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# The results of open reduction and screw or K-wire fixation for isolated type II radial head fractures

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**Objectives:** We evaluated the functional and radiographic results of patients treated with open reduction and screw or K-wire fixation for isolated Mason type II radial head fractures.

**Methods:** The study included 21 patients (14 men, 7 women; mean age 36 years; range 25 to 58 years) who were treated with open reduction followed by mini screw (n=11) or K-wire (n=10) fixation for isolated type II radial head fractures. Functional results were evaluated using the modified Morrey functional rating index. Radiographically, osteoarthritis or heterotopic ossification were investigated. The mean follow-up was 30.5 months for K-wire fixation, and 32.1 months for screw fixation.

**Results:** Union was achieved in all the patients, within a mean of 6.2 weeks with screw fixation, and 5.8 weeks with K-wire fixation. The range of motion of elbow flexion-extension and pronation-supination were 131.4° and 144.4° with screw fixation, and 127.5° and 146.5° with K-wire fixation, respectively. The mean Morrey index was 94.5 (range 73 to 100) with screw fixation, yielding excellent or good results in 10 patients. One patient whose result was fair had a 2-mm step-off on the joint surface, resulting in osteoarthritis. The mean Morrey index was 92.1 (range 73 to 100) in the K-wire group, with excellent or good results in nine patients, and fair in one patient. All the patients returned to preinjury work in a mean of 11.7 weeks and 12.5 weeks in screw and K-wire groups, respectively. Heterotopic ossification was not observed. The two fixation groups were similar with respect to union time, joint range of motion, Morrey score, and time to return to work ($p>0.05$).

**Conclusion:** Our results suggest that both methods provide sufficient fixation resulting in similar functional results in isolated type II radial head fractures.

**Key words:** Bone screws; bone wires; fracture fixation, internal/methods; radius fractures/surgery; range of motion, articular.

The radial head plays an important role in rotation of the forearm, preventing valgus stress on the elbow and proximal migration of the radius. Radial head fractures account for about 30% of all elbow fractures and mostly occur as a result of falling onto an outstretched hand.[1] Restoration of impaired biomechanics of the elbow is essential for successful functional results.[1,2]

The intensity and mechanism of trauma causing radial head fracture also determine the type of associated injuries. Soft tissue injuries such as medial and lateral collateral ligament injuries, olecranon, coronoid or capitellum fractures, and elbow dislocations are the pathological conditions that may accompany radial head fractures and affect the results of treatment.[3]

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In this study, we aimed to evaluate the functional and radiographic results of open reduction and screw or K-wire fixation performed in patients with isolated Mason type II (displaced two-part fractures) radial head fractures.

## Patients and methods

Isolated radial head fractures of 34 patients were treated with open reduction and screw or K-wire fixation between 2001 and 2008. Of these, 21 patients (14 males, 7 females; mean age 36 years; range 25 to 58 years) with Mason type II fractures were enrolled in the study. Involvement was in the right radial head in 13 patients, in the left radial head in eight patients, and in the dominant extremity in 15 patients.

The absence of associated fractures was verified radiographically in all the patients. The patients were operated on under general anesthesia after a mean of 2.4 days (range 2 to 4 days) following injury. Preoperative stability tests were performed clinically, and examination of the lateral and medial collateral ligaments was repeated under anesthesia during surgery.

Access to the radiocapitellar joint was obtained via a Kocher incision between the anconeus and extensor carpi ulnaris muscles. Following anatomical repositioning of the fracture fragment, mini screw fixation was used in 11 patients (7 males, 4 females; mean age 40 years; range 30 to 58 years) and K-wire fixation was used in 10 patients (7 males, 3 females; mean age 33 years; range 25 to 54 years) (Fig. 1, 2). When choosing the fixation material, the size of the spongious bone around the fracture and the availability of the material were considered. In cases in which screw fixation was not feasible due to the small size of the spongious bone or unavailability of the screws, K-wire fixation was performed. In screw fixation, a 2.5-mm AO screw or headless compression screws (2-3 screws) were used, K-wire fixation was performed using 2-mm K-wires (3 to 5 wires). Particular attention was paid to insert the screws and wires through the safe zone and, after fixation, compression was evaluated. K-wires were inserted with angulation and were cut flush with the surface of the bone. The patients wore a functional brace for three weeks postoperatively, that allowed elbow flexion-extension and restricted forearm rotation. After three weeks, the brace was removed and rotational movements were allowed. Functional results were evaluated using the modified Morrey functional rating index.[4] Range of joint motion was measured. Time to return to preinjury work was questioned (Table 1). Radiographically, fracture reduction and union, and development of osteoarthritis and heterotopic ossification were evaluated. Clinically, pain and elbow stability were evaluated. A visual analog scale was used for evaluation of pain. The mean follow-up was 30.5 months (range 11 to 80 months) in the K-wire group, and 32.1 months (range 18 to 63 months) in the screw group. The two fixation groups were compared with respect to range of joint motion, Morrey scores, and time to return to work using the paired t-test.

## Results

Union was achieved in all the patients within a mean of 6.2 weeks (range 5 to 7 weeks) in the screw group, and 5.8 weeks (range 5 to 8 weeks) in the K-wire group. The mean elbow flexion-extension arc and the mean pronation-supination arc were 131.4° (range 115° to 140°) and 144.4° (range 100° to 160°)


**Fig. 1.** **(a, b)** Preoperative and **(c, d)** postoperative anteroposterior and lateral radiographs of a patient whose displaced two-part Mason type II radial head fracture was treated with screw fixation.

**Fig. 2.** **(a, b)** Preoperative and **(c, d)** postoperative anteroposterior and lateral radiographies of a patient whose displaced two-part Mason type II radial head fracture was treated with K-wire fixation.

in the screw group, and were 127.5° (range 105° to 140°) and 146.5° (range 130° to 160°) in the K-wire group, respectively.

In the screw group, the results were excellent or good in 10 patients (8 excellent, 2 good), and fair in one patient according to the modified Morrey functional rating index, with the mean index score being 94.5 (range 73 to 100). The patient with a fair result had a 2-mm step-off on the joint surface. Although the step-off did not increase during the follow-up, sclerosis was seen at 12 weeks, and joint space narrowing was detected at 20 weeks, leading to a diagnosis of osteoarthritis. The patient had a flexion contracture of 15° and pronation-supination range was limited to 50°. One patient with an excellent result also had a flexion contracture of 13°.

In the K-wire group, the results were excellent or good in nine patients (5 excellent, 4 good), and fair in one patient. The mean index score was 92.1 (range 73 to 100). Good and fair results were associated with flexion contractures of 10° to 15°, and limited pronation-supination to 65° to 75°.

All the patients returned to their preinjury work without any problem, within a mean of 11.7 weeks (range 10 to 14 weeks) in the screw group, and 12.5 weeks (range 10 to 14 weeks) in the K-wire group. Overall, no signs of heterotopic ossification were observed. All affected elbows were evaluated to be stable. One patient who had radiographic signs of osteoarthritis in the screw group reported mild pain at the end of the motion arc. There were no significant differences between the two groups with respect to time to union, range of joint motion, Morrey score, and time to return to work ($p>0.05$; Table 1).

## Discussion

Anatomy and biomechanics of the elbow joint are much more complex than many other joints. Flexion-extension and rotation movements comprise the two primary planes of the triplanar elbow range of

**Table 1**
Data on range of joint motion, Morrey score, and time to return to work in two fixation groups

| | Screw fixation (n=11) | | | K-wire fixation (n=10) | | | |
|---|---|---|---|---|---|---|---|
| | Mean | Standard deviation | Standard error | Mean | Standard deviation | Standard error | *p* |
| Range of motion (°) | | | | | | | |
| Flexion | 134.1 | 3.8 | 1.1 | 131.0 | 7.0 | 2.2 | 0.297 |
| Extension | -2.3 | 5.2 | 1.2 | -2.0 | 4.2 | 1.3 | 0.343 |
| Pronation | 73.2 | 8.7 | 2.6 | 73.0 | 5.9 | 1.9 | 0.343 |
| Supination | 70.9 | 8.1 | 2.4 | 73.5 | 6.3 | 2.0 | 0.434 |
| Morrey score | 94.5 | 8.8 | 2.7 | 92.1 | 9.5 | 3.0 | 0.695 |
| Return to work (weeks) | 11.7 | 1.2 | 0.5 | 12.5 | 1.5 | 0.5 | 0.46 |

motion. During motion, ligamentous and muscular stability are as important as skeletal harmony.[5] The classification first developed by Mason in 1954 and then modified by Johnston in 1962 is still the most commonly used classification for radial head fractures.[6-8] According to this classification, type I fractures are nondisplaced fractures that are generally treated conservatively. Type II fractures are displaced marginal fractures, type III fractures represent comminution, and type IV fractures are associated with elbow dislocations.[9,10] Although the Mason classification is descriptive, it is not much helpful in the selection of appropriate treatment. Therefore, several modifications have been proposed to the Mason classification in an attempt to define the degree of displacement that requires surgery and the mechanical block effect. Hotchkiss[11] suggested that fractures with no or minimal (<2 mm) intra-articular displacement and causing no block to forearm rotation, or marginal lip fractures be classified as type I fractures and be treated conservatively. Type II fractures present displacement (>2 mm) or angulation, causing limitation in motion. In this modification, there may be comminution in type II fractures. These fractures can be treated with open reduction and internal fixation. Type III fractures, on the other hand, are so comminuted that operative fixation is not possible and they usually require excision.[11]

Morrey defined fracture displacement as having the following features: involvement more than 30% of the joint surface, displacement greater than 2 mm, and presence of fracture-dislocation.[12] Capo and Dziadosz[10] defined displaced fractures as involvement more than one-fourth of joint surface, displacement greater than 2 mm, and the presence of a step-off causing mechanical block and recommended surgical intervention. Other authors also recommended open reduction and internal fixation for displacements greater than 2 mm due to the high possibility of osteoarthritis in the short term.[13,14] In our study, two-part fractures involving more than 25% of the radial head and causing a step-off greater than 2 mm were considered type II fractures and were treated surgically.

Isolated radial head injuries are uncommon. Gupta et al.[9] reported the incidence of associated bone or soft tissue injuries as 52% in Mason type I fractures and 94% in type III fractures. Nalbantoğlu et al.[15] determined chondral defects in the capitellum in 10 of 51 patients with Mason type II or III radial fractures. Van Riet et al.[16] reported that injuries to the medial or lateral collateral ligaments or both were detected in 51% of patients with radial head fractures, requiring surgical intervention in 44%. Itamura et al.[17] examined 24 patients with Mason type II or type III fractures by magnetic resonance imaging and found that the ulnar or lateral collateral ligaments, or both were injured in 54%, 80%, and 50%, respectively. Gupta et al.[9] also demonstrated a strong correlation between the number of associated injuries and adverse functional results. Fixation of the fracture is of particular importance for stabilization of the elbow joint especially in patients with associated soft tissue injuries.[5] In order to clearly evaluate the results of the selected method in a homogeneous patient group, we included only the patients with isolated type II fractures after excluding medial or lateral collateral ligament injuries by preoperative elbow instability tests and intraoperative examination under anesthesia.

Treatment options for radial head fractures include conservative treatment, excision, open reduction-internal fixation, and arthroplasty. There is a consensus on conservative treatment of non-displaced type I fractures.[1,9,10,18] In contrast, conservative treatment is not recommended for displaced fractures. Khalfayan et al.[19] reported high rates of pain, motion restriction, loss of strength, and signs of arthritis in patients treated conservatively for displaced fractures. Although Mason type II fractures used to be treated by various methods ranging from conservative treatment to excision, open reduction and internal fixation have now become the method of choice after attaining a better insight into the biomechanics of the elbow and forearm.[2,3,10] Struijs et al.[20] reported less pain in patients treated surgically versus conservatively for Mason type II fractures. In our study, all fractures were classified as Mason type II based on the amount of comminution and displacement, and were treated by open reduction and internal fixation.

Excision of the radial head is a treatment option particularly for comminuted fractures and fractures that cannot be reduced.[10,21,22] Following excision of the radial head, however, many complications have been reported such as pain, instability, new bone formation at the excision site, proximal radial migration, ulnar neuritis, arthrosis, and cubitus valgus.[13,23,24] Leppilahti and Jalovaara[4] examined wrist and elbow joints of 23 patients following radial head excision due to isolated fractures and found that 15 elbows and 13 wrists were symptomatic. They concluded that excision was not an ideal treatment option for the management of isolated fractures, and recommended internal fixation for all patients whenever technically feasible.[4] In cases in which excision cannot be avoided, the use of radial head prostheses has been recommended to decrease potential complications of resection.[17] On the other hand, arthroplastic surgery is also not free from complications. In a review of the literature, Furry and Clinkscales[23] concluded that there was no consistent evidence favoring radial head arthroplasty over open reduction-internal fixation. The authors emphasized the necessity of open reduction-internal fixation as the method of choice.

Recently, several studies have reported encouraging findings concerning the results of internal fixation of the radial head. Open reduction-internal fixation has been recommended as the method of choice particularly in type II fractures.[2,25] Esser et al.[26] reported excellent or good results at the end of seven-year follow-up of 20 patients treated with internal fixation for Mason type II or type III fractures. Similarly, King et al.[14] reported a success rate of 100% (excellent or good results) following internal fixation of type II fractures. Öztürk et al.[3] treated type II fractures of seven patients with internal screw (n=4) or plate (n=3) fixation; the results were excellent in all the patients undergoing screw fixation, while plate fixation was associated with excellent and good results in two patients and one patient, respectively. Pearce and Gallannaugh[8] used Herbert screws for internal fixation of Mason type II fractures in 19 patients and achieved excellent results in 16 and good results in three patients. Similarly, McArthur[27] reported excellent results in all patients following internal fixation of type II fractures with Herbert screws. Ikeda et al.[28] showed that internal fixation could yield good results even in comminuted fractures of the radial head. We also think that radial head fractures should be treated with osteosynthesis whenever possible.

The primary goal of treatment with open reduction-internal fixation is to achieve early mobilization with stable fixation after anatomical reduction of the joint surface. While various types of screws or plates can be used alone or in combination for internal fixation, K-wires can also be used for temporary or permanent fixation.[2,3,10,29,30] Adequate stability without causing intrafragmental compression, ease of application, and requirement of minimal soft tissue dissection are important factors that should be considered in the selection of fixation material. There are many studies that demonstrate successful results with the use of low-profile implants (mini or headless screws, K-wires).[8,13,14,28,30] Anatomic features of the fracture and the experience of the surgeon are also important factors in choosing the fixation material. Another important factor that was observed in our study was the availability of the implant. K-wires offer ease of application due to low cost and availability. Our study provides support for the use of K-wires since there was no significant difference between the results obtained with screw and K-wire fixation.

In order to avoid restriction of rotation, It is recommended that fixation materials be placed in a safe zone, namely, the nonarticular area, to avoid restriction in rotation. Plates or screws inserted outside the safe zone cause compression in the proximal radioulnar joint.[10] We paid particular attention to inserting the screws and K-wires through the safe zones in relation to the fracture fragments and clinically evaluated the presence or absence of compression after fixation. In particular, insertion of plates adjacent to the lateral ligamentous complex and annular ligament may lead to material compression resulting in restriction in forearm rotation and scar development.[9,29] Superfluous soft tissue dissections during plate insertion and separation of muscles towards the radial neck carry high risk for heterotopic bone formation.[29] Koslowsky et al.[30] used a new low-profile implant, fragment fixation system (FFS), and obtained excellent or good results in all patients with Mason type III fractures, and in type IV fractures, only three out of 11 patients developed loss of fixation. Smith et al.[29] compared low-profile implants and plates and found that, albeit not significant, the latter was associated with less satisfactory joint motion and functional results and a higher rate of revision (40% *vs.* 35%) at the end of three years; in addition, heterotopic bone formation was observed in five patients after plate fixation compared to only one patient in the low-profile implant group. In an experimental study by Koslowsky et al.,[14] it was demonstrated that the use of FFS implants, mini screws and K-wires resulted in a significantly better stability compared to the use of mini plates. Our findings together with the fact that none of the patients required revision surgery support the use of K-wire and screw fixation in obtaining adequate stability.

In conclusion, the use of mini screws or K-wires, which are low-profile implants, for the fixation of Mason type II fractures, which are less comminuted compared to type III fractures, provided excellent or good results in all but two patients. Early mobilization was possible with the use of a functional brace, there was no loss of fixation, and no patient required revision surgery. All the patients returned to work in a mean of 11.5 weeks (range 10 to 14 weeks) without any problem. Functional results of internal fixation were similar with the use of screws and K-wires, the latter being cheaper and readily available. To our knowledge, screw and K-wire fixations have not been compared in standard groups of patients.

Although the small number of patients somewhat limits our study, we think that the standardized patient groups add to the reliability of our results.

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