Measuring the Impact of Motor Impairments on Reaching Function in Individuals with Chronic Hemiparetic Stroke

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Background

- Flexion synergy, weakness, and limited passive range of motion are common impairments following a stroke.
- These impairments are often studied in isolation leaving their relative predictive capacity of reaching function unknown.

Research Objectives

- Evaluate the relative contribution of the impairments that impact reaching function in individuals with chronic moderate to severe hemiparetic stroke.
- Determine the independent contributions of these variables on reaching function to aid in the prioritization of interventions for this population.

Participants

- N = 34 (23 males and 11 females; 58.3 ± 8.3 years post-stroke; 26 ± 7 out of 66 arm motor Fugl-Meyer score).
- Participants provided written consent and completed the IRB-approved study.

Methods

- Movement kinematics and kinetics quantified using a robotic device (Figures 1 & 2).
- Isometric shoulder abduction and elbow extension strength measured using goniometry at end-range with overpressure.
- Three randomized dynamic protocols completed to quantify reaching function and the emergence and takeover thresholds of flexion synergy (Figure 4).
- Multiple linear regression used to determine the relative contributions of each impairment to reaching function.

Results

- Original model: significant regression equation was found (F(5,20) = 4.18, p = 0.009) with R² of 0.511.
- Reaching function (Mean ± SD; 0.61 ± 0.36) was significantly correlated with flexion synergy emergence (0.31 ± 0.24, r = 0.63, p = 0.001), shoulder abduction strength (0.56 ± 0.19, r = 0.39, p = 0.023), and elbow extension strength (0.44 ± 0.19, r = 0.41, p = 0.017).
- Passive range of motion and flexion synergy takeover did not have significant correlations (p > 0.05) with reaching function.
- Flexion synergy emergence was the only significant regressor with a standardized beta coefficient of 0.585 (p = 0.007).
- Second model with non-correlated regressors removed: significant regression equation was found (F(1,22) = 6.858, p = 0.002) with R² of 0.483.
- Flexion synergy emergence was the only significant regressor with a standardized beta coefficient of 0.521 (p = 0.005).

Conclusions

- This study included a specific sample population which was limited to individuals attempting to restore reaching function in chronic moderate to severe stroke.
- The findings of this study indicate that impairments such as strength and passive range of motion may not contribute to reaching dysfunction to the same extent as flexion synergy.
- The substantial contribution of flexion synergy to reaching function suggests that prioritizing flexion synergy impairment is likely to have the greatest impact when attempting to restore reaching function in chronic moderate to severe stroke.

Limitations

- This study included a specific sample population which was limited to individuals with enough function in the affected arm to elevate against gravity to shoulder height in order to quantify reaching function.
- The study was also limited to a sample with moderate to severe generalized impairment as measured by the arm motor Fugl-Meyer score.