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Computed tomography diagnosis of distal radioulnar subluxation

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Abstract. Eight patients with suspected diagnosis of distal radioulnar joint (DRUJ) subluxation underwent computed tomographic (CT) scans of the wrist. Five underwent surgery and had DRUJ subluxation or dislocation; CT scans revealed subluxation in four. Three CT criteria for the evaluation of DRUJ subluxation are discussed and compared in this manuscript.

Key words: Distal radioulnar subluxation – Wrist, trauma – Wrist, computed tomography – Wrist, pain – Wrist, radiography

The diagnosis of distal radioulnar joint subluxation is difficult. The symptoms and physical examination are often nonspecific, and the condition is impossible to confirm radiographically. Since computed tomography (CT) delineates the cross-sectional anatomy of the distal radioulnar joint (DRUJ), this technique can be utilized for the evaluation of suspected distal radioulnar joint subluxation. It became apparent to us that previously published criteria [7, 8] had its limitations. We therefore evaluated three CT methods for the assessment of DRUJ subluxation. Herein we discuss our findings and pitfalls in the diagnosis of distal radioulnar joint subluxation.

Methods and materials

Eight patients suspected of a distal radioulnar subluxation are reported (Table 1). Symptoms include loss of forearm rotation and clicking at the distal radioulnar joint, weakness of grip, and the feeling of wrist instability. Clinical instability led the referring physician to suspect distal radioulnar joint subluxation. The radiographic examination included an eight-view wrist series (posteroanterior roentgenography in neutral, fist-making, ulnar and radial deviation; and lateral roentgenography in neutral, fist-making, flexion, and extension), arthrography, and computed tomography.

The CT scan was obtained on a Technicare Delta 2020 Scanner with a scan time of 4 s, 120 kV, and 100 mA. The patient was instructed to place the affected wrist in a position that produced the symptoms or in which they felt the wrist to be "out". The normal wrist served as a control. One patient had a repeat scan following recurrence of symptoms after treatment for radioulnar subluxation. Five millimeter thick scans were obtained from above Lister tubercle through the carpus at 5 mm intervals. Thus, determination of subluxation could be made in addition to assessment of the proximal carpal bones and the presence of occult intra-articular bodies.

Three criteria were used to assess radioulnar joint subluxation.

1) Initially the dislocation was graded in the following manner. Since the distal radius rotates about its axis within the sigmoid notch of the ulnar, the center of distal radioulnar joint rotation was placed at a point halfway between the ulnar styloid process and the center of the ulnar head. A perpendicular line drawn from a line connecting the ventromedial aspect and dorsomedial aspect of the ulnar sigmoid notch (the chord of the sigmoid notch) to this point was drawn (Figs. 1A and 2). Radioulnar joint position was considered normal if the perpendicular fell in the middle half of the chord drawn across the sigmoid notch (grade 1). A mild subluxation of the ulnar head was diagnosed when the perpendicular fell on the outer 25% of the sigmoid notch chord (grade II), and a severe one when the perpendicular fell outside of the sigmoid notch chord (grade III). We called this method the epicenter method (Figs. 1A and 2).

2) Second, using Mino's criteria, a line was drawn through the dorsal border of the radius, and a second line through the palmar border of the distal radius [7, 8]. Articulation of the ulna with the radius was considered normal if the ulnar head was between these lines (Figs. 1B and 2).

3) A third method consisted in examining the congruity of the arcs made by the ulnar head and sigmoid notch. This was simply recorded as normal or abnormal (Figs. 1C and 2).

Figures 1 and 2 demonstrate the use of these criteria in the three different wrist positions. Any one of these criteria can be used in a supinated wrist, pronated wrist, or a wrist in neutral postion.

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Table 1. Clinical evaluation of eight patients with suspected distal radioulnar subluxation

Case	Side injured	Age (years), Sex	Mechanism of injury	Symptoms	Physical examination
1	Right	16, M	Fracture of radius and ulna (at age 6 years)	Loss of supination	Suggestive of dislocation
2	Right	26, F	Fracture of distal radius (at age 20 years)	Wrist pain worse with pronation	Suggestive of subluxation
3 (same as Case 2)	Right	26, F	Fracture of distal radius (at age 20 years)	Wrist pain	Swelling and tenderness of distal radioulnar joint
4	Right	38, F	Twisting of wrist	Ulnar wrist pain	Normal
5	Left	38, F	None	Painful mass over palm	Swelling and tenderness over hook of hamate
6	Right	18, F	Twisting of wrist (at age 11 years)	Ulnar wrist pain	Suggestion of subluxation
7	Left	23, F	Hit dorsum of wrist	Dorsal wrist pain	Suggestion of subluxation
8	Right	20, M	Roller wrist injury	Diffuse hand and wrist pain with swelling	Suggestion of subluxation

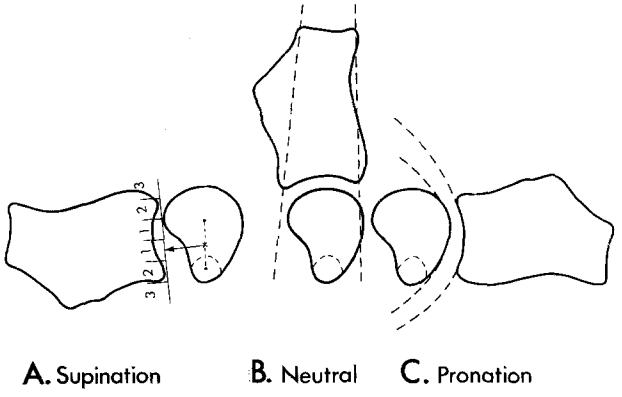

Fig. 1A–C. Methods for assessing radioulnar subluxation. **A** Epicenter method. A perpendicular is drawn from the center of rotation of the distal radioulnar joint (a point halfway between the ulnar styloid process and center of the ulnar head) to the chord of the sigmoid notch. It is considered normal if this line is in the middle half of the sigmoid notch. (The *dotted lines* represent the location of the styloid process which in many cases is extrapolated from contiguous distal scans). **B** Radioulnar line method. Articulation of the ulnar head with the radius is normal if the head falls between the two lines pictured above (see text). **C** Congruity method. Note congruity of the arc of the ulnar head with that of the sigmoid notch

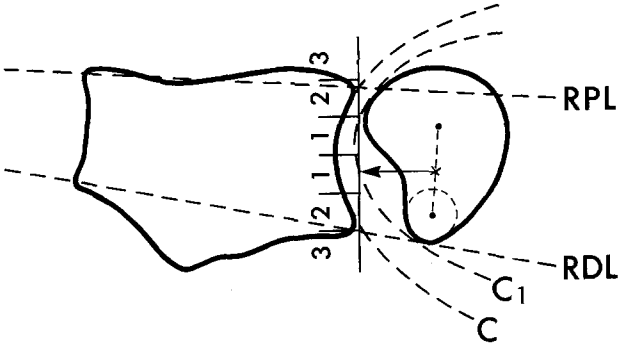

Fig. 2. This figure demonstrates the use of all three criteria in a normal supinated wrist. The ulnar head appears dislocated using Mino's criteria of radioulnar lines. (C=arc of the sigmoid notch, C_1=arc of the ulnar head, RDL=radiodorsal line, RPL=radiopalmar line)

Results

The results in of eight patients suspected of having a DRUJ subluxation are summarized in Table 2. After complete evaluation, three patients were considered normal and did not undergo surgery. Their radiographs were all normal. Using Mino's criteria of radioulnar lines, one CT scan was normal, one could not be assessed, and one was considered subluxated. The other two CT criteria (the epicenter and congruity methods) were normal in all these patients.

At surgery, four patients had dorsal radioulnar subluxation or dislocation and one had palmar subluxation. Using the epicenter method in evaluating these five patients, there were two normals and three subluxations. Using the radioulnar lines, there were four normals and one subluxation. The congruity method detected subluxation in four patients and none in one patient (Table 2). In one patient all three methods were normal; however, the CT scan had been done in supination, and at operation the wrist subluxated dorsally in pronation.

The clinically normal contralateral wrists of these patients served as normal controls. There was

Table 2. Radiological evaluation of eight patients with suspected distal radioulnar joint subluxation

Case	Radiographs	Computed tomography				Surgery
		Position	Radioulnar lines	Epicenter	Congruity	
1	Dorsal dislocation	Pronation	Normal	Grade I	Incongruous	Dorsal dislocation
2	Normal	Pronation	Normal	Grade II	Incongruous	Dorsal subluxation reduced in supination
3	Normal	Neutral	–	Grade I	Normal	–
4	Normal	Neutral	Normal	Grade I	Normal	–
5	Normal	Neutral	Palmar subluxation	Grade I	Normal	–
6	Normal	Supination	Palmar subluxation	Grade II palmar	Incongruous	Palmar subluxation
7	Normal	Supination	Normal	Grade I	Normal	Dorsal subluxation reduced in supination
8	Normal	Pronation	Normal	Grade II dorsal	Incongruous	Dorsal subluxation

Table 3. CT evaluation of contralateral (normal) wrist of eight patients with suspected distal radioulnar joint subluxation

Case	Computed tomography			
	Position	Radioulnar lines	Epicenter	Congruity
1	Neutral (slight pronation)	Normal	Grade I	Normal
2	Neutral	Normal	Grade I	Normal
3	Neutral	Normal	Grade I	Normal
4	Neutral	Normal	Grade I	Normal
5	Neutral (slight supination)	Normal	Grade I	Normal
6	Supination	Normal	Grade I	Normal
7	Supination	Normal	Grade I	Normal
8	Supination	Normal	Grade I	Normal

no evidence of subluxation in any of these patients. These results are summarized in Table 3.

Discussion

The semi-circular convex ulnar head articulates in a convexity of the distal radius known as the sigmoid notch. The integrity of this joint is maintained by the triangular fibrocartilage complex (TFCC). The TFCC arises from the ulnar aspect of the distal radius, is joined by fibers arising from the ulnar styloid, and inserts distally into the triquetrum, hamate, and base of the fifth metacarpal [10].

Chronic pain may first bring the patient with DRUJ subluxation to medical attention; there may be clicking around the distal radioulnar joint, painful or loss of forearm rotation, weakness of grip, and a feeling of wrist instability. This may follow a distal forearm fracture or a seemingly insignificant wrist injury. Dorsal dislocation is often obvious, with marked prominence of the ulnar head on the dorsum of the wrist, the hand locked in pronation and severely painful when attempting to supinate. A subluxation, however, may present with no clinical deformity, especially if it is not accompanied by a radial fracture. Symptoms of an acute injury include pain and tenderness, with reluctance to move the wrist out of the pronated position [3]. A chronic injury may have even a more subtle presentation.

Wrist radiography for the diagnosis of distal radioulnar subluxation is imprecise. Mino et al. demonstrated that with 10° of supination from the neutral position, dorsal dislocation appeared subluxated and dorsal subluxation appeared reduced. Palmar dislocation could be determined; but palmar subluxation could not. With 10° pronation, dorsal dislocation was not interpretable and dorsal subluxation appeared dislocated [7]. Other authors agree on the imprecision of radiography in diagnosing distal radioulnar joint subluxation [1, 4, 6, 9, 12]. The reasons given are inability of an acutely injured patient to place the wrist properly, inconsistent placement by the technologist, and casting of the wrist which prevents positioning and obscures bony detail. Arthrography is helpful for diagnosing tears in the triangular fibrocartilage, but does not diagnose subluxation.

Wrist computed tomography has been used for evaluation of the carpal tunnel and the detection of intra-articular calcified bodies [5, 14, 15]. CT verification of distal radioulnar dislocation has

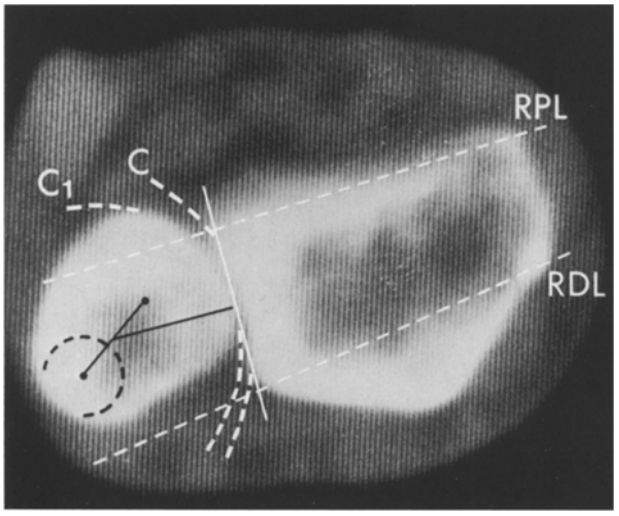

Fig. 3. *Case 5.* CT scan of the uninvolved normal right wrist in supination. According to Mino's criterion there is palmar subluxation (ulnar lies outside radioulnar lines) there is no abnormality using the epicenter or congruity methods. (*C* = arc of the sigmoid notch, C_1 = arc of the ulnar head, *RDL* = radioulnar line, *RPL* = radial palmar line)

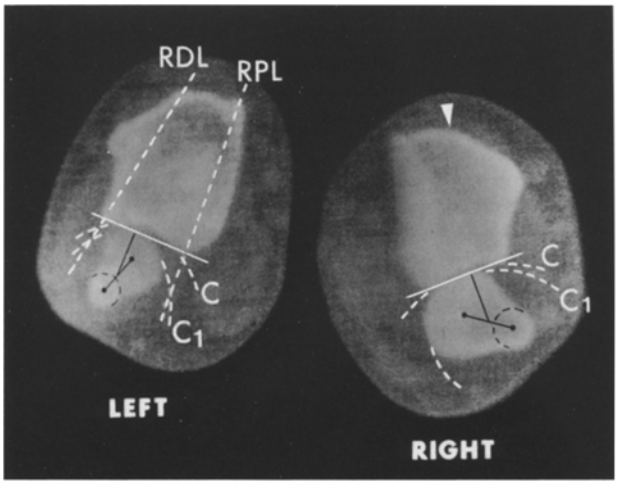

Fig. 4. *Case 3.* Normal left wrist (neutral position) by all three criteria. Rounded aspect (*arrowhead*) of the lateral aspect of the distal right radius makes the use of the radioulnar lines difficult. The other two methods reveal no evidence of radioulnar subluxation. *C* = arc of the sigmoid notch, C_1 = arc of the ulnar head, *RDL* = radioulnar line, *RPL* = radiopalmar line

been reported [8, 11, 13]. Early in our experience we used the radioulnar lines to assess distal radioulnar subluxation and found that, contrary to the experience of Mino et al., these were often poor criteria for several reasons. In the neutral position the ulnar head lies between the dorsal and palmar radioulnar lines, but during supination and pronation the ulna does not necessarily remain centered in the articular fossa of the distal radius (Figs. 2, 3) [2]. Another problem with this method is that

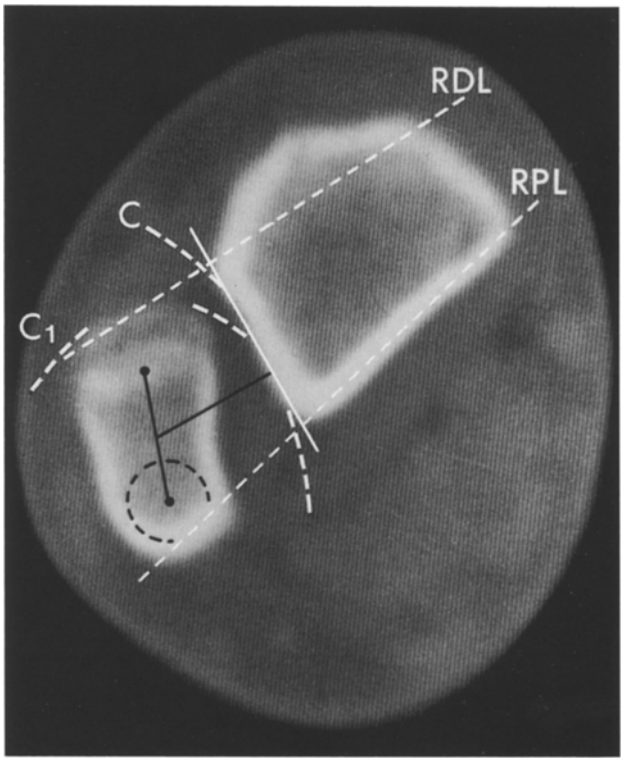

Fig. 5. *Case 1.* Right wrist in pronation. The arcs made by the ulnar head (*C*) and sigmoid notch (C_1) are markedly incongruous. Note that the radioulnar lines and epicenter methods reveal no dislocation. At surgery dorsal subluxation was found. *RDL* = radiodorsal line, *RPL* = radiopalmar line

the lateral aspect of the radius at the level of the sigmoid notch is often rounded, so that placement of the radioulnar lines is at best speculative. This was the reason that the radioulnar lines could not be assessed in case 3 (Fig. 4). In contrast, the epicenter method was positive in three of five patients with surgically proven subluxation, and the congruity method was positive in four of five patients with distal radioulnar joint subluxation or dislocation (Fig. 5).

In one patient, a dorsal subluxation was missed by all three criteria. However, this scan was taken in supination and on the operating table the subluxation was in pronation. It is now apparent that the position in which the patient feels most uncomfortable may be the reduced position, not subluxated as was assumed at the start of this study. CT scans of the wrist for distal radioulnar subluxation must be done in both supination and pronation to avoid picturing a dynamic subluxation that is reduced. CT scanning performed in only one position is the reason, we feel, for our false negative examinations.

In summary, subluxation or dislocation of the distal radioulnar joint can be easily diagnosed by

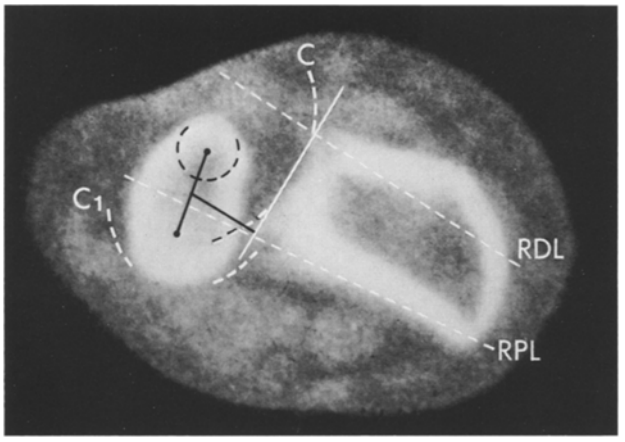

Fig. 6. *Case 6.* CT scan of right wrist done in supination reveals palmar subluxation using the radioulnar lines, a grade II palmar subluxation using the epicenter method, and incongruity of the distal radioulnar joint. Palmar subluxation was confirmed at surgery. C = arc of the sigmoid notch, C_1 = arc of the ulnar head, RDL = radioulnar line, RPL = radiopalmar line

CT scanning, if the examination is performed correctly (Fig. 6). The study must be obtained in full supination as well as in pronation in order to visualize the position in which the wrist is subluxated or reduced. The distal radioulnar line method used by Mino et al. is, in our experience, often not helpful unless the subluxation occurs in the neutral position. The epicenter and congruity methods seem to be more accurate. As in all radiographic studies, proper technique is essential.

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