Neuromuscular Electric Stimulation in Rehabilitation of Dysphagia in pediatric Patients with Cerebral Palsy

Thesis

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List of Abbreviations

Abb.	Full Term
ASHA	American Speech-Language Hearing Association
BASOF	Behavioural assessment scale of oral Function in feeding
CI	Confidence interval
CP	Cerebral palsy
EDACS	Eating and drinking ability classification system
e-Stim	Electric stimulation
FDA	Food and Drug Administration
FEES	Fiberoptic endoscopic evaluation of swallowing
FEES-ST	Fiberoptic endoscopic evaluation of swallowing with sensory testing
FOIS	Functional oral intake scale
GER	Gastroesophageal flux
GMFCS E&R	Gross motor function classification system extended and revised
GMFCS	Gross motor function classification system
ISMR	Insbruck sensorimotor activator & regulator
MBS	Modified barium swallow
NICU	Neonatal intensive care unit
NMES	Neuromuscular electric stimulation
NOMS	National outcome measurement system
OST	Oral stimulatory therapy
PAS	penetration aspiration scale
PEG	Percutaneous endoscopic gastrostomy
SD	Standard deviation
SE	Standard error
SIGN	Scottish Intercollegiate Guidelines Network
US	Ultrasonography
VFSS	Videofluoroscopic swallow study

INTRODUCTION

Cerebral palsy (CP) is a chronic movement disorder resulting from an abnormal development or injury in the immature brain. Children with CP demonstrate various movement disorders, including muscle weakness, abnormal postural responses, coordination failure, and slow muscle contraction, which cause functional problems, including abnormal gait ***(Shkedy Rabani et al., 2014)***, hand dysfunction ***(Klingels et al., 2012)***, and dysphagia ***(Arvedson, 2013)***. These functional dysfunctions frequently limit participation in daily activities.

In children, eating is one of the most important activities of daily living, especially for development and quality of life ***(Song, 2015)***. Dysphagia causes malnutrition and negatively impacts development in patients with CP. Approximately 75% of children with CP has dysphagia, and that statistic increases to 86% in patients with quadriplegia ***(Song, 2015)***. Children with CP have some difficulty with postural balance, postural control, and oral-motor control, which are all necessary for proper eating. Oral-motor and sensory dysfunctions are primary reasons for difficulties with swallowing in children with CP ***(Arvedson, 2013)***.

Children with CP have a difficulty recognizing oral sensation for localization of the input, because the sensory threshold is different from normal. Due to an abnormal oral sensory threshold, it is difficult to determine where the

stimulation occurs within the oral area, including the lips, cheeks, tongue, and oral plates ***(Erasmus et al., 2009)***. During the oral phase of swallowing, sensory information is essential for chewing and controlling the bolus of food. The touch and pressure receptors of the tongue and oral-cavity surfaces transmit sensory information to the brainstem and cerebral cortex to guide tongue shape and pharyngeal pressure according to bolus volume and viscosity ***(Song, 2015)***.

Swallowing disorders can be evaluated by a Video fluoroscopic swallow study (VFSS) that provides dynamic visualization of oral, pharyngeal and upper esophageal phases of swallowing. Video fluoroscopic assessment of oral motor function has been the accepted "gold standard" investigation for several years but has significant drawbacks, including the time constraints set by the use of ionizing radiation and the problems posed by the cumbersome equipment in mimicking the child's normal feeding situation ***(Yang et al., 1997)***.

Ultrasonography (US) has been suggested as an alternative or additional investigation of oral motor function in children with CP as a portable, non-invasive, and radiation free technique. US imaging provided useful information with regard to the oral cavity and the soft tissue structures, capturing the silent features of tongue/hyoid/palate activity and bolus transport across the tongue and through the hypo pharyngeal area impairment ***(Hsiao et al., 2012).***

Video endoscopic evaluation of swallowing is performed with a Fiber optic Endoscopic Evaluation of Swallowing (FEES) for studying the physiology and physiopathology of certain stages of swallowing, particularly the pharyngeal stage. This examination offers detailed information of swallowing and of the relative functions of the upper airways and upper digestive tract. It can also be achieved by testing laryngeal sensitivity; this is accomplished by directly stimulating the various pharyngeal-laryngeal areas with the tip of the rhino pharyngolaryngoscope. This evaluation can be completed by the rhythmic administration of air in a sequence of pressures, to elicit laryngeal adduction and consequently establish the sensitivity threshold ***(Sitton et al., 2011).***

Specific competence is required for performing a FEES examination: in particular, the otorhinolaryngology's and/ or phoniatric specialist involved must be familiar with the physiology and physiopathology of swallowing, the principle disorders that cause dysphagia, as well as the manoeuvres, exercises and techniques used in rehabilitation. In addition, the specialist performing FEES must not only be able to manage a subject with swallowing disorders but should also be well trained in the use of flexible endoscopy especially FEES in dysphagic patients. FEES have the advantage of absence of radiation and possibility to do bedside examinations ***(Sitton et al., 2011).***

The American Speech Language Hearing Association (ASHA)'s scale is used to evaluate and follow up of the severity of dysphagia clinically ***(Mullen & Schooling, 2010).***

The ASHA NOMS is a multidimensional tool developed to assess supervision and diet level, and represents functional status, which is rated on a scale from 1 to 7. Level 7 means that a participant has the ability to eat independently without limitation of swallowing function, while level 1 indicates that a participant does not have ability to swallow anything safely by mouth ***(Song et al., 2015).***

Oral sensory stimulation by speech therapists has been applied to improve the feeding ability in children with CP ***(Arvedson et al., 2010b)***. Vibration stimuli in the oral region normalize the abnormal muscle tone during feeding activities. Oral sensory stimulation, including thermal, tactile, and pressure stimuli, was also shown to reduce tongue thrust and the bite reflex disturbing the swallowing process, and to improve the chewing and swallowing functions in children with CP. It has been widely used to treat dysphagia in children ***(Arvedson et al., 2010&Scott, 2014)***.

In addition, electrical stimuli have been applied as an intervention protocol to improve or pharyngeal swallowing in neurological disorders, including stroke ***(Carnaby-Mann & Crary, 2007)***, traumatic brain injury ***(Clark et al., 2009)***, Parkinson's disease ***(Baijens et al., 2012)***, and CP ***(Christiaanse et al., 2011; Rice, 2012)***. In brain-imaging

studies, electrical pharyngeal sensory stimulation induced the activation of areas in the cerebral cortex related to swallowing, such as the sensorimotor cortex ***(Fraser et al., 2002)***. Electrical stimulation is one of the most crucial tools in rehabilitation of swallowing to restore muscle use. This can be achieved either transcutaneously (surface electrical stimulation) or percutaneously (intramuscular, intrinsic) they act by depolarizing the nerves that are responsible for motor innervation to a particular muscle or particular muscle fibers ***(Ianessa et al., 2012)***.

A few previous studies have suggested that Neuro Muscular Electrical Stimulation (NMES) might provide positive effects on swallowing function in paediatric patients ***(Christiaanse et al., 2011; Rice, 2012)***. However, there remains a lack of studies investigating the effects of NMES on oral functions related to feeding in CP with dysphagia.

AIM OF THE WORK

To assess the effectiveness of surface neuro- muscular electrical stimulation in rehabilitation of dysphagia in children with cerebral palsy.

Chapter 1

CEREBRAL PALSY

Cerebral palsy (**CP**) is a group of permanent movement disorders that appear in early childhood that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain.. Signs and symptoms vary among people. Often, symptoms include poor coordination, stiff muscles, weak muscles, and tremors which cause functional problems including abnormal gait ***(Shkedy Rabani et al., 2014)*** & hand dysfunction ***(Klingels et al., 2012).*** There may be problems with sensation, vision (42%), hearing, swallowing and speaking ***(Arvedson, 2013 & Scott, 2014)***.

Often babies with cerebral palsy do not roll over, sit, crawl, or walk as early as other children of their age. Difficulty with the ability to think or reason (56%) and seizures (28%). While the symptoms may get more noticeable over the first few years of life, the underlying problems do not worsen over time ***(National Institute of Neurological Disorders and Stroke, 2015).***

Causes of cerebral palsy

Cerebral palsy is due to abnormal development or damage occurring to the developing brain. This damage can occur during pregnancy, delivery, the first month of life, or less commonly in early childhood as shown in figure (1). Structural problems in the brain are seen in 80% of cases, most commonly