SAFE PERCUTANEOUS PINNING FOR SUBCAPITAL FIFTH METACARPAL FRACTURES: AN ANATOMICAL STUDY

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ABSTRACT

Objectives: When treating closed fractures of the neck of the little finger metacarpal (boxer fractures) with percutaneous transverse K-wire fixation and other procedures, there may be iatrogenic injury to the dorsal digital branch to the little finger (DDBLF) of the dorsal branch of the ulnar nerve (DBUN). In this study we aimed to describe the relationship of the DDBLF of the DBUN and the insertion points on the external side of the fifth metacarpal during percutaneous transverse K-wire fixation of subcapital fractures. Methods: Dissections and measurements regarding this branch were performed after percutaneous transverse pinning to distal part of fifth metacarpal bones in ten cadaver hands formalin fixed. Results: The results of this study confirm the close proximity of the trajectory of the with this branch and demonstrate its potential iatrogenic injury during K-wire fixation of the fifth metacarpal. Conclusions: To avoid penetration of this nerve and limit the chances of iatrogenic injury it is important to know its course. The authors describe the anatomical insertion points and believe that using the anatomical knowledge, subcapital fifth metacarpal fractures can be treated without risk of sensory deficits.

Keywords: Fractures, bone. Hand injuries. Metacarpal bones. Bone wires. Fracture fixation, intramedullary.

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INTRODUCTION

Subcapital fifth metacarpal fractures, also known as boxer fractures,are one of the most common injuries encountered by hand surgeons. Closed reduction and plaster cast immobilization, Kirschner wires and lag screws are treatment options. Short oblique fractures are ideally treated with Kirschner wires or with plate fixation. Most fifth metacarpal fractures can be treated with predictably good outcomes. Nowadays, most fifth metacarpal fractures requiring surgical intervention are treated with percutaneous pinning employing intraoperative radiological evaluation. Hand fractures are among the most common in the skeletal system, comprehending from 15% to 20% of total fractures, and the majority compromise the metacarpal head and neck; they were considered stable impacted fractures.[1,2] Inside the hand, fifth metacarpal fractures are the most common, and are reportedly responsible for 16% to 34% of hand fractures.[1-3] Fifth metacarpal fractures can be classified as subcapital (neck), diaphyseal or basal. In the subcapital fracture, the etiology is generally punching a person or an object, with a clenched fist, causing a direct blow to the finger joints.[3-5] Accordingly, the subcapital fracture is also known as boxer fracture. In urban areas, this type of fracture is common in the emergency departments.[3] Treatment of the boxer fracture usually depends on the degree of angulation and of rotation of the metacarpal head. If the fracture is severely displaced, closed reduction and Kirschner wire fixation is widely accepted as adequate treatment.[6] Previous studies showed that fifth metacarpal neck fracture with angular deformities up to 45° can be treated in a non-surgical manner with adequate functional outcome.[7,8] Researchers affirmed that the treatment of closed fractures of the metacarpal neck, diaphyseal fractures and intra-articular fifth metacarpal base fractures with transversal percutaneous pinning, using two K-wires distally and one proximally, demonstrated excellent functional and anatomical outcome.[9] The dorsal branch of ulnar nerve (DBUN) emerges proximally to the wrist, passes distally and dorsally deep to the extensor carpi ulnaris muscle, perforates the fascia profundis and descends along the medial side of the wrist and of the hand to split in two or, frequently, three dorsal digital nerves that innervate the ulnar side of the ring finger and both sides of the little finger. One innervates the medial (ulnar) side of the little finger, the second, the adjacent sides of the little and ring fingers, while the third, when present, innervates the contiguous sides of the ring and middle

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fingers; nevertheless, it can be totally or partially substituted by a radial nerve branch, always communicating with it on the back of the hand.[10] In the little finger, the dorsal digital nerves extend to the base of the distal phalanx.[11]Sensitive innervation of the fingers in the ulnar region of the little finger plays an important role in the hand's function. The injury of this nerve and loss of sensibility in this region can affect the ability and function of the hand. Moreover, there may be a higher risk of injury to the little finger after the loss of this protective sensibility. The DDBLF of the DBUN that then innervates the medial (ulnar) side of the little finger follows a course along the fifth metacarpal bone, for which reason there is a risk of injury to the nerve when Kirschner wires are inserted.

The purpose of this study was to examine the DDBLF ratio of the DBUN in cadavers and to define the insertion points of the transversal wires used for percutaneous pinning in subcapital metacarpal fractures and to throw light on the anatomical access required to avoid iatrogenic injury to the nerve.

MATERIALS AND METHODS

Ten upper limbs (n = 10; five right, five left) were used in this study. The limbs were obtained from six formalin-fixed cadavers (mean age at death = 61 years, 45-72 year bracket). Previously dissected or damaged parts were excluded from the study. The total length of the fifth metacarpal bone was measured. The wires were introduced in parallel in the distal third of the fifth metacarpal bone. Two wires were introduced 0.5 cm proximally and distally to the fracture line, which was defined as the margin in which 5/6 and 6/6 distal parts of the fifth metacarpal bone came together (these two points were defined after the calculation using the total length of the fifth metacarpal bone) and that can reflect the usual line of the boxer fracture.

The dorsal branch of the ulnar nerve and its branches were then carefully dissected along its course up to the little finger. All the measurements were made using a digital compass with precision of 0.01 mm. The descriptive statistical analysis was applied to determine mean and standard deviation (SD). Furthermore, the proximity between the DDBLFand DBUN was measured in relation to the wires that penetrated, as well as the distances between the DDBLF of the DBUN and the proximal K-wire (mm) and between the DDBLF of the DBUN and the distal K-wire (mm).

RESULTS

Proximally, the DDBLF of the DBUN took a course alongside the medial (ulnar) region of the bone in some parts. (Figure 1) As the nerve proceeded to distal, it took a dorsal course in the hand. The mean length of the fifth metacarpal bone found here was 57.63 ± 6.24 mm.

The insertion points, as already described, were marked and were not on the nerve branch, following the lateral side of the fifth metacarpal bone. (Figure 2)

For both groups, the mean distance between the DDBLF of the DBUN and the proximal K-wire was 3.33 mm and the mean distance between the DDBLF of the DBUN and the distal K-wire was 5.86 mm. The details of each measurement were shown in Table 1.

The edge of the opponens digiti minimi on the lateral side of the fifth metacarpal bone was defined as standard level for pinning. (Figure 2)

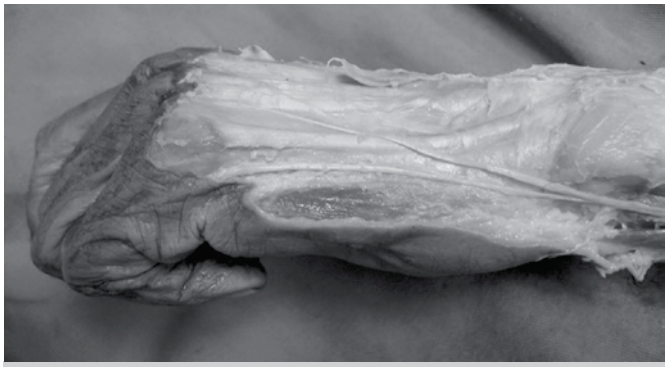

Figure 1. *Demonstrates that the DDBLF ofthe DBUN ran along the medial (ulnar) side of the fifth metacarpal.*

Figure 2. *Relationship of the wire insertion points with the course of the DDBLF of the DBUN and the edge of the opponens digiti minimi on the lateral side of the fifth metacarpal bone.*

Table 1. *Details of the measurements taken on ten cadaveric upper limbs*.

Sample	Right/ Left Side	LENGTH OF FIFTH METACARPAL (mm)	DISTANCE BETWEEN DDBLF AND PROXIMAL K-WIRE (mm)	DISTANCE BETWEEN DDBLF AND DISTAL K-WIRE (mm)
1	Left	66.37	4.85	5.98
2	Right	65.81	3.05	6.45
3	Left	55.12	2.56	5.67
4	Right	62.71	4.52	7.84
5	Right	50.13	2.82	6.96
6	Right	52.86	2.98	4.87
7	Right	52.09	2.91	4.34
8	Left	57.62	3.35	6.45
9	Left	51.13	3.21	5.61
10	Left	62.43	3.01	4.37

DISCUSSION

Fifth metacarpal neck fractures are among the most common types of hand fracture, but rarely require surgery. For these fractures especially, although the acceptable degree of angulation is controversial, up to 50° to 60° can be well tolerated, with good functional results and, in general, can be treated with very simple procedures, unless the angulation or the rotation are severe. The treatment of metacarpal neck fractures is based on the presentation of these fractures, on the degree of displacement and on the difficulty in maintain fracture reduction. Fixation with Kirschner wire is successful in metacarpal neck fractures.[12] In a previous study, there were no differences among the clinical outcomes of 18 metacarpal neck fractures treated with surgery and 105 treated without surgery. The additional outcome (that is, aesthetic) was expressively better for the 113 diaphyseal metacarpal fractures not treated surgically than the 26 submitted to surgery.[13] The DBUN descends along the medial side of the back of the wrist, about 4 cm beyond its proximal insertion, proximally to the wrist. It follows a deep course up to the flexor carpi ulnaris muscle, penetrates the fascia profundis and continues along the ulnar side of the back of the hand. This nerve in general divides into two dorsal digital branches, innervating fingers 1 and 5 in the dorsal ulnar region. On the fifth finger, the dorsal digital branch extends to the base of the distal phalanx, while it only extends to the middle phalanx of the fourth finger. The most distal areas are innervated by the palmar branches of the median nerve (proper palmar digital nerves).[14] They originate two or, often, three dorsal digital nerves. One proper digital nerve for the ulnar margin of the little finger is responsible for the sensitive innervations of the ulnar side of the little finger, the second, for the adjacent sides of the fifth and of the fourth fingers, while the third innervates the contiguous sides of the fourth and third fingers.[11,15] Bozkurt *et al*.[16] found a proper palmar digital nerve for the little finger, which emerged from the DBUN and penetrated the fascia profundis, to become subcutaneous and to travel distally along the palmar-ulnar side of the hand until it reaches the little finger. Windish, G.[17] also identified an uncommon case in cadaver with variation of vascularization and innervation of the fifth finger with two branches of the DBUN. One of them for the dorsal-radial side of the little finger and for the dorsal-ulnar side of the ring finger and a second, which continued running a course on the ulnar side of the hypothenar muscles, moving from the dorsal to the palmar side of the little finger and following an ulnar--palmar course up to the tip of the fifth finger, two tiny nerves running back, dorsally, to innervate the dorsal-ulnar side of the little finger. In literature there is a significant variation of degree of palmar angulation that can be acceptable for fifth metacarpal neck fractures. Some authors[18-20] believe that palmar angulation exceeding 30° requires reduction and others tolerate angles of up to 40°,21 50°22 or even 70°.[23] There is no consensus on the need to reduce the fracture or on how to maintain reduction. Although reduction is very easy to obtain, immobilization is frequently unable to maintain reduction with conservative treatment, due to the combination of the palmar region of the metacarpal neck and the intrinsic muscles that act in the distal fragment.[20,21,24-26] It was demonstrated that surgical treatment affords better correction of angulation than conservative treatment with reduction and immobilization.6 The treatment was described by Bosworth,[27] in 1937, and used K-wires to fix the fifth metacarpal head and diaphysis to the fourth metacarpal bone. Retrograde osteosynthesis with crossed K-wires, described by Smith and Peimer,[28] in 1977, was widely accepted for a long time. Although there are reports of good results, the disadvantages of this technique are that it demands considerable expertise and that it is not possible to obtain control of the rotation. Transverse K-wire fixation for metacarpal fracture stabilization was described for the first time by Berkman and Miles.[29] It can be used for all fracture configurations, due to the ready availability in any surgical installation and to the easy technique. If fracture reduction or pinning is unacceptable, reinsertion is a simple procedure. On the other hand, pins without stiffness can divert the fracture and work loose or cause infection. In unstable metacarpal fractures, Lamb *et al*.[30] suggested the use of two K-wires, one proximal and a distal to the fracture site. With this technique, Paul *et al*.[31] demonstrated that totally pivoting control at the axis of the distal wire is essential to obtain fixation of two points in the two diaphyseal fragments. This is obtained proximally through the intact carpometacarpal joint intact and through the wire, and distally, using two wires. The selection of the ideal treatment depends on several factors, such as fracture location (intra-articular or extra-articular), fracture geometry (transversal, spiral, oblique, comminuted), deformity (angular, rotation, shortening), opened or closed, injuries to bones and associated soft tissues, and fracture stability. Other considerations are age, occupation and socioeconomic condition of the patient, presence of systemic diseases, expertise of the surgeon and cooperative capacity of the patient in treatment implementation. Regardless of the preferred treatment method, the goal is fast and total restoration offunction. Percutaneous pinning with transverse K-wire can be performed easily with fluoroscopic guidance with regional anesthesia and does not require postoperative plaster cast immobilization, but with the potential occurrence of injury to the DDBLF of the DBUN. The authors of this study attempt to define transverse percutaneous pinning to avoid iatrogenic injury lesion to the nerve during the types of treatment of boxer fracture.

CONCLUSIONS

The results of this study confirm the significant proximity of the DDBLF of the DBUN to the course of the pin with K-wire, with potential iatrogenic injury during fifth metacarpal subcapital fracture treatment. This cadaveric study emphasizes the risk of iatrogenic injury to the DDBLF of the DBUN and is important because loss of sensibility can affect the nimbleness and function of the hand. Standard access of the pin should preferably be on the margin of the opponens digiti minimi, on the median line of the lateral side of the fifth metacarpal bone.

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