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A Stepwise Approach for Interpretation of Wrist X-Ray: A Practical Guideline

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Background

Wrist trauma is a common cause of visits to orthopaedic emergency room, which includes more than 20% of trauma cases (1). Mild or subtle trauma to the wrist can lead to carpal instability and it may finally lead to degenerative changes of the wrist and severe collapse (2). So, although it is easy to detect gross fractures and injuries, considering the anatomic complexity of this joint and the important role of soft tissue elements (especially ligaments) in the stability of the wrist, the interpretation of the wrist radiograph has its own merits. The goal of this article is to provide a practical and stepwise guideline for systematic interpretation of the wrist radiography with more focus on carpal instability.

Step 1. Positioning and Standard Technique

The first step in radiological evaluation of the wrist is to have a standard package of images. These series consist of:

1. Posteroanterior (PA) view
2. True lateral view
3. External oblique view
4. PA view in ulnar deviated wrist (3) (Table 1)

By the findings from physical examination and reviewing standard views, decision could be made whether or not to obtain other views.

PA View

It must be taken while the wrist and elbow both are at shoulder level and shoulder is in 90 degrees abduction and elbow in 90 degrees of flexion (Figure 1).

Figure 1. Standard position for wrist posteroanterior (PA) view

It is the only position that radius and the ulna are parallel to each other. Forearm, wrist, and hand should be in neutral position. This position prevents any rotation of radius and ulna and allows accurate investigation of the relationship between carpal bones and the length of bones (4).

True Lateral View

This image is taken with the arm adducted to the side. Shoulder, elbow, and wrist are again in one line. Elbow is flexed to 90 degrees and again wrist and forearm are in neutral position (5) (Figure 2). This positioning will make the lateral and PA view exactly perpendicular to each other.

Table 1. Positioning and acceptability criteria for standard wrist x-ray series

View	Position	Acceptability condition
PA View	Shoulder 90 degree abduction Elbow 90 degree flexion Wrist and forearm neutral	ECU groove radial side to styloid of ulna
Lateral	Shoulder adduction Elbow 90 degree flexion Wrist and forearm neutral	Pisiform volar cortex between scaphoid and capitate volar cortices by equal distances
External oblique	Ulnar side of the wrist on the table Radial side 30 degree tilted and elevated	Trapezio-trapezoidal joint must be visible
Scaphoid view	In the PA position Wrist 30 degree ulnar deviated	No overlap of radius on the scaphoid Whole length of scaphoid should be visible

ECU: Extensor carpi ulnaris; PA: Posteroanterior

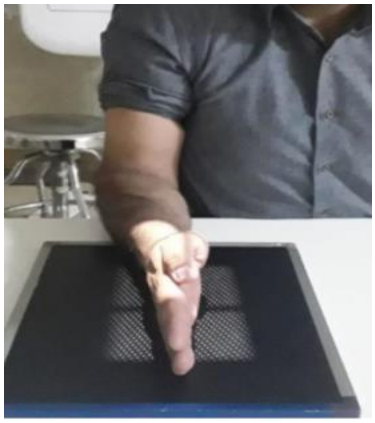

Figure 2. Standard position for wrist lateral view

External Oblique View

This view is obtained while the radial side of wrist is tilted from the film by 30 degrees and the ulnar side is just on the table (Figure 3).

This is the only one in the package that checks the trapezio-trapezoidal joint. Also, this is useful in diagnosis of fractures of scaphoid waist and tubercle and dorsal margin of triquetrum (6).

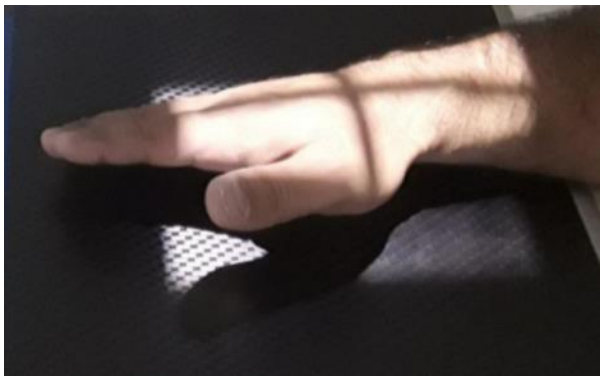

Figure 3. Positioning for wrist external oblique view

Scaphoid View

Obtaining a PA view in an ulnar deviated wrist (Figure 4) can show the scaphoid bone and its fractures much better. In ulnar deviation of the wrist, distal part of scaphoid bone moves dorsally and its length appears more accurately (7).

Figure 4. Scaphoid view position

Step 2. Identifying True Images

First step in interpretation of any x-ray image is to determine whether it is a true view or not.

In a correctly-positioned PA view, the extensor carpi ulnaris (ECU) groove lies just radial to the midline of the ulnar styloid process (Figure 5).

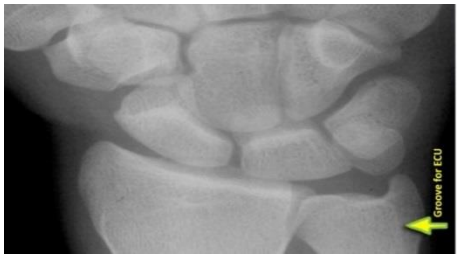

Figure 5. True posteroanterior (PA) view

Also, a line drawn through the head and base of the 3rd metacarpal should pass through the center of capitate, radial aspect of lunate, and center of lunate fossa of distal radius (8) (Figure 6).

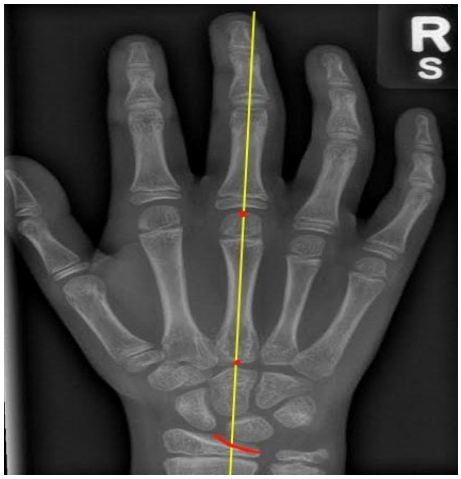

Figure 6. Normal axis of 3rd metacarpal, capitate, lunate, and lunate fossa are aligned

For a lateral view to be correct, palmar cortex of pisiform should be centrally located between volar cortices of the capitate and scaphoid (9) (Figure 7).

Figure 7. Pisiform location in a true lateral wrist x-ray (P: Pisiform; C: Capitate; S: Scaphoid)

In addition, anatomical axis of 2nd metacarpal should pass through capitate, lunate, and radius; and scaphoid will lie in an angle of 45 degrees to this line (8) (Figure 8).

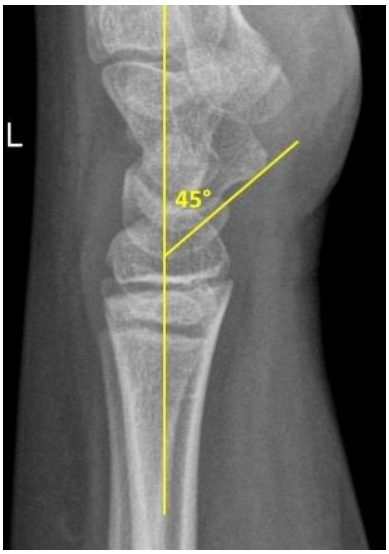

Figure 8. True lateral view (note the axis of scaphoid)

Step 3. Joint Spaces

Normally intercarpal joint spaces are symmetric and parallel and bones are separated by a space of 2 mm or less (Figure 9). Any overlap between carpal bones, except for pisiform and triquetrum, definitely suggests abnormality but joint diastasis should not be considered as pathology unless it is asymmetric (10).

Figure 9. Parallel and symmetric joint spaces

Gaps more than 3 mm are considered suspicious and if more than 5 mm, they are diagnostic for a pathology (11).

In a borderline condition or when there is clinical suspicion of disruption of carpal ligaments, clenched fist view can be diagnostic by accentuating the widening of joint spaces (Figure 10). In scapholunate dissociation, this widening is called "Terry-Thomas sign".

In non-traumatic conditions, joint spaces more commonly become narrow. In wrist osteoarthritis (OA), the quantitative joint space measurement shows a good relation with clinical condition (12).

Figure 10. Terry-Thomas sign. A: Posteroanterior (PA) view shows disrupted gilula line but no widening in joint spaces; B: Clenched fist view of the same patient reveals widening of scapholunate space.

Step 4. Carpal Arches

In a normal wrist, proximal and distal outlines of proximal carpal row and proximal outline of distal row are smooth and parallel (so-called Gilula lines) without any breaks in their continuity or step-off (9) (Figure 11).

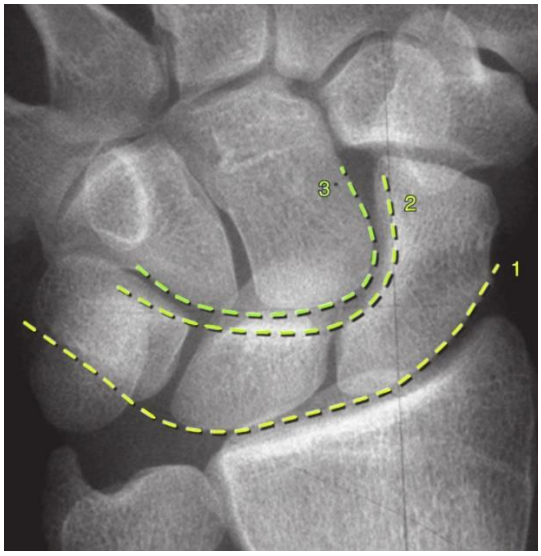

Figure 11. Gilula lines

Any disruption or step-off in these lines is an indicator for pathology in that location.

In lunotriquetral dissociation, usually a break in the ulnar side of proximal carpal row is the only finding (11).

Step 5. Carpal Height Measure

Carpal height measurement is a method for diagnosing carpal collapse and by several ways it can be calculated (13). Carpal height ratio (CHR) is measured by dividing the distance between the distal end of radius and base of the 3rd metacarpal bone (so-called carpal height) by length of 3rd metacarpal (Figure 12).

Values above 50% are considered normal and values below 45% are indicative of carpal collapse.

Figure 12. Carpal Height Ratio (CHR) Calculated by CH/ML (CH: Carpal height; ML: Metacarpal lenght)

Revised CHR (RCHR) (14) and capitate radius distance (CR index) (13) are two alternative measures for diagnosing carpal collapse.

RCHR is calculated by dividing carpal height by the greatest length of capitate (capitate length) (Figure 13). Normal range is 1.57 ± 0.05 in this method.

Figure 13. Revised Carpal Height Ratio (RCHR) (CL: Capitate lenght; CH: Carpal height)

CR index (Figure 14) is a new manner and is calculated by measuring the least distance between the distal end of radius and proximal end of the capitate and values below 0.92 cm are considered to be abnormal (15).

In this step, shape of two bones, lunate and scaphoid, should be our focus and any abnormality must be recognized.

Figure 14. Capitate Radius (CR) Distance

Step 6. Shape of Bones

A. Lunate

Normally lunate has a trapezoidal shape in PA view with converging sides from proximal to distal. In carpal instability or lunate and perilunate dislocation, lunate shape changes to a triangular one, so-called "piece of pie" sign (Figure 15).

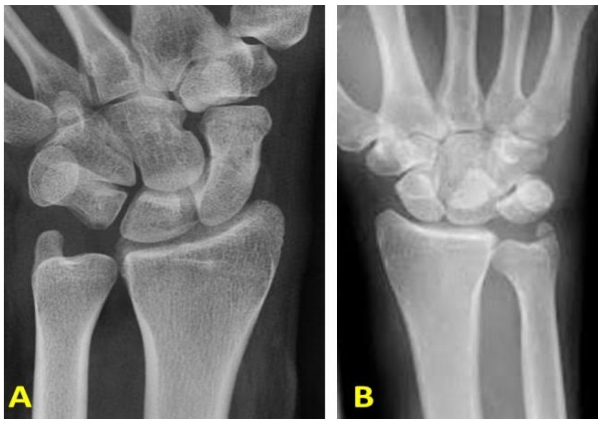

Figure 15. A: Normal Lunate Shape; B: Piece of Pie Sign

It should be noted that during wrist flexion and extension, lunate coordinately moves and it causes a change in the shape of lunate to a triangular one, that is not pathologic (16, 17) (Figure 16).

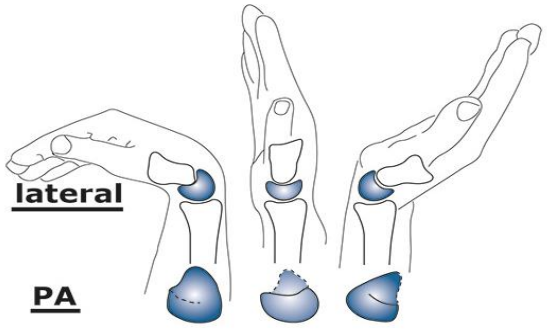

Figure 16. Lunate Motion and Change in Shape during Flexion and Extension (PA: Posteroanterior)

B. Scaphoid

Scaphoid bone shape depends on its position and position of wrist. During flexion and extension of the wrist, scaphoid follows these movements; on the other hand, during radial and ulnar deviation of the wrist, scaphoid moves to flexion and extension, respectively (17).

When the scaphoid bone is flexed, as a consequence of scapholunate dissociation or during wrist radial deviation, in PA view a "signet ring" or "cortical ring" sign may appear (18) (Figure 17).

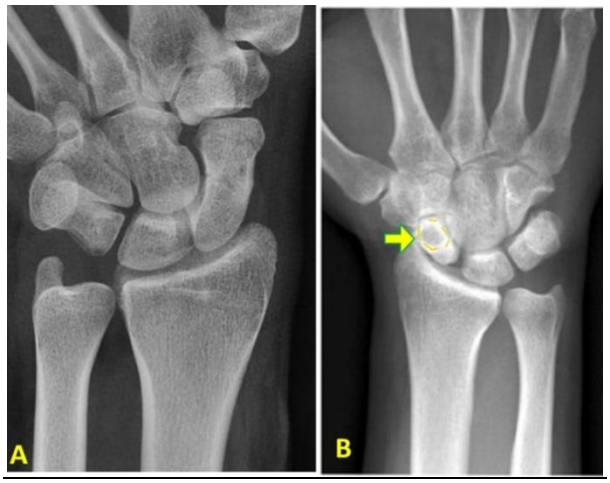

Figure 17. A: Normal Scaphoid Shape; B: "Signet Ring" or "Cortical Ring" Sign

To identify whether or not this sign is due to scapholunate ligamentous tear, distance between the proximal end of the ring and proximal end of the scaphoid, so-called “cortical ring distance”, can be measured. Values below 7 mm or values 4 mm shorter than contralateral wrist are considered to be due to this pathology (19).

Step 7. Axis of Bones and Angles

The final step in interpretation of a wrist x-ray, focused on carpal structure, is to determine the axis of bones and angles between them. These parameters are measured in lateral view and show the relationship between carpal bones.

Scaphoid Axis: A line tangential to the proximal and distal poles of the scaphoid bone (Figure 18-A)

Lunate Axis: A line perpendicular to the line that connects volar and dorsal lips of lunate (Figure 18-B)

Capitate Axis: A line between midpoint of proximal end of 3rd metacarpal and midpoint of proximal pole of capitate (Figure 18-C)

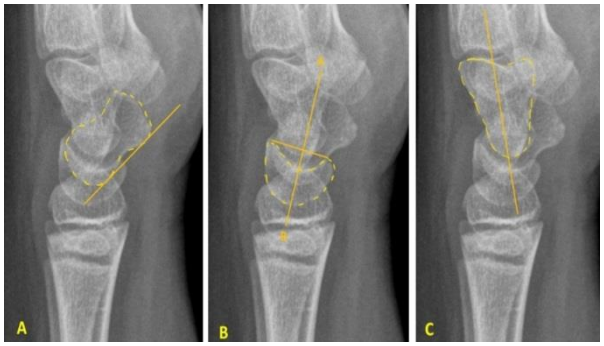

Figure 18. Carpal Bone Axes. A: Scaphoid Axis; B: Lunate Axis; C: Capitate Axis

Intercarpal Angles

Angles between the axes named above are measured in true lateral view. Normal values and pathologic ranges are listed below (3, 11, 19) (Figure 19).

A. Scapholunate Angle:

Normal: 45 degrees

Range: 30 to 60 degrees

B. Capitolunate Angle

Normal: 15 degrees

Pathologic: More than 15 to 20 degrees

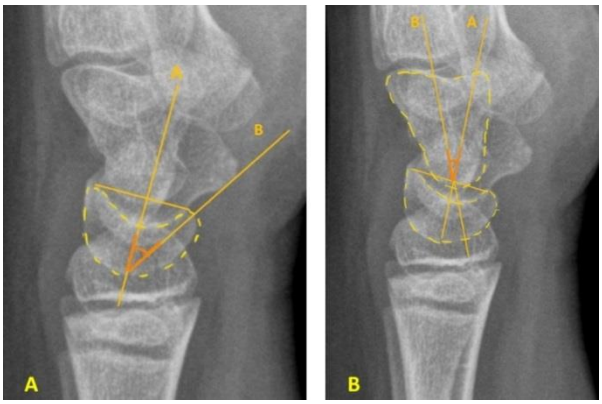

Figure 19. A: Scapholunate Angle between Line A (Lunate Axis) and B (Scaphoid Axis); B: Capitolunate Angle between Line A (Lunate Axis) and Line B (Capitate Axis)

The most common use of these angles is to differentiate between different types of carpal instability [volar intercalated segment instability (VISI) and dorsal intercalated segment instability (DISI)] and displacement or deformity in scaphoid fractures (3).

Summary

Interpretation of wrist x-rays could be somewhat complex, due to the complexity of this joint. In this paper, a stepwise approach (Figure 20) was designed to facilitate this and to prevent important parts being missed, especially in emergency conditions.

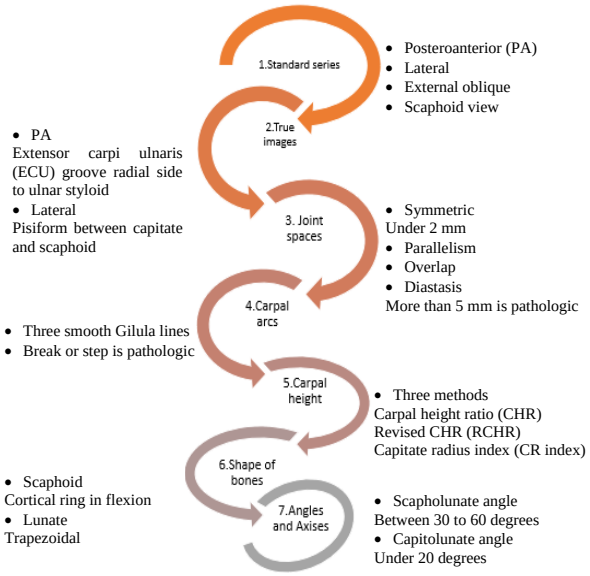

Figure 20. Summerized Approach

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

None.

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