Results of treatment of oblique and spiral fractures of metacarpals and hand phalanges by mini lag screws.

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Abstract

Background
Hand fractures represent a considerable burden upon society in terms of medical costs and reduced workplace productivity. Optimal treatment for metacarpal and phalangeal fractures remains to be debated. In general they can be treated conservatively or surgically with Kirschner wires, screws or plates.

Patients and methods
This study evaluated the range of motion, functional and radiological results after treatment of 35 oblique and spiral metacarpal and phalangeal fractures by open reduction and internal fixation using lag 2 mm screws. Twelve phalangeal and 23 metacarpal fractures were followed up for 31.47 (26 – 42) weeks. Gender distributed as four females and 26 males with Patients' mean age of 29.4 (17-54) years old. Seventeen patients were manual workers, four housewives, four students, four drivers and a lawyer. Time lag between the trauma and the surgical procedure was 3.6 (1-7) days.

Results
Proximal phalanges revealed total active motion (TAM) score of 222 ± 11.35 (200-240) while middles of 195 ± 7.07 (190-200). Regarding Quick DASH score, metacarpals revealed 9.09 ± 2.93 (4.5-15.9), proximal phalanges 14.32 ± 5.03 (6.8-22.7) and middles 28.4 ± 1.56 (27.3-29.5). The mean period for radiologic union was 7.51 ± 1.22 (5-11) weeks.

Conclusion
Using mini screws with lag technique is a reliable option for oblique and spiral hand fractures. However metacarpal fractures revealed better range of motion and hand function than phalangeal. Proximal phalangeal fractures also revealed better results than middles. Smoking, increased time lag before surgery and postoperative splint duration have a significant negative effect on outcome.

Keywords
Metacarpals, phalanges, lag screws.

Introduction

Hand fractures represent a considerable burden upon society in terms of medical costs and reduced workplace productivity.[1] Fractures of the metacarpals and phalanges are the most common fractures of the upper extremity. Those fractures are broadly classified into three types: transverse, oblique and spiral, and comminuted. Each fracture type presents characteristic deformities that may lead to complications if unrecognized or improperly treated. Oblique and spiral fractures are usually the result of torsional forces and can cause rotational malalignment. [2]

Outcome of conservative treatment in displaced, irreducible, unstable and rotational fractures is poor. Surgical treatment is preferred in these types of fractures.[3] Metacarpal and phalangeal fractures in general can be treated surgically with Kirschner wires, screws or hand plates.[4] The most critical elements in deciding between operative and non-operative treatment are the assessment of rotational alignment and stability. Where reduction and early motion are deemed necessary, a closed reduction with percutaneous K-wire stabilization may be considered. Open surgery increases soft tissue trauma, but can potentially achieve the most stable and anatomic reduction and so allow aggressive early mobilization.[1] Lag screws are the implant of choice for oblique and spiral fractures of the metacarpals and phalanges.[5] The technique involves drilling a glide hole in the near cortex followed by a concentrically placed smaller hole in the far cortex for appropriate compressed fixation.[6]

Patients and Methods

This prospective study included 35 metacarpal and

phalangeal fractures in 30 hands that were treated at Menoufia University and Kafr Eldawar general hospitals during the period from February 2017 to January 2018. They were followed up for a mean period of 31.47 (range 26-42) weeks.

Four females (3 phalangeal and 1 metacarpal fractures) and 26 males (9 phalangeal and 17 metacarpal fractures) patients with mean age of 29.40 ±8.59 (range 17-52) years old were included. There were 17 manual workers, 4 housewives, 4 students, 4 drivers and a lawyer. Seven patients were smokers. Fourteen dominant and sixteen non-dominant hands were affected.

Twenty three metacarpal (4 second, 7 third, 8 fourth and 4 fifth) fractures were included. Five hands had double metacarpal (four of them with combined third and fourth metacarpal) fractures. Regarding twelve phalangeal fractures, ten proximal (4 index, 1 middle, 4 ring and 1 little fingers) and two middle (1 index and 1 middle fingers) phalanges were affected. Four metacarpal and three phalangeal fractures had intraarticular extension.

Methods:

Anteroposterior and oblique plain radiographic images of the hand were obtained for all patients. In cases of phalangeal trauma additional lateral views were obtained. Pronation oblique views were helpful to interpret fractures of radial sided metacarpals including second and third. While supination oblique views were helpful in patient of ulnar sided metacarpals including fourth and fifth.

All patients were operated within seven days of their trauma. Mean time lag between the trauma and the surgical procedure was 3.6 (range 1-7) days. One gm ceftriaxone was administrated intravenously for all patients one hour prior to the operation. All patients operated in supine position with the involved hand on a side table. Surgeries were carried out for 27 patients under general anesthesia and three had intravenous regional anesthesia (Bier block). Intraoperative fluoroscopy was used in two surgical operations.

A 2mm fully threaded mini screws set was used. The screws within this set have a core diameter of 1.5mm and thread diameter of 2mm with star shaped head driving recess and screws length ranges from 6 to 20 mm. This set also includes 1.5 mm drill bit for threaded holes 2 mm drill bit for gliding holes, countersink, star shaped screw driver and depth gauge.

Dorsal approaches for metacarpal and phalangeal fractures were used with extensor tendons retraction. Internal fixation of the fracture was done with screw direction aimed to be perpendicular to fracture plane to avoid any displacement when the screw was tightened. At first the 1.5 mm drill bit was used to drill both cortices then the 2 mm drill bit was used to drill the near cortex only forming a gliding hole that apply fracture compression as the screw tightened. The screw head was countersunk to reduce soft tissue irritation and allow maximal contact area with bone so distributing the forces from the screw head more widely. Twenty eight fractures received two screws, six fractures received three and one fracture received four.

Postoperative plaster of Paris splint in the functional position was applied for a week. In the second week, the patients were allowed to start movement with a protective orthotic and buddy taping to the adjacent finger however some patients were delayed due to non-regular follow up visits. In the third week, the patients continued active movement without buddy taping.

Range of motion of twelve fingers with phalangeal fractures were assessed using goniometer six weeks after surgery and at final follow up according to TAM score. Results of TAM score obtained were interpreted and classified to excellent (260-220)°, good (219-180)°, Fair (179-130)° and poor (<130)° results. Functional outcome of thirty hands with metacarpal or phalangeal fractures were assessed using Disabilities of the Arm, Shoulder and Hand (Quick DASH) score six weeks after surgery and at final follow up. Radiologic evaluation of fracture union was done through serial plain X-rays. (Fig. 1,2)

Results

Six weeks postoperative TAM score of twelve phalangeal fractures was 198.3± 25.9 (range 150-240)°. Early range of motion assessment revealed two (16.7%) fair, eight (66.7%) good and two (16.7%) excellent results. While TAM score at the end of follow up was 217.5 ± 14.9 (range 190-240)°. Final range of motion assessment revealed four (33.3%) good and eight (66.7%) excellent results.

Regarding TAM score, females revealed significant better results (233.3 ±5.77) at final follow up visits compared with males (212.22 ± 13.02) (P=0.018). Proximal phalanges (207.0 ± 17.67) revealed significant better results than middles (155.0 ± 7.07) at early follow up (P=0.029). Regarding late follow up, proximal phalanges (222.0 ± 11.35) also had significant better results than middles (195.0 ± 7.07) (P=0.036). Time lag before surgery had a significant negative correlation with TAM score at both early (P<0.001)

and late (P=0.025) follow up. While splint duration had a significant negative correlation with TAM score at early follow up (P=0.001).

Figure 1 (a) preoperative and (b) postoperative plain X-ray of third metacarpal fracture fixed by two screws (c) six weeks postoperative range of motion (d) Ten months follow up plain X-ray

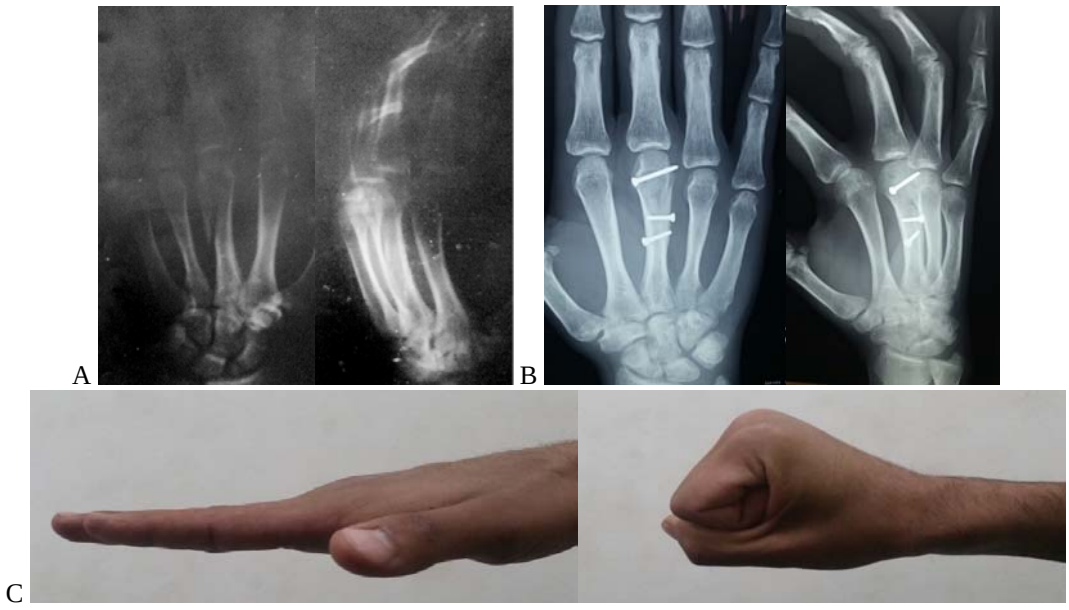

Figure 2 (a) preoperative and (b) six weeks postoperative plain X-ray of third metacarpal fracture with intraarticular extension to metacarpophalangeal joint fixed by three screws (c) six weeks postoperative range of motion

Six weeks postoperative Quick DASH score for thirty hands was 24.02 ± 11.70 (range 6.8-50). While the mean result at the final follow up visit was 12.12 ± 6.21 (range 4.5-29.5). Females with phalangeal fractures (9.10 ± 2.30) had significant better hand function at final follow up visits compared with males (19.19 ± 6.34) (P=0.016). Regarding patients with metacarpal fractures, non-smokers (19.31 ± 9.21) had significant better hand function than smokers (38.63 ± 8.71) at early follow up (P=0.011). Regarding hand function at final follow up visits, patients with metacarpal fractures (9.09 ± 2.93) had significant better results than those with phalangeal. While patients with proximal phalangeal fractures (14.32 ± 5.03) had significant better results than those with middles (28.40 ± 1.56) (P=0.002). Time lag before surgery had a significant negative impact on hand function both at early (P<0.001) and late (P=0.017) follow up. Regarding patient with metacarpal fractures, increased splint duration and union time also had a sig-

nificant negative impact on hand function both at early (P<0.001) and late (P<0.001) follow up.

The mean period for radiologic signs of union to appear was 7.51 ± 1.22 (range 5-11) weeks. Manual workers with metacarpal fractures (7.93 ± 1 weeks) needed a significant longer time for signs of union compared by other patients with metacarpal fractures (P=0.032). Smokers (9.33 ± 1.53 weeks for phalanges, 8.75±0.5 for metacarpals) needed a significant longer time for signs of union compared by non-smokers (7.33 ± 0.71 weeks for phalanges, 7.05 ± 1.08 weeks for metacarpals) (P=0.025 for phalanges and P=0.01 for metacarpals). Regarding phalangeal fractures, Two patients that complicated by wound infection (10 ±1.41 weeks) revealed a significant longer time for union compared with those without complications (7.4 ± 0.7 weeks) (P=0.023). Increased time lag before surgery (P=0.037 for phalanges and P<0.001 for metacarpals) and splint duration (P=0.009 for phalanges and P<0.001 for metacarpals) had a significant negative impact on union.

There were three patients who suffered from complications in the form of infection. Two of them had phalangeal fractures (one proximal and one middle phalanx) with postoperative superficial wound infection which were treated by debridement and antibiotics. (Fig. 3) The other had fourth metacarpal fracture with postoperative deep infection that necessitated removal of implants. (Fig. 4)

Figure 3 (a) superfacial wound infection two weeks postoperative (b) Nine weeks postoperative plain X-ray of middle phalanx fracture of middle finger fixed by two screws.

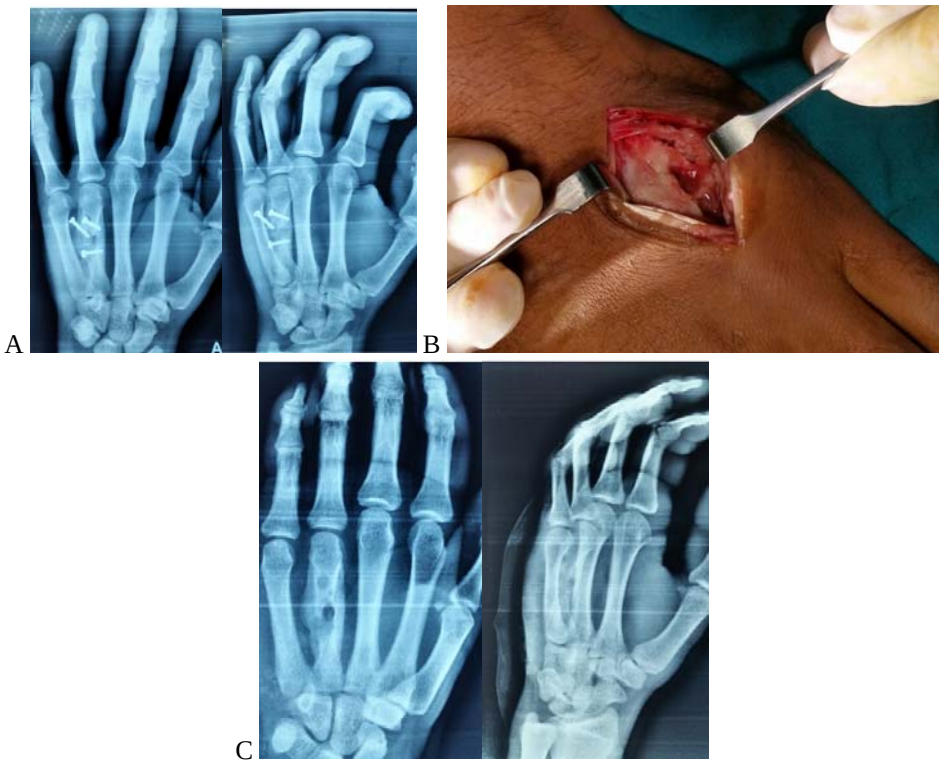

Figure 4 (a) Nine weeks post operative plain X-ray of fourth metacarpal fracture fixed by three screws showing screws lossning due to infection (b) removal of screws and sequestrectomy (c) plain X-ray after screws removal

Discussion

Optimal treatment for metacarpal and phalanx fractures remains to be debated. Closed reduction and immobilization or functional bracing is reported, but requires careful selection of patients with fracture patterns amenable to non-operative treatment.[7,8] Long oblique fractures with the fracture length more than the diameter of the bone or isolated corner articular fractures may be especially amenable to lag screw fixation.[9] Many surgeons employ this technique because of the implants' low profile and biomechanical stability.[10] This technique involves drilling a glide hole in the near cortex followed by a smaller hole in the far cortex for appropriate compressed fixation.[11]

Hakan Başar et al. (2015) evaluated the results of treatment of oblique and spiral metacarpal and phalangeal fractures with mini screws only compared to mini plates and screws.[3] Ford et al. (1986) treated 36 patients for fractures of the proximal and middle phalanges with mini screws.[12] Crawford (1976), in period from 1969 to 1975, treated twenty one phalangeal and metacarpal fractures with screws.[13] Nalbantoglu et al. (2009), evaluated the functional results of open reduction and low-profile plate and/or screw fixation in the treatment of 17 patients with phalangeal fractures.[14] Roth et al, (2005) published their results of using bicortical screws without lag technique for treating 37 fractures in 36 hands.[15]

Mean ages of patients of all mentioned studies including this study run closely around thirty years old. Males revealed obvious incidence predominance through all mentioned studies the thing that met results of this study. Ford et al. (1986) agreed with this study that manual workers had high incidence of hand fractures. Middle ages, males and manual workers are more liable to hand fractures because of their activities and work patterns. Screws with 2 mm threads diameter were used widely within mentioned studies however, Ford et al. (1986), used also 1.5 mm screws that deal better with small fragments while Crawford (1976), used also 2.7 mm screws that were the available screws during this period. Crawford (1976), had 60% incidence of intra-articular fractures and Roth et al. (2005), had incidence of 62%. However this study revealed only incidence of 20%.

Hakan Başar et al. (2015), revealed better TAM score for phalangeal fractures fixed by lag screws than this study. However they agreed with this study that metacarpal fractures treated with lag screws had better results regarding range of motion and hand function than phalangeal fractures treated with the same manner. Regarding range of motion, this study revealed satisfactory results for all phalangeal fractures with superior results than Ford et al. (1986), (three unsatisfactory results), Crawford (1976), (one unsatisfactory result) and Nalbantoglu et al. (2009), who used postoperative splint for three weeks (three unsatisfactory results). This study revealed union time close to Roth et al. (2005).

Conclusion

Lag screws fixation is a suitable option for treatment of long oblique and spiral hand fractures. Metacarpals revealed better results than phalanges. While proximal phalanges revealed better results than middles. Time lag before surgery, postoperative splint duration, smoking and postoperative infection were important factors that affected surgical outcome.

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