Abstracts

Neurology Section Platform Presentations

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TITLE: Distinct Patterns of Walking Recovery Following Therapeutic Intervention Post-stroke: Responders vs. Non-Responders.

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ABSTRACT BODY:

Purpose/Hypothesis : Walking recovery is one of the highest rehabilitation priorities for persons post-stroke. However, detection of clinically meaningful effects is challenging, due in part to heterogeneity of population characteristics and interacting clinical factors including severity and chronicity. Here we differentiate patterns of response to therapeutic intervention in an effort to identify characteristics of responders and non-responders.

Number of Subjects : 36 persons post-stroke (13.9 (S.D. 4.85) months post-stroke, 10 females) participated.

Materials/Methods : Participants underwent a staged intervention including 15 sessions of unilateral lower-extremity power training followed by 9 sessions of clinic-based gait training. Walking function was studied at baseline and following each treatment phase using instrumented 3D-motion analysis. Participants were classified as Responders(RES) or Non-responders(NRES) on the basis of gait speed improvements exceeding a minimal important difference (MID) of 0.115 m/s, derived from baseline data.

Results : Overall, significant improvements in gait speed were revealed post-intervention (p=0.0). However, by identifying RES vs. NRES, two distinct patterns of response emerged. RES improved gait speed (0.21 m/s, 53.23%, p=0.0) and also improved their walking pattern as reflected by changes in spatiotemporal parameters including: cadence 70.26 to 82.18 steps/min, stride length 0.63-0.84m, paretic single-limb stance 21.25-26.19%gait cycle (GC), non-paretic step-length 0.304-0.412m, paretic first double-limb support decreased from 22.07-17.56%GC and paretic second double-limb support decreased from 25.35-20.75%GC (p's <0.05) In contrast, NRES revealed modest improvement in gait speed (0.06 m/s, 15.45%, p=0.0) unaccompanied by changes in walking pattern. Interestingly, at baseline the RES and NRES groups revealed equivalent gait speed (0.385±0.18 vs. 0.37±0.24 m/sec) and did not reveal any significant differences on the scores of the clinical outcome scales measuring impairments, activity and participation.

Significant isometric strength gains were observed for the paretic knee extensors, knee flexors, hip flexors, ankle dorsiflexors and plantarflexors and knee extensor and ankle plantarflexor power (p's <0.05). In contrast to responses in walking function, strength and power gains were similar between RES and NRES.

Conclusions : These distinct patterns of behavioral response suggest intrinsic, as-yet-unidentified physiological difference(s) in the capacity for motor recovery post-stroke. Notably, baseline clinical equivalence in this sample reveals a significant limitation of existing clinical assessments for predicting treatment response.

Clinical Relevance : Differentiation of Responders and Non-responders in apparently clinically equivalent individuals provides the opportunity to develop approaches for identification of key subject-specific characteristics and ultimately to optimize walking recovery post-stroke.

TITLE: Prospective Identification of Fallers with Parkinson Disease Using the BESTest and MiniBESTest

AUTHORS/INSTITUTIONS: G. Earhart, R.P. Duncan, A. Leddy, , Washington University in St. Louis, Saint Louis, MO; J. Cavanaugh, , University of New England, Portland, ME; T. Ellis, , Boston University, Boston, MA; M. Ford, , University of Alabama at Birmingham, Birmingham, AL; K.B. Foreman, L.E. Dibble, , University of Utah, Salt Lake City, UT;

ABSTRACT BODY:

Purpose/Hypothesis : Falling is a major problem among individuals with Parkinson disease (PD), and may lead to injury, fear of falling, reduced quality of life, and increased mortality. The ability to prospectively identify individuals at risk for falls is essential as intervention is often necessary. This study is the first to evaluate the ability of two recently published balance measures, the BESTest and miniBESTest, to prospectively predict those with PD who will fall.

Number of Subjects : Fifty-three individuals with idiopathic PD (mean age = 67.5 ± 8.8 yrs, H&Y = 2.3 ± 0.6) were evaluated ON medication.

Materials/Methods : Participants were assessed using the BESTest and miniBESTest. They were followed prospectively for 6 months and the number of falls in that 6 month period was recorded. Individuals were characterized as fallers if they reported 2 or more falls in the 6 month tracking period. The Area Under the ROC Curve (AUC) was used to assess the ability of each test to discriminate between future fallers and non-fallers and to determine cutoff scores. Positive (LR+) and negative (LR-) likelihood ratios were also determined.

Results : Twenty-seven percent of the sample fell more than once in the 6 month period. ROC analysis yielded an AUC of 0.87 for both the BESTest and the miniBESTest. The optimal cutoff score for the BESTest was 69% with a LR+ of 5.8 and LR- of 0.08. The optimal cutoff score for the miniBESTest was 56% with a LR+ of 5.6 and LR- of 0.25. Post-test probability of being a faller with a score below the cutoff was 69.0% for the BESTest and 68.4% for the miniBESTest.

Conclusions : Both the BESTest and miniBESTest may be useful for prospective estimation of fall risk among individuals with PD. AUC values for prospective fall assessment are similar to those previously reported using retrospective fall reports.

Clinical Relevance : Differences between the two tests are minimal; as such the miniBEST may be preferred in clinical settings because it is shorter and faster to administer than the full BESTest.

TITLE: Effects of Short Term Sleep Deprivation on Dynamic Visual Acuity

AUTHORS/INSTITUTIONS: M. Scherer, P. Claro, K. Heaton, Military Performance Division, U.S. Army Research Institute of Environmental Medicine, Natick, MA;

ABSTRACT BODY:

Purpose/Hypothesis : Traumatic Brain Injury (TBI) is a significant risk for deployed Service Members (SMs). Dizziness and gaze instability are common sequelae to blast-related TBI known to be related to vestibulo-ocular reflex (VOR) dysfunction. The Dynamic Visual Acuity Test (DVAT)is a compact and easily administered behavioral measure of VOR function used in clinical settings to assess gaze stability by measuring the difference between head stationary- and head moving-visual acuity. Future use of the DVAT in operational environments for early detection of TBI related vestibulopathy necessitates investigation of potentially confounding environmental stressors such as sleep deprivation. While evidence of degraded attention and memory are well documented in relation to prolonged sleeplessness, less is known about this stressor's effects on sensorimotor function in general and gaze stability in particular. The purpose of this study was to investigate the effects of 26 hours of sleep deprivation on DVA in Active Duty SMs.

Number of Subjects : N= 16

Materials/Methods : SMs with no history of vestibular insult or head trauma were assessed using a VORTEQ DVA System. Active (participant initiated) and passive (examiner mediated) yaw (horizontal) and pitch (vertical) plane head impulses were obtained at T1 (T- 24 hours), T2 baseline (T= 0 hours) and T3 (T + 26 hours) after 26 hours of supervised sleep deprivation. SAS 9.2 was used to perform a mixed model analysis with random individual intercept to account for correlation of repeated measurements within participants between conditions.

Results : Yaw DVA analysis revealed a mean improvement of 0.30 Log of the minimum angle resolved (LogMAR) from T1 to T2 ($p = 0.02$). No change in yaw DVA was identified post sleep deprivation ($p = 0.27$). Pitch DVA results demonstrated improvement of 0.31 LogMAR from T1 to T2, ($p = 0.0008$) and a subsequent decrement of 0.25 LogMAR ($p = 0.007$) with sleep deprivation. Head movement direction (e.g. left vs. right) and head movement type (i.e., active vs. passive) variables were not significant. Test-retest reliability for the DVAT was assessed using Pearson correlation coefficients from T1 to T2 revealing: $r=0.59$ active yaw impulses; $r=0.53$ passive yaw impulses; $r=0.47$ active pitch impulses; and $r=0.77$ passive pitch impulses.

Conclusions : Preliminary findings reveal that the DVAT was robust to the effects of sleeplessness for yaw but not pitch head movements. DVAT test-retest reliability was moderate to excellent and markedly improved with passive relative to active pitch impulses.

Clinical Relevance : These data suggest that yaw DVA testing could be a useful screen for TBI related VOR pathology in theater where sleep deprivation is pervasive. Clinicians should however be aware that the DVAT may be subject to "practice effects" if successive testing iterations are administered within a short temporal span.

TITLE: Improved Gait-Related Mobility without Improvements in Postural Responses: The Blessing and the Curse of Dopamine Replacement

AUTHORS/INSTITUTIONS: K.B. Foreman, C. Wisted, O. Addison, R.L. Marcus, P.C. LaStayo, L.E. Dibble, Department of Physical Therapy, The University of Utah, Salt Lake City, UT;

ABSTRACT BODY:

Purpose/Hypothesis : Recent studies estimate that up to 70% of those with Parkinson disease (PD) fall each year. Although dopamine replacement medication (L-dopa) appears to improve gait-related mobility, it does not appear to improve reactive postural responses. This raises the possibility that L-dopa may increase exposure to postural hazards, while not improving postural responses. To examine this possibility directly, this study quantitatively measured reactive postural responses as well as clinical balance and mobility tests of persons with PD during both ON and OFF L-dopa conditions. We hypothesized that L-dopa would not improve the kinematics of reactive postural responses, but would improve performance during clinical balance and mobility tasks.

Number of Subjects : 15 persons (9 male, 6 female; mean age: 67 ± 13 years) with PD (duration: 7.5 ± 5.0 years).

Materials/Methods : Subjects were tested twice in laboratory and clinical settings. OFF medication testing was conducted 12 hours after their last L-dopa dose, while ON medication testing was performed 1 to 1.5 hours after taking their L-dopa medication. Within the laboratory setting, each PD participant's postural reactive responses to the Pull test, as described in the UPDRS, were examined during five trials ON medication, and five trials OFF medication. Quantitative measurements of movement kinematics were performed using a motion analysis system (Vicon; Oxford, UK). Reactive postural responses were measured using the following variables (reaction time, step length, average step velocity, COM reaction time, COM displacement, and COM average velocity). Clinical balance and mobility were measured using the Function Gait Assessment (FGA) and the 6 Minute Walk test (6MW). Performance during OFF and ON medication conditions was compared using non-parametric tests for differences and an alpha level of 0.05.

Results : Persons with PD demonstrated no significant difference in any of the reactive postural response measures between ON/ OFF medication conditions ($p>0.30$). In contrast, participants' demonstrated significantly better performance on the FGA ($p<0.006$) and improvement on the 6MW test during ON medication testing compared to OFF medication testing.

Conclusions : Our data indicated that reactive postural responses are not improved by L-dopa, while, in contrast, L-dopa does improve gait-related balance and mobility. Fall events in everyday life are a product of exposure to postural challenges and postural abilities. These findings suggest that L-dopa may result in improved mobility and therefore increased exposure to postural challenges without commensurate improvements in postural responses. Such medication effects may contribute to increased fall events and future research should prospectively examine this possibility.

Clinical Relevance : Pharmacologic intervention alone may result in iatrogenic increases in fall risk. Physical therapists should implement interventions to improve postural responses and be aware of the side effects and the limitations of medication treatment.

TITLE: Four Square Step Test Performance in Individuals with Parkinson Disease

AUTHORS/INSTITUTIONS: R. Duncan, G.M. Earhart, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO;

ABSTRACT BODY:

Purpose/Hypothesis : The Four Square Step Test (4SST) may be a quick, useful measure of function in people with Parkinson disease (PD), but no studies have examined use of the test in this population. We sought to: 1) examine 4SST performance OFF and ON anti-PD medications, 2) determine intrarater and interrater reliability, and 3) assess relationships between 4SST performance and other factors.

Number of Subjects : Fifteen subjects (8 males; mean age 72.2 ± 8.9; mean H & Y Stage 2.3 ± 0.4) with idiopathic PD participated. Unified Parkinson Disease Rating Scale-III (UPRDS-III) scores OFF and ON medication were 37.8 ± 9.3 and 28.1 ± 7.6, respectively.

Materials/Methods : The 4SST was administered as described by Dite and Temple (Dite W, Temple VA. Arch Phys Med Rehabil, 2002). Subjects performed the 4SST both OFF and ON medication and in both states were allowed a practice trial before being timed. Two raters timed 2 trials for intrarater and interrater reliability purposes. The first trials from the OFF and ON states were used to describe 4SST performance in PD. Additional tests included the UPDRS-III, mini-Balance Evaluations Systems Test (mini-BEST), Five Times Sit to Stand Test (FTSTS), 6 Minute Walk Test (6MWT), and 9 Hole Peg Test (9HPT). Intraclass Correlation Coefficients (ICCs) were used to determine intrarater and interrater reliability. Pearson correlations established relationships between 4SST performance and other tests. Regression analysis determined factors predictive of 4SST performance.

Results : Mean performance of the 4SST OFF medication was 13.1 seconds ± 5.5 seconds, and ON medication was 11.1 ± 3.5 seconds. A paired t-test showed a significant difference between OFF and ON medication 4SST performance ($p=0.03$). Intrarater reliability for the OFF medication phase for both raters was high (ICC=0.90). For the ON medication phase, intrarater reliability for raters 1 and 2 was slightly worse (ICC=0.78, ICC=0.77, respectively). Interrater reliability for both OFF and ON medication states was high (ICC=0.99). All tests, except the FTSTS, were correlated with 4SST performance ($r \geq .61$, $p < .05$), notably the mini-BEST ($r= -.70$). Regression analysis revealed that the mini-BEST ($r2=.50$) and 9HPT (change in $r2=.10$) explained 60% of the variance in FSST performance.

Conclusions : The 4SST has high interrater and moderate intrarater reliability and is sensitive to change in medication status. 4SST performance in people with PD is related to disease severity (UPRDS-III), balance (mini-BEST), endurance (6MWT), and bradykinesia (9HPT). Balance and bradykinesia appear to be most predictive of 4SST performance in people with PD.

Clinical Relevance : The 4SST is reliable, quick to administer, and may allow for rapid insight into the functional mobility of individuals with PD. Future studies should examine the ability of the 4SST to predict falls in this population.

TITLE: Title: The Effect of the L300Plus, a Peroneal and Thigh muscles FES system, on gait performance

AUTHORS/INSTITUTIONS: S. Springer, Y. Laufer, Department of Physical Therapy Faculty of Social Welfare and Health Sciences, University of Haifa,, Haifa, ISRAEL; J. Vatine, R. Zucker, Outpatient and Research Division, Reuth Medical Center, Tel Aviv, ISRAEL; R. Lipson, Clinical Department, Bioness Neuromodulation, Ra'anana, ISRAEL;

ABSTRACT BODY:

Purpose/Hypothesis : While peroneal FES is used effectively to enhance gait in patients with hemiparesis, many of these patients also suffer from thigh muscle dysfunction affecting their ambulation. The purpose of this study was to assess the effect of applying peroneal & thigh muscle FES on gait performance.

Number of Subjects : 45 subjects (mean age: 57.8 ± 14.8) suffering from foot drop and thigh muscles weakness due to upper motor neuron lesion (5.37±5.43 yrs post injury).

Materials/Methods : Patients were fitted with the L300Plus that consists of 2 electrical stimulation cuffs for dorsiflexors and thigh muscles activation, both synchronized with gait by a heel sensor. Thigh stimulation was applied either to the quadriceps or to the hamstrings muscle depending on the knee dysfunction impacting gait. At the fitting session, gait was assessed with and without the system; as well as while using peroneal stimulation alone. A second assessment was conducted after 6 weeks of daily use. Gait was assessed during a 2 minute walk. Outcome measures included gait velocity, interlimb asymmetry, and the percentage of single limb stance. Gait velocity was also measured during a 10 meter walk over an obstacle course. Finally, the patients were asked to provide feedback about their level of satisfaction with the system following 6 weeks of use.

Results : All patients were able to walk with the system immediately after fitting. Thirty nine patients (87%) used the thigh FES on the hamstrings and six (13%) on the quadriceps muscle. Analysis, using the Wilcoxon matched pairs test with Bonferroni corrections, indicated significant benefits in all outcome measures when gait with L300Plus was compared with no stimulation ($p<0.0001$). For example, while wearing the L300Plus, gait speed immediately improved by 16% (from 0.50±0.25m/sec to 0.58±0.28 m/sec) and after 6 weeks by 40% (to 0.70±0.3.1m/sc). The single limb stance increased from 24.37±6.98% to 25.74±6.34% and to 26.83±6.41% after 6 weeks. Furthermore, significant advantages were demonstrated when comparing the gait results with the L300Plus to those achieved with peroneal stimulation alone. For example, after 6 weeks, obstacle course gait velocity with the L300Plus was 0.43±0.21m/sec and with peroneal stimulation 0.40±0.20m/sec ($p<0.0001$), the gait asymmetry index, a marker of gait stability, improved by 8% from 0.43±0.26 to 0.40±0.30 ($p=0.006$). The system was perceived by the users as safe and highly beneficial. The primary reported benefit was greater confidence while walking. 80% of the subjects indicated that the L300Plus is more useful than any other aid to assist with their ambulation.

Conclusions : The use of peroneal and thigh muscles FES may achieve walking enhancements, which for appropriate patients are greater than those gained from dorsiflexors stimulation alone.

Clinical Relevance : Based on this analysis clinicians should consider using the combination of peroneal and thigh muscles FES.

TITLE: Improved balance, expanded limits of stability, and reduced trunk and pelvic compensatory strategies after locomotor training in a person with chronic stroke

AUTHORS/INSTITUTIONS: J.K. Malouf, S.A. Ostertag, New Directions Wellness Center, University of Montana, Missoula, MT; R.L. Mizner, Physical Therapy, University of Montana, Missoula, MT; S. McCarthy, , Great Northern Physical Therapy, Bozeman, MT;

ABSTRACT BODY:

Background & Purpose : People post stroke are often walk with an energy expensive hemiparetic gait involving poor volitional control of core body segments and compensatory trunk and pelvic movements. Locomotor training (LT) is a commonly used treatment for individuals post stroke, however most studies on LT have focused on changes in gait speed and lower extremity kinematics during gait. Few studies have investigated the impact of LT on limits of stability, balance, or manipulating trunk and pelvic kinematics. Our purpose is to describe the care of an individual with chronic stroke who was treated in an outpatient setting with LT. Our primary aims were to reduce compensatory strategies at the trunk and pelvis, improve balance, and extend limits of stability.

Case Description : A 71-year-old male 5 years status post left cerebrovascular accident (CVA) participated in 12 weeks of bi-weekly LT using body weight support (BWS) over the treadmill. Training parameters were selected and progressed with the intent of reducing hip circumduction and hip hike, forward and left lateral trunk flexion, right trunk and pelvis rotation, and improving hip extension during gait. Primary outcome measures included the Berg Balance Scale (BBS), the multidirectional reach test (MDRT), and three dimensional motion analysis. Secondary outcome measures included the 10 meter walk preferred and fastest, the timed up and go (TUG), and the 6 minute walk test (6MWT).

Outcomes : The patient demonstrated a reduced reliance on BWS, physical assistance, and verbal cuing to maintain pelvic and trunk stability in all planes as training progressed. The patient's BBS score improved by 15% post training (46-53 points). His forward reach improved by 11% (34.3-38.1 cm), right lateral reach improved by 47% (20.3-29.8 cm), and left lateral reach improved by 76% (21.6-38.1 cm). His 10 meter preferred speed increased by 31% (.67-.88 m/s) and fastest speed improved by 33% (.96-1.28 m/s). His 6MWT distance improved by 64% (219-358.1 m) and his TUG time was halved (22-11 sec). Significant findings in the motion analysis consisted of a decrease in trunk sagittal motion and a more vertical postural alignment of the trunk over the pelvis. Transverse plane pelvis range of motion during fast paced gait increased and underwent a left rotational shift from pre to post-training. The patient also demonstrated increased hip extension and decreased stance time bilaterally with twice the hip flexion torque supported by the paretic leg during terminal stance.

Discussion : The magnitude of improvements in our patient was considerable and exceeds those of many prior studies on LT for people with chronic stroke. The patient exhibited enhanced dynamic trunk mobility and a reduction of compensatory trunk and pelvic strategies during gait after training. The potential impact of LT as a tool to enhance control and positioning of the large body segments of the trunk and pelvis has a good potential for future research.

TITLE: The use of visual and proprioceptive feedback for locomotor training post-stroke

AUTHORS/INSTITUTIONS: M.D. Lewek, C. Giuliani, Division of Physical Therapy, University of North Carolina at Chapel Hill, Chapel Hill, NC; E. Wentz, Human Movement Science Curriculum, University of North Carolina at Chapel Hill, Chapel Hill, NC; J. Feasel, F. Brooks, M.C. Whitton, Department of Computer Science, University of North Carolina at Chapel Hill, Chapel Hill, NC;

ABSTRACT BODY:

Purpose/Hypothesis : Despite intensive locomotor training, people with stroke continue to exhibit deficits in gait speed and spatiotemporal symmetry. We propose that after a stroke, people are unaware of the movement errors experienced during locomotor training. Thus, explicit feedback of movement patterns should provide active engagement in the motor learning process for enhanced locomotor outcomes. Therefore, we hypothesize that providing visual and proprioceptive feedback during locomotor training will yield greater gains in gait speed and spatiotemporal symmetry than locomotor training without feedback.

Number of Subjects : To date, 11 individuals with chronic stroke (8M/3F; 56±11 years old) have been trained in our ongoing trial.

Materials/Methods : Our group has developed the Immersive Virtual Environment and Rehabilitation Treadmill (IVERT) system, which provides congruent visual and proprioceptive feedback through a coupled virtual environment and dual-belt treadmill. Spatiotemporal asymmetry is depicted as a curved walking trajectory in the virtual environment while belt speeds are updated independently to operate at different speeds. As gait becomes more symmetric, the walking trajectory in the virtual environment becomes straighter and the difference in belt speeds decreases. Using a randomized controlled design, individuals participated in 18 sessions of high-intensity locomotor training with (N = 6) or without (N = 5) the IVERT system. Subjects walked over a GaitRite mat to measure gait speed and step length and stance time symmetry ratios (1.00 = symmetry) prior to and one week following training. We used non-parametric statistics to compare the change in symmetry and gait speed over time, with an α=0.05.

Results : All subjects trained to improve their step length symmetry, except for one subject in the IVERT group who trained to improve stance time symmetry. Two subjects in the Control group did not complete training due to exercise intolerance. The IVERT group improved both spatiotemporal symmetry ratios (pre: 1.81±1.04; post: 1.40±0.23; p=0.06) and gait speed (pre: 0.56±0.28 m/s; post: 0.68±0.36 m/s; p=0.03). In contrast, the Control group showed no change in symmetry (pre: 1.37±0.41; post: 1.31±0.26; p=0.59) but a trend towards improved gait speed (pre: 0.48±0.25 m/s; post: 0.57±0.32 m/s; p=0.11) was evident.

Conclusions : We provide preliminary evidence that spatiotemporal symmetry can be improved with six weeks of intensive locomotor training incorporating visual and proprioceptive feedback of gait asymmetry. A larger study is warranted to confirm the findings with this small sample.

Clinical Relevance : Despite previous evidence that spatiotemporal asymmetry does not change following locomotor training, we were able to elicit robust changes in spatiotemporal symmetry. Making individuals post-stroke aware of their movement errors allows them to self-correct movements for lasting changes.

TITLE: Preliminary Results of a Randomized Controlled Trial of a Novel Locomotor Training Intervention in Individuals with Chronic Stroke

AUTHORS/INSTITUTIONS: T. Wright, S. Binder-Macleod, D. Reisman, T.M. Kesar, Physical Therapy, University of Delaware, Newark, DE; M. Roos, E. Helm, Biomechanics and Movement Science, University of Delaware, Newark, DE;

ABSTRACT BODY:

Purpose/Hypothesis : Stroke leads to gait impairments that can greatly affect propulsion, walking speed, and endurance. Treadmill training allows a large dosage of stepping practice for individuals post-stroke but it is unclear what type of walking training is most beneficial. We hypothesize, based on our recent preliminary study, that a group undergoing FastFES treadmill training (subjects walking at their fastest speed paired with functional electrical stimulation of the ankle dorsi- and plantar-flexors muscles) will demonstrate greater improvements in propulsion, walking speed, and endurance compared to a group receiving FAST treadmill training (subjects walking at their fastest speed) or a group receiving SS treadmill training (subjects walking at their self-selected speed). The purpose of this study is to compare the effects of three different treadmill training programs on individuals post-stroke.

Number of Subjects : To date 9 subjects with chronic (>6 months) stroke with hemiparesis have completed training; 2 subjects in the FastFES group, 4 subjects in the FAST group, and 3 subjects in the SS group. We project having 15 subjects per group at the end of the study.

Materials/Methods : Subjects are randomly assigned to one of the three groups. Each subject participates in 12 weeks (3 sessions/week) of treadmill training. Subjects walk for a total of 30 minutes on the treadmill and then perform 6 minutes of over ground walking. Pre- and post- testing measures include motion analysis, over ground Self-Selected Gait Speed (SS), over ground Fast Gait Speed (FS), and the 6 Minute Walk Test (6MWT).

Results : Preliminary results demonstrate that FAST and FASTFES groups improved on propulsion, walking speed, and endurance. The FastFES group, however, show the greatest average change in all categories as follows:
Peak propulsion Average Change (%): (SS=-18, FAST=47, FastFES=95)
SS over ground Walking Speed Average Change (m/s): (SS=.11; FAST=.22; FastFES=.25)
FS over ground Walking Speed Average Change (m/s): (SS=.13; FAST=.19; FastFES=.37)
6MWT Average Change (m): (SS=24.67; FAST=63.93; FastFES=108.40)

Conclusions : Our preliminary results support our hypothesis that FastFES subjects will improve propulsion, walking speed and endurance to a greater extent than in the other two groups. The changes in the Fast and FastFES groups exceed the minimal detectable change values for persons with chronic stroke, suggesting that the improvements are beyond what can be expected due to day to day variability of the measurements.

Clinical Relevance : This randomized controlled trial will provide rehabilitation therapists with evidence-based treadmill training strategies that improve propulsion, walking speed, and endurance for their patients post-stroke.

TITLE: Older Adults Utilize Sensory Information for Balance Differently Based on their Risk of Falls

AUTHORS/INSTITUTIONS: D.M. Wrisley, Physical Therapy, Lynchburg College, Lynchburg, VA;

ABSTRACT BODY:

Purpose/Hypothesis : Platform perturbations in different planes can provide information on the use of sensory information for balance with rotational perturbations requiring use of vestibular information and translational perturbations requiring the use of somatosensory information. The purpose of this study was to determine whether older adults utilize sensory information differently for balance based on their classification of falls risk using platform perturbations.

Number of Subjects : 37 older adults participated; 13 classified as being at risk of falls (7 males; mean age 77.1± 6.7 years) and 24 classified as not at risk of falls (12 males; mean age 70.1± 7.4 years) based on clinical tests (Functional Gait Assessment and Timed “Up & Go”).

Materials/Methods : Subject’s kinematic responses to 2 conditions of sway referencing (AP rotation, and AP translation) platform perturbations and a static platform condition were compared as an indication of subject’s use of sensory information. All conditions were performed with the eyes closed. A 2X3 MANOVA (falls risk X platform condition) was used to analyze differences in postural response (trunk displacement, velocity and variability) based on falls classification. Post-hoc testing using Tukeys HSD determined if there was a difference in postural response based on the platform condition.

Results : A significant fall risk by condition effect was found. Significant differences were found in all dependent variables based on fall risk classification but only during the AP rotation condition indicating difficulty using vestibular but not somatosensory information for balance.

Conclusions : Older adults who are classified at risk of falls demonstrate decreased ability to utilize vestibular information for balance compared to those who are not classified at risk of falls.

Clinical Relevance : Older adults may be trained to increase their use of vestibular information for balance and this may decrease their risk of falls.

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TITLE: Mechanisms of walking recovery in adults with incomplete spinal cord injury

AUTHORS/INSTITUTIONS: E.J. Fox, S. Suter, A.L. Behrman, Physical Therapy, University of Florida, Gainesville, FL; D.R. Howland, College of Medicine, Neuroscience, University of Florida, Gainesville, FL; S.A. Kautz, Health Sciences & Research, Medical University of South Carolina, Charleston, SC; K.V. Day, Rehabilitation Research, Cardinal Hill Rehabilitation, Lexington, KY; D.J. Clark, Brain Rehabilitation Research Center, Malcom Randall VAMC, Gainesville, FL;

ABSTRACT BODY:

Purpose/Hypothesis : Incomplete spinal cord injury (ISCI) disrupts neuromuscular and biomechanical control of walking. Locomotor training (LT) promotes walking recovery by activating the neuromuscular system and enhancing activity-dependent plasticity. Although LT is beneficial for individuals with ISCI, the underlying mechanisms are not well-understood. Emerging research suggests that the uninjured nervous system may control walking by associating a limited set of neural commands with activation of functional muscle groups (modules) to perform biomechanical functions. A set of 4-5 modules may be sufficient to control walking in healthy adults, while individuals post-stroke may use fewer modules. The aim of the current study was to investigate modular control following ISCI and how LT affects this control, as well as muscle timing and gait biomechanics.

Number of Subjects : Eight adults with chronic ISCI, American Spinal Cord Injury Association classification 'D' (44.9 +/- 14.8 years; 5 males) participated.

Materials/Methods : Pre and post-45 sessions of LT, subjects walked on an instrumented treadmill (TM) while ground reaction forces, kinematic data, and EMGs from 8 lower extremity (LE) muscles were recorded. Non-negative matrix factorization was applied to EMG data and the number of modules explaining ≥90% of the EMG variance was determined. Muscle timing was assessed in key regions of the gait cycle. Gait biomechanics were assessed by determining minimal and maximal leg angles and foot trajectory range.

Results : Pre-LT, individuals performed TM walking without assistance at 0.27 +/- 0.10 m/sec and an average of 3.8 modules (mode=4) accounted for LE EMGs. Post-LT, speed increased to 0.54 +/- 0.30 m/s ($p=0.017$). Overall,the number of modules did not change; however, individual changes in muscle composition and timing were evident. Post-LT, the duration of soleus activation increased in late stance ($p=0.035$, one sided) and gluteus medius timing decreased ($p=0.015$), but increased during late swing ($p=0.055$, one sided). Individual changes in muscle timing also were evident post-LT. Foot trajectory ranges ($p=0.001$) and maximal leg angles ($p=0.006$) increased and these changes were associated with changes in gait speed.

Conclusions : In contrast to individuals post-stroke, the number of modules required to explain LE EMGs was not reduced. This may reflect differences in lesion location (cortical vs. spinal cord) or severity. Post-LT gait recovery was characterized by increased TM gait speed. Changes in muscle timing and biomechanics were evident and may be related to increased propulsion during stance and improved limb deceleration during late swing.

Clinical Relevance : Understanding the effect of SCI on the modular organization of muscle coordination may be useful in determining the effect of injury and rehabilitation on the neuromuscular control of walking. Furthermore, identification of the underlying mechanisms associated with gait recovery may lead to refinement of the LT approach to better target these mechanisms and to further enhance walking recovery in individuals with ISCI.

TITLE: Robotic exoskeleton device improves walking performance and alters motor cortical excitability in patients post-stroke.

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ABSTRACT BODY:

Purpose/Hypothesis : Patients with stroke often require assistance during walking. Recently, exoskeleton devices have been used to provide assistance to patients during walking. One such exoskeleton provides optimal assistance based on the information from hip moments during walking. The purpose of this study was to investigate the effects of the robotic exoskeleton Walk Assist device by HONDA R&D ® on walking performance, and motor cortical excitability (MCE) of the lower extremity muscles on the paretic and non-paretic side in patients post-stroke.

Number of Subjects : 11 ambulatory patients with chronic stroke participated in the study. All participants were screened for contraindications to transcranial magnetic stimulation (TMS).

Materials/Methods : Participants were explained the purpose of the study. The exoskeleton device was donned on the participant's waist. Behavioral and MCE measures were recorded under two conditions that were counterbalanced across participants: (1) with the device ON and (2) with the device OFF. Behavioral measures included the distance covered during the 6 minute walk test and the maximum speed tolerated on the treadmill. MCE of bilateral Tibialis Anterior (TA) and Rectus Femoris (RF) was assessed with precisely-timed suprathreshold TMS applied over the lower extremity primary motor cortex (M1) as the participants walked on a treadmill at their comfortable speed. For the RF, TMS was applied during the mid-stance phase, while for TA, TMS was applied during the swing phase. At least 12-15 MEPs were collected for each of the muscles in each condition.

Results : Participants covered a longer distance during the 6-min walk test when the device was ON (mean distance=826.37 feet) compared to when the device was OFF (mean distance=866 feet). Participants were able to tolerate a higher maximal treadmill speed when the device was ON (speed= 0.87 m/s) compared to when the device was OFF (speed= 0.76 m/s). The measures of motor cortical excitability demonstrated a high variability in the response of the corticospinal system to the assistance provided by the exoskeleton device. MEP amplitudes were more variable on the paretic than the nonparetic side. For majority of the patients, paretic and non-paretic RF MEP amplitudes were larger when the device was ON compared to when the device was OFF. In contrast, paretic and non-paretic TA MEP amplitudes were smaller in majority of the patients when the device was ON compared to when the device was OFF.

Conclusions : The assistive exoskeleton device benefited walking performance in patients with chronic stroke. However, the corresponding change in the MCE in RF and TA was highly variable across participants. Inter-subject variability in impairment levels (e.g., strength) and gait patterns may be factors that likely influence the effect of exoskeleton assistance on MCE.

Clinical Relevance : Understanding the effects of exoskeleton devices on the nervous system is a critical step in the decision-making process about the use of such devices in patients post stroke.

TITLE: A Comparison of the Balance Accelerometry measure (BAM) and the Balance Error Scoring System (BESS) in Persons with and without Concussion.

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ABSTRACT BODY:

Purpose/Hypothesis : The Balance Error Scoring System(BESS) is a widely used measure that assesses post-concussion subjects both on the field and in the clinic. The BESS test includes both subjective and objective elements and may be biased based on the rater's experience. An objective, light and portable device is needed to assess postural sway in person's post-concussion. It was hypothesized that Balance Accelerometry measure(BAM) is a more sensitive measurement of postural sway post concussion compared to the BESS test.

Number of Subjects : 18 healthy control and 9 post-concussion subjects.

Materials/Methods : The NIH toolbox protocol using the BAM and the BESS test were applied in one visit. The NIH toolbox protocol includes six conditions:(1) solid surface, feet together, eyes open, and(2) eyes closed;(3) foam surface, feet together, eyes open, and(4) eyes closed;(5) solid surface, tandem standing, eyes open, and(6) eyes closed. Subjects were given three attempts to complete the six 45 second conditions. The BESS test consists of three different stances (double, single leg and tandem) on two different surfaces (firm and foam surface). The subjects were asked to hold testing position for 20 seconds. Performance was videotaped for scoring purposes. The scoring was determined by recording the number of errors including:(1)opening eyes (2)lifting hands from hip (3)taking a step (4)moving hip into more than 30 degrees (5)remaining out of position for 5 seconds or (6)lifting toes or heels. A Two-way Mixed ANOVA was used to analyze the testing condition (within-subject effect), concussing vs. healthy (between-subject effect) and condition x group interaction for BAM test. The Mann-Whitney U test was used to compare the groups for the BESS test scores. The Receiver operating characteristic (ROC) curve was used to identify which test was the best to distinguish normal and post-concussion subject. Only subjects who completed all six conditions of the two tests were included.

Results : 17 healthy control subjects(94%) and eight(89%) of the post-concussion subjects completed six BAM conditions. No subjects failed the BESS test. In the BAM test, significant within-subject effect and between subject effect were found ($p<0.05$). Standing on foam and in tandem with eyes closed showed significantly increased sway ($p<0.01$). The post-concussion subjects displayed greater overall mean sway than the healthy controls. No condition x group interaction effect was found. No significant difference found between groups in the BESS test scores. The ROC curve demonstrated that standing on foam eye open in the BAM test best discriminated post concussion from healthy subjects (AUC=0.82).

Conclusions : The BAM test demonstrated greater sensitivity in identifying increased postural sway in post-concussion acute subjects. More studies are needed to investigate the feasibility of BAM test in post-concussion persons.

Clinical Relevance : The BAM device is portable, cost effective, and could be used to assess sway defects in post-concussion persons during their acute phase.

TITLE: RCT Comparing 3 Exercise Programs for People with Parkinson Disease

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ABSTRACT BODY:

Purpose/Hypothesis : Exercise interventions for people with Parkinson disease (PD) have demonstrated improvements in function, balance, gait and impairments. Yet to be established is which interventions are most effective in the short-term and which can be sustained over the long-term. We compared two interventions to usual care. We hypothesized that a Flexibility/Balance/Function (FBF) program would result in better short- and long-term overall functional ability, economy of movement, and balance compared with Aerobic Endurance (AE) exercise and home-based standard of care (CONtrol). Primary end points were 4 and 10 months. Secondary end point was 16 months.

Number of Subjects : 121 participants in early- and mid-stage PD

Materials/Methods : The sample was 63% male; mean age (SD) was 64.8 (10.4). Participants were randomly assigned to 3 groups: FBF, AE, or CON. All participants were instructed to exercise 3X/wk for 16 months. Those in FBF and AE participated in supervised exercise 3X/wk for 16 wks. FBF participants received one-on-one flexibility training for 2 mo and group balance and functional training for 2 mo. AE participants exercised under direct supervision at 65-80% of max heart rate for 4 mo. The CON participants exercised at home using the National Parkinson Foundation Exercise program and participated in group exercise 1X/mo. Primary outcomes included the Continuous Scale Physical Functional Performance test (CS-PFP), Functional Reach (FR) and O2 consumption during gait (Economy of Movement, slope of VO2 vs. gait speed as mph). A linear mixed model with fixed effects for wave (baseline, 4, 10 and 16 months), stratification variable used in randomization (gender), and interaction between exercise group and wave was used to estimate the intervention effect over time for each dependent variable. Levodopa equivalent was included as a time-varying covariate. For all tests $\alpha = 0.05$.

Results : 96 participants (79.3%) completed the 16-mo study. At 4 mo, FBF was significantly better on CS-PFP than CON (54.8 vs. 50.5, 95% CI Δ: 1.2, 7.3, p = 0.006). At 16 mo, AE was significantly better than either FBF or CON on economy of movement (3.57 mph vs. 3.97 mph, 95% CI Δ: -0.68 mph , -0.14 mph, p= .003, and 3.57 mph vs. 3.89 mph, 95% CI Δ: -0.62 mph, -0.04 mph, p=.027, respectively). FR was not significantly different at any time point.

Conclusions : This is the first investigation of 16 mo outcomes from exercise for people in early- and mid-stage PD and, importantly, demonstrates that people engaging in aerobic conditioning can sustain improvements for as long as 16 months. FBF was most effective in improving overall functional ability at 4 months, but benefits were not sustained. In contrast, AE did not show significant improvements early, but was significantly and substantially better at sustaining economy of movement after 16 months.

Clinical Relevance : People with PD should begin to engage in aerobic conditioning exercises early in the disease as a routine part of their weekly activity.

TITLE: Attentional focus during balance training in idiopathic Parkinson's disease: a randomized clinical trial

AUTHORS/INSTITUTIONS: M.R. Landers, R.M. Blazer, A. Richards, A.D. Davis, L.E. Rosenlof, Physical Therapy, University of Nevada Las Vegas, Las Vegas, NV;

ABSTRACT BODY:

Purpose/Hypothesis : The purpose of this study was to test the generalizability of previous research findings, which demonstrate immediate improvements in postural stability when subjects adopted an external focus of attention relative to an internal focus or no focus. Specifically, this study aimed to apply these concepts to the long-term learning effects of attentional focus on balance in people with PD. A secondary purpose of this study was to determine if balance training, regardless of attentional focus, was better than no training in people with PD.

Number of Subjects : 49 community-dwelling adults with idiopathic PD participated in the study.

Materials/Methods : Participants were randomized into one of four conditions (internal focus, external focus, no focus, and control). The three intervention groups participated in a month-long balance training program (one hour per day, three days per week) that consisted of gait training, obstacle course negotiation, and static balance tasks on compliant surfaces. The outcomes measured were the sensory organization test (SOT), Berg Balance Scale (BBS), self-selected gait velocity (SSGV), Dynamic Gait Index (DGI), Activities-specific Balance Confidence Scale (ABC) and the time taken to complete the obstacle course. These outcomes were measured at baseline, post intervention, 2-weeks post intervention, and 8-weeks post intervention.

Results : Data were analyzed using intent to treat (ITT) and per protocol (PP) analyses. In the ITT and PP analyses, no interactions were noted among the 4 conditions over time for the SOT, BBS, SSGV, DGI, ABC, and obstacle course (ps ≥ .122). When comparing all three treatment groups to the control group over time, the ITT and PP analyses yielded no interaction for the SOT, BBS, SSGV, DGI, ABC, and obstacle course (ps ≥ .167).

Conclusions : Results from this study suggest that attentional focus instructions may not have a long-term effect on balance in individuals with PD. Specifically, an external focus of attention did not demonstrate a positive long-term effect as was anticipated. This is not consistent with the many articles in the literature that purport its effectiveness. In addition, the standardized balance training program used in this study was not sufficient to drive meaningful changes in balance in people with PD. As this study was underpowered, we cannot rule out the possibility of a type II error.

Clinical Relevance : Despite early evidence in improving balance in individuals with PD and considerable evidence for various motor tasks using healthy adults in the motor learning literature, it does not appear that an external focus of attention has any positive long-term benefits in PD in terms of improved balance performance. While an external focus may cause an immediate improvement in balance, it may not be sufficient enough to drive clinically relevant improvements in long-term balance performance. In addition, the standardized balance training used in this study was not better than the control group which may be because the program was not individualized and impairment-based.

TITLE: Serotonergic agents facilitate locomotor recovery in individuals post-stroke only when paired with locomotor training.

AUTHORS/INSTITUTIONS: T. Hornby, Department of Physical Therapy, Univ Illinois, Chicago, IL; C.R. Kinnaird, J. Kahn, M. Rafferty, K. Nance, Sensory Motor Performance Program, Rehabilitation Institute of Chicago , Chicago, IL;

ABSTRACT BODY:

Purpose/Hypothesis : Exogenous administration of serotonergic agents in animal models of neurological injury may partially restore cortical and spinal excitability and facilitate locomotor recovery with repeated step training. Recent data suggest that administration of agents which facilitate serotonergic transmission (i.e., selective serotonin reuptake inhibitors, SSRIs) can improve neurological function in patients post-stroke when provided early during therapy. However, a controlled dosage of physical therapy was not provided. Previous data suggest that SSRIs may increase involuntary (spastic) reflex activity, however, which is thought to impair locomotor function. We hypothesized that administration of single doses of SSRIs to patients post-stroke would lead to minimal changes in walking function. In contrast, combining SSRIs with repeated locomotor training (LT) was hypothesized to enhance walking recovery, despite potential increases in spastic reflexes.

Number of Subjects : Twenty individuals with chronic (> 6 mos) hemiparesis post-stroke

Materials/Methods : Two separate double-blinded randomized crossover studies were performed: 1) assessment of single doses of SSRIs (Lexapro) vs. placebo administration, and 2) assessment of repeated doses of SSRIs combined with LT. For single dose studies, gait testing was performed prior to and 5 hrs following single 10 mg doses of overencpasulated SSRI or placebo agent, with one week between testing sessions. For LT studies, gait assessments were performed prior to and following 4 weeks/12 sessions of LT, with SSRIs administered 5 hrs prior to each session. Primary outcomes included assessment of walking function overground, and walking performance during graded treadmill testing, with determination of kinematics, kinetics, and muscle activity patterns at peak treadmill speed.

Results : For single dose administration, only increased, “abnormal” (swing phase) plantarflexor muscle activity with SSRIs was significantly different between groups. Most clinical and quantitative walking assessments were slightly worse with SSRI administration. In contrast, repeated SSRI administration with LT resulted in statistically significantly improvement in peak treadmill speed (mean ± SD) following SSRI (0.77±0.41 to 0.95±40 m/s) vs placebo (0.85±36 to 0.90±0.33 m/s, $p < 0.01$) administration. Such changes were accompanied by increase peak plantarflexor power post-SSRI+LT. Changes in clinical measures of walking function were not different between SSRI and placebo groups.

Conclusions : Repeated LT with SSRI vs placebo administration resulted in greater improvements in quantitative and clinical measures of walking function post-stroke. Single dose responses to SSRIs could not account for changes in motor performance.

Clinical Relevance : The data suggest that SSRIs with repeated LT are necessary to augment motor function post-stroke, whereas single doses may impair walking function.