The Dorsopalmar Stability of the Distal Radioulnar Joint

Paul R. Stuart, MD, Richard A. Berger, MD, PhD, Ronald L. Linscheid, MD, Kai-Nan An, PhD, Rochester, MN

Sixteen fresh-frozen adult human cadaveric upper extremities were used in a biomechanical analysis of distal radioulnar joint (DRUJ) stability. The relative contribution to stability of the DRUJ by the surrounding anatomic structures presumed to stabilize the joint was analyzed with respect to forearm rotation and wrist flexion and extension using a purpose-built 4-axis materials testing machine. The dominant structures stabilizing the DRUJ were the ligamentous components of the triangular fibrocartilage complex proper. The major constraint to dorsal translation of the distal ulna relative to the radius is the palmar radioulnar ligament. Palmar translation of the distal ulna relative to the radius is constrained primarily by the dorsal radioulnar ligament, with secondary constraint provided by the palmar radioulnar ligament and interosseous membrane. The ulnocarpal ligaments and extensor carpi ulnaris subsheath did not contribute significantly to DRUJ stability; however, approximately 20% of DRUJ constraint is provided by the articular contact of the radius and ulna. These relationships were consistent regardless of wrist position or degree of forearm rotation. (J Hand Surg 2000;25A: 689–699. Copyright © 2000 by the American Society for Surgery of the Hand.)

Key words: Distal radioulnar joint, stability, biomechanics.

Instability of the distal radioulnar joint (DRUJ) represents a relatively common clinical problem, but substantial controversy regarding the structures responsible for this instability exists. This in turn has led to a confusing array of treatment techniques intended to re-establish stability. It is generally accepted that DRUJ stability is found in the combination of bony anatomy, the DRUJ capsule, muscular-tendinous structures, and ligamentous structures, including the interosseous membrane (IOM). The relative contributions of these structures to DRUJ stability remain controversial. Recent studies have improved earlier work by examining the DRUJ without disarticulating the wrist, leaving those structures that cross the DRUJ region intact. These studies have increased our understanding of the degree of subluxation permitted by sectioning certain structures, but have not led to the quantification of the relative contribution to DRUJ stability of the surrounding soft tissues. The potential importance of dynamic stabilization of the DRUJ by the extensor carpi ulnaris and the pronator quadratus, especially the deep head, have been advanced and even recognized in some innovative surgical reconstruction procedures. The mainstay of reconstructive efforts, however, remains centered about the static stabilizers of the DRUJ.

The influence of forearm rotation on DRUJ stability has been investigated but the influence of wrist position on DRUJ stability has not been reported. Because the ulnocarpal ligaments have been described as originating in part from the palmar radio-
ulnar ligament (PRUL), the potential exists for these structures to influence the DRUJ. This in turn may be influenced by wrist position.

Clinically, the majority of dislocations involving the DRUJ are dorsal, where the distal ulna is dorsal to the distal radius. It has been felt that the combination of forearm pronation and wrist hyperextension predisposes to this injury pattern. Conversely, palmar dislocations, in which the distal ulna is anterior to the distal radius, are thought to occur in a supinated forearm. Any variation in the contribution to stability of the soft tissues supporting structures of the DRUJ created by forearm rotation and wrist position may be relevant in defining which structures are most likely to be disrupted following injury and, hence, which structures should be repaired or reconstructed.

This study was designed to quantify the constraint contribution to DRUJ stability of the component parts of the triangular fibrocartilage complex, including the extensor carpi ulnaris subsheath (ECUS) and the IOM. Additionally, the study was designed to evaluate the potential influence of forearm rotation and wrist position on these constraint contributions.

Materials and Methods

Sixteen fresh-frozen adult human cadaveric upper extremities were used in this experiment. All specimens were obtained following established procurement protocols through the Department of Anatomy of the Mayo Clinic/Mayo Foundation. The distribution of specimens was 4 paired female, 1 paired male, 4 unilateral female, and 2 unilateral male specimens. There were 10 left upper extremities and 6 right upper extremities used, with a mean age of the donors at the time of death of 68 years (range, 24–88 years). Medical histories were available and reviewed for all donors of the specimens used; all were free of diseases known to influence the characteristics of the soft tissues surrounding the DRUJ. All specimens were evaluated radiographically, with any substantial evidence of instability or articular pathology used to reject the specimen. Postinvestigational dissections were completed. If major pre-existing soft tissue disruptions about the DRUJ were found the data from that specimen were withdrawn from analysis. All specimens were thawed at room temperature before use and were constantly kept moist with normal saline during testing.

The testing was conducted using a custom-built 4-axis testing machine (Avalon Technologies Corp, Rochester, MN). The testing machine consists of a rigid aluminum frame incorporating 3 translational and 1 rotational axes driven by microstepping motors (Fig. 1). The machine is controlled by an industry standard personal computer that contains a motor indexer and analog-to-digital board. The custom motion control software is designed to accommodate both stepper and servo controllers in displacement or load control modes or a feedback mode using analog-to-digital inputs to control axis velocity. Each axis acts either independently or dependently as a function of another axis. A 6-component load cell is incorporated for force and moment measurement.

Specimen preparation began with excision of extraneous skin and muscles, leaving the capsuloligamentous structures of the wrist and elbow and the IOM intact. The basic specimen testing consisted of translating a fixed radiocarpal unit on a fixed ulnohumeral unit. The radiocarpal, midcarpal, and carpometacarpal joints (with the exception of the first carpometacarpal joint) remained intact.

The specimens were divided into 3 groups with the forearms fixed in neutral rotation (n = 6), 60° pronation (n = 5), and 60° supination (n = 5). The degree of pronation or supination was established through the use of a clinical goniometer with 1 arm placed tangential to the anterior cortex of the distal radius and the other arm parallel to the longitudinal axis of the humerus, estimated through the olecranon fossa. Those specimens tested in pronation or supination were temporarily held in the designated position by passing a 1.6-mm wire between the distal diaphyses of the radius and ulna before mounting in the testing machine. This wire was removed, allowing mounting and testing in the testing machine. After each phase of testing, the specimen was returned to its initial position and the wire was passed through the holes to verify the proper positioning of the specimen before the next experimental step. The ulna was fixed to the humerus using a contoured 8-hole 3.5-mm AO dynamic compression plate (Synthes, Paoli, PA) (Fig. 2). A minimum of 1 cortical screw and 1 wire were passed across the ulnohumeral joint, with the plate protruding proximal to the olecranon to allow fixation of the specimen to a polymethyl–methacrylate block used to secure the specimen to the testing device. Care was taken to ensure that the hardware did not restrict the potential motion between the radius and ulna. The specimen was secured vertically in the testing machine, with a clamp securing the polymethyl methacrylate block to a universal clamp mounted on the base of the ma-
chine. Two 5-mm threaded Steinmann pins were passed in the sagittal plane through the distal radius. The pins were then bolted to an extension system connected with the load cell apparatus on the testing machine. Before tightening the specimen in place, it was preconditioned by translating the radius relative to the ulna in the dorsal and palmar directions a minimum of 20 cycles.26,27

Testing was performed by palmarly and dorsally translating the radiocarpal unit relative to the ulnohumeral unit. Because the testing machine has a moveable X-Y stage at the base to which the ulnohumeral unit was fixed, pure palmar and dorsal translation of the radiocarpal unit relative to the ulnohumeral unit based on the coronal plane of the radius was assured. A load limit of 67 N and a displacement limit of 20 mm were imposed, both of which were found in pilot experiments to be reasonable end points without obvious disruption of the soft tissues being studied in these experiments (Fig. 3). All translation tests were conducted in displacement-control mode, which allowed sequence independence to the soft tissue sections made on the specimen. As translation occurred a load–displacement curve was plotted on the monitor of the computer and the raw data were stored on disk.

After the preconditioning runs a test of anterior–posterior translation was performed with the intact specimen, followed by serial sectioning of the PRUL, dorsal radioulnar ligament (DRUL), ulnocarpal ligament complex (UCC), ECUS, distal interosseous membrane (IOMd), and the proximal interosseous membrane (IOMP) (Fig. 4). The PRUL and DRUL are defined as the respective ligaments, the DRUJ capsule on the volar or dorsal joint surfaces, respectively, and the volar or dorsal 50% of the triangular fibrocartilage, respectively. Each structure was sectioned independently at its attachment to the radius at the level of the sigmoid notch. The UCC, including the ulnolunate, ulnotriquetral, and

Figure 1. The 4-axis materials testing machine. 1, Z slide (vertical actuator); 2, 6 component load cell; 3, rotary stage; 4, X-Y slide; 5, computer used for testing control and data collection.
ulnocapitate ligaments, was defined as the soft tissue forming the ulnocarpal joint capsule extending dorsally from the palmar extent of the ECUS through the ligaments extending distally from the PRUL. The ulnolunate and ulnotriquetral ligaments emanate from the PRUL. The ulnocapitate ligament originates from the fovea of the ulna and passes distally in a plane just palmar to the PRUL and the ulnolunate and ulnotriquetral ligaments. The UCC was sectioned transversely, just distal to the PRUL. The ECUS is a distinct structure forming the anterior floor of the extensor carpi ulnaris tendon sheath extending from the sulcus between the ulnar styloid process and the base of the fifth metacarpal, where the extensor carpi ulnaris tendon inserts. It was divided by retracting the extensor carpi ulnaris tendon and completely sectioning the subsheath just distal to the tip of the ulnar styloid process and was expanded to include the dorsal ulnocarpal joint capsule, just distal to the DRUL. The IOMd was defined as the region of the IOM distal to the central band, including the pronator quadratus; the IOMP was defined as the remainder of the IOM, including the central band. Both regions were independently sectioned longitudinally.

For the intact specimen and each successive section, the translation test was repeated for a total of 3 trials with the wrist positioned in neutral extension, 60° flexion, and 60° extension. The wrist was held in...
the respective positions by a K-wire passed through the second or third metacarpal, which was subsequently secured to the mounting frame of the testing machine.

The load-displacement data from each experimental trial were analyzed using the method of Minami et al²⁸ to derive, for each structure sectioned, percentages of constraint contribution. These percentages were then analyzed for variations between individual structures and to determine the effects of forearm rotation and wrist position. Repeated-measures analyses were performed using a 3-way ANOVA and post hoc t-tests with a Bonferroni correction when necessary. The limit defining statistical significance was considered to be $p = .05$.

Results

Acceptable load-displacement data were collected in all experimental conditions from all 16 specimens and were subjected to statistical analysis. A typical set of load-displacement curves is shown in Figure 5. There were no statistically significant effects or discernible trends related to wrist position during any test phase.

The mean percentage contributions to DRUJ constraint for each structure related to the direction (dorsal or palmar) of displacement of the radius relative to the ulna and forearm rotation (neutral, pronation, or supination) were plotted to produce the histograms depicted in Figure 6.

Clinical convention refers to palmar subluxation/dislocation of the radius relative to the ulna as dorsal instability, and vice versa. The following descriptions of the results will be grouped according to volar or dorsal displacement of the radius.

Palmar Displacement of the Radius
(Dorsal Instability of the Distal Radioulnar Joint)

The principal constraint to volar translation of the radius is the PRUL, which has a greater constraint

Figure 4. Soft tissue sectioning. 1, Ulnocarpal ligament section; 2, ECUS section; 3, dorsal half of triangular fibrocartilage complex section; 4, palmar half of triangular fibrocartilage complex section; 5, IOMd (including pronator quadratus, not shown); 6, IOMp.
percentage than all other structures (p < .01), regardless of forearm rotation (Fig. 6, right column). In forearm pronation, the DRUL contributes a significantly greater degree of constraint than the UCC, ECUS, or interosseous membrane (p < .01), but still contributes less constraint than the PRUL.

**Dorsal Displacement of the Radius**
*(Palmar Instability of the Distal Radioulnar Joint)*

The data from the tests evaluating dorsal translation of the radius are more complex than for palmar displacement of the radius. In forearm pronation, the DRUL has a greater constraint percentage to dorsal displacement of the radius than the PRUL and IOMp (p < .05) and the UCC, ECUS, and IOMd (p < .01) (Fig. 6, bottom left). In forearm supination, the DRUL has a greater constraint percentage than the UCC, ECUS, and IOMp (p < .01) but does not have greater constraint contributions than the PRUL and IOMd (Fig. 6, middle left). Additionally, the constraint contribution of the PRUL is greater than the IOMp and the ECUS (p < .05). In neutral forearm rotation the distribution of constraint percentages is more evenly distributed among the structures tested. The IOMd contributes the greatest constraint but is statistically significantly greater only to the UCC and ECUS (p < .01). Regardless of forearm rotation or wrist position, the ECUS and UCC do not contribute to constraint to either dorsal or volar displacement of the radius relative to the ulna.

The IOMd constrains dorsal displacement of the radius more than volar displacement (p < .01); this effect is greater in forearm supination than in pronation (p < .01) (Fig. 6, middle and bottom left). The IOMp also constrains dorsal displacement of the radius more than volar displacement; this effect is significantly great in a pronated forearm compared with a forearm in supination or neutral rotation (p < .005). In all testing conditions, there was approximately 30% of the total constraint contributed by “residual” structures (Fig. 6). Since all soft tissues were sectioned at the level of the DRUJ, this residual effect was attributable to the contact forces between the ulnar head and the sigmoid notch as well as potential residual constraint at the level of the proximal radioulnar joint (PRUJ).

**Discussion**

Pain on the ulnar side of the wrist is a frequent cause of impairment and yet remains poorly understood. Often referred to as the “low back pain of the wrist,” ulnar-sided wrist pain may involve intra-articular, capsular, or extracapsular structures, leading to a seemingly endless list of differential diagnoses. One of the least-understood aspects of ulnar-sided wrist pain remains instability of the DRUJ. Such instability must involve a loss of mechanical integrity of the joint such that the kinematics under normal loaded conditions are rendered abnormal. Because of the intimate anatomic relationship between the wrist and DRUJ, such instability may have an effect on or be caused by pathomechanics of the
DRUJ proper, the ulnocarpal joint, or both. The etiology of these instabilities is equally varied, stemming from trauma, inflammatory arthropathy, or developmental/congenital disorders.

In recent years studies of the biomechanics of the DRUJ have appeared somewhat contradictory and have led to substantial controversy over the structural importance of different ligaments in varying wrist and forearm positions and as constraints to instability. At the foundation of this controversy is the complex anatomy of these supporting structures of the DRUJ and their undefined mutual interactions. Laboratory studies of the DRUJ conducted after radiocarpal disarticulation may have introduced variables sufficient to influence the conclusions from those studies performed with the wrist left intact. The constraining effects on the DRUJ created by the influence of the UCC, ECUS, and dorsal radiocarpal joint capsule have been previously unknown. As our understanding of the complexity of the DRUJ anatomy increases it has become clear that the somewhat arbitrary sections performed in biomechanical studies may not resemble the pathologic anatomy associated with clinical instability. Indeed, comparisons of separate studies is rendered difficult as individual research groups have different understandings of anatomy and use different nomenclature to describe the anatomy.

The terminology used to discuss instability of the DRUJ is confusing. Convention implies that the distal ulna has been considered the mobile element of the DRUJ in situations of instability, with a dorsal DRUJ dislocation indicating a dorsal position of the distal ulna relative to the distal radius. It is well recognized that the radius is the mobile element of the DRUJ whereby the mobile radiocarpal unit

Figure 6. Histograms of percentage contribution to constraint in each position of forearm rotation. Since there was no difference detected in the results with varying wrist position, all histograms reflect the wrist in neutral extension. Residual, all remaining constraints after soft tissue sectioning, including the PRUJ and the articular contact between the ulnar head and the sigmoid notch.
moves around a relatively fixed ulnohumeral unit. This is the situation that our mechanical cadaveric model attempts to emulate. Instability of the DRUJ involves a pivoting action of the radius relative to the ulna and must therefore imply a rotational displacement at the radiocarpal level.38 A so-called “dorsal dislocation” of the DRUJ may be considered to represent a combined palmar displacement of the distal radius relative to the ulna and a supination displacement of the carpus on the distal ulna.16,39 Because of the intimate relationship between the radius and ulna and the behavior of the DRUJ and PRUJ functioning as a single unit,39 the integrity of the elbow joint is of importance to mechanical testing of the DRUJ. With the elbow disrupted, or the forearm amputated below the elbow, the rotation of the forearm bones becomes nonphysiologic and renders interpretation of the results of testing difficult and suspect.6,21

The concept of determining the percentage of total constraint offered by individual soft tissue regions is based on the load-displacement method of testing.28 Laboratory testing of joint systems to determine constraint can be based on either a stiffness model or a laxity model. A stiffness model uses load-control testing in which the components of a joint are moved to a defined displacement point while recording the resultant loads. A laxity model used load-control testing in which the components of a joint are moved until a defined load is encountered while recording the resultant displacement. Under displacement control, the capsuloligamentous structures of the joint will stretch and limit displacement through a restraining force. The total restraining force represents the sum of the restraining forces contributed by the individual soft tissue elements supporting the joint. In this study each identified soft tissue element was sequentially sectioned while observing resultant differences in load at the predetermined displacement point. Each soft tissue element is independent of the other elements. The sectioning sequence does not affect the results because the amount of stretch (hence, tension) of each element is controlled by the amount of displacement produced by the testing machine. For each element sectioned the remaining elements are unaffected because reproduction of the displacement reproduces the tension in the remaining soft tissue elements. Therefore, the results of the testing are independent of the sectioning sequence. The change in resultant load observed after each element was sectioned is represented as a percentage of total restraining load. It is impossible to determine the degree of subluxation potential created with each soft tissue sectioning step under displacement-control testing because the displacement of the joint is maintained as a constant for each experimental step. The results of displacement-control testing are important to the clinician, however, because they provide information about the relative contributions to displacement constraint of the joint provided by individual ligaments, capsules, etc. A study of subluxation potential would require load-control testing, in which resultant changes in displacement of the joint from sequential soft tissue sectioning are measured. If load-control was used as the testing method the displacement of the joint would vary between experimental steps, and the sequence of sectioning would affect the results. Such an experimental protocol would have to include different sectioning sequences to determine the relative contribution of each soft tissue element.

The decision to include the palmar and dorsal 50% of the attachment of the triangular fibrocartilage to the sigmoid notch in the respective DRUL sectioning process reflects the generally accepted opinion in the literature that the central fibrocartilaginous region of the triangular fibrocartilage is of little structural importance to the mechanical integrity of the DRUJ.32 Additionally, any attempt to divide this region separately would have been unreliably reproduced between test specimens. All remaining sections in our study used unambiguous landmarks to define the structure, which substantially improved the interspecimen reliability. Sectioning the triangular fibrocartilage at its ulnar insertion may more accurately reproduce the pathologic anatomy found in DRUJ instability but would have precluded assessment of the contributions of the isolated volar radioulnar ligament (VRUL) and DRUL. Additionally, there are other anatomic structures converging in this region that would have made isolated sections of specific structures impossible.18,19,36 Perhaps the complexity of the anatomy of this region is best termed the medial fibrous node of the wrist,11 at least until our understanding of the region is more complete. A separate study has been conducted, to be reported later, that focuses on the effects on constraint of sectioning the foveal and styloid insertions of this fibrous node.

Sectioning IOM in 2 parts was performed to differentiate between potential mechanical effects of the central band and a reinforcement of the DRUJ dorsal joint capsule,40 hereby called the dorsal radial metaphyseal arcuate ligament, which was found consistently in all dissections. The rationale behind sec-
tioning the IOM through a division at the proximal level of the pronator quadratus muscle was for identification reliability and convenience and was not based on any mechanical presupposition. The pronator quadratus muscle was excised before testing because it was felt that this passively contributes little, if any, to joint stability. The studies of Kihara et al \(^{28}\) and King et al \(^{4}\) similarly divided the IOM into 2 parts for study, permitting a relatively straightforward comparison of results with those in the current study. The VRUL and DRUL have been studied in each biomechanical analysis mentioned above. The DRUJ capsule was evaluated by Palmer and Werner \(^{21}\) who found it to be of little structural importance. The ECUS was studied by King et al \(^{4}\) who felt that it was of great importance in guiding normal kinematics. Unfortunately, the subsheath was defined as all structures attaching to the styloid process of the distal ulna, and the study did not include an analysis of the specimens after the application of dislocating forces.

Through an analysis of constraint properties of the structures surrounding the DRUJ, rather than length changes, tension changes, or degree of subluxation permitted after sectioning, this study has been able to compare the relative importance of individual structures in preventing excessive displacement of the distal radius on the ulna. It also helps to resolve the apparent paradox of the results of the studies reported by Schuind et al \(^{6}\) and af Ekenstam and Hagert \(^{29}\). This paradox arose from the fact that both groups evaluated the same structures but essentially asked different questions. Schuind et al \(^{6}\) evaluated the relative changes in length of the DRUL and PRUL during normal rotation of the DRUJ and found that the DRUL increased in length during pronation and that the VRUL increased in length during supination. These findings led to the assumption that the dorsal ligament constrained subluxation of the DRUJ in pronation and the volar ligament constrained subluxation in supination. Careful analysis of the results, however, shows that these assumptions are unfounded based on the method of investigation in which a normal joint was studied in an intact state. In the study reported by af Ekenstam and Hagert \(^{29}\) the DRUL was felt to constrain dorsal displacement of the radius and the VRUL was found to constrain volar displacement of the radius on the ulna. The results of this study confirm those reported by af Ekenstam and Hagert \(^{29}\) but do not refute the work of Schuind et al \(^{6}\). In this study the VRUL provided the greatest constraint against volar displacement of the radius on the ulna (dorsal subluxation of the ulna), regardless of forearm rotation. In contrast, the DRUL is a constant constraint to dorsal radial displacement, but the action of the VRUL constraint properties are dependent on forearm rotation, which implies some change in action, perhaps related to length/tension changes as a function of forearm rotation. This supports the results reported by Schuind et al \(^{6}\).

By studying the contribution to restraint of the structures surrounding the DRUJ rather than the length of the structures, the tension in the structures, or the degree of subluxation permitted after sectioning those structures, we have been able to compare the relative importance of structures in preventing excessive translation of the radius on the ulna. The apparent paradox in the results of Schuind et al \(^{6}\) and af Ekenstam and Hagert \(^{29}\) suggest that an anatomic structure may be at its maximum length in a certain position of forearm rotation but be of little importance in restraining subluxation in a particular direction.

The 4 axis materials testing machine used in this experimental series was operated under displacement control mode, which allows for complete sequence independence, thus allowing 6 structures to be evaluated with relatively small specimen numbers while maintaining statistically valid results.\(^{28}\) The ability to directly compare the results of sectioning relative to forearm position changes would have been possible if each specimen had been tested in all 3 positions of forearm rotation, as was initially envisaged. The testing machine is designed to induce rotation but this could not be achieved without the risk of inducing large displacement forces at the DRUJ. These forces were of a magnitude similar to those measured during testing and thus could not be separated. This makes interpretation of resultant forces impossible without recalibrating the machine after each rotation and invalidating the comparisons. Using 3 groups of specimens fixed in either neutral rotation, pronation, or supination allowed calibrating of the load cell before testing. Previous biomechanical studies of the DRUJ have all used small specimen numbers \(^{2,5-11,21,29-32}\) without the advantage of sequence independence of serial sections.

Preparation of the specimens used in this series of experiments required the removal of all nonligamentous soft tissues. These soft tissue structures undoubtedly have a restraining effect on the DRUJ, perhaps even in a dynamic fashion through the pronator quadratus and extensor carpi ulnaris.\(^{3,4,12,14}\) This study was strictly limited to passive constraints,
but current studies designed to evaluate the role of dynamic stabilization are under way.

As shown in Figure 5, a consistent residual constraint to DRUJ translation that is of significant magnitude is found after sectioning all soft tissues. We hypothesize that this residual constraint has 3 potential sources: (1) the constraint offered by the PRUJ may contribute to the residual constraint, as it is in physical connection between the radius and ulna only after serial tissue sections are complete; (2) there may be a constraint offered by the geometry of the DRUJ itself; and (3) it should be recognized that the mounting mechanism itself may impart some constraint to the joint during testing. The forearm is mounted assuming that the length of the radius relative to the ulna is constant during dorsal and palmar translation. In actuality, as the radius is “translated,” it describes an arc due to the PRUJ constraint.41–44 The forces thus created by this arc effect were felt to be of no significance considering the small magnitudes of translations performed in this experiment.

This study has shown that wrist motion has no significant effect on DRUJ stability. The hypothesis that varying the tension in the ulnocarpal complex and ECUS through wrist motion influences the tension in the static stabilizers of the DRUJ is not supported. It is possible that the dynamic function of these structures may influence the dynamic aspects of the DRUJ, kinematics. Additionally, the hypothesis that the ulnocarpal ligaments constrain the DRUJ was not verified in these experiments. This does not, however, preclude the possibility that disruption of the stabilizers of the DRUJ, such as the PRUL, will have an adverse effect on the stability of the ulnocarpal joint.

The dominance of the PRUL in preventing the more common clinical scenario of volar subluxation of the radius relative to the ulna (so-called “dorsal dislocation of the DRUJ”), regardless of forearm position, has been clearly demonstrated, which is in agreement with the work of af Ekenstam and Hagert.29 Previously reported surgical techniques designed to treat dorsal dislocations of the DRUJ have concentrated on reconstruction of the DRUL.1,16,44 We feel that the results of this study imply that results may be more reliable by shifting reconstructive efforts to the PRUL.

For the less common clinical condition of palmar instability of the DRUJ, in which the radius subluxates dorsally relative to the ulna, we have demonstrated that no single structure is dominant in all positions of forearm rotation. Both radioulnar liga-

ments as well as the IOM share responsibility for stabilizing the joint against palmar subluxation, which is in close agreement with Kihara et al.5 Continued study of the complex problem of DRUJ stability and instability is required to more fully understand the action of the dynamic stabilizers and their interaction with the passive structures before the ideal reconstructive procedure can be developed.

References

15. Johnson RK. Stabilization of the distal ulna by transfer of


