The Unstable Distal Radius Fracture—How Do We Define It? A Systematic Review

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Abstract

Keywords

- ▶ unstable distal radius fracture
- ▶ instability
- ▶ generalizability
- ▶ systematic review
- ▶ definition

Background Unstable distal radius fractures are a popular research subject. However, to appreciate the findings of studies that enrolled patients with unstable distal radius fractures, it should be clear how the authors defined an *unstable distal radius fracture*.

Questions In what percentage of studies involving patients with unstable distal radius fractures did the authors define *unstable distal radius fracture*? What are the most common descriptions of an unstable distal radius fracture? And is there one preferred evidence-based definition for future authors?

Methods A systematic search of literature was performed to identify any type of study with the term *unstable distal radius fracture*. We assessed whether a definition was provided and determined the level of evidence for the most common definitions.

Results The search yielded 2,489 citations, of which 479 were included. In 149 studies, it was explicitly stated that patients with unstable distal radius fractures were enrolled. In 54% (81/149) of these studies, the authors defined an unstable distal radius fracture. Overall, we found 143 different definitions. The seven most common definitions were: displacement following adequate reduction; Lafontaine's definition; irreducibility; an AO type C2 fracture; a volarly displaced fracture; Poigenfürst's criteria; and Cooney's criteria. Only Lafontaine's definition originated from a clinical study (level IIIb).

Conclusion In only half of the studies involving patients with an unstable distal radius fracture did the authors define what they considered an *unstable distal radius fracture*. None of the definitions stood out as the preferred choice. A general consensus definition could help to standardize future research.

Unstable distal radius fractures are the subject of numerous studies. However, a prerequisite for implementing the findings of these studies is the generalizability of the results. Generalizability is the degree to which the findings in the study population can be applied to another, future population of patients.^{1,2} Studies that focus on the treatment of unstable distal radius fractures should therefore clearly

describe what their authors regard as an unstable distal radius fracture.

However, instability is in the eye of the beholder, and therefore a situation that is difficult to capture in a definition. It is often quoted that a fracture of the distal radius is considered to be unstable if it is unable to resist displacement once it has been anatomically reduced. There are various

radiological and clinical criteria that would predispose distal radius fractures to instability, but it remains a subjective assessment. Nevertheless, clinical studies require established inclusion criteria and consequently a clear definition of an unstable distal radius fracture.

The absence of this definition or variability in definitions hampers apparent comparison of studies. Standardization or agreement on a definition for an unstable distal radius fracture would facilitate combining study outcomes in meta-analyses and contribute to a higher level of evidence. Therefore, we sought to examine (1) in what percentage of studies involving patients with unstable distal radius fractures the authors defined what they considered an *unstable distal radius fracture*; (2) what the most commonly mentioned descriptions of an unstable distal radius fracture in any type of study were; and (3) whether there was one preferred definition to recommend to future authors.

Methods

The present study was reported according to the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines.³ A review protocol was drafted and registered on PROSPERO with number CRD42014011840.

Data Sources

Two reviewers independently conducted a search of the Medline, EMBASE, and Cochrane Central Register of Controlled Trials databases on November 24, 2013, for any type of study in which the term *unstable distal radius fracture* occurred (see supplementary file for the detailed search strings. In order not to miss recently published literature, the use of Medical Subject Headings (MeSH) terms was avoided. The complete search strategy is depicted in the supplementary files. The bibliographies of all articles included were reviewed for additional articles of interest.

Eligibility Criteria and Study Selection

Two reviewers independently reviewed all titles and abstracts for relevance. If title and abstract did not provide sufficient information, full text was examined. All articles with the term *unstable* or *instability* in combination with *distal radius/radial fracture* were included. Publication language was restricted to English, German, or Dutch. Studies were excluded if (1) they regarded pediatric patients, (2) they used the term *unstable* or *instability* in relation with carpal instability or the distal radioulnar joint (DRUJ), (3) it was not clear to what the term *unstable* or *instability* referred; or (4) they regarded conference abstracts. Disagreement was resolved by discussion between the two reviewers.

Data Extraction

Two reviewers extracted data independently from eligible studies using a data collection form. Items included general information (authors, year, journal), study type, and number of subjects. Additionally, they determined whether *unstable distal radius fracture* was used as an inclusion criterion. Subsequently, the reviewers evaluated whether a clear defi-

nition of fracture instability was described in the methods section or elsewhere in the paper. Definitions were documented word for word.

We regarded the following description as a definition: (1) radiologic criteria or patient characteristics; (2) fracture types; (3) fracture classifications. We did not consider statements that denoted a possibility of fracture instability a definition (for example: "intra-articular fractures are sometimes unstable").

Data Synthesis and Quality Assessment

The primary outcome was the percentage of clinical studies involving patients with unstable distal radius fractures in which the authors defined what they considered an *unstable distal radius fracture*. We regarded randomized controlled trials, cohort studies, case-control studies, and case series as clinical studies. Secondary outcomes included the most frequently mentioned description of an unstable distal radius fracture in any type of study (including systematic reviews, current concepts, and cadaver studies) and the available evidence for these descriptions or definitions.

If applicable, we procured the full text manuscripts of the study from which each definition or description of an unstable distal radius fracture originated. Subsequently, we evaluated the overall quality of the study and determined whether the primary research question was to define the term *unstable distal radius fracture*. If this was the case, we determined the level of evidence using the Oxford Centre for Evidence-based Medicine Levels of Evidence (March 2009).⁴

Results

The initial search yielded 2,489 citations of which 479 studies were included in this review (► Fig. 1, ► Table 1).

In What Percentage of Clinical Studies Involving Patients with Unstable Distal Radius Fractures Did the Authors Define the Term?

There were 254 clinical studies, and in 149 studies (59%) the authors explicitly stated that they enrolled patients with an unstable distal radius fracture. In 54% (81/149) of these studies, the authors defined what they considered an unstable distal radius fracture.

What Were the Most Commonly Mentioned Descriptions of an Unstable Distal Radius Fracture in Any Type of Study?

Overall, 213 of the 479 studies (45%) provided one or more descriptions of an unstable distal radius fracture. In total, we found 143 different descriptions. There were seven descriptions that were used most frequently to define an unstable distal radius fracture. The most commonly mentioned description was a situation in which displacement or loss of position following anatomical closed reduction had occurred (20%, 42/213, ► Table 2).⁵⁻⁴⁶ The second most common description that was mentioned was the definition proposed by Lafontaine et al (9%, 20/213).⁴⁷ According to this definition, a distal radius fracture is unstable if three or more of the

Fig. 1 PRISMA flowchart.

following factors are present: dorsal angulation exceeding 20°; dorsal comminution; intra-articular radiocarpal fracture; associated ulnar fracture; and age over 60 years.⁴⁸

The third most common description was a volarly displaced fracture (Smith or volar Barton fracture) that was defined as an inherently unstable fracture in 6% (12/213) of the studies.^{27,49–59} This was followed by an irreducible fracture in 5% (11/213) of the studies.^{10,33,40,42,43,60–65}

The most frequently used classification system to describe an unstable distal radius fracture was the AO classification (8%, 18/213).^{23,66–82} An AO type C2 was the fifth most commonly mentioned description used to define an unstable distal radius fracture (5%, 10/213).^{66,67,70–74,79,81,82}

In 4% (9/213) of the studies, the description according to Poigenfürst (radioulnar separation; the presence of dorsal comminution, and an associated ulnar fracture) was

used.^{49,83–90} An equal number of studies (4%, 9/213) mentioned the definition of an unstable distal radius fracture according to Cooney (severe comminution; intra-articular components and severe displacement defined as >20° dorsal angulation and > 10 mm of radial shortening).^{27,42,44,91–96} All other type of descriptions were mentioned in only three studies (1%) or less.

Is There One Preferred Definition to Recommend to Future Authors?

Where possible, we verified the origin of the most common definitions and procured the full text manuscripts of the original studies. Four definitions did not originate from any study but were stated as expert opinions (loss of position, volar displacement, irreducibility, and AO type C2 fractures). Poigenfürst's definition was proposed in 1980 in a narrative

Table 1 Type of studies included

Type of studies included (N = 479)	n (%)
Meta-analysis	5 (1.0)
Systematic Review	10 (2.1)
Randomized controlled trial	45 (9.4)
Cohort study	224 (46.8)
Case-control	2 (0.4)
Case series	33 (6.9)
Case report	6 (1.3)
Surgical technique	23 (4.8)
Cadaver study	36 (7.5)
Biomechanical study	9 (1.9)
Current concepts/ nonsystematic review	73 (15.2)
Letter to the editor	6 (1.3)
Editorial	3 (0.6)
Other*	4 (0.8)

*Guideline (n = 1), decision analytic model (n = 1), translation (n = 1), and interobserver study (n = 1).

article as an expert opinion.⁹⁰ According to Poigenfürst, the presence of an associated ulnar styloid fracture, resulting in a rupture of the ulnar ligaments from the carpal bones, would permit further shift of the distal fracture fragment and therefore constitute fracture instability.^{90,97}

Cooney's definition was first used in 1979 when Cooney et al performed a cohort study in which 130 patients were treated with an external fixator.⁴⁴ They included patients with an unstable distal radius fracture and defined *unstable* as "the inability to maintain satisfactory fracture alignment at the time of reduction or in the presence of severe comminution; intra-articular components and severe displacement defined as >20° dorsal angulation and > 10 mm of radial shortening." No reference or explanation as to the choice of these criteria was provided, and therefore this definition is an expert opinion (► Table 3).

Only Lafontaine's definition originated from a clinical study, describing a retrospective cohort of 167 cases.⁴⁷

Lafontaine et al performed a univariate analysis for each risk factor and found a significant influence of each factor on the radiological outcome. They concluded that only patients with three or fewer instability factors had a satisfactory radiological outcome. Accordingly, Lafontaine considered a distal radius fracture unstable if three or more of the following factors were present: dorsal angulation exceeding 20°; dorsal comminution; intra-articular radiocarpal fracture; associated ulnar fracture; and age over 60 years.⁴⁸ Based on the Oxford Centre for Evidence-based Medicine Levels of Evidence, this study is a level 3b (nonconsecutive retrospective cohort study without consistently applied reference standards).

Discussion

In clinical studies, specification of the inclusion criteria for enrollment is paramount. These criteria are used to define the study population and therefore reflect whether the findings in this population are generalizable to other future patients. Some criteria, however, such as an unstable distal radius fracture, can be hard to capture in a definition.

The term *unstable distal radius fracture* describes a situation in which the distal radius fracture has an intrinsic potential for secondary displacement.⁹⁸ It is an assessment of the probability that a fracture will lose its position, and therefore it is highly subjective. However, regardless of its subjectivity, a standardized or universally accepted definition for an unstable distal radius fracture could have several benefits. It would increase awareness of the importance of specification of inclusion criteria among authors, help authors to write their study protocols, and facilitate combining study outcomes in meta-analyses. Conversely, there might not exist a universal definition that all experts in the field agree upon. Moreover, defining what constitutes an unstable distal radius fracture could impact clinical practice and surgical decision making. Nevertheless, for the sake of standardization in research, we sought to examine (1) in what percentage of clinical studies involving patients with unstable distal radius fractures the authors defined what they considered an *unstable distal radius fracture*; (2) what the most commonly mentioned descriptions of an unstable distal radius fracture were in any type of study; and (3) whether

Table 2 The most common descriptions or definitions of an unstable distal radius fracture

Ranking	Definition	n (%)*
1	Loss of position following adequate reduction	42 (19.7)
2	Lafontaine	20 (9.4)
3	Volarly displaced fracture (Smith's or reversed Barton)	12 (5.6)
4	Irreducible fracture	11 (5.2)
5	AO type C2	10 (4.7)
6	Poigenfürst	9 (4.2)
7	Cooney	9 (4.2)

*Percentage of total studies with definition (N = 213).

Table 3 Level of evidence for the most commonly used definitions

	Year	Definition	Level of evidence*
Secondary displacement	NA	Displaced fracture following adequate reduction	Expert opinion (V)
Lafontaine	1989	At least three of the following criteria: <ul style="list-style-type: none"> • Dorsal angulation > 20° • Dorsal comminution • Intra-articular radiocarpal fracture • Associated ulnar fracture • Age > 60 years 	III
Volarly displaced	NA	<ul style="list-style-type: none"> • Smith fracture • Reversed Barton fracture 	Expert opinion (V)
Irreducible	NA	<ul style="list-style-type: none"> • Irreducible fracture 	Expert opinion (V)
AO type C2	1990	<ul style="list-style-type: none"> • Complete articular fractures • Simple articular fracture • Multifragmentary metaphyseal component 	Expert opinion (V)
Poigenfürst	1980	<ul style="list-style-type: none"> • Radioulnar separation • The presence of dorsal comminution • Associated ulna fracture resulting in ulnar disinsertion 	Expert opinion (V)
Cooney	1979	One or more of the following: <ul style="list-style-type: none"> • Radial shortening of 10 mm • Dorsal angulation > 20° • Marked comminution combined with intra-articular fragments 	Expert opinion (V)

Abbreviation: NA, not applicable.

*The levels of evidence for definition of unstable distal radius fracture based in original study on the Oxford Centre for Evidence-based Medicine Levels of Evidence (March 2009).⁴

any of these descriptions was the preferred definition that can be recommended to future authors.

We found that in only 54% of the clinical studies that explicitly stated that they enrolled patients with an unstable distal radius fracture did the authors define what they considered an unstable distal radius fracture.

Our search in any type of article resulted in 143 different descriptions of an unstable distal radius fracture. There were seven descriptions that were used most frequently to define an unstable distal radius fracture: (1) displacement of the fracture following anatomical reduction; (2) Lafontaine's; (3) an irreducible fracture; (4) an AO type C2 fracture; (5) a fracture with volar dislocation; (6) Poigenfürst's definition; and (7) Cooney's definition.

The most obvious description was secondary displacement after adequate closed reduction. The occurrence of secondary displacement is what constitutes an unstable fracture and is a clear definition.

The second most common description of an unstable distal radius fracture was according to the definition from Lafontaine. It was used in 9% of the studies,^{11,32,34,43,47,99–112} of which six studies added radial shortening exceeding 5 mm to the definition.^{104,107–110} The definition originates from a French publication on a retrospective study of 167 cases.⁴⁷ In this study the authors conclude that only patients with three or fewer instability predictors had a satisfactory radiological outcome. Since then, two studies have attempted to validate Lafontaine's criteria.^{98,100} Of all five criteria, only age > 60 years was found to be predictive of fracture instability.¹⁰⁰

All other definitions were expert opinions. A volarly displaced fracture, for example, is generally considered inher-

ently unstable, and primary operative treatment is regularly recommended.^{113,114} However, we found no studies that assessed fracture instability in volarly displaced fractures. The same is true for irreducibility that cannot be equated to instability.¹¹⁵

Instability, or the inability of a fracture to resist displacement after closed reduction,¹⁰⁰ is often defined according to criteria regarding initial displacement, such as dorsal angulation, shortening, and the presence of dorsal comminution. The definition is in fact an assessment of the probability that a fracture will redisplace. Predictors of redisplacement have been studied extensively, and several scoring systems to calculate the probability of instability based on initial presentation and injury films exist.^{48,98,116,117} The largest study to investigate predictors of instability was performed by Mackenney et al, who examined 1595 patients. They identified several significant risk factors for fracture instability with displaced fractures and found that age, the presence of any type of comminution, and a positive ulnar variance compared with the uninjured radius were significant predictors of early (< 2 weeks) instability.¹¹³ Other studies found that age > 60 years; initial shortening, and dorsal angulation exceeding 20° are significant predictors of redisplacement.^{32,82,117–120} Surprisingly, more than half the definitions were not based on any of these predictors.

This systematic review is limited by the quality of the articles included and the subjectivity of the reviewers. The exclusion of the literature not in English, Dutch, or German also introduces a source of bias. Determining the level of evidence for a definition was a subjective endeavor. Most definitions did not originate from any study and were

therefore not suited to establish any level of evidence. We have attempted to reduce subjectivity as much as possible by discussing any doubts or disagreements between reviewers. Nevertheless, we have demonstrated that there is little evidence for definitions that are most frequently used.

Conclusion and Recommendation

In only half of the studies that explicitly stated to have enrolled patients with an unstable distal radius fracture did the authors define what they considered an *unstable distal radius fracture*. There is an enormous variety of different descriptions of an unstable distal radius fracture circulating in the literature. Unfortunately, none of the descriptions we found stands out as the preferred definition to be used in future studies.

For the sake of generalizability, we would like to urge future authors to describe clearly what they regard as an unstable distal radius fracture. We propose that the definition of an unstable distal radius fracture includes the predictors that are known to increase the probability of displacement, such as comminution, initial shortening, and age > 60 years. Further attempts to arrive upon a universally accepted consensus definition could possibly help to standardize distal radius fracture research.

Conflict of Interest

None

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