

TEMPORAL CHANGES IN MOTOR IMPAIRMENTS AND GAIT FUNCTION POST STROKE

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INTRODUCTION

The ability to safely ambulate is the prime factor that determines whether a stroke patient will be discharged to a skilled nursing facility or return home, and whether he or she will return to pre-morbid levels of social and occupational activities (Wall and Turnbull 1986). Therefore understanding the factors that contribute to gait recovery, as well as how they change with time are important research topics. Specifically, it remains to be seen how the evolution of multiple impairments contributes to improvements in functional activities throughout the recovery process. In order to determine these relationships, the time course of these variables must first be determined. Therefore, the goal of this investigation is to acquire a set of quantitative and clinical measures of impairments and activity at monthly intervals between the onset of the disease and twelve months post stroke. We hypothesize that onset of walking ability will vary with subject. We further hypothesize that increased strength may not mirror functional improvements. The outcomes of this study may provide insight into factors that influence clinical discussions regarding the return to pre-morbid activities of daily living and allocation of resources.

METHODS

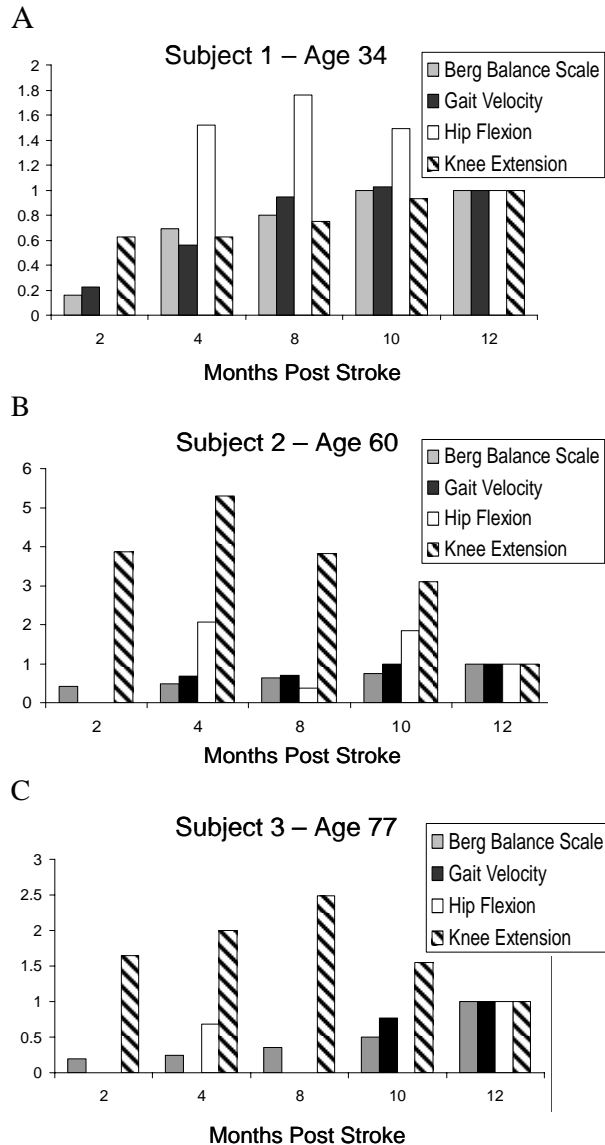
Subjects with first ever, monohemispheric CVAs were recruited within two months of the onset of CVA and tested every two months up to one year post-stroke. Several types of impairment measures and functional outcomes were collected as able by the subjects, including overground gait, isometric

strength, across joint synergies, balance, endurance, and spasticity. Overground gait analysis was performed using standard procedures and equipment (Cleveland Clinic marker set and an eight camera Motion Analysis Corp). Subjects walked with comfortable shoes on a 10m walkway at a self-selected walking speed for a minimum of five trials. Stroke subjects were tested with and without assistive devices (ankle-foot-orthoses and canes), as able. Kinematic, kinetic, and spatial-temporal variables were measured.

For the isometric data collection, a previously published experimental paradigm was used (Cruz and Dhaher 2008). Briefly, the subjects' lower limbs were secured in an instrumented exoskeleton locked in the standing toeoff posture. Subjects were instructed to produce maximum hip frontal and sagittal plane torque and hold for 200ms, while receiving real-time visual feedback. Subjects were unaware that knee flexion/extension torque measurements were recorded simultaneously, providing a measure of across-joint coupling. The paretic knee and ankle sagittal plane strengths were measured in the seated posture using a Biodex® chair. Finally, balance, endurance, and spasticity were measured using the Berg Balance Scale (Berg, Wood-Dauphinee et al. 1995), six minute walk test, and Modified Ashworth (Bohannon and Smith 1987), respectively. These values were recorded every two months from the acute, sub-acute and chronic phases of stroke recovery (2 to 12 months post stroke).

RESULTS AND DISCUSSION

Seven subjects have been recruited; four have completed the twelve month study, and three will complete the program within the next four months. Preliminary findings reveal different non-linear changes over time with regards to all variables collected; see Figures 1 A, B, and C for exemplar data.



Figures 1 A, B & C: The recovery of function and strength by high (A), middle (B), and low functioning (B) stroke survivors. Data normalized to chronic values within a subject.

For example, the onset of walking varied with subject and appears to be related to age, as younger subjects walked earlier than older subjects. While the evolution of functional measures (walking speed and balance) were similar within a subject, the rate of change of all strength measures did not mirror these improvements. Moreover, the patterns of return differed between the functional and strength measures. Specifically, the functional measures logarithmically approached asymptotic chronic values, while the strength measures appeared parabolic. More data is required to define these trends.

SUMMARY/CONCLUSIONS

Consistent with clinical observations, recovery was found to be subject specific. Larger datasets may provide distinct clusters of subjects, and this data may reveal insights into the modes of walking recovery. For example, it may be determined how changes to lower limb motor impairments influence gait recovery. This information may be used to design therapeutic interventions and better allocate resources.

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ACKNOWLEDGEMENTS

Funding for this project was provided by the American Heart Association, the National Institute on Disability and Rehabilitation Research, National Institute of Child Health & Human Development, and the Searle Fund.