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Klinik Çalışma

Unstable metacarpal and phalangeal fractures: treatment by internal fixation using AO mini-fragment plates and screws

Stabil olmayan metakarp ve falanks kırıkları: AO mini-fragman plak ve vida kullanılarak internal fiksasyon yöntemiyle tedavi

Mohammad Umar MUMTAZ,[1] Muneer Ahmad FAROOQ,[1] Altaf Ahmad RASOOL,[2] Altaf Ahmad KAWOOSA,[1] Abdul Rashid BADOO,[1] Shabir Ahmad DHAR[1]

BACKGROUND

Accurate open reduction and internal fixation for metacarpal and phalangeal fractures of the hand is required in less than 5% of the patients; otherwise, closed treatment techniques offer satisfactory results in most of these cases as these fractures are stable either before or after closed reduction. AO mini-fragment screws and plates, when used in properly selected cases, can provide rigid fixation, allowing early mobilization of joints and hence good functional results while avoiding problems associated with protruding K-wires and immobilization. The advantages of such internal fixation urged us to undertake such a study in our state where such hand injuries are commonly seen.

METHODS

Forty patients with 42 unstable metacarpal and phalangeal fractures were treated with open reduction and internal fixation using AO mini-fragment screws and plates over a period of three years in a prospective manner.

RESULTS

The overall results were good in 78.5% of cases, fair in 19% of cases and poor in 2.5% of cases, as judged according to the criteria of the American Society for Surgery of the Hand.

CONCLUSION

This technique is a reasonable option for treating unstable metacarpal and phalangeal fractures as it provides a highly rigid fixation, which is sufficient to allow early mobilization of the adjacent joints, thus helping to achieve good functional results.

Key Words: AO mini-fragment plates and screws; fractures; metacarpal; phalangeal; unstable.

AMAÇ

El metakarp ve falanks kırıklarıyla ilgili olarak, uygun açık redüksiyon ve internal fiksasyon, hastaların %5'inden daha azında gerekli olmaktadır. Bunun dışında kalanlarda, bu kırıkların kapalı redüksiyondan gerek önce gerek sonra stabil olmaları nedeniyle, kapalı redüksiyon teknikleri olguların çoğunda tatmin edici sonuçlar vermektedir. AO mini-fragman plak ve vidalar doğru seçilmiş olgularda kullanıldığında eklemlerin erken hareketlenmesine ve böylelikle dışarı uzanan K-telleri ve hareketsizlik sorunlarını önleyerek iyi fonksiyonel sonuçlara olanak tanıyan sert fiksasyon sağlayabilir. İnternal fiksasyonun avantajları, bizi bu tip el yaralanmalarının yaygın olarak görüldüğü eyaletimizde böyle bir çalışma yapmaya teşvik etmiştir.

GEREÇ VE YÖNTEM

Kırk iki adet stabil olmayan metakarp ve falanks kırığı bulunan 40 hasta, AO mini-fragman plak ve vida kullanılarak, ileriye dönük olarak üç yıllık sürede açık redüksiyon ve internal fiksasyon yöntemiyle tedavi edildi.

BULGULAR

Genel olarak sonuçlar Amerikan El Cerrahisi Derneği ölçütlerine göre, olguların %78,5'inde iyi, %19'unda orta derece ve %2,5'inde kötü olarak değerlendirilmiştir.

SONUÇ

Bu teknik, komşu eklemlerin erken hareketlenmesine olanak sağlamaya yetecek oldukça sert bir fiksasyon sağlaması ve iyi fonksiyonel bulgular elde etmeye yardım etmesi nedeniyle, stabil olmayan metakarp ve falanks kırıklarını tedavi etmeye yönelik uygun bir seçenektir.

Anahtar Sözcükler: AO mini-fragman plak ve vida; kırıklar; metakarp; falanks; stabil olmayan.

[1]Government Hospital for Bone and Joint Surgery Barzulla, Srinagar, Kashmir; [2]Sher-i-Kashmir Institute of Medical Sciences Soura, Srinagar, Kashmir, India.

[1]Kemik ve Eklem Cerrahisi Devlet Hastanesi, Barzulla, Srinagar, Kaşmir; [2]Sher-i-Kashmir Tıp Bilimleri Enstitüsü, Soura, Srinagar, Kaşmir, Hindistan.

Correspondence *(İletişim):* Mohammad Umar Mumtaz, M.D. Government Hospital for Bone and Joint Surgery, Barzulla, Srinagar, India.
Tel: +01942491290 e-mail *(e-posta):* umarmumtaz72@gmail.com

A majority of hand fractures are stable either before or after closed reduction and can be effectively treated by closed means. The indications for accurate open reduction and internal fixation are few, probably less than 5% of all hand fractures,[1] and include unstable fractures, displaced intraarticular fractures, multiple fractures, open fractures with associated soft tissue injury (tendon, ligament or neurovascular injury, where rigid skeletal stabilization may allow soft tissue injury to be dealt with more effectively[2]), fractures with segmental defect and substance loss, disabling malunions/nonunion, and re-implantation of amputated digits. AO mini-fragment screws and plates, when used in properly selected cases, can provide rigid fixation, allowing early mobilization of joints and hence good functional results while avoiding problems associated with protruding K-wires and immobilization.[3-5]

In this paper, we report our experience and results of internal fixation of unstable metacarpal and phalangeal fractures with AO mini-fragment plates and screws.

MATERIALS AND METHODS

From April 2001 to July 2004, a total of 40 patients with 42 unstable metacarpal and phalangeal fractures were treated with AO mini-fragment screws and plates. A fracture was considered as unstable if it was irreducible, if acceptable reduction could not be maintained, and/or motion at the adjacent joints could not be started without loss of reduction.[6] Certain fracture patterns like displaced transverse, long spiral and short oblique fractures as well as displaced articular condyle fractures with >25% articular surface involvement were recognized as inherently unstable and were selected for surgery if they met the above criteria for instability. Intraarticular fractures of the base of the thumb as well as open fractures were excluded from this study.

Operative Technique

Metacarpal fractures were exposed through a direct incision made on the radial border of the first and second metacarpals and ulnar border of the fifth metacarpal. The third and fourth metacarpals were exposed through a dorsal longitudinal incision between these bones. Proximal phalangeal fractures were exposed through a dorsal midline extensor splitting approach. For exposure of middle phalangeal fractures, a midlateral (mid-axial) approach was used. After exposure, accurate anatomical reduction of the fracture was carried out and maintained using fine-pointed reduction forceps or a small K-wire. Next, internal fixation was carried out using appropriate miniature screws and/or plates. Interfragmentary lag screws alone were used in unstable spiral or long oblique fractures and displaced intraarticular fractures (2.7 mm or 2.0 mm screws for 2 metacarpals and 2.0 mm or 1.5 mm screws for phalangeal fractures (Figs. 1a, 1b, 2a and 2b). Contoured AO miniature plates were used for unstable transverse or short oblique diaphyseal fractures of metacarpals or proximal phalanges (Figs. 3a, 3b, 4a and 4b). 2.7 mm or 2.0 mm straight mini-dynamic compression plate (DCP) was used for metacarpal shaft fractures while a 2.0 mm T or L condylar plate was used for metacarpal head or neck fractures. For proximal phalangeal fractures, a 2.0 mm or 1.5 mm mini-plate was used. Meticulous attention was paid to dissection as well as to the steps involved in internal fixation. In the proximal phalanx, where a dorsal extensor splitting approach was used, the extensor mechanism was repaired using fine prolene sutures. After wound closure, a compression dressing was applied and the limb was elevated. A plaster splint was used for support for 48 hours. In most cases, the splint was discarded after 48 hours and active range of motion (ROM) exercises were started and increased progressively within the limits of pain tolerance. The patients were discharged on the fifth

Fig 1. **(a)** Periarticular unstable fracture involving proximal phalanx. **(b)** After stabilization with two interfragmentary lag screws.

Fig 2. **(a)** Unstable oblique fracture involving proximal phalanx. **(b)** After internal fixation using two interfragmentary lag screws.

postoperative day. After discharge, physiotherapy was carried out on an outpatient basis. The patients were evaluated clinically and radiologically. Active ROMs of all the joints of each finger in the involved hand were measured. Serial radiographs were taken to detect any loss of reduction and to evaluate bone healing. The assessment of functional results was made on the basis of the criteria of the American Society for Surgery of the Hand, in which total active movement (TAM) of the digit (other than the thumb) is measured. TAM is defined as the total active 3 flexion range of metacarpophalangeal [MCP] and interphalangeal [IP] joints. The results were graded as follows: TAM ≥210° as good, TAM of 210-180° as fair and TAM of <180° as poor[2,7] (normal TAM for fingers=260°). For thumb fractures, we used the assessment method proposed by Gingrass and Associates,[8] which involves measuring palmar abduction and TAM of the MCP and IP joints of the thumb.

RESULTS

Forty patients with 42 fractures were included in this study. Two patients had multiple fractures affecting the same hand. Twenty-nine patients were male and 11 were female. The average age was 28.5 years. The right hand was involved in 27 cases. There were 21 metacarpal, 17 proximal phalangeal, and 4 middle phalangeal fractures. The distribution of the above fractures was as follows: thumb ray 9, index ray 14, middle ray 3, ring ray 10, and little ray 6. Mechanism of injury included fall, direct blow and traffic accident. Of 42 fractures, 10 were transverse, 21 were oblique,

Fig 3. **(a)** Unstable displaced transverse fracture of thumb metacarpal. **(b)** After open reduction and internal fixation with miniature T-plate.

Fig 4. **(a)** Unstable displaced transverse fracture of second metacarpal. **(b)** After stabilization with AO miniplate.

3 were spiral, 6 were intraarticular, and 2 were comminuted. All the fractures were closed.

Twenty-seven fractures were fixed with miniature plates and 15 with interfragmentary lag screws. The final assessment was made at one year. All fractures had united consistently. For digits other than the thumb, the results were good (TAM ≥210°) in 24 (73%) fractures, while poor results (TAM <180°) was seen in only one case. In all the nine thumb fractures, good results (>100° flexion at MCP+IP joints with average palmar abduction of 55°) were seen. The overall functional results (all digits including thumb) were good in 78.5% of cases, fair in 19% of cases and poor in 2.5% of cases. There were seven complications. The complications included four cases of superficial wound infection, one case of deep infection and two cases of residual deformity (angulation >10° or rotation) attributed to fracture comminution. The implant was removed in eight cases, which included six mini-plates and two interfragmentary lag screws. In one case, the indication for removal was deep infection while the rest had local tenderness over implant. The case of deep infection was treated by antibiotics and implant removal at three months when radiological union was demonstrated. In all other cases, the implant was removed after six months.

DISCUSSION

A majority of hand fractures are stable either before or after closed reduction and can be successfully treated by non-operative methods, which include protective splintage and early mobilization. On the other hand, results of closed treatment in the remaining small percentage of unstable hand fractures are usually unsatisfactory. James[9] reported loss of function in 77% of fingers with unstable phalangeal fractures treated by closed means. On the other hand, open reduction and internal fixation with K-wires produces a less rigid fixation with little rotational stability, leaving much to be desired. The problems are compounded by the protruding ends of the K-wires. Interosseous wiring when combined with K-wire provides more rigid stabilization; however, this technique is applicable to transverse diaphyseal fracture patterns only. Osteosynthesis using AO miniature plates and screws in this small group of unstable metacarpal and phalangeal fractures produces anatomical reduction of fractures with stabilization that is rigid enough to allow early mobilization of adjacent joints without allowing loss of reduction, thereby preventing stiffness and hence good functional results. Many studies in the literature have demonstrated biomechanical superiority of AO mini-plates and screws over other modes of internal fixation in hand fractures. A biomechanical study by Fyfe and Mason[10] to evaluate the rigidity of various modes of internal fixation showed that AO mini-plates and screws and IO wiring produced much stronger stabilization than K-wires. A similar study by Black[11,12] concluded that dorsal plating with or without lag screws provided significantly more stability than K-wires/IO wiring. In the literature, several studies have reported satisfactory results with internal fixation of unstable metacarpal and phalangeal fractures using AO mini-plates and screws.[2,4,6,13-20] Agarwal,[21] in a more recent prospective review of 20 hand fractures treated with a new ultra low profile plating system, in which 0.6-mm-profile-height plates were used for both metacarpals (11 cases) and phalanges (9 cases), reported very favorable results, with no incidence of plate failure. The overall results in our study were similar to those above with good results achieved in 78% of the fractures. We would like to emphasize that surgical dissection should be meticulous, avoiding soft tissue trauma and excessive periosteal strip-

ping. Further, a high degree of precision is required in the technique. The plates must be carefully contoured to avoid fracture site distraction. Drilling and tapping must be accurate so that no threads are stripped because in the event of loosening or stripping of screw holes, repositioning of the plate or replacement with a longer plate may not be possible because of the limited bone length.

We conclude that although AO mini-plate/screw fixation is a reasonable option for treatment of such unstable fractures where other methods of treatment can be less effective, reasonable caution must be exercised in patient selection, and indiscriminate use of the technique should be avoided at all costs. Detailed clinical and radiological assessment of the fracture, careful preoperative planning, meticulous dissection, and precision in the technique are the keys for achieving good results and minimizing complications.

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