The purpose of this study was to evaluate the effect of initial manual registration on the final registration for kinematic analysis of the radioulnar joint during grasp. We also evaluated the effect of image plane orientation (90° image plane rotation) on the accuracy of the final registration. It was hypothesized that variation in manual registration and image plane orientation will significantly alter the final kinematics obtained by image registration.

MRI images of wrist joint of 2 human subjects* were taken with a 3T scanner. Set 1a was taken with the wrist relaxed (unloaded) in supination, and Set 1b was taken during active light grasp (loaded) in supination. Set 2a was obtained with the wrist relaxed (unloaded) in supination, and Set 2b was taken during active light grasp in neutral forearm rotation. Thus, for Set 2 the ulna was viewed in two different rotations/configurations. Individual bones were isolated from the images using Adobe Photoshop and image registration was performed using ANALYZE 5.0 software to determine the kinematic transformation from the unloaded to the loaded configuration (with the radius as fixed reference). All registrations were initially performed to obtain the best manual registration possible. Then iterative automatic registration was performed for up to 25 iterations. All the registrations are manually viewed and the best overall fit is selected for the final kinematic transformation. To analyze the effect of manual registration accuracy, perturbations from the best manual registration of 1, 2, 3 voxel translations and 1°, 2°, 3° rotations (along and about image plane axes) were made to vary the initial conditions for auto-registration. The best registration following each perturbation was compared to the results of the best auto-registration following the best/standard manual registration using RMS error.

For radius registration perturbations of voxel translations resulted in 60% difference for Set 1 (all supination) except for 3 voxel perturbations and 28.6%-62% difference for Set 2 (rotated). Rotation perturbations for the radius resulted in 10.2%-33.8% differences in Set 1 and 16%-78% differences in Set 2.Ulna translation perturbations yielded 2%-58.5% differences for Set 1 and 69.8%-95.3% differences in Set 2. Ulna rotation perturbations yielded 14%-36% differences in Set 1 and 2.5%-17.5% differences for Set 2. The error variations in attitude vector were high for radius and ulna in Set 2 than Set 1 both in translation and rotation in general.

The variations in results for translation vector were less for the radius than ulna in translation. Errors for rotation and translation were higher for perturbations in the z-direction (perpendicular to the image plane). In general, the ulna rotation in image Set 2 resulted in higher kinematic differences. This emphasizes the need for consistent forearm/wrist position when imaging for kinematic analysis.
*Approved by the Human Subjects Committee, Lawrence, KS