Case Report

SAGE Open Medical Case Reports

SAGE Open Medical Case Reports
Volume 11: 1–5

DOI: 10.1177/2050313X221149527
journals.sagepub.com/home/sco
SAGE

Efficacy of interferential current transcutaneous electrical sensory stimulation through the neck skin for treating dysphagia in children with disabilities: A case series

Michinori Funato[1], Kanako Maruta[2], Mitsuru Yano[2], Mitsue Kai[3], Yaeko Umezawa[3], Kunihiko Yasuda[4], Emi Ohta-Noda[5] and Keika Gen[5]

Abstract

Finding a suitable treatment for dysphagia has been challenging and the efficacy of neuromuscular electrical stimulation has been recognized. Moreover, the beneficial effect of interferential current transcutaneous electrical sensory stimulation has recently been described. However, the efficacy of interferential current transcutaneous electrical sensory stimulation in children with disabilities is unknown. Therefore, the aim of this study was to confirm the efficacy of interferential current transcutaneous electrical sensory stimulation in children with disabilities. Four children with disabilities of various types underwent interferential current transcutaneous electrical sensory stimulation once a week. All patients showed improved symptoms after interferential current transcutaneous electrical sensory stimulation treatment. Videoendoscopic examination showed reduced accumulation of secretion in all patients and decreased residual bolus in two. We also felt an increased forcefulness when swallowing in two. In addition, the questionnaire results regarding dysphagia indicated improvements. No significant side effects were observed. The interferential current transcutaneous electrical sensory stimulation treatment may be effective and safe in children with disabilities. The effect of this treatment on swallowing ability needs to be further investigated by studying more cases.

Keywords

Children, disabilities, dysphagia, interferential current, transcutaneous electrical sensory stimulation

Date received: 26 September 2022; accepted: 19 December 2022

Introduction

Dysphagia is caused by many factors, such as advancing age, neurological diseases, and head and/or neck diseases.[1] In children, congenital or intranatal disability also causes dysphagia. In any of these cases, it is occasionally associated with aspiration pneumonia, severe nutritional and respiratory complications and even death.[1] Although dysphagia rehabilitation, such as swallowing training and oral care,[2] non-invasive brain stimulation, such as transcranial direct current stimulation,[3,4] and surgery for improving swallowing function or preventing aspiration[5–7] have been performed, they are not always effectual in both children and adults. In addition, medical therapy such as the use of botulinum toxin,[8] capsaicin,[9] angiotensin-converting enzyme

[1]Department of Pediatric Neurology, National Hospital Organization Nagara Medical Center, Gifu, Japan
[2]Department of Pediatrics, National Hospital Organization Nagara Medical Center, Gifu, Japan
[3]Department of Rehabilitation, National Hospital Organization Nagara Medical Center, Gifu, Japan
[4]Department of Pediatric Surgery, National Hospital Organization Nagara Medical Center, Gifu, Japan
[5]Department of Dentistry for Disability and Oral Health, Asahi University School of Dentistry, Gifu, Japan

Corresponding Author:
Michinori Funato, Department of Pediatric Neurology, National Hospital Organization Nagara Medical Center, 1300-7 Nagara, Gifu 502-8558, Japan.
Email: mfunato@mac.com

inhibitors,[10] and the antiplatelet cilostazole[11] has been developed for adult patients, but it has been challenging.

The benefits of electrical sensory stimulation treatment through the neck skin have been described in patients with dysphagia.[12,13] It was divided into two main therapies; one is neuromuscular electrical stimulation (NMES) with muscle contraction and another is transcutaneous electrical sensory stimulation (TESS), without muscle contraction. In addition, the TESS involved both pulsed current and interferential currents. Efficacy of NMES was reported in adult patients with various types of dysphagia,[14–17] but the efficacy of NMES in children could not be described.[18] On the contrary, the use of TESS involving a pulsed current was reported to improve swallowing in adult patients with dysphagia.[19–23] In addition, the beneficial effects of interferential current TESS (IFC-TESS) have been reported in adult patients recently,[24,25] but there are no reports about the beneficial effects of IFC-TESS in children thus far.

In this report, we discuss the benefits of IFC-TESS through the neck skin for dysphagia in children with disabilities because we think that IFC-TESS is also well-tolerated and usable device in children. To our knowledge, this is the first report that indicates the possible benefits of IFC-TESS treatment in children.

Case presentations

We studied the efficacy of IFC-TESS with a low-frequency massage device delivering an interferential current (Gentle Stim®; J Careido Co., Ltd., Kanagawa, Japan) (Figure 1). Four children with disabilities of various types have performed oral care and swallowing training, but had limited effect. Therefore, they underwent IFC-TESS once a week. All patients were evaluated by videoendoscopic examination (VE) for swallowing and administered three questionnaires regarding dysphagia (A questionnaire to screen dysphagia[26] (Q1) the 10-item Eating Assessment Tool[27] (Q2) and the modified assessment scale of dysphagia risk for elderly persons[28] (Q3) (Appendix Table 1). The characteristics and results of the four patients are summarized in Table 1.

Case 1

A 15-year-old boy was treated for cerebral palsy and epilepsy in our hospital. He was born spontaneously at 39 weeks of gestation, and had hypoxic-ischemic encephalopathy (HIE) caused by asphyxia. At present, he has the head control ability and a cough reflex, in spite of spastic quadriplegia and not being able to maintain the sitting position without support. VE before IFC-TESS treatment showed insufficient nasopharyngeal closure and accumulation of secretion in the pharynx. In addition, oral inspection showed difficulty of food transport in oral phase of swallowing, when he ate soft food. After the second IFC-TESS treatment, he exhibited forceful and smooth swallowing.

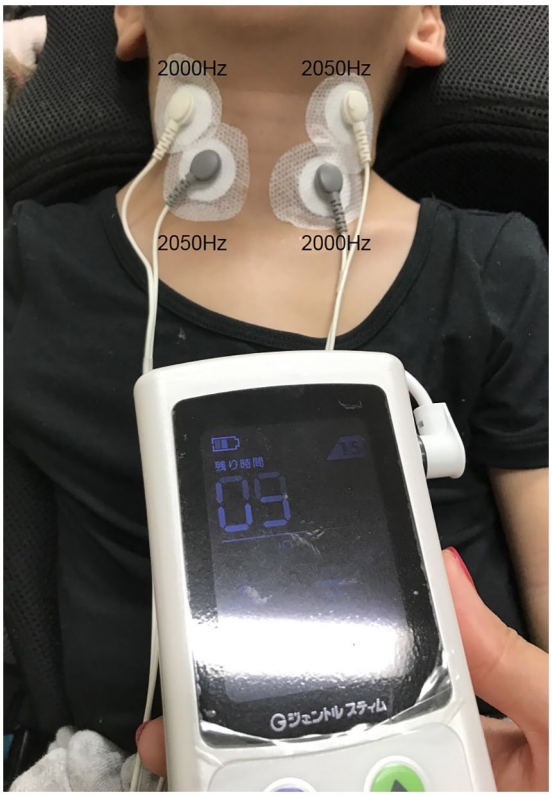

Figure. 1. Electrode placement. Two pairs of electrodes with different frequencies (2000 and 2050 Hz) were placed across the neck, stimulating the sensory nerves with a beat frequency of 50 Hz inside the neck.

He showed a decrease in the accumulation and sound of secretions in the throat after the sixth treatment. VE after the ninth treatment also showed a decrease in the accumulation of secretion despite residual bolus in the pyriform sinus. One and a half months after completing nine TESS treatments, his symptoms returned to the pretreatment conditions. At present, his improvements are being maintained by one IFC-TESS treatment every 2 weeks.

Case 2

A 5-year-old boy presented to our hospital for dysphagia rehabilitation. He had West syndrome and an enlarging head size 2 months after birth. At 3 years old, he also had acute encephalopathy of uncertain cause. At present, he cannot hold his head up and has spastic quadriplegia. VE showed an aspiration for drinking the feeding formula, although he barely swallowed jelly and slurry food. He had a forceful and smooth swallowing technique and decreased accumulation and sounds of secretion in his throat after the fifth IFC-TESS treatment. He showed a decrease in choking and reduced mealtime duration, and increase in the forcefulness

Table 1. Clinical characteristics and evaluation data of patients in this study.

	Case 1	Case 2	Case 3	Case 4
Age (years)	15	5	12	4
Gender	Male	Male	Female	Male
Body weight (kg)	30	15	23	15
Disorder	HIE	Unknown	Microdeletion	HIE
PH of pneumonia	Rarely	Often	Sometimes	Never
TESS intensity (mA)	3.0	1.5	1.5	1.5
Time (minutes)	30	10	10	10
Frequency (per week)	1	1	1	1
Total treatment time (minutes)	270	90	90	110
Reversion (months)	1.5	1.5	1.5	1.5
VE findings after treatment				
Accumulation of secretion	↓	↓	↓	↓
Residual bolus of food	→	↓	↓	→
Power of swallowing	→	→	↑↑	↑
A questionnaire to screen dysphagia (11)* before→after treatment				
A = always or severe	3→3	8→5	9→1	5→1
B = sometimes or mild	6→6	2→4	0→8	3→6
C = never	2→2	1→2	2→2	3→4
The 10-item eating assessment tool (8)* before→after treatment				
0 = never	1→2	0→1	0→0	2→2
1 = rarely	1→0	2→1	0→0	0→1
2 = sometimes	2→6	2→0	1→6	3→3
3 = often	3→0	1→4	5→0	2→1
4 = always	1→0	3→2	2→2	1→1
Total	18→12	21→21	25→20	16→14
The modified assessment scale of dysphagia risk for elderly persons (16)* before→after treatment				
0 = never	3→2	0→1	0→4	3→4
1 = rarely	2→3	1→1	0→6	3→7
2 = sometimes	7→10	8→7	6→5	9→4
3 = always	4→1	7→7	10→1	1→1
Total	28→23	38→36	42→19	24→18
Side effects	None	Mild exanthema	None	None

HIE: hypoxic-ischemic encephalopathy; Microdeletion: microdeletion syndrome of chromosome; PH: past history; TESS: transcutaneous electrical sensory stimulation; VE: videoendoscopic examination of swallowing.
*Indicates number of items evaluated in this study.

of mastication after the eighth treatment. VE after the final, ninth treatment also showed decreased accumulation of secretion in the pharynx and less residual bolus. One and a half months after the ninth treatment, his symptoms returned to pretreatment condition. At present, his condition is being maintained by one treatment every 2–4 weeks.

Case 3

A 12-year-old girl with 14q11.2-q12 microdeletion syndrome has been followed in our hospital. She had epilepsy, obstructive apnea, and dysphagia. At present, she has been confined to bed and had spastic quadriplegia. VE showed accumulation of secretion in the pharynx. When she swallowed stew, it stayed on her pharynx and posterior part of her tongue. In addition, although she had the swallowing reflex, she had difficulty in swallowing. She had reduced accumulation and sounds of secretion in the throat after the second treatment. She showed a decrease in choking after the third treatment and increased forcefulness of swallowing after the fifth treatment. VE after the final ninth treatment also showed forceful and smooth swallowing, decreased accumulation of secretion in the pharynx and less residual bolus. One and a half months after the nine IFC-TESS treatments, her symptoms returned to pretreatment condition. In particular, she showed increased mealtime duration. At present, her condition is being maintained with one treatment every two weeks.

Case 4

A 4-year-old boy with HIE caused by asphyxia as a newborn, cerebral palsy and epilepsy presented to our hospital for this study. He can hold up his head but not maintain a sitting

position. VE showed a great number of residual bolus in the pharynx and oral inspection in swallowing showed difficulty of food transport in oral phase of swallowing. He showed a decrease in choking after the second IFC-TESS treatment and he had increased forcefulness of sucking after the third treatment. When he swallowed jelly food, he had a shorter mealtime. After the seventh treatment, his sternocleidomastoid muscle became evident and he could close his mouth. He could swallow food-paste after the ninth treatment. VE after the final, 11th treatment also showed decreased accumulation of secretion in the pharynx and a small increase in forcefulness of swallowing. At present, his condition is being maintained with one IFC-TESS treatment every 2 weeks.

All patient's mothers answered three questionnaires regarding dysphagia. The following improvements were recorded: 75% of patients reported less liquid and food being pushed up into the nasal cavity during swallowing (3 of 4 patients in Q3-1), most patients reported less retention of food in their throat after swallowing (2 of 4 patients in Q1-7, 3 of 4 patients in Q3-6), 75% of patients reported less choking when swallowing foods (3 of 4 patients in Q1-4, 3 of 4 patients in Q3-9), 75% of patients reported less coughing while swallowing foods (3 of 4 patients in Q2-9, 3 of 4 patients in Q3-9), most patients reported a shortened mealtime (3 of 4 patients in Q1-8, 1 of 4 patients in Q3-20).

Discussion

The IFC-TESS treatment through the neck skin was thought to help improve the swallowing reflex by the activation of peripheral sensory nerves in the deep layers of the pharynx and larynx, especially superior laryngeal nerve that can trigger swallowing, without being uncomfortable.[29] Recently, Maeda K et al. and Hara Y et al. studied and reported the effect of IFC-TESS, in patients at mean 84 years with dysphagia rehabilitation for over 3 weeks, and in patients at mean 84 years with dementia, respectively.[24,25] They showed that IFC-TESS improve the cough reflexes and nutritional states of patients.[24,25] In this report, we reported a possible beneficial effect of IFC-TESS on dysphagia in children with disabilities. Although our study could not be objectively analyzed for children, our cases showed reduced accumulation of secretion, reduced residual bolus, increased forcefulness of swallowing, reduced choking and coughing during swallowing, and shortened mealtimes. In addition, approximately one and a half months after the treatment, the symptoms of all patients returned to pretreatment condition. These findings indicate TESS treatment, using interferential current through the neck skin, may improve dysphagia in children with disabilities, particularly in children with the decreased swallowing reflex.

Very few adverse effects of IFC-TESS have been described,[24] unlike with NMES that can cause pain or uncomfortable feelings in patients and include increased risk of aspiration and the possible risks of laryngospasm, arrhythmia, hypotension, glottic closure, and skin burns.[21] In our study, one of the four children developed a rash on the neck skin after IFC-TESS treatment, but it was transient and harmless. We thought IFC-TESS could be a safe and effective treatment even in children.

Conclusion

We have reported on the potential beneficial effects of IFC-TESS for dysphagia in children with disabilities. The benefits of IFC-TESS, particularly in children, needs to be further investigated by an objective study with a larger number of cases with dysphagia, which will lead to better management including dysphagia rehabilitation and medical therapy.

Acknowledgements

The authors greatly appreciate the co-operation of the patients and their family in this study. They would also like to thank Editage (www.editage.com) for English language editing.

Author contributions

M.F. designed the study, analyzed subjects, and drafted the manuscript. K.M., M.K., Y.U., M.Y., and K.Y. contributed to study design and analysis of subjects. E.O. and G.K. contributed to the study design, the analysis of subjects, and reviewed and edited the manuscript. All authors read and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics approval

Ethical approval to report these cases was obtained from the ethical board of the Nagara Medical Center (APPROVAL NUMBER/ID 2018-8 and 2018-25).

Informed consent

We obtained written informed consent and agreement from each patient's parent before commencement of the study.

ORCID iD

Michinori Funato https://orcid.org/0000-0001-8836-8333

Supplemental material

Supplemental material for this article is available online.

References

1. Clavé P and Shaker R. Dysphagia: current reality and scope of the problem. *Nat Rev Gastroenterol Hepatol* 2015; 12(5): 259–270.
2. Watando A, Ebihara S, Ebihara T, et al. Daily oral care and cough reflex sensitivity in elderly nursing home patients. *Chest* 2004; 126(4): 1066–1070.
3. Hummel FC and Cohen LG. Non-invasive brain stimulation: a new strategy to improve neurorehabilitation after stroke? *Lancet Neurol* 2006; 5(8): 708–712.
4. Yang EJ, Baek SR, Shin J, et al. Effects of transcranial direct current stimulation (tDCS) on post-stroke dysphagia. *Restor Neurol Neurosci* 2012; 30(4): 303–311.
5. Mills CP. Dysphagia in pharyngeal paralysis treated by cricopharyngeal sphincterotomy. *Lancet* 1973; 1: 455–457.
6. Goode RL. Laryngeal suspension in head and neck surgery. *Laryngoscope* 1976; 86(3): 349–355.
7. Biller HF, Lawson W and Baek SM. Total glossectomy. A technique of reconstruction eliminating laryngectomy. *Arch Otolaryngol* 1983; 109(2): 69–73.
8. Moerman MB. Cricopharyngeal Botox injection: indications and technique. *Curr Opin Otolaryngol Head Neck Surg* 2006; 14(6): 431–436.
9. Ebihara T, Takahashi H, Ebihara S, et al. Capsaicin troche for swallowing dysfunction in older people. *J Am Geriatr Soc* 2005; 53(5): 824–828.
10. Ohkubo T, Chapman N, Neal B, et al. Perindopril protection against recurrent stroke study collaborative group. Effects of an angiotensin-converting enzyme inhibitor-based regimen on pneumonia risk. *Am J Respir Crit Care Med* 2004; 169: 1041–1045.
11. Shinohara Y. Antiplatelet cilostazol is effective in the prevention of pneumonia in ischemic stroke patients in the chronic stage. *Cerebrovasc Dis* 2006; 22(1): 57–60.
12. Carnaby-Mann GD and Crary MA. Examining the evidence on neuromuscular electrical stimulation for swallowing: a meta-analysis. *Arch Otolaryngol Head Neck Surg* 2007; 133(6): 564–571.
13. Clark H, Lazarus C, Arvedson J, et al. Evidence-based systematic review: effects of neuromuscular electrical stimulation on swallowing and neural activation. *Am J Speech Lang Pathol* 2009; 18(4): 361–375.
14. Freed ML, Freed L, Chatburn RL, et al. Electrical stimulation for swallowing disorders caused by stroke. *Respir Care* 2001; 46(5): 466–474.
15. Xia W, Zheng C, Lei Q, et al. Treatment of post-stroke dysphagia by vitalstim therapy coupled with conventional swallowing training. *J Huazhong Univ Sci Technolog Med Sci* 2011; 31(1): 73–76.
16. Tsukano H, Taniguchi H, Hori K, et al. Individual-dependent effects of pharyngeal electrical stimulation on swallowing in healthy humans. *Physiol Behav* 2012; 106: 218–223.
17. Chen YW, Chang KH, Chen HC, et al. The effects of surface neuromuscular electrical stimulation on post-stroke dysphagia: a systemic review and meta-analysis. *Clin Rehabil* 2016; 30(1): 24–35.
18. Christiaanse ME, Mabe B, Russell G, et al. Neuromuscular electrical stimulation is no more effective than usual care for the treatment of primary dysphagia in children. *Pediatr Pulmonol* 2011; 46(6): 559–565.
19. Rofes L, Arreola V, López I, et al. Effect of surface sensory and motor electrical stimulation on chronic poststroke oropharyngeal dysfunction. *Neurogastroenterol Motil* 2013; 25(11): 888–e701.
20. Tsujimura T, Udemgba C, Inoue M, et al. Laryngeal and tracheal afferent nerve stimulation evokes swallowing in anaesthetized guinea pigs. *J Physiol* 2013; 591: 4667–4679.
21. Lim KB, Lee HJ, Lim SS, et al. Neuromuscular electrical and thermal-tactile stimulation for dysphagia caused by stroke: a randomized controlled trial. *J Rehabil Med* 2009; 41(3): 174–178.
22. Zhang M, Tao T, Zhang ZB, et al. Effectiveness of neuromuscular electrical stimulation on patients with dysphagia with medullary infarction. *Arch Phys Med Rehabil* 2016; 97(3): 355–362.
23. Ortega O, Rofes L, Martin A, et al. A comparative study between two sensory stimulation strategies after two weeks treatment on older patients with oropharyngeal dysphagia. *Dysphagia* 2016; 31(5): 706–716.
24. Maeda K, Koga T and Akagi J. Interferential current sensory stimulation, through the neck skin, improves airway defense and oral nutrition intake in patients with dysphagia: a double-blind randomized controlled trial. *Clin Interv Aging* 2017; 12: 1879–1886.
25. Hara Y, Nakane A, Tohara H, et al. Cervical interferential current transcutaneous electrical sensory stimulation for patients with dysphagia and dementia in nursing homes. *Clin Interv Aging* 2021; 15: 2431–2437.
26. Ohkuma R, Fujishima I, Kojima C, et al. Development of a questionnaire to screen dysphagia [in Japanese]. *JJDR* 2002; 6: 3–8.
27. Belafsky PC, Mouadeb DA, Rees CJ, et al. Validity and reliability of the eating assessment tool (EAT-10). *Ann Otol Rhinol Laryngol* 2008; 117: 919–924.
28. Fukada J, Kamakura Y, Manzai T, et al. Development of dysphagia risk screening system for elderly persons [in Japanese]. *JJDR* 2006; 10: 31–42.
29. Furuta T, Takemura M, Tsujita J, et al. Interferential electric stimulation applied to the neck increases swallowing frequency. *Dysphagia* 2012; 27(1): 94–100.