COMPARISON OF THE VALIDITY AND RELIABILITY OF THREE DIFFERENT METHODS USED FOR WRIST PROPRIOCEPTION MEASUREMENT

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STUDY PROTOCOL

Participants

The prior sample size calculation section of G*Power 3.1.9.2 software revealed that the inclusion of 32 healthy participants (64 wrists) was necessary for achieving 95% power individuals who suffered an injury or underwent a surgical procedure in the last six months that could affect hand functions or senses were excluded from the study. Additionally, individuals with a history of neuromuscular disease, traumatic nerve injury, congenital anomalies, or skin infections were excluded. An informed consent form was obtained from all participants. An independent ethics committee approved the study (approval number:24074710--028).

Instrumentation

The Cybex isokinetic dynamometer [Cybex NORM®, Humac, CA, USA] was used as a reference standard to test the validity of the universal goniometer, inclinometer [Acumar, Lafayette Instrument Co., Lafayette, USA], and JPSG. The isokinetic dynamometer is a well-known instrument for measuring passive and active joint position sense (AJPS) and provides a target angle result without rater bias (Relph & Herrington, 2015). The Cybex isokinetic dynamometer has a good reliability in evaluating wrist AJPS (Seven et al., 2019).

Procedures

The evaluation of proprioception using the isokinetic dynamometer was performed with the participants in sitting. The shoulder was positioned in the midline, the elbow was flexed about 90°, and the wrist was positioned in supination (Brown, 2000). During the evaluation, the forearm was fixed with a strap to prevent the forearm from moving and changing the angle of the wrist. The rotation axis of the dynamometer was aligned with the diagonal axis of the distal tubercule of radius and the head of ulna (Figure 1). The

wrist was placed in a 0° position. In this starting position, the range of motion was set as 40° flexion and 40°extension (Ellenbecker et al., 2006). The device was calibrated before the evaluation of each participant.

The goniometric (1° scale increments) measurement was performed with the elbow positioned at 90° flexion and resting on the table, the forearm was in mid-pronation, and the fingers were relaxed (Hagert, 2010; Karagiannopoulos et al., 2016; Pilbeam & Hood-Moore, 2018). The movement axis of the mid-carpal and radiocarpal joints is defined as the pivot point of the goniometer to ensure a compatible measurement of wrist movement. The stable arm of the goniometer was placed parallel to the radius, and the mobile arm was followed the third metacarpal bone (Figure 2) (Pilbeam & Hood-Moore, 2018).

The JPSG consists of two wooden boards fixed at an angle of 90°. The plate perpendicular to the ground has an opening that the wrist can go through. 0 to 180° angle values with 1° increment were drawn on the plate that parallels the floor (Erdem, 2013). For the evaluation, the participant was asked to sit in front of the table with the trunk upright and the shoulder in the neutral position. The patient's forearm passed through the opening in the JPSG, and the wrist joint was adjusted to match the axis of movement (Figure 3). The forearm was positioned in mid-pronation, the wrist was positioned at 0° flexion/extension, and the forearm was in the neutral position. Participants were asked not to contact the plates during the measurements.

Another tool used to evaluate wrist AJPS was the digital dual inclinometer. The limb position used during the inclinometer evaluations was the same as the position for the goniometer. One of the inclinometer sensors was placed on the 3rd metacarpal bone on the dorsal side of the hand. The other sensor was placed on the dorsal side of the forearm, perpendicular to the flexion/extension movement axis (Figure 4).

AJPS was measured to evaluate wrist proprioception. An eyepatch was used during all tests to prevent visual stimuli, and the evaluations were performed in a quiet room. The

30° extension, which is the functional position of the wrist, was selected as the target angle for AJPS assessment (Neumann, 2002; Seven et al., 2019). After the test was explained to the participants, they were asked to actively bring the wrist from the neutral (0° flexion/extension) to 30° extension (a barrier was placed at 30° line) and wait for 5 seconds at this position. The participants were then asked to return to the starting position (a block was also placed at 0°). The participants were then asked to find the target angle. This trial was repeated three times. The amount of error between the target and achieved angles were recorded as the absolute angular error. The relative error amount was calculated using the arithmetic mean of these three absolute angular errors (Suner-Keklik et al., 2017). The same measurements were repeated for the other limb. The same rater performed all measurements.

All evaluations were repeated at the same hour of the day, seven days after the first measurement by the same rater to examine the test-retest reliability of the methods (Holmbäck et al., 1999). To avoid the learning effect(Feiring et al., 1990), the order which extremities were assessed (right/left) was determined using a web-based "Random Sequence Generator Application" (https://www.random.org/sequences/).The same randomization method was used to determine the order of the evaluation methods. The sequence used for each participant on the first evaluation was repeated on the second evaluation. A five-minute rest period was given between each measurement to eliminate the effect of muscle fatigue. As AJPS was demonstrated to significantly reduce during the menstruation period, the evaluation days of the female participants were arranged not to coincide with the week of menstruation (Aydoğ et al., 2005).

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