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The Utilization of Bioness L300+ as an Adjunct to Physical Therapy Treatment for a Patient with Left Hemiparesis: A Case Report

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Abstract

Background: It has been well established that the global burden of stroke is continuing to increase at an alarming rate with individuals under the age of 65 years old making up roughly one-third of the total new stroke cases each year. Residual deficits in active ankle dorsiflexion and knee control lead to impaired gait mechanics. Bioness L300+ is a form of functional electrical stimulation that can be utilized by clinicians to aide in motor recovery after stroke and aide in the normalization of gait. The purpose of this case report was to describe the use of Bioness L300+ for an individual receiving outpatient physical therapy following an ischemic stroke. **Case Description**: The patient was a 54-year-old male status post right middle cerebral artery sign with right internal carotid artery occlusion demonstrating left sided hemiparesis of upper and lower extremities, dysarthria, and dysphagia. He was in acute care for five days, received two-weeks of inpatient rehabilitation and was then discharged to outpatient neuro physical therapy. At the time of initial evaluation, the patient demonstrated limitations in strength, range of motion, balance, endurance, motor control/planning, and functional mobility. **Intervention**: Interventions included: lower extremity strengthening, functional electrical stimulation bike, Bioness L300+, static/dynamic balance, transfer, gait, and stair training. **Outcomes:** Several outcome assessments were evaluated, including: manual muscle testing, Postural Assessment Scale for Stroke, Berg Balance Test, Timed Up and Go, six-minute walk test, and ten-meter walk test. **Discussion:** Bioness L300+ is a rehabilitation intervention that is both easy to set-up and utilize in the clinical setting to improve lower extremity strength and gait mechanics. Following interventions that involved the Bioness L300+ in combination with other exercises, the patient demonstrated increased independence with mobility related activities of daily living and functional tasks.

Keywords: Hemiparesis; hemiplegia; stroke; neurology; functional electrical stimulation; FES; physical therapy; rehabilitation

Background

Strokes are the fifth leading cause of death, affecting roughly 795,000 people and resulting in approximately 133,033 deaths in the United States each year[1]. The cost of stroke on our society in 2017 was estimated at 34 billion dollars[2]. With the trend towards longer lifespans, the global impact of stroke on society is going to continue to increase. The average lengths of stay post mild, moderate, and severe stroke are 8.9, 13.9, and 22.2 days respectively[3]. The average length of stay post-stroke in 2005 was 36 days[4] demonstrating that patients are currently entering outpatient neurological physical therapy services earlier in the rehabilitation process than ever before. It is imperative that physical therapists are capitalizing on the potential for neuroplasticity related improvements by choosing therapeutic interventions that will best benefit each individual patient in returning to prior level of function in the shortest number of clinic visits.

A stroke is defined as a “brain attack” secondary to a blockage in a blood vessel leading to a decrease in blood flow to an area of the brain. The subsequent damage leads to issues resulting from upper motor neuron damage such as temporary weakness, upper extremity and/or lower extremity paralysis, spasticity, speech disorders, motor planning disorders, and gait abnormalities. Over two-thirds of these individuals end up having some form of disability related to their stroke for the remainder of their life, placing strokes as the number one cause of adult disability in the United States[5]. It is well understood that the severity of the stroke is one of the strongest prognostic factors for degree of expected recovery post-stroke[6]. Factors such as: comorbid conditions, stroke mechanism, infarct location, and clinical findings are all components considered when determining the severity[7]. The skilled clinician must consider all of the above factors and their interactions to develop the most accurate prognosis and plan of care.

A typical plan of care consists of a variety of therapeutic interventions aimed at improving strength, range of motion, endurance, balance, and functional mobility. The greatest amount of change is noted during the first-year post-stroke as this is when the human central nervous system has the highest potential to undergo adaptation and reorganization of lesioned areas[8]; however, there exists a plethora of research implying that progressive, skilled practice is important during all stages of recovery and can lead to improvements in excess of five years post-neurological event. Many individuals in the chronic stroke population demonstrate deficits in gait mechanics secondary to lack of knee stability and ankle dorsiflexion[9]. Roughly 20% of individuals develop a condition known as “drop foot” following stroke[10], leading to the inability to control dorsiflexion at the ankle. The above deficits, in combo with residual distal weakness, place individuals at a decreased ability to properly position the paretic limb during gait; resulting in a slower gait speed and an increased risk for falls.

Lower extremity functional electrical stimulation is a tool used in the clinical setting to stimulate motor nerves in individuals with upper motor neuron lesions to assist in regaining control of the paretic limb[11]. Peroneal functional electrical stimulation has been shown to cause meaningful improvements in walking speed, steadiness of gait, rhythm of gait, and incidence of falls. It has been demonstrated that the combination of peroneal and quadricep/hamstring functional electrical stimulation is more beneficial than just peroneal functional electrical stimulation as the former leads to improvements in strength[12], assists in knee control, and controls for drop foot[9]. Bioness L300+ is a form of functional electrical stimulation that serves as a gait/training aide for individuals demonstrating drop foot, knee extensor thrust, and thigh weakness by supplying electrical stimulation to lower extremity musculature dependent on the phase of the gait cycle that the individual is progressing through[13]. This tool has been proven useful in both the acute and chronic stroke population, leading to an increase in popularity in both the clinical setting and in current research studies focusing on safety and gait following stroke.

The alternative treatment for post-stroke drop-foot is the traditional ankle-foot-orthosis. This device was designed to aid in toe clearance and ankle/knee control to provide stability and assist with toe clearance. Current research suggests that peroneal functional electrical stimulation may actually be

superior to ankle-foot-orthosis for treatment of post-stroke drop foot as the former has been shown to improve propulsion, toe clearance, knee stability, and ankle plantarflexion power compared to an ankle-foot-orthosis alone. Recent literature has also shown that individuals prefer use of functional electrical stimulation over an ankle-foot-orthosis with gait training and everyday life if given the option[9,14].

Case Description

History

A fifty-four-year-old African American male presented to the emergency room of a rural hospital after his wife noted stroke-like symptoms of left facial droop, slurred speech, and weakness of left upper extremity. He noted tingling and numbness of his left foot and hand. He was administered tissue plasminogen activator and transferred via ambulance to the main hospital. Imaging performed at the main hospital revealed dense right middle cerebral artery sign with right internal carotid artery occlusion and a left ventricular ejection fraction of sixty percent. A positive right middle cerebral artery sign on a computed tomography scan is viewed as one of the earliest signs of acute ischemic stroke[15]. Left ventricular ejection fraction is frequently measured as it has been shown to be indicative of the degree of neurological impairment following ischemic stroke[16]. Repeat head computed tomography scan performed twenty-four hours later revealed a large territory right middle cerebral artery infarction with minimal hemorrhagic transformation. He was placed on clinical institute withdrawal assessment for alcohol protocol due to his past history of excessive alcohol use, a mechanical soft diet, and transferred to the stroke floor.

After a five day stay, he was admitted to inpatient rehabilitation to receive comprehensive speech, occupational, and physical therapy care to address the following: left-sided neglect, right gaze preference, left facial weakness, aphasia, dysphagia, weakness of left upper and lower extremity, numbness/tingling of left hand, and numbness/tingling left foot.

He spent two weeks at inpatient rehabilitation prior to being discharged home with continued intervention at an outpatient neuro physical therapy clinic. At the time of discharge from hospital, he had undergone two weeks of inpatient rehabilitation care and demonstrated the following abilities: transfer from wheelchair to mat via stand pivot transfer with modified assistance; ambulate seventeen to nineteen feet using right wall rail and left posterior leaf spring ankle foot orthosis, modified assistance and wheelchair follow; and propel manual wheelchair two-hundred forty eight feet with right upper extremity/right lower extremity, verbal cues and modified assistance.

Prior to his stroke, the patient was working forty to fifty hours/week in the construction industry. His primary role was performing the electrical work on construction projects. He lived with his wife and young child. Prior to his stroke, he was the primary source of income for his family and was completely independent with all aspects of life. He had a pertinent past medical history of hypertension, tobacco use, marijuana use, and alcohol abuse. Upon admittance to the hospital, the patient did not have insurance. He was placed under the “financial assist program” until his family and hospital social workers were able to find him an insurance provider. This enabled the patient to receive two-weeks of inpatient rehabilitation and eight visits each of outpatient physical, occupational, and speech therapy services free of charge. After these eight visits, he went on hold for three weeks. After three weeks, he was picked up by vocational rehabilitation services and was able to continue his episode of care at outpatient neuro physical therapy, which is the focus of this case report.

Objective Evaluation

At the time of initial evaluation at outpatient physical therapy, the patient presented with the following problem list: left neglect, dysarthria, dysphagia, left lower extremity weakness, disorder of

motor control, and disorder of motor planning. Other impairments impacting the plan of care included: lack of safety awareness and poor orientation to midline. Since this patient was receiving his care at a multimodal clinic, occupational therapy services completed the evaluation and rendered the treatment for the deficits related to the upper extremity. Physical therapy interventions were focused on improving upon lower extremity deficits.

Table 1. Functional Independence Measures[19]

Score	Significance
1	Total Assistance (patient does <25% of task)
2	Maximal Assistance (patient does ≥25% but < 50% of task)
3	Moderate Assistance (patient does ≥50% but < 75% of task)
4	Minimal Assistance (patient does ≥75% of task)
5	Supervision
6	Modified Independent
7	Complete Independence

Functional independence measures were as follows: 5 for bed mobility (see Table 1 for definitions), 4 for transfers, and 2 for gait. Bed transfer and sit to stand were performed with minimum assistance. He was unable to be assessed on ascending/descending stairs at that time secondary to safety concerns. He scored a 6/56 on the Berg Balance Test and a 20/36 on the Postural Assessment Scale for Stroke. His score on the Berg Balance Tests qualified him as a high fall risk and classified him as wheelchair bound for ambulation[17]. His score on the Postural Assessment Scale for Stroke signified that this patient's posture while maintaining and changing body positions was below normal[18].

Table 2. Manual Muscle Test Scores at Initial Evaluation.

	Left	Right
Hip Flexion	2	4
Hip Extension	Not tested	3-
Hip Abduction	2	4
Hip Adduction	2	4
Knee Flexion	2	5
Knee Extension	2-	5
Ankle Dorsiflexion	1	5
Ankle Plantarflexion	1	4

Range of motion was within functional limits bilaterally, manual muscle testing on the left lower extremity rendered scores between 1/5 and 2/5, manual muscle testing on the right lower extremity rendered scores between 4/5 and 5/5 (see Table 2). Hip extension was unable to assessed on the left due to the patient's inability to understand the movement pattern. Right hip extension was the only manual muscle test score of less than a 4/5 on the right, earning a 3-/5 (see Tables 2 and 3 for specifics of manual muscle testing). As stated earlier, upper extremity was not assessed by physical therapy, however no active movement of the left upper extremity was noted during the initial evaluation. Spasticity of the left lower extremity was graded via the Modified Ashworth Scale to be 2/5 for the left quadriceps, 1+/5 for the left hip extensors, 1/5 for the left hamstring, and marked clonus of the left ankle. See Table 4 for more specific details regarding scoring on the Modified Ashworth Scale.

He was able to ambulate in the parallel bars for a total of eight feet, requiring right upper extremity support, modified assistance, and left lower extremity double metal upright ankle-foot-orthosis. He demonstrated decreased hip and knee flexion in swing phase, poor foot placement, and decreased stance time on left contributing to the decreased step length on the right. He attempted two steps with a left posterior-leaf-spring ankle-foot-orthosis and demonstrated poor left knee control and

extensor thrust in stance phase. Sensory testing revealed that the patient's sensation was relatively intact bilaterally.

Table 3. Manual Muscle Test Scoring System[20]

Score	Significance
0 / zero	No contraction felt in the muscle.
1 / trace	Tendon becomes prominent or feeble contraction felt. No visible movement.
2- / poor minus	Moves through partial range of motion in gravity minimized positioning.
2 / poor	Moves through complete range of motion in gravity minimized positioning.
2+	Moves through partial range of motion with gravity.
3- / fair minus	Gradual release from test position with gravity.
3 / fair	Holds test position, but cannot hold against any pressure.
3+ / fair plus	Holds test position against slight pressure.
4- / good minus	Holds test position against slight to moderate pressure.
4 / good	Holds test position against moderate pressure.
4+ / good plus	Holds test position against moderate to strong pressure.
5 / normal	Holds test position against strong pressure.

Table 4. Modified Ashworth Scale for Spasticity[21] (taken from Bohannon and Smith, 1987)

Score	Significance
0	No increase in muscle tone.
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of range of motion when the affected part is moved into flexion or extension.
1+	Slight increase in muscle tone, manifested by a catch followed by minimal resistance throughout the remainder (less than half) of the range of motion.
2	More marked increase in muscle tone through most of the range of motion, but the affected part(s) easily moved.
3	Considerable increase in muscle tone, passive movement difficult.
4	Affected part(s) rigid in flexion or extension.

Clinical Impression

After physical therapy evaluation, the patient was deemed a great physical therapy candidate to address the following deficits: left lower extremity weakness, decreased endurance, and impairments in balance, gait, functional mobility, and safety awareness. Patient and family goals were to return to work and to return to prior level of function. His wife stated that he didn't require any equipment or assistance prior to his stroke.

Intervention

The patient received a wide-array of treatments at outpatient physical therapy. These included, but were not limited to: transfer training, lower extremity strengthening exercises, functional electrical stimulation during bicycling and gait (Bioness L300+), stair training, gait training, Nu-step recumbent stepper endurance training, balance training, and stretching. The first episode of Bioness L300+ gait training occurred on the sixth session of physical therapy, which corresponded with six and a half weeks after the date of his stroke. The first and second Bioness L300+ gait training sessions were separated by roughly one and half months secondary to lack of insurance approval for physical therapy visits and poor safety awareness, placing both the patient and physical therapist at increased risk for an adverse event. Bioness L300+ was then used approximately weekly for the next six weeks.

This patient was deemed a good candidate for use of the Bioness L300+ for gait training because he was able to generate a strong response to the stimulation in his left lower extremity and his sensation was intact on the involved side. Unfortunately, the patient's decrease in safety awareness and lack of insurance coverage resulted in a temporary removal of this intervention until these issues could be sufficiently improved. It was determined that this patient would benefit the most from Bioness L300+ quadricep and anterior tibialis components due to his lack of propulsion force, lack of knee stability, and decrease in safety awareness with gait. Current research has demonstrated that the use of peroneal nerve stimulation can increase knee stability in stance phase, increase ankle plantarflexion propulsion force, and lead to a more anteriorly directed ground reaction force vector when utilized over the traditional ankle-foot-orthosis for gait[14]. These outcomes were the basis of its use with this patient.

Since treatment sessions were on a strict forty-five-minute schedule, the Bioness L300+ would be donned at beginning of the physical therapy session and worn for the remainder of the scheduled time. Use of Bioness L300+ in the literature starts with the patient wearing the functional electrical stimulation device for short periods of time, starting around fifteen minutes, and progressing to wearing the device all day over the span of a number of weeks. This was unrealistic given this setting and the lack of the ability to send the patient home with the device. Despite this limitation, the patient tolerated it well and demonstrated notable improvements in gait mechanics and safety further warranting its continued, though limited, use in the clinical setting.

The Bioness L300+ system is comprised of multiple parts: a lower leg cuff, thigh cuff, Intelli-sense gait sensor, wireless control unit, specially designed electrodes for placement in the leg cuffs, and a personal digital assistant for data storage (see https://www.bioness.com/Products/L300_Plus_For_Thigh_Weakness.php for photos of the device). The lower leg and thigh cuff are equipped with adjustable Velcro straps to ensure a snug fit and are specially designed to fit either the left or the right lower extremity. All components of this device are re-chargeable through a standard wall outlet, eliminating the potential of a battery failure. The device used in this case, was designed for use in the clinic; however, there is also a version designed for everyday use in the community environment[13].

Each treatment session would begin by wheeling the patient back to a mat table for ease with placement of the various components of the device. The removable portion of the electrode was lightly doused in water and then attached to the respective cuff. The electrodes are integrated into the thigh and lower leg cuffs ensuring better contact with both the individual and the source of the stimulation. Both cuffs were then strapped into place. Parameters were saved from session to session on the PDA, however these were re-assessed each visit prior to training to ensure proper cuff placement and electrical stimulation intensity. Intensity of stimulation was provided to patient tolerance with the instructions that the stimulation needed to be strong yet tolerable. When testing the lower leg component, the therapist also looked for a strong ankle dorsiflexion contraction with minimal ankle eversion. With the thigh component, a contraction was palpated for and patient response was noted. Intensity was rarely increased once a gait training session was initiated. Parameters were based off of

those established by Springer, 2012 and adjusted as necessary[9]. For this particular patient we attempted to control knee hyperextension during stance phase of gait so the hamstring parameters were set for maximal stimulation from 10-90% of stance phase. The anterior tibialis stimulation was set to extend from beginning of heel contact through 30% of stance phase to assist with foot control and prevention of foot slap.

Verbal cues, tactile cues and visual targets were provided to the patient while training with the Bioness L300+. Training varied by day with an increased emphasis on breaking down gait mechanics one day and an emphasis on taking as many steps as possible on others. He was instructed in navigation of obstacle courses and ascending/descending variable numbers of steps to encourage variability into his sessions. Feedback was provided variability throughout training as a means to encourage patient to be an active participant and to problem solve through certain tasks. By encouraging active involvement, we were attempting to further increase cortical excitability and to aide in carryover from session to session. He used a narrow base quad cane and required contact-guard assistance for safety purposes. Rest breaks were provided as necessary and the patient was encouraged to walk longer distances each session. Decreased safety awareness and left neglect were issues encountered on a regular basis in all aspects of therapy and were not unique to this intervention. The patient regularly ran into obstacles on his left-hand side and made efforts to traverse obstacles leading with his weaker side. The Bioness L300+ likely aided in the prevention of a fall during many circumstances as it helped provide stability to the involved lower extremity during times at which a fall was likely.

This intervention can monitor how many steps a patient has ambulated over the course of a therapy session; however, this was not assessed for this specific patient. Our overarching goals were aimed at increasing safety with gait and improving gait mechanics, so instead the patient was assessed on performance. Gait assessment was performed on standardized tests such as the six-minute walk test, ten-meter walk test, and timed up and go. Values were obtained with and without the device. Lack of time during a session and limited resources prevented a more formal assessment of gait from being performed.

As mentioned earlier, this patient received a wide variety of treatment interventions. He would spend one day each week cycling on the functional electrical stimulation bike as another means by which to receive electrical stimulation to motor nerves of the lower extremity. This intervention was utilized in an attempt to influence both spinal and supraspinal pathways[22]. The remaining day of physical therapy was focused on cardiovascular training on the Nu-step, lower extremity training, and functional tasks aimed at increasing safety with activities of daily living and functional mobility.

Outcomes

Outcomes were assessed regularly throughout his episode of care for this patient. This case report considers his first 35 sessions, but the patient continued to receive skilled neurological physical, occupational, and speech therapy services as he had yet to achieve either of his goals of independent ambulation and returning to work. He was attending therapy three times a week for each discipline and making slow, steady progress. Table 5, below, displays the main items re-assessed by physical therapy throughout his first thirty-five sessions. Short term goals were based off of minimal detectable change and minimal clinical important difference values found on Shirley Ryan AbilityLab[23]. Given this patient's level of dependence at the start of his episode of care, he was able to achieve the minimal clinical important difference and/or the minimal detectable change values for the majority of the items tested at initial evaluation. The minimal clinical importance difference was the preferred method for monitoring progress; however, the minimal detectable change was utilized when the minimally clinically important difference was not established. As initial short-term goals were met, new goals were established based off the minimal detectable change and/or minimal clinical importance difference for each test.

The minimal detectable change for the Postural Assessment Scale for Stroke test is 3.2 points and the cut-off score for ambulation is a 20/36. The patient's initial score was at the cut-off for ambulation and he improved eight points between his first two assessments. Although, he was easily able to achieve his short-term goals for the Postural Assessment Scale for Stroke, it's continued use was warranted in the clinical setting as he had yet to achieve a near-perfect score and the items tested were relevant to increasing mobility and stability[23]. Assessment of the Berg Balance Test followed a similar pattern. The minimal detectable change for this test is 4.66 points in the stroke population. This increase was obtained between the initial visit and the first progress note. However, his current score is 35/56 which falls below the cut-off score of 40/56. A score of less than 40 has close to a 100% predictor of future falls in the older adult population, indicating that although this patient has improved his Berg Balance Test score by a notable value, he is still at increased risk for falling compared to the general population[23].

Since Bioness L300+ has been demonstrated to improve lower extremity strength[12], manual muscle testing was performed to assess if any notable improvements in strength could be attributed to the use of this gait/training aide. Unfortunately, the patient's continued cognitive deficits led to difficulties with performing the testing, which may have skewed the results. Manual muscle test values are listed in Table two; above, however the accuracy of these values is questionable given the patient's cognitive abilities and difficulties with motor control and planning.

Due to safety concerns, we were unable to assess walking tests with this patient until further along in his episode of care. This delay provided physical therapy with a short time frame to assess improvements in gait that could be attributed to use of the Bioness L300+ anterior tibialis and hamstring components. It is worth mentioning, that this patient required a minimum of minimal assistance at all times when ambulating without Bioness L300+ anterior tibialis and quadricep components. When ambulating with the device, he required contact guard assist.

Gait was assessed both with and without Bioness L300+ to further evaluate the impact that the device would have on gait speed and distance ambulated in six minutes. It would have been best if the testing could have been performed on the same day or at least within the same week of therapy, however difficulties with scheduling and obtaining access to the necessary equipment led to these tests being performed roughly two weeks apart. Noteworthy improvements were made in both the ten-meter walk test and the six-minute walk test with the Bioness L300+ donned as compared to doffed. These improvements can likely be attributed to the increase in single-leg stability and foot clearance provided by the functional electrical simulation, however further research is necessary in order to make this claim. The minimal detectable change for the stroke population on the six-minute walk test is 60.98 meters which is equivalent to roughly two hundred feet. The patient had an improvement of fifty-three feet. Although, this is not the minimal distance necessary to be determined to be clinically meaningful, this increase is noteworthy as it occurred between two different testing conditions. It is also worth noting that on the day of assessment of six-minute walk test with Bioness L300+, the patient took multiple standing breaks to wipe the sweat off his narrow base quad cane as it was much warmer in the testing area. Despite verbal cues to stay focused on the task at hand, the patient took a few breaks during the six-minute walk test and the ten-meter walk test to attempt to talk to those around him. We are unable to hypothesize as to how great of an impact these factors had on his test results, but it is worth noting the impact that cognitive deficits can have on obtaining accurate test results.

Table 5. Outcome measures over time.

	Initial Outpatient Evaluation	1-month Re-Evaluation	2-month Re-Evaluation	3-month Re-Evaluation	Re-Evaluation at 35th visit (~3.5 mo)
Postural Assessment Scale for Stroke	20/36	28/36	28/36	Not tested	33/36
Berg Balance Test	6/56	15/56	21/56	Not tested	35/56
Transfers via Functional Independence Measure (FIM) Scoring System	4 for stand-pivot transfer	4 for sit to stand 4 for stand-pivot-transfer	3 for sit to stand transfer 4 for stand-pivot transfer		6 for sit to stand transfer 5 for stand pivot transfer
Gait	2 (FIM) 8' parallel bars with right upper extremity support and left double metal upright AFO	2 (FIM) 121' with left double metal upright AFO and right narrow base quad cane. Decreased stance time left; poor knee control/ knee extensor thrust left.	2 (FIM) 65' with left posterior-leaf-spring AFO and right wide base quad cane. Decreased stance time left; poor knee control/ knee extensor thrust left.	5 (FIM) 416' with left posterior-leaf-spring AFO and right narrow base quad cane. Decreased stance time left; poor knee control/ knee extensor thrust left.	5 (FIM) 469' with Bioness L300+ anterior tibialis and quad components and narrow base quad cane.
6 Minute Walk Test	Not tested	Not tested	Not tested	416' with left posterior-leaf-spring AFO and right narrow base quad cane.	469' with Bioness L300+ anterior tibialis and quad components and narrow base quad cane.
Timed Up and Go	Not tested	Not tested	Not tested	27 sec with left posterior-leaf-spring AFO and right narrow base quad cane.	28 sec with Bioness L300+ anterior tibialis and quad components and narrow base quad cane.
10 Meter Walk Test	NT	NT	NT	0.32m/s with left posterior-leaf-spring AFO and right narrow base quad cane.	0.40m/s with left posterior-leaf-spring AFO and right narrow base quad cane.

Discussion

Interventions following a stroke are aimed at increasing safety and functional mobility, with an emphasis on returning a patient to their prior level of function with the least restrictive device possible. This is accomplished through an array of treatment interventions based off of clinic resources, financial availability, skill level of available clinicians, patient motivation, and family support. Despite undergoing comprehensive rehabilitation, 42% percent of individuals report having activity limitations and 28.2% reported limited participation when surveyed four years post-stroke[24]. This deficit is alarming given that roughly 795,000 individuals suffer a stroke in the United States each year[1]. Recent medical advances and growing community awareness to the signs and symptoms of stroke abetted a 35.8% decrease in deaths as a result of a stroke between the years 2000 and 2010[25]; which can be further extrapolated to correlate with the burden of stroke on society. Participation and community limitations are a major concern in the acute and chronic stages of stroke, secondary to a decreased ability to traverse environmental barriers. It is important that physical therapists are using all available resources to aide their patients in returning to their prior ambulatory status to lessen the burden of stroke on both the patient and on society.

Bioness L300+ is one mechanism by which we may aide a patient in achieving safe ambulation in the community. The benefit of this device, is that it can be transition to community use given that the patient's qualifies for coverage through their insurance and/or that the patient has the financial means to pay out of pocket. One of the goals with this particular patient was to further assess effectiveness and potential for ambulation with a similar device, the Bioness Go, for use in his community and/or at a job. The Bioness Go is a product that is designed similar to the Bioness L300+ in that it comes with the hamstring/quad cuff, lower leg cuff, Intelli-sense gait sensor, wireless control unit, and integrated electrodes. This device is easier to operate than the version designed for clinical use, in that the device parameters are pre-set, so the individual is able to start walking as soon as they turn the device on. Trained staff will customize the device settings to the individual and then educate them on its use, maintenance, and storage. The individual simply has to don the device and press the power button to start using their Bioness Go. When the patient in this case study was asked about pursuing a Bioness Go for use in his community, he expressed interest.

He responded well to the intervention due to good sensation, ability to ambulate prior to use of this device, and strong motivation to normalize his gait pattern so that he could return to work. At the time of this report, he had not returned to work. He continues to receive skilled physical, occupational, and speech therapy services three times a week. Data is limited due to a delay in obtaining initial walk test values, secondary to the patient requiring at least minimum assistance to ambulate for the first few months of his therapy. Once he was able to ambulate with contact guard assist, walking tests were performed and improvements were noted in six-minute walk distance and gait speed on the ten-meter walk test when the Bioness L300+ was donned. These results may be due to the use of the functional electrical stimulation provided by the device to create stability at the patient's knee and ankle during stance phase or the results may be due to a combination of interventions performed as a part of his comprehensive therapy.

This case report may not be able to attribute any direct improvements in function to the Bioness L300+, but it is important to note that both the family and other clinicians commented on the improvements in gait that the patient demonstrated when ambulating around the clinic with the Bioness L300+ donned. It is my hope that these observations in combination with the values reported in table five, above, can be utilized by other clinicians looking for alternative treatment interventions to include in adjunct to their usual care when working with individuals' post-stroke who demonstrate deficits in stance leg stability during gait.

Conclusion

The purpose of this case report was to describe the use of the Bioness L300+ as an adjunct to physical therapy for an individual post-stroke. This particular patient underwent a total of thirty-five outpatient physical therapy sessions over sixteen weeks and utilized the Bioness L300+ for gait/training during seven of those sessions.

Despite limited data gathered during physical therapy sessions, it is likely that this particular patient benefited from incorporating functional electrical stimulation with activities performed in the clinic. The improvements in walking distance on the six-minute walk test and the improvement in gait speed on the ten-meter walk test with the Bioness L300+ as compared to without it in just over two weeks, supports its role in contributing to these functional gains. However, further research is needed to fully characterize the impact Bioness L300+ can have on gait speed and six-minute walk test distance. This patient also received a wide-array of treatment interventions over the course of his skilled comprehensive therapy care, making it difficult to attribute his improvements to simply one intervention. However, he tolerated the use of the Bioness L300+ well and expressed an interest in using the device both in the clinic and in the community to increase his safety and speed of walking. Thus, he provides a good example of encouraging short-term outcomes with the use of a functional electrical stimulation device, such as the Bioness L300+ as a form of functional electrical stimulation, for use of a more comprehensive treatment intervention program.

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