뇌신경재활

게시일시 및 장소 : 10 월 18 일(금) 13:15-18:00 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 15:57-16:01 Room G(3F)

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Reliability of inertial sensor-based post-stroke spasticity measurements

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Objectives

Spasticity causes major disabilities in activities of daily living in stroke survivors. While Modified Ashworth scale (MAS) and Modified Tardieu scale (mTS) are most commonly used methods for measuring spasticity, there are fundamental limitations of ambiguity and reliability. These drawbacks are especially due to inconsistency of manual or goniometer-based measurement of angle of catch (AoC). We developed inertial measurement unit (IMU) sensors to quantitatively measure a joint angle during passive range of motion (ROM). In this study, we investigated to compare the test-retest and inter-rater reliability of goniometer- and IMU sensor-based measurement of AoC. Also, we aimed to describe individual variability of MAS grade 2 using IMU sensors.

Methods

A total of 23 stroke patients with 29 spastic (MAS 1 to 2) elbows were included. Patients with co-morbidity or with serious cognitive impairments were excluded. The test protocol was based on the dynamic part of the mTS measurement of spasticity. Two examiners (A and B) measured the spasticity using two instrumentations: 1) a digital goniometer (Bluebird 200mm Digital Angle Ruler Meter Goniometer) and 2) an IMU-based system (Human Track, Rbiotech Co., Ltd., Seoul, Korea). Each limb was examined for two times. Two IMU sensors tracked the motion during the tests, with a sample frequency of 100 Hz. The angles of full ROM and acceleration rate of the movements were calculated using MATLAB program. AoC was defined as maximal deceleration point. Test-retest and inter-rater reliability of AoC measurement for both digital goniometer and IMU data were calculated with Cronbach's α. From the time-angle curve, we classified the patterns of curve that correspond to the MAS grade 2.

Results

Test-retest reliabilities using digital goniometer were excellent (Crohnbach's α = 0.970 and 0.968 for examiner A and B), but inter-rater reliability was acceptable (Crohnbach's α = 0.770). For IMU sensor method, both test-retest (Crohnbach's α = 0.964 and 0.949 for examiner A and B) and inter-rater reliabilities (Crohnbach's α = 0.933) were excellent. In 8

spastic elbows measured as MAS grade 2, patterns of AoC were as followings: (A) marked AoC point before a half of the full ROM; (B) marked AoC point after a half of the full ROM; (C) unapparent AoC during the full ROM (Figure 1), which means that spasticity classified as MAS 2 can be classified in detail according to AoC patterns measured with IMU based system.

Conclusion

Post-stroke spasticity measurement using IMU sensors showed more reliable results than digital goniometry. Spastic limbs with MAS grade 2 can be subclassified according to AoC patterns measured with IMU sensors. Further studies should be needed to investigate a new spasticity measurement using IMU sensor.

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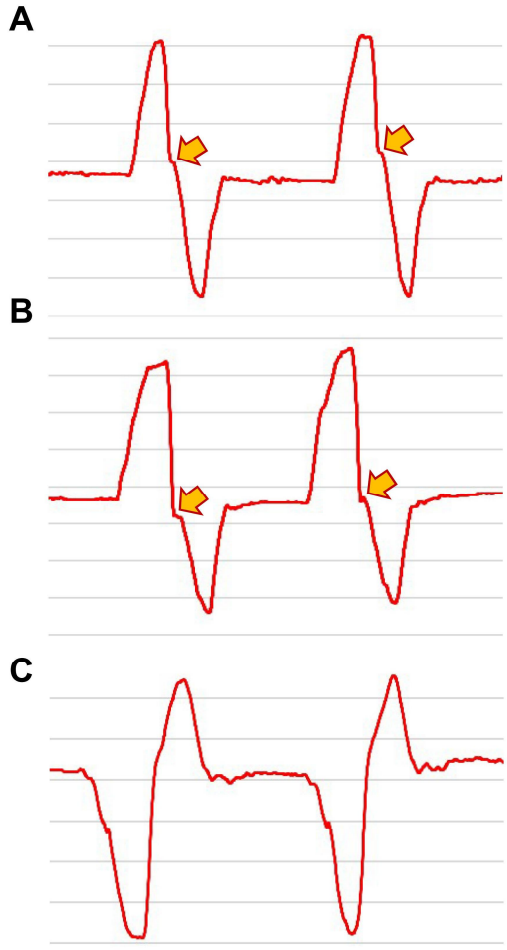

Figure 1. Patterns of angle of catch (AoC) in elbows with MAS grade 2.