

Research Article

Effectiveness of electrical stimulation in idiopathic Parkinson's disease

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ABSTRACT

Background: Parkinson's disease is one of the most disabling chronic neurologic diseases and leads to a significant loss of quality of life. Electrical stimulation activate nerves innervating extremities affected by paralysis resulting from Spinal Cord Injury (SCI), head injury, stroke and hence is primarily used to restore function in people with disabilities.

Methods: The study was performed after the institutional ethical clearance and informed consent from all the participants. The parameters assessed were time taken to complete 20 M walk with turn round, distance covered in the first 3 minutes of walking, gait dynamics like stride length, step length and cadence and number of falls with the help of video tape recorder, stop watch and measuring tape.

Results: We observed a non-significant reduction ($P = 0.471$) of UPDRS, mean score of PDQ-39 was declined non-significantly ($P = 0.36$), time taken to complete 20 meters walk with turn was declined significantly ($P = 0.017$), The distances walked in 3 minutes by the patients were increased significantly ($P = 0.000$), number of steps during 20 meter walk was recorded and was found to be declined significantly ($P = 0.088$), stride length of the patients were increased significantly ($P = 0.000$), step length of the patients was increased significantly ($P = 0.000$), average number of falls reduced significantly ($P = 0.00$) during the stimulation period from week 0 to week 8.

Conclusion: This study demonstrated the superior efficacy of electrical stimulation over best medical management in patients with advanced Parkinson's disease.

Keywords: Parkinson's disease, UPDRS, PDQ-39, Stride length, Electrical stimulation

INTRODUCTION

Repeated attempts have been made over the years to substitute an electronic device to the missing parts of the nervous system. The aim was to bypass damaged centers and to allow control of remote parts of the body. Electrical Stimulation (ES) is used in standing and gait from the 1960's.¹ Since then different devices have been developed to enhance the voluntary control of the limbs. Electrical stimulation is a technique that uses electrical currents to activate nerves innervating extremities affected by paralysis resulting from Spinal Cord Injury (SCI), head injury, stroke and other neurological

disorders. Electrical Stimulation is primarily used to restore function in people with disabilities. It is sometimes referred to as neuromuscular electrical stimulation (NMES). ES involves the use of a current generator which delivers an electric impulse to the peripheral nervous structures, thus eliciting the physiologic response. During the years ES has been proven to improve gait in hemiplegic patients. Single or multichannel devices were used, with surface or implanted electrodes. In 1978, Stanic et al.² found that multichannel FES, given 10 to 60 minutes, 3 times per week for 1 month, improved gait performance in hemiplegic subjects. Improvement of dorsiflexion of the

foot is the easiest and most frequently encountered procedure. The treatment period in published papers ranges from 3 weeks to long term home use.

Recent reviews have documented the neuroprosthetic effect of Peroneal Nerve Stimulation (PNS) with positive impact on multiple specific gait parameters^{3,4} and speed of ambulation. An evidence-based review of stroke rehabilitation has concluded that there was strong evidence that peroneal nerve stimulators improve hemiplegic gait parameters.⁶ Taylor et al.⁷ reported significant improvements in device-free walking speed in a retrospective review of 151 stroke survivors treated with the Odstock Dropped Foot Stimulator (ODFS) for an average of 4.5 months. Kottink et al. suggested that Functional Electrical Stimulation seemed to have a positive orthotic effect on walking speed.⁵ It was also reported that, increases in gait speed after the use of FES, alone or in combination with other procedures.⁸⁻¹³ Therefore, the present study has been undertaken to study the effectiveness of electrical stimulation in idiopathic Parkinson's patients.

METHODS

The study was performed after the institutional ethical clearance and informed consent from all the participants. Patients attending James Parkinson's movement disorder research center with a diagnosis of idiopathic Parkinson's Disease (PD) were selected. The diagnosis of PD was made according to UK brain bank criteria by a movement disorder specialist neurologist. Patients with idiopathic Parkinson's disease having gait disturbances, in spite of the best medical therapy were recruited for the study. The patients of either sex, above 30 years of age diagnosed for Idiopathic PD, responsive to levodopa medication, Hoehn and Yahr stages II-IV, stable on current medication, able to walk at least 100 M with or without a walking aid, able to comply with assessment procedures, able to give informed consent and a score 23 or more on the mini-mental state examination were included.

Patients with suspected atypical Parkinsonism disorders such as multiple system atrophy or progressive supranuclear palsy were excluded. Patients having diabetes with peripheral neuropathy was excluded. Mini-mental scale assessment was done to exclude those scoring below 24. Bed ridden and wheelchair bound patients, any other neurologic condition, other than Idiopathic PD, any musculoskeletal or cardiovascular condition affecting locomotion and severe dyskinesias or dystonias affecting locomotion were excluded.

Patients were made to walk a distance of 10 meter. Walk over an even surface at the end of 10 meters there is a doorway; patient is made to walk through the doorway then turn around and is asked to walk back the rest of the 10 meters. The parameters assessed were time taken to complete 20 M walk with turn round, distance covered in the first 3 minutes of walking, gait dynamics like Stride

length, step length and cadence and number of falls with the help of video tape recorder, stop watch and measuring tape.

For assessing the time taken to complete 20 M walk with turn round patients were made to walk a distance of 10 meter: Walk over an even surface of the ground at the end of 10 meters there is a doorway; patient was made to walk through the doorway then turn around and is allowed to walk back the rest of the 10 meters. The time noted using stopwatch.

The assessment of the distance covered in the first 3 minutes of walking was done using stopwatch and measuring tape.

Assessment of gait dynamics like stride length, step length and cadence were measured using wearable sensors. Force sensitive insoles were placed in or under the subject's shoe. The sensors produce a measure of the force applied to the ground during ambulation. Typically, a small, lightweight (5.5×2×9 cm³; 0.1 kg.) recorder was worn on the ankle (or lower back). An onboard analog-digital converter sampled the output of the footswitches (e.g., at 300 Hz) and stored the digitized force record. Subsequently, the digitized data were transferred to a computer workstation for analysis using software that extracts the initial and end contact time of each stride.^{4,6}

Number of falls was assessed by observation and recording was done while walking for 20 meters at time of investigation.

After the base line assessment the patients were given ES daily a minimum of one hour for 8 weeks. Pre-test Assessments were conducted at week 0. ES was given for a period of 8 weeks. The post-test assessment using the same scale was conducted at the end of 2, 4, 6, and 8 weeks respectively. The UPDRS and PDQ-39 questionnaires were administered at week 0 and week 8.

The electrical stimulator device was attached to the waist band and the electrodes were connected to the gastrocnemius and tibialis anterior bulk of both the legs and stimulation was given to both the legs. The gait was reanalyzed after switching on the electrical stimulator. The efficacy of the device was tested for different intensities. Different pulse width was 30 Hz, 60 Hz and continuous stimulation. The patients were sent home with the electrical stimulator and instructions was given for home use. The electrical stimulation to be carried out at least a minimum of one hour for 8 weeks. The quality of life was assessed at the beginning of baseline, week 0 and 8 weeks using PDQ39. The data was statistically analyzed using ANOVA.

RESULTS

The observations of all the parameters studied are expressed in Figures 1-8. The Unified Parkinson's

Disease Rating Scale (UPDRS) was performed to assess the motor activities of the patients and was observed a nonsignificant reduction ($P = 0.471$) of UPDRS between week 0 and week 8 respectively (Figure 1). The qualities of life of the patients were assessed using Parkinson's disease Questionnaire. The mean score of PDQ-39 was declined nonsignificantly ($P = 0.36$) when compared between week 0 and week 8 respectively (Figure 2). The time taken to complete 20 meters walk with turn was declined significantly ($P = 0.017$) when compared between week 0 and week 8 respectively (Figure 3). The distances walked in 3 minutes by the patients were increased significantly ($P = 0.000$) when compared between week 0 and week 8 respectively (Figure 4).

The number of steps during 20 meter walk was recorded and was found to be declined significantly ($P = 0.088$) when compared between week 0 and week 8 respectively (Figure 5) by the patients. The stride length of the patients were increased significantly ($P = 0.000$) when compared between week 0 and week 8 respectively (Figure 6). The step length of the patients was increased significantly ($P = 0.000$) during the stimulation period from week 0 to week 8 (Figure 7). The average number of falls of the patients from week 0 to week 8 also reduced significantly ($P = 0.00$) during the stimulation period from week 0 to week 8 (Figure 8).

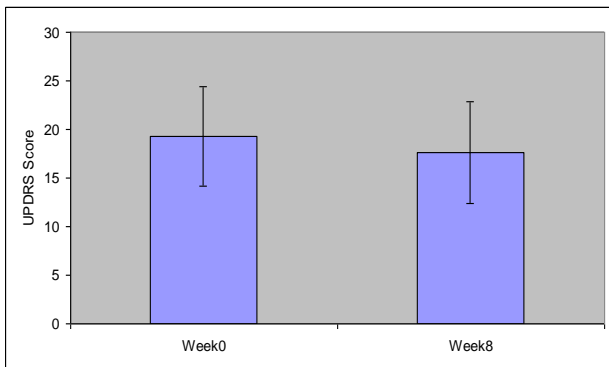


Figure 1: The Unified Parkinson's Disease Rating Scale to assess the motor activities of the patients. Values are expressed as Mean ± SE (N=10).

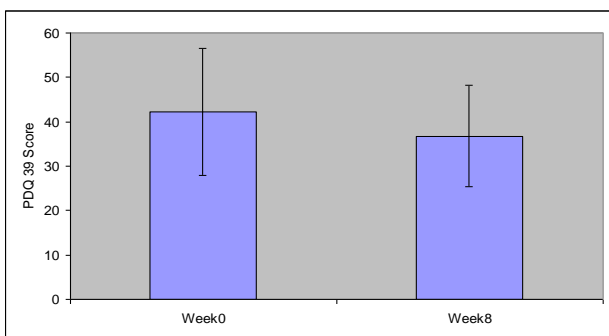


Figure 2: The Parkinson's Disease Questionnaire to assess the quality of life of the patients. Values are expressed as Mean ± SE (N=10).

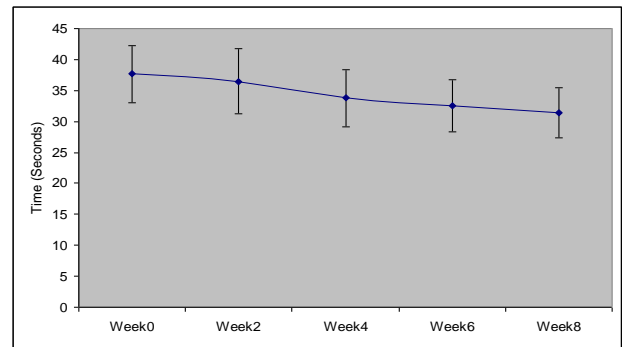


Figure 3: The time taken for completing 20 meters walk with turn by the patients. Values are expressed as Mean ± SE (N=10).

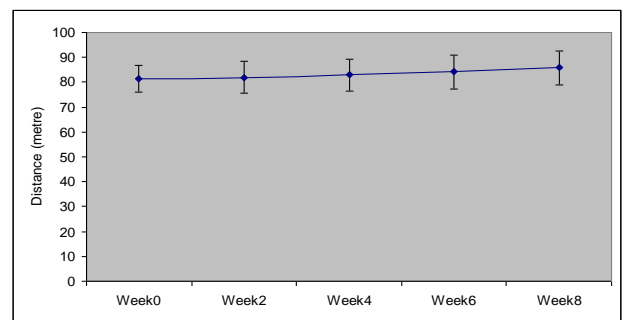


Figure 4: The distance walked in 3 minutes by the patients. Values are expressed as Mean ± SE (N=10).

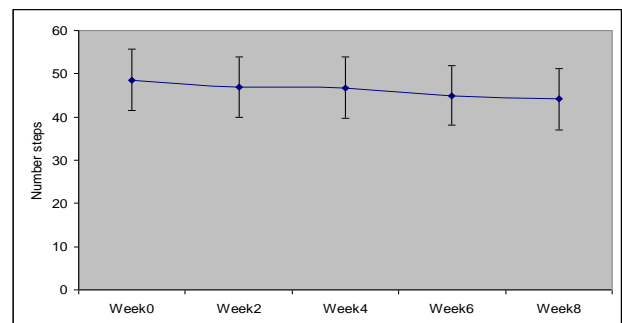


Figure 5: The number of steps during 20 meter walk or cadence by the patients. Values are expressed as Mean ± SE (N=10).

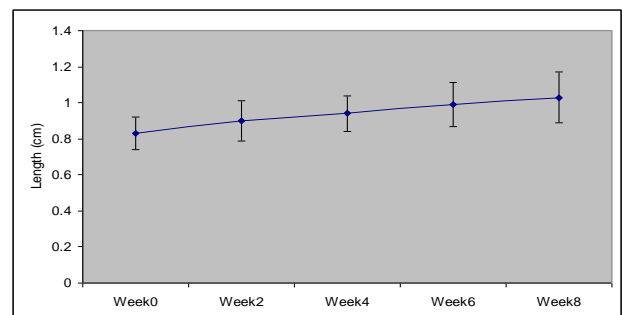


Figure 6: The stride length of the patients. Values are expressed as Mean ± SE (N=10).

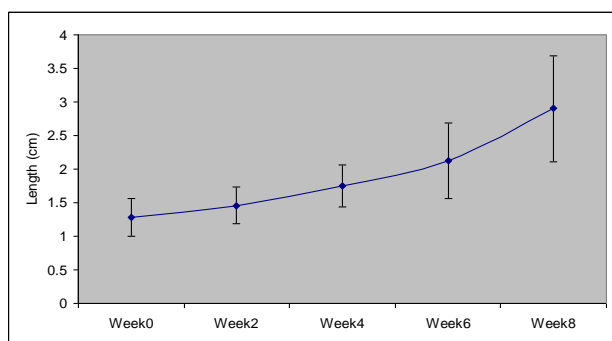


Figure 7: The step length of the patients. Values are expressed as Mean ± SE (N=10).

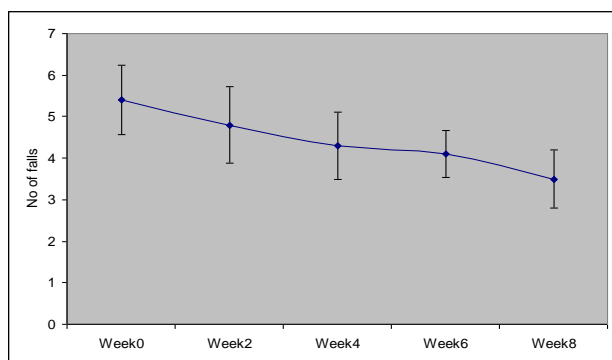


Figure 8: The number of falls of the patients. Values are expressed as Mean ± SE (N=10).

DISCUSSION

This study demonstrated the superior efficacy of electrical stimulation over best medical management in patients with advanced Parkinson's disease. Parkinson's disease is one of the most disabling chronic neurologic diseases and leads to a significant loss of quality of life.^{14,15} Several drugs are available that can effectively treat the symptoms of the disease, but long term medical management is often complicated by the appearance of levodopa-induced motor complications, leading to rapid changes between periods of severe akinesia and periods of mobility that may be accompanied by troublesome hyperkinesias.¹⁶ Dopamine agonists, amantadine, catechol O-methyltransferase (COMT) inhibitors¹⁶ and other drugs can effectively improve mobility and reduce dyskinesias initially but typically fail after several years.¹⁷

Management of Parkinson's disease, due to its chronic nature, requires a broad-based program including patient and family education, support group services, general wellness maintenance, exercise, and nutrition. At present, no cure for PD is known, but medications or surgery can provide relief from the symptoms.

While many medications treat Parkinson's, none actually reverses the effects of the disease or cures it. Furthermore, the gold-standard treatment varies with the

disease state. People with Parkinson's, therefore, often must take a variety of medications to manage the disease's symptoms. Several medications currently in development seek to better address motor fluctuations and nonmotor symptoms of PD.

In our study, electrical stimulation was associated with an improvement in the PDQ-39 summary index, which is within the range of the improvements described in uncontrolled case series^{18,19} and is consistent with the improvement in the generic quality-of-life scale. In contrast to many previous studies of Parkinson's disease, which focused on motor scales, we used quality-of-life measures as the primary outcome criteria. Factors in addition to motor function contribute to such a complex variable as the quality of life.

Improvements in the scores on the PDQ-39 subscales for mobility and activities of daily living reflect changes in motor aspects of the disease. Indeed, evaluation of motor performance by means of the UPDRS-III, and patients' diaries mainly documented a decrease in the severity and duration of periods of immobility and a decrease in the duration and severity of periods of dyskinesias among patients who received neurostimulation. Scores for emotional well-being, stigma, and bodily discomfort also improved, resulting in an improvement in the overall quality of life in the stimulated group.

CONCLUSIONS

The UPDRS reduced non-significantly indicating improved motor activity of the patient is improved. PDQ-39 score was decreased non-significantly indicating that quality of life has improved. Time taken to complete 20 meter walk reduced significantly. Distance walked in 3 min was increased non-significantly. Number of steps during 3 min walk was found to be reduced non-significantly. Stride length was increased significantly. Step length was also increased significantly. Number of falls decreased non-significantly.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Lieberman WHH, Scot D, Dow M. Functional electrotherapy: stimulation of the peroneal nerve synchronized with the swing phase of the gait of hemiplegic patients. *Arch Phys Med Rehabil.* 1961;42:101-5.
2. Stanic U, Acimovic-Janezic R, Gros N, Trnkoczy A, Bajd T. Multichannel electrical stimulation for correction of hemiplegic gait. *Scand J Rehabil Med.* 1978;10:75-92.
3. Lyons GM, Sinkjaer T, Burridge JH, Wilcox DJ. A review of portable FES-based neural orthoses for

- the correction of drop foot. *IEEE Trans Neural Syst Rehabil Eng.* 2002;10(4):260-7.
4. National Institute for Health and Clinical Excellence. Interventional procedure overview of functional electrical stimulation for drop foot of central neurological origin. In: NICE, eds. *Interventional Procedures Programme.* London UK: NICE; 2008: 1-29.
 5. Kottink AI, Oostendorp LJ, Buurke JH, Nene AV, Hermens HJ, IJzerman MJ. The orthotic effect of functional electrical stimulation on the improvement of walking in stroke patients with a dropped foot: a systematic review. *Artif Organs.* 2004;28:577-86.
 6. Teasell RW, Foley NC, Bhogal SK, Speechley MR. An evidence based review of stroke rehabilitation. *Top Stroke Rehabil.* 2003;10(1):29-58.
 7. Taylor PN, Burridge JH, Dunkerley AL, Wood DE, Norton JA, Singleton C, et al. Clinical use of the Odstock dropped foot stimulator: its effect on the speed and effort of walking. *Arch Phys Med Rehabil.* 1999;80(12):1577-83.
 8. Burridge JH, Haugland M, Larsen B, Pickering RM, Svaneborg N, Iversen HK, et al. Phase II trial to evaluate the ActiGait implanted drop-foot stimulator in established hemiplegia. *J Rehabil Med.* 2007;39:212-8.
 9. Burridge JH, Taylor PN, Hagan SA, Wood DE, Swain ID. The effects of common peroneal stimulation on the effort and speed of walking: a randomized controlled trial with chronic hemiplegic patients. *Clin Rehabil.* 1997;11:201-10.
 10. Daly JJ, Roenigk K, Holcomb J, Rogers JM, Butler K, Gansen J, et al. A randomized controlled trial of functional neuromuscular stimulation in chronic stroke subjects. *Stroke.* 2006;37:172-8.
 11. Johnson. The effect of combined use of botulinum toxin type A and functional electrical stimulation in the treatment of spastic drop foot after stroke: a preliminary investigation. *Arch Phys Med Rehabil.* 2004;85(6):902-9.
 12. Sheffler LR, Hennessey MT, Naples GG, Chae J. Peroneal nerve stimulation versus an ankle foot orthosis for correction of foot-drop in stroke: impact on functional ambulation. *Neurorehabil Neural Repair.* 2006;20(3):355-60.
 13. Stein RB, Chong S, Everaert DG, Rolf R, Thompson AK, Whittaker M, et al. A multicenter trial of a foot drop stimulator controlled by a tilt sensor. *Neurorehabil Neural Repair.* 2006;20(3):371-9.
 14. Schrag A, Jahanshahi M, Quinn N. What contributes to quality of life in patients with Parkinson's disease? *J Neurol Neurosurg Psychiatry.* 2000;69:308-12.
 15. Martinez-Martin P. An introduction to the concept of "quality of life in Parkinson's disease". *J Neurol.* 1998;245(Suppl 1):S2-6.
 16. Goetz CG, Poewe W, Rascol O, Sampaio C. Evidence-based medical review update: pharmacological and surgical treatments of Parkinson's disease: 2001 to 2004. *Mov Disord.* 2005;20:523-39.
 17. Rascol O, Brooks DJ, Korczyn AD, De Deyn PP, Clarke CE, Lang AE. A five-year study of the incidence of dyskinesia in patients with early Parkinson's disease who were treated with ropinirole or levodopa. *N Engl J Med.* 2000;342:1484-91.
 18. Martinez-Martin P, Valldeoriola F, Tolosa E, Pilleri M, Molinuevo JL, Rumià J, et al. Bilateral subthalamic nucleus stimulation and quality of life in advanced Parkinson's disease. *Mov Disord.* 2002;17:372-7.
 19. Lezcano E, Gomez-Esteban JC, Zarranz JJ, Lambarri I, Madoz P, Bilbao G, et al. Improvement in quality of life in patients with advanced Parkinson's disease following bilateral deep-brain stimulation in subthalamic nucleus. *Eur J Neurol.* 2004;11:451-4.

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