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Case Report
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Effects of 12 Weeks Huber Motion Lab Training on Strength Walking Performance and Balance on Foot Drop: A Case Report

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Abstract

Foot drop is a neuromuscular syndrome characterized by muscle weakness of dorsiflexor muscles resulting in loss of foot control and stabilization. Foot clearence is an important problem for patients during walking.

The aim of this study to report the effectiveness of FES at the case who had drop foot caused by T4 transvers process fracture. Secondly, to discuss the underlying mechanism of the improvement we observe.

Case is a 27 year old man who had a wreck in 2011 and broke right transvers processuss of T4 vertebrae. After he was diagnosed with CST damage and left hemothorax, he had decompression surgery in 2011. After the accident he had physiotherapy for 3 years while he was almost immobile. We could present objective results since HML is able to monitorize MVIC during training.

Key words: Walking Performance, Huber Motion, Foot Drop

Introduction

Foot drop is a neuromuscular syndrome characterized by muscle weakness of dorsiflexor muscles resulting in loss of foot control and stabilization. Foot clearence is an important problem for patients during walking. Since patients with foot drop could not rise their toes they display abnormal walking pattern which is called "steppage gait". And another compensatory gait pattern is cimcumduction gait. In this gait type; the leg is stiff, without flexion at knee and ankle, and with each step is rotated away from the body, then towards it, forming a semicircle. Underlying problem of this pathology is mainly peroneal nerve degenaration of foot flexor muscles. Other etiologies include surgery nerve trauma, stroke, neuropathies, drug intoxication, spinal stenosis, diabetus mellitus, vasculitis etc (1,2).

Corticospinal Tract (CST), a descenting tract, is associated with voluntary skilled motor tasks especially in distal part of extremities. Functions of CST does not include only voluntary movements but also it has the speed and agility of movements. Thus CST is employed when quick and nimble movements needed (1) . Defining the spesific role of CST during normal gait

will ensure a more precise assessment of inadequancies after CST lesion. Previous studies about stroke patients reported that CST is involved in elevation of foot during swing phase of gait so its damage causes drop foot. (2,3). Another study has showed that assessing maximal toe elevation could be an objective way to measure the CST damage in spinal cord injury (4). It is generally believed that foot drop following stroke and spinal cord injury (SCI) in human subjects is also explained by impaired corticospinal transmission or lesion to the corticospinal tract (Calancie et al. 1999; McKay et al. 2005; Nathan 1994; Thomas and Gorassini 2005). Animal studies also have shown that inadequate paw lift in the cats and monkeys during gait is associated with CST lesion (5,6).

Functional Electrical Stimulation (FES), aims to stimulate dorsiflexor muscles that lifts foot off the ground by using low current impulses. It is clinically proven that FES improves walking speed and reduces walking effort (8). FES stimulates peripheral motor nerve thus promotes functional movement. In patient with drop foot, FES assists active dorsi flexion at swing phase of walking by stimulating peroneal nerve. FES also enhances foot stabilization during swing phase. FES can be used as a treatment in diseases caused by central nervous system (CNS) injury (7).

Huber Motion Lab (HML) is a modern physiotherapy application that scientific studies also support. It improves physical condition while strengthening core muscles. Patient stands on a mobile platform which provides balance training and feed forward neural network at the same time. HML can show maximum voluntary isometric contraction (MVIC) value thereby physiotherapist would get objective data of physical improvement. A study in 2014 reported that 8 weeks training program with HML effects body composition and muscle performance in possitive way (9).

Among all other new devices, HML provides patient balance, coordination and strength training simultaneously while exercising. However, scientific literature remains sparse to show the reliability of physiological responses that HML ensure. Neurologic disorders are often associated with immobilization which is a serious risk factor that reduces cardiac capasity. Studies have shown that HML has important possitive effects on carciac rehabilitation. A study in 2008 has indicated that HML stimulated anaerobic metabolism when used isometric muscle contraction mode especially in upper extremity (7-9).

The aim of this study to report the effectiveness of FES at the case who had drop foot caused by T4 transvers process fracture. Secondly, to discuss the underlying mechanism of the improvement we observe.

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Case Description

Case is a 27 year old man who had a wreck in 2011 and broke right transvers processuss of T4 vertebrae. After he was diagnosed with CST damage and left hemothorax, he had decompression surgery in 2011. After the accident he had physiotherapy for 3 years while he was almost immobile. He could only ambulate with wheelchair or crutch. His walking pattern was circumduction gait. In 2014 a small mobile functional electrical stimulator ,Bioness, applied to the patient for the first time to ensure him to walk independently. Bioness, stimulates the common peroneal nerve to support the foot elevation, thus inhibits the circumduction gait. One of an electrode placed on the heel and other two ones placed on the peroneal nerve. All electrodes are connected to the operating unit via wireless technology. Patient could carry the tiny compact device with himself all the day long and he could use the device himself easily. The aim of FES application was to elevate the foot during swing phase of gait, provides foot stability, prevent the possibility of disuse atrophy and maintan ROM. Device also continues electrical stimulation at rest in order to keep muscle strength.

Patient started walking without crutch for the first time immediately after Bioness application. He also had physical therapy while using Bioness but the therapy sessions were not regular. In 2016 the patient was evaluated in our clinic and we observed diffuse weakness particularly in trunk and hip muscles. He was able to walk only with stick since his gait pattern was asymmetric and had high energy consumption. Following evaluation, we had planned a 12 week exercise program with HML that targeted to train directly Quadriceps Femoris, Rectus Abdominis, Trapezius, Lattisimus Dorsi muscles and to improve balance as well. (Quadriceps Femoris strengthening exercises were eccentric while others were concentric). The mobile platform of HML provides not only balance training but also lower extremity weight bearing which is very useful in neurologic patients. In addition to these, patient practiced walking exercises with physiotherapists as a part of the rehabilitation program during this period. 5 days a week for 12 weeks HML program applied with FES that was off only when patient had been exercising on HML. Additionally pysiotherapists used electrical muscle stimulation to strengthen foot dorsi flexors and evertors for 12 weeks.

Results

We could present objective results since HML is able to monitorize MVIC during training. Figure 1,2,3 and 4 demonstrated the increment in maximum contraction of target muscles values before and after the exercise program.

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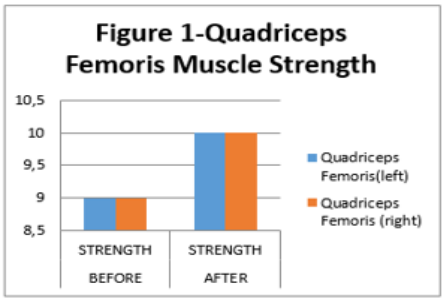
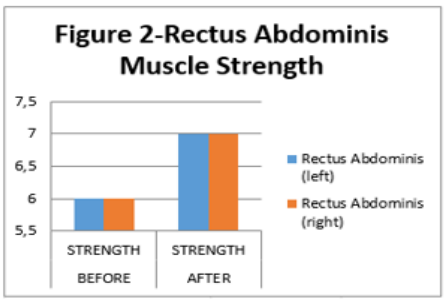
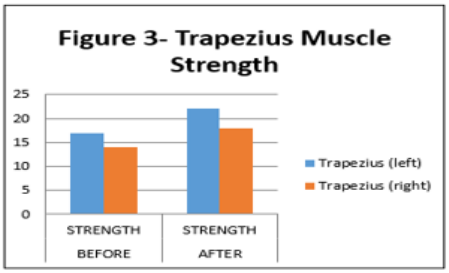
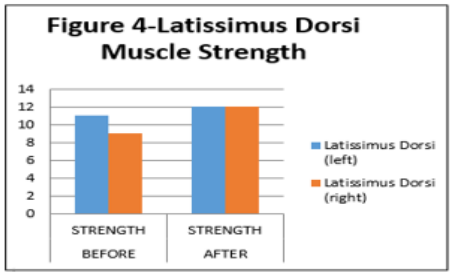
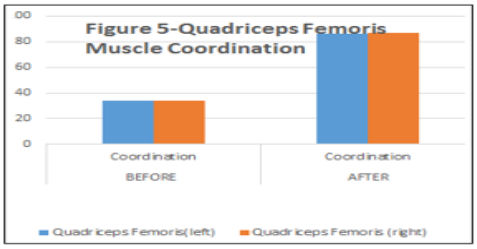


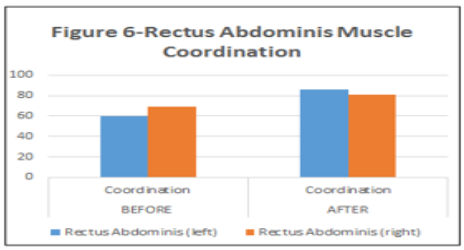


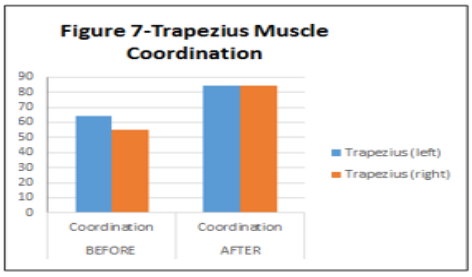


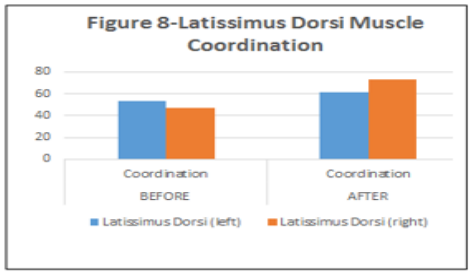


It could be said that core and lower extremity muscles strengthened as well because patient achieved totally independent ambulation for the first time after 12 weeks of HML training. We also exercised his balance and coordination via the moving platform of HML. Balance training led with closed and open eyes which was the same as conventional physical therapy. Figure 5,6,7 and 8 demonstrated that the improvement of coordination datas that we recorded during training.









Physiotherapists analyzed the gait before and after the program and reported significant improvements of walking ability. We consider that electrical stimulation we applied to foot dorsiflexors and evertors had positive

effects on patient's drop foot after 12 weeks.

Discussion

Despite the widespread use in worldwide, research studies done with HML remain sparse. It has been studied only in chronic heart disease however it has not been founded any study in spinal cord injury.

It is previously reported that HML has possitive effects on both strenghthening and balance simultaneously which makes it a "all-in-one" machine (10).

Studies in literature have indicated the corticospinal pathway has been fasilitated and walking performance has been improved after FES for foot drop (7). Based on these results FES could affect neural plastisity which is very important in patient with neurologic dysfunctions.

In present study we have showed the improvements after 12 weeks HML training that included trunk and lower extremity exercises in patient with spinal cord injury caused by T4 fracture. In addition to HML training, patient also had been treated with conventional physiotherapy and electrotherapy techniques for muscle strengthening. He has continued using Bioness during daily activities except only during the treatment sessions.

We agreed that the most possible explanation of the improvement in walking is that central stabilization leads more effective movement in distal part of the body. Cental stabilization is one of the most popular approach which is based on the basis of strengthening of core muscles thus enabling more effective distal movement (11). We have attributed the progress in lower extremitiy and walking to central stabilization because HML made possible to strength core mucles in group. Another reason of the success in HML treatment is that one session of HML focuses several components (such as balance, proprioceptive facilitation, weight shifting) at the same time, which provides time saving treatment.

Before treatment we evaluated the patient in terms of fitness for both HML and Bioness. His foot dorsiflexors responded to FES which is not suitable for the majority of patients with foot drop. Despite HML had special seat, similarly he was comfortable while standing position which is not possible way for every SCI patient. Standing position has promoted independent walking in this case because it has allowed weight shifting . Limitation of this study was that there was not much more similar cases. HML and Bioness are not appropiate for every patient as explained above. Even so there is need for future researches that shed light on whether HML has superiority to other exercise methods or not.

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