

Outcomes following Application of Functional Electrical Stimulation as it Relates to Increased Functional Mobility in a Patient Post-Chronic Stroke: A Case Report

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Introduction

- Stroke is the third leading cause of disability with approximately 65% of all survivors experiencing ambulatory deficits to some degree. Implementation of effective interventions is critical to successful recovery of motor function.
- Literature review:** existing research supports FES as an effective intervention for post-stroke rehabilitation.
- Gap in the literature:** most studies are based on subjects less than 2 years post-CVA due to challenges in subject recruitment within the chronic post-stroke phase .
- Case Report Objective:** describe the development and application of FES as an adjuvant to P.T. treatment by a practicing clinician for a patient presenting with foot drop two years post-stroke.

Patient History/Systems Review

- 78 y/o female s/p right hemorrhagic stroke and craniotomy.
- HPI: L UE and LE hemiparesis, L foot drop, and LLE extensor tone.
- Received PT in 2012, 2015, 2016, 2018, one treatment period/year, lasting a duration of six to nine weeks.
- Began using Bioness L300 System in 2012
- Concurrent medical tx: L Achilles tendon release, Botox-injection to reduce tone, and intermittent use of AFO.

Examination

- Selection criteria:** s/p CVA (hemorrhagic or ischemic), development of foot drop second to CVA, and FES use to correct for foot drop
- Posture:** increased trunk flexion, weight shift of the body to right, sacral sitting, mild cervical lordosis, forward head posture
- Strength:** L ankle strength grossly 0/5 for DF, PF, eversion and inversion.
- Fall-risk:** in 2012, patient unable to perform 30 second chair-stand test or Timed-Up and Go.
- Balance:** static standing balance via Romberg with feet apart for 30 seconds (eyes open) and 20 seconds (eyes closed)
- Gait:** decreased L ankle DF during swing phase of gait

Clinical Impression

- Diagnosis:** L foot drop s/p R hemorrhagic CVA
- Examination:** findings indicated neuromuscular impairment as the primary factor affecting the subject's gait/functional mobility
- Prognosis:** potentially complicated by the subject's intermittent participation in therapy resulting in extended periods of no physical therapy intervention
- Initial application of FES in 2012 elicited the desired contractile response, which deemed the subject appropriate for use of this technology.

Intervention

- Objective:** stimulate left anterior tibialis, peroneus longus and brevis to permit ankle dorsiflexion and eversion.
- FES Parameters:**
 - Symmetric biphasic waveform
 - Alternating current
 - Pulse width = 200 microseconds
 - Frequency = 30 hertz
 - Amplitude set to achieve a strong muscular contraction and increased to patient's maximum level of tolerance.
- Modifications to FES Delivery:** medial repositioning of the electrodes to achieve greater ankle eversion, increase in the amplitude to achieve greater ankle dorsiflexion, and adjustment of the amplitude when the patient indicated discomfort.
- Treatment Duration:** six to nine weeks, 2x/week, 45 minutes per session.



| Therapeutic Exercise/Activity | Description | Parameters |
|--|---|----------------------------------|
| Sit-to-stand transfer with facilitation to left LE | With arms folded across chest, subject stands to erect position from chair and then returns to seated position with manual support provided by therapist to the LLE for proper limb positioning | 2 sets x 10 reps |
| Gait training with step-to pattern | On level surface within clinic, PT assist as needed, distance achieve based on subject tolerance | Distance as tolerated by subject |
| Gait training with step-through pattern | On level surface within clinic, PT assist as needed, distance achieve based on subject tolerance | Distance as tolerated by subject |
| Gait training via obstacle course | On a variety of surfaces and circumduction of objects placed in path. | 1 set x 2-3 reps |
| Side stepping | If starting exercise stepping in the left direction, step with left foot a distance equivalent to shoulder width apart, and then bring right foot into contact with the left, and repeat for a distance of 10 feet. | 4 reps x 10 feet |
| Treadmill gait training | | 5-10min at 0.0-1.0 mph |
| Step touch onto threshold | Subject instructed to gently tap toes of right foot onto approx. 4-inch threshold and then place back on the ground, then repeat with toe-tapping of left foot and then return foot to the ground. | 2 sets x 10 reps |
| Ascending/descending ramp | Walking up/down ramp in clinic, and progressed to stepping up/down curb outside clinic | 1 set x 10 reps |
| Ascending/descending stairs | Stepping up/down a flight of stairs | 1 set x 10 reps |
| NuStep recumbent bicycling | Exercise equipment in clinic | 7-10 min., level 4 |

Outcomes

- Outcome measures:
 - 30-second chair-to-stand test
 - Timed-up and go (TUG)
 - Romberg Test
 - 6-minute walk test in 2018: pre-tx = 50 feet with SBQC and SBA; post-tx = 400 feet with SBQC and supervision.
- Results: increased cardiovascular and muscular endurance, walking distance, standing balance, and safer/more functional gait.

| Manual Muscle Testing | 2012 | 2015 | 2016 | 2018 |
|-----------------------|------|------|------|------|
| Hip Flexion | 2+ | 2+ | 3+ | 2+ |
| Hip Abduction | 3- | -- | -- | 2- |
| Hip External Rotation | 2+ | -- | -- | -- |
| Hip Internal Rotation | 2+ | -- | -- | -- |
| Knee Flexion | 1 | 1 | 2- | 0 |
| Knee Extension | 3+ | 2+ | 3- | 2+ |
| Ankle Plantarflexion | 1 | 0 | 0 | 0 |
| Ankle Dorsiflexion | 1 | 0 | 0 | 0 |
| Ankle Inversion | -- | 0 | 0 | 0 |
| Ankle Eversion | -- | 0 | 0 | 0 |

| | 30-Second Chair Stand | Romberg Balance Test | Timed Up and Go |
|------|---|--|------------------|
| 2012 | -- | 30 sec (EO), 20 sec (EC) | -- |
| 2015 | Unable to perform independently – required minimal assistance from PT | Zero seconds – immediate loss of balance | -- |
| 2016 | 3 reps (High Fall Risk) | 30 sec EO and EC, with RLE weight shift | 46 sec with LBQC |
| 2018 | 2 reps/10 reps (High Fall Risk) | No loss of balance | 22 sec with LBQC |

Clinical Implications

- Successful patient outcomes with FES as therapeutic adjuvant.
- Produce outwardly immediate results for the appropriate patient population
- Confounding variables to consider:** prior medical management and surgical intervention, the use of supportive bracing, and/or limited availability to attend treatment.
- Further research needed to:**
 - Evaluate the influence of FES on neuroplasticity of the brain
 - Investigate the effect of FES on neuroplastic changes within the brain as it relates to motor function recovery to determine a carryover effect/long-term effects following removal of the device.