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Effects of Postural Load Perturbations on the Stroke-impaired Spinal Circuitry

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EFFECTS OF POSTURAL LOAD PERTURBATIONS

ON THE STROKE-IMPAIRED

SPINAL CIRCUITRY

By

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A doctoral project submitted in partial fulfillment
of the requirements for the

Doctor of Physical Therapy

Department of Physical Therapy
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Doctoral Project Approval

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Abstract

Objective

Transitioning from supported sitting position to standing activities requires coordinated interactions among postural muscles with appropriate reflexive responses to adapt to an increase in postural loading. Previous studies have found the failure to accommodate the challenge of increased postural loads in the stroke-impaired nervous system. In this study, we examined the H-reflex in response to different magnitudes of loads under static postural conditions, and compared the responses directly between individuals with a stroke-impaired nervous system and those with a non-neurologically impaired nervous system. We tested the hypothesis that the reflex amplitude would increase with increased load during standing in the non-neurologically impaired nervous system but would remain unchanged in the stroke-impaired nervous system.

Methods

Nine individuals with a history of stroke and thirteen healthy individuals each completed a reflex recording during static standing, under 3 loading conditions (1) -20% of body weight unloaded condition, (2) body weight condition, (3) +20% of body weight loaded condition. H-reflexes were elicited via electrical stimulation at the tibial nerve, and reflex responses were recorded on the soleus muscle.

Results

We observed increased H-reflex amplitudes under the weighted condition in controlled participants, compared to body weight and unweighted conditions. We observed a higher Hmax/Mmax ratio in the paretic leg regardless of loading conditions, which is in agreement with previous literature reporting higher H-reflex amplitudes in individuals with lesions in the central

nervous system. In both paretic and non-paretic legs, we did not observe changes in H-reflex amplitudes with each loading condition.

Conclusion

Our findings suggest that an impaired ability to modulate the H-reflex pathway appropriately to increase the reflex stiffness of Ia afferent pathway, in response to changes in postural loads, may explain the reduced ability to adequately bear weight through lower limbs for standing, locomotion, and postural support tasks in individuals post-stroke.

Significance

The results of this study support the importance of early facilitation of weight-bearing activities with the incorporation of postural loading and unloading training, when considering clinical application for stroke recovery. Future studies will examine the adaptations of the Ia afferent pathway relative to postural loading during the subacute phases post-stroke, and its role during loaded and unloaded overground walking.

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Introduction

Stroke is one of the most common causes of disability, and post-stroke concerns often include gait impairments due to the inability to execute upright locomotion and postural control.[16] Following a stroke, individuals have many neurological complications, with effects ranging from pathological cognitive processing to aberrant motor control. Deficits in postural and gait control are commonly seen when neural tissues in the brain are affected, particularly in the white matter of the brain.[6]

Hemiparetic disruptions in neural processing lead to unilateral muscular weakness and imbalances in static and dynamic postural stability,[2, 5] which can come in the form of spasticity or flaccidity. Impaired muscular control and strength of one side of the body following a stroke often result in an increased loading on the unaffected side as a compensatory mechanism for the lack of muscular control. Furthermore, muscles involved in hip stability during ambulation, such as the hip joint abductors, are often negatively affected in individuals post stroke, which has significant implications for postural and gait control.[3]

In the process of ambulation, significant hip joint torque is required, particularly for propulsion of the body forward.[16] In individuals following stroke, this ability to produce torque is severely impaired.[16] Muscles of the hemiparetic lower extremity around the joints exhibit a significant strength decrease, noticeably in hip abductors and flexors. There is also a significant decrease in hip joint range of motion in the hemiparetic lower extremity, along with abnormal persistent contraction of adductor longus muscles.[16] Furthermore, individuals post stroke have significantly worse lower limb dynamic load perception, coordination, proprioception, and balance control that may contribute to increased gait abnormalities.[4] These deficits are strongly associated with inappropriate responses by the intact spinal reflex–Ia afferent pathway, modulated by the higher centers in the brain, which have been damaged following a stroke.

To assess problems with postural feedback and response necessary for locomotion, the Hoffman reflex (H-reflex) is used to quantify and visualize the amplitude of an individual's spinal reflex. The H-reflex is often used for measuring and indicating potential conduction disorders through the length of afferent and efferent pathways[1]. The H-reflex is elicited using electrical stimulation delivered via four superficial electrodes, which were placed on the tibial nerve in the popliteal fossa, soleus muscle, and lateral malleolus. The stimulated muscles then generate a reflex response that is recorded via electromyography (EMG). Using EMG, the reflex amplitude (RA), which is the intensity of the reflex activity following electrical stimulation, can be observed in the soleus muscle.[14] In non-neurologically impaired population, it has been suggested that the H-reflex is modulated in response to the level of muscle activation needed for functional movement requirements.[13] With increased postural loading, such as in full weight bearing, when compared to decreased limb loading e.g. 50% bodyweight off-loaded, an increased H-reflex has been observed.[11] In contrast, a study assessing the spinal circuitry in healthy individuals and individuals post stroke, it was observed that weight shifting onto either lower extremity had no significant effect on the amplitude of the H-reflex.[11] These results contribute to the uncertainty in how postural loading affects the H-reflex and presents a requirement for more research looking into this phenomenon in individuals post stroke.

According to Liang & Brown,[12] the ability for modulating reflexes during supported, non-postural loaded locomotor tasks remains intact in individuals post stroke, but to a lesser extent than in healthy individuals.[12, 15] As postural loads are added, such as when moving from sitting to standing–increased loading on lower extremities, the challenge on the neuromuscular system increases to maintain balance and postural control. It is observed that the nervous system in individuals post-stroke fails to regulate to accommodate the increase in loading, leading to exacerbation in impairment seen with ambulation, which is a more demanding task compared to static standing. Currently, there is limited evidence available showing the effects of postural loading and unloading on the H-reflex response in both non-neurologically impaired participants and stroke-impaired individuals. In addition, limited research has systematically analyzed the Ia afferent pathway in response to different magnitudes of postural loads, during static standing, comparing between individuals with a stroke-impaired nervous system and individuals with a non-impaired nervous system. This gap in reflex response research and the conflicting results from studies that test H-reflex at different postural loads yield the need for further study examining the extent of post-stroke effects on spinal reflex circuitry with a non-neurologically impaired group comparison. Therefore, the purpose of this study was to systematically examine and analyze the H-reflex in response to different magnitudes of loads under static postural conditions (i.e., upright standing) comparing directly between individuals with a stroke-impaired nervous system and with a non-neurologically impaired nervous system. Based on previous research findings aforementioned, we hypothesized that the reflex amplitude would increase with increased load during standing in the non-neurologically impaired nervous system but would remain unchanged in the stroke-impaired nervous system.

Methods and Materials

Participants

All recruited participants were screened for eligibility through inclusion criteria of (1) at least 6 months post-stroke, (2) more than 18 years of age, (3) able to stand without support/assistance, and exclusion criteria of (1) stroke occurred within 6 months, (2) neurological conditions other than stroke, (3) surgeries or history of fractures in the lower extremities.

Participants were recruited via flyers, word of mouth to persons within the School of Integrated Health Sciences, at local outpatient Physical Therapy clinics, at an outpatient rehabilitation hospital, and from directly contacting individuals who participated in previous studies. Each participant attended a single testing session, running an average of 2.5 hours, at the Gait and Balance laboratory located in the Integrated Health Sciences building on the University of Nevada, Las Vegas campus. Of the 9 stroke-impaired participants, 2 individuals did not have a reproducible H-max and one person with no detectable H-wave mid-study. Hence, only 6 sets of data collected from the stroke-impaired group were considered usable for data analysis. Of the 13 non-neurologically impaired participants, 2 had H-max with too small of an amplitude to differentiate from background EMG data, and one had no reproducible H-max, which were deemed unsuitable for data analysis.

Measurements

To quantify the functional status of our participants prior to our study interventions, each individual was assessed in gait speed and anthropometric measurements, with the additional assessment of the Fugl-Meyer for stroke-impaired individuals.

Fugl-Meyer Assessment of the Lower Extremity (FMA-LE) is a performance-based impairment index, specifically designed to assess motor function, sensory, and balance abilities following a stroke[8]. FMA-LE was assessed for each participant in the stroke-impaired group.

Gait Speed was assessed for every participant to determine the functional performance status of individuals in both stroke-impaired and non-neurologically impaired groups. Each participant's gait was recorded in a video format, which was then analyzed using a 2D video-based sport analysis tool, Kinovea® software (Nouvelle-Aquitaine, France), to determine gait speed, along with additional joint angles data.

Anthropometric measurements including participants' body mass, height, and the body mass index. Each participant's body mass was measured using a portable Bertec force plate. Height was collected via questionnaire. Body mass index (BMI) was calculated per the accepted formula (BMI = mass/height^2, kg/m^2).

Procedure

The study protocol was approved by the Institutional Review Board of the University of Nevada, Las Vegas. All participants provided written informed consent to participate and verbal explanation of the study protocol at the beginning of the study.

This study was a cross-sectional comparison between stroke-impaired individuals and non-neurologically impaired individuals. The independent variable being manipulated in this study is load during static standing: (a) 20% of body weight unloaded condition, (b) body weight condition, (c) +20% of body weight loaded condition. The dependent variable, H-reflex amplitude, was measured via EMG of the soleus muscles.

All measures were performed by 3 unblinded investigators; however, to limit potential biases and confounding variables, pseudo-randomization was introduced via alternating conditions within data collecting order. Each participant was prepared for gait recording, with a verbal explanation of the tasks and applying removable colored dot stickers on bony landmarks for recording and analyzing gait speed and mechanics. Each participant was instructed to walk down and back on a 4’ x 14’ standard gait mat at two speeds (1) comfortable, “normal”, self-selected walking speed, and (2) “as fast as possible while maintaining safety” walking speed, with or without an assistive device. Two trials at each speed were completed with a practice trial allowed at both speeds, if the participant desired. The use of assistive devices were recorded, if used. During these walking trials, gait was recorded via two Canon cameras set-up in the sagittal and frontal views, frame rate: 60p, shutter speed: manual 350. Rests were provided between trials according to the participant’s needs. After gait recording was completed, each participant in the post-stroke group was assessed using FMA-LE. Each participant was then prepared for reflex recording using the following steps: cleaning the skin of the popliteal fossa and soleus using alcohol wipes, adhering electrodes on cleaned areas, and connecting appropriate lines to the electrodes.

Loading Protocols

In order to achieve the loaded weight-bearing condition, a Kensui weight-vest with an olympic plate horn that can hold weight plates with an olympic sized hole was used, which provided the flexibility to adjust increased load appropriate to each participant. Participants wore the vest to increase their weight-bearing demand to 120% of their body weight. The off-loading condition was achieved using a full-body harness, attached to a moveable suspension ceiling rail, to partially decrease the participant’s mass to 80% weight-bearing. These percentages were chosen by taking into consideration the maximal amount of external load a participant with chronic stroke hemiparesis might be able to carry and stand independently during data collection. The percentages would also produce a notable comparison between groups, extracting from Liang &

Brown,[12] and we also aimed to maintain the offloading percentage to be similar to the loading percentage.

For individuals in the non-neurologically impaired group, H-reflex data was collected from a single lower limb, whichever produced the most visible and clear H-wave and M-wave on EMG outputs. For individuals in the post-stroke group, data were collected from both lower limbs; this was to provide additional information for comparison of reflex responses between involved and uninvolved limbs.

H-reflex Recording Protocol

H-reflex amplitude was measured using a constant current stimulator and isolation unit. To elicit soleus H-reflex, three electrodes were placed over the soleus muscle for each participant. Using bipolar self-adhesive electrodes aligned with the tibial nerve, the stimulating electrode was placed over the tibial nerve in the popliteal fossa with the cathode proximal to the anode to avoid anodal block[7]. The recording electrode was placed over the soleus muscle 3 cm distal to the bifurcation of the gastrocnemius in-line with the Achilles tendon[1]. The reference electrode was placed 2 cm distal to the recording electrode. Lastly, a ground electrode was placed on the lateral malleolus.

Once placed, the electrodes were not removed for the duration of the study to maintain consistency. The tibial nerve was stimulated with a square pulse stimulus of 1ms with a current range of 50 mA~200 mA with a total output of 400 V.[12] A rest time of 10 seconds was allotted between impulses to decrease the H-reflex post-activation depression effect.[9]

The study area was set-up with a portable Bertec force plate (model 4060-05, Bertec, Columbus, Ohio, USA) directly below a ceiling-mounted harness track. A stable rail was placed sideways, in front of the force plate to provide safety and assistance to the participants. Once preparation for EMG data collection was completed, each participant was instructed to step onto the force plate and maintain static standing. During this period body mass was collected, which data was then utilized to estimate the amount of weight required to load and offload.

Following skin preparation and body mass recording, a recruitment curve (RC)–created from H-reflex data points, was collected next. The RC recording started with the threshold intensity–the maximal intensity with a non-detectable reflex on the EMG. The stimulus intensity was then gradually increased by 0.25x10mA until the H-wave on the EMG decreased and became undetectable. Five stimuli were given per intensity. A graph of H-wave and M-wave curves was outputted by EPOCS software (National Center for Adaptive Neurotechnologies at 113 Holland Avenue, Albany, New York 12208, USA), and it was used to determine maximal reflexive response (H-max) of the Soleus.

Each H-reflex was associated with a concurrent M-wave that appeared on the EMG. Concurrent M-wave range of such H-max was then determined and maintained for the following H-reflex data collection–20 stimulations at or near the stimulus intensity that created H-max for each loading condition, external stimulation intensity were adjusted accordingly to maintain the determined M-wave. The process was repeated for ½ M-wave range. Peak to peak amplitudes of the H-reflexes and M-waves were calculated and expressed as Hmax/Mmax ratio. Bodyweight condition (0%) was collected first, and followed by weighted condition (+20%) or partially weighted condition (-20%), depending on the order of pseudo-randomization.

Once the electrical stimulation protocol for bodyweight, weighted, and partially weighted conditions completed, another RC was completed using the same protocol as described previously, except with 2 stimulus per intensity. The last RC was completed to determine the quality of the data collected–same H-max produced, and to ensure that the electrodes on the participant's skin maintained in the same position during the full trial.

Statistical Analysis

Data collected was analyzed using SPSS Statistical software (Version 27.0.1; IBM Inc., Chicago, IL, USA). Descriptive statistics were generated for participants' characteristics, including age, biometrics, duration post-stroke, gait speed, and FMA-LE scores. Alpha level was set to <0.1 and a two-way mixed ANOVA was used to compare between non-neurologically impaired participants and stroke-impaired individuals for gait speed, and precision in the loading and unloading protocol.

Results

Characteristics

There were thirteen non-neurologically impaired participants recruited (table 1), ten of which were used in the data analysis. The mean age was 38.3 (± 16.9) years. Their mean body mass was 79 kg (±17.3).

Eight stroke-impaired individuals (table 1) were recruited, those of which six were used in the data interpretation. The mean age was 56 (±16.9). The mean weight was 79.64 kg (±5.04). The mean amount of months after stroke was 135.3 months (±80.8 months). The mean FMA-LE score was 26 (±6.9).

There was no statistically significant difference in age between groups (table 1). Overground walking speed in individuals post-stroke was found to be significantly lower when compared to individuals without stroke impairments (table 1).

Data Collection

In the non-impaired legs, recordings showed a statistically significant increase in H_{max}/M_{max} measurements in the weighted condition (0.49±0.06) compared to the body weight (0.41±0.03) and unweighted conditions (0.42±0.05)($p>0.05$)(table 1).

In contrast, it was observed that there were no statistically significant differences in H_{max}/M_{max} measurements across the three conditions in paretic and non-paretic limbs in individuals post-stroke ($p>0.05$)(table 1).

Table 1. Participant Characteristics

	Non-neurologically impaired (n=13)	Stroke impaired (n=8)
Age (Years)(mean ± SD)	38.3 ± 16.9	56 ± 16.9
Gender (Female/Male)	7/6	3/5
Time Since Stroke (Years)(mean ± SD)	-	11.3 ± 6.7
Paretic Limb (Left/Right)	-	6/2
FM-LE Score[a] (mean ± SD)	-	26 ± 6.9
Overground Walking Speed (m/s)(mean ± SD)	1.19 ± 0.13	0.52 ± 0.42 *

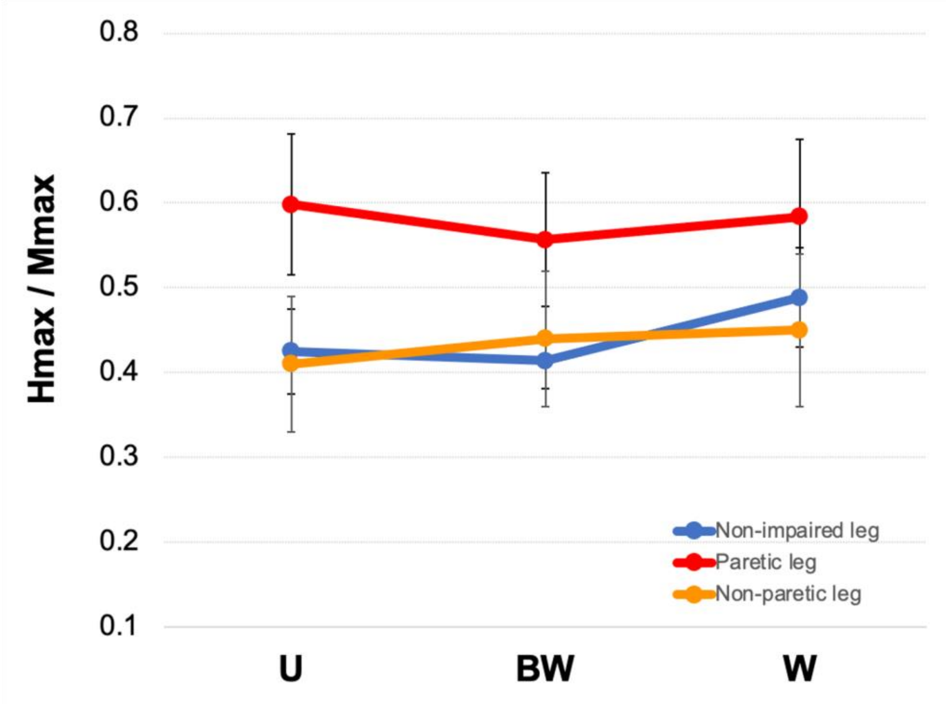
[a]Fugl-Meyer (FM) Assessment - Lower Extremity (LE) motor function (total=34)
*indicates statistical significance ($p>0.05$) between groups.

Table 2. H_{max}/M_{max} Ratios (mean±SE) for each loading condition.

	Paretic	Non-paretic	Non-impaired
Unweighted (U)	0.60 ± 0.08	0.41 ± 0.08	0.42 ± 0.05
Body weight (BW)	0.56 ± 0.08	0.44 ± 0.08	0.41 ± 0.03
Weighted (W)	0.58 ± 0.09	0.45 ± 0.09	0.49 ± 0.06*

*indicates statistically significant difference ($p>0.05$) from BW and U.

Figure 1. H_{max}/M_{max} Ratios (mean±SE) for each loading condition.



Discussion

The captured H-reflex activity of the non-neurologically impaired group demonstrated our expected findings of H-reflex modulation of the intact spinal circuitry. With an increase in postural load, the H-reflex upregulated to compensate for the additional demand to remain upright. With a decrease in postural load, the H-reflex down modulated its response to correlate with the decreased demand.

The captured H-reflex response in stroke-impaired participants suggests that stroke-impaired spinal circuitry is not able to modulate depending on the load applied on it. There was no statistically significant difference between loading conditions on the H-reflex in the stroke-impaired circuitry of the more-affected side. In addition, the H-reflex was increased throughout all three conditions instead of down-regulating appropriately.

Lastly, the H-reflex on the non-impaired side of stroke-impaired participants was able to regulate the amplitude but to a lesser extent compared to the non-neurologically impaired group. The less-affected side was able to regulate between unweighted and bodyweight conditions but was not able to upregulate with an increased load.

These findings suggest that stroke survivors do not have the ability to regulate the amplitude of postural reflexes on the affected side and have a decreased ability to regulate the response on the non-affected side when compared to a non-neurologically impaired spinal circuitry. This data could be useful in future research to determine the implications of postural loading and spasticity during the gait cycle and dynamic tasks. The inability to regulate the H-reflex during different postural loads could explain the impaired ability to up and down regulate lower extremity reflexes during the gait cycle but this is beyond the scope of this study and may be considered for future research.

Because the study did not differentiate between areas of the stroke lesion or between hemorrhagic versus ischemic stroke, it is possible that data may have been skewed to a particular area of the brain and should be taken into consideration.

The result of this study supported our hypothesis that the reflex amplitude would increase with increased load during standing in the non-neurologically impaired nervous system but would remain unchanged in the stroke-impaired nervous system.

Conclusion

In this study, we examined the H-reflex in response to different magnitudes of loads under static postural conditions and compared the responses between stroke survivors to those with a non-neurologically impaired nervous system. Our findings suggest that stroke survivors do not have the ability to regulate the amplitude of postural reflexes on the affected side and have a decreased ability to regulate the response on the non-affected side when compared to a non-neurologically impaired spinal circuitry. Future studies could investigate the ability to modulate the H-reflex during the gait cycle to gain a further understanding how reflexes are modulated during dynamic tasks.

Limitations

Stroke lesion location, severity, and type was also not controlled for in our study. Due to the limited outreach available during the conduction period of our study, we were unable to single out a specific type of stroke lesion. As well, all individuals post-stroke included in this study scored relatively high on the Fugl-Meyer Assessment, indicating high functional ability post-stroke. Future research could investigate a specific type or area of stroke lesion and severity of stroke to more specifically analyze an individual’s spinal circuitry post-stroke.

References

1. Ali, A. A., & Sabbahi, M. A. (2000). H-reflex changes under spinal loading and unloading conditions in normal subjects. *Clinical neurophysiology: official journal of the International Federation of Clinical Neurophysiology*, *111*(4), 664–670. doi:10.1016/s1388-2457(99)00304-1
2. An CM, Son YL, Park YH, Moon SJ. Relationship between dynamic balance and spatiotemporal gait symmetry in hemiplegic individuals with chronic stroke. *Hong Kong Physiother J*. 2017;37:19-24. Published 2017 Mar 8. doi:10.1016/j.hkpj.2017.01.002
3. Beyaert, C., Vasa, R., & Frykberg, G. E. (2015). Gait post-stroke: Pathophysiology and rehabilitation strategies. *Clinical Neurophysiology*, *45*(4-5), 335–355. doi:10.1016/j.neucli.2015.09.005
4. Chu, V. W., Hornby, T. G., & Schmit, B. D. (2015). Perception of lower extremity loads in stroke survivors. *Clinical Neurophysiology*, *126*(2), 372-381. doi:10.1016/j.clinph.2014.06.047
5. de Haart M, Geurts AC, Huidekoper SC, Fasotti L, van Limbeek J. Recovery of standing balance in postacute stroke individuals: a rehabilitation cohort study. *Arch Phys Med Rehabil*. 2004;85(6):886-895. doi:10.1016/j.apmr.2003.05.012
6. de Laat KF, Tuladhar AM, van Norden AG, Norris DG, Zwiers MP, de Leeuw FE. Loss of white matter integrity is associated with gait disorders in cerebral small vessel disease. *Brain*. 2011;134(Pt 1):73-83. doi:10.1093/brain/awq343
7. Fisher, M. A. (1992). AAEM Minimonograph #13: H reflexes and F waves: physiology and clinical indications. *Muscle Nerve*, *15*(11), 1223-1233. doi:10.1002/mus.880151102

8. Gladstone, D. J., Danells, C. J., & Black, S. E. (2002). The Fugl-Meyer assessment of motor recovery after stroke: a critical review of its measurement properties. *Neurorehabilitation and neural repair*, *16*(3), 232–240. doi:10.1177/154596802401105171

9. Grey, M. J., Klinge, K., Crone, C., Lorentzen, J., Biering-Sørensen, F., Ravnborg, M., & Nielsen, J. B. (2008). Post-activation depression of Soleus stretch reflexes in healthy and spastic humans. *Experimental Brain Research*, *185*(2), 189–197. doi:10.1007/s00221-007-1142-6

10. Hwang, I., Lin, C., Tung, L., & Wang, C. (2004). Responsiveness of the H reflex to loading and posture in individuals following stroke. *Journal of Electromyography and Kinesiology*, *14*(6), 653-659. doi:10.1016/j.jelekin.2004.01.002

11. Hwang S, Jeon HS, Kwon OY, Yi CH. (2011). The effects of body weight on the soleus H-reflex modulation during standing. *International Society of Electrophysiological Kinesiology*. *21*(3):445–9. Epub 2010/12/15. doi:10.1016/j.jelekin.2010.11.002 PMID: 21144768.

12. Liang, J. N., & Brown, D. A. (2015). Impaired H-reflex Gain during Postural Loaded Locomotion in Individuals Post-Stroke. *PloS one*, *10*(12), e0144007. doi:10.1371/journal.pone.0144007

13. Makihara Y, Segal RL, Wolpaw JR, Thompson AK. H-reflex modulation in the human medial and lateral gastrocnemii during standing and walking. *Muscle Nerve*. 2012;45(1):116-125. doi:10.1002/mus.22265

14. Palmieri RM, Ingersoll CD, Hoffman MA. The hoffmann reflex: methodologic considerations and applications for use in sports medicine and athletic training research. *J Athl Train*. 2004;39(3):268-277.

15. Phadke CP, Wu SS, Thompson FJ, Behrman AL. (2006). Soleus H-reflex modulation in response to change in percentage of leg loading in standing after incomplete spinal cord injury. *Neurosci Lett*, *403*(1–2):6–10. Epub 2006/05/26. doi:10.1016/j.neulet.2006.04.058 PMID: 16723187

16. Sánchez, N., Acosta, A. M., Lopez-Rosado, R., Stienen, A. H. A., & Dewald, J. P. A. (2017). Lower Extremity Motor Impairments in Ambulatory Chronic Hemiparetic Stroke: Evidence for Lower Extremity Weakness and Abnormal Muscle and Joint Torque Coupling Patterns. *Neurorehabilitation and Neural Repair*, *31*(9), 814–826. doi:10.1177/1545968317721974

17. Virani SS, Alonso A, Benjamin EJ, et al. Heart Disease and Stroke Statistics-2020 Update: A Report From the American Heart Association. *Circulation*. 2020;141(9):e139-e596. doi:10.1161/CIR.0000000000000757

Curriculum Vitae

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Education

Doctorate of Physical Therapy (2020-present)
University of Nevada Las Vegas

Bachelor of Science in Nursing (Dec 2017)
University of Nevada Las Vegas

Associate's Degree in Nursing (Jun 2011)
University of Nevada Las Vegas

Licensure

- Nevada State Board of Physical Therapy Examiners – License Pending Graduation May 2023
- Nevada State Board of Nursing, License # RN72093

Certifications

- **BLS – Basic Life Support**
- **ACLS – Advanced Cardiovascular Life Support**
- **NIHSS – NIH Stroke Scale**
- **OTAGO - The Otago Exercise Program: Falls Prevention Training**
- **HIPAA**

Clinical Experience

NeuroRestorative - Reno (Jan 2023 - Mar 2023)
Student Physical Therapist
- Skilled Nursing Facility

Providence Health & Services - Northeast Rehabilitation (Sep 2022 - Dec 2022)
Student Physical Therapist
- Outpatient Neuro Rehabilitation
- Vestibular Rehabilitation
- ALS clinic every other week

University Medical Center of Southern Nevada (Jul 2022 - Sept 2022)
Student Physical Therapist

- Acute care inpatient
- Level I trauma and burn units

Active Physical Therapy (Jun 2021 - Jul 2021)
Student Physical Therapist

- Orthopedic Outpatient McKenzie

Employment Experience

Spring Valley Medical Hospital (Jul 2016 - Aug 2021)
Registered Nurse III – ICU – Vascular Access Specialist

- Inserted central lines, midlines, evaluate placement
- Inserted PICC lines using 3CG and Sherlock technology
- Educated nursing staff on PICC line placement and precautions
- Discussed with patients the risks and purpose of PICC line/midline placement
- ICU with specialized programs in Neurosurgical, Open Heart, Surgical, and Medical patients
- Provided care to patients on IABP (Intra-Aortic Balloon Pump), CRRT (Continuous Renal Replacement Therapy), and Therapeutic Hypothermia
- Cared for immediate post-anesthesia Open Heart surgical patients
- Titrated drips on critically ill patients

St. Rose – San Martin Hospital (Feb 2015 - Jul 2016)
Registered Nurse III - ICU

- Provided advanced care in an ICU with specialized programs in Neurosurgical, Open Heart, Surgical, and Medical patients
- Administered continuous drips and cared for patients on IABP (Intra-Aortic Balloon Pump), CRRT (Continuous Renal Replacement Therapy), and Therapeutic Hypothermia
- Cared for immediate post-anesthesia Open Heart surgical patients
- Titrated drips on critically ill patients

Spring Valley Medical Hospital (Jul 2012 - Feb 2015)
Registered Nurse III – ICU

- Part of Code Team and Rapid Response
- Precepted new orientees/graduates/students
- Provided respiratory and ventilator management
- Titrated drips on critically ill patients

Membership in Professional Organizations

- Member of APTA (Aug 2019)
- APTA Sections: Hand & Upper Extremity, Private Practice, Research (Aug 2019)

Service / Volunteer Activity

Health Careers Panelist for Guinn Middle School Session 3 (Nov 2021)

- Panelist for health career
- Represented PT as a career choice for middle school students

Current Research Activity

Effects of Postural Load Perturbations on the Stroke-Impaired Spinal Circuitry (2020-present)
University of Nevada Las Vegas

Continuing Education Attended (last 3 years)

	Combined Sections Meeting (CSM)	(Feb 2023)
	Combined Sections Meeting (CSM)	(Feb 2022)
	Combined Sections Meeting (CSM)	(Feb 2021)
94672	Pneumonia	(Jul 2021)
94343	Sepsis: Diagnosis and Management	(Jul 2021)
94150	The Coronavirus Disease (COVID-19) Pandemic	(Jul 2021)
34020	Analgesic Overdose	(Feb 2017)
91920	Clinical Care of the Transgender Patient	(Feb 2017)

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Doctor of Physical Therapy	May 2020 – May 2023
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Honors College	Fall 2015 – Fall 2016

Employment / Clinical Experience

Jan 2023 – Mar 2023	**Student Physical Therapist**—Avamere Nursing & Rehabilitation in Issaquah
Sep 2022 – Dec 2022	**Student Physical Therapist**—Providence Health Services—Providence Regional Medical Center in Everett
July 2022 – Sep 2022	**Student Physical Therapist**—Therapeutic Associates - Queen Anne
June 2021 – July 2021	**Student Physical Therapist**—Concentra Urgent Care, Henderson, NV
Feb 2019 – May 2019	**Physical Therapy Technician**—Synergy Physical Therapy, Henderson, NV
May 2017 – May 2018	**Building Manager**—Student Recreational & Wellness Center at UNLV
May 2017 – May 2018	**Facility Attendant**—Student Recreational & Wellness Center at UNLV
Nov 2015 – April 2017	**Fitness Attendant**—Student Recreational & Wellness Center at UNLV
	Personal Trainer—Student Recreational & Wellness Center at UNLV

Service Volunteer Activity & Learning Participation

Integrated Clinical Experience:

- Good Shepherd: Cardiopulmonary Rehabilitation — 1.5 hours (04/22)
- Mountain View Hospital: Acute Care — 4 hours (04/22)
- Summerlin Hospital: Outpatient Pediatric — 2 hours (04/22)
- Summerlin Hospital: Wound Care — 3 hours (04/22)
- Centennial Hill Hospital: Acute Care — 4 hours (02/22)
- Dignity Health: Outpatient Neurological Rehab — 4 hours (11/21)
- Dignity Health: Outpatient Concussion & Vestibular Rehab — 4 hours (10/21)

- Fyzical PT: Outpatient Neurological & Vestibular Rehab 4 hours (10/21)

Fall Prevention & Memory Screening Community Event Sept 2021
Rock Steady Boxing, Henderson, NV Nov 2021 – Dec 2021

Research Activity

The Effect of Various Postural Load Perturbations on the Stroke-Impaired Spinal Circuitry
In collaboration with Jose Galvez, SPT & Brandon Yee, SPT
Under direct supervision of primary investigator Dr. Jing Nong Liang, PT, PhD
Presented at APTA Combined Section Meeting 2023

Certifications

- American Heart Association, BLS for Healthcare Providers (04/2021 – 04/2023)
- HIPAA Training Certified
- Blood-borne Pathogens Training Certified
- UNLV Personal Training In-house Certification

Continuing Education Attended (last 3 years)

STEADI Training, August 2021 – 3.0 CEU
OTAGO Fall Prevention Training, November 2021 – 3.0 CEU

Honors and Awards

Dean’s Honors List (Fall 2015 – Spring 2020 semesters)
2015 Rebel Challenge Scholarship – Presidential Award

Brandon Yee
BrandonYee34@gmail.com

EDUCATION

University of Nevada, Las Vegas | Doctorate of Physical Therapy
Spring 2023

California State University, Sacramento | Bachelor of Science – Kinesiology, Exercise Science
Spring 2019

CLINICAL EXPERIENCES

St. Rose Dominican Hospital – San Martin Campus | Las Vegas, NV | Clinical Experience IV
Acute Care Physical Therapy – 10 Week Rotation | Included IMC/ICU experience
January 2023-March 2023

Baylor, Scott, & White – Dripping Springs | Austin, TX | Clinical Experience III
Outpatient Physical Therapy – 10 Week Rotation **September-December 2022**

Providence Regional Medical Center Everett | Everett, WA | Clinical Experience II
Neurological Inpatient Rehabilitation Facility – 10 Week Rotation **July-September 2022**

Meier & Marsh Physical Therapies | Tooele, UT | Clinical Experience I
Outpatient Physical Therapy – 5 Week Rotation & PT Technician Internship
May 2021-August 2022

CERTIFICATIONS

Mechanical Diagnosis and Therapy – Part B | The Mckenzie Institute USA
Completed January15, 2023 Mechanical evaluation, assessment, and treatment of the cervical and thoracic spine

Mechanical Diagnosis and Therapy – Part A | The Mckenzie Institute USA
Completed February 13, 2023 Mechanical evaluation, assessment, and treatment of the lumbar spine

VOLUNTEERING

Shelby Estocado Fundraiser Golf Tournament **October 24, 2020 & November 22, 2021** Assisted with tournament operations and raffle sales | Instruct volunteers on rules of competition for additional fundraising activities | Collect and organize raffle prizes

UNLV DPT Virtual Information Session

September 11, 2021 Spoke to prospective program applicants about the UNLV DPT program

RESEARCH

Effects of Postural Load Perturbations on the Stroke Impaired Spinal Circuitry | Liang et. al. | Co-Investigator | Presented at CSM 2023

Investigating the Limits of Improvement in Walking Recovery in Chronic Stroke | Moore et. al. | Research Volunteer

Assisted participants with PROM/stretching prior to participation | Provided assistance during overground and treadmill training