The effects of dorsally angulated distal radius fractures on the distal radioulnar joint stability

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Introduction
Distal radius fractures are common fractures whose complication rates are relatively high. Malunion is the most common complication with an inadequate closed treatment. The deformity of the distal radius may lead to the functional impairment of the distal radioulnar joint (DRUJ) including limited or painful forearm rotation, arthritis, and joint instability. Those impairments can induce persistent symptoms and patients need osteotomy for malunited distal radius fractures.1,2 Several biomechanical studies3-5 have examined the effect of malunion of the distal radius on the kinematic in the DRUJ and forearm rotation but few studies emphasized effects of malunited distal radius fractures on the DRUJ stability. The purpose of this study was to evaluate the relationship between increased dorsal tilt and DRUJ stability. We also examined the effect of disruption of the ulnar attachment of the TFCC on DRUJ stability in malunited distal radius, since the rupture of the TFCC often occurred in association with distal radius fractures and might cause DRUJ instability.

Materials and Methods
Seven fresh-frozen upper extremities (3 male and 1 female, with a mean age of 85) amputated at the midportion of the humerus were used. The ulna and humerus were affixed firmly to a custom mount that allowed 60° of forearm rotation with the elbow at 90° of flexion. An osteotomy of the radius was performed just proximal to the DRUJ and a custom-designed plate which could control the dorsal angulation of the distal radius was attached to the lateral side of the radius. The radius was attached to the multi axis load cell (Autograph AG-10kNBS; Shimadzu, Japan), which was mounted on the materials testing machine. The load-displacement curves were obtained while translating the distal radius dorsally or palmarly with respect to the ulna at 1.25 mm/sec. The data was sampled at 1000 intervals until 30° of dorsal angulation. The measurements of condition of the radius was then compared with controls(0° dorsal angulation of the intact specimens) at 60° pronation, neutral position, and 60° supination. The tests were repeated after sectioning either the dorsal or palmar portion of the radioulnar ligament (RUL) and then after complete sectioning of the RUL. Each portion was sectioned at its attachment to the ulnar fovea. The significance of changes in the stiffness was analyzed statistically using One-way analysis of variations (one way-Anova) with a post hoc test of the Dunnett method. A p value of less than 0.05 was considered significant.

Results
In the intact specimens, the DRUJ stiffness in the dorsal translation of the radius with respect to the ulna decreased significantly with 20° and 30° of dorsal angulation in the pronated position (Figure 1). In the neutral position, the greater the dorsal angulation of the distal radius, the lesser the DRUJ stiffness was, although the changes were not significant. In the palmar translation of the radius, significant changes of the DRUJ stiffness were not noted.

After partial sectioning of the RUL, the DRUJ stiffness in the dorsal translation of the radius significantly decreased at 10°, 20° and 30° of dorsal angulation in the neutral and pronated position. In the palmar translation of the radius, significant changes of the DRUJ stiffness were not noted.

After total sectioning of the RUL, the DRUJ stiffness in the dorsal translation of the radius in the supinated position and in the palmar translation in the pronated position markedly decreased in all angulated conditions of the radius (Figure 2A and 2B). More than 10° dorsal angulation decreased the DRUJ stiffness in both the dorsal and the palmar translation of the radius significantly in all forearm positions.

Discussion
In the present study, we found the dorsal angulation of the distal radius decreased stiffness of the DRUJ. The dorsal angulation induces instability of the DRUJ likely due to the distortion of TFCC and laxity of RUL.

From our results, More than 10° dorsal angulation of the distal radius should be corrected to prevent DRUJ instability. When there is a partial disruption of the RUL, the dorsal angulation should be corrected less than 10° and if the DRUJ instability still remains, the RUL should be repaired. When there is complete disruption of the RUL, the dorsal angulation should be corrected less than 10° and repair of the RUL is necessary.

Figure 1. Changes in the stiffness of the DRUJ in the specimens with intact RUL in the dorsal translation of the radius with respect to the ulna (*, p<.05; **, p<.01)

Figure 2. Changes in the stiffness of the DRUJ in the specimens with total section of the RUL in the (A) dorsal and (B) palmar translation. of the radius with respect to the ulna. (*, p<.05; **, p<.01)

References