Degrees Of Volar Angulation In Distal Radius Fracture Effects Distal Radioulnar Joint Stability: a Biomechanical Study

Yuki Bessho, MD, Toshiyasu Nakamura, MD PhD, Takeo Nagura, MD PhD, Yoshimori Kiriyama, PhD, Noboru Matsumura, MD PhD, Takuji Iwamoto, MD PhD, Kazuki Sato, MD PhD, Yoshiaki Toyama, MD PhD.
Keio University, Tokyo, Japan.

Disclosures:

Introduction: Distal radius fracture is most common fracture in upper extremity, which sometimes induces malunion. Distal radius malunion may lead to functional impairment of the distal radioulnar joint (DRUJ), including limited or painful forearm rotation, arthritis, and joint instability. Several studies have examined the effect of distal radius malunion on kinematics in the DRUJ and forearm rotation, few studies have emphasized the effects of distal radius malunion fractures on DRUJ stability, however. Recently, Saito et al. have examined the biomechanical effects of dorsally angulated distal radius fracture on DRUJ stability. To best of our knowledge, there has been no biomechanical study regarding degrees of deformity and its effect for forearm function in volarly malunited distal radius fracture. We examined the relationship between increased volar tilt of the distal radius and DRUJ stability in a biomechanical study. We hypothesize that degree of volar tilt significantly affects DRUJ stability and results in limitation of forearm range of motion, as seen in the clinical cases.

Methods: Six fresh-frozen upper extremities that amputated at the midportion of the humerus were used. A custom-designed plate that could control volar angulation of the distal radius was used and radial osteotomy was performed. The humerus and ulna were affixed to a custom mount and the radius was attached to the multi axis load cell of the MTS machine. The distal radius was translated perpendicular to the coronal plane of the radius in a dorsal or palmar direction. Load-displacement data were obtained at 60° of forearm pronation, the neutral position and 60° of forearm supination. The distal radius was angulated at 10° intervals from 0° of volar tilt to 30° volar tilt. Tests were repeated after partial sectioning of the radioulnar ligament (RUL), then after complete sectioning of the RUL. Stiffness was compared with controls(10°of volar tilt, intact RUL) and described as percent stiffness relative to the control level.

Results: In the intact specimens, the DRUJ stiffness increased more than 20° volarly angulation of the distal radius, significantly in dorsal direction at supination and in palmar direction at pronation (Fig.1). There were no statistical differences in the DRUJ stiffness in 0° of volar tilt and 10° of volar tilt. Partial sectioning of the RUL indicated decrease of the DRUJ stiffness (approximate 90% of stiffness compared with intact), however the more the volar tilt, the greater the DRUJ stiffness (Fig.2). Twenty degrees volar angulation indicated the equivalent DRUJ stiffness with the control. After complete sectioning of the RUL, the DRUJ stiffness significantly decrease (approximate 70% compared with intact and 10° of volar tilt) and the stiffness never changed in volarly angulations of the radius at any forearm positions or either dorsal or palmar direction (Fig.3).

Discussion: In this study, the greater the volar angulation of the distal radius, the greater the DRUJ stiffness, although statistical significance was only noted in 20° and 30° angulation of the distal radius in the intact specimen. Increased DRUJ stiffness may restrict range of forearm rotation, which has already described in clinical practice. Partial section of the TFCC did not indicated significant increase of the DRUJ stiffness, however the tendency that increased DRUJ stiffness was noted with increased volar angulation was seen in each rotatory position. After complete sectioning of RUL, the DRUJ stiffness no longer changed with the volarly angulation of the radius. These results suggested that an increase of DRUJ stiffness might be due to tightening of TFCC. Volarly angulation of the distal radius may increase a tension of the TFCC structures due to increased torsion inside of the TFCC. Tightening of TFCC may limit the motion between radius and ulna, increase incongruence of DRUJ, and decrease range of forearm rotation.

Complete sectioning of the RUL indicated decrease of the DRUJ stiffness compared with the intact. The DRUJ stiffness was not changed with increased volarly angulation. These results suggested that the TFCC must be the critical stabilizer of the DRUJ. Once the RUL was ruptured completely at the fovea, volar angulation did not influence on DRUJ stability. Because the DRUJ stiffness significantly increased at 20° of volar tilt (10° from anatomical tilt: 10° of palmar tilt), volar angulation of the distal radius should be corrected to less than 20°. Restriction of forearm rotation by volar angulation of the distal radius less than 20° is also indication for corrective osteotomy.

Significance: The DRUJ stiffness increased with greater volarly angulation of the distal radius may be due to tightness of TFCC. The TFCC must be the critical stabilizer of the DRUJ. The volar angulation of the distal radius should be corrected to less than 20°

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Fig. 1
TFCC intact

Dorsal

Volar

* P<0.05
** P<0.01
Fig. 2
TFCC partial section

Dorsal

Volar

neutral pronation supination

neutral pronation supination

0 10 20 30 0 10 20 30 0 10 20 30

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P<0.01 P<0.05
Fig. 3
TFCC
complete section

**P < 0.01**

**P < 0.05**