Validity and Reliability of Range of Motion Measured on Smartphone (mROM)

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Abstract

Background: Nowadays, as internet-based communication is advancing rapidly, it is getting more and more interesting to adapt clinical examination of patients to remote communication. The use of smartphone photographic is presented as a method for studying the measurement of shoulders joint ROM.
Objective: To investigate the reliability of smartphone photographic measurements of upper limbs abduction angle through mRom app compared to inertial sensors as the criterion standard.
Methods: This cross-sectional involved 28 subjects: 14 healthy persons and 14 persons suffering from shoulder pathology. Descriptive and anthropometric independent variables were included. A physical property was included corresponding to a dependent variable: mobility angle (degrees), which was obtained thought two different devices. On the one hand, as criterion standard, the inertial measurement sensors with two inertial sensors (InertiaCube3™ Intersense Inc., Billerica, Massachusetts) located in the middle third of the humerus slightly posterior and in the flat part of the sternum. It contains an inertial 3 Degree of Freedom orientation tracking system: yaw, pitch, and roll. On the other hand, degrees were also obtained using a smartphone Nexus 4 (LG Electronics INC, Yeouido-dong, Seoul) with an 8 megapixels main camera and a 4.7 inches Corning Gorilla Glass 2 touchscreen. The app used was mROM Lite (Brain Dynamics SL, Málaga, Spain), available in google store. Three photographs were taken by two examiners from 3 independents set of images, and they were taken at the same time as inertial measurement. Participants were placed standing, starting from neutral position, performing shoulder abduction.
Results: The mean ± SD age of the healthy participants (8 female, 6 male) was 56.1 ± 9.1 years, and their body mass index (BMI) was 27.12 ± 3.8 Kg/m2. The mean ± SD age of the participants with shoulder pathology (8 female, 6 male) was 54.4 ± 10 years and their average BMI was 28± 6.7 Kg/m2.
Intraclass correlation coefficients ICC(2-1) for intrarrater reliability for inertial measurements taken by the first examiner was 0.993 (95%CI: 0.983, 0.998) for subject with pathological shoulders, 0.982 (95%CI: 0.736, 0.962) for healthy subjects and 0.992 (95%CI: 0.984, 0.996) for the total sample. Values for photographic measurements were 0.865 (95%CI: 0.670, 0.953) for healthy subjects, 0.991 (95%CI: 0.977, 0.997) for subjects suffering from shoulder pathology and 0.996 (95%CI: 0.992, 0.998) for the total sample.
The ICC(2-1) for measurements taken by two different examiners was 0.711

(95%CI: 0.099, 0.907) for the first photograph, 0.703 (95% CI: 0.076, 0.905) for the second one and 0.892 (95%CI: 0.663, 0.965) for the third one in healthy subject. In subject with pathology it was 0.994 (95% CI: 0.982, 0.998), 0.998 (95% CI: 0.993, 0.999) and 0.996 (95% CI: 0.989, 0.999) respectively. In the total sample it was 0.997 (95%CI: 0.992, 0.998), 0.998 (95%CI: 0.995, 0.999) and 0.998 (95%CI: 0.995, 0.999) respectively.
Conclusions: Smartphone photographic measurements of upper limbs abduction angle through mRom app are reliable compared to inertial sensors. This method provides a convenient and precise tool in assessment of shoulder motion.