Review Article

Carpal Instability Nondissociative

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Abstract

Carpal instability nondissociative (CIND) represents a spectrum of conditions characterized by kinematic dysfunction of the proximal carpal row, often associated with a clinical "clunk." CIND is manifested at the midcarpal and/or radiocarpal joints, and it is distinguished from carpal instability dissociative (CID) by the lack of disruption between bones within the same carpal row. There are four major subcategories of CIND: palmar, dorsal, combined, and adaptive. In palmar CIND, instability occurs across the entire proximal carpal row. When nonsurgical management fails, surgical options include arthroscopic thermal capsulorrhaphy, soft-tissue reconstruction, or limited radiocarpal or intercarpal fusions. In dorsal CIND, the capitate subluxates dorsally from its reduced resting position. Dorsal CIND usually responds to nonsurgical management; refractory cases respond to palmar ligament reefing and/or dorsal intercarpal capsulodesis. Combined CIND demonstrates signs of both palmar and dorsal CIND and can be treated with soft-tissue or bony procedures. In adaptive CIND, the volar carpal ligaments are slackened and are less capable of inducing the physiologic shift of the proximal carpal row from flexion into extension as the wrist ulnarly deviates. Treatment of choice is a corrective osteotomy to restore the normal volar tilt of the distal radius.

The terms carpal instability dissociative (CID) and carpal instability nondissociative (CIND) were first proposed by Dobyns et al[1] in 1985 to distinguish between two major classes of carpal instability. CID is characterized by instability between bones within a single carpal row.[2,3] CIND is characterized by dysfunction of the entire proximal carpal row, manifested at either the radiocarpal joint, the midcarpal joint, or both.

These disorders are frequently associated with a clinical "clunk." CIND may be distinguished radiographically from CID by the lack of a separation or bony break within the proximal carpal row (Figure 1).

Conceptually, radiocarpal ligament insufficiencies are CIND problems, in which the entire carpus is translocated in a palmar, dorsal, radial, or ulnar direction, often without a proximal row dissociation. However, because their clinical features are so dissimilar from those observed in patients with a proximal carpal row dysfunction, they are not discussed here.

The typical features of CIND were first identified in 1934 by Mouchet and Belot, who referred to symptomatic laxity of the carpus as "snapping wrist."[4] Since then, several investigators have identified subcategories of CIND with subtle differences in presentation and demographics. The no-

Figure 1

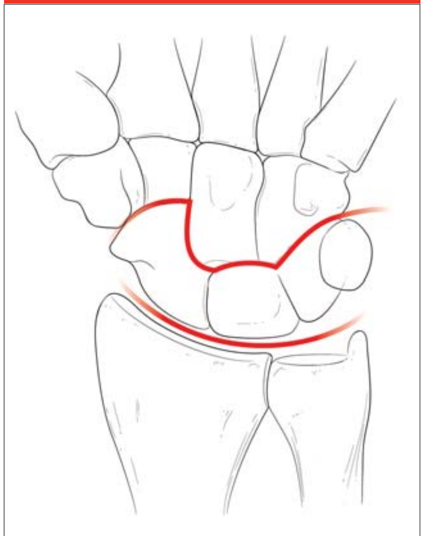


Illustration of carpal instability nondissociative, which represents instability at the radiocarpal joint, the midcarpal joint, or both joints (outlined in red). Unlike patterns of instability in carpal instability dissociative, there is no break between bones within either the proximal or distal carpal rows.

menclature used to describe these subcategories has been variable and confusing at times, but the clinical entities encompassing CIND can be understood by dividing them into four major groups: palmar CIND (or CIND-VISI [volar intercalated segmental instability]), dorsal CIND (or CIND-DISI [dorsal intercalated segmental instability]), combined CIND, and adaptive CIND (Figure 2).

Palmar CIND

The most common type of CIND is the palmar type, or CIND-VISI. This disorder was first characterized as a true clinical syndrome by Lichtman et al[5] in 1981 in a small series of patients who presented with painful clunking of the wrist. These patients had a visible or palpable volar depression or sag at the midcarpal joint, tenderness to palpation over the ulnar carpus at the triquetrohamate joint, and painful clunking that occurred with pronation and ulnar deviation.[4] Lichtman et al[6] initially referred to this disorder as ulnar midcarpal instability until 1993, when these authors renamed it palmar midcarpal instability to distinguish it from reports of dorsal midcarpal subluxation. Because the instability occurs across the entire proximal carpal row and is not isolated to dysfunction of either the radiocarpal or midcarpal joints, palmar CIND (or CIND-VISI) is the more descriptive and inclusive term.

Clinical Presentation

Patients with symptomatic palmar CIND typically report a painful clunk while performing activities that require ulnar deviation, such as pouring liquids. Generalized ligamentous laxity is a common finding in this population, and many patients do not recall a specific injury associated with the onset of symptoms. A volar sag of the ulnar carpus is often noted on visual inspection (Figure 3). The condition is often bilateral, despite presentation with symptoms predominantly in one wrist. Persons with congenital ligamentous laxity (most frequently women, children, and adolescents) or with pathologic ligament laxity (eg, Ehlers-Danlos syndrome, cutis laxa) commonly have asymptomatic or minimally symptomatic palmar CIND.

Most patients with palmar CIND demonstrate the classic catch-up clunk (Figure 4) as the proximal carpal row pops from a flexed posture into an extended posture during radial to ulnar deviation (Video 1).

Lichtman and colleagues[5-8] described a clinical test, the midcarpal shift test, to demonstrate this clunk. The patient's wrist is positioned in neutral flexion-extension, with slight radial deviation and forearm pronation. The examiner passively translates the distal carpal row and central metacarpals in a palmar direction, and the wrist is then ulnar-deviated by the examiner. As the wrist is brought into ulnar deviation, a dramatic clunk is noted as the proximal carpal row pops into extension (Video 2). The driving force of this clunk is the articular surface of the distal carpal row. The helicoidal surface of the hamate forces the hyperflexed triquetrum into sudden extension, pulling the attached lunate and scaphoid into extension with it.[9] The clunk may or may not be painful.

Pathomechanics

When a normal wrist deviates from a radial-deviated to ulnar-deviated posture, the three bones of the proximal carpal row rotate from flexion into extension. Two entities ensure that this rotation is smooth and progressive: the palmar midcarpal ligaments and the coordinated function of the flexor carpi ulnaris and extensor carpi ulnaris muscles. Particularly important are the most proximal fibers of the triquetral-hamate-capitate ligament and the anterolateral scaphotrapezium ligaments (Figure 5). As the wrist deviates ulnarly, these two ligaments become progressively taut and pull the proximal row smoothly into extension. The coordinated contraction of the flexor carpi ulnaris and extensor carpi ulnaris muscles also helps extend the proximal row by realigning the flexed triquetrum into a more extended posture. The results of several cadaver-sectioning studies suggest that injury or attenuation of the ulnar arm of the palmar arcuate (ie, triquetral-hamate-capitate) ligament or the dorsal radiotriquetral ligament is also implicated in symptomatic palmar CIND[5,6,10,11] (Figure 5).

Figure 2

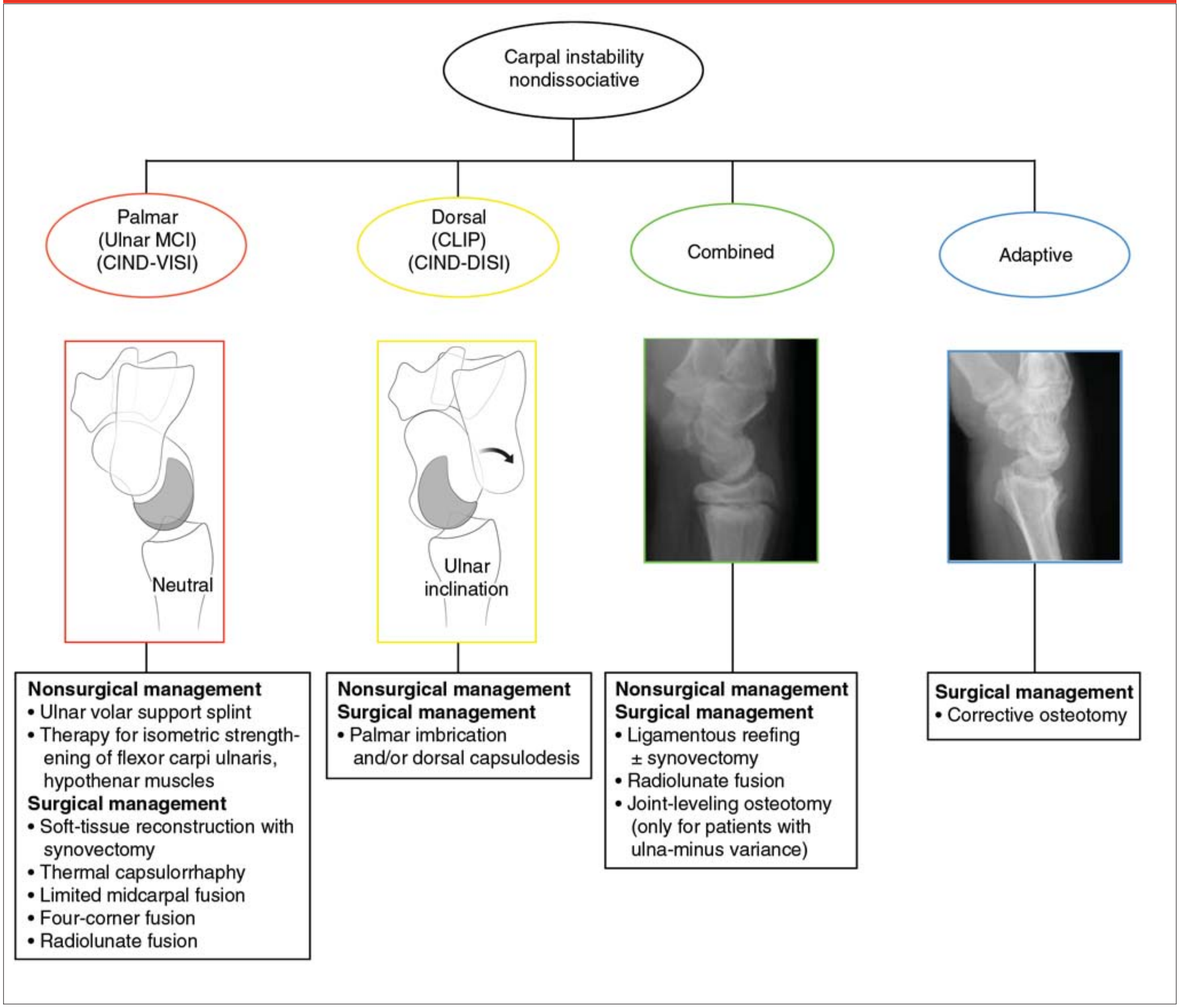
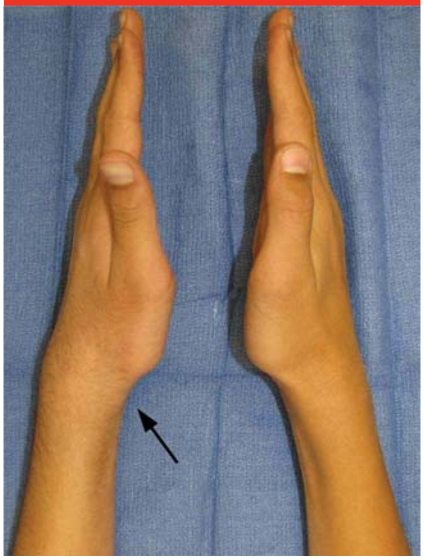


Diagram of the four subcategories of carpal instability nondissociative (CIND) and the nomenclature by which they are often referred. Nonsurgical management is less successful for combined CIND than for palmar or dorsal CIND. Surgical results for adaptive CIND generally are superior to surgical results for the other subcategories of CIND. CIND-DISI = CIND dorsal intercalated segmental instability, CIND-VISI = CIND volar intercalated segmental instability, CLIP = capitolunate instability pattern, ulnar MCI = ulnar midcarpal instability. (Adapted with permission from Garcia-Elias M: The non-dissociative clunking wrist: A personal view. *J Hand Surg Eur* 2008;33[6]:698-711, except for the radiographs, which are reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

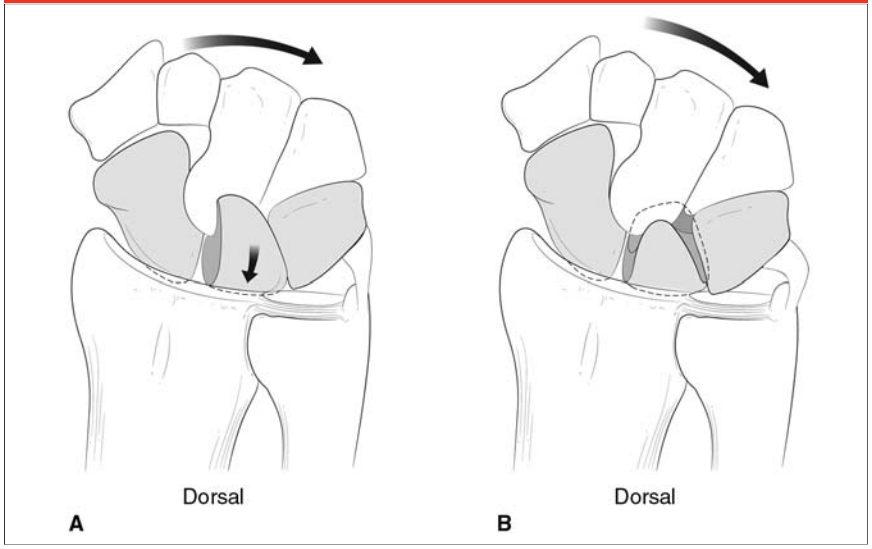
Palmar CIND occurs when these supportive structures become dysfunctional, either by rupture, attenuation, increased elasticity, or poor proprioception. The entire proximal row rotates into flexion, which causes an associated volar translation (ie, volar sag) of the distal carpal row (Figure 6). The proximal carpal row will remain flexed during ulnar deviation until the triquetrohamate joint becomes engaged and the joint-compressive forces across that helicoidally shaped articulation force the proximal row to rotate suddenly and abruptly into extension.[4,9] Forearm pronation accentuates the clunk because it increases the tension in the ulnolunate and ulnotriquetral ligaments (Figure 5, A and B). Increased tension in these two ligaments resists the extension force on the proximal carpal row and causes the clunk to occur a bit later in ulnar deviation, resulting in a more intense clunk in pronation than in supination.

Figure 3



Clinical photograph demonstrating volar sag (arrow) of the carpus in a patient with left-sided palmar carpal instability nondissociative. (Reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

Figure 4



A and **B,** Illustrations of the wrist going into ulnar deviation (large arrows). The catch-up clunk (small arrow) occurs when the proximal carpal row shifts suddenly from flexion into extension as the wrist translates from radial to ulnar deviation. **B,** With the wrist in ulnar deviation, the proximal carpal is now extended. The dashed outline indicates the extended position of the lunate.

Diagnostic Workup

Most patients with palmar CIND have generalized ligamentous laxity, so it is important to obtain bilateral wrist radiographs. Plain radiographs may be normal or they may demonstrate varying degrees of the VISI pattern of lunate volar tilt. Videofluoroscopy may be more helpful to establish the diagnosis than plain radiography. Lateral fluoroscopy captures the maintenance of the volar-flexed position of the proximal row as the wrist moves from radial to ulnar deviation. Toward the extremes of ulnar deviation, the proximal row suddenly and dramatically snaps into extension.[4]

Stress views can also be performed under fluoroscopy to assess for palmar CIND. A lateral view in neutral, radial, and ulnar deviation demonstrates the extremes of lunate posture. The anterior drawer stress view can be performed by translating the distal carpal row in a palmar direction and observing for either widening of the scaphotrapeziotrapezoid joint or for palmar capitolunate subluxation.[12]

Dorsal CIND

The dorsal CIND subcategory encompasses the capitolunate instability pattern (CLIP) first described by Louis et al[13] in 1984 and the chronic capitolunate instability pattern (CCIP) described by Johnson and Carrera[14] in 1986. Dorsal CIND is also referred to as CIND-DISI because, in this variant, the clinical clunk occurs secondary to dorsal subluxation of the capitate from the dorsally tilted proximal carpal row in ulnar deviation. Dorsal CIND is less common than palmar CIND.

Clinical Presentation

Patients with dorsal CIND typically report pain and clicking while grasping objects with the forearm supinated.[4] As the condition becomes chronic, the pain and clicking are accompanied by weakness, as described in the series of 12 patients with CCIP of Johnson and Carrera.[14] Patients with dorsal CIND may report a history of an extension injury to the wrist, but this may or may not be causally related.

Louis et al[13] described a dynamic dorsal displacement test to diagnose patients with CLIP or dorsal CIND. To perform this test, the wrist is placed in flexion, and ulnar deviation and longitudinal traction are applied. Dorsally directed pressure is then placed over the scaphoid tubercle, which causes simultaneous dorsal subluxation of the proximal row and dorsal subluxation of the capitate from the lunate (Figure 7). In a positive test, this degree of dorsal subluxation reproduces the patient's pain.

Figure 5

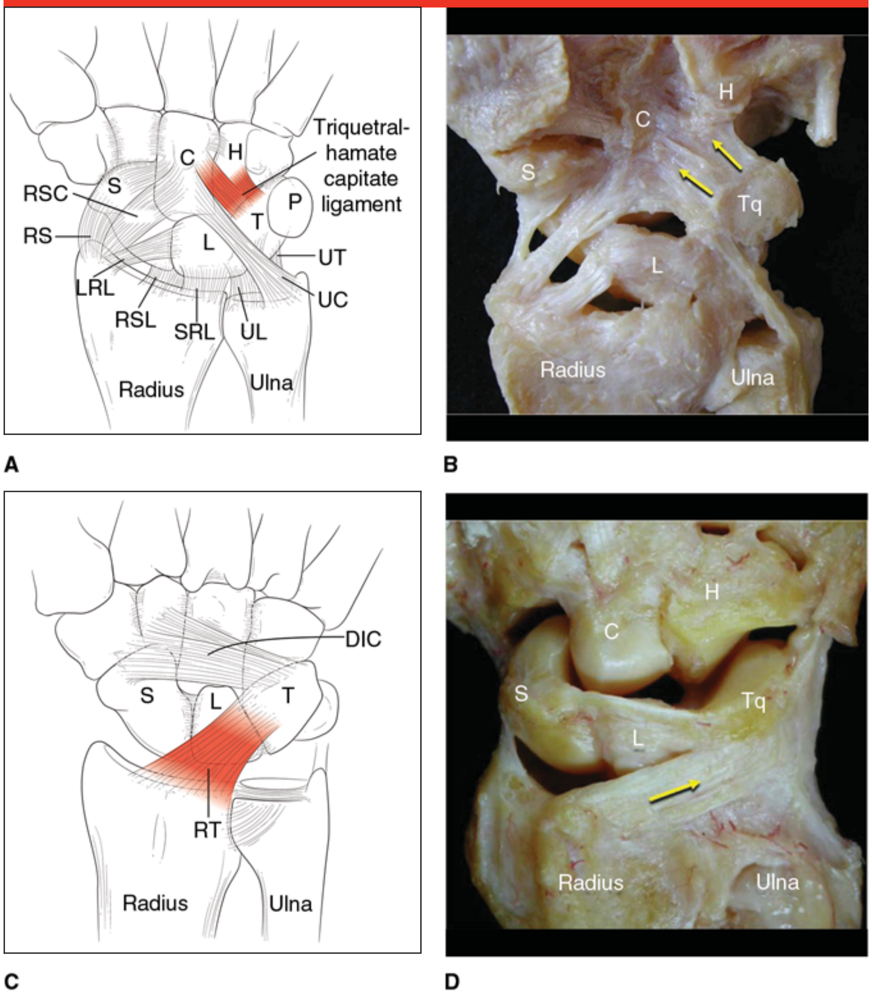


Illustration (**A**) and clinical photograph of a cadaver specimen (**B**) demonstrating that the ulnar arm of the palmar arcuate ligament (panel A, shaded in red; panel B, yellow arrows) is implicated in palmar carpal instability nondissociative (CIND). Illustration (**C**) and clinical photograph of a cadaver specimen (**D**) demonstrating that the dorsal radiotriquetral ligament (panel A, shaded in red; panel B, yellow arrow) is also implicated in palmar CIND. C = capitate, DIC = dorsal intercarpal ligament, H = hamate, L = lunate, LRL = long radiolunate ligament, P = pisiform, RS = radioscaphoid ligament, RSC = radioscaphocapitate ligament, RSL = radioscapholunate ligament, RT = radiotriquetral ligament, S = scaphoid, SRL = short radiolunate ligament, T/Tq = triquetrum, UC = ulnocapitate ligament, UL = ulnolunate ligament, UT = ulnotriquetral ligament. (Panels A and C adapted with permission from Lichtman DM, Wroten ES: Understanding midcarpal instability. *J Hand Surg Am* 2006;31[3]: 491-498. Panels B and D reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

Pathomechanics

In patients with normal wrist kinematics, the proximal carpal row moves smoothly into extension, and the distal carpal row translates dorsally with ulnar deviation. Palmar and dorsal CIND conditions are both characterized by the lack of these smooth transitions secondary to carpal ligament dysfunction.[4] In contrast to the initial volar sag of palmar CIND, the carpus is often normally aligned in dorsal CIND. In dorsal CIND, the clunk occurs in ulnar deviation because the capitate subluxates dorsally from its reduced resting position.

There is some uncertainty regarding the specific ligaments responsible for dorsal CIND. Louis et al,[13] who first described CLIP, hypothesized that dorsal subluxation of the capitate occurs secondary to laxity of the radiolunate ligaments, the dorsal capitolunate ligament complex, and the extrinsic stabilizers of the scaphoid (Figures 4 and 5, A and B). Johnson and Carrera,[14] who described CCIP, theorized that dorsal capitate subluxation occurs secondary to posttraumatic attenuation of the palmar radiocapitate ligament. Most likely, there is a combination of factors explaining this type of instability. Underdevelopment or increased laxity of the dorsal intercarpal ligament (Figure 5, C and D), particularly the thick scaphotriquetral fascicles, and excessive laxity of the space of Poirier are two major factors that contribute to dorsal CIND. The scaphotriquetral fascicles of the dorsal intercarpal ligament act as a pseudolabrum, deepening the ball-and-socket–like articulation of the scapholunocapitate joint and preventing subluxation. Deficiency of the dorsal intercarpal ligament and attenuation of the long radiolunate and the radioscaphocapitate ligaments (the two margins of the space of Poirier) allow the capitate to subluxate dorsally when the proximal row extends during ulnar deviation.

Diagnostic Workup

In dorsal CIND, plain radiography and arthrography are not typically helpful. Occasionally, lateral wrist radiographs may demonstrate a slight dorsal tilt to the lunate. Fluoroscopy is critical for the diagnosis of dorsal CIND.

Figure 6

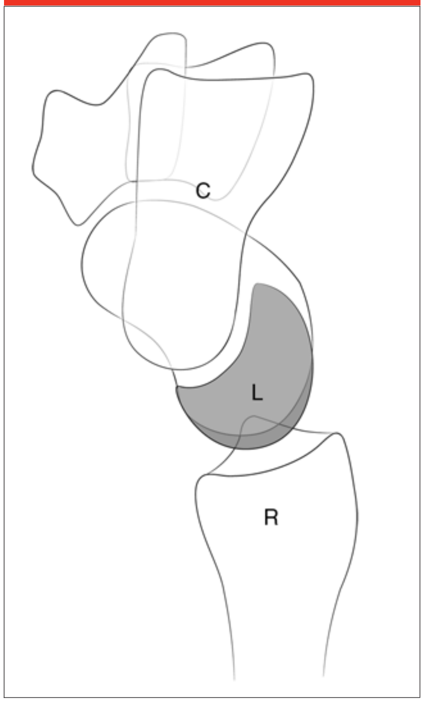
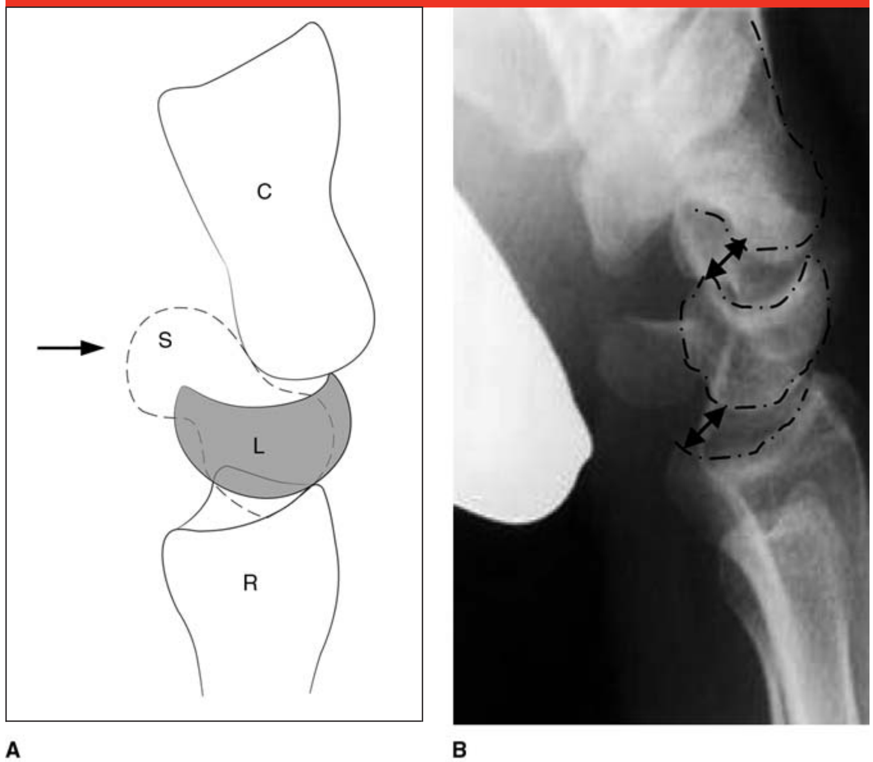


Illustration demonstrating the palmar translation of the capitate (C) and the flexion of the lunate (L, shaded) that are characteristic of patients with palmar carpal instability nondissociative (CIND) when the wrists are in a neutral position. In palmar CIND, the head of the capitate translates palmarly, and the proximal carpal row remains flexed until the extremes of ulnar deviation, when the triquetrohamate joint is re-engaged and the proximal row clunks into extension. R = radius. (Adapted with permission from Garcia-Elias M: The non-dissociative clunking wrist: A personal view. *J Hand Surg Eur* 2008;33[6]:698-711.)

Figure 7



A, Illustration of the dorsal capitate-displacement test. The examiner applies longitudinal traction and mild flexion to the wrist while applying dorsally directed pressure to the scaphoid tubercle (arrow). This pressure causes the dorsal subluxation of the capitate and the proximal row. **B,** Lateral radiograph demonstrating both dorsal subluxation of the capitate (top double arrow) on the lunate and dorsal subluxation of the proximal row (lunate) (bottom double arrow) on the distal radius during a dorsal capitate-displacement stress test in a patient with dorsal carpal instability nondissociative. C = capitate, L = lunate, R = radius, S = scaphoid. (Panel B reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

The diagnosis of dorsal CIND can be made using the dorsal capitate-displacement stress test;[13] this maneuver involves performing the dynamic dorsal displacement test under videofluoroscopy. As demonstrated in Figure 7, the examiner applies dorsally directed pressure to the scaphoid tubercle with the wrist in flexion. Videofluoroscopy demonstrates dorsal subluxation of the capitate. The diagnosis is made when instability at the capitolunate joint reproduces the patient's pain and clunking.[15]

Combined CIND

The combined subcategory of CIND was first described by Apergis[16] in 1996 in a series of 14 patients with chronic wrist pain, vague numbness, and reduced grip strength. These patients demonstrated volar sag of the carpus on visual inspection suggestive of palmar CIND and also had positive dorsal displacement tests with dorsal subluxation noted on videofluoroscopy.

Clinical Presentation

Combined CIND is more common in females than males, and it often presents in teenage girls with generalized ligamentous laxity. In addition to hyperlaxity, these patients often have a history of an extension injury to the wrist. They typically present after playing sports that involve repetitive gripping or striking, such as volleyball, tennis, and gymnastics.

Patients with combined CIND demonstrate signs of both palmar and dorsal CIND on physical examination. They have markers of overall ligamentous laxity, such as hyperextension of the elbows and thumbs. Volar sag of the ulnar carpus may be noted on inspection, and both the dorsal and palmar displacement tests are positive.

Pathomechanics

The instability in combined CIND typically results from attenuation or congenital laxity of both the volar and dorsal carpal ligaments. In many instances of combined CIND, there are also features of radiocarpal instability, with increased subluxation at that level.

In radial deviation, the proximal carpal row is flexed and ulnarly translated. With ulnar deviation, the lunate clunks into extension, similar to palmar CIND. In addition, extremes of ulnar deviation cause dorsal subluxation of the capitate, similar to dorsal CIND. Most patients with combined CIND have an increased distal radial inclination in the frontal plane and ulna-minus variance.[4] Though seemingly associated, it is unclear what role these two factors play in the pathomechanics of combined CIND.

Diagnostic Workup

As with palmar and dorsal CIND, videofluoroscopy is the most helpful diagnostic tool for confirming a combined pattern of CIND. Bilateral radiographs are particularly important in this group of patients, given their high incidence of generalized ligamentous laxity. An increased radial inclination of the distal radius articular surface and ulna-minus variance may be noted on plain radiographs.[12]

Adaptive CIND

Unlike the other three subcategories of CIND, adaptive CIND conditions are characterized by clunking and instability secondary to abnormalities that are extrinsic to the carpus. The classic example of adaptive CIND occurs following a malunited distal radius fracture. The pattern was first described by Linscheid et al[17] in 1972. Taleisnik and Watson[18] presented a series of 13 patients with instability and pain at the midcarpal joint secondary to distal radial malunions in 1984, for which the term extrinsic instability was used.

Clinical Presentation

Patients with adaptive CIND present with clunking or snapping of the wrist in ulnar deviation with the forearm pronated. They typically have tenderness to palpation at the capitolunate and triquetrohamate joints. In the classic case, the patient provides a history of having sustained a distal radius fracture. Radiographs demonstrate a dorsal malunion of the distal radius.

Pathomechanics

In adaptive CIND conditions, the volar carpal ligaments are effectively slackened and are less capable of inducing the physiologic shift of the proximal carpal row from flexion into extension as the wrist ulnarly deviates. The carpal ligaments are not typically torn or attenuated, but the distances between their origins and insertions are decreased by the dorsal tilt of the malunited distal radius and compensatory jackknife extension of the proximal row and flexion of the distal carpal row. The decreased distances result in insufficiently taut ligaments that are incapable of preventing dorsal translation of the capitate and distal carpal row.[4]

In lateral radiographs of adaptive CIND secondary to dorsal malunion of the distal radius, the lunate is typically in extension and the capitate is typically in flexion. The capitate and lunate are not collinear with the longitudinal axis of the proximal radius, and the normal force transmission across the carpus and extrinsic musculotendinous units is altered.

Diagnostic Workup

Plain radiographs typically demonstrate a malunited distal radius with a dorsal tilt. The patients reported on by Taleisnik and Watson[18] had an average dorsal tilt of 23° of the radial articular surface. The capitate is flexed relative to the lunate and positioned dorsal to the longitudinal axis of the proximal radial shaft.[18]

Management

Management of CIND is primarily nonsurgical. Patients with generalized laxity may present with a painless clinical clunk secondary to CIND. These patients require no treatment unless they develop pain or dysfunction.

For symptomatic patients, nonsurgical management is typically successful. Treatment should include patient education on the nature of the problem and, occasionally, splinting, anti-inflammatory medications, and short courses of hand therapy. For refractory cases, surgical management may be attempted, but outcomes are not predictable. Surgical management of each CIND subcategory varies to address the specific sites of pathology implicated in each group. Results are better for the subcategories in which the pathomechanics are better understood.

Palmar CIND

Initial management of palmar CIND is nonsurgical; most patients respond to such management alone. Nonsteroidal anti-inflammatory drugs and activity modification are typically helpful to relieve symptoms. A splint with ulnar volar support often helps reduce the symptomatic volar sag of the proximal row and main-

Figure 8

Clinical photograph demonstrating the use of splints with ulnar volar support to manage palmar carpal instability nondissociative. (Reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

tain the lunate in a neutral position[19] (Figure 8). Alternatively, and especially when palmar CIND is unilateral and identified following an acute injury, the affected wrist can be casted for 4 to 6 weeks in neutral flexion and ulnar deviation. Hand therapy should focus on reestablishing proprioceptive control of the wrist. Isometric strengthening of the flexor carpi ulnaris and extensor carpi ulnaris muscles counteracts flexion of the proximal carpal row by generating a realigning force to the pisotriquetral unit.[12]

When many months of conservative management have failed, surgical treatment options include arthroscopic thermal capsulorrhaphy and soft-tissue reconstruction for milder cases and limited radiocarpal or intercarpal fusions for more severe cases. Mason and Hargreaves[20] performed arthroscopic shrinkage of the volar extrinsic ligaments in 15 wrists and reported improved or resolved instability in all wrists, as well as patient satisfaction in 14 of 15 patients at 3.5-year follow-up. Long-term results after thermal capsulorrhaphy for CIND are unknown. Although the early results reported by Mason and Hargreaves[20] are promising, information from the shoulder literature about chondrolysis and articular cartilage damage with capsulorrhaphy[21,22] should be considered before widespread adoption of this technique for management.

Soft-tissue reconstruction options include stabilization of the triquetrohamate joint by rerouting the extensor carpi ulnaris tendon, advancement of the ulnar arm of the volar arcuate ligament across the midcarpal joint, reefing of the dorsal radiotriquetral ligament, and double-level tenodesis using a slip of the extensor carpi radialis brevis.[4,12] Prior to soft-tissue reconstruction, arthroscopy or arthrotomy and/or synovectomy can be performed at the discretion of the surgeon. With the exception of capsulorrhaphy, soft-tissue reconstructions have been less successful than limited midcarpal or four-corner fusions for palmar CIND.[6,23,24] In 1993, Lichtman et al[6] compared six patients treated with limited midcarpal arthrodesis with nine patients who were treated with one of four different soft-tissue procedures for palmar CIND. All of the limited midcarpal arthrodeses were successful compared with the soft-tissue reconstruction group, in which six of the nine procedures failed. Rao and Culver[23] reported less favorable outcomes with limited midcarpal fusions for this group, with success in only 6 of 11 cases. Goldfarb et al[24] reported that seven of eight patients were satisfied with four-corner arthrodesis and that six of the eight had no pain or mild pain after the procedure.

Although midcarpal fusions have had reasonable results for palmar CIND, the limited carpal motion inherent in these procedures is a matter of concern with patients and may cause functional impairment. The importance of maintaining the dart thrower's motion for recreational, occupational, and household activities has been increasingly recognized.[25] Triquetrohamate fusions and four-corner fusions correct the clunk and posture abnormality associated with palmar CIND. However, these procedures ablate midcarpal motion and the dart thrower's motion, leading to marked loss of ulnar deviation, an abnormal arc of circumduction, and mixed clinical results.[23]

An alternative surgical option proposed for palmar CIND is radiolunate fusion. Radiolunate fusion stabilizes the entire proximal row in neutral and prevents the dramatic flip in lunate posture that characterizes this condition[12] (Figure 9). Unlike midcarpal fusion for palmar CIND, radiolunate fusion preserves motion at the midcarpal joint and preserves the dart thrower's motion.[26,27] Halikis et al[27] reported excellent pain relief in five patients who underwent radiolunate fusion for CIND. All patients, including one with a nonunion, resolved the catch-up clunk. At a minimum 2.5 years of follow-up, extension was reduced by 25% compared with the contralateral side. Flexion was reduced by 32%, radial deviation was reduced by 37%, and ulnar deviation was reduced by 33% compared with the contralateral side.[27] Garcia-Elias[12] reported good preliminary results in a small series of nine patients with combined CIND who exhibited

Figure 9

A B C

D

Radiolunate fusion preserves the dart thrower's motion and is a suitable management option for recalcitrant palmar CIND and combined CIND. **A,** PA radiograph demonstrating radiolunate fusion stabilized with Kirschner wires. PA (**B**) and lateral (**C**) radiographs demonstrating a radiolunate fusion stabilized with compression screws. **D,** PA radiograph demonstrating a radiolunate fusion after hardware removal. (Reproduced with permission from Scott W. Wolfe, MD, New York, NY.)

features of radiocarpal and midcarpal instability. Six were stabilized with Kirschner wires, and three were stabilized with two crossed compression screws (Figure 9). One patient developed a nonunion that required reoperation. At an average follow-up of 19 months, all patients had normal grip strength and had returned to their previous occupations. Clunking resolved in all patients. Compared with the contralateral side, there was an average reduction of 32% flexion-extension motion.[12] Further studies on the use of radiolunate fusion for managing CIND are warranted, but the preservation of the dart thrower's motion suggests that this technique will be successful in preserving function while eliminating instability.

Dorsal CIND

Similar to palmar CIND, dorsal CIND usually responds to nonsurgical management.[4] However, Ono et al[28] reported on a group of five patients for whom nonsurgical management did not provide sustained, long-term relief. In refractory cases, palmar ligament reefing and/or dorsal intercarpal capsulodesis have both been used successfully. Johnson and Carrera[14] treated 11 of the 12 patients in their CCIP series by suturing the volar radioscaphocapitate ligament to the long radiolunate ligament and closing down the space of Poirier. They reported good to excellent results in nine patients, fair results in one, and poor results in one at an average follow-up time of 4 years and 4 months. The lunate and capitate were stabilized by their procedure, but they reported some loss of wrist extension. There is insufficient evidence at this time to determine what role, if any, radiolunate fusion may have in the management of dorsal CIND.

Combined CIND

Although activity modification and nonsurgical management should be the initial line of management, patients with combined CIND may not respond as well to nonsurgical management as do those with the isolated palmar or dorsal variants. In the series reported by Apergis[16] in 1996, none of the 14 patients with combined CIND responded to nonsurgical management.

Combined CIND can be managed with soft-tissue or bony procedures. Apergis[16] treated all 14 patients in his series with ligamentous reefing. On the volar radial side, he sutured the volar radioscaphocapitate ligament to the long radiolunate ligament. On the ulnar side, he sutured the triquetrocapitate ligament to the lunotriquetral ligament. He reported good to excellent results in 13 patients and a fair result in 1 patient. No recent case series are available.

Wright et al[2] published a retrospective review of 45 patients with CIND. Seven patients were treated nonsurgically and 38 were treated surgically with soft-tissue reconstructions, joint-leveling osteotomies, or midcarpal fusions. Although not clearly stated, most of the patients in their series appeared to have symptoms consistent with combined CIND, with evidence of both dorsal and volar instability on provocative maneuvers. The authors excluded patients with adaptive CIND secondary to distal radius malunions. In this series, only 56% of patients had good or excellent results. The best results were in the subgroup of six patients who were treated with joint-leveling osteotomies for CIND associated with ulna-minus variance. Eighty-three percent of the patients with preoperative ulna-minus variance had good or excellent results after joint-leveling osteotomy. The rationale for surgical success in this subgroup is not completely understood, but the authors noted that they could eliminate the clunk in these patients preoperatively by providing ulnar-sided pressure. They theorized that joint-leveling procedures might restore ulnar-sided support by tensioning ligamentous stabilizers, thus facilitating a smooth transition of the proximal carpal row as the wrist moves from radial to ulnar deviation.[2]

Radiolunate fusion, as described above, is also an attractive option for combined CIND. For example, Garcia-Elias[12] reported excellent early results in nine patients. Radiolunate fusion provides stability and eliminates the clunk without interfering with midcarpal motion. Patients with combined CIND tend to be younger, so preserving motion and function is particularly important in this group.

Adaptive CIND

The pathomechanics responsible for adaptive CIND are well understood. Surgical management is aimed at correcting the extrinsic deformity responsible for effectively slackening the palmar ligaments. In the case of adaptive CIND secondary to a malunited distal radius fracture, the treatment of choice is a corrective osteotomy to restore the normal volar tilt of the distal radius. Correction of the bony anatomy has the potential to realign the lunate and capitate with the longitudinal axis of the radius, thereby removing the tendency for dorsal tilt of the lunate and compensatory flexion of the capitate. In addition, realignment of the bony anatomy rebalances the tension of the extrinsic ligaments, the capsule, and the extrinsic muscle tendon forces, thus stabilizing the carpus. In chronic cases, however, adaptive carpal malalignment is generally incompletely corrected by osteotomy.

Overall, the results from surgical management of adaptive CIND tend to be superior to the results for the other subcategories of CIND. This is likely because of our increased understanding of the pathomechanics responsible for adaptive CIND, which allows us to better target our surgical management, as well as the absence of generalized ligamentous laxity, which can confound soft-tissue stabilization procedures.

Summary

CIND represents a spectrum of disorders associated with wrist pain, often with clunking that is caused by instability at the midcarpal and/or radiocarpal joints. Despite the results of cadaver and clinical studies, the pathomechanics responsible for most of the CIND disorders are incompletely understood. In general, nondissociative instability is thought to occur because of congenital, adaptive, or posttraumatic insufficiency of various intrinsic and extrinsic carpal ligaments. Four types of CIND have been described: palmar, dorsal, combined, and adaptive. Radiocarpal instability, including ulnar translation, can be dissociative or nondissociative and does not fit entirely within the CIND category from an etiologic or management perspective. CIND typically responds to nonsurgical management. When nonsurgical management fails, surgical options for palmar CIND include arthroscopic thermal capsulorrhaphy, soft-tissue reconstruction, or limited radiocarpal or intercarpal fusions (Figure 2). Refractory cases of dorsal CIND respond to palmar ligament reefing and/or dorsal intercarpal capsulodesis. Combined CIND can be treated with either soft-tissue or bony procedures. Treatment of choice for adaptive CIND is a corrective osteotomy to restore the normal volar tilt of the distal radius.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, reference 8 is a level II study. References 2, 6, 10, 16, 20, and 22 are level III studies. References 1, 5, 11, 13-15, 18, 19, 21, 23, 24, 26, and 28 are level IV studies. References 3, 4, 7, 9, 12, 17, 25, and 27 are level V expert opinion.

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