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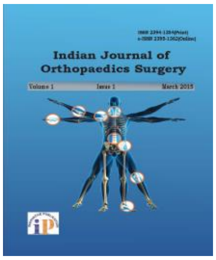

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CLASSIFYING DISTAL RADIUS FRACTURES AND NEW YARDSTICK TO ORTHOPAEDIC RESIDENTS

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Introduction

Medicine has evolved from simple observations by our ancestral founders of different diseases to more evidence based medicine in our recent past and now to genetic based knowledge of various pathologies. As in other fields of life, medicine has also evolved tremendously from last two centuries. So is the case with fractures of various bones. Knowledge of fracture of distal end of radius has also evolved over a long period of time. Fracture eponyms pay tribute to those who initiated the process: Pouteau,[1] Colles,[2,3] Barton,[4] Goyrand, and Smith.[6,7,] Classification of distal radial fractures has largely occurred in the past two hundred years.

Various authors described one or more specific fractures that they characterized by clinical evaluation or laboratory dissection, without the aid of X-rays. With this foundation, many investigators progressively contributed to the breadth and depth of understanding of distal radial fractures based on fracture attributes and severity. Until the last decade, Frykman's classification [8] was the most popular, but it does not define displacement, shortening, or the extent of comminution. Each method of classification had its merit and demerits. Functional outcome of distal radius fracture after various treatment modalities primarily depends upon the fractures attributes and characteristics. Despite controversial studies some attributes accepted to affect the long term functional outcome are described as follows.

Location: Fracture location would be defined as extra articular or intra-articular. Intra-articular fractures would be designated as those involving the radio carpal joint, distal radio-ulnar joint, or both. As we know the joint congruity is utmost important to decrease the chances of secondary osteoarthritis in intra-articular fractures.

Configuration: Fracture configuration not only helps us to understand the fracture complexity but also to apply various treatment modalities and stabilising means. Simple fractures would be either transverse or oblique. Comminution may be defined as involving the dorsal or palmer cortex, or both; and/or the articular surface of the distal radius at the radio-carpal joint, the distal radio-ulnar joint or both. Level of comminution determines whether the fracture is stable or unstable. Fragments designating the styloid [9] and dorsal and volar medial die punch fragments are recognized.

Displacement: Displacement of fracture is usually due to energy transferred during the trauma to the bone. It also determines the level of associated soft tissue injuries. Displacement of fracture also determines the fracture behaviour in cast. A fracture with an offset of more than 1 mm in any plane or in the articular surface is considered displaced. Axial shortening, radial inclination and radio-ulnar displacement can be measured on the routine posterior/anterior film. Dorsal inclination and dorsal palmar displacement can be measured on the routine lateral X-ray. Fragment displacement and rotation may be further defined on computed tomography scan

Ulnar styloid integrity: Ulnar styloid should be always determined in x-rays of wrist to see whether it is intact or fractured. The fracture should be designated as to its level at the tip, mid portion, or base. The amount of displacement can be measured on routine films. When the DRUJ is stable, an untreated ulnar styloid fracture does not affect the wrist outcome of the patient with an unstable DRF treated with external fixation.[9]

Distal radio-ulnar joint integrity (DRUJ): DRUJ is essential to the long term functional outcome of distal end radius fractures as its incongruity or malunion directly affects the rotator movements of the wrist. Clinical and radiological evaluation of DRUJ is must for the stability and long term functional results. Evaluation can be compared to the opposite and non-involved side. Any subluxation or instability should be noted as well as its direction; dorsal or palmar. Similarly, dorsal or palmar dislocation should be noted.[10, 11]

Stability: Any fracture which displaces again after bringing to its normal anatomical position is considered unstable fracture. Definite instability criteria's to differentiate between stable and unstable fracture pattern are being described by various experimental studies which latter on determine the treatment modality appropriate for the fracture. The instability criteria's are for all types of fractures patterns and presence of one or more unstable criteria makes any fracture unstable.[12,13,14,15] These criteria's are:

a. Dorsal comminution
b. Fracture volar buttress plate
c. Fracture Angulations >20^{o}
d. Articular step >2mm
e. Radial shortening >5mm and
f. DRUJ incongruity

Associated injuries: Associated injuries of the distal radius fractures are determined by the level of trauma received by the bone at the time of trauma. Any laceration, crush, loss or avulsion of skin, muscle, tendon, nerve, artery, ligament, or fracture dislocation of bone should be noted.
Ligament injuries of the wrist should evaluate the triangular fibrocartilage complex, as well as the intrinsic and extrinsic wrist ligaments. Location and extent can classify each of these.[16] A well-recognized classification of triangular fibrocartilage complex injury exists.[17] The peripheral tears can be further classified by the arcs and the number of degrees subtended. Wrist intrinsic and extrinsic tears can be classified as in continuity, partial and complete. Carpal instability can be defined by classically measured intracarpal angles. Carpal fractures, especially those of the scaphoid,[18] can also be classified by location, configuration, displacement and stability.

Bone mineralisation: As we know dual presentation of distal radius fractures, one is due to high velocity trauma in young population and another is low energy trauma in elderly group. It has been seen that low mineralisation status of osteoporotic bones give way to low velocity trauma. Bone mineral density influences the fracture pattern, displacement, the ability of fixation implants to purchase the fragments; and, consequently the outcome.[19] The presence of osteopenia can be categorized by measurement of metacarpal cortical indices or by photon dosimetry. Single photon absorptiometry is the preferred method for highest precision and accuracy in the distal radius.[20]

Various classifications of distal radius fractures are;

1. *Classification of Gartland,* [21]

Type	*Fracture pattern*
Group 1	Simple Colles' fracture
Group 2	Comminuted Colles' fracture with undisplaced intraarticular fragments
Group 3	Comminuted Colles' fracture with displaced intra-articular fragments.

2. *Classification of Lidstrom*[22]

Type	***Fracture pattern***
Group 1	Undisplaced
Group 2a	Dorsal angulation, extra-articular
Group 2b	Dorsal angulation, intra-articular but without gross separation of fragments
Group 2c	Dorsal angulation plus dorsal displacement, extra-articular
Group 2d	Dorsal angulation plus dorsal displacement, intra-articular but without gross separation of fragments
Group 2e	Dorsal angulation plus dorsal displacement, intra-articular with separation of fragments

3. *Classification of Older, T.M. Et Cassebaum*[23]

Type	***Fracture pattern***
Group 1	Non displaced - up to 5° dorsal angulation, radial articular surface at least 2 mm distal ulnar head
Group 2	Displaced with minimal comminution - dorsal angulation or displacement, radial articular surface no lower than 3 m proximal to the ulnar head, minimal comminution of dorsal radius
Group 3	Displaced with comminution of dorsal radius - comminution of dorsal radius; radial articular surface proximal to ulnar head; minimal comminution of distal fragment
Group 4	Displaced with severe comminution of radial head - marked comminution of dorsal and distal radius; radial articular surface 2-8 mm proximal to ulnar head

4. *Classification of Frykman*[24]

Type	***Fracture pattern***
Group 1	Extra-articular without fracture of the distal ulna
Group 2	Extra-articular with fracture of the distal ulna
Group 3	Intra-articular involving the radio-carpal joint without fracture of the distal ulna
Group 4	Intra-articular involving the radio-carpal joint with fracture of the distal ulna
Group 5	Intra-articular involving the distal radio-ulnar joint without fracture of the distal ulna
Group 6	Intra-articular involving the distal radio-ulnar joint with fracture of the distal ulna
Group 7	Intra-articular involving both radio-carpal and distal radio-ulnar joints without fracture of the distal ulna
Group 8	Intra-articular involving both radio-carpal and distal radio-ulnar joints with fracture of the distal ulna

5. *Classification of Jenkins*[25]

Type	***Fracture pattern***
Group 1	No radiographically visible comminution
Group 2	Comminution of the dorsal radial cortex without comminution of the fracture fragment
Group 3	Comminution of the fracture fragment without significant involvement of the dorsal cortex
Group 4	Comminution of both the distal fragment and the dorsal cortex. As the fracture line involves the distal fracture fragment in Groups 3 & 4, intra-articular involvement is not, however, inevitable, nor does it affect the fracture's placement within the classification.

6. *Classification of Sarmiento*[26]

Type	***Fracture pattern***
Group 1	Non displaced fractures without radiocarpal joint involvement
Group 2	Displaced fractures without radiocarpal joint involvement
Group 3	Non displaced fractures with radiocarpal joint involvement
Group 4	Displaced fractures with radiocarpal joint involvement

7. *Classification of Fernandez, D.L*[27]

Type	*Fracture pattern*
Type 1	One cortex of the metaphysis fails due to tensile stress (Colles and Smith fractures) an the opposite undergoes a certain degree of comminution Shearing
Type 2	Fracture of the joint surface - Barton's, reversed Barton's, styloid process fractures, simple articular fracture Compression
Type 3	Fracture of the surface of the joint with impaction of subchondral and metaphyseal bone (die-punch fracture), intra-articular comminuted fracture Avulsion
Type 4	Fracture of the ligament attachments ulnar and radial styloid process, radiocarpal fracture dislocation Combinations
Type 5	Combination of types, high velocity injuries

8. *Classification of Mc Murtry, R.Y. and Jupiter*[28]

Type	*Fracture pattern*
Group 1	2 Parts: the opposite portion of the radiocarpal joint remains intact dorsal Barton, palmar Barton, Chauffeur, die punch
Group 2	3 Parts: the lunate and scaphoid facets separate from each other and the proximal portion of the radius
Group 3	3 4 Parts: The same plus lunate facet fractured in dorsal and volar fragment
Group 4	5 Parts or more

9. *Classification AO*[29]

Type	*Fracture pattern*
Group 1	Extra-articular
Group 2	Partial articular
Group 3	Complete articular; C1 - simple articular and metaphyseal, C2 - simple articular and complex metaphyseal, C3 - Complex articular and complex metaphyseal + fracture distal end

10. *Classification of Mayo, Intra-articular fractures*[30]

Type	*Fracture pattern*
Type 1	Extra-articular radiocarpal, intra-articular radioulnar
Type 2	Intra-articular scaphoid fossa of distal radius
Type 3	Intra-articular lunate fossa of distal radius +/- sigmoid fossa
Type 4	Intra-articular, scaphoid fossa, lunate fossa and a sigmoid fossa of the distal radius

11. *Classification of Melone, Ch.P. Intra-articular Fractures*[31]

Type	*Fracture pattern*
Type 1	Minimal comminution, stable
Type 2	Comminuted - Stable, displacement of medial complex: ® post: die punch Barton ® ant: Smith 2
Type 3	Displacement of medial complex as a unit + anterior spike
Type 4	Wide separation or rotation of the dorsal fragment and palmar fragment rotation

12. *Classification of Castaing and Le Club.(1964)*[32]

Type	*Fracture pattern*
Type 1	Compression - extension (posterior displacement) *Pouteau, Colles *With postero-medial fragment complex a) Sagittal T b) with medial component c) with lateral component d) postero-lateral rim isolated or complex e) frontal T f) cross lines in two planes g) comminuted h) undisplaced
Type 2	Compression - flexion *Goyrand-Smith *Anterior rim isolated or anterolateral *Complex anterior rim isolated or anterolateral *Complex anterior rim,
Type 3	Associated osteoarticular injuries *Ulnar styloid *Ulnar head *Ulnar neck *Radioulnar dislocation *Radioulnar diastasis *Carpal injuries *Other injuries of the upper limb *Open fracture *Bilateral
Type 4	Non classified

13. *Classification of Cooney, Universal Classification of Distal Radius Fractures*[30]

Type	***Fracture pattern***
Type 1	Articular Un-displaced
Type 2	Non articular* Reducible ** Reducible * Irreducible Displaced Stable Unstable
Type 3	Articular Non-displaced
Type 4	Non articular* Reducible ** Reducible * Irreducible Displaced Stable Unstable * (by ligamentotaxis only)

14. *Classification of Mathoulin, C., Lestrsne, E., Saffar, P*[33]

Type	**Fracture pattern**
Type 1	1 Articular line in the coronal plane - Barton, reverse Barton's
Type 2	1 Articular line in the sagittal plane involving: a) scaphoid facet b) lunate facet c) radioulnar joint
Type 3	2 Lines associated: a) One extra-articular horizontal b) One intra-articular = type 2a,b +/- other fragments or dorsal comminution (T- fractures, die punch)
Type 4	3 Lines associated: a) one extra-articular horizontal b) two articular, one coronal, one sagittal (postero-medial fragments, T-frontal and sagittal

New yardstick to orthopaedic residents

Our endeavour on the topic of distal radius fractures has devised a unique and dynamic protocol particularly for the orthopaedic residents who see majority of distal radius fractures that too in the start of the orthopaedic understanding. We have given the name of *Barzullah Working Classification* of distal radius fractures to this endeavour which has proved very useful and handy to our residents. The new *Barzullah Working Classification* is originally modification of Melone classification. Our classification is simple to remember and reproduce and it is also hierarchal, as the fracture complexity increases with advancing class of fracture. In addition our new classification guides regarding the management of a particular fracture type, so reducing the forthcoming loss of reduction and poor outcome of these fractures. It is prognostic classification as well, as can predict the likely outcome of a particular fracture type.

We have included definite instability criteria's to differentiate between stable and unstable fracture patterns and this becomes the basis for line of treatment to be given. The instability criteria's are for all types of fractures patterns and presence of one or more unstable criteria makes any fracture unstable. These criteria's are;

a. Dorsal comminution involving two-third to three-fourth cortex
b. Fracture volar buttress plate
c. Fracture Angulations >20°
d. Articular step >2mm
e. Radial shortening >5mm and
f. DRUJ incongruity

Distal end radius fractures are classified according to the ***Barzullah Working Classification*** system into:

Location	***Type and Fracture pattern***
Metaphyseal fractures	**Type I. STABLE FRACTURE** (extra-articular DRF without unstable fracture criteria)
	Type II UNSTABLE FRACTURE (extra-articular DRF with one or more unstable criteria
Radiocarpal fractures	**Type III. STABLE FRACTURE** (intra-articular DRF with no unstable fracture criteria)
	Type IV. UNSTABLE FRACTURE (intra-articular DRF like carpal fracture-dislocation, Barton fractures and Chauffeur fractures)

X- Rays showing different types of distal end radius fractures based on Barzullah working classification

Figure 1 Type I Metaphyseal Stable

Figure 2 Type II Metaphyseal unstable

Figure 3 Type III Radiocarpal Stable

Figure 4 Type III Radiocarpal Unstable

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