Scaphoid and Lunate Translation in the Intact and Injured Wrist

INTRODUCTION: Injury to the wrist may include complete or partial rupture of a number of ligaments. Detection of ligament injury is difficult. Frequently a plain radiograph is taken and a surgeon will look for angular changes or gross gaps between the carpal bones. Little is known regarding how the scaphoid and lunate carpal bones may translate in the normal or injured wrist. A previous study (Sutton et al) only examined lunate motion. The 3 goals of this study were to determine how much the scaphoid and lunate translate during wrist motion in the intact wrist, to determine how these translations might change after injury to the wrist and to assess whether these changes are detectable on a plane radiograph.

METHODS: The motions of the scaphoid and lunate were measured in 37 cadaver wrists as each wrist was moved using a wrist joint motion simulator. Physiological forces were applied to cause wrist flexion-extension, wrist radioulnar deviation, and a wrist dart throwing motion. The motion of each bone was measured by an electromagnetic sensor attached to a platform and post that was cemented into each bone. Kinematic data was acquired in each intact wrist and then in two subsets of these wrists. In 18 wrists, data was collected after the scapholunate interosseous ligament (SLIL) as well as the dorsal radiocarpal (DRC) and dorsal intercarpal ligaments (DIC) were sectioned. In 19 wrists, data was collected after the SLIL and 2 volar ligaments (the scaphocapitate special (ST) and the radioscapholunate capitae (RSC)) were sectioned. Data was collected immediately after sectioning and again after 1000 cycles of motion to simulate repeated use after injury. In each wrist, the centroid of scaphoid and lunate motion was captured by a) taking CT scans of each wrist (and the motion sensors), b) animating the motion of the bones by using the collected kinematic data and then c) computing the centroid at each of the 273 frames of motion during each cycle of motion in the intact and simulated injured wrist. Movement of the centroid was computed relative to a reference position at neutral wrist flexion-extension and radioulnar deviation.

Changes in the translational positions of the scaphoid and lunate centroids for the intact wrist, were statistically analyzed using a one way repeated measures ANOVA at p<.05. Two factor, repeated measure ANOVAs were used to examine the changes in the centroid position after the ligaments were sectioned with one factor being wrist angle and the other factor being whether the ligaments were intact or sectioned.

RESULTS: In the intact wrist, statistical differences in the translational position of the scaphoid centroid were in the radial-ulnar direction (p<0.034) during the wrist flexion-extension motion (figure 3). There were no statistical changes in the scaphoid centroid after the volar ligaments were sectioned with any of the wrist motions (p > 0.127).

Statistical changes in the lunate centroid position were observed after the dorsal ligaments were sectioned during wrist flexion-extension and wrist radioulnar deviation in the radial-ulnar and dorsal-volar directions (p<0.047). During the dart throw motion there were statistical changes in the centroid position in all three directions (radial-ulnar, dorsal-volar and distal-proximal; p<0.047). After the volar ligaments were sectioned, the lunate centroid position changed in the radial-ulnar and dorsal-volar directions (p<0.003) during wrist flexion-extension, in the dorsal-volar direction (p<.008) during wrist radioulnar deviation, and in the dorsal-volar direction (p<0.030) during the dart throw motion.

DISCUSSION: These results suggest that the centroid of the scaphoid and lunate do translate with wrist motion, especially radially during ulnar deviation. Following simulated ligamentous injury, changes in the centroid position were more common with the lunate, especially in the radial-ulnar direction. However, these changes are small and perhaps not detectable using a radiographic method, as might be used by a surgeon as an initial screening method. Since they are relatively small, these results support those of Viegas et al. that ulnar translation of the lunate does not occur unless multiple ligaments are sectioned. Injury of more than the SLIL along with either the RSC and STT or the DIC and DRC may be needed to have large amounts of ulnar translation. Clinical evidence of lunate ulnar translation warrants concern that a majority of the dorsal and volar ligaments have been damaged.


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