Utilizing a Mobile Electrode (PEN) for Functional Electrical Stimulation (FES) to Treat Facial Paralysis Caused by a Brain Injury
A Case Study

Fabiana S. B. Perez[1], Adson Ferreira da Rocha[1], Karla de Castro Cardoso[2], Hellen Orlando Veloso[2] and Inez Janaina de Lima Amaral[3]
[1]*School of Medicine, University of Brasília, Brasília, DF, Brazil*
[2]*State University of Goiás, Anapolis, GO, Brazil*
[3]*Catholic University of Goiás, Goiania, GO, Brazil*

Keywords: Electrical Stimulation, Facial Paralysis, Pen-shaped Mobile Electrode, Brain Injury.

Abstract: This research is a case study that evaluated the therapeutic efficacy of Functional Electrical Stimulation (FES) associated with the method of Proprioceptive Neuromuscular Facilitation (PNF) in a patient with central facial paralysis caused by brain damage resulting from brain anoxia. The treatment involved the application of Orofacial Regulation Therapy, associated with physical therapy using a pen-shaped electrode whith an FES current. The treatment was administered for a period of one year and involved two weekly 15 minute sessions. The stimuli were performed with modulated current at a frequency of 60 hertz, pulse width of 300 miliseconds, rise of four (4) seconds, decay of four (4) seconds, time ON of one (1) second, time OFF of five (5) seconds, in trapezoidal pulses (forming a mini cycle of 14 seconds with 30 pulses) at an intensity level measured according to the patient's sensitivity, associated with the PNF method. The mobile pen-shaped electrode was positioned at precise points on the paralyzed muscles of the face, and the fixed-electrode was positioned on the Deltoid muscle. There was satisfactory rehabilitation of muscles in the left hemiface and acquired improvement in the oral consumption of the bolus. The symmetry of the face was also enhanced, along with facial expressions and connotation measuring four (4) on the Chevalier scale.

1 INTRODUCTION

Facial paralysis can cause an individual to lose one form of non-verbal communication. Non-verbal communication is significant when oral expression can no longer be used to transmit information to a recipient (Calais et al., 2005).

Facial expressions can be utilized to more accurately demonstrate the feelings of an individual and sometimes transmit more information than actual verbal communication. An individual with facial paralysis often feels insecure and embarrassed about these changes, which often results in isolation. This can also cause a family to feel alienated because of a member's communication difficulties and even an inability to feed normally in some cases (Lima, 2001).

Central Facial Paralysis (CFP) or supranuclear palsy consists of lesions on the pyramidal motor neurons of the frontal cortex (responsible for voluntary movements), that manifest on the ipsilateral (upper face) and contralateral (top and bottom) of the facial motor nucleus (Lazarini et al., 2002). Thus, involuntary movements or emotion can be preserved. It is usually caused by vascular lesions, tumors, degenerative or inflammatory processes and can be accompanied by other neurological manifestations including hemiplegia and dysarthria (Bento et al., 1998); (Esborrat, 2000); (Testa and Antunes, 2000); (Chevalier et al., 1987).

Facial paralysis consists of two phases: flaccid and sequel. The flaccid phase is characterized by sagging muscles while at rest and reduced muscle activity during movement. During this phase there is potential for regeneration and normal mobility can return. In the sequel phase, aberrant reinnervation of the facial nerve can occur and symptoms including synkinesis (involuntary movements), motor skills paralysis and contractures may be exhibited (Goffi - Gomez, 1999); (Moran and Neely, 1996).

S. B. Perez F., Ferreira da Rocha A., de Castro Cardoso K., Orlando Veloso H. and Janaina de Lima Amaral I..
Utilizing a Mobile Electrode (PEN) for Functional Electrical Stimulation (FES) to Treat Facial Paralysis Caused by a Brain Injury - A Case Study.
DOI: 10.5220/0004252002690272
In *Proceedings of the International Conference on Biomedical Electronics and Devices* (BIODEVICES-2013), pages 269-272
ISBN: 978-989-8565-34-1

The Kabat Method or Proprioceptive Neuromuscular Facilitation (PNF) assists in the rehabilitation process of an individual's physical condition by requiring a learning of motor skills, improving flexibility and range of motion, increased muscle strength and coordination. PNF exercises combine diagonal movements, based on a deep anatomical study, with the biomechanical and neurophysiological. These exercises resemble the functional movements of daily life and can be used in the treatment of facial paralysis (Alencar et al., 2011). This method is more efficient when associated with electrical stimulation.

FES (Functional Electrical Stimulation) enables a selective repeat afferent input of the central nervous system which activates not only the targeted location, but also the reflex mechanisms of the muscle. These are very important for the reorganization of motor activity and movements that are impaired due to the injury of the upper motor neurons. Furthermore, FES produces a general increase in the potential that the electric current will reach the balance of excitatory and inhibitory pulses, stimulating the disabled motoneurons while the patient has the opportunity to consciously experience the "normal movement". Thus with repetition, the patient may relearn movement and modulate their tonus. (Perez, 2011).

The smaller the diameter of the electrode, the more concentrated the electrical charge becomes, thus requiring a lower dose of current to achieve the same result as a larger electrode in relation to muscular contraction (Agne, 2004).

The movable electrode used for facial stimulation had a pen shape and was smaller in diameter than others electrodes. These features promoted a deeper and more intense stimulation of the muscle fiber utilizing a lower intensity current than required by other conventional electrodes (Perez, 2011).

According to Roberts (1997), physical therapy uses myotherapy, and in some cases, electrical stimulation with the aim of recovering facial symmetry. Speech therapy uses this practice to achieve facial symmetry and adequate stomatognatic functions (chewing, sucking and swallowing), in addition to improving verbal communication as a whole.

2 MATERIAL AND METHODS

This research is a case study of a patient with left-sided facial paralysis who was treated with the pen-shaped electrode, utilizing FES current therapy associated with the PND Method and Orofacial Regulation Treatment.

Patient VLN, now deceased, was a Caucasian female. At age 31 she suffered anoxia after exogenous poisoning (ingestion of poison as a result of depression). She was discovered 24 hours after the incident and was unconscious. The patient suffered cardiac arrest and fell into a comatose state. Patient VLN was initially diagnosed with brain damage from anoxia and remained on a tracheostomy for 18 days and a gastrostomy for a month.

Three years after the incident the patient was admitted to the Center for Integrated Rehabilitation and Stimulation (CEREI) in Goiânia-Goiás, Brasil, to undergo a multidisciplinary rehabilitation program. During the physiotherapeutic examination the patient appeared apathetic, lacking initiative and spontaneous verbal fluency. During a neurological examination, we observed impaired expressive language and language comprehension as only preserved for simple orders. She exhibited spastic rigidity ranked degree five on the Ashworth Scale, as well as spastic tetraplegia, hyperreflexia, preserved sensation, facial paralysis and opisthotonos. During the evaluation of facial movements it was possible to identify facial asymmetry and spastic facial palsy was only visible as an eye twitch (a sign noted on Chevalier's Scale). Patient VLN also lacked the ability to contract the following muscles: occipitofrontal,corrugator supercilii, orbicularis oculi, transverse nose, risorius and the orbicularis oris of the left hemiface. She also had synkinesis and unintelligible vocalization.

The speech therapy evaluation uncovered left-sided facial hemiparesis (falling oral rhyme and difficulty in labial sealing), a decrease in the tone and mobility of the organs that compose the orofacial complex (COF), as well as the presence of mild drooling from the left side of the mouth. When food was administered orally (in both a liquid and paste form), difficulty was observed during the swallowing cycle. Patient VLN's tongue thrust forward during swallowing and signs of laryngeal penetration were noted (gagging and coughing after swallowing).

Patient VNL was referred to undergo both physical and speech-language therapy twice a week for a year without interruption. Therapy sessions

utilizing FES associated with the PNF Method lasted for 15 minutes. The apparatus that was used was the Electro Scientific ORION – Quark/ Br (featuring TENS and FES functions) with two channels. For this case, the channel was coupled with two types of electrodes while in the FES program. A synchronous current in a trapezoidal shape was generated by the apparatus through both a pen-shaped mobile electrode (which identified the precise musculature in the face) and a fixed electrode in the deltoid muscle (Figure 1). Ten facial motor points were stimulated, noted in Figure 2. The stimuli were performed with modulated current at a frequency of 60 hertz, pulse width of 300 miliseconds, rise of four (4) seconds, decay of four (4) seconds, time ON of one (1) second, time OFF of five (5) seconds, in trapezoidal pulses (forming a mini cycle of 14 seconds with 30 pulses) (figure 3). The intensity of the treatment was measured in accordance with the sensitivity of the patient, based on the gestural communication. The total cycle was 140 seconds, therefore each point was stimulated for six mini-cycles. During the "off" time the pen position was changed along with the movement of PNF.

The following muscles were stimulated: 1 – Buccinator, 2 – Masseter, 3 – Levator anguli oris, 4 – Levator labii superioris, 5 - Zygomaticus, 6 – Levator anguli oris, 7 – Orbicularis oris, 8- Depressor labii inferioris, 9 – Depressos anguli oris and 10 – Mentalis. Following on FES session, we performed tactile and gustatory intra and extra oral stimulation.

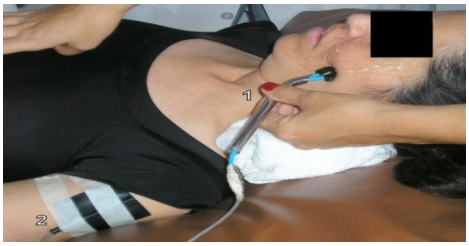

Figure 1: (1) Is the mobile electrode- (2) is the electrode fixed to the Deltoid.

3 RESULTS AND DISCUSSION

In this case study, we used a combination of traditional ideas and contemporary concepts of functionality. Upon the conclusion of the treatment, a satisfactory rehabilitation in the muscles of the left hemiface was achieved. Patient VLN acquired the ability to communicate by meaningfully unsystematic vocalizations and an improvement in

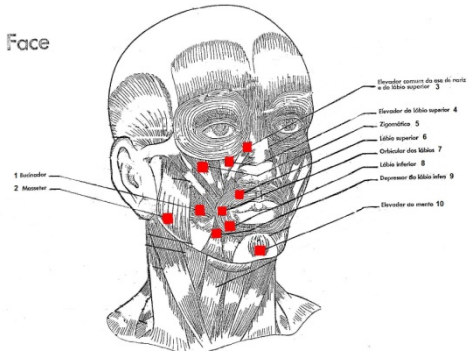

Figure 2: Points of the face that were stimulated.

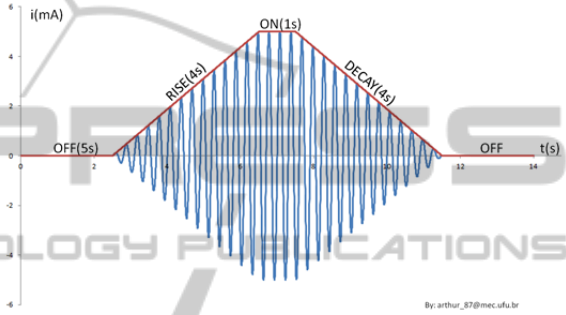

Figure 3: Graphic of the FES current.

the oral consumption of the food bolus. She also gained facial symmetry and expressions, along with vast connotation abilities ranked level four on Chevalier's scale (motion made broadly, synchronously and symmetrically to one side).

The assumption is made that electric stimulation in facial paralysis can interfere with neural regeneration after facial nerve injury, but there are few studies about its effectiveness. Due to the small size and proximity of the muscles in the face, it becomes difficult to isolate contractions, causing massive movements that generate abnormal motor skill patterns (Rodrigues, 1997). In our study, the goal of electric stimulation was to return the movement (muscle contraction) of the facial muscles. The pen-shaped electrod developed by Perez (2011) differentiates itself from other devices by modulating the intensity of the stimulus in order to visualize muscle contraction instead of only relying on motor sensitivity. Another benefit is that the smaller diameter of the electrode is capable of stimulating an isolated muscle mass, as opposed to an entire cluster of muscles. The aim of the myofunctional exercises is to accelerate the return of movement and muscle function to the facial muscles, thus preventing atrophy of these muscles, which would hinder their recovery (Goffi-Gomez, 1999). The use of electric current therapy for muscle

strengthening, the aid of the pen-shaped electrode and myofunctional therapy increases and enhances the effectiveness of exercise. These combined techniques are effective treatments for the rehabilitation of CFP.

4 CONCLUSIONS

The treatment of facial paralysis with electrical stimulation is a long-lasting process that requires dedication on the part of the individual and family (caregivers).

FES provides a selective repetitive afferent input to the central nervous system which not only activates the targeted location, but also the reflex mechanisms of muscles. This process reorganizes the motor activities and movements that are impaired. FES leads to a general increase in the potential that electric currents will reach the balance of excitatory and inhibitory pulses, thus stimulating disabled motoneurons while the patient has the opportunity to consciously experience the "normal movement." As a result, through repetition, the patient can relearn movement. (Perez, 2011)

Electrical stimulation, the type of electrode used and the method of exercises associated with PND seem to be important factors that enhance training by increasing the balance of the COF structures and their functions. Ultimately, this results in an improvement in the quality of life of patients and families, and supports an increasing acceptance of the treatment.

The combination of both physical and speech therapy is essential to the effectiveness of the method and an improvement in the technique.

REFERENCES

Agne, J. E. Electro-thermotherapy Theory and Practice. 2nd ed. Santa Maria: Orium, 2004, 346 p.

Alencar, R. F. et al. Proprioceptive Neuromuscular Facilitation mat in the reacquisition of functions in spinal cord injury. *Journal Neuroscience*, v. 19, n. 3, p. 512-518, 2011.

Bento, R. F.; Miniti, A.; Marone, S. A. M. Treaty of Otology. *New York*: Edusp, 1998

Calais, L. L.; Gomez, M. V. S. G.; Bento, R. F.; Comerlatti, L. R. Avaliação funcional da mímica na paralisia facial central por acidente cerebrovascular. *Pró- Fono Revista de Atualização Científica,* Barueri (SP), v. 17, n. 2, p. 213-222, maio-ago. 2005.

Chevalier, A. M. et al. Evaluation of motor function in the face of the central and peripheral lesions. IN: Lacote, M., Chevalier, AM, Miranda, A.; Bleton, JP; Stévenin, P. *Clinical evaluation of muscle function. Manole*, 13-24,1987.

Comitê de Motricidade Oral – SBFa. Motricidade Oral – Como atuam os especialistas. *Pulso Editorial. São José dos Campos*, 2004.

Esborrat, L. M. Facial paralysis (Part I). Chiron, v. 31, n. 1, p. 18-35, 2000.

Goffi-Gomez, M.V.S. -The contribution of speech therapy in facial paralysis in head and neck cancer. In: Kowalski, LP, DIB, LL, Ikeda, MK & ADDE, C., Reg-prevention, diagnosis and treatment of oral cancer. *New York: frontis*, 523-8, 1999.

Lazarini, P. R.; Fernández, A. M. F.; Brasileiro,V. S. B.; Custódio, S. E. V. Peripheral facial palsy by impairment of the brainstem - the purpose of a clinical case. *Journal of Otolaryngology*, v. 68, n. 1, p. 140-144, 2002.

Lima, C. M. O.; Atuação Fonoaudiológica na Paralisia Facial. Monografia de Conclusão de Especialização em Motricidade Oral Hospitalar. CEFAC. Londrina. 2001.

Morales, R. C.: Terapia de Regulação Orofacial. Edições Científicas Memnon. São Paulo, 1999.

Moran, C. J. & Neely, J. G. - Patterns of facial nerve synkinesis. Laryngoscope, 106, 1491-6, 1996.

Perez, F. S. B. . Comparative study between a fixed electrode and movable electrode (pen) in strengthening perineal. Brasilia, 2011. 35 p. *Thesis (Master of Medical Sciences) - Faculty of Medicine*, UNB.

Rodrigues, R. R. The Speech Therapy and Physical Therapy in Peripheral Facial Paralysis, New York, 1997. 25 p. *Monograph - Centre of Specialization in Clinical Speech Pathology.*

Tessitore, A.; Regulação Orofacial: Sua importância no equilíbrio das funções estomatognáticas. *Anais do 16º. Conclave Internacional de Campinas, ACDC*. Mar/Abr, 2005, São Paulo.

Testa, J. R. G.; Antunes, M. L. Facial palsy: diagnosis and treatment. Compact, v. 1, n. 4, p. 5 15, 2000.