Iatrogenic comminution of the phalangeal head during reduction or fixation of phalangeal neck fractures

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INTRODUCTION: Iatrogenic comminution of the phalangeal head during management of phalangeal neck fractures has not been previously investigated.

OBJECTIVE: To investigate the causes and outcomes of this particular iatrogenic complication.

METHODS: A database of phalangeal neck fractures over a six-year period (2006 to 2011) was reviewed for this iatrogenic complication. Special attention was devoted to documenting the cause and pattern of comminution of the phalangeal head, as well as the outcome in range of motion.

RESULTS: Of 152 cases treated during the study period, there were five (two children and three adults) with comminution. Two patterns of comminution were encountered: splitting and fragmentation of the phalangeal head. The complication occurred during open reduction and K-wire fixation, or during closed reduction in the emergency room. The outcome was generally poor and worse in patients with fragmentation of the entire head. Two of the five cases ultimately resulted in medicolegal claims.

CONCLUSION: Comminution of the phalangeal head is a serious iatrogenic complication that may occur during the management of phalangeal neck fractures. Awareness of this complication is important and attempts should be made to avoid it.

Key Words: *Comminution; Fracture; Phalangeal neck*

Phalangeal neck fractures are fractures through the necks of the proximal or middle phalanges of the fingers, or through the neck of the proximal phalanx of the thumb, and occur more commonly in children (1) than in adults (2). Several articles have discussed the various complications associated with these fractures such as vascular injury, malunion, nonunion, avascular necrosis of the phalangeal head, rotational deformity of the digit and extension lag/stiffness of the involved joint (3-11). A review of the English language literature did not reveal any study on iatrogenic comminution of the phalangeal head during reduction/fixation of phalangeal neck fractures. In the present article, we present five cases involving this complication to increase awareness of its occurrence and to increase awareness that such a complication may result in medicolegal claims.

METHODS

The author has developed a special interest in phalangeal neck fractures and receives referrals of complicated cases from the central province (population of approximately six million) of Saudi Arabia. A database containing records of phalangeal neck fractures over the past six years was reviewed for iatrogenic comminution of the phalangeal head during reduction or fixation of phalangeal neck fractures. Over the six-year period (2006 to 2011), a total of 152 patients with phalangeal neck fractures were treated. Of these, five cases experienced iatrogenic comminution of the phalangeal head. The following data were documented for these five cases: age, sex, phalanx/digit involved, fracture type, and the presence or absence of ischemia of the fractured digit at the time of injury. Fracture type at the time of injury was documented according to the classification proposed by Al-Qattan

Une comminution iatrogène de la tête de la phalange pendant la réduction ou la fixation de fractures de la phalange distale

HISTORIQUE : La comminution iatrogène de la tête de la phalange pendant la prise en charge de fractures de la phalange distale n'a jamais été examinée auparavant.

OBJECTIF : Explorer les causes et les issues de cette complication iatrogène.

MÉTHODOLOGIE : Les chercheurs ont analysé une base de données sur les fractures de la phalange distale sur une période de six ans (2006 à 2011) pour dépister cette complication iatrogène. Ils se sont attardés à étayer la cause et le profil de la comminution de la tête de la phalange, ainsi que l'issue de l'amplitude de mouvement.

RÉSULTATS : Sur les 152 cas traités pendant la période de l'étude, cinq (deux enfants et trois adultes) ont présenté une comminution. Il y avait deux profils de comminution : une fente et une fragmentation de la tête de la phalange. La complication s'est produite pendant la réduction ouverte et la fixation par broche de Kirschner, ou pendant la réduction fermée à l'urgence. L'issue était généralement médiocre, et pire encore chez les patients présentant une fragmentation de toute la tête de la phalange. Deux des cinq cas ont donné lieu à des réclamations médico-légales.

CONCLUSION : La comminution de la tête de la phalange est une complication iatrogène qui peut se produire pendant la prise en charge des fractures de la phalange distale. Il est important de connaître cette complication et de tenter de l'éviter.

(1) as follows: type I are undisplaced fractures; type II are displaced fractures with bone-to-bone contact between the proximal and distal fracture fragments; and type III fractures are displaced fractures with no bone-to-bone contact. Initial and secondary management of these fractures were also documented with particular attention devoted to the causes of comminution of the phalangeal head during management. At final follow-up, the net range of motion of the joints (defined as active flexion minus the extension lag at the same joint) of the fractured digits was recorded. Finally, cases in which medicolegal claims were filed were noted.

RESULTS

Table 1 summarizes the results in the five patients studied (two children and three adults). In all cases, the injury was caused by entrapment of the digit in a closing door. None of the fractured digits showed evidence of ischemia at the time of injury.

Case 1

A four-year-old girl presented to hospital with a type III fracture of the middle phalanx of the little finger (Figure 1A). Open reduction and K-wire fixation was performed through a dorsal approach. There were difficulties in achieving accurate reduction; therefore, the wire was passed through the phalangeal head twice. A longitudinal split of the phalangeal head was noted during the second pass of the K-wire but there was no displacement and the intraoperative x-ray was acceptable (Figure 1B). An x-ray at four weeks (Figure 1C) showed evidence of healing and periosteal reaction in the middle phalanx. The wire was removed and an x-ray revealed the split

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TABLE 1
Cases of iatrogenic comminution of the phalangeal head during reduction or fixation of phalangeal neck fractures

Patient	Age, years/sex	Phalanx/digit involved	Fracture type	Initial treatment	Secondary surgery	Follow-up, months	Net range of motion at final follow-up
1	4/female	MP/little finger	III	Open reduction/K-wire fixation	No	6	MPJ: 90°, PIPJ: 110°, DIPJ: 10°
2	10/male	PP/index finger	II	Open reduction/K-wire fixation	No	5	MPJ: 90°, PIPJ: 0°, DIPJ: 50°
3	18/male	PP/thumb	II	Closed reduction in the emergency room	No	3	MPJ: 80°, IPJ: 0°
4	19/male	PP/thumb	II	Closed reduction in the emergency room	Yes	12	MPJ: 90°, IPJ: 40°
5	17/female	MP/index finger	II	Open reduction/K-wire fixation	No	5	MPJ: 90°, PIPJ: 100°, DIPJ: 0°

DIPJ Distal interphalangeal joint; MP Middle phalanx; MPJ Metacarpophalangeal joint; PIPJ Proximal interphalangeal joint; PP Proximal phalanx

Figure 1) Case 1. A The fracture. B Intraoperative x-ray. C X-ray at four weeks just before removal of the wire. D X-ray immediately after removal of wire (four weeks after surgery) showing the split head. E The united fracture at six months

Figure 2) Case 2. A The fracture. B X-ray immediately following K-wire fixation. C X-ray five months postoperatively. Note that the split in the phalangeal head is still seen. The ulnar segment of the head has united but the radial segment appears sclerotic

phalangeal head (Figure 1D). At final follow-up six months after surgery (Figure 1E), the fracture united but significant stiffness was noted at the distal interphalangeal joint (only 10° of motion).

Case 2

A 10-year-old boy presented to another hospital with type II fracture of the proximal phalanx of the index finger (Figure 2A). During open reduction and K-wire fixation, a longitudinal split of the phalangeal head was noted; however, the intraoperative x-rays were acceptable (Figure 2B). The wire was removed after four weeks and physiotherapy was started. The patient sought a second opinion from the author five months after surgery. There was fixed flexion contracture of the proximal interphalangeal joint. X-rays (Figure 2C) revealed a split displaced phalangeal head. The ulnar segment of the

head united but the radial segment was displaced dorsally and showed sclerosis suggesting avascular necrosis. The patient was offered revision surgery but the family refused and requested a report for a medicolegal claim.

Case 3

An 18-year-old man presented to another hospital with a type II fracture of the proximal phalanx of the thumb (Figure 3A). Closed reduction was attempted in the emergency room of the other hospital and resulted in fragmentation of the entire phalangeal head (Figure 3B). The patient presented to the author three months later with stiffness and pain at the interphalangeal joint. Joint fusion was offered, but the patient refused and requested a report to support a medicolegal claim.

Case 4

A 19-year-old man presented to another hospital with a type II fracture of the proximal phalanx of the thumb. Closed reduction was attempted in the emergency room and resulted in splitting of the phalangeal head. He was transferred to the University Hospital on the same day of injury. X-rays revealed a split head, and the ulnar half of the head was noted to have flipped 180° (Figures 4A and 4B). After discussing the risks and complications with the patient, a decision was made to proceed with open reduction and K-wire fixation. The procedure was performed using a dorsal approach. Care was devoted to preserving the single collateral ligament attachment to each half of the phalangeal head during exposure. The ulnar half of the head was flipped back 180° and fixed with a single K-wire. The radial half of the head was then reduced and appeared to be stable and, hence, no K-wire fixation was used for the radial segment (Figure 4C). A thumb spica cast was applied for five weeks, after which the cast and wire were removed. Although there was radiological evidence of union of each half of the head to the diaphysis, there was a persistent visible line between the two halves for approximately four months after surgery (Figure 4D). At final follow-up one year after surgery (Figures 4E and 4F), range of motion of the interphalangeal joint was from +30° to +70° (Figures 4G and 4H). The patient was satisfied with the result.

Case 5

A 17-year-old woman presented to another hospital with a type II fracture of the middle phalanx of the index finger (Figure 5A). During open reduction and K-wire fixation, comminution of the phalangeal head occurred and the K-wire was left in place (Figure 5B). The wire was removed at four weeks. The patient presented two weeks later and

Figure 3) Case 3. **A** The fracture at the time of injury. **B** Appearance immediately following closed reduction in the emergency room

x-rays showed early union despite the comminution (Figure 5C). At final follow-up five months after surgery, the fracture had united but the involved joint was stiff, with complete loss of the joint space (Figure 5D). There was no pain and the patient was lost to follow-up.

Figure 4) Case 4. **A** and **B** The split phalangeal head following closed reduction. Note that the ulnar half of the head has flipped 180°. **C** X-ray following open reduction and K-wire fixation. Note that only one K-wire was used to fix the ulnar half of the head. **D** X-ray at three months. Note the persistent line between the two segments of the phalangeal head. **E** and **F** X-ray at one year. **G** and **H** Range of motion at one year

Figure 5) Case 5. **A** X-ray at the time of injury. **B** X-ray immediately following K-wire fixation. **C** X-ray two weeks after K-wire removal. **D** Complete loss of joint space at five months postsurgery

DISCUSSION

The present study was the first to investigate the causes and outcome of iatrogenic comminution of the phalangeal head during the management of phalangeal neck fractures. The incidence of this complication could not be calculated from the current study because the hand unit is a referral centre and the comminution in four of the five cases occurred at other hospitals.

Two other iatrogenic complications of these fractures have been discussed in the literature: avascular necrosis of the phalangeal head (1) and flipping of the phalangeal head 180° (8,9).

Following phalangeal neck fractures, the blood supply to the phalangeal head comes from the collateral ligament attachments and, hence, the head is considered to be relatively ischemic (6). Therefore, during reduction and fixation of these fractures, the collateral ligaments should be protected. Furthermore, the heat from multiple passes of K-wires through the head should be avoided because it may lead to avascular necrosis (6).

The most common type of phalangeal neck fracture are type II fractures that are usually displaced dorsally (1). Occasionally, type III fractures with 90° rotation are seen. Fruitless attempts at closed manipulation with longitudinal traction may open the space at the fracture site enough to allow further displacement of these fractures to 180° rotation (1,9). Therefore, excessive longitudinal traction during reduction of these fractures should be avoided. In one of the cases with split head (case 4), the radial half of the head flipped 180° during attempts at closed reduction.

The present study demonstrated that comminution of the phalangeal head is another serious iatrogenic complication of phalangeal neck fractures. Two patterns of comminution were seen: 'splitting' and 'fragmentation' of the entire phalangeal head. In the series, 'splitting' of the head was usually noted intraoperatively during open reduction and K-wire fixation. The use of thin K-wires and avoiding multiple K-wire passes should minimize such a complication. It is interesting to note that splitting of the head does not usually lead to avascular necrosis. This is probably because each half is still supplied through its collateral ligament attachment. In case 3, complete 'fragmentation' of the phalangeal head occurred during closed reduction in the emergency room. Several authors (6,11) strongly recommended that closed reduction of phalangeal neck fractures should be performed under x-ray control by an experienced hand surgeon in an operating room.

Another observation from the present study pertains to the outcome following comminution of the phalangeal head. Compared with pediatric and adult series reported in the literature (1,2), the results (in range of motion) in the present series were generally worse. Also noted was that a split head that unites without displacement (ie, cases 1 and 4) may still preserve some motion at the involved joint. However, fragmentation of the head (cases 3 and 5) resulted in a worse outcome, and these patients will probably end up with joint fusion because of pain.

Finally, medicolegal claims were filed in two cases in the present series: one with fixed flexion contracture of the proximal interphalangeal joint, and one with a stiff and painful interphalangeal joint of the thumb. It is interesting to note that none of the other patients experienced proximal interphalangeal joint involvement or pain.

CONCLUSION

Results of the present study raise awareness that comminution of the phalangeal head may occur during open or closed management of phalangeal neck fractures. Also provided are recommendations to reduce the risk of this complication, which is expected to result in a poor outcome and may ultimately result in a medicolegal claim.

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