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Original Article

The use of plain radiographs in the classification of distal radius fractures

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ABSTRACT

Introduction: Classification systems guide surgical planning. We reviewed the accuracy of interpreting plain radiographs to classify distal radius fractures.

Methods: Pre-operative radiographs of 24 consecutive distal radius fractures were classified using Frykman and AO methods. Classification was repeated intra-operatively under direct vision for comparison.

Results: Mean age of the patients was 51 years. Pre-operative Frykman scores and AO grades were underestimated, compared with intra-operative visual classification ($p < 0.001$). One over-estimate occurred, while only 3 of 24 cases were classified correctly pre-operatively.

Conclusion: Sensitivity of radiographs to classify Frykman or AO grades was 12.5%, indicating interpretation using plain radiographs alone is often inadequate.

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1. Introduction

Distal radius fractures are responsible for 17% of all bone fractures.¹ It is common in adolescents following major trauma and osteoporotic women experiencing low energy injuries.² The presenting incident is usually typical with a hand-first descent to the ground.³ The resulting fracture type is dependent on a host of factors at the time of the fall.³ Organisation of the distal radius fracture into a widely utilised classification arrangement is important for the determination and planning of the treatment.

The Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification was developed in 1986 and categorises the type of injury on the basis of the fracture's severity.³ This organisation focuses on distinguishing extra-articular fractures from partial and complete articular fractures. Frykman's classification describes the injury according to the involvement of the distal radius articulations.⁴

Studies have demonstrated significant inter- and intra-observer differences in AO and Frykman classifications of distal radial fractures.^{3,5–8} Limitations of utilising plain radiographs for the fracture using these systems have also been demonstrated.⁵

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Radiographs are a routine diagnostic modality used to identify the fracture and assess its severity, which consequently influences the management. This study was designed to assess the diagnostic accuracy of pre-operative radiographs in grading distal radius fractures based on the Frykman and AO classification, against intra-operative findings.

2. Methods

A prospective study was conducted over a four-month period to identify all patients presenting to our trauma unit who underwent open reduction and internal fixation (ORIF) within 4 weeks of an acute distal radius fracture. Patients with open fractures or injuries occurring in skeletally immature individuals were excluded from the study.

True antero-posterior and lateral radiographs of each injured wrist were assessed at initial presentation. An intra-operative Frykman and AO classification was subsequently assigned to each patient using direct visualisation of the fracture pattern. The senior author (B.M.) graded the fracture both pre- and intra-operatively. Pre-operative radiographs were anonymised to avoid bias and re-assessed by the senior author before being assigned a pre-operative Frykman and AO classification grade.

The design of this study was in accordance to the QUADAS-2 (Quality Assessment Tool for Diagnostic Accuracy Studies-2) guidelines⁹ and was approved by the ethics committee at the study institution. There was no deviation from standard practise care amongst the study cohort, with the exception that the Frykman and AO grades were documented in a study register in addition to the patient notes. The data collected included the patient's age, gender and the pre-operative and intra-operative classification grades.

Simple summary statistics were collated using SPSS v20 software (IBM Corp., Armonk, New York). The Wilcoxon ranked sign test was used to evaluate the significance of differences for paired ordinal data, with an alpha level set at 0.05.

3. Results

The prospective cohort constituted 24 consecutive patients who met the inclusion criteria, with a mean (standard deviation) age of 51 (± 15) years. There was a female predominance of 66.6% ($n = 16$) in our cohort. The overall difference between the pre-operative and intra-operative assessment is summarised in Table 1 below.

The median value (range) for Frykman classification grades at pre-operative assessment was 3 (1–7), and at intra-operative assessment 6.5 (2–8). The median AO grades at the

pre-operative and intra-operative assessment were 23B2 and 23B3 respectively. The modal average for the AO grades at pre-operative assessment was 23A2 and 23B3 (range 23A2–23C3), whilst at intra-operative assessment the mode was 23C3 (range 23A2–23C3).

Pre-operative Frykman scores were significantly underestimated, compared with intra-operative visual classification ($p < 0.001$). Differences in the AO classification were equally prevalent and significant ($p < 0.001$). In males the median change was an increase by 3 grades in both the Frykman and AO classification at intra-operative assessment. Differences in females were similar with an increase of 4 and 3 grades for Frykman and AO classification respectively at the intra-operative assessment.

The Frykman and AO classification was over-estimated pre-operatively in only a single case. The grading remained the same at intra-operative assessment in only three cases. This tells us the sensitivity of radiographs to accurately predict the specific Frykman or AO grade is 12.5%.

4. Discussion

Our study demonstrates that plain radiographs alone provide an accurate interpretation of the fracture pattern in only 12.5% of distal radial fractures. Even the categorisation of the AO grades into the 3 types (A,B,C) in place of the 9 groups (i.e. A1, A2, A3, B1...), did not improve this diagnostic accuracy. Discrepancy between radiographs and intra-operative assessment of fractures has previously been reported in lateral condyle fractures of the humerus in children,¹⁰ however, our study is the first such conducted to review possible discrepancies between radiographs and intra-operative assessment in distal radial fractures.

Human error by the assessor may be a factor in the poor accuracy of the radiographs, however quality of plain radiographs as the imaging modality is a more likely culprit. This is evident in the various studies documenting the poor inter-observer reliability and intra-observer reproducibility.^{3,5–8} It is quite difficult for a group to collectively agree on a specific grade for a radiograph; it is likely that individual assessors are perhaps inadequately skilled to interpret the radiograph for classification purposes of distal radius fractures. One particular study revealed that the percentage inter-observer agreement of a particular classification grade ranged between 17 and 40% when assessing radiographs.⁷ Inter-observer agreement for the three AO types has been found to be substantial,^{5,8} whereas that for the nine AO groups has been found to be moderate⁸ and poor.⁵ The employment of different classification systems did not change the inter-observer and intra-observer agreements significantly; suggesting the difficulty in interpretation is not confined to a particular classification system.⁵ In fact six assessors using a simplified Frykman classification consisting of only four grades were only able to agree on the same grade in a mere 25% of the cases.⁶ Clinical experience and familiarity with the classification system has not been found to play a significant bearing on the inter-observer agreement.⁸ Using a single upper limb orthopaedic consultant to assess and grade the fracture, avoids these two potential confounding factors.

Table 1 – Difference between the pre-operative and intra-operative assessment.

Classification	Pre-operative assessment (range)	Intra-operative assessment (range)
Frykman	3 (1–7)	6.5 (2–8)
AO Grade	B2	B3

The disparity in the grades also suggests that the surgeon was unlikely to have been biased by being able to recall the pre-operative grade during the intra-operative assessment. Using a single surgeon assessor allows potential intra-observer inconsistencies. Evidence reveals that intra-observer agreement for the 3 AO types to be substantial,^{5,8} whilst for the 9 AO groups to be poor.⁵ We are unable to quantify the effect this may have had on our results.

Anderson et al⁵ advised the use of computed tomography (CT) scanning as an adjunct when management is directly based on the classification, such as in the instance of querying articular surface involvement. Pruitt et al¹¹ found that CT-scan demonstrated distal radio-ulnar joint involvement and articular surface depression better than radiographs in distal radius fractures. Requesting a CT-scan may not improve the inter-observer agreement⁷ but can improve diagnostic accuracy. Five out of 19 patients who underwent a CT-scan were found to have a higher Frykman score than the initial assessment based on the radiographs.¹² Furthermore the CT-scan diagnosed fractures in 3 of 22 patients with a clinical history suggestive of fractures that the radiographs had failed to demonstrate. Katz et al demonstrated that a review of CT-scans after the assessment of radiographs led to the change in treatment from closed surgical to an open surgical approach in 62%–92% of cases, clarifying its importance in dictating treatment plans.¹³ There remains a case to undertake CT in all distal radius fractures to provide a more accurate classification grade, however no evidence is available assessing the diagnostic accuracy of CT-scan in comparison to the intra-operative assessment.

5. Summary

Orthopaedic surgeons endeavour to classify fractures for academic and practical purposes. Classification systems can help plan the method of fixation and, in the case of distal radius fractures, guide the surgeon in deciding on the type of implant to be used during open reduction and internal fixation. It is clear that interpretation of plain radiographs alone to accurately classify a fracture can be difficult. In particular, those with intra-articular fracture components or significant comminution are often underestimated pre-operatively. It has become common practice to perform rapid pre-operative CT-scanning of intra-articular fractures, especially around the knee¹⁴ and ankle¹⁵ as a guide to surgeons in planning their approach and fixation method. We would advocate the use of pre-operative CT-scanning in any distal radius fracture where plain radiographs do not clearly delineate the fracture pattern. This will enable surgeons to plan operative time appropriately and aid their choice of implant. Further work is required on identifying the frequency of changes to pre-operative planned implants used, and any impact on tourniquet or surgery duration, as result of inaccurate interpretation of pre-operative radiographs.

Conflicts of interest

All authors have none to declare.

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