Learning objectives

To understand and apply the different radiological techniques for assessing Distal Radioulnar Joint instability using standard radiographs, MRI, ultrasound and dynamic CT imaging.

Background

Distal radioulnar joint (DRUJ) instability is an important cause of ulnar sided wrist pain, often associated with distal radial fractures. DRUJ instability can also manifest as an isolated injury and is occasionally seen in the context of DRUJ arthritis.

DRUJ instability is often underappreciated both clinically and radiologically, leading potentially to long-term morbidity if the diagnosis is missed.

By convention, the stability of the DRUJ is described by the relationship of the distal ulnar to the radius with dorsal subluxation being more common than volar. Several radiological techniques exist to assess the stability of the DRUJ, including plain radiographs, ultrasound and dynamic CT. Multiple different evaluation methods using dynamic CT have been proposed to measure the degree of dorsal or volar translation of the distal ulnar relative to the radius.

The technical details of these different techniques and lack of a standardised methodology can be confusing for both radiologists and clinicians when assessing patients suspected of having DRUJ instability.

In this review, we look at the main radiological techniques used to assess for DRUJ instability with the aim of clarifying the technical details and increasing the reliability of using the different methods available.

Imaging findings OR Procedure Details

Radiography
Plain radiographs can be helpful in identifying features suggestive of DRUJ subluxation secondary to DRUJ instability. Dorsal subluxations are most common and result from a fall onto a pronated hand, while volar subluxations occur less frequently, usually from forced supination.

Radiographic features suggestive of instability include widening of the radioulnar joint on the AP view, significant shortening of the radius, fracture at the base of the ulnar styloid or obvious dislocation on the lateral view.

On a true lateral view of the wrist, a radiolunar distance, as measured by the dorsal projection of the distal ulnar beyond the dorsal cortex of the radius should not measure more than 6mm (Fig. 1 on page 7).

**MRI**

MRI findings in DRUJ instability are dependent on the relevant mechanism involved and include an abnormal relationship of the distal ulnar with the sigmoid notch. Other findings may include ligamentous and capsular injuries such as disruption of the radioulnar ligaments (Fig. 2 on page 9).

**Dynamic Computed Tomography**

Dynamic CT evaluation performed with the wrist in supination, neutral and pronation can be used to diagnose subluxation of the DRUJ. A number of different methods have been proposed, each of which have been reported to demonstrate or quantify DRUJ instability. Park et al. evaluated these methods in normal subjects to quantify the normal range.

We describe the dynamic CT protocol and use example cases to demonstrate the different calculation methods used to assess DRUJ instability.

**Dynamic CT Protocol**

At our local institution patients are scanned prone with both arms overhead (superman position) in the pronated (Fig. 3 on page 9) supinated (Fig. 4 on page 1)
and neutral position (Fig. 5 on page 11). 0.63mm axial slices are acquired with no reformatfs required (pronated and supinated at approximately 70°) (Fig. 6 on page 12).

Measurement methodology

1. The Subluxation Ratio Method

A line is drawn through the dorsal and volar margins of the sigmoid notch. Two perpendicular lines are drawn though the dorsal and volar margins of the sigmoid notch. The distance that the ulnar head lies either dorsal or volar to these lines is measured with the ratio of this distance to the distance of the sigmoid notch calculated.

Dorsal displacement is recorded as positive and volar translation as negative.

Comment on method:

Selection of the dorsal and volar sigmoid notch points are relativley consistent with lines perpendicular to the sigmoid notch used to assess the presence of subluxation. This allows for a more reproducible method with lower interobserver variation. As such, this is the method we use in our unit.

The normal values for measuring translation of the DRUJ are shown in table 1.

Table 1: Subluxation Ratio

<table>
<thead>
<tr>
<th>Wrist Position</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0.01</td>
<td>-0.25 to 0.26</td>
</tr>
<tr>
<td>Pronation</td>
<td>0.20</td>
<td>0.01 to 0.39</td>
</tr>
<tr>
<td>Supination</td>
<td>-0.13</td>
<td>-0.29 to 0.03</td>
</tr>
</tbody>
</table>

Example cases:

2 Example cases are shown using the Subluxation Ratio Method (Fig. 7 on page 13 & Fig. 8 on page 14)
2. The Radioulnar Line Method

The distance that the ulnar head lies either dorsal or volar to lines drawn through the dorsal and volar aspects of the ulnar and radial borders of the radius is measured with the ratio of this distance to the distance of the sigmoid notch calculated. Initially described as abnormal if the position of the ulna crossed these lines, but the degree of displacement has subsequently been quantified.

Dorsal displacement is recorded as positive and volar translation as negative.

Comment on method:

Whilst this method is the simplest, selection of the position of the dorsal and volar lines is subjective, resulting in potential false positives and interobserver variability.

The normal values for measuring translation of the DRUJ are shown in table 2.

Table 2: Radioulnar Line

<table>
<thead>
<tr>
<th>Wrist Position</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0.02</td>
<td>-0.22 to 0.26</td>
</tr>
<tr>
<td>Pronation</td>
<td>0.16</td>
<td>0.00 to 0.35</td>
</tr>
<tr>
<td>Supination</td>
<td>-0.11</td>
<td>-0.27 to 0.00</td>
</tr>
</tbody>
</table>

Example cases:

Example cases are shown using the Radioulnar Line Method (Fig. 9 on page 15 & Fig. 10 on page 16)

3. The Epicentre Method

The halfway point between the centre of the styloid process to the centre of the ulnar head is marked. A line is drawn from this point perpendicular to a line drawn through the dorsal and volar margins of the sigmoid notch. The ratio of the distance between
this perpendicular line and mid point of the sigmoid to the length of the sigmoid notch is calculated $^6$.

Dorsal displacement from the midpoint is recorded as positive and volar translation as negative.

**Comment on method:**

This method relies on the identification of the axis of rotation of the DRUJ, which has the advantage of minimising the effect of normal translation of the ulnar head during rotation of the forearm. However, this method is dependent on the subjective selection of discreet reference points on the ulna head with the potential for error and variation in results $^2,^6$.

The normal values for measuring translation of the DRUJ are shown in table 3 $^2$

**Table 3: Epicentre**

<table>
<thead>
<tr>
<th>Wrist Position</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0.09</td>
<td>-0.09 to 0.23</td>
</tr>
<tr>
<td>Pronation</td>
<td>-0.01</td>
<td>-0.19 to 0.18</td>
</tr>
<tr>
<td>Supination</td>
<td>0.11</td>
<td>-0.01 to 0.21</td>
</tr>
</tbody>
</table>

**Example cases:**

2 Example cases are shown using the Epicentre Method (*Fig. 11 on page 17* & *Fig. 12 on page 18*)

**4. The Radioulnar Ratio Method**

Using concentric circles, the centre of the ulnar head is found. A perpendicular line is drawn from this point to a line drawn through the dorsal and volar margins of the sigmoid notch. The ratio of the distance from this point to the volar aspect of the sigmoid notch to the length of the sigmoid notch is calculated $^7$.

**Comment on method:**
This method has the advantage of eliminating the reliance on more subjective reference points such as the centre of the ulnar styloid and whilst sensitive in demonstrating early subluxation this is the most technically challenging method, making it less reliable\textsuperscript{2,7}.

The normal values for measuring translation of the DRUJ are shown in table 4\textsuperscript{2}.

\textbf{Table 4: Radioulnar Ratio}

<table>
<thead>
<tr>
<th>Wrist Position</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0.51</td>
<td>0.32 to 0.69</td>
</tr>
<tr>
<td>Pronation</td>
<td>0.66</td>
<td>0.48 to 0.86</td>
</tr>
<tr>
<td>Supination</td>
<td>0.42</td>
<td>0.28 to 0.52</td>
</tr>
</tbody>
</table>

\textbf{Example cases:}

2 Example cases are shown using the Radioulnar Ratio Method (\textbf{Fig. 13 on page 19} & \textbf{Fig. 14 on page 20}).

\textbf{Ultrasound}

DRUJ instability and associated surrounding soft tissue injuries can also be assessed using dynamic ultrasound with comparison to the normal contralateral side. However this method is highly subjective and potentially technically challenging. In addition, a clear objective measure of the degree of subluxation can be difficult to quantify.

\textbf{Images for this section:}
**Fig. 1:** Lateral radiograph of the wrist, which demonstrates 7mm of dorsal subluxation of the distal ulnar, suggestive of DRUJ instability.

**Fig. 2:** Axial T1-weighted fat suppressed MR of the right wrist shows dorsal displacement of the ulnar head, capsular high signal soft tissue thickening, extensor compartment tenosynovitis and a DRUJ effusion.
Fig. 3: Dynamic CT protocol: Pronated position

Fig. 4: Dynamic CT protocol: Supinated position
Fig. 5: Dynamic CT protocol: Neutral position
Fig. 6: Axial CT images demonstrating the different positions acquired during dynamic CT evaluation of the DRUJ
Fig. 7: Subluxation Ratio calculation in the neutral position = CD/AB. Distance AB = 14.4mm Distance CD = -1.5mm. Ratio = -1.5/14.4 = -0.10. This degree of volar displacement is within normal limits for the neutral position.
Fig. 8: Subluxation Ratio calculation in the pronated position = CD/AB. Distance AB = 14.7mm Distance CD = +7.3mm. Ratio = +7.3/14.7 = 0.50. This degree of dorsal displacement is outside normal limits for the pronated position.
**Fig. 9:** Radioulnar line calculation in the neutral position = CD/AB. Distance AB = 14.4mm Distance CD = -1.2mm. Ratio = -1.2/14.4 = -0.08. This degree of volar displacement is within normal limits for the neutral position.
**Fig. 10:** Radioulnar line calculation in the pronated position = CD/AB. Distance AB = 14.7mm Distance CD = +6.3mm. Ratio = +6.3/14.7 = + 0.43. This degree of dorsal displacement is outside normal limits for the pronated position.
**Fig. 11**: Epicentre calculation in the neutral position = CD/AB. Distance AB = 14.4mm Distance CD = +1.6mm. Ratio = +1.6/14.4 = + 0.11. This degree of dorsal is within normal limits for the neutral position.
Fig. 12: Epicentre line calculation in the pronated position = CD/AB. Distance AB = 14.7mm Distance CD = +3.5mm. Ratio = +3.5/14.7 = + 0.24. This degree of dorsal displacement is outside normal limits for the pronated position.
Fig. 13: Radioulnar Ratio calculation in the neutral position = AD/AB. Distance AB = 14.4mm Distance AD = 7.2mm. Ratio = 7.2/14.4 = 0.50. This is within normal limits for the neutral position.
Fig. 14: Radioulnar Ratio calculation in the pronated position = AD/AB. Distance AB = 14.7mm Distance AD = 13.7mm. Ratio = 13.7/14.7 = 0.93. This degree of dorsal displacement is outside normal limits for the pronated position.
Conclusion

Radiological assessment of DRUJ instability can be assessed using different methods. Familiarity with the different techniques is important to confidently make this frequently missed and important diagnosis.

References


Personal Information