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Review Article

Management of Mason II Fractures of the Radial Head

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Abstract

The purpose of this review is to describe the detailed elbow anatomy and the role of the radial head, as well as associated structures, in elbow stability. The roles of primary and secondary elbow stabilisers in the decision making of definitive treatment of Mason type II fractures are discussed. The classification systems of radial head fractures and their impact on treatment are also reviewed. A thorough literature review comparing conservative versus operative management of radial head fractures was performed and analysed to determine the superiority of one versus the other.

Keywords: *Radial head; Fractures; Mason*

Abbreviations: ROM: Range of Motion; LCL: Lateral Collateral Ligament; MCL: Medial Collateral Ligament; ORIF: Open Reduction and Internal Fixation

Introduction

The radial head plays an important role in the structure and function of the elbow [1]. A thorough knowledge of its stabilizing role in elbow function is required to appropriately manage radial head fractures [1,2]. Injury severity for radial head fractures ranges from minimally displaced fractures to highly comminuted fractures [3]. There is universal agreement that undisplaced fractures (Mason Type I) should be managed nonoperatively and Type III should be managed surgically. There however remains no universal agreement on Type II injuries [4], where there is still disagreement over indications for conservative and operative treatment [5].

Discussion

Radial head fractures are the most common skeletal injury in the adult elbow [6,7] occurring mainly between ages 20-60 years [6]. Combined radial head and neck fractures account for 26% of all elbow injuries [8]. The most common mechanism of injury is a fall on the outstretched hand with the elbow partially flexed and the forearm pronated [6]. Patients usually present with elbow swelling, pain and decreased ROM [7]. There may be an audible click or a mechanical block which limits elbow flexion/extension and proximal radio ulnar joint supination/pronation. There may be varus or valgus laxity [9]. The distal radioulnar joint maybe painful or unstable and must be assessed [7].

Mason [10] classified radial head fractures into 3 types. Type I is an undisplaced marginal sector fracture or fractures involving a section of the lateral quadrant. Type II is a marginal sector fracture separated from the other quadrants or is impacted or depressed. Type III occurred when there was comminution of the entire head.

The modified Mason classification is currently the most commonly utilised classification and is a more useful guide for treatment and predicting prognosis than the original Mason's classification [7]. Hotchkiss [11] suggested that the Mason classification was based on retrospective data and his modification was based on examination and assessment of associated injuries as well as x-rays. Type II fractures in this modified classification is said to be a displaced fracture, usually greater than 2mm of the radial head or neck (angulated) where motion may be mechanically blocked and comminution if present is not severe and the fracture involves more than a marginal lip [11].

The radial head is cylindrical in shape with a concave proximal articulating surface [3,7]. Its axial alignment with the capitellum forms the lateral column [7]. Smooth gliding is of paramount importance, thus articular fractures with post traumatic arthrosis may cause mechanical impediment to motion [3]. The articulation with the proximal ulna at the lesser sigmoid fossa is secured by the annular ligament around the radial neck [7]. The articulation between the capitellum and proximal ulna allow flexion/extension of the elbow and pronation/supination of the forearm [3]. The articular cartilage covers 2/3 of the radial head surface which contributes to the proximal radioulnar joint. The anterolateral quadrant is more prone to injury because of a relative deficiency of subchondral bone [7]. This quadrant does not articulate with either the humerus or ulna [3] and is considered the safe zone for hardware placement [3,11-14] because importantly, impingement is avoided [12]. The safe zone lies between the radial styloid and Lister's tubercle [3]. Implants placed outside this zone must be countersunk [12].

The radial head has increasingly been recognised as an important stabiliser of the elbow and forearm [11,15]. Ring and Jupiter [15] described the stabilising structure of the elbow as a ring with four columns: anterior, posterior, lateral and medial. They stated that if one column is disrupted, then injuries in other columns ought to be sought after, and managed appropriately in order to restore stability. The radial head is surrounded by a lateral collateral ligament (LCL) complex which originates from the inferior most part of the tubercle on the lateral epicondyle which corresponds with the centre of rotation of the elbow in flexion and extension with a variable broad insertion into the proximal ulna, the insertion is also confluent with the annular ligament [16]. There are important fascial contributions from overlying muscle to the LCL which are critical to elbow stability, which must be preserved or repaired during surgical approaches.

During the Kocher's approach, keeping the incision in line with extensor carpi ulnaris fibres aids in avoiding iatrogenic injury to the fascial band [7]. Morrey., *et al.* [17] found that the radial head plays a more important role in elbow stability when there is concurrent damage to either or both collateral ligaments. By varying the order of serial release of the MCL complex and radial head removal, each structure's contribution to valgus stability was ascertained. They found that in an otherwise intact elbow, excision of the radial head did not significantly alter the three dimensional characteristics of elbow motion. There was a 6-8° increase in abduction rotation laxity and elbow subluxation following release of both collaterals. The study thus defined the MCL as a primary restraint to valgus stress whereas the radial head acts as a secondary stabiliser. They concluded that a comminuted radial head fracture with an intact MCL should be treated by excision without the need for an implant. It was felt that this did not alter the normal kinematics of the elbow. The radial head has subsequently been described as a multifunctional conjoint stabiliser of the elbow where in the coronal plane it works in conjunction with the MCL to prevent valgus instability [2,3] and works with the posterolateral ligamentous structures, medial ligaments and coronoid process in the sagittal plane to prevent posterior dislocation [2]. In the axial plane, it works with the interosseus membrane to prevent the radial shaft from migrating proximally [2]. Based on Morrey., *et al's* study, it has been recommended that if the MCL and the interosseus ligament are injured, excision is not advised and the anatomical integrity of the radius ought to be preserved by fixation or replacement [18].

The management of Mason II fractures has evolved over the years [7], and remains controversial [14,19,20] as there is no consensus on optimal treatment [4]. This evolution is due to an increased understanding of the role of the radial head in elbow and forearm stability [7]. Management issues such as duration of immobilisation, preoperative planning and surgical techniques have changed, as our knowledge of elbow pathology has increased [7]. Management options of Type II injuries include nonsurgical management, excision, open reduction and internal fixation [19] and arthroplasty [13]. Treatment goals include preservation of ROM, maintenance of radial length and restoration of elbow stability [1,13].

Before the eighties, the only surgical option for displaced or comminuted fractures was resection of the radial head [11]. Total resection was favoured because of disappointing results from partial head excision [21,22]. The incidence, severity and consequences of proximal migration of the radius have been a long time source of debate [21]. In addition to this, instability, valgus deformity, osteoarthritis and reduced ROM have all been reported following excision [18, 23]. Morrey., *et al.* [23] looked at 13 patients (6 with Type II fractures) who were on average 20 years post excision. The patients had a mild decrease in ROM, which was painless. There was less than 10% loss of strength in pronation and supination which was only noted after prolonged use.

Proximal migration occurred in 12 of 13 patients but only averaged 1.9mm. None of those deficiencies affected the patients daily functioning. Other authors have found acceptable long term results post excision [23-26]. Karlsson [24] noted a larger valgus angle which he believed increased the risk of ulnar neuropathy and ulnar irritation at the elbow; however this occurred in the minority of patients.

Other authors have demonstrated significant long term complications especially proximal migration of the radius with associated wrist pain [27,28]. With some authors achieving good results with nonsurgical management in the majority of their patients delayed excision for those who had unsuccessful nonsurgical management, was advocated with the expectation of achieving good results post delayed excision including adequate pain relief [26,29-31]. Herbertsson [26] found no significant difference between primary and delayed excision hence the recommendation previously mentioned.

Coleman., *et al.* [32] agreed with the results of Morrey., *et al's* 1979 study that patients who had significant pain tended to have advanced arthritis and reduced strength. Beingessner [33] found that excision alters the kinematics and the varus/valgus laxity with intact ligaments. There was also an increase in the external rotation of the ulna with respect to the humerus during passive motion with the forearm in supination post excision with intact ligaments. He concluded that excision reduces elbow stability when either or both collateral ligaments were damaged. Michels., *et al.* [19] suggested that excision be reserved for low demand patients with inadequate ROM or as a salvage procedure, while Ikeda and Oka [34] concluded that excision should not be recommended in patients engaging in prolonged heavy use of the upper extremity e.g. manual labourers. They felt that these patients were prone to wrist, elbow and forearm pain with associated reduction in power.

In determining excision versus ORIF, the elbow should be examined under anaesthesia for axial migration, MCL integrity in pronation and 30° flexion, the end point feel and the distal radioulna joint (under fluoroscopy) [14]. The patient should be classified on the basis of whether they are low or high demand. When considering internal fixation and thus preservation of the head, the patient should fit into the high demand group. Low demand patients are less likely to suffer ill effects of proximal migration [11]. Other considerations include the presence of associated ligamentous and bony injuries around the elbow [14]. The theoretical advantage of ORIF over prosthetic replacement or excision for maintenance of radiocapitellar contact has been controversial [35]. It may be argued that due to the biomechanical role of the radial head, as well as the potential complications post resection, the head should be preserved and fixed when possible [18, 36]. The decision to fix is also based on whether fixation of the fragments allows motion after 5 to 7 days and if the fracture subsequently has a chance to heal [36].

Choices of internal fixation include the thin and biomechanically strong AO plate and screw systems, Herbert screws, intramedullary fixation and Kirshner wires [18]. Once embarking on surgery, inventory in the operating room should allow the surgeon to perform internal fixation, excision or arthroplasty. The final decision is often intraoperative because fractures are sometimes more comminuted than expected when visualised [37].

There has been a trend recently towards stable fixation to allow for early mobilisation [7,14,18,34,38,39]. Parasa [5] stated that most authors advocate ORIF if there is greater than 25% involvement of the radial head, but opinions vary as to the best form of fixation. In addition, Capo and Dziadosz [14] used an articular stepoff of greater than 2 mm or a mechanical block to motion as indications for surgery. Ironically, they admitted that Akesson., *et al.* [29] documented favourable outcomes following nonsurgical management in patients with 2 to 5 mm displacement in his long term study. Akesson., *et al.* [29] stated that although there is a push for internal fixation, this result compared favourably to Ring., *et al's* [35] who did ORIF for Mason II and III fractures. Lindenhovius., *et al.* [40] reviewed this long term results of ORIF in Mason II fractures and also admitted that they were not superior to studies in which patients were managed non operatively including Herbertsson., *et al.* [8], Akesson., *et al.* [29] and Stuffman., *et al.* [37] studies. Their indication for surgery in stable displaced Mason II is a mechanical block to rotation. Akesson., *et al.* [29] also stated that although Khalfayan., *et al.* [39] clearly had better surgical results than nonoperative management in terms of pain, ROM and strength the sample sizes were small. Ring., *et al.* [35] found ORIF to be less predictable when there was more than a single simple fragment especially when a comminuted fracture was part of a complex injury pattern, which they felt should be treated with excision plus or minus replacement. It was concluded that ORIF should be done in injuries with three or fewer fragments based on their results despite the technical possibility of fixing most small articular fractures with current implants and techniques.

Pearce., *et al.* [20] looked at 19 patients with Mason II fractures and had good to excellent results utilising Herbert screws via an open approach. Emphasis was placed on preservation of soft tissue attachments on bony fragments, the LCL, repair or preservation of the annular ligament, rigid fixation and early rehabilitation. All fractures healed with a 10-15° extension lag and hence he strongly recommended this approach [19]. Herbert screws may also be successfully utilised via an arthroscopic approach [19]. A theoretical advantage includes less capsular disturbance compared to an open approach which improves stability and was said to obviate the need for a second screw. The greatest downside however is that a skilled arthroscopist is required [19].

Another option for fixation is the use of Kirshner wires [36]. Although Kirshner wires are usually utilised for temporary fixation [11], Li., *et al.* [36] successfully used kirshner wires definitively in a patient who had a comminuted fracture. Despite requiring one month of immobilisation, full grip strength and ROM was achieved along with no difficulties performing activities of daily living [36]. Kirshner wires are cost effective, more readily available than miniplates, minimal soft tissue stripping is required and a wide inventory of sizes allows for use in small fragments [2,13,36]. After using Kirshner wires in eight patients with Mason II fractures, Kumar and Singh [2] were able to immediately mobilise the patients once postoperative pain was controlled. This was in contrast to Hotchkiss [11] statement that Kirshner wires did not allow for early mobilisation due to lack of rigid fixation and that their use was for temporary fixation. In comparing the use of Kirshner wires and miniscrews in patients with Mason II fractures, Erturer., *et al.* [13] found no significant difference in results in both groups; however the Kirshner wire group wore a functional brace for three weeks.

Unfortunately, most studies in the literature are non-randomised with a significant lack of quality due to a lack of power as a result of small numbers. Struijs., *et al.* [4] were unable to find any randomised control trial during their systematic review. Confounding variables include classification of fractures, differences in outcome measure, treatment regimes, patient comorbidity, injury severity and surgical skill makes it difficult to compare studies [5,29]. Karlsson., *et al.* [24] felt there are variable results in the literature because authors mixed displaced two fragment fractures, comminuted fractures and fractures in different ages in their studies.

Conclusion

Based on the overall evidence for Mason Type II fractures, it is still debatable as to whether surgery is superior to conservative treatment. Due to lack of randomised trials and heterogeneity of retrospective studies, this hinders one from making a firm conclusion. There is however a current trend towards fixation in an attempt to preserve stability.

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