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Original article

Statistical analysis on the concordance of the radiological evaluation of fractures of the distal radius subjected to traction☆

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ABSTRACT

Objective: The objective of this study was to evaluate the current classifications for fractures of the distal extremity of the radius, since the classifications made using traditional radiographs in anteroposterior and lateral views have been questioned regarding their reproducibility. In the literature, it has been suggested that other options are needed, such as use of preoperative radiographs on fractures of the distal radius subjected to traction, with stratification by the evaluators. The aim was to demonstrate which classification systems present better statistical reliability.

Results: In the Universal classification, the results from the third-year resident group (R3) and from the group of more experienced evaluators (Staff) presented excellent correlation, with a statistically significant *p*-value ($p < 0.05$). Neither of the groups presented a statistically significant result through the Frykman classification. In the AO classification, there were high correlations in the R3 and Staff groups (respectively 0.950 and 0.800), with *p*-values lower than 0.05 (respectively <0.001 and 0.003).

Conclusion: It can be concluded that radiographs performed under traction showed good concordance in the Staff group and in the R3 group, and that this is a good tactic for radiographic evaluations of fractures of the distal extremity of the radius.

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Análise estatística da concordância na avaliação radiológica das fraturas de rádio distal submetidas a tração

Palavras-chave:
Fraturas do rádio
Radiografia
Tração

RESUMO

Objetivo: Avaliar as classificações atuais da fratura da extremidade distal do rádio, pois as classificações feitas em radiografias tradicionais nas incidências anteroposterior e perfil têm sido questionadas quanto a sua reprodutibilidade e é sugerida pela literatura a necessidade de outras opções, com o uso das radiografias pré-operatórias submetidas a tração de fraturas de rádio distal, estratificados pelos avaliadores, com vistas a demonstrar quais classificações apresentam melhor confiabilidade estatística.

Resultados: Na classificação Universal os resultados dos grupos de R3 e Staff apresentaram uma ótima correlação, com um p-valor estatisticamente significativo ($p < 0,05$). Quando avaliada a classificação de Frykman, nenhum grupo apresentou um resultado estatisticamente significativo. Na classificação AO, nos grupos R3 e Staff, a correlação foi alta (respectivamente 0,950 e 0,800) com um p-valor abaixo de 0,05 (respectivamente < 0,001 e 0,003).

Conclusão: A tração para feitura das radiografias se mostrou com uma boa concordância principalmente nos grupos avaliadores de maior experiência (Staff) e no residente de 3° ano e é uma boa tática na avaliação radiográfica da fratura da extremidade distal do rádio.

Introduction

Fractures of the distal extremity of the radius are very frequent injuries nowadays and this, along with technological advances, has led to much debate among orthopedists with regard to improvement of their treatment.[1]

The different approaches and outcomes have stimulated authors to seek classification systems that would guide diagnosis and treatment.[2] Classifications for the distal extremity of the radius have the aims of ranking the injuries, enabling better knowledge and serving as facilitators in the decision-making process, either for conservative treatment or for surgical treatment, and with regard to the latter, determining which technique would be best. A wide variety of methods for treating the distal extremity of the radius exists,[3] going from conservative to surgical treatment, using different techniques (fixation using Kirschner wires; ligamentotaxis using an external fixator with or without associated Kirschner wires; open reduction using rigid internal fixation; and absolute stabilization by means of osteosynthesis using a plate and screws with or without grafting). Use of imaging technology for classifications within orthopedics has been analyzed by researchers,[4] in relation to radiography,[5,6] computed tomography or magnetic resonance imaging.[7] The reproducibility of fracture evaluations through using classification systems is extremely important for reliability. Use of such systems is an important stage in quantifying the severity of the injury and this demonstrates the safety of using certain classifications.[8–11] Inter and intraobserver consistency is a prerequisite for efficient use of any classification system.

Classifications that are made using traditional radiographs in posteroanterior and lateral views have been questioned regarding their reproducibility. IN the literature, it has been suggested that there is a need for other options, such as computed tomography.[9] However, among the limitations of computed tomography is its greater cost and higher radiation dose in relation to radiography. Radiography performed under traction is among the other options of lower cost and greater practicality, and this may increase the reliability of analyses on joint fractures.[12]

The objective of this study was to evaluate the current classification systems for fractures of the distal radius by means of preoperative radiographs produced under traction, with stratification by the evaluators, with a view to demonstrating which classification systems present the best statistical reliability.

Methodology

A retrospective observational study was conducted in our institution based on 30 radiographs on patients who had been admitted to the orthopedics and traumatology service and who underwent surgical procedures to treat fractures of the distal extremity of the radius.

The authors declare that this study was in accordance with the Declaration of Helsinki.

Radiographs on these patients were produced preoperatively, at the time of admission, and these were performed under traction in order to evaluate the fracture, as part of the established routine within our service. Two radiographs were produced on each patient: in anteroposterior and lateral views.

After this, the images were evaluated. The evaluators were grouped according to their year of residency or position as a member of the hospital staff.

Universal classification (Cooney)

I. extra-articular without displacement
II. extra-articular with displacement
  A. stable and reducible
  B. unstable and reducible
  C. irreducible
III. intra-articular without displacement
IV. intra-articular with displacement
  A. stable and reducible
  B. unstable and reducible
  C. irreducible
  D. complex

Frykman classification

I. extra-articular
II. extra-articular + fracturing of the distal ulna
III. intra-articular (radiocarpal joint)
IV. intra-articular (radiocarpal joint) + fracturing of the distal ulna
V. intra-articular (distal radioulnar joint)
VI. intra-articular (distal radioulnar joint + fracturing of the distal ulna
VII. intra-articular (radiocarpal and distal radioulnar joints)
VIII. intra-articular (radiocarpal and distal radioulnar joints) + fracturing of the distal ulna

AO classification

A – extra-articular

A1 – ulna and radius intact
A2 – simple and impacted fractures of the radius
A3 – multifragmented fracture of the radius

B – partial intra-articular

B1 – sagittal facture of the radius
B2 – frontal and dorsal edge fracture of the radius
B3 – frontal and volar edge fracture of the radius

C – complete intra-articular fracture of the radius

C1 – simple at joint and simple in metaphysis
C2 – simple at joint and multifragmented in metaphysis
C3 – multifragmented at joint

Each group according to year of residency comprised three residents. Thus, three evaluators were first-year residents, three were second-year residents and three were third-year residents. Three staff physicians also formed part of the group, as a reference group.

Statistical analysis

The results from analyzing the radiographs with regard to the different classification systems (Frykman, AO and Universal) were tabulated and the SPSS statistical package (IBM), version 13.0, was used for the concordance analysis.

First stage: exploratory analysis of the central trend and dispersion measurements on the variables obtained.

Second stage: evaluation of the intra and inter-group inter-examiner concordance (R1/R2/R3 and Staff) by means of the intraclass correlation (ICC).

Third stage: identification of concordance between the control group (Staff) and R3 in the universal classification with and without the subtypes.

Results

The three classifications presented very different results in correlations that were made with the aim of examining the consistency of the evaluations between the groups of evaluators.

In evaluating the universal classification proposed by Cooney,[13] the groups of evaluators presented behavior that differed greatly.

The group of first-year residents presented low concordance (0.236), with low statistical significance (p-value = 0.278).

The group of second-year residents presented greater concordance, although still at an intermediate level (0.566), with a p-value of 0.064, which was at the limit of significance.

The results from the R3 and Staff groups presented excellent correlations, with statistically significant p-values ($p < 0.05$). When the Cooney classification was used without evaluating the criterion of stability of position (full Staff versus Staff), the concordance was seen to increase (from 0.725 to 0.786), with a significant p-value ($p < 0.05$). When the R3 and Staff groups were compared, this showed high concordance between the groups (Table 1).

When the Frykman classification was evaluated, none of the groups presented a statistically significant result (all of them presented p-values >0.05), although the Staff group presented an adequate correlation (0.885) (Table 2).

Analysis on the AO classification showed that the groups presented behavioral differences (Table 3).

The R1 group presented low concordance and also a p-value with low statistical significance.

The R2 group presented good correlation, with a p-value of 0.032 (statistically significant).

For the R3 and Staff groups, the correlations were high (respectively 0.950 and 0.800), with p-values less than 0.05 (respectively <0.001 and 0.003).

Table 1 – Analysis on the intraclass correlation between the groups of evaluators using Cooney's universal classification system.

Group	Correlation	p value
R1	0.236	0.278
R2	0.566	0.064
R3	0.828	0.009
Staff (Complete)	0.725	0.012
Staff	0.786	0.003
Staff/R3	0.738	0.008

Source: Hospital.

Table 2 – Analysis on the intraclass correlation between the groups of evaluators using Frykman's classification system.

Group	Correlation	*p* value
R1	0.222	0.302
R2	0.557	0.077
R3	0.515	0.159
Staff	0.885	0.835

Source: Hospital.

Table 3 – Analysis on the intraclass correlation between the groups of evaluators using the AO classification system.

Group	Correlation	*p* value
R1	0.057	0.432
R2	0.656	0.032
R3	0.95	<0.001
Staff	0.8	0.003

Source: Hospital.

Discussion

Fractures of the distal extremity of the radius are among the most frequent types of fractures of the skeleton, according to Reis et al.,[14] and account for up to 10% of skeletal fractures. Paksima et al.[15] stated that they are responsible for one in six emergency orthopedic cases attended.

The concern for observing radiographic results in relation to functional outcomes has been evaluated recently.[16]

The initial status of the fracture,[3] along with the comminution, is considered to be a factor that contributes toward the outcome from the fracture.

The existence of various classifications demonstrates that there is a need to obtain a single ideal classification that would be very wide-ranging and would provide support for therapeutic and prognostic conduct.[17] More than 20 classification systems for fractures of the distal extremity of the radius have been described. If a classification system has fulfilled all the premises for supplying support, it will still need to present intra and interobserver reproducibility. Several authors have stated that choosing the ideal treatment for stabilizing the fracture is of fundamental importance.[3,10,15] According to Downing and Karantana,[18] no other fracture treatment has been influenced by technology in the way that treatments for fractures of the distal extremity of the radius have.[18,19] Therefore, the prospect of making an appropriate diagnosis, classifying the fracture with greater reproducibility and reliability and choosing the most appropriate technique have become the pillars for achieving the best result possible.[20–22] Recognizing the characteristics of the fracture is extremely important,[23–25] since certain factors that predict instability, as described by Lafontaine et al.,[26] need to be well recognized in making the radiographic assessment.

In a study on radiographic assessment without traction, Flinkkilä et al.[27] suggested that the AO and Frykman classifications presented low value and that this was accompanied by low concordance regarding the clinical outcome. The percentage concordance between different evaluators through using the complete AO classification has ranged from 17 to 40% from radiographs and from 17 to 50% from tomography. In the study by Kreder et al.,[28] the interobserver concordance values from the AO classification was 0.67 between residents and 0.86 between surgeons, through evaluating the major types (A, B and C). When all the subtypes were used, the concordance decreased to 0.25 and 0.42, respectively. Use of additional tools such as computed tomography has the aim of improving the classification. Better results with regard to identifying the presence or absence of six specific fragments of the fracture (radial column, dorsal wall, dorsoulnar corner, volar-ulnar corner, volar edge and central impaction), so as to make treatment recommendations are found through radiography under traction and computed tomography.[9] In our study, we observed a good correlation through the universal classification. The Frykman classification showed a low level of concordance in the present study, and this was in line with the literature. On the other hand, the AO classification presented excellent concordance. According to Küçük et al.,[22] the classification systems for evaluating fractures of the distal extremity of the radius presented inconsistent results and they suggested that there was a need to create new classifications. In the study by Evans et al.,[29,30] the sensitivity of radiographs for making classifications using the Frykman and AO systems was only 12.5%. These authors stated that evaluations using radiographs alone were insufficient and suggested that there was a need for other types of examinations in order to increase the reliability and reproducibility, as we found in the presented study, in which we achieved good concordance using the universal and AO classification systems.

Conclusion

In the present study, it was observed that evaluations on radiographs produced under traction presented high concordance through the AO and universal classification systems.

Regarding the Frykman classification, we did not find good reliability from this evaluation, even on radiographs produced under traction.

We conclude that radiographs produced under traction showed good concordance, especially in the groups with greater experience that were evaluated (staff and third-year residents), and that this is a good tactic in making radiographic assessments of fractures of the distal extremity of the radius through Cooney's universal classification and the AO classification.

Conflicts of interest

The authors declare no conflicts of interest.

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