Scientific/Clinical Article

Responsiveness of the active wrist joint position sense test after distal radius fracture intervention

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ABSTRACT

Study Design: Prospective cohort study.
Introduction: The active wrist joint position sense (JPS) test has been determined to be a clinically useful test for assessing wrist sensorimotor (SM) status after distal radius fracture (DRF). Its responsiveness is yet to be determined.
Purpose of the Study: Primary study aim was to determine the active wrist JPS test responsiveness to detect change in wrist SM status at 8 and 12 weeks after DRF treatment intervention. Secondary aims were to compare group (nonsurgical, surgical, high, and low pain) test responsiveness; compare pain-level group participants test scores; determine the relationship between test minimal clinically important difference (MCID) value and function; compare functional outcomes across assessment times; and determine the Patient Global Impression of Change Scale intrarater reliability.
Methods: A total of 33 male and female participants were tested at baseline, 8, and 12 weeks after nonsurgical ($n = 13$) and surgical ($n = 20$) DRF treatment interventions. Distribution-based analysis encompassed both group- (ie, effect size, standardized response mean) and individual-based (ie, minimum detectable change) statistical indices. Anchor-based analysis determined the MCID value by linking test scores to the Patient Global Impression of Change Scale.
Results: The active wrist JPS test is highly responsive based on effect size (8 weeks = 1.53 and 12 weeks = 2.36) and standardized response mean (8 weeks = 1.57 and 12 weeks = 2.14). Statistically significant minimum detectable change values were 4.28° and 4.94° at 8 and 12 weeks, respectively. Clinically meaningful MCID values were 5.00° and 7.09° at 8 and 12 weeks, respectively. Between treatment type and pain-level group responsiveness levels were not significantly different. High-pain participants demonstrated significantly greater JPS deficit. Test MCID values and function were significantly associated.
Discussion: This is the first study to determine the active wrist JPS test responsiveness as reflected by its group- and individual-based statistical indices following DRF surgical and non-surgical interventions among low- and high-pain level participants. The statistical analysis approach, which was used to determine the aforementioned variables of the active wrist JPS test, is consistent with current research. This study's strengths included its design, methodology, and statistical approach. The study findings must be interpreted, however, within the content of several methodological limitations.
Conclusions: The active wrist JPS test was determined to be highly responsive to detect wrist SM status change at 8 and 12 weeks regardless of treatment type or pain level. Clinicians can use this test with confidence to measure clinically meaningful SM impairment after DRF treatment.
Level of Evidence: 2b

Introduction

The initial 12 weeks after distal radius fracture (DRF) nonsurgical and surgical interventions are a clinically important period,[1-7] involving up to 50% of patient-reported functional recovery.[8] During this period, the Patient-Rated Wrist Evaluation (PRWE)[6] is commonly used to assess pain and ability.[9,10] Wrist sensorimotor (SM) control impairment has also been reported during this period, which embodies both sensory (ie, sensibility and joint position sense [JPS] deficit) and motor (ie, muscle recruitment, grip force production, and muscle fatigue) deficits.[11] JPS is an important component of the SM control system, providing conscious sense of joint position recognition.[12-14]

The SM control system consists of central processing of sensory input from peripheral neuroreceptors, resulting in involuntary neuromuscular responses for maintaining joint stability and postural balance during human kinesis.[15] It consists of unconscious and conscious proprioceptive senses.[12,16] The unconscious sense controls the body's reflexive neuromuscular mechanisms toward postural stability and equilibrium.[15,16] The conscious sense produces willful perceptions of joint motion (ie, kinesthesia) and position (ie, JPS).[12,16] Active JPS represents the ability to accurately reproduce a specific joint angle with vision blocked[16] (ie, visual proprioceptive input plays a complementary role on SM joint control).[15] This can be simply assessed via the active wrist JPS test by goniometer measures.[13,16]

The active wrist JPS test follows a standardized protocol to assess ability of memorizing and reproducing a specific joint angle of reference at the ipsilateral wrist with vision occluded.[11] Its score indicates joint position recognition error.[16] This test has been determined to be a clinically meaningful measure for conscious SM impairment after DRF.[11] Higher active wrist JPS impairment has been linked to greater functional deficit (ie, higher PRWE scores) after DRF. Another clinically meaningful impairment after DRF is pain[8,11,17] due to its influence on wrist SM control[11] and function.[4] Higher pain scores have been linked to increased wrist SM deficit after DRF.[11]

Current knowledge on the psychometric properties of the active wrist JPS test is limited. Only its intrarater reliability has been determined to date. Critical patient-care decisions after DRF interventions are heavily dependent on clinically meaningful results derived from responsive measures.[10] An instrument's responsiveness refers to its ability to accurately detect change that has occurred within its specific clinical domain.[18] The active wrist JPS test responsiveness[18] as reflected by group- (ie, effect size [ES], standardized response mean [SRM]) and individual-based (ie, minimum detectable change [MDC], minimum clinical important difference [MCID]) statistical indices has yet to be reported. The same is true for the possible influences of treatment intervention and pain level on active wrist JPS test responsiveness as well as its association with function after DRF intervention.

Purpose of the study

The primary aim of this study was to determine the responsiveness of the active wrist JPS test to detect wrist SM change at 8 and 12 weeks after DRF treatment intervention. Secondary aims of this study were to (1) compare the active wrist JPS test responsiveness as reflected by its MCID value between nonsurgical and surgical interventions as well as high- and low-pain DRF participants groups; (2) compare the active wrist JPS test scores between participants with high- and low-pain levels; (3) assess the relationship between active wrist JPS test MCID value and function; (4) compare reported functional outcomes among 3 intervals (ie, baseline, 8, and 12 weeks); and (5) determine the intratester reliability of the Patient Global Impression of Change (PGIC) Scale for

accessing global health status change. This study intended to improve clinical knowledge toward measuring meaningful wrist SM deficit change after DRF intervention.

Methods

Study design and participants

A prospective longitudinal cohort study design was used to determine the active wrist JPS test responsiveness as reflected by its group- and individual-based statistical indices to detect wrist SM status change after nonsurgical and surgical treatment interventions after DRF. The independent variables were treatment group (nonsurgical and surgical), pain level (high and low), and time (baseline at study induction as well as at 8 and 12 weeks after DRF treatment). The dependent variables consisted of active wrist JPS psychometric properties of group- (ie, ES and SRM) and individual-based (ie, MDC and MCID values) statistical indices of responsiveness as well as PGIC and PRWE composite scores. Potential covariates were age, gender, and hand dominance. A 1-tail 0.80 a priori power analysis with a 0.05 alpha level and 0.80 (large) ES determined that a sample size of 40 was required for the study.

A convenience sample of 33 participants aged older than 18 (range 25-90) years after any nonsurgical and surgical DRF treatment was recruited during their first physical therapy visit at the study's primary research center, which is an outpatient orthopedic physical therapy facility. The study was approved by the Temple University Institutional Review Board, and each participant completed and signed approved informed consent.

Participation in the study was voluntary. Eligibility was determined based on the following inclusion criteria: (1) attending surgeon ($n = 7$) approval for study participation; (2) ability to speak and read English; (3) 18 years of age or older; (4) completion of a nonsurgical or surgical DRF treatment intervention; (5) provision of supervised physical therapy by a certified hand therapist; and (6) ability to actively flex and extend the wrist a minimum of $10°$ and $30°$, respectively.

Specific exclusion criteria applied to all potential participants of the study. The exclusion criteria consisted of extended length of immobilization that precluded testing at 8 weeks after fracture treatment, carpal tunnel syndrome, or other neurological pathology resulting in paralysis or paresis of the involved arm, wrist, or hand rheumatoid disease, cognitive impairment that prevented the patient from following instructions safely, ipsilateral extremity trauma within the last 6 months, concomitant ulna fracture, ipsilateral extremity lymphedema that affected wrist and hand motion, blindness, pregnancy, and workers compensation or no fault auto accident carrier insurance coverage.

Measures

Data recording forms

Three investigator-generated data recording forms were used in the study: Participant Demographic and Characteristics, Participant Screener, and Data Collection. The Participant Demographic and Characteristics Form was used to collect information regarding participants' demographics, treatment intervention, and physical therapy. The Participant Screener Form was used to obtain information regarding each participant's past and present medical conditions, which was used to determine study participation eligibility. The Data Collection Form was used to record data for the active wrist JPS test.

Patient's Global Impression of Change Scale

The PGIC scale is a global disability rating scale, which is used as an external criterion instrument to determine clinically significant treatment outcome changes.[19-22] In this study, the PGIC scale was