

# The Comparative Study of Reliability and Reproducibility of Distal Radius' Fracture Classification among: AO Frykman and Fernandez Classification Systems

Yongyut Siripakarn MD\*,  
Sunyarn Niempoog MD\*, Krit Boontanapibul MD\*

\* Department of Orthoprdic Surgery, Faculty of Medicine, Thammasart University, Pathumtani, Thailand

**Objective:** To study the reliability and reproducibility of distal radius fracture classification in plain radiographs.

**Material and Method:** Ninety-eight displaced distal radius fractures radiographs were classified in four groups of observers. The first group consisted of one senior orthopedics staff and two hand-orthopedic surgeons (with experience ranging from ten to thirty years). The first group conducted and evaluated the research altogether. This first group was also regarded as standard adjustment. The three other groups comprised fourth year orthopedics residents, using AO, Frykman, and Fernandez classification systems with six weeks intervals. The results were processed with kappa statistics. The Research to be approached by Thammasat Ethic Committee.

**Results:** The highest kappa coefficient in interobserver agreement was determined in Fernandez classification (0.415), AO classification (0.342), and Frykman classification (0.280). When intraobserver were evaluated, Fernandez classification had a highest mean kappa value (0.343). Then Frykman classification (0.310) and AO classification (0.292) followed. Likewise, the classification, of which each of senior orthopedics residents evaluated most resemble to standard adjustment, was Fernandez classification with a mean of 62.34%.

**Conclusion:** Fernandez classification provided satisfactory outcome comparing to standard adjustment and gave a highest inter and intraobserver agreement. Nevertheless, none of the classification systems examined in the present study has achieved an excellent outcome.

**Keywords:** Intraarticular fracture, Distal radius, Classification, Reliability, Reproducibility

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Distal radius fracture accounted for approximately 17% of skeletal fractures<sup>(1)</sup> or 75% of forearm fractures<sup>(2)</sup> that were present at the emergency room. The characteristics of such fractures were described due to mechanism of injuries, trace location, possible joint involvement, and severity. The good classification of distal radius fracture should be organized by 1) reproducible diagnosis 2) prognosis consideration 3) associated soft tissue lesion 4) recommend treatment option<sup>(3)</sup>. Up until now, there were more than 20 different wrist fracture classifications but none of these various classifications was reported to function as an outstanding guideline for the prediction of prognosis and for the definition of the treatment method. In addition, there has been no

reliability and agreement using between orthopedic surgeons.

The present study, three different popular distal radius fracture classification systems were selected (AO, Frykman and Fernandez) to consider inter-intraobserver agreement. AO classification consisted of three main groups with further division and subgroups into 27 fracture patterns<sup>(4)</sup> (Fig. 1). Frykman classification evaluated under eight groups according to the involvement of radiocarpal and distal radius-ulna joints and the presence or absence of ulnar styloid<sup>(5)</sup> (Fig. 2). Fernandez classification was characterized into five groups based on the trauma mechanism and fracture displacement<sup>(6)</sup> (Fig. 3).







The purpose of this method was to acquire the most precise and reliable classification by considering the interobserver reliability and intraobserver reproducibility that should be effortlessly understandable between the orthopedic surgeons. Furthermore, these could apply advantage and

## Correspondence to:

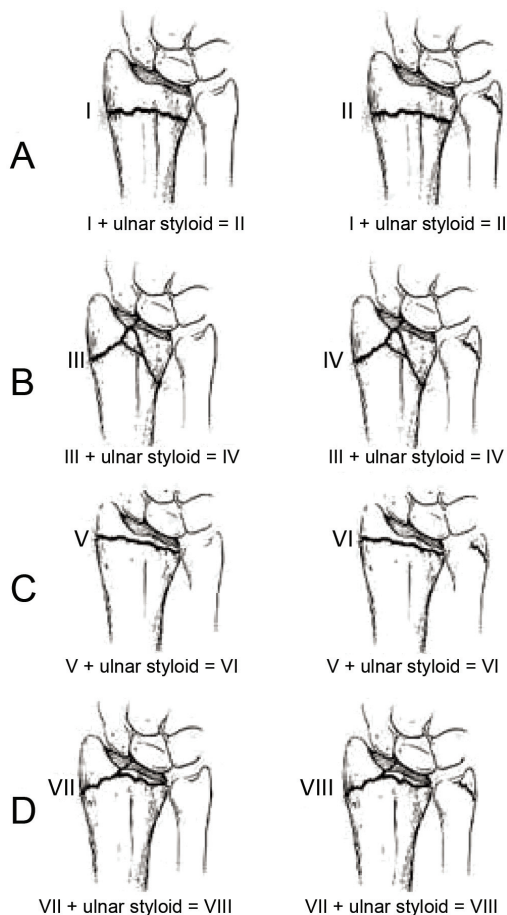
Siripakarn Y, Department of Orthopedic Surgery, Faculty of Medicine, Thammasart University (Rungsit Campus), Pathumtani 20120, Thailand.

Phone : 0-2926-9775, Fax : 0-2926-9793

E-mail: [yongsiripakarn@gmail.com](mailto:yongsiripakarn@gmail.com)

 <p>A</p>	<p>A. Extra-articular fracture</p>	
 <p>B</p>	<p>B. Partial-articular fracture</p>	
 <p>C</p>	<p>C. Completed articular fracture</p>	

**Fig. 1** AO classification: modify from Diego L. Fernandez, M.D. Fractures of the Distal Radius: A Practical Approach to Management 1995 Springer.



**Fig. 2** Frykman classification: modify from Diego L. Fernandez, M.D. Fractures of the Distal Radius: A Practical Approach to Management 1995 Springer.






distinctive point of each classification to be beneficial in clinical applications.

### Background

For the high-energy injury, distal radius fractures are one of the most common fractures present in the trauma unit. The treatment decisions depend on fracture's pattern, degree of displacement and stability. Many classifications were developed to describe the characteristic of fracture to help surgeons to consider proper treatment. There are many classifications for distal radius fracture described in orthopedic literatures. The best classification must be able to identify the pattern of fracture, describe the stability and anatomic malalignment of the fracture, and have validity and reproducibility. In order to find out one of the most easy to remember and appropriate for the authors' to use as a reference in clinical practice. The authors selected the most commonly used classification such as AO classification, Fernandez classification and Frykman classification to investigate the inter-observer reliability and intra-observer reproducibility.

### Material and Method

Anteroposterior and lateral radiographs were evaluated in 124 displaced distal radius fractures from 122 patients who presented at the Emergency

	<p>Type 1 Bending fracture of metaphysis</p>
	<p>Type 2 Shearing fracture of the joint surface</p>
	<p>Type 3 Compression fracture of joint surface</p>
	<p>Type 4 Avulsion of radiocarpal fracture dislocation</p>
	<p>Type 5 Combined fracture associated with high velocity injury</p>

**Fig. 3** Fernandez classification: modify from Diego L. Fernandez, M.D. Fractures of the Distal Radius: A Practical Approach to Management 1995 Springer.

Department, Thammasart University Hospital between April 2007 and July 2009. After excluding those with previous fractures of the ipsilateral wrists, with inadequate quality radiographs, with direct trauma injuries and with articular involvement by other systemic conditions, The authors' only had 98 patients left that were aged between 27 and 88 years (average age: 67.2 years).

Ninety-eight true anteroposterior and lateral sets of displaced distal radius radiographs of 55 men and 43 women that had sufficient quality were taken from the same radiography device with a distance of 105 cm (40 inches) using two orthopedic surgeons who were not assessors of performed selection. Postreduction radiographs were excluded in order to minimize the bias from the process.

Three different distal radius fracture classification systems were selected (AO, Frykman and Fernandez), which were evaluated by six observers with different levels of experience: one senior orthopedic staff and two hand-orthopedic surgeons who have ten to thirty years of experience and have more than 200 cases per year. All of them evaluated the film together. The other three groups were fourth year orthopedic residents. Each group of assessors studied the series individually. It was mandatory that each classification provided only one result.

Before evaluation, all of the observers would be provided diagrams of the classifications in order to derive the same direction. For the Frykman system, the fracture was classified into the standard eight categories (I-VIII). Fernandez classification was divided into five categories (I-V) and AO classification consisted of nine main groups (A1-C3) for conveniently applying in clinical practice. Names and identifying marks on the radiographs were covered, and all sets of film were randomly numbered.

The result from each senior orthopedic resident was compared with that from the group of senior orthopedic staff and hand-orthopedic surgeons using the latter group as a standard adjustment. Interobserver reliability and intraobserver reproducibility were assessed by comparing how each fracture was classified from the three orthopedic residents. The second reading was conducted six weeks after the first reading by each observer on the same sets of random radiographs.

### Statistical analysis

Interobserver reliability and intraobserver reproducibility were accomplished by the use of Kappa

coefficient as proposed by Method of Landis and Koch<sup>(7,8)</sup>. According to this classification, kappa values below 0 were considered poor agreement, 0 to 0.20 slight, 0.21 to 0.40 fair, 0.41 to 0.60 moderate, 0.61 to 0.80 good, and 0.81 to 1.00 near perfect. All data were evaluated using SPSS that were percentage, mean and standard deviation. The authors assigned percentage of the radiographs that have the same standard adjustment <50% was unsatisfactory, 50 to 75% was satisfactory, and more than 75% was excellent.

### Results

Ninety-eight anteroposterior and lateral sets of radiographs that were evaluated by a group of senior orthopedic staff and hand orthopedic surgeons regard as standard adjustment, are shown in Fig. 4.

From the present study, the classification that each of senior orthopedic residents evaluated most resemble to standard adjustment, was Fernandez classification (mean 62.34%), the second was AO classification (mean 48.34%), and Frykman classification (mean 48%) (Table 1).

For the Fernandez classification, the highest mean interobserver kappa coefficient was determined, 0.415 considered to be moderate. The other two classifications were determined as AO (0.342), and Frykman (0.280) respectively (Fig. 5).

As for the intraobserver evaluation, Fernandez classification also had the highest mean kappa value (0.343), and then Frykman classification (0.310), and

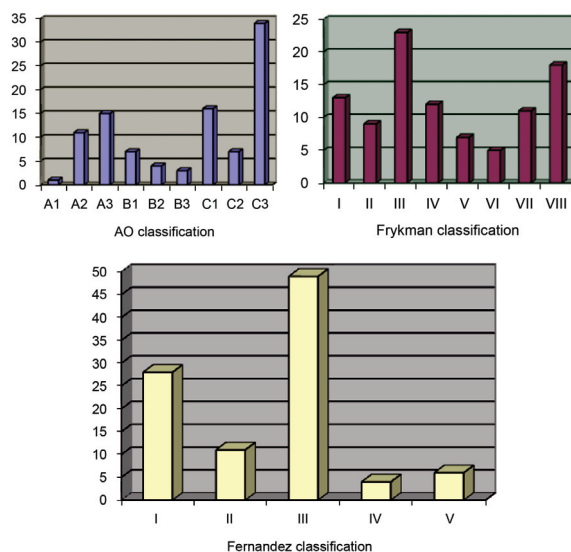


Fig. 4 Population distribution of 98 observations for three distal radius fracture classifications.

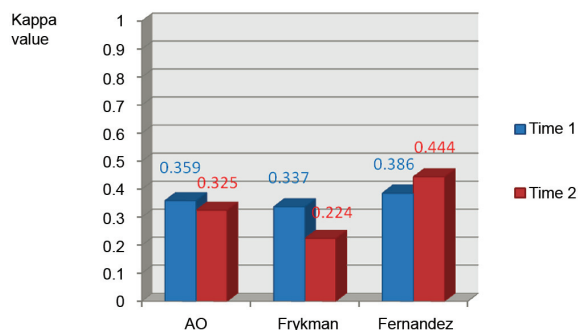
AO classification (0.292). All of them were evaluated as fair (Fig. 6).

### Discussion

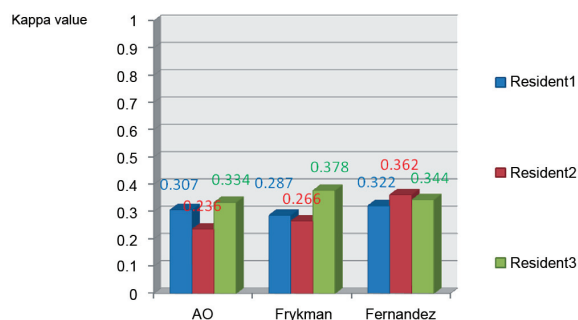
The present study focused on experience of the assessors that differed from previous studies. Three senior orthopedic residents evaluated distal radius fracture classifications by comparing with the group of senior orthopedic staff and hand-orthopedic

**Table 1.** Percentage of senior orthopaedics residents versus standard adjustment (n = 98)

Classification	Senior resident	Outcome same as standard adjustment (%)	Mean (%)
AO	1	50	48.34
	2	47	
	3	48	
Frykman	1	50	48.00
	2	39	
	3	55	
Fernandez	1	58	62.34
	2	58	
	3	71	



**Fig. 5** Interobserver agreement of each classification at Time 1, 2.



**Fig. 6** Intraserver agreement of each classification.

surgeons as standard adjustment. The popular classifications used in clinical application and research that the authors selected, were AO Frykman and Fernandez classifications. From the study, we found the classification that all senior orthopedic residents assessed most resemble to standard adjustment was Fernandez classification, mean 62.34% that was satisfactory outcome, followed by AO and Frykman classification consecutively.

The intraobserver agreement was found kappa value = 0.343 (fair) in Fernandez classification, 0.310 (fair) in Frykman classification, 0.292 (fair) in AO classification. Furthermore, the interobserver agreement was found kappa value = 0.415 (moderate) in Fernandez classification, 0.342 (fair) in AO classification, and 0.28 (fair) in Frykman classification.

Fernandez had the highest interobserver kappa values because this classification was simple for the mechanism of injury considering directions of fracture displacements. For such a reason, it made the observers speculate using the same method. As for Frykman, this classification focused on intra-articular extension. However, it appeared difficult to determine exactly where fracture line extended from plain radiographs<sup>(9)</sup>. Therefore, Frykman classification had the lowest interobserver kappa value and lower than simplified AO classification (9 subtypes).

The authors compared the present study with other literatures. The present results seemed to correlate with a study conducted by Belloti et al<sup>(10)</sup> since both studies revealed the best interobserver reliability rate in Fernandez classification (0.43) and the worst in Frykman classification (0.26). Nevertheless, previous literatures revealed the difference between inter-intraobserver agreements of each classification<sup>(11-15)</sup>.

Even though none of the classification systems examined in the present study achieved the excellent outcome that one would rely on, in clinical practices, using the classification for communication between orthopedic surgeons can improve understanding and provides more advantages. In conclusion, the present study revealed that Fernandez classification had satisfactory outcome comparing to the standard adjustment and had the highest inter-intraobserver agreement.

### Potential conflicts of interest

None.

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## ประเมินความน่าเชื่อถือและความถูกต้องของรูปแบบการจัดประเภทของกระดูกข้อมือหักส่วนปลายจากฟิล์มเอกซเรย์

ยงยุทธ ศิริปการ, สัญญาณ เนียมปุก, กฤต บุณรนาพิบูลย์

**ภูมิหลัง:** ภาวะการแตกหักของกระดูก radius ส่วนปลาย ที่เกิดจากการบาดเจ็บที่รุนแรง (high energy injury) มีลักษณะการแตกหักหลากหลาย มีวิธีการรักษาได้หลายแบบ ขึ้นอยู่กับลักษณะที่แตกหัก (pattern of fracture), การเคลื่อนหลุดจากตำแหน่ง (displacement) ของปลายกระดูก ตำแหน่งที่แตกหัก (location) และความมั่นคง (stability) ของภาวะการแตกของกระดูก การรักษาจึงจำเป็นต้องอาศัยการจัดแบ่งกลุ่มที่สามารถสื่อสถานภาพที่แท้จริงของลักษณะการแตกหักได้ดี เพื่อช่วยให้สามารถตัดสินใจเลือกวิธีการรักษาที่เหมาะสมที่สุด classification ที่มีรายงานในวารสารทางการแพทย์มีมากมาย อาทิเช่น AO classification, Frykman classification และ Fernandez classification และอื่น ๆ แม้ว่าจะมีการศึกษาถึงความเที่ยง ความน่าเชื่อถือมาแล้ว แต่ผู้นิพนธ์มีวัตถุประสงค์ที่จะหา classification ที่สามารถจำได้ง่าย มี reliability และ reproducibility ที่ดี จึงได้ทำการศึกษาด้วยวิธี diagnostic study โดยเก็บฟิล์ม X-ray ข้อมือของผู้ป่วยกระดูกแตกหักที่ distal end radius มาให้ผู้เชี่ยวชาญอ่านแบบต่างคนต่างอ่าน (inter observer) และทั้งระยะเวลาสั้นระยะหนึ่ง แล้วกลับมาอ่านใหม่ (intra observer) เพื่อเปรียบเทียบผลที่อ่านอีกครั้ง

**วัตถุประสงค์:** ศึกษาเปรียบเทียบ reliability และ reproducibility ของการจัดกลุ่มภาวะ และลักษณะการแตกของกระดูกข้อมือ (Classification of distal radius) จากแผ่นฟิล์มเอกซเรย์ธรรมดา

**วัสดุและวิธีการ:** ใช้แผ่นฟิล์มเอกซเรย์ธรรมดาของผู้ป่วยที่ประสบอุบัติเหตุเกิดภาวะกระดูกข้อมือแตกหัก บริเวณ distal radius ทั้งชนิดแตกเข้าข้อ หรือ ที่แตกไม่เข้าข้อ ที่เป็นฟิล์มที่ถ่ายทำ AP และ lateral จำนวน 98 ราย แล้วให้แพทย์ทางศัลยกรรมออร์โธปิดิกส์ อ่านและแปลผลเป็นหมวด ๆ ตามการจัดกลุ่มของ AO classification, Frykman and Fernandez classification ผู้อ่านประกอบด้วยอาจารย์อาวุโส 3 คน เปรียบเทียบกับแพทย์ประจำบ้านปีที่ 4 อีก 3 คน จากนั้นให้แพทย์ประจำบ้านคนเดิมทั้ง 3 คน กลับมาอ่านซ้ำอีกที่เมื่อเวลาผ่านไปอีก 6 เดือน เพื่อวัดความเที่ยงตรงของการอ่านซ้ำ โดยใช้สถิติ Kappa coefficient เป็นตัววิเคราะห์ (การศึกษานี้ได้ผ่านการพิจารณาอนุมัติจาก Ethic committees ของมหาวิทยาลัยธรรมศาสตร์)

**ผลการศึกษา:** พบว่าการอ่านฟิล์มเปรียบเทียบระหว่างกลุ่ม (Inter observers) การจัดกลุ่มแบบ Fernandez, AO classification and Frykman classification ได้ค่า Kappa coefficient ที่ 0.415, 0.342 และ 0.280 ตามลำดับ เมื่อเปรียบเทียบผลการอ่านซ้ำ (Intra observer) ของแพทย์ประจำบ้าน พบว่าได้ค่า Kappa coefficient ที่ 0.343 ใน Fernandez classification และได้ค่า 0.310 และ 0.292 ใน Frykman และ AO classification ตามลำดับ

**สรุป:** จากการศึกษาเปรียบเทียบพบว่า การจัดกลุ่มแบบ Fernandez ได้ผลความน่าเชื่อถือ (reliability) และความแม่นยำ (reproducibility) ที่ดีกว่าค่า kappa coefficient ทั้ง 0.415 และ 0.342

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