Outcomes of Fixation of Radial Head Fractures with Kirschner Wire (K-Wire) in Adult Patients with Terrible Triad of Elbow Dislocations
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Abstract
Background: Elbow dislocation is one of the most prevalent dislocations among adults, following shoulder dislocation. The present study aimed to evaluate the effects of Kirschner wire (K-wire) on fixation of comminuted radial head fracture when radial head prosthesis is inaccessible in terrible triad of elbow (TTE) dislocation.
Methods: In this retrospective study, a total of 21 adult patients with TTE dislocation, who were scheduled for fixation of radial head using K-wire, were enrolled according to the inclusion criteria. Variables, such as supination, pronation, range of flexion-extension motion, forearm rotation, and Mayo elbow performance score (MEPS) index, were measured, and the patients were followed-up for 1 postoperative year.
Results: After surgery, the mean forearm rotation and elbow joint flexion-extension range of motion were 121.42 ± 29.71 and 115.23 ± 32.34 in patients with TTE dislocation, respectively. Regarding the MEPS results, the mean MEPS score was above 70, and the majority of patients showed good performance in the follow-up.
Conclusions: Considering the limitations and side effects of prosthesis in TTE dislocation, K-wire can be used as an effective approach for fixing comminuted radial head fractures, such as TTE dislocation.
Keywords: Kirschner Wire, Elbow Dislocation, Radial Head Fracture, Terrible Triad

1. Background

Elbow dislocation is the most common dislocation in adults, followed by shoulder dislocation. Terrible triad of elbow (TTE) dislocation is an elbow dislocation, characterized by radial head fracture and coronoid dislocation; in some cases, it is followed by comminution (1). TTE dislocation accounts for 31% of total elbow dislocations and is common among males, aged 40 - 50 years (2). Approximately 20% of these patients experience neurological complications, such as advanced ulnar neuropathy, besides recurrent and frequent dislocations (3-5).

In order to examine comminuted radial head fractures, computerized tomography (CT) is routinely performed prior to surgery (6, 7). According to the Mason classification (8), a radial head fracture, along with dislocation, is categorized as a type-IV fracture. The complications of TTE dislocation include range of motion (ROM) limitations, permanent instability, pseudarthrosis, and proximal radioulnar joint synovitis (6). The main purpose of TTE treatment is restoration of elbow joint stability and optimal ROM of the joint.

A great number of therapeutic protocols support the fixation of radial head, coronoid process, and lateral collateral ligament (LCL) restoration to achieve elbow stability (9). Pugh and colleagues applied a systematical approach for the surgical treatment of TTE. The proposed approach involves osteosynthesis or arthroplasty of the radial head and repair of the coronoid process, joint capsule, and lateral ligament complex (LCL) (10, 11).

According to previous studies, screws and plates or prosthesis can be used for fixation of the radial head in comminuted TTE dislocation. Open reduction and internal fixation (ORIF) is performed in comminuted radial head fractures. Under certain conditions, the outcomes of ORIF are not satisfactory considering metaphyseal bone loss, fragment defects, bone compression, and fragment deformity. Therefore, prosthesis should be used in radial head reconstruction; on the other hand, there is no access to prosthesis in most cases (5, 12).

The outcomes of ORIF using plates and screws are not satisfactory, particularly when there are more than three pieces of radial head fractures. Today, radial head prosthesis is the first choice in these patients, while if the surgeon
has no access to prosthesis in some conditions, fixation of small fragments with fine smooth pins is a proper alternative. Accordingly, the main objective of this study was to evaluate the clinical outcomes of elbow dislocation using K-wire (0.5) rather than prosthesis for fixation of the radial head in comminuted fractures.

2. Methods

2.1. Subjects

In this retrospective study, we evaluated 24 patients with TTE dislocation and comminuted radial head fractures, who were scheduled for K-wire fixation and referred to the emergency wards of Alzahra and Ayatollah Kashani hospitals of Isfahan, Iran between March 2012 and August 2016. Patients with TTE dislocation were diagnosed according to clinical presentations, physical examination, X-ray radiography, CT scan findings, and Mason classification (8).

The inclusion criteria were as follows: 1) patients with TTE dislocation who were under K-wire fixation of radial head fractures; 2) age range of 18 - 70 years; 3) non-use of immunosuppressive and corticosteroid drugs; and 4) giving an informed consent for participation in the study. On the other hand, patients who were not followed-up for one year after surgery and those with ipsilateral upper extremity injuries were excluded. During the follow-up, three patients did not cooperate and were excluded from the study. Finally, we analyzed 21 participants. The information of patients, such as gender, age, length of hospital stay, etiology of injury, affected hand, and other injuries, besides Mason and O’Driscoll classifications, was collected in a checklist.

2.2. Surgical Technique

After preparing the patients in the operating room, general anesthesia was induced according to the standard protocol. The surgical technique was selected according to the Kocher approach (13). The lateral Kocher approach was adopted to gain access to the elbow joint, as the Kocher interval could be explored between the extensor carpi ulnaris and anconeus muscles, using detached LCL spacing (13).

Type 1A coronoid fragment was reinserted into the ulnar bone, using Ethibond No. 2 threads; also, cannulated screws, Kirschner wires, and plates were used for large fragments. In some specific cases, the medial Hotchkiss approach (1) was applied for type B coronoid fractures. Then, the radial head fragments were reconstructed with an intramedullary pin No. 0.5 (K-wire); the K-wire was reinserted into the proximal radial metaphysis inside or outside (3 cases) the body.

Outside the body, fragments of soft tissues were reconstructed over the operating table in patients with comminuted radial head fractures and fixed to the radial neck using K-wires; then, K-wires were freed from the bone. While the forearm was placed in the pronation position to avoid damage to the posterior interosseous nerve, LCL was reinserted into the lateral epicondyle of the humerus with transosseous sutures, using Ethibond No. 2 threads or 4.0 metal anchors at the end of surgery. In TTE patients, the elbow was immobilized at 90° flexion in the neutral position.

2.3. Assessment

The patients were visited postoperatively in the first, second, third, sixth, twelfth, and twenty-fourth weeks. The anteroposterior and lateral radiographs were acquired on the first day, as well as 2, 6, 12, and 24 postoperative weeks, to evaluate centric reduction or other complications. After 2 weeks, the splint was removed, and the patients were advised to start controlled active-assisted physiotherapy according to the standard guidelines; they were also asked to avoid full extension and overhead activity.

Controlled motions should be initiated for prevention of joint stiffness. In order to prevent heterotopic ossification (HO), indomethacin (25 mg) was prescribed 3 times a day for 8 weeks, besides cefixime (intravenous injection, followed by 500-mg tablets for 2 weeks). The final evaluation was performed after an average postoperative period of 12 months. In order to evaluate the surgery results, we used Mayo elbow performance score (MEPS) (14) in 12 months. This index evaluates pain, mobility, stability, and function and is scored as follows: 90-100, excellent; 75-89, good; 60-74, fair; and < 60, poor. In addition, all information, such as forearm rotation, supination, pronation, and flexion-extension ROM, was recorded in a checklist. The collected data were entered in SPSS version 24. Data are presented as frequency (percentage) and mean ± SD.

3. Results

Among 21 (15 males, 6 females) adult patients with TTE dislocation, the mean age was 39.80 ± 13.74 years. The etiology of injury was falling from heights in 18 (85.7%) patients and motor accidents in others. The mean length of hospital stay was 3.66 ± 1.68 days. The right and left hand injuries were reported in 8 (38.1%) and 13 (61.9%) patients, respectively. Other injuries (in the same limb or other limbs) were reported in 10 (47.6%) patients. The final flexion-extension ROM and pronation-supination rotational movements were also evaluated. The mean forearm rotational range, supination, pronation, and flexion-
extension ROM were 121.42 ± 29.71°, 67.14 ± 13.09°, 54.28 ± 18.32°, and 115.23 ± 32.34°, respectively (Table 1).

Table 1. Clinical and Paraclinical Features of TTE Patients

| Characteristics                        | Number or Mean | Number or Mean |
|----------------------------------------|----------------|----------------|
| Number of subjects                     | 21             |                |
| Gender (M/F)                           | 15/6           |                |
| Age, y                                 | 39.80 ± 13.74  |                |
| Length of hospital stay, d             | 3.66 ± 1.68    |                |
| Etiology of injury                     |                |                |
| Falling                                | 18 (85.7)      | 18 (85.7)      |
| Others                                 | 3 (14.3)       | 3 (14.3)       |
| Involved hand                          |                |                |
| Right                                  | 8 (38.1)       | 8 (38.1)       |
| Left                                   | 13 (61.9)      | 13 (61.9)      |
| Other injuries                         |                |                |
| Yes                                    | 10 (47.6)      | 10 (47.6)      |
| No                                     | 11 (52.4)      | 11 (52.4)      |
| Forearm rotation, °                    | 121.42 ± 29.71 | 121.42 ± 29.71 |
| Supination, °                          | 67.14 ± 13.09  | 67.14 ± 13.09  |
| Pronation, °                           | 54.28 ± 18.32  | 54.28 ± 18.32  |
| Flexion-extension range of motion, °  | 115.23 ± 32.34 | 115.23 ± 32.34 |

*Values are expressed as mean ± SD or No. (%).

According to O’Driscoll classification (15) for coronoid fractures, 11, 4, 3, and 3 patients had type 1A, type 1B, type 2, and type 3 fractures, respectively. According to the MEPS index, the mean MEPS score was 79.04 ± 15.05 in the TTE group. In addition, according to the results of MEPS index, 28.6%, 38.1%, 23.8%, and 9.5% of the patients had excellent, good, fair, and poor performances, respectively. Also, 57.1% of patients had mild pain, 57.1% had an arc > 100°, 76.2% showed stability, and 38.1% could manage their personal hygiene; the results of MEPS index are summarized in Table 2. Insertion of K-wire for TTE dislocation did not have any side effects, such as avascular necrosis, redislocation, nonunion, malunion, HO, and infection.

4. Discussion

Elbow dislocation is one of the most prevalent joint dislocations with numerous complications, which cannot be efficiently managed by supportive therapies for fractures and dislocations; in these cases, surgery is required. If radial head fracture of the elbow or lower radio ulnar joint dislocation at the wrist occurs, it is not possible to perform radial head resection; therefore, either fixation or replacement prosthesis can be used (5, 10, 16, 17).

In the present study, for TTE patients with comminuted radial head fractures, K-wires were used instead of prosthesis to fix radial head fractures (Figure 1). In a study by Vocke (18), it was concluded that supportive therapies for radial head fractures can cause numerous complications, poor functional outcomes, and discomfort for patients. The present study is the first analysis of the outcomes of fixing radial head fracture and elbow dislocation in TTE pa-

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**Table 2. Variables and Scores of MEPS Index in Patients**

| Subject                  | TTE* |
|--------------------------|------|
| Pain                     |      |
| None                     | 7 (33.3) |
| Mild                     | 12 (57.1) |
| Moderate                 | 2 (9.5) |
| Severe                   | 0 (0.0) |
| Pain score               | 33.57 ± 9.37 |
| Motion                   |      |
| Arc > 100°               | 12 (57.1) |
| Arc= 50-100°             | 7 (33.3) |
| Arc < 50°                | 2 (9.5) |
| Motion score             | 16.90 ± 4.60 |
| Stability                |      |
| Stable                   | 16 (76.2) |
| Moderate instability     | 5 (23.8) |
| Gross instability        | 0 (0.0) |
| Stability score          | 9.90 ± 2.18 |
| Function                 |      |
| Combing hair             | 0 (0.0) |
| Feeding                  | 0 (0.0) |
| Hygiene                  | 8 (38.1) |
| Wearing shirts           | 6 (28.6) |
| Wearing shoes            | 7 (33.3) |
| Function score           | 19.76 ± 4.32 |
| Results                  |      |
| Excellent                | 6 (28.6) |
| Good                     | 8 (38.1) |
| Fair                     | 5 (23.8) |
| Poor                     | 2 (9.5) |
| Results score            | 79.04 ± 15.05 |

*Values are expressed as mean ± SD or No. (%).
tients using K-wires.

In studies by Egol et al. (19) and Pugh et al. (11), who investigated the outcomes of standard surgical treatments using radial head prosthesis for TTE dislocations, the average MEPS scores were reported to be 81 and 88, respectively. In our study, the average score of TTE patients was 79.04 ± 15.05, which is close to the results of the mentioned studies. In addition, based on the MEPS index, most TTE patients were classified in good or excellent categories in terms of performance. In this regard, Bahavkar (20) reported that surgery results in young TTE patients (or those with less severe injuries restored by surgery) can be considered good or excellent, based on the MEPS index.

In the present study, the mean age of the patients was 39.80 ± 13.74 years, which is consistent with previous studies (40 years). Most of the patients were male (70%) similar to previous studies (21, 22). The most frequent cause of TTE fracture was falling from heights. In our study, ROM limitation was fairly good, and the mean ROM exceeded 100°. Some studies demonstrated that favorable treatment of TTE dislocation is characterized by ROM higher than 100° (23). In a study by Gonçalves et al. (24), the mean flexion-extension ROM was 112° after surgery in TTE patients, and the final flexion-extension and supination-pronation ROM was more than 100° in patients.

Although we used K-wires, the mean flexion-extension ROM approximated the mentioned reports. In our study, infection and HO were not observed. In addition, use of K-wires instead of prosthesis had good effects on treating elbow dislocation. In a recent study, the anteromedial approach, along with the lateral approach, could improve early functional recovery in TTE patients (25). Moreover, in a study by Yan (26), who compared surgical replacement and repair in TTE management, they concluded that use of prosthesis is better than screws and plates; also, prosthesis complications were fewer, and management of radial head dislocation was more effective.

4.1. Conclusions

According to the results of our study and previous research, K-wire may facilitate proper treatment of elbow dislocations; also, pin therapy can be considered an effective and valuable method for radial head fracture, concomitant with TTE dislocation, particularly when prosthesis is inaccessible. This study had a limited sample size, and no similar research has been performed on this protocol so far. Therefore, further research with a larger sample size is needed to confirm our results.

Footnote

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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