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Percutaneous elevation of radial head fractures without fixation – a promising technique

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In Mason type II radial head fractures surgical treatment is recommended. A promising technique is percutaneous elevation for depressed monofragmentary articular surface fractures. This study aimed to investigate the radiographic outcome, complication and revision rate following percutaneous radial head reduction without fixation in Mason type II fractures.

A retrospective study was performed between 2016 and 2021. Data on demographics, dislocation in mm based on pre, one week and at least 6 weeks post-operative x-rays as well as complications including revision surgery were noted. In all patients a 2.0mm K-wire was used as metal bone tamps to reduce the fracture under imaging intensifier until no step was identifiable following an immobilization in a backslap for a week. If no secondary dislocation was noted patients were allowed to actively move the elbow. In 36 patients at a mean age of 38.6±10.7years a percutaneous elevation was performed. The mean displacement at time of initial presentation was 2.2±1.1mm on Coyle and on lateral view 1.2±1.0mm. At initial and final follow up (9.3±2.1days, respectively 64.6±180.8days), the fracture gap was reduced with a displacement of 0.2±0.6mm on Coyle view, respectively 0.2±0.5mm, and 0.3±0.5mm, respectively 0.1±0.3mm on lateral view ($p<0.005$). The mean surgical time was 14.8±12.2minutes and no complication nor secondary fracture dislocation was observed. This study shows that percutaneous closed reduction without fixation in Mason type II fractures is a very effective technique with a short surgical time and no complications if patients are selected correctly.

Level of evidence: Level III, retrospective trial

Keywords: radial head, fracture, treatment, percutaneous, Mason, injury.

INTRODUCTION

The radial head is crucial for stability and allows full range of motion in rotation, flexion and extension. Injuries account for about 5% of all fractures[1] and can cause devastating problems including instability and functional limitations[2]. Therefore, fractures require an optimal anatomical reduction and potential internal fixation to allow a satisfactory outcome. In isolated radial head fractures resulting from low- to high energetic injuries, an early mobilization is required to accomplish prompt full range of motion after an injury. Consequently, non-displaced fractures are immobilized for a short period of time followed by early full mobilization. This approach shows good results in more than 80% of cases[3,4]. Mason type II fractures, (loss of cortical contact of at least one fragment) surgical treatment is required which includes mostly open reduction and internal fixation[5]. Depending on the fracture pattern and considering the anatomy of the lateral ulnar collateral ligament (LUCL) (Kocher) as well as branches of the radial nerve (Kaplan), specific extensor intervals can be used for the approach (Kocher, Kaplan interval)[6,7]. Although this approach will not disrupt the LUCL – if not already torn, injuries may cause elbow instability if not properly restored[8]. An even higher risk includes osteoarthritis and elbow stiffness related to the trauma. Because of the above-mentioned potential risks even in Mason type II fractures (greater than 2mm displacement), non-operative treatment shows excellent functional results however literature lacks in describing the risk of post traumatic osteoarthritis[9]. To avoid osteoarthritis in long-term an anatomical reduction should be achieved without disrupting the surrounding ligaments. This study aimed to analyze the radiographic outcome and

complication rate following a percutaneous closed reduction in Mason type II fractures.

MATERIALS AND METHODS

Between 2016 and 2021 a retrospective study was conducted investigating all radial head fractures undergoing percutaneous closed reduction. The surgery was performed by a trauma fellowship trained orthopaedic surgeon. Inclusion criteria consisted of patients presenting with a radial head fracture affecting the articulating surface who obtained a preoperative x-ray and CT scan. Patients' demographics, affected side, stability of the elbow joint, revision surgery were noted from the charts and operative notes. On radiographies the fracture pattern were observed including the dislocation of the fragments in millimeter on anteroposterior, lateral and Coyle view. The fractures were classified applying the Mason classification before surgery, one week after and at final follow up (at least 6 weeks) after accident[10]. Primary endpoint was bony fusion. Exclusion criteria were patients with multi-fragment radial head fractures, affection of adjacent joints including the distal humerus, the proximal ulnar (Monteggia fracture), Essex Lopresti fractures or a highly unstable fracture dislocation which required ligamentous repair respectively reconstruction. Complications were defined as secondary displacement, injury to the posterior interosseous nerve (PIN), elbow joint stiffness or instability.

In all patients who presented to the emergency department with a radial head fracture, a x-ray and CT scan were obtained. If the diagnosis for a percutaneous closed reduction was indicated, patients were consented for surgery and explained that if percutaneous reduction failed an open approach was required. In the operating theater, patients were under general anesthesia and an unsterile tourniquet was placed on the humerus. Furthermore, the patient was prepped and draped in standard fashion for an open approach. The patient was positioned in supine and the arm placed on a radiolucent arm or hand table. Using an image intensifier, the elbow joint was tested for stability. If stable, a Coyle and a lateral view were obtained to identify the maximum displacement of the radial head. Then a 2.0mm K-wire was inserted percutaneously from distally aiming for the fragment which was used as metal bone tamps. If the tip of the K-wire was located at the fragment the K-wire was tapped and the fracture was reduced percutaneously until no radiographic step was identifiable. If no anatomical reduction was obtained the surgery was converted into an open reduction and internal fixation. Postoperatively, the elbow was immobilized using a backslap for one week and a radiography in anteroposterior, lateral and Coyle's view were obtained. If no secondary dislocation was observed one week after surgery, an early functional postoperative treatment including early active and passive range of motion was initiated without resistance for further 5 weeks. If a secondary displacement was diagnosed a week after the percutaneous reduction, an open reduction and internal fixation was indicated and patients were consented for revision surgery.

IBM SPSS 25 (IBM, Armonk, New York, USA) was used for statistical analysis applying a multivariate analysis of variance t-test. The differences between the preoperative displacement, and the reduction in short term as well as long term were calculated. The level of significances was set to * p-value ≤ 0.05.

RESULTS

A total of 216 radial head fractures presented to the emergency department of which 36 patients (16.7%; n=36/216) met inclusion criteria and underwent percutaneous elevation. The mean age was 38.6±10.7 years and males were predisposed in 64.7% of cases (n=22/36). The surgery was performed in mean 2.1±1.5 days after initial presentation to the emergency department and the average surgical time was 14.8±12.2 minutes. In all patients a Mason type II fracture was identified (n=36/36) and the left sided was slightly more affected in 52.9% (n=19/36). The average fragment displacement on Coyle view was 2.2±1.1mm and on lateral view 1.2±1.0mm.

The first follow up was performed 9.3±2.1 days after surgery showing a reduction of the fracture in 96.4% of cases. 57.1% of cases showed no visual step and 39.3% were converted into a Mason type I fracture. However, in 1 patient only a minor reduction (type II Mason fracture) was noted. The average postoperative fragment displacement was 0.2±0.6mm on Coyle view, and 0.3±0.5mm on lateral view. This was significantly less compared to the preoperative displacement with $p<0.005$ each. The final follow up was 64.6±180.8 days after surgery showing a fusion rate in 100% of cases. No difference in reduction was observed with a mean displacement of 0.2±0.5mm on Coyle view and 0.1±0.3mm on lateral view. Likewise, at initial follow up a highly significant difference between the preoperative values were observed with $p<0.005$ whereas no significance was observed between initial and final follow up with $p=0.947$ for Coyle view and $p=0.184$ on lateral view. In all cases no complications

Table I. — Demographics and findings in patients undergoing percutaneous elevation of radial head fractures.

	Preoperative	Initial follow up	Final follow up	p-value
Age in years	38.6±10.7			
Gender (male)	22/36; 64.7%			
Time in days		9.3±2.1	64.6±180.7	
Displacement on Coyle view (in mm)	2.2±1.1	0.2±0.6	0.2±0.5	**<0.005**
Displacement on lateral view (in mm)	1.2±1.0	0.3±0.5	0.1±0.3	**<0.005**

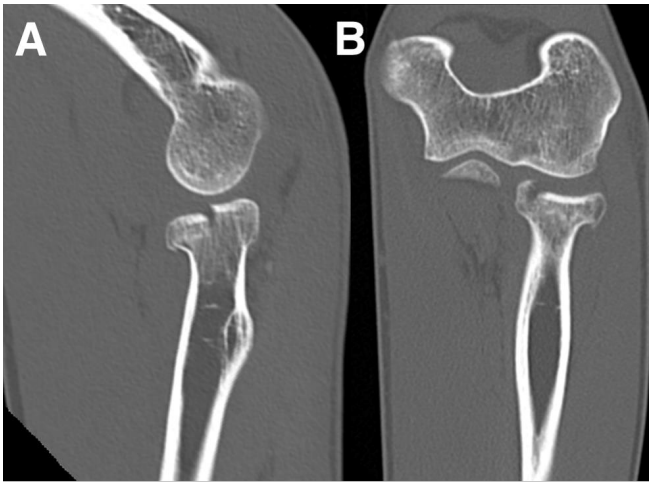

Figure 1 — Preoperative computed tomography.

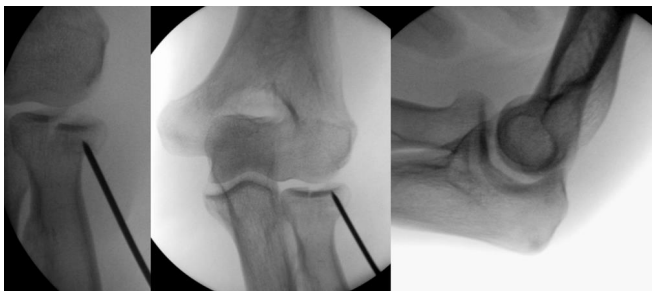

Figure 2 —Intraoperative reduction using image intensifier.

were observed and no revision surgery or conversion was required. All findings are illustrated in table I. In figures 1 to 3 the preoperative, intraoperative and post-operative findings are shown.

DISCUSSION

This study describes an easy, fast and reliable technique allowing an anatomical reduction for Mason type II radial head fractures. Statistically significant improvement in reduction was achieved in all patients and none of our patients required an intraoperative conversion to an open reduction and internal fixation

Figure 3 —Postoperative imaging.

nor a revision surgery. Further, patients can recover much quicker and an early functional therapy can be initiated to gain full range of motion without the risk of post -traumatic osteoarthritis.

With an overall incidence of 55.4 per 100,000 people, radial head fractures account for approximately 5% of all fractures and one third of all elbow fractures[11,12]. Even if conservative treatment is able to provide excellent long-term results[9], Hackl et al showed in a large retrospective study evaluating 438 radius head fractures that 76% of cases suffer from severe pain after Mason type II injury related to elbow stiffness and symptomatic osteoarthritis. Latter ones represent the main indications for revisions. Overall, Other complications after conservative therapy include instability, and secondary fracture displacement. Lindenhovius et al.[8], found a significant lower incidence of post-traumatic degenerative changes in operatively treated Mason type II fractures in comparison to patients undergoing conservative treatment. The authors concluded that surgical treatment is associated with a more predictable outcome and ORIF of Mason type II fractures may therefore lower the risk of post-traumatic osteoarthritis.

However, minimally invasive methods such as arthroscopically assisted fracture fixation or the percutaneous elevation technique described in this study represent a good compromise in terms of limited soft tissue affection and adequate reduction of the joint level. Percutaneous elevation technique shows excellent results with a highly significant reduction ($p<0.005$) obtained both on Coyle and lateral view with a little or no displacement. The soft tissue is not further violated and as shown in Mason type I fracture the risk of secondary dislocation is rather low. Therefore, the guidelines recommend non-operatively treatment for Mason type I fractures including a short period of immobilization following an x-ray to confirm no secondary displacement after approximately 7 to 14 days.

Limitations to this treatment include cartilage fragments, which can be stuck in the fracture gap and prohibit the fracture from healing properly. In addition, the stability should be examined intraoperatively to avoid any persisting instability. Further, an open reduction fails. However, if percutaneous elevation succeeds this approach saves surgical as well as anesthesia time and traumatizes less trauma the soft tissue. Finally, this study aims to investigate the radiographic outcome as well as complications, why no functional outcome scores were assessed.

CONCLUSION

Percutaneous elevation of type II Mason radial head fractures is an easy and reliable technique to reduce fractures with statistically significant improvement in the outcome. Postoperatively, immobilization is recommended for a week following an early functional rehabilitation with free range of motion to gain full strength and mobility. In our cohort union was obtained in all patients without any complications including secondary dislocation or revision surgery.

Conflict of interest: The authors have no conflict of interest directly related to this work.

IRB approval was obtained.

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