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Oro-Motor Skills and Gross Motor Abilities in Children with Diplegic Cerebral Palsy Following Electrical Stimulation

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***Abstract*---**Feeding difficulties are common in children with diplegic cerebral palsy (CP). Swallowing difficulties, extended feeding times, poor postural control, frequent chocking/coughing, trouble drinking, and frequent vomiting are the most common feeding challenges. The dysfunctional daily eating activities among these population result in reduced quality of life, limited functional performance, and they become dependent in most of oral health care and mealtimes.The specific nature and severity of the feeding problems may differ to some degree, in relation to sensorimotor impairment, gross and fine motor limitations. This study was conducted to investigate the effect of electrical stimulation on oro-motor skills and gross motor abilities in children with diplegic cerebral palsy and to find out if there was a relationship between them. Eighteen children with diplegic cerebral palsy aged from 3 to 5 years from both sexes participated in this study. They received a designed physical therapy, oromotor exercises for 60 minutes followed by electrical stimulation for 40 minutes. The treatment was conducted two sessions per week for three successive months. Data obtained from both groups pre treatment and post treatment regarding Gross Motor Function Measure (GMFM-88), Oral Motor Assessment Scale (OMAS). The main findings in the present study showed a significant improvement of gross motor functions (p = 0.0001) and oro-motor skills (p = 0.0001). The correlation between

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OMAS and GMFM-88 was moderate positive significant correlation (r = 0.55, p = 0.01). Oro-motor skills have positive significant relationship with gross motor abilities in children with spastic diplegia, after the application of electrical stimulation.

***Keywords*---**cerebral palsy, diplegia, oro-motor skills, gross motor abilities, electrical stimulation.

Introduction

Cerebral palsy (CP) is a non-progressive irreversible abnormality of the growing immature brain, which marked with a wide range of subsequent musculoskeletal dysfunctions in children, such as altered muscle tone, posture, and mobility. (2) Spastic diplegia is the most common type of CP, affecting the lower extremities more than the upper extremities and having a significant impact on functional performance and walking. (3)

Spastic diplegic cerebral palsy is characterized by a lack of muscle control and coordination, as well as elevated muscle tone, which results in tight muscles and exaggerated reflexes. Leg muscles are notoriously tight. (4) Feeding difficulties are prevalent in children with Diplegic CP. The most common cause of feeding difficulties is oromotor dysfunction (OMD). Another typical cause of feeding difficulties is a lack of postural control. (5)

The oral region including the lips, teeth, gums, cheeks, oral cavity, soft palate, hard palate, and palatine tonsils work in coordination with muscles of mastication and larynx to operate oro-motor skills. The laryngeal framework is moved by the extrinsic and intrinsic muscles of the larynx. The larynx must close during deglutition to prevent food from being aspirated into the airway. Extrinsic muscles of the larynx composed of Infrahyoid and Suprahyoid muscles. (6)

These muscles play a major role in swallowing in the pharyngeal phase. The suprahyoid muscles contraction pull the hyolaryngeal complex, which includes the hyoid bone and the larynx. (7) Suprahyoid muscles also facilitate Jaw opening during mastication by elevating hyoid bone and lowering the mandible to assist in function of mastication. (6) Oral motor skills are (a) Lip closure; (b) lip closure on utensil; (c) lip closure during swallowing; (d) control of food during swallowing (solid/soft); (e) mastication; (f) straw-sucking; and (g) control of liquid during swallowing. (9) Swallowing is a multi-step process involving reflexive and voluntary muscular control as well as intraoral sensory processing. It allows for safe food and beverage consumption when combined with sensorimotor integration and autonomic regulation. (10)

Because of the physiological complexity of swalloing, it is extremely vulnerable to disruption if there is structural or neurogenic damage resulting in dysphagia. (11) Reduced anterosuperior movement of the hyolaryngeal complex during swallowing due to suprahyoid muscle atrophy and weakness may result in dysphagia symptoms such as pharyngeal remnants and aspiration. (12) Neuromuscular electrical stimulation (NMES) is a therapy tool that activates nerves which innervate muscles that are affected by neurological disturbances using a small electrical current. (13)

Neuromuscular electrical stimulation (NMES) is used for recruiting motor units and increasing muscle strength in innervated muscles. (14) The changes in functional capacity that result from the combination of NMES and voluntary contractions are more realistic practically. (15) Surface neuromuscular electrical stimulation and pharyngeal electrical stimulation target the peripheral neuromuscular system in an attempt to enhance the oropharyngeal musculature, which is weak. (16)

Electrical stimulation (ES) has been shown to improve swallowing processes, notably in adult patients with a variety of neurodegeneratine conditions. (17) However, most previous investigations on the effects of electrical stimulation on swallowing muscles have been undertaken in adults with post-stroke dysphagia, only few studies in children with cerebral palsy and dysphagia have been conducted. (18) Sufficient head, neck, and trunk control may also be important to achieve these serial and coordinated oral motor movements because these faculties are essential for the stability, control, and coordination of oral structures during feeding/swallowing process. (19)

The intergration of growth and enlarging structures with increasing neurological control over posture are implanted for oral-motor pattern so any important milestone that delay in gross motor or oral motor development can decrease feeding efficiency and foster swallowing incompetency. (20) There is a general opinion that the frequency of chewing disorders increases as the gross motor function level decreases. (21) Postural control training may be added to a chewing training programme to ensure adequate chin and lip closure, and facilitate tongue movement for more effective, safe chewing by providing proper head and trunk control. (22) The aim of this study was to investigate the effect of electrical stimulation on oro-motor skills and gross motor abilities in children with diplegic cerebral palsy and to find out if there was a relationship between them.

Methodology

Subjects

Eighteen children with diplegic CP from both sexes aged from 3 to 5 years participated in this study. They were selected to be grade 1 to 1+ spasticity using Modified Ashworth scale and level III and IV motor function using the Growth Motor Function Classification System – extended and revised version.

Procedures for evaluation:

- *Oral motor assessment scale:* It was used to measure oro-motor skills. It has adequately established validation and reproducibility. (23)
- *Gross motor Function Measure-88:* it aimed to measure changes in gross motor function. Its reliability and validity has been considered. (24)

Procedures for treatment

All children received a designed physical therapy for 30 minutes, oromotor exercises for 30 minutes, followed by electrical stimulation for 40 minutes (25). The treatment was conducted two sessions per week for three successive months.

- *Designed physical therapy program* included stretching exercises, core stability exercises, balance training, strengthening exercises and active gait training.
- *Oro-motor exercises* included perioral sensory stimulation, tapping, tongue pressure, jaw exercises, intraoral stimulation and training with different sizes of straws.

Lectrical stimulation

It was applied using "Soleo Galva (Zimmer) MedizinSystem GmbH" device, and adhesive electrodes with suitable pediatric size (1.7 cm), the two channels were aligned vertically in submandibular region to simulate suprahyoid muscles. Placement of higher electrodes was horizontally just below the mandible, the lower electrodes placed in the level of hyoid bone.

Stimulation intensity was based on the response of the child with optimal intensity at which the child appeared to swallow the best while remaining calm**.** Fixed 80-Hz pulse rate and a biphasic pulse width of 700 µs were used. (18) While using NMES, the patients also received conventional swallowing therapies, such as chin tuck, effortful functional swallowing of liquid and puree consistencies and multiple swallowing**.**

Statistical analysis

Paired t test was conducted for comparison of OMAS and GMFM-88 between pre and post treatment, Pearson Correlation Coefficient was conducted to determine the correlation between OMAS and GMFM-88. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social sciences (SPSS) version 25 for windows.

Results

Data obtained pre treatment and post treatment regarding Gross Motor Function Measure (GMFM-88) and Oral Motor Assessment Scale (OMAS) were statistically analyzed and compared.

Pre and post treatment mean values of GMFM-88

The mean ± SD value of GMFM-88 pre treatment was 68.79 ± 12.77% and that post treatment was 81.91 ± 10.15%. The mean difference between pre and post treatment was -13.12% and the percent of change was 19.07%. There was a significant increase in the GMFM-88 post treatment compared with pre treatment ($p = 0.0001$). (Table 1).

Table 1
Comparison between pre and post treatment mean values of GMFM-88

	Pre treatment	Post treatment	MD	% of change	t-value	p-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD					
GMFM-88 (%)	68.79 ± 12.77	81.91 ± 10.15	-13.12	19.07	-11.61	0.0001	S

x̄: Mean SD: Standard deviation
MD: Mean difference
t value: Paired t value p value: Probability value
S: Significant
%: Percentage GMFM: Gross motor function measure

Pre and post treatment mean values of OMAS

The mean ± SD value of OMAS pre treatment was 10.61 ± 1.91 and that post treatment was 16.77 ± 1.95. The mean difference between pre and post treatment was -6.16 and the percent of change was 58.06%. There was a significant increase in the OMAS post treatment compared with pre treatment (p = 0.0001). (Table 2).

Table 2
Comparison between pre and post treatment mean values of OMAS

	Pre treatment	Post treatment	MD	% of change	t-value	p-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD					
OMAS	10.61 ± 1.91	16.77 ± 1.95	-6.16	58.06	-17.38	0.0001	**S**

x̄: Mean SD: Standard deviation
MD: Mean difference
t value: Paired t value p value: Probability value
S: Significant
%: Percentage OMAS: Oral motor assessment scale

Relationship between OMAS, GMFM-88

The correlation between OMAS and GMFM-88 was moderate positive significant correlation (r = 0.55, p = 0.01). (Table 3).

Table 3
Correlation between OMAS, GMFM-88

		r value	p value	Sig
OMAS	GMFM-88 (%)	0.55	0.01	S

r value: Pearson correlation coefficient p value: Probability value
S:Significant

%: Percentage OMAS: Oral motor assessment scale GMFM: Gross motor function measure

Discussion

The aim of this study was to investigate the effect of electrical stimulation on oro-motor skills and gross motor abilities in children with diplegic cerebral palsy and to find out if there was a relationship between them. The main findings in the present study showed a significant improvement regarding measured variables post treatment, Gross Motor Function Measure (GMFM-88) and Oral Motor Assessment Scale (OMAS). The study showed moderate significant positive correlation between OMAS and GMFM-88.

The improvement in Gross Motor Function Measure (GMFM-88) in the current study following the designed physical therapy program which focused on stretching exercises, core stability exercises, balance training, strengthening exercises and active gait training comes in accordance to Gerasimos et al. (26) who reported that stretching exercises, core stability exercises, muscle strengthening and functional activities are the main physiotherapy management techniques that are used to improve or maintain function for CP.

Children with CP experience different sensory problems in peri and intra-motor areas such as hypersensitivity or hyposensitivity that cause food acceptance problems. As designed oro-motor training program included sensory stimulation (perioral and intraoral) to enhance oro-motor skill, this reported improvement in Oral Motor Assessment Scale (OMAS) could be attributed to normalization of the sensitivity of oral region.

This comes in agreement with Scully et al. (27) who reported that oral facial facilitation techniques in form of brushing and manipulation (tapping and compression) and oral motor exercises as jaw, lip and tongue exercises will help to improve oral motor control, sensory awareness and swallowing which in turn will improve muscle tone. It also comes in agreement with Graham et al. (28) who highly recommended interventions, including oromotor approaches (sensory awareness training), strengthening exercises to enhance head posture and mouth closure, as well as general postural treatment because of their great impact on oro-motor functions in children with CP.

The significant improvement in (OMAS) in the current study comes in agreement with the work of Ma and Choi (17) who found that enhanced muscle activity via electrical stimulation of submental muscles (mylohyoid, geniohyoid, and digastric muscles) appears to reduce aspiration in children with cerebral palsy. Good posture and proper head and trunk stability provide the basis for improving the oral control for oral motor skills. Therefore, improvement of gross motor functions and oro-motor skills can be attributed to designed physical therapy program which was directed to enhance motor performance and functional abilities.

The study showed moderate significant positive correlation between OMAS and GMFM-88 which is supported by Benfer et al. (29) who found That the majority of children with diplegia who had oro-pharyngeal dysfunction (OPD) had lower average GMFM scores than children with diplegia who did not have eating difficulties. This shows that combining motor type/distribution with functional severity can help identify which children are at risk for feeding difficulties.

Similarly, Weir et al. (30) reported that attainment of eating skills was closely associated with GMFCS level in young children with CP. It can be interpreted as impairment of structure and function of the head and neck, and trunk may also affect postural stability. Together these impairments potentially affect the ability of children with CP to eat, drink, and self-feed and thereby impact negatively on their ability to safely ingest adequate nutrition. These results emphasize the need for early oral-motor and feeding screening in young children with CP across gross motor functional abilities.

This positive correlation comes in agreement with El Rouby (31) who found that the results of the Gross Motor Function Classification System "GMFCS" were correlated with facial profile, terminal plane relationship, and open bite. The study findings also agree with a recent study done by Benfer et al. (32) who reported that the rate of oropharyngeal dysphagia increased by up to 100 percent in tandem with the level of the Gross Motor Function Classification System (GMFCS).

The positive correlation in the current study is also in consistence with the work of Louise. (33) who reported that good posture and proper head and trunk stability provides the basis for improving the oral control of swallowing. According to Arvedson et al, (34) the risk of aspiration in children with CP can decrease over time as developmental improvements are made. The results of the current study also agree with Strudwick (35) who stated that child's ability to control the tone, their stability, symmetry and degree of independence must be carefully assessed in children with feeding difficulties.

Conclusion

From the obtained results supported by the relevant literature it could be concluded that oro-motor skills have positive significant relationship with gross motor abilities in children with spastic diplegia after the application of electrical stimulation.

References

1. Penagini, F., Mameli, C., Fabiano, V., Brunetti, D., Dilillo, D., & Zuccotti, G. (2015). Dietary intakes and nutritional issues in neurologically impaired children. Nutrients, 7(11), 9400-9415.
2. Patel DR, Neelakantan M, Pandher K, Merrick J. (2020). Cerebral palsy in children: a clinical overview. Transl Pediatr. (Suppl 1):S125-S135.
3. Emara H.(2015).Effect of a new physical therapy concept on dynamic balance in children with spastic diplegic cerebral palsy. Egypt J Med Hum Genet; 16:77-83.
4. Elshafey M. A., Abd-Elaziem A., Gouda R E (2014) Functional stretching exercise submitted for spastic diplegic children: a randomized control study. Rehabilitation Research and Practice:814279.

5. Sjakti, H., Syarif, D., Wahyuni, L., & Chair, lmral. (2008). Feeding difficulties in children with cerebral palsy. Paediatrica Indonesiana, 48(4),224-9.
6. Rathod, P. V., Vidhyadharan, S., & Iyer, S. (2018). Anatomy of Swallowing. Dysphagia Management in Head and Neck Cancers, 3–26.
7. Pearson WG, Langmore SE, Zumwalt AC (2011). Evaluating the structural properties of suprahyoid muscles and their potential for moving the hyoid. Dysphagia.;26:345–51.
8. De Oliveira Lira Ortega A, Ciamponi A, Mendes F, Santos M.(2009).Assessment scale of the oral motor performance of children and adolescents with neurological damages. J Oral Rehabil;36 (9):653–659.
9. Rangarathnam B, Kamarunas E, McCullough GH (2014). Role of Cerebellum in Deglutition and Deglutition Disorders. Cerebellum.; 13: 767-76.
10. Simons, A. & Hamdy, S. (2017). The Use of Brain Stimulation in Dysphagia Management. Dysphagia, 32(2), 209-215.
11. Park JS, Hwang NK, Kim HH, Choi JB, Chang MY, Jung YJ (2019). Effects of lingual strength training on oropharyngeal muscles in South Korean adults. J Oral Rehabil
12. Van den Engel-Hoek L, Harding C, van Gerven M, Cockerill H (2017) Pediatric feeding and swallowing rehabilitation: An overview. J Pediatr Rehabil Med 10(2):95–105.
13. Giselle D. Carnaby-Mann, Michael A. Crary.(2007). Examining the Evidence on NeuromuscularElectrical Stimulation for Swallowing. A Meta-analysis;ArchOtolaryngol Head Neck Surg;133:564-571.
14. Carvalho S, French M, Thibaut A, LimaW, Simis M, Leite J & Fregni F (2018). Median nerve stimulation induced motor learning in healthy adults: A study of timing of stimulation and type of learning. Eur J Neurosci 48, 1667–1679.
15. Geeganage, C., Beavan, J., Ellender, S., & Bath, P. M. (2012). Interventions for dysphagia and nutritional support in acute and subacute stroke. Cochrane Database of Systematic Reviews.
16. Umay, E., Gurcay, E., Ozturk, E. A., & Unlu Akyuz, E. (2019). Is sensory-level electrical stimulation effective in cerebral palsy children with dysphagia? A randomized controlled clinical trial. Acta Neurologica Belgica.
17. Ma SR, Choi JB (2019) Effect of electrical stimulation on aspiration in children with cerebral palsy and dysphagia. J Phys Ther Sci. ;31(1):93–4.
18. Ortega Ade O, Ciamponi AL, Mendes FM, Santos MT (2009). Assessment scale of the oral motor performance of children and adolescents with neurological damages. J Oral Rehabil. Sep;36(9):653-9.
19. Redstone F, West JF. (2004). The importance of postural control for feeding. Pediatr Nurs. 30:97–100.
20. Bell, K. L., Boyd, R. N., Tweedy, S. M., Weir, K. A., Stevenson, R. D., & Davies, P. S. (2010). A prospective, longitudinal study of growth, nutrition and sedentary behaviour in young children with cerebral palsy. BMC Public Health, 10(1): 179.
21. Edvinsson SE, Lundqvist LO. (2016). Prevalence of orofacial dysfunction in cerebral palsy and its association with gross motor function and manual ability. Dev Med Child Neurol. 58:385–394.
22. Selen Serel Arslan, Numan Demir, Özgü İnal & Aynur A. Karaduman (2018). The severity of chewing disorders is related to gross motor function and trunk control in children with cerebral palsy, Somatosensory & Motor Research.
23. Russell, D. J, D. J., Rivard, L. M., & Hanna, S. E., Bartlett.(2008). Reference

Curves for the Gross Motor Function Measure: Percentiles for Clinical Description and Tracking Over Time Among Children With Cerebral Palsy. Physical Therapy, 88(5), 596 607.

24. Nieves Estrada, N. A., &Echevarría González, A. C. (2013). Efecto de la electroestimulación neuromuscular y el Kinesio taping® en la sialorrea en pacientes con parálisis cerebral leve y moderada. Fisioterapia, 35(6), 272–276.
25. Marcus S, Friedman JN, Lacombe-Duncan A, et al.(2019).Neuromuscular electrical stimulation for treatment of dysphagia in infants and young children with neurological impairment: a prospective pilot study. BMJ Paediatrics Open;3:e000382.
26. Gerasimos Taflampas, Cherry Kilbride, Wendy Levin, Grace Lavelle & Jennifer M. Ryan (2017): Interventions to Improve or Maintain Lower-Limb Function Among Ambulatory Adolescents with Cerebral Palsy: A Cross-Sectional Survey of Current Practice in the UK, Physical & Occupational Therapy In Pediatrics.
27. Scully, C., Limeres, J., Gleeson, M., Tomás, I., & Diz, P. (2009). Drooling. Journal of oral pathology & medicine : official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology, 38(4), 321–327.
28. Graham D, Paget SP, Wimalasundera N (2019). Current thinking in the health care management of children with cerebral palsy. Med J Aust. Feb; 210(3):129-135.
29. Benfer, K. A., Weir, K. A., Bell, K. L., Ware, R. S., Davies, P. S. W., & Boyd, R. N. (2013). Oropharyngeal Dysphagia and Gross Motor Skills in Children With Cerebral Palsy. PEDIATRICS, 131(5), e1553–e1562.
30. Weir, K. A., Bell, K. L., Caristo, F., Ware, R. S., Davies, P. S., Fahey, M., Boyd, R. N. (2013). Reported Eating Ability of Young Children With Cerebral Palsy: Is There an Association With Gross Motor Function? Archives of Physical Medicine and Rehabilitation, 94(3), 495–502.
31. El Rouby, S.H., Dowidar, K., Ahmed, A.M., & Omar, T.E. (2019). Occlusal characteristics in a group of children with cerebral palsy in Alexandria Egypt. Alexandria Dental Journal.
32. Benfer, K. A., Weir, K. A., Bell, K. L., Ware, R. S., Davies, P. S. W., & Boyd, R. N. (2017). Oropharyngeal Dysphagia and Cerebral Palsy. Pediatrics, 140(6), e20170731.
33. Louise C. (2008): Text book of Clinical Linguistics (Edinburgh University Press, pp.95-99.
34. Arvedson JC.(2013).Feeding children with cerebral palsy and swallowing difficulties. Eur J ClinNutr; 67(Suppl 2): S9–12.
35. Strudwick, S. (2009), “Oral motor impairment and swallowing dysfunction: assessment and management”, in Sullivan, P.B. (Ed.), Feeding and Nutrition in Children with Neurodevelopmental Disability, Mac Keith Press, London, pp. 35-56.