees. There was an active extension deficit in only one interphalangeal joint.

**Table 3.** Method of treatment

Method	Cases
C/R & I/F with K-wire	2
C/R & I/F with K-wire	11
C/R & I/F with Kpullout wire	2
Osteoclasia & bone graft	1
Total	16

## CASE REPORTS

During the past 5 years, the authors have treated 16 cases of an unusual phalangeal neck fracture of a finger or thumb with a rotation of the condylar fragment, which is then entrapped by the capsule or collateral ligaments. Lack of recognition and treatment of this fracture will result in permanent impairment of a hand. The incapacity produced by

a stiff and painful finger can be considerable, and may lead to serious disability, with a consequent loss of earning power. Clinical cases will be presented to demonstrate the difficulty of diagnosis and the usual requirement for early open reduction.

#### **Case 1.**

A 12-year-old boy's dominant right hand was crushed when it was caught in a folding table. He sustained closed neck fractures of the second proximal phalanges for two months. Initial treatment consisted of a short arm splint that was worn for one month. He was referred to us for the treatment of a painless, persistent angulation accompanied by clinical deformity. Active and passive range of flexion of the proximal joints of the index finger was limited to 80 degree. Radiographic examination revealed malunited, angulated neck fracture of the second proximal phalanges(Fig. 1-A,B). Two months following his injury, open reduction and two internal Kirschner wires fixation with osteoclasis of the fractures were performed on an out patient operation case(Fig. 2). He was immobilized in a finger splint for 14 days postoperatively. After then active range of motion exercise in the interphalangeal joint started. After removal of the K-wire at four weeks, the malunion went on to

heal.

The final functional and cosmetic result was excellent. One year after operation, there was fusiform swelling of the finger and no limitation of motion of the proximal interphalangeal and distal interphalangeal joint(Fig. 3-A,B.).

#### **Case 2.**

A 3-year old boy, had his right little finger caught in a closing door. The finger was immobilized with a splint for two weeks at a private clinic. He was admitted to our hospital 28 days after the injury. Radiographs demonstrated a dorsal displacement of a fracture fragment of the proximal phalangeal neck(Fig. 4). A dorsal-lateral skin inci-

**Fig. 2.** Postoperative radiography. The fracture was reduced and fixated with two criss-cross K-wires.

**Fig. 1-A.** Preoperative photograph shows the limit of motion and ulnar deviation deformity of right index finger.  
**B.** Preoperative radiograph shows malunited proximal phalangeal neck fracture.

**Fig. 3-A.** Postoperative photograph shows normal range of motion and appearance of right index finger.  
**B.** Postoperative radiograph shows excessive callus formation at the fracture site.

**Fig. 4.** Preoperative radiograph shows the displaced and rotated condylar fragment of proximal phalanx

sion was used. To reduce the extruded joint the middle and proximal phalanges were distracted, and the fragments were manipulated in the place. There yielded a "click" and a completed reduction was obtained. Once this fracture was reduced, but it remained clinically unstable. With the proximal interphalangeal joint flexed 30 degrees, one Kirschner wire was passed through the dorsum of the middle phalanx, and into the proximal phalanx. Then pullout wiring was done for the prevention of rotation(Fig. 5). The child was treated without a finger splint with the fourth finger taped to the adjacent fingers. The wire was removed 3 weeks postoperatively. At 18 months follow up the pulp of the right small finger could be actively flexed to the proximal palmar crease. Active

**Fig. 5.** Postoperative radiograph shows the reduction state of fracture site with a K-wire and pull-out wire.

extension was zero degree in all joints. Passive range of motion was 0 degree/110 degrees in the proximal interphalangeal joint.

### **Case 3.**

A 23-year-old male caught his right first finger in a closing door. He did not receive any treatment after the initial injury. Four years after the trauma, the roentgenograms showed the dorsal displaced appearance of the fractured neck at distal end of the proximal phalanx of the first finger(Fig. 6). The preoperative range of motion in the interphalangeal joint was 30 degree flexion contracture state with no further flexion. The lateral roentgenogram demonstrated the rotated distal

degree extension deficit. Pinch strength averaged 86% of the unoperated side.

## RESULTS

In our follow-up study we recorded the following data : deviation of the fingers during active maximum extension, the minimum distance between the tip of the finger pulp and the palm, relief of pain, and the subjective cosmetic result. Objective data on the functional positions of the small joints of the hand needed for performing activities of daily living were analyzed using electrogoniometric and standard techniques to assess active and functional ranges of motion of the metacarpophalangeal and interphalangeal joints during activities of daily living. The x-ray films were used to investigate a possible displacement of fracture, bone resorption and rotation of fragment, irregularity of articular surface and bone production around the joint area. The results were rated as follows : excellent indicated fracture union plus full range of motion of the proximal interphalangeal joint, no clinical deformity, no angulation greater than five degrees in any plane, no rotation, no pain, no infection. Good indicated fracture union and one criteria missing. Fair indicated fracture union with two criteria missing. Poor indicated fracture union with three criteria

**Fig. 6.** Preoperative radiograph shows a malunited proximal phalangeal neck fracture of the thumb

condyle. Regional nerve block was administered. Through a longitudinal mid-dorsal skin incision, the dorsal apparatus was exposed. The proximal interphalangeal joint was extruded dorsally and entrapped between the dorsal apparatus and proximal phalanx. The volar plate was detached from the proximal phalanx. The attachment to the distal phalanx was not explored. The osteoclasis of the fracture site was done. Following several attempts at anatomical reduction, a percutaneous cross pin fixation with two 0.035 smooth Kirschner wires and an autogenous bone graft was done. Follow-up examinations one year after the operation showed limitation of motion of the interphalangeal joints but no swelling (Fig. 7-A.B.). The postoperative range of motion was 55 degree flexion, 10

**Fig. 7-A.** Immediate postoperative radiography of the malunited neck fracture of the thumb  
**B.** Postoperative one year after an operation. There was no functional disturbance of interphalangeal joint.

missing. Based on this grading system the results were excellent, good, fair and poor. Sixty two percent of the patients were satisfied with the clinical result. According to subjective data, thirteen of the sixteen patients believed that their symptoms and deformity had significantly improved. But three cases with primary surgical intervention injuries eight weeks after the initial trauma were rated as poor. In two patients, there was no improvement and one patient, the finger was judged worse (Table 4). Complete ranges of motion as well as grip and pinch strength were obtained in ten of the 16 patients. All who had stable internal fixation (twelve of sixteen patients) were able to use the hand immediately following the reduction. There was no radiological difference between the patients with full or limited movement of the injured joint.

After the operation, the radiographs showed no sign of any joint damage on ossification at the injured site. There was one extension lag of the finger, but limitation of motion in injured fingers were noted in four cases. Subjectively, two patients complained of aching in the injured joint when they did grips. One complained of mild aching with the full grip exercise. Two of these patients did have occasional pains with excessive or strenuous activity. Complication occurred in nine patients.

One was a minor pin-site infection that was resolved with local wound care and a short course of oral antibiotics. One operatively treated patient had a small segmental fracture of the phalangeal head after an operation, which healed uneventfully after pin removal. No patient had ectopic bone formation and most required late reoperation (Table 5).

## DISCUSSION

Neck fractures of the proximal phalanx of the finger is a relatively common injury. When dis-

placed or unstable, neck fractures of phalanx represent a difficult management problem. These usually involved the proximal phalanx. Leonard and Dubravick<sup>13)</sup> in a review of 263 finger fractures in children, found that 15% were fractures of the phalangeal neck. Of 38 cases, nine required open reduction and internal fixation, either for dorsal displacement and volar angulation of the head or for a 180 degree proximal rotation of the head. In children, neck fractures of the proximal phalanx of the finger and fractures involving the head of the phalanges are relatively common injuries<sup>1)</sup>. We have three cases of adult neck fracture at phalanges.

Only flexion and extension are possible in the interphalangeal joints. The interphalangeal joint has greater inherent stability than the metacarpophalangeal joint secondary to its bicondylar shape, combined with the stout collateral ligament and volar plate complex. Gad<sup>9)</sup> in 1967, described two thick lateral parts and a thin midline part of the volar ligament. The thicker lateral portions were firmly attached to the bony phalangeal ridges just proximal to the condyles, while the thin midline axial portion gradually blended with the synovial reflection and the midline vascular hilum containing the vincula. He thought that most of the fibrous attachment of the volar plate to the proximal phalanx was laterally through the slinglike accessions, collateral ligaments. Moberg and Stener<sup>18)</sup> noted that the volar ligament's proximal attachment was composed of connective tissue bands imparting strength to the volar capsular ligament strength to that of the collateral ligament. Nine of ten ruptures occurred proximally, but at a kilogram weight equal to that of the collateral ligament. Eaton<sup>8)</sup> described the thick plate as spanning the volar aspect of the joint 2 to 3 mm thick at its insertion. Resistance to deviating forces in changed little throughout the arc of flexion and extension as the collateral ligaments are nearly equally taut in all positions. The essential origin

**Table 4. Results**

Result	Cases(%)
Excellent	6(37)
Good	4(25)
Fair	4(25)
Poor	2(13)
Total	16

**Table 5. Complications**

Complication	Cases
Limit of motion	3
Residual swelling	1
Pain	3
Swan-neck deformity	1
Pin tract infection	1
Extraction of pin	1
Fracture of head	1

of the collateral ligaments further produces the cam effect increasing ligamentous support when the joint is flexed. Intra-articular fractures at the interphalangeal joint usually represent ligament avulsion injuries.<sup>6,15,17</sup> The lack of tendon insertion into the distal aspect of the proximal phalanx easily allow rotation of this fragment. It is suggested that this shearing force coupled with the hard withdrawal reaction may open the fracture site enough for rotation to occur.<sup>5,12,19</sup> This is followed by entrapment of the rotated condyle by the capsule and the collateral ligaments. Injuries involving dorsal rotation of the condyles of the proximal phalanx seem to occur without exception from shearing forces across the proximal interphalangeal joint.

A simultaneous attempt to withdraw the digit at the time of injury probably contributes to the trauma by locking the displaced fragment dorsally when the distraction force is relaxed. At the proximal interphalangeal joint, it is usually the middle phalanx compressing against the head of the proximal phalanx that causes a condylar fracture of the proximal phalanx. The mechanism of injury seems similar to the lost finger tip seen in children, except that the finger is further into the door or is

subjected to other types of shearing forces. Most of the phalangeal head and neck fractures are secondary to compressive forces<sup>2,10,16</sup>.

Fractures of the phalangeal neck are basically unstable because of comminution of the volar cortex. For this reason, there is a tendency for the reduced fracture to settle back to its original angulated position. Reduction of the fracture is easy, but redisplacement in the splint or cast is likely to occur. Because of this instability and the difficulties in maintaining reduction, many techniques of treatment have been proposed. Neck fractures should be reduced and properly immobilized in short arm finger splints after closed reduction, including the digit of the injured phalanges. A second neighboring digit may also be included in the splint for better control of rotation and angulation, particularly if the child's hand is small<sup>3,11</sup>. The collateral ligaments of the PIP joints are under greatest tension (length) in approximately 15 degree of flexion when the fibers are tented over the lateral aspect of the condyle of the proximal phalanx. We prefer the "intrinsic plus" of immobilization with the proximal joint flexion and the middle and distal joints. The problem in recognizing this complication is that it is difficult to visualize the bone clearly on the post-reduction lateral views because of superimposition of the other fingers in the splint. The problem of adequate visualization of the fracture in the splint can be overcome by the use of a single laminagraphic cut in the lateral view at a measured distance to coincide with the long axis of the injured finger.

This injury, if not diagnosed early and treated properly, causes significant morbidity such as malunion of the head and neck, angulation and cosmetic deformity of the finger. The resulting loss of reduction will cause an unacceptable deformity and late treatment of the healed displaced fracture (even as early as three weeks after injury) is very difficult. Remodelling will not correct rotational deformity, and for this reason it is impera-

tive to reduce all fractures of the phalanges in perfect rotational alignment<sup>11,14</sup>. Early open reduction or closed reduction and percutaneous pinning of the fracture generally yields better results than attempts to correct the malunion later. If displacement of the fracture fragment is substantial and the "new" joint shape has lost its congruency or any deviation at the joint is apparent, reduction is mandatory. Once reduced, these fragments will be unstable and almost always require internal fixation. Gentle surgical technique and constant elevation of the injured hand for 14 days after operation will minimize ligamentous scarring. Dixon and Moon<sup>7</sup> also reported an experience with rotational condylar fractures of the proximal phalanx in children. If reduction is inadequate, the pin fixation will ensure permanency of the angular or rotational displacement. Great care must be taken to avoid rotational malalignment<sup>4,20</sup>. In this study in nine of these the phalangeal head and neck had been displaced with rotation and in seven it was slightly displaced without rotation. The two axioms of treatment of phalangeal neck fractures of fingers must be near-anatomical treatment of phalangeal neck fractures of fingers must be near-anatomic and stable position of fracture fragments with or without open reduction and early active motion exercises. The use of K-wires was the standard of care for these injuries. Although Barton<sup>1</sup> advocated reduction and percutaneous pinning of phalangeal neck fractures, nonoperative means should initially be tried. But, when the wires are carefully placed, if they are left percutaneously, the motion of the skin with exercise increases the risk of infection in the pin tract. The indications for closed reduction and percutaneous pin fixation of phalangeal head and neck fractures are limited. An important advantage of stabilization of fractured areas by percutaneous pinning is that it allows the patient to move the small joints of the injured digit during the period of fracture healing. Many authors advocate early mobilization of the digits

following fractures in the hand to prevent stiffness, although different methods are used to help achieve this goal. The open reduction and internal fixation obviates the need for external support and allows early motion, but occasionally the dissection may in itself lead to adhesions that prevent full range of motion. For fractures of the proximal phalanx head and neck at the proximal interphalangeal joint, the screws can usually be placed through small longitudinally oriented incisions in the collateral ligaments. In our cases the most common surgical approach was mid-dorsal incision. Of 16 cases, thirteen required open reduction and internal fixation with K-wires.

The most serious complications after treatment for neck fracture in the phalanx result from stiffness secondary to scarring of the ligamentous structures and either inadequate reduction or loss of position of fracture fragments. Complications were found in nine cases and loss of motion was the most frequent. There was one extension lag of the finger, but limitation of motion in injured fingers were noted in five cases. When the final outcome is unacceptable, a salvage procedure may be necessary if symptoms are of sufficient severity. At the proximal interphalangeal, fusion may be the procedure of choice. Therefore, the most reliable techniques must be used in the initial treatment of these uncommon injuries. Apparently, a late attempt at reconstruction did provide some satisfactory improvement in function.

## CONCLUSION

Injuries around the interphalangeal joints are of small size but may be of great importance. Unstable or malunited head and neck phalangeal fractures should be operated on. Meticulous surgical technique and rigid fixation will decrease the possibility of inadequate reduction or loss of position of fracture fragments. Even if the fragments can be maintained in the reduced position by



external means, instability will prevent the use of early motion and greatly increase the chance of stiffness. The best results can be achieved only with near-anatomic restoration of the joint surface and early active motion exercises. We conclude that, with careful patient selection and close attention to operative detail, operative treatment of phalangeal neck fracture can be an effective treatment for displaced or malunited phalangeal fractures.

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## 수지골 경부 골절의 수술적 치료

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수지골간 관절은 독특한 해부학적 구조를 가지고 있는 관절로 그 중에서도 수지골 경부 골절 치료에는 많은 어려움이 있습니다. 대부분은 도수정복으로 좋은 결과를 얻을 수 있으나, 정복이 불가능하거나, 정복의 유지가 안된 경우에는 많은 합병증을 초래됩니다. 이외에 전위골절이나 부정유합된 수지골 경부골절은 동통의 증가와 함께 초기에 외상성 관절염, 수지기형, 운동장애 등을 초래케 됩니다. 연세대학교 정형외과 교실에서는 1988년 3월부터 1992년 3월까지 수지골 경부골절로 수술적 치료를 받은 바 있는 16명의 환자에 대하여 분석 하였다.

1. 여자에서 더 많이 발생하였으며 10대가 9예로 가장 많았다.

수술시기의 평균나이는 18세 였다.

2. 제 2수지의 근위지골 경부골절의 빈도가 5예로 가장 많았다.

중위지골 경부골절은 4예 있었으며, 2예에서는 경부골절선이 두부로 연장된 상태였다. 손상원인으로는 운동이 가장 많았으며 문틈에 끼인 경우가 3예 있었다.

3. 손상과 수술적 치료사이의 기간은 3일에서 6년 사이로 평균 6개월이었으며 수상 후 2주에서 3개월사이가 7예로 가장 많았다. 이중에서 6예는 초기에 진단이 안된 경우였다. 골절의 전위는 10예는 배측, 9예는 요골측으로 전위되었다.

4. 수술적 치료로는 수지의 배측 도달법이 가장 많이 사용되었다.

고정방법으로는 10명이 관혈적 정복술 및 K-강선 고정술을 시행하였고, 3예는 도수 정복후 K-강선 고정술을, 2예는 pull-out wire 방법을 이용하였다.

5. 수술적 치료후 결과는, 10예가 만족할 만한 결과를 얻었다. 4예가 양호하였으며 2예가 불량이다. 주관적 만족도에서는 13예에서 수술전과 비교하여 운동범위나 수지의 외형상 기형에서 만족할만한 결과를 얻었으며 3예에서는 불만을 표시하였다.

6. 합병증으로는 손상관절의 운동장애가 3예로 가장 많았다. 이외에 수지의 기존 편향기형이 남아있는 예가 2예, 백조목기형이 2예 있었다.

진단이 늦어졌거나, 부정유합 혹은 보존적 치료가 어려운 수지골 경부골절시 정확한 골절상태 파악, 수지관절의 해부학적인 이해후 수술적 방법을 이용하면 만족할 만한 결과를 얻을 수 있을것으로 사료된다.

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