In Brief

The Mason Classification of Radial Head Fractures

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History

The initial report of a radial head fracture is attributed to Beard, who, in 1834, noted the presence of this injury at autopsy [16]. Despite Beard's observation, it was not until Wilhelm Röntgen's discovery of the x-ray that diagnosis of radial head and neck fractures was possible in living patients [16]. In the early years of x-ray, radiographs were termed skiagraphs from the Greek *σκιά* (skia), or shadow, and it was the skiagraph that allowed physicians to document radial head fractures in sufficient numbers to permit creation of a classification system.

Although the classification of radial head fractures is associated primarily with Mason and his seminal article published in the *British Journal of Surgery* in 1954 [9], previous classification systems did exist. The most

important example is that of Cutler, who described three classes of radial head fractures in an article published in 1926 [2]. According to Cutler, Class 1 fractures represented a simple crack in the head of the radius without displacement; Class 2 were fractures of the radial head with separation of one fragment; and Class 3 were fractures with two or more pieces. A fourth class existed in Cutler's classification, but this encompassed what we now call radial neck fractures. Although most surgeons now are more aggressive in terms of how intraarticular fracture displacement is managed, Cutler's treatment recommendations will still look familiar to those who treat these injuries today: nonoperative treatment unless the fragments blocked motion, prevented reduction of a dislocation, or were malunited [2]. Despite Cutler's contributions, it is Mason's name – despite later modifications by Broberg and Morrey [1] and Hotchkiss [6] – that remains synonymous with the classification of radial head fractures today.

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Purpose

Radial head fractures range in severity from occult and nondisplaced fractures to fractures with severe displacement and comminution. The principal goal of the Mason classification – like many fracture classifications – is to guide treatment according to the pattern of the injury. In his original paper, Mason reviewed the cases of 100 consecutive patients who sustained radial head fractures and were treated with operative or nonoperative methods [9]. At an average of 26 months he assessed each patient's pain, ROM, time away from work, ability to return to work, and radiographic alignment. Using these data, Mason established three groups of radial head fractures for the purposes of making treatment decisions.

Description of the Mason Classification System of Radial Head Fractures

The Mason classification separates radial head fractures based on the location of the fracture and the amount of comminution and displacement involved (Table 1); Mason described a Type 1 fracture as one that either had a fissure (nondisplaced) or a peripheral fracture of the rim, a Type 2 fracture as a marginal sector fracture with displacement, and a Type 3 fracture as a comminuted, displaced fracture involving the entire radial head [9]. By grouping radial head fractures this way, Mason sought to have the classification help guide treatment. Type 1 fractures were immobilized in a splint for an average of 16 days followed by active ROM; Type 3 fractures were treated with excision of the radial head. Type 2 fractures were treated either nonoperatively or with excision of the radial head. Type 2 injuries treated nonoperatively included depressed, but not tilted, fractures less than ¼ of the radial head or fractures greater than ¼ of the articular surface that were determined not to interfere with movement of the joint [9]. Treatment of radial head fractures remains similar today and continues to be based primarily on the Mason classification [15].

Validation

The Mason classification has been evaluated in terms of its intraobserver and interobserver reliability and its ability to classify severity of injury, dictate management, and predict outcome. Matsunaga et al. [10], in the largest single study addressing interobserver and intraobserver reliability, reported κ values of 0.429 to 0.560 and 0.582, respectively. Another study by Morgan et al. [11] found similar κ values; these results suggest that different individuals will classify the same fracture the same way in 60% to 65% of cases, while one individual will agree with his own classification of a fracture 78% of the time, with κ values of 0.540 and 0.635, respectively.

Table 1. Mason classification

Type	Description
Type 1	Fissure or marginal fractures without displacement
Type 2	Marginal sector fractures with displacement (Segment of the lateral border of the radial head is separated from the other quadrants, is impacted and depressed, or is tilted out of line)
Type 3	Comminuted fractures involving the whole head of the radius

Reproduced with permission from Mason ML. Some observations on fractures of the head of the radius with a review of one hundred cases. *Br J Surg.* 1954;42:123–132.

The ability of the Mason classification to predict the volume and number of fragments associated with a radial head fracture also has been assessed using quantitative three-dimensional CT analysis. In their study, Guitton et al. [5] determined that the type of radial head fracture did not necessarily correlate with either the number of fragments or the volume of the head that was fractured. Type 2 fractures involved three or more fragments 73% of the time, whereas Type 3 fractures involved greater than three fragments only 24% of the time [5]. Based on these results, Guitton et al. concluded that Type 2 fractures often are more difficult to repair than previously thought.

Despite the limitations of Mason classification, the ability to establish a radial head fracture as a Mason Type 1 or Type 3 may help determine whether these injuries should be treated with or without surgery. In his original article, Mason proposed nonoperative treatment for Type 1 fractures and operative treatment for Type 3 fractures. Outcome studies have validated the nonoperative treatment of Type 1 radial head fractures, with 95% of patients in one large series obtaining excellent or good outcomes [4]. Type 3 fractures continue to be treated operatively and general consensus agrees with this approach, despite the paucity of data confirming improved outcomes with surgical management [14]. Type 2 fractures have been treated nonoperatively with excellent results in one series [4]; however, other authors have reported very good results with operative treatment [8].

Finally, the Mason classification has been evaluated with respect to its prognostic implications. Duckworth et al. [4] evaluated 201 patients with radial head and/or neck fractures treated either operatively or nonoperatively. They found that the type of fracture as determined by the Mason classification was not associated ($p = 0.057$) with improved Mayo Elbow scores [4].

Limitations

The Mason classification has several shortcomings, including (1) its interobserver and intraobserver reliability, which is only moderate; (2) its limited ability to drive treatment, because it does not consistently predict the amount of comminution or the complexity of the fracture; and (3) its limited ability to predict the short-term prognosis of radial head fractures.

Moderate interobserver reliability affects communication among physicians and the utility of the classification in terms of guiding treatment. Although the κ values determined by Matsunaga et al. [9] and Morgan et al. [11] show reasonable interobserver and intraobserver reliability; however, their data also indicate there are a large number of fractures in which the classification of a particular injury will not be made consistently.

In the Mason classification system, Type 2 fractures presented a group in which Mason could not determine the most appropriate treatment, and this challenge persists today. In addition to the difficulties that Type 2 fractures present in the Mason classification, the specific management required for Type 3 fractures is unclear, as certain Type 3 fractures may benefit from open reduction and internal fixation whereas others may benefit from resection with or without arthroplasty [12]. Ultimately, as reported by Duckworth et al. [4], patient outcome is unrelated to Mason classification alone.

Broberg and Morrey [1] sought to broaden the utility of the Mason classification by incorporating into their classification system fracture-dislocations about the elbow that are associated with radial head fractures. They included these as a fourth type in their modification of Mason's classification scheme. While many papers cite Broberg and Morrey for the creation of this fourth type of injury, the true credit lies with Johnston, who wrote about four types of radial head fractures in 1962 and used the fourth type to denote a fracture of the radial head with associated dislocation [7]. In their paper, Broberg and Morrey rightly attribute this addition to Johnston. A limitation of the Broberg and Morrey approach becomes quickly evident, though, as under their schema, any dislocation of the elbow with a concomitant fracture of the radial head, regardless of the how the radial head fracture would be classified under the original Mason classification scheme, is considered a Type IV injury. The inclusion of radial head fractures of differing complexities into a single type limits the modified classification's utility in its ability to convey the severity of an injury and to dictate treatment; in their original paper, the treatment of Type IV injuries ranged from simple closed management to ORIF through radial head excision or prosthetic replacement.

In another attempt to link treatment of radial head fractures to classification, Hotchkiss [6] modified the Mason classification (Table 2), by suggesting that the presence of a mechanical block preventing movement qualifies a radial head fracture as Type II. The Hotchkiss classification has shown moderate interobserver reliability with agreement of 72.3% (κ value 0.585) [13]. Improved agreement also exists regarding treatment; the majority of Hotchkiss Type II injuries undergo either open reduction and internal fixation or excision of unstable radial head fragments. With its ability to better define fractures requiring surgical treatment, the Hotchkiss classification improves on one of the main weaknesses of the Mason classification.

Conclusions/Uses

Although neither the first nor likely the last classification system addressing these injuries, the name Mason has

Table 2. Hotchkiss modification of the Mason classification

Type	Description
Type 1	Nondisplaced or minimally displaced fracture of the head or neck, forearm rotation limited only by acute pain and swelling, intra-articular fracture usually < 2mm or marginal lip fracture
Type 2	Displaced (usually > 2mm) fracture of the head or neck (angulated), motion may be mechanically blocked or incongruous, without severe comminution (technically possible to repair by ORIF), or fracture that involves more than a marginal lip of the radial head
Type 3	Severely comminuted fracture of the radial head and neck, judged not reconstructible on basis of radiologic or intraoperative appearance, usually requires excision for movement

Reproduced with permission from Hotchkiss RN. Displaced fractures of the radial head: internal fixation or excision? *J Am Acad Orthop Surg.* 1997;5:1–10.

become synonymous with the classification of radial head fractures. Mason's original paper described the outcome of 100 patients who sustained radial head fractures [9]. His average followup was 26 months, and his assessment of these patients included pain, ROM, radiographic appearance, function, and time away from work. It is likely that the thoroughness of his evaluation and his length of followup have driven his association with radial head fracture classification since he first described it in 1954. However, contemporary research suggests that Mason's original scheme is limited in its reliability and usefulness, and that modifications of his classification – in particular that of Hotchkiss – may better communicate fracture severity and dictate treatment of radial head fractures.

References

1. Broberg MA, Morrey BF. Results of treatment of fracture-dislocations of the elbow. *Clin Orthop Relat Res.* 1987;216:109–119.
2. Cutler CW. Fractures of the head and neck of the radius. *Ann Surg.* 1926;83:267–278.
3. Dillon MT, Getz CL, Beredjiklian PK, Wiesel BB, Carolan GF, Ramsey ML. Evaluation of reliability of the Mason classification for radial head fractures. *Am J Orthop (Belle Mead NJ).* 2010;39:430–432.
4. Duckworth AD, Watson BS, Will EM, Petrisor BA, Walmsley PJ, Court-Brown CM, McQueen MM. Radial head and neck fractures: functional results and predictors of outcome. *J Trauma.* 2011;71:643–648.
5. Guitton TG, van der Werf HJ, Ring D. Quantitative three-dimensional computed tomography measurement of radial head fractures. *J Shoulder Elbow Surg.* 2010;19:973–977.
6. Hotchkiss RN. Displaced fractures of the radial head: internal fixation or excision? *J Am Acad Orthop Surg.* 1997;5:1–10.

7. Johnston GW. A follow-up of one hundred cases of fractures of the head of the radius with a review of the literature. *Ulster Med J.* 1962;31:51–56.
8. King GJ, Evans DC, Kellam JF. Open reduction and internal fixation of radial head fractures. *J Orthop Trauma.* 1991;5:21–28.
9. Mason ML. Some observations on fractures of the head of the radius with a review of one hundred cases. *Br J Surg.* 1954;42:123–132.
10. Matsunaga FT, Tamaoki MJ, Corderio EF, Uedhara A, Ikhawa MH, Matsumoto MH, dos Santos JB, Belloti JC. Are classifications of proximal radius fractures reproducible? *BMC Musculoskelet Disord.* 2009;10:120–124.
11. Morgan SJ, Groshen SL, Itamura JM, Shankwiler J, Brien WW, Kuschner SH. Reliability evaluation of classifying radial head fractures by the system of Mason. *Bull Hosp Jt Dis.* 1997;56:95–98.
12. Ring D. Displaced, unstable fractures of the radial head: fixation vs. replacement: what is the evidence? *Injury.* 2008;39:1329–1337.
13. Sheps DM, Kiefer KR, Boorman RS, Donaghy J, Lalani A, Walker R, Hildebrand KA. The interobserver reliability of classification systems for radial head fractures: the Hotchkiss modification of the Mason classification and the AO classification systems. *Can J Surg.* 2009;52:277–282.
14. Struijs PAA, Smit G, Steller EP. Radial head fractures: effectiveness of conservative treatment versus surgical intervention: a systematic review. *Arch Orthop Trauma Surg.* 2007;127:125–130.
15. Tejwani NC, Mehta H. Fractures of the radial head and neck: current concepts in management. *J Am Acad Orthop Surg.* 2007;15:380–387.
16. Thomas TT. Fractures of the head and neck of the radius. *Ann Surg.* 1907;46:280–291.