IMPACT OF IMPAIRED WRIST MOTION ON HAND AND UPPER EXTREMITY PERFORMANCE

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INTRODUCTION

In the treatment of wrist arthritis, motion-preserving procedures are commonly preferred over complete arthrodesis because it is perceived these procedures provide higher patient satisfaction. Potential reasons for higher satisfaction include better function and reduced impact on other joints. Reported risks with these procedures include further arthritic changes, failure of fusion, and implant loosening. To justify the risks and added technical challenges associated with these procedures, the benefits should be objectively measurable.

Our goals were to quantify and compare the impairments caused by reduced and absent wrist motion using objective measurements of task performance and perceived impairment, and to assess the compensatory motions of the shoulder, elbow, forearm, and trunk imposed by impaired wrist motion.

METHODS

Twenty-one subjects (average age 23.8 years) without upper extremity compromise were recruited. After informed consent was obtained from all subjects, each subject’s dominant side was tested on three consecutive days.

A custom brace (Figure 1) containing a single hinge at the wrist was made for each subject.

Figure 1: A Rolyan Incremental Wrist Hinge (Rehabilitation Division, Smith and Nephew, Germantown, WI) joined the components.

The mini-BIRDS® electromagnetic tracking system (Ascension Technology, Inc., Burlington, VT) was used to track wrist, forearm, elbow, and shoulder motions of the tested extremity and trunk. The Disabilities of the Arm, Shoulder and Hand (DASH) and Patient Rated Wrist Evaluation (PRWE) standardized patient questionnaires were administered to each subject to assess the difficulty of completing various tasks.

Task performance was measured under three conditions: 1) unrestricted wrist motion 2) fully restricted wrist motion, and 3) partially restricted wrist motion. Each subject performed the Jebsen hand function test, then a series of 13 tasks obtained from questions in the DASH, PRWE, and previous studies on wrist and elbow motions. Time was recorded in seconds and perceived difficulty of task completion was measured by the completion of a modified version of the DASH and PRWE, as well as a study specific questionnaire regarding tasks in the Jebsen test and the 13 Activities of Daily Living.
The process began with the subject completing a baseline DASH and PRWE surveys. After a practice run of all the activities, subjects were then braced, randomly assigned an order of bracing method, and instructed to wear the brace until testing the next day.

On reporting the next day for testing, the subject completed the DASH and PRWE. The Jebsen test and the 13 ADL were then performed, with each task timed in seconds and joint motions recorded. Subjects then completed the Jebsen and ADL surveys. The brace was removed and the protocol repeated. The subject was dismissed wearing the brace set for the other condition of restricted motion. The third day, the protocol was repeated as on the second day.

Mixed-model, analysis of variance (ANOVA) techniques were run using the SAS system (version 8.2; SAS Institute Inc., Cary, NC). Statistical analyses were conducted for individual joints and planes of motion. Both the brace and task orders were considered “nuisance” conditions, and analyzed for their effects. Repeated baseline measurements on days 2 and 3 assessed learned-effects.

RESULTS AND DISCUSSION

Times to complete the Jebsen test were significantly increased (p<0.05) for both the fully and partially restricted wrists. The times were highly variable among subjects, with standard deviations of 4.8, 5.8, and 9.4 seconds respectively.

The times for the ADL test also significantly increased (p<0.05) for both the fully and partially restricted wrists (Figure 2), and times were highly variable among subjects. Both restricted wrist motion conditions were associated with small increases in ipsilateral forearm, elbow, shoulder, and trunk motions, of which some were statistically significant. The average differences between the partially and fully restricted wrists were not statistically significant, however the changes in motions were highly variable among subjects and tasks.

SUMMARY

An individual’s perceived impairment with performance of common tasks appears to be influenced by their available wrist motion. Simulated motion preserving procedures rated better than simulated arthrodesis by several parameters but the differences were not as great as we had anticipated. Thus, it may be hard to predict a patient’s response to reduced wrist motion.