

Chapter 14

Low Cost, User–Controlled Peroneal Stimulator for Foot Drop in Patients With Stroke: An Experiment in Indian Rehabilitation Set–Up

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ABSTRACT

Foot drop is a common disabling condition following stroke. It has been conventionally managed using an ankle foot orthosis (AFO). An alternate rehabilitation option is the functional electrical stimulation (FES) systems that has undergone numerous improvisations over past few decades to make it more efficient and user friendly. This chapter aims to evaluate a prototype low-cost FES device in an Indian rehabilitation set-up to match the patients' cultural and socio-economic needs. It illustrates a pilot study designed to test the orthotic and clinical efficacy of the device in terms of dynamic ankle angle change during ambulation and comparing the walking speed and endurance with the AFO. A significant change with nearly two-thirds of normal ankle angle change during swing phase of the gait cycle was observed with nearly equivalent orthotic effects in terms of walking endurance and speed. In terms of receptivity, the device received a mixed response from the patients regarding its effectiveness as an orthosis.

INTRODUCTION

Stroke/Cerebrovascular accident (CVA) is one of the leading causes for acquired neurological disabilities

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worldwide. In recent decades, a rise in the prevalence of stroke in developing countries like India has been observed (World Health Organization [WHO], 2017). Stroke often results in multiple neurological sequelae, impacting not only the patient, but also his/her family resulting in significant financial crisis, thus affecting the quality of life and thereby, adding to the socio-economic burden of the country (WHO, 2017). Hence, rehabilitation of these patients with a context-specific approach is very important.

The spectrum of sequelae following stroke range from cognitive and behavioural impairments as well as swallowing and speech deficits to visual dysfunction, motor and sensory impairments (Langhorne et al, 2011). Of these, the motor impairment is the most notable as it affects daily activities and mobility of the patients. Among the motor impairments, weakness of ankle dorsiflexors resulting in foot drop is one of the commonest, leading to difficulty in ground clearance of the foot and consequently, a spectrum of gait impairments (Langhorne et al, 2011). Gait training is hence an important goal of stroke rehabilitation (Jauch et al., 2013; Langhorne et al, 2011). The ankle is supported with an ankle foot orthosis (AFO), which enables the ankle joint to be in neutral position and provides stability to the ankle while the other muscle groups in the affected limb are trained so that the patient can ambulate efficiently (Shahabi et al, 2020). A walking aid like cane or quadripod may be required to assist the ambulation and for safety purposes (Allet et al., 2009).

In past few decades, an alternate option that has been frequently researched and improvised is the Functional Electrical Stimulation (FES) system (Gil-Castillo et al., 2020). In FES system, the electric current is applied to stimulate the nerve or muscle to bring about muscle contraction used for a functional activity. These systems have to be worn by the patient to utilize the muscle contraction and hence, are called neuroprosthesis (Mendes et al, 2020; Takeda et al., 2017). Peroneal Stimulator is the one of the widely explored FES systems for management of foot drop following stroke. This has both orthotic effect by correcting gait abnormalities and also, therapeutic effect by strengthening of muscles and enhancing the voluntary control, promoting recovery in these patients (Kottink et al, 2007, 2008).

Literature reveals that numerous studies have been conducted to compare the efficacy of these systems with traditional AFO in different stages of rehabilitation post-stroke and in different subgroups of patients (Mendes et al, 2020; Prenton et al., 2016). Moreover, research has been conducted to bring about various innovations and improvements in the architectural designs of these systems including trials for non-invasive and invasive devices (Gil-Castillo et al., 2020). Initial trials have been using surface electrodes activated by foot switches. More recently, implantable devices and automatic sensors based on accelerometers and gyroscopes have been tried (Gil-Castillo et al., 2020). Thus, constant attempts have been made to make these devices more user-friendly and with better orthotic efficacy.

However, these available systems are not very cost-effective for a developing country like India, where the cheaper option of AFO is used. Hence, an attempt was made to fabricate a low cost peroneal stimulator in the rehabilitation department of a tertiary care institute in India using an indigenous design. It was also smaller in size and technically simpler than most of the current available devices. After fabrication of the assistive device, a pilot study was conducted to test its efficacy. This chapter elaborates the study conducted with the prototype device. Firstly, it aims to explore the orthotic and clinical efficacy of the device in patients with stroke, comparing it with the standard intervention of AFO in Indian settings. Within Indian context, many patients prefer walking barefoot thereby, avoiding usage of AFOs or footwear within the house. As the device's sensor was mounted on walking aid, it allowed walking bare-foot which is not possible if foot switch based sensor is used. Secondly, as the device was in its pilot phase, its receptivity by the patients was also looked into. Lastly, these findings are discussed in the light of research done so far, providing recommendations for possible future work.

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