

A STROKE-T KAPOTT EGYENEK REHABILITÁCIÓS ESZKÖZEIBEN JELENTŐS FEJLŐDEST MUTATÓ HATEKONY TECHNIKÁK ÁTTEKINTÉSE

REVIEWING THE NOTABLE PROGRESS OF EFFECTIVE TECHNIQUES IN THE DEVELOPMENT OF STROKE HAND REHABILITATION DEVICES

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Abstract

A stroke characterized as a sudden onset of symptoms that can cause a wide range of different problems. If the stroke affecting the right side of the brain the problems occurs on the left side of the body and inversely (affecting the left side of the brain, the problems occurs on the right side). Stroke victims often lose proper function of at least one hand and fingers. With exercises, the survivors have been changed to recover their hand functions, in this paper we are going through the most effective technologies based on stroke hand rehabilitation with the devices which could do that exercises. During the last few years, interest has been growing for the hand rehabilitation technologies, FES “function electrical assimilation” has been widely used to restore upper limb functions in people with hand disability and it has improved their ability to perform their activities of daily living (ADL)

Keywords: *stroke, functional electrical stimulation, rehabilitation, upper extremity, therapy*

Összefoglalás

A stroke hirtelen fellépő tünetekkel jár, melyek számos különböző problémát okozhatnak. Ha a stroke az agya jobb oldalát érinti, a probléma a test bal oldalán jelentkezik és fordítva. A stroke áldozatai gyakran elvesztik legalább az egyik kezük és ujjaik megfelelő funkcióit. Gyakorlatokkal a túlélők visszaszerezhetik a kezek funkcióját. Ebben a tanulmányban bemutatjuk a leghatékonyabb technológiákat egy stroke-ot kapott egyén kezének rehabilitációjára, valamint azokat az eszközöket, amelyekkel ezek a gyakorlatok végezhetők. Az elmúlt néhány évben a kéz rehabilitációját célzó technológiák irányába mutató érdeklődés folyamatos növekedést mutat a FES. A FES, mint funkcionális elektromos stimuláció széles körben használt a felső végtagok funkcióinak visszaállítására a kezet érintő fogyatékossgal élő emberek esetében és ez fejleszti ezen emberek képességét a mindennapi tevékenységeik elvégzésére.

Kulcsszavak: *stroke, funkcionális elektromos stimuláció, Rehabilitáció, felső végtag, terápia*

1. Introduction

Recent development in neuroimaging techniques allows an in-depth investigation of brain motor recovery mechanisms. This is critical to better understanding the effectiveness of different rehabilitation techniques in the treatment of neurological disorders [1]. With the help of robotic technology and artificial intelligence the process becomes much more reliable and effective. Technology, in general, has advanced over the years, one of the most innovative technology is function electrical stimulation. The upper limb FES devices that have shown promising results during the clinical trials are summarized here. However, FES has helped in rehabilitation of people with tetraplegia by restoring some of the upper limb functions, which has enabled them to perform ADL independently. The devices that have shown clinically significant results are summarized in the next section [2]

2. Functional Electrical Stimulation (FES) Technology for Hand Rehabilitation

Functional electrical stimulation (FES) is an effective technique for the hand rehabilitation functions such as grasping and releasing [3]. It is a technique that causes a muscle to contract through the use of an electrical current. This might sound strange, but in fact, the body naturally uses electrical currents to make muscles move. Normally, when a part of the body needs to move, the brain sends electrical signals through the nervous system. After a stroke, some of these electrical signals do not function as well as they should. FES allows muscles that have been paralyzed or partially paralyzed by stroke to move again [4]. Electrical stimulation can be applied in a variety of ways to the hemiparesis upper extremity following a stroke. In particular, electromyography (EMG) - triggered

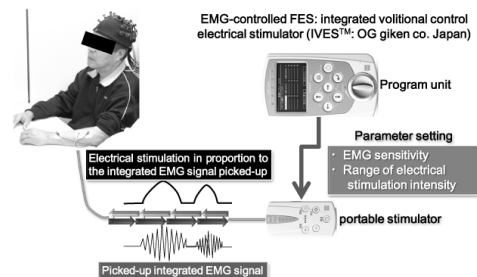
electrical muscle stimulation improves the motor function of the hemiparesis arm and hand [5].

2.1. EMG Controlled FES

The EMG controlled FES utilizes the surface electrodes which deliver electrical stimulation [6]. Using this technique comes with a huge drawback, as it is difficult to control and monitor the EMG signals parallel to the Functional electrical stimulation after beginning of the programmed system [3].

Another portable system (Integrated Volitional Control Electrical Stimulator (IVES): OG GIKEN, Okayama, Japan) was proposed which consists of a 2 Channel neuromuscular stimulator that targets the finger and wrist movements except muscle contraction. However this system impacts efficient muscle contraction in correspondence with voluntary integrated EMG signals as shown in **Figure.1**.

The device consists of input, setting and stimulator. The mechanism is established in such a way that the surface electrode gets the EMG signal and triggers the muscle along with the integrated signal. A setting is configured to capture the EMG signal sensitivity and defined range for the electrical stimulation. After the initial arrangement of the system, no more further process is required, as it is an auto driven EMG controlled FES unit as shown in the **Figure. 1** [5].



1. Figure. EMG-controlled FES instrumentation

2.2. Hybrid EMG – Controlled FES

Robotic devices combined with FES technology for recovery of impaired limbs is an innovative field in research domain [7]. The hemiparesis hand function is required to be enhanced by reducing the wrist and finger flexor spasticity. For this purpose, FES is able to restrain the antagonist muscle activity [8]. In order to fully improve the hand functionality, the FES is combined with motor point block. However, this technique is used in the clinic to treat patients for improving the motor control and enhancing the balance of activity at a joint [5]. The patients with stroke are being treated with EMG controlled FES combined with motor point block for antagonist muscles as hybrid FES system [9].

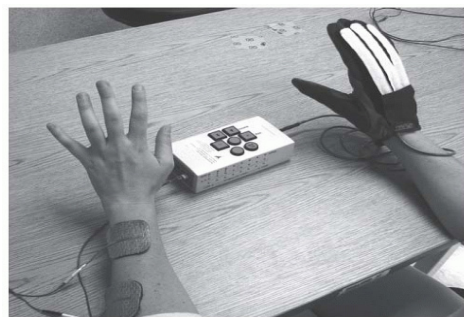
2.3. A home based rehabilitation program using FES

FES based home program for stroke patients initiated a trial for 5 months, which aims to analyse the daily routine tasks based on FES therapy on 20 patients which were having stroke attack at least 1 year ago and having spastic upper extremity impairments. The power assisted devices were used by FES groups to persuade the muscle contraction in terms with integrated EMG signals and electrical stimulation [10].

2.4. Contralaterally Controlled Functional Electrical Stimulation (CCFES)

The novel approach for reviving the impaired limbs caused by stroke by providing the neuromuscular electrical stimulation is known as Contralaterally controlled functional electrical stimulation (CCFES). Research is conducted on this technique for improving the rehabilitation process for arm, hand functions and ankle

dorsiflexion in chronic patients. Hence the studies proved the efficiency of CCFES system [11]. It's a technique which targets to enhance the recovery process of impaired hand function in unilateral paralyzed patients [12]. The system works with the willingness of unimpaired hand contralateral that intensifies the party finger and thumb extensors. The glove is used to detect the opening of hand [12]. Unilateral paralyzed patients are able to open their impaired hand as shown in **Figure 2**. The system consists of surface electrodes for positioning of the hand and forearm, 3 independent monopolar channels and programmed stimulator for the opening of a glove from minimum to maximum pulse duration. The glove consists of 3 bend sensors for abaxial side of the index, middle and ring finger [5]. As compared to the cyclic neuromuscular technique, CCFES proved to be the efficient on upper extremity impairment for the post stroke patient's [13].



2.Figure. *Contralaterally controlled functional electrical stimulation*

5. Conclusion

The rehabilitation technologies can improve the quality of life for people with disabilities. The field of FES for hand rehabilitation is still far from being perfect but continues to grow. But it's one of the

promising technology Overall, the field of hand rehabilitation has a bright future, Doctors, patients and researchers involved in hand rehabilitation will benefit and have further tools in the coming years.

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