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Imaging of the Elbow or Proximal Forearm

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Abstract

The elbow is where the arm and forearm meet anatomically. While the elbow adjusts the height and length of the extremity as well as the position of the hand to effectively perform prehensile tasks, the shoulder is used to position the upper extremity anywhere within the broad range of its mobility.

Clinicians working to treat damage and dysfunction at these joint face particular difficulties since the elbow has three distinct synovial articulations housed within a single joint capsule.

Keywords: Mobility, Humerus, Joint Capsule.

Introduction

The distal humerus, proximal ulna, and proximal radius are the bones that make up the elbow joint. The humero-ulnar joint is where the humerus and ulna articulate. The humero-radial joint is where the humerus and radius articulate.

The proximal radio-ulnar junction is the point where the proximal parts of the ulna and radius meet. The elbow joint is made up of these three distinct articulations that are contained within a single joint capsule.

The following views can considerably aid fluoroscopic vision of anatomical fracture reduction and proper implant placement for the proximal forearm:

A. AP view of the proximal forearm
B. Lateral view of the elbow
C. Oblique view of the proximal forearm
D. Axial view of the proximal forearm
E. AP view of proximal radio-ulnar joint

The following represent ideal imaging with the patient placed in the supine position. The posture of the arm and forearm remain the same for patients in lateral decubitus and prone positions.

The orientation of the C-arm has to be adjusted accordingly.

A. AP view of the proximal forearm

Positioning for optimal view

1. Shoulder is in 90° abduction and neutral rotation
2. The elbow is in full extension
3. The forearm is in full supination
4. The beam is placed perpendicular to the forearm

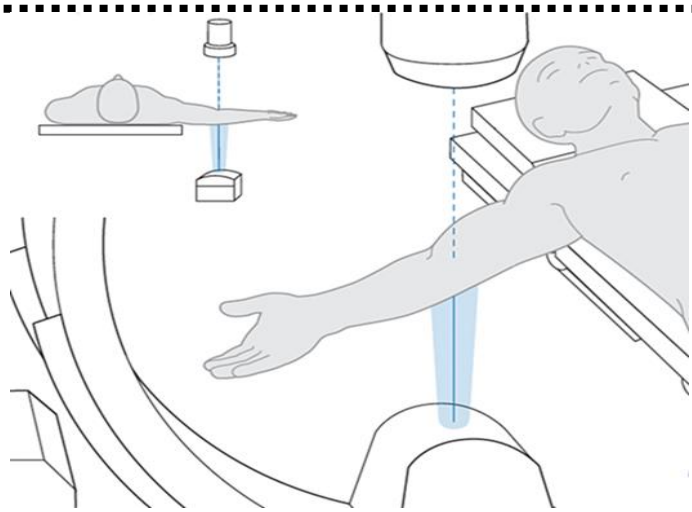

Figure 1: Positioning for optimal AP view

In case the elbow cannot be fully extended (e. g 20° flexion) the AP view can be compensated by extending the shoulder as illustrated (e. g 20°).

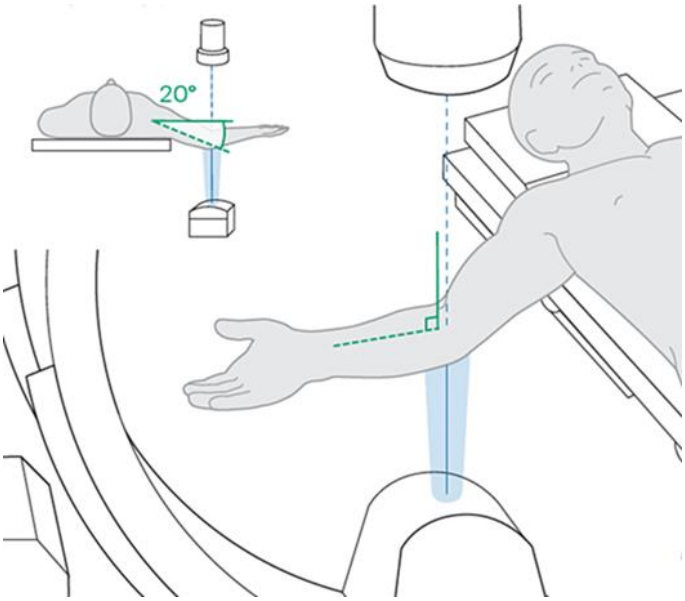

Figure 2: Positioning for optimal AP view

Verification of optimal view

The optimal view is obtained when the:

1. Ulnohumeral joint lines are congruent

2. Tip of coronoid is midway between the radial and ulnar borders of the proximal ulna

Anteromedial facet coronoid is visible.

Figure 3: Optimal AP view

Anatomical landmarks and lines

The following lines and landmarks can be observed:

1. Joint line of distal humerus
2. Joint line of proximal ulna and radius
3. Antero-medial facet of coronoid
4. Tip of coronoid (arrow-head)
5. Radial border of proximal ulna
6. Ulnar border of proximal ulna

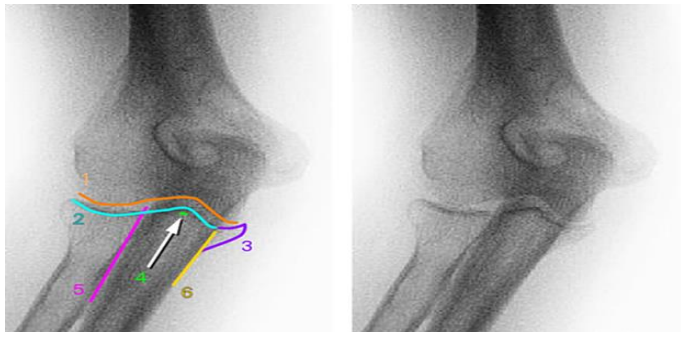

Figure 4: Anatomical lines and landmarks in AP view

What can be observed?

This view is particularly useful to identify:

1. Fractures and malalignment of ulnohumeral joint, radial head (rotate through pronation and supination range), anteromedial facet and tip of coronoid, and olecranon

2. Implant malposition Ing on the proximal ulna and radial head.

B. Lateral view of the elbow

Positioning for optimal view

1. Shoulder in 90° abduction and 90° internal or external rotation. (In cases with restricted shoulder motion, the beam can be rotated as needed)
2. The elbow is flexed 90°
3. The forearm is in neutral rotation
4. The beam is placed perpendicular to the humerus and the forearm

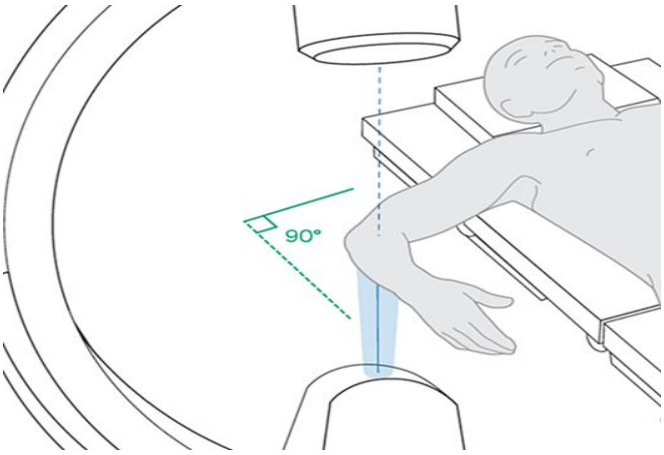

Figure 5: Positioning for optimal Lateral view

Verification of optimal view

The optimal view is obtained when:

1. Ulnoradiohumeral joint space is visible (Note: the joint line between olecranon tip and olecranon fossa cannot be assessed on this view)
2. Radial head and coronoid process are aligned
3. The axis of the proximal radial shaft is aligned with the centre of the capitellum

Figure 6: Optimal optimal lateral view

Anatomical lines and landmarks

The following lines and landmarks are seen:

1. Joint line of radial head
2. Joint line of coronoid process
3. Proximal ulnar dorsal angle (PUDA)
4. The anterior cortex of humerus bisects the circular projection of the trochlea
5. The axis of the proximal radial shaft is aligned with the centre of the capitellum

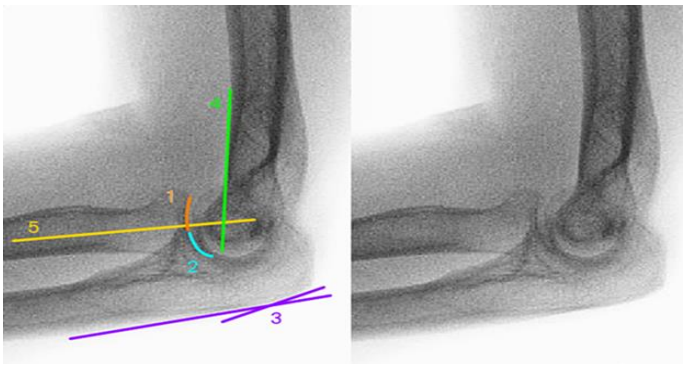

Figure 7: Anatomical lines and landmarks in the lateral view

What can be observed?

This view is particularly useful to identify:

1. Fracture reduction with correct alignment of PUDA and radial shaft alignment with capitellum
2. Joint incongruency (step off, gap, subluxation)
3. Implant positioning on the radial head and proximal ulna

C. Oblique view of the proximal ulna

1. Shoulder in 90° abduction and 20-30° extension (the beam needs to be 60-70° to the axis of the humerus)
2. The humerus is rotated internally 30°

Intraoperative imaging

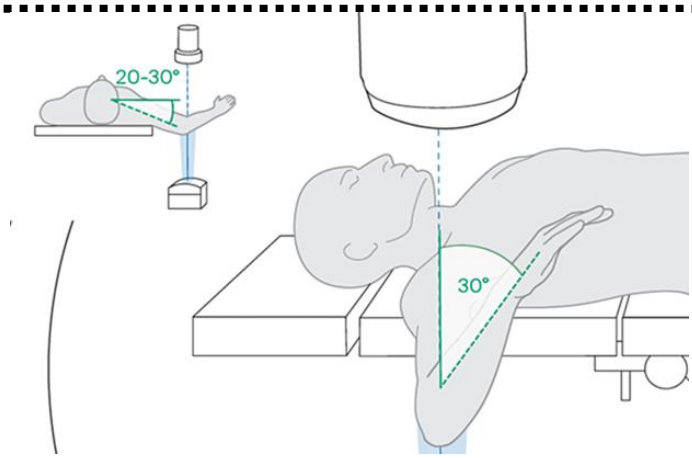

Figure 8: Oblique view of the proximal ulna

1. The elbow is flexed 30-45°
2. The forearm is in neutral rotation

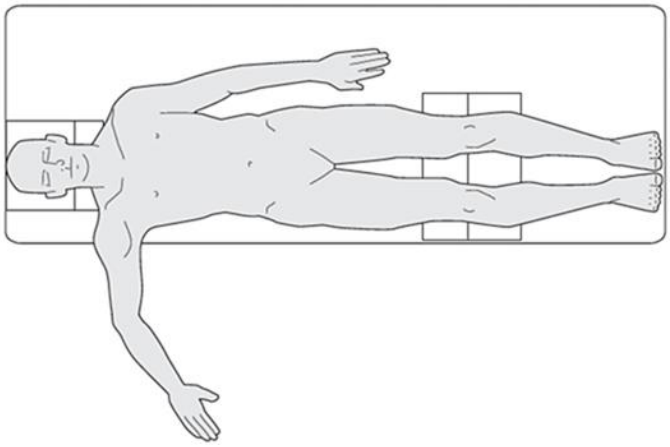

Figure 9: Positioning for optimal oblique view

Verification of optimal view

1. The radial head is superimposed on the proximal ulna and has to project posteriorly to assess the coronoid process.
2. The humerus is rotated internally until the olecranon, the tip of the coronoid and the anteromedial facet of the coronoid are visible.
3. Overlap of distal humerus with the tip of the coronoid can be avoided by bringing the elbow into extension.

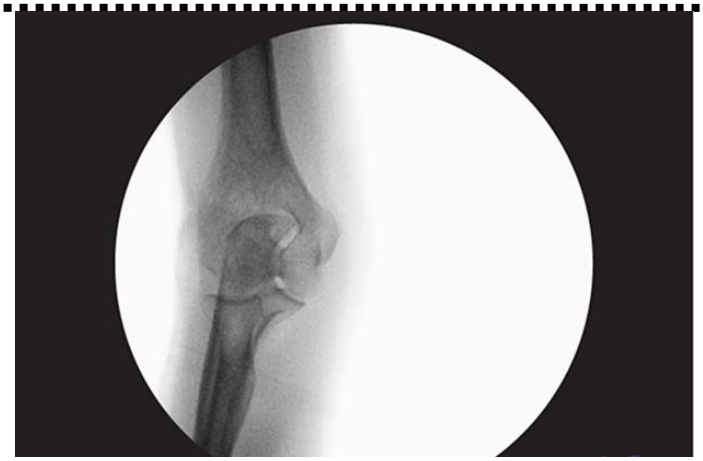

Figure 10: Optimal oblique view

Anatomical landmarks and lines

The following lines and landmarks can be observed:

1. Medial edge of greater sigmoid notch with the tip of olecranon
2. Coronoid tip
3. Antero-medial facet of the coronoid process

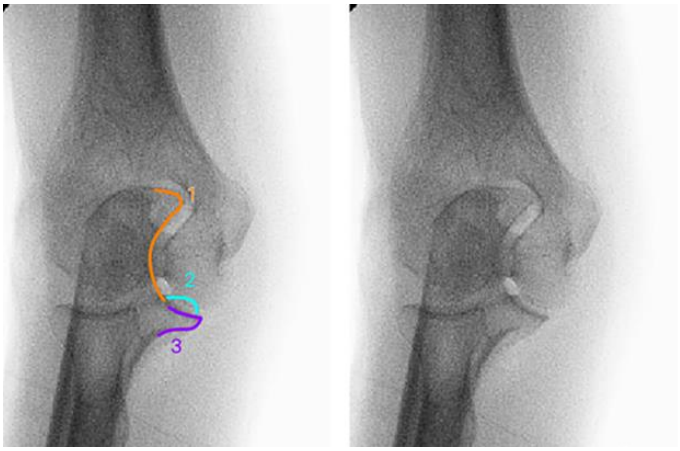

Figure 11: Anatomical lines and landmarks in the oblique view

What can be observed?

This view is particularly useful to identify:

1. Fractures and malalignment of coronoid tip or antero-medial facet
2. Penetration of screws into the ulnohumeral joint space
3. Implant malposition

D. Axial view of the proximal forearm

Positioning for optimal view

1. Shoulder in 90° abduction and neutral rotation

2. The elbow is flexed as much as possible
3. The forearm is in neutral position
4. The beam is placed perpendicular to the humerus (and in the plane created by the humerus and the forearm)

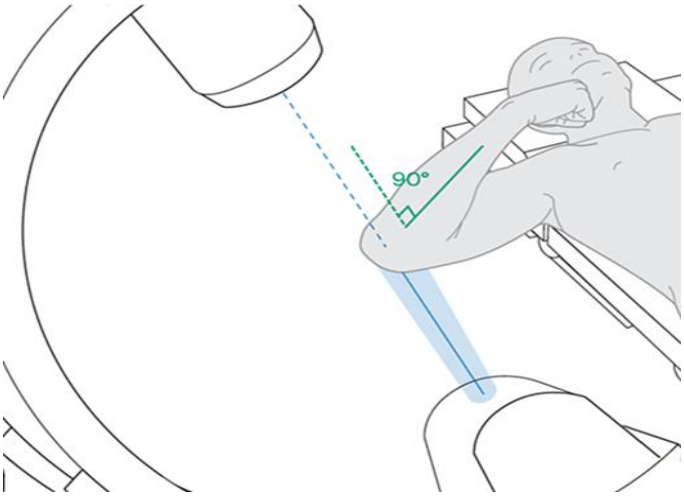

Figure 12: Positioning for optimal axial view

Verification of optimal view

The optimal view is obtained when the:

1. Elbow is completely flexed
2. Olecranon tip is cantered and congruent with the distal humeral joint line

Figure 13: Optimal axial view

Anatomical landmarks and lines

The following lines and landmarks can be observed:

1. Posterior trochlear joint line
2. Anterior trochlea joint line
3. Radial head joint line
4. Coronoid process joint line
5. Olecranon tip
6. Capitellum

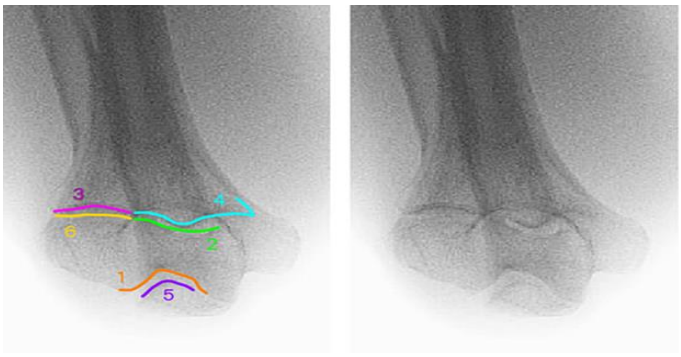

Figure 14: Anatomical lines and landmarks in the axial view

What can be observed?

This view is particularly useful to identify:

1. Screw penetration into the ulnohumeral joint
2. Joint incongruency
3. Intraarticular fracture malreduction

E. AP view of proximal radio-ulnar joint (PRUJ)

Positioning for optimal view

1. Shoulder in 90° abduction and 20-30° external rotation
2. The elbow is in full extension
3. The forearm is in full supination
4. The beam is placed perpendicular to the forearm (but 20-30° to the plane created by the humerus and the forearm)

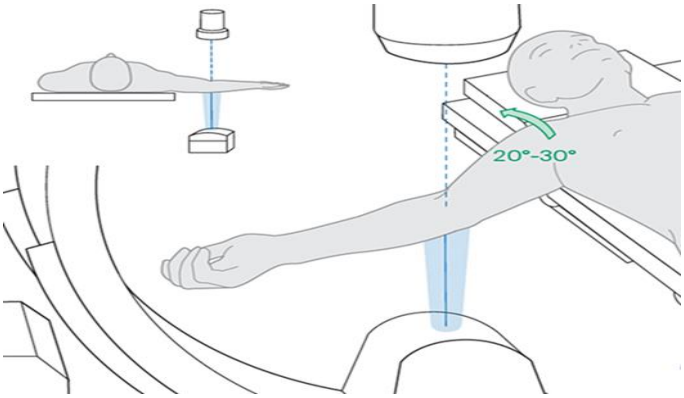

Figure 15: Positioning for optimal AP view PRUJ

In case the elbow cannot be fully extended (e. g 20° flexion) the AP view can be compensated by extending the shoulder as illustrated (e. g 20°).

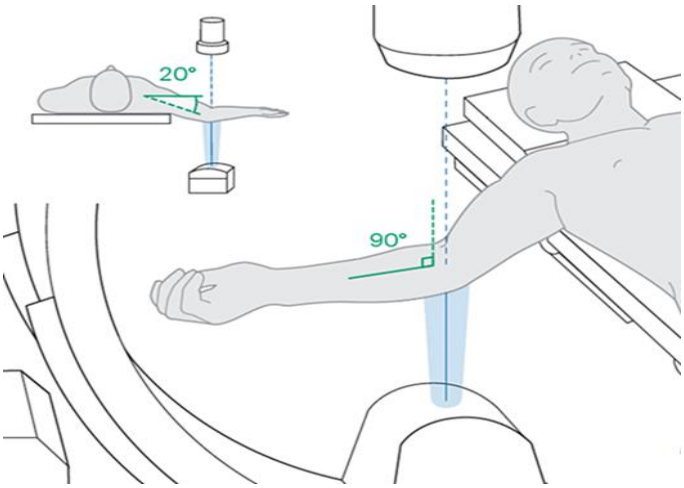

Figure 16: Intraoperative imaging

Verification of optimal view

The optimal view is obtained when the:

1. Anterior and posterior edge of sigmoid notch form one line
2. Supinator crest is visible
3. Radial tuberosity is visible
4. Curvilinear shape from PRUJ to radial tuberosity

Figure 17: Optimal AP view PRUJ

Anatomical lines and landmarks

The following lines and landmarks can be observed:

1. Joint line of radial head at the proximal radio ulnar joint (PRUJ)
2. Joint line of sigmoid notch of ulna at PRUJ
3. Supinator crest of the ulna
4. Radial tuberosity

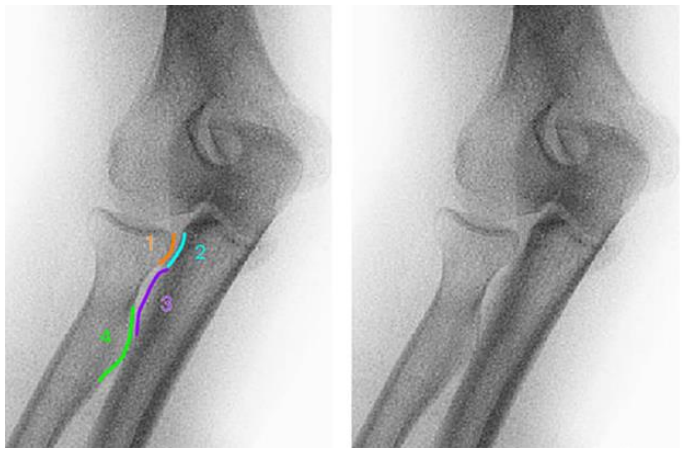

Figure 18: Anatomical lines and landmarks in AP view PRUJ

What can be observed?

This view is particularly useful to identify:

1. Fractures and malalignment of the radial head (check from supination to pronation) and PRUJ
2. Implant malposition Ing on the radial head and proximal ulna (with respect to PRUJ)

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Declarations

Informed consent

Informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

"Institutional Ethical Committee Approval"

Taken from Institutional Ethical Approval Committee, MGM Medical College & Hospital, Navi Mumbai, Maharashtra, India.

Availability of data and materials

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32. Fluoroscopy of the Elbow A Cadaveric Study Defining New Standard Projections to Visualize Important Anatomical Landmarks Sebastian A. Muller, MD, Lars Adolfsson, MD, Cornelia Baum, MD, Magdalena M ¨ uller-Gerbl, MD, ¨ Andreas M. Muller, MD, and Daniel Rikli, MD. JBJS Open Access d 2021: e20.00160. http://dx.doi.org/10.2106/JBJS.OA.20.00160