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BRIEF ARTICLE

Surface electromyography for diagnosing dysphagia in patients with cerebral palsy

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Abstract

AIM: To determine the accuracy of 2-channel surface electromyography (sEMG) for diagnosing oropharyngeal dysphagia (OPD) in patients with cerebral palsy.

METHODS: Participants with cerebral palsy and OPD between 5 and 30 years of age and age- and sex-matched healthy individuals received sEMG testing during swallowing. Electrodes were placed over the submental and infrahyoid muscles, and sEMG recordings were made during stepwise (starting at 3 mL) determination of maximum swallowing volume. Outcome measures included submental muscle group maximum amplitude, infrahyoid muscle group maximum amplitude (IMGMA), time lag between the peak amplitudes of 2 muscle groups, and amplitude difference between the 2 muscle groups.

RESULTS: A total of 20 participants with cerebral palsy and OPD (OPD group) and 60 age- and sex-matched healthy volunteers (control group) were recruited. Among 20 patients with OPD, 19 had Dysphagia Outcome and Severity Scale records. Of them, 8 were classified as severe dysphagia (level 1), 1 was moderate dysphagia (level 3), 4 were mild to moderate dysphagia (level 4), 3 were mild dysphagia (level 5), and 3 were within functional limits (level 6). Although the groups were matched for age and sex, participants in the OPD group were significantly shorter, weighed less and had lower body mass index than their counterparts in the control group (both, $P < 0.001$). All sEMG parameter values were significantly higher in the OPD group compared with the control group ($P < 0.05$). Differences were most pronounced at the 3 mL swallowing volume. IMGMA at the 3 mL volume was the best predictor of OPD with a sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 85.0%, 90.0%, 73.9%, 94.7% and 88.8%, respectively.

CONCLUSION: Two-channel sEMG may be useful in the diagnosis of OPD in patients with cerebral palsy.

Key words: Cerebral palsy; Dysphagia; Surface electromyography; Maximum swallowing volume

Core tip: Surface electromyography (sEMG) parameters obtained using 2-channel recordings of submental and infrahyoid muscle activity differ significantly during swallowing between patients with oropharyngeal dysphagia (OPD) and cerebral palsy and healthy control individuals. These findings suggest that with further optimization and testing, 2-channel sEMG may be useful for the diagnosis of OPD in patients with cerebral palsy, as well as patients with other disorders.

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INTRODUCTION

Oropharyngeal dysphagia (OPD), defined as difficulty in the oral and/or pharyngeal phases of swallowing, which includes tolerance of secretions/saliva control and food/liquid, is a relatively common clinical condition that can have serious consequences[1]. OPD may result in inadequate food intake, which can result in malnutrition, dehydration, and decreased quality of life[2]. In addition, a common and potentially serious complication of OPD is aspiration pneumonia[3,4]. Unsurprisingly, OPD is associated with increased morbidity and mortality[2]. The incidence of OPD increases with age, and is particularly common in patients with neurologic disorders[1,5,6] including cerebral palsy[7]. The prevalence of OPD in children with cerebral palsy is estimated to be between 19% and 99%, and OPD can impact children's growth, nutrition and overall health[8,9]. Early diagnosis of OPD is essential for the prompt initiation of therapy to lower the risk of complications[9].

The current gold standard for diagnosing OPD is video fluoroscopic study of swallowing (VFSS). Despite the accuracy of VFSS, this approach has several limitations including exposure to radiation, high cost, and the need for specialized equipment and trained personnel[10]. Thus, the availability of a simple, fast, and low cost means of diagnosing OPD would be of significant benefit.

Surface electromyography (sEMG) has been used to assess the involvement of individual muscles in swallowing[11-15]. Gupta *et al*[16] first outlined the potential use of sEMG for the diagnosis of OPD. Crary *et al*[17] reported a strong degree of accuracy in identification of swallows *vs* non-swallow movements from sEMG traces and concluded that the sEMG graphic record is a valid and reliable tool for identifying normal swallows. In another study by Crary *et al*[18] the authors evaluated healthy adults with simultaneous videofluoroscopy and sEMG while swallowing 5 mL of liquid barium sulfate and found that swallow onset in the sEMG signal preceded the onset of all biomechanical events, and all biomechanical events demonstrated a strong correspondence to the sEMG signal with the strongest relationship between hyoid elevation-anterior displacement and the sEMG signal. These results suggest that because the sEMG signal is a useful indicator of major biomechanical events in the swallow, it can be used as the tool for investigating OPD. Vaiman *et al*[10,19] have been strong advocates of the use of sEMG in the screening of swallowing disorders including OPD, and have published evidence suggesting that 4-channel sEMG may be an effective means of screening for OPD in certain patient populations.

To our knowledge, however, no study has examined the use of sEMG for diagnosing OPD in patients with cerebral palsy. As OPD is relatively common in patients with cerebral palsy, the applicability of sEMG for diagnosing OPD in this patient population warrants investigation. Thus, the aim of this study was to determine the clinical feasibility and accuracy of using 2-channel sEMG for diagnosing OPD in patients with cerebral palsy.

MATERIALS AND METHODS

Participants

Participants with spastic bilateral cerebral palsy between 5 and 30 years of age and OPD who exhibited coughing during mealtime were recruited from the rehabilitation department clinic of the Maria Social Welfare Foundation of Taiwan. In all patients, OPD was diagnosed by videofluoroscopy within 1 mo of sEMG testing. In brief, videofluoroscopy was performed with the patient in the upright (sitting) position and lateral and/or posteroanterior views were obtained. Swallowing was evaluated by simultaneous video and audio recording, and the agents used were thin liquid barium, thick liquid barium, puree barium, paste barium, and solid barium cookie. The caregiver was instructed to feed the thin liquid to the patient in volumes of 2, 5, and 10 mL *via* spoon-feeding (or through a straw or directly from a cup if patient is able). Thick liquid, puree, and paste were fed in volumes of 2, 5, and 10 mL *via* spoon. The barium cookie was divided into 2 cm^2 sized pieces and fed with a small amount of paste barium.

Age- and sex-matched healthy volunteers were recruited from the general public as a control group. Individuals who had skin diseases or wounds located where the electrodes would be attached were excluded. This study was approved by the Institutional Review Board of Cheng-Ching Hospital, Taichung, Taiwan. All participants provided written informed consent before the commencement of any study-related procedures. For participants unable to provide consent or under the age of 18, consent was obtained from a parent or legal guardian.

Dysphagia outcome and severity scale

The severity of OPD was assessed in each participant using the Dysphagia Outcome and Severity Scale (DOSS)[20], which classifies dysphagia as follows: level 7 = normal; level 6 = within functional limits; level 5 = mild dysphagia; level 4 = mild to moderate dysphagia; level 3 = moderate dysphagia; level 2 = moderate to severe dysphagia; and level 1 = severe dysphagia. The DOSS was scored according to the results of videofluoroscopy and was representative of the videofluoroscopic evaluation.

sEMG examination

A 2-channel sEMG device (Bagnoli™ Handheld EMG System, Delsys Inc., Boston, MA) was used for examinations. Electrodes were placed on the skin over the submental (0.5 cm above the hyoid, parallel to, and right of the midline) and infrahyoid (0.5 cm below the hyoid, parallel to, and right of the midline) muscles as described

by Vaiman[19] to record changes in sEMG potential when different volumes of water were swallowed. sEMG signals were amplified (1000 ×) and filtered (wide band: 20-450 Hz), and root mean square values were used for analysis. Parameters measured included submental muscle group maximum amplitude (SMGMA), infrahyoid muscle group maximum amplitude (IMGMA), the time lag between the peak amplitudes of 2 muscle groups (TDBMG), and the amplitude difference between the 2 muscle groups (ADBMG). Sample volumes of water for testing were based on amounts used by Ozdemirkiran *et al*[21]. Testing began at 3 mL, followed by 5, 8, 12, and 15 mL. Thereafter, 5 mL was added to each successfully swallowed volume until the participant could not ingest the new volume in a single swallow. If a participant could not ingest the initial 3 mL of water in a single swallow, the volume was reduced to 2 or 1 mL as necessary. The maximum volume of water that each participant was able to ingest in a single swallow, the maximum swallowing volume (MSV), was recorded.

Statistical analysis

Continuous variables are presented as mean ± SD, unless otherwise indicated, whereas categorical variables are presented as frequencies with percentages. Demographic variables were compared between groups by independent samples *t*-test (continuous variables) or χ^2 test (categorical variables). After adjusting for body mass index (BMI), sEMG parameters were compared between groups using analysis of covariance. The relationships between DOSS score and different sEMG parameters were determined by calculating Spearman's partial correlation coefficients after adjusting for BMI. Standard measures of test validity including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for each sEMG parameter. Receiver operating characteristic (ROC) curves, plots of 1-specificity *vs* sensitivity for all cutoff values over the range of values for each sEMG parameter, were constructed to examine the diagnostic performance of different sEMG parameters. The optimal cutoff values for sEMG parameters to distinguish the experimental group from the control group were determined using the maximized Youden index, defined as sensitivity + specificity-1. A univariate logistic regression model was constructed with the OPD group as the binary dependent variable (1 = dysphagia, 0 = control), and the sEMG parameters as the continuous variable. The *c* statistic from the logistic regression model corresponds to the area under the ROC curve (AUC). An AUC of 0.5 indicates that the variable does not provide a better than chance prediction of OPD. A test of the null hypothesis that the AUC was 0.5 was performed using the Wilcoxon rank sum test. Comparisons between AUCs for different sEMG parameters were conducted using a previously described method[22]. Statistical analyses were performed using SAS software version 9.2 (SAS Institute Inc., Cary, NC). A two-tailed $P < 0.05$ indicated statistical significance.

Table 1 Demographic characteristics of participants in the oropharyngeal dysphagia and control groups *n* (%)

Characteristic	OPD group[1] (*n* = 20)	Control group[2] (*n* = 60)	*P* value
Sex			
Male	14 (70.0)	42 (70.0)	1.000[3]
Female	6 (30.0)	18 (30.0)	
Age (yr)	14.5 ± 6.2	14.5 ± 6.1	0.998[4]
Height (cm)	128.1 ± 19.2	153.4 ± 20.1	< 0.001[4]
Weight (kg)	25.4 ± 12.7	47.7 ± 17.6	< 0.001[4]
BMI (kg/m^2)	14.6 ± 3.4	19.5 ± 3.5	< 0.001[4]
DOSS[6]			
Level 1	8 (42.1)	0 (0.0)	< 0.001[5]
Level 2	0 (0.0)	0 (0.0)	
Level 3	1 (5.3)	0 (0.0)	
Level 4	4 (21.1)	0 (0.0)	
Level 5	3 (15.8)	0 (0.0)	
Level 6	3 (15.8)	0 (0.0)	
Level 7	0 (0.0)	60 (100.0)	

Data are presented as mean ± SD. [1]Participants in the dysphagia group had cerebral palsy; [2]Participants in the control group did not have cerebral palsy and were healthy; [3]Determined by χ^2 test; [4]Determined by independent samples *t*-test; [5]Determined by Fisher's exact test; [6]Dysphagia outcome and severity scale (DOSS) score was missing for one oropharyngeal dysphagia (OPD) patient. BMI: Body mass index. Level 7 = normal; Level 6 = within functional limits; Level 5 = mild dysphagia; Level 4 = mild to moderate dysphagia; Level 3 = moderate dysphagia; Level 2 = moderate to severe dysphagia; Level 1 = severe dysphagia.

RESULTS

Demographic characteristics

A total of 20 participants with cerebral palsy and OPD (OPD group) and 60 age- and sex-matched healthy volunteers (control group) were recruited. Among 20 patients with OPD, 19 had DOSS records. Of them, 8 were classified as severe dysphagia (level 1), 1 as moderate dysphagia (level 3), 4 as mild to moderate dysphagia (level 4), 3 as mild dysphagia (level 5), and 3 were within functional limits (level 6). Although the groups were matched for age and sex, participants in the OPD group were significantly shorter, weighed less and had lower BMI than their counterparts in the control group (both, $P < 0.001$, Table 1).

MSV and sEMG parameters

After adjusting for BMI, the MSV was significantly lower, and all sEMG parameters were significantly higher, in the OPD group compared with the control group (all, $P < 0.05$, Table 2). Although there were significant between group differences for all sEMG parameters at the 3 mL swallowing volume and at the MSV, the between group differences were more pronounced at the 3 mL swallowing volume.

Correlations between DOSS score and sEMG parameters

After adjusting for BMI, DOSS score was negatively correlated with all sEMG parameters (Table 3). The correlations were significant for SMGMA, IMGMA, and ADBMG at the 3 mL swallowing volume (all, $P < 0.05$). None of the sEMG correlations at the MSV were significant.

Table 2 Surface electromyographic findings for participants in the oropharyngeal dysphagia and control groups after adjusting for body mass index

Characteristic	OPD group (n = 20)	Control group (n = 60)	β[1] (SE)	P value
MSV (mL)	3.70 ± 3.01	54.50 ± 24.47	-33.87 (5.32)	< 0.001
At 3 mL swallowing volume				
SMGMA (μV)	80.77 ± 65.00	35.02 ± 13.02	38.30 (10.21)	< 0.001
IMGMA (μV)	88.89 ± 78.52	30.23 ± 10.55	44.09 (11.68)	< 0.001
TDBMG (s)	0.35 ± 0.35	0.13 ± 0.12	0.22 (0.06)	< 0.001
ADBMG (μV)	60.59 ± 71.50	10.18 ± 11.49	38.55 (10.84)	< 0.001
At MSV				
SMGMA (μV)	100.24 ± 96.96	52.78 ± 28.05	34.90 (16.10)	0.033
IMGMA (μV)	98.28 ± 89.75	51.32 ± 21.78	30.59 (14.20)	0.034
TDBMG (s)	0.35 ± 0.35	0.15 ± 0.15	0.20 (0.07)	0.004
ADBMG (μV)	62.87 ± 73.05	18.75 ± 22.00	33.92 (12.20)	0.007

Data are presented as mean ± SD unless otherwise indicated. [1]Mean difference between experimental and control group adjusted for body mass index (BMI). MSV: Maximum swallowing volume; SMGMA: Submental muscle group maximum amplitude; IMGMA: Infrahyoid muscle group maximum amplitude; TDBMG: Time difference between 2 muscle groups; ADBMG: Amplitude difference between 2 muscle groups; OPD: Oropharyngeal dysphagia.

Table 3 Spearman's partial correlations between Dysphagia Outcome and Severity Scale score and surface electromyographic findings after adjusting for body mass index (n = 79[1])

Characteristic	Correlation coefficient	P value
At 3 mL swallowing volume		
SMGMA (μV)	-0.329	0.003
IMGMA (μV)	-0.389	< 0.001
TDBMG (s)	-0.153	0.182
ADBMG (μV)	-0.353	0.002
At MSV		
SMGMA (μV)	-0.117	0.309
IMGMA (μV)	-0.056	0.626
TDBMG (s)	-0.168	0.140
ADBMG (μV)	-0.193	0.091

[1]One patient with a missing Dysphagia Outcome and Severity Scale score value was omitted from this analysis. MSV: Maximum swallowing volume; SMGMA: Submental muscle group maximum amplitude; IMGMA: Infrahyoid muscle group maximum amplitude; TDBMG: Time difference between 2 muscle groups; ADBMG: Amplitude difference between 2 muscle groups.

Diagnostic performance of sEMG parameters

The sEMG parameters at the 3 mL swallowing volume were better predictors of OPD than the sEMG parameters at the MSV (Table 4). The AUCs for IMGMA and ADBMG at the 3 mL swallowing volume were significantly higher than the AUCs for SMGMA, IMGMA, and ADBMG at the MSV ($P < 0.05$). Similarly, the AUC for SMGMA at the 3 mL swallowing volume was significantly higher than the AUC for SMGMA at the MSV ($P = 0.001$). Of the sEMG parameters at the 3 mL swallowing volume, IMGMA was the best predictor of OPD, followed by SMGMA. At the MSV, SMGMA and IMGMA were poor (no better than chance alone) predictors of OPD. Because sEMG parameters at the 3 mL swallowing volume showed better diagnostic performance for detecting OPD than those at the MSV did, the effectiveness of various combinations of these 4 parameters to detect OPD was further analyzed. Since TDBMG exhibited the lowest diagnostic performance (AUC = 0.723) among these 4 parameters, 3 scenarios were investigated as follows: (1) Of 4 parameters, at least 2 parameters met diagnostic criteria (≥ cutoff value); (2) Of 4 parameters, at least 3 parameters met diagnostic criteria; and (3) Of 3 parameters other than TDBMG, at least 2 parameters met diagnostic criteria. The diagnostic performances of these 3 scenarios are shown in Table 5.

DISCUSSION

Our study is the first to compare sEMG parameters obtained using a 2-channel surface electromyograph during swallowing between patients with cerebral palsy and OPD and healthy control individuals. We found that there were marked between group differences for all sEMG parameters at the 3 mL swallowing volume and the MSV. Specifically, all sEMG parameters were significantly higher in the OPD group compared with the control group. Further analyses indicated that sEMG parameters at the 3 mL swallowing volume, in particular IMGMA, were the best predictors of OPD. The DOSS used in this study has been shown to exhibit high inter-rater (90%) and intra-rater (93%) agreement[20] and has been used in the evaluation of infants with Apert syndrome[23].

Our finding that sEMG parameters were significantly different during swallowing between patients with OPD and cerebral palsy and healthy control individuals is consistent with the finding of Vaiman *et al*[10] that there are differences in sEMG between patients with various diseases and conditions including OPD, tonsillitis, and salivary gland disease and normal healthy individuals, and those of Crary *et al*[17] who have reported that sEMG can reliably identify normal swallows and that sEMG signals are strongly correlated with the biomechanical events of swallowing[18]. Our findings also support the assertion of Vaiman *et al*[10] that sEMG is a viable screening method for OPD. Different than in the studies by Vaiman *et al*[10,19] in which a 4-channel sEMG was used, we used a 2-channel sEMG and found this to be adequate for detecting between group differences. Compared to 4-channel sEMG, 2-channel sEMG is less expensive and more accessible. The 2-channel system makes sEMG examinations on patients who cannot cooperate for a long period of time easier, thus making it more practical in clinical settings. Various other non-invasive, swallowing-based means of screening for OPD have been described in the literature (Table 6), and the 2-channel sEMG for detecting OPD at the 3 mL swallowing volume in patients with cerebral palsy we have described compares favorably with the majority of previously reported approaches in terms of sensitivity, specificity, PPV, and NPV.

Importantly, we found that sEMG parameters measured during swallowing of a 3 mL volume were better

Table 4 Diagnostic performance of difference surface electromyographic parameters for detecting oropharyngeal dysphagia

Characteristic	AUC (95%CI)	*P* value	Optimal cutoff value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
At 3 mL swallowing volume								
SMGMA (μV)	0.80 (0.68-0.92)[1]	< 0.001	39.27	80.0	73.3	50.0	91.7	75.0
IMGMA (μV)	0.88 (0.78-0.98)[1,2,3]	< 0.001	37.30	85.0	90.0	73.9	94.7	88.8
TDBMG (s)	0.72 (0.59-0.86)	< 0.001	0.19	70.0	70.0	43.8	87.5	70.0
ADBMG (μV)	0.82 (0.71-0.93)[1,2,3]	< 0.001	12.02	75.0	76.7	51.7	90.2	76.3
At MSV								
SMGMA (μV)	0.63 (0.48-0.79)	0.091	110.00	40.0	98.3	88.9	83.1	83.8
IMGMA (μV)	0.64 (0.48-0.81)	0.097	79.55	45.0	90.0	60.0	83.1	78.8
TDBMG (s)	0.72 (0.59-0.84)	< 0.001	0.19	70.0	70.0	43.8	87.5	70.0
ADBMG (μV)	0.70 (0.56-0.84)	0.005	35.69	50.0	90.0	62.5	84.4	80.0

[1]Area under receiver operating characteristic curve (AUC) significantly higher compared with submental muscle group maximum amplitude (SMGMA) at maximum swallowing volume (MSV) ($P < 0.01$, *vs* SMGMA at MSV); [2]AUC significantly higher compared with infrahyoid muscle group maximum amplitude (IMGMA) at MSV ($P < 0.05$, *vs* IMGMA at MSV); [3]AUC significantly higher compared with amplitude difference between 2 muscle groups (ADBMG) at MSV ($P < 0.01$, *vs* ADBMG at MSV). PPV: Positive predictive value; NA: Not applicable; NPV: Negative predictive value; TDBMG: Time difference between 2 muscle groups.

Table 5 Diagnostic performance of combinations of surface electromyography parameters at the 3 mL swallowing volume for detecting oropharyngeal dysphagia

sEMG parameters at the 3 mL swallowing volume	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Of 4 parameters					
≥ 2 parameters met diagnostic criteria[1]	100	71.7	54.1	100	78.8
≥ 3 parameters met diagnostic criteria[1]	85.0	93.3	81.0	94.9	91.3
Of 3 parameters other than TDBMG					
≥ 2 parameters met diagnostic criteria[1]	95.0	75.0	55.9	97.8	80.0

[1]Diagnostic criteria of each surface electromyography (sEMG) parameter at the 3 mL are as follows: submental muscle group maximum amplitude (SMGMA) ≥ 39.27 μV; infrahyoid muscle group maximum amplitude (IMGMA) ≥ 37.30 μV; time difference between 2 muscle groups (TDBMG) ≥ 0.19 s; amplitude difference between 2 muscle groups (ADBMG) ≥ 12.02 μV. AUC: Area under receiver operating characteristic curve; PPV: Positive predictive value; NA: Not applicable; NPV: Negative predictive value; MSV: Maximum swallowing volume.

Table 6 Summary of studies of non-invasive screening methods for oropharyngeal dysphagia

Ref.	Test	No. of participants	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
DePippo *et al*[24]	Burke Dysphagia Screening Test	44	76	59	-	-
Gottlieb *et al*[25]	50 mL Drinking Test	180	80	86	-	-
Ellul *et al*[26]	Standardized Swallowing Assessment	136	68	86	50	88
Smithard *et al*[27]	Bedside Swallowing Assessment	83	70	66	50	85
Hinds *et al*[28]	Timed Test	115	73	67	-	-
Mari *et al*[29]	3oz Water Swallow Test	93	74	74	71	77
Smith *et al*[30]	Pulse Oximetry	53	86	-	69	
Martino *et al*[31]	Toronto Bedside Swallowing Screening Test	115	82	39	24	90
Kopey *et al*[32]	3-Sp Test	223	21	99	88	72
Antonios *et al*[33]	Modified Mann Assessment of Swallowing Ability	150	93	86	79	95

PPV: Positive predictive value; NPV: Negative predictive value.

predictors of OPD than those measured during MSV, and that IMGMA was the best diagnostic predictor at the 3 mL swallowing volume, as indicated by relatively high sensitivity, specificity, PPV, NPV, and accuracy. It is interesting to postulate why sEMG is more sensitive at predicting OPD at a volume of 3 mL than at MSV. Crary *et al*[34] used sEMG to evaluate the patients with OPD secondary to brainstem stroke and compared the results with those of age- and sex-matched controls. The results showed that patients with OPD secondary to brainstem stroke differed in both amplitude and timing aspects of swallowing attempts from asymptomatic controls. Specifically, during swallow attempts dysphagic patients produced more muscle activity over a shorter duration and with less coordination. Peak microvolt values (max amplitude) during the swallowing attempts represent the maximum myoelectric activity observed during swallowing, and the brains that have experienced stroke produced

more muscle activity due to poor coordination. Similarly, our findings showed that the maximum amplitude of the patients with dysphagia secondary to cerebral palsy differed from the age-matched controls. Presumably the patients with OPD and cerebral palsy produce more muscle activity as a result of poor coordination than healthy individuals. For healthy individuals it is relatively easy to swallow a small volume (3 mL), whereas a larger volume is more difficult. In the individuals with OPD and cerebral palsy, the difficulty occurs at even small volumes.

We believe the approach for diagnosing OPD described herein offers several advantages over other diagnostic options. First, the examination is relatively quick because only 2 electrodes need to be attached to the patient. Second, only a small volume of fluid (3 mL) is required to be swallowed for optimal testing. Third, because only 3 mL of fluid is used, the risk of choking is reduced. Fourth, the test is non-invasive and avoids radiation exposure that is unavoidable with VFSS. Finally, this is a low cost procedure that requires minimal training and can be conducted in the absence of a speech therapy specialist. Given the aforementioned benefits, sEMG may be used as a simple screening assessment to initiate referral to speech therapy for more extensive evaluation and management.

There are several limitations to this study that warrant acknowledgement. First, all participants in the OPD group had cerebral palsy; thus, the findings may only be applicable to individuals with OPD and cerebral palsy. Nevertheless, we feel our findings are still important because OPD is a common comorbidity in patients with cerebral palsy, particularly in children with severe cerebral palsy[7]. Second, control participants were healthy individuals. A more appropriate control group in this context would have been patients with cerebral palsy, but not OPD. This was not part of the study design due to ethical concerns. Having patients with cerebral palsy, of whom most are children, with no swallowing problems endure the lengthy and intensive evaluation from which they would gain no benefit would bring unnecessary hardship and distress to these patients. A third limitation is the relatively small number of participants in the OPD group. Lastly, because of the small number of patients subgroup analysis could not be performed.

In conclusion, we have found that sEMG parameters differ significantly during swallowing between patients with OPD and cerebral palsy and healthy control individuals. Notably, these findings were obtained using 2-channel recordings of submental and infrahyoid muscle activity. Our findings lead us to suggest that, with further optimization and testing, 2-channel sEMG may be useful for the diagnosis of OPD in patients with cerebral palsy, and indeed other patients.

COMMENTS

Background

Oropharyngeal dysphagia (OPD) may result in inadequate food intake, which can result in malnutrition, dehydration, and decreased quality of life. In addition, aspiration pneumonia is a common and potentially serious complication. The incidence of OPD increases with age, and is particularly common in patients with neurologic disorders, including cerebral palsy. The current gold standard for diagnosing OPD is video fluoroscopic study of swallowing (VFSS); however, has several limitations including exposure to radiation, high cost, and the need for specialized equipment and trained personnel. Thus, the availability of a simple, fast, and low cost means of diagnosing OPD would be of significant benefit.

Research frontiers

Surface electromyography (sEMG) has been used to assess the involvement of individual muscles in swallowing. As OPD is relatively common in patients with cerebral palsy, the applicability of sEMG for diagnosing OPD in this patient population warrants investigation.

Innovations and breakthroughs

This study is the first to compare sEMG parameters obtained using a 2-channel surface electromyograph during swallowing between patients with cerebral palsy and OPD and healthy control individuals. The authors found that there were marked between group differences for all sEMG parameters at the 3 mL swallowing volume and the maximum swallowing volume. Specifically, all sEMG parameters were significantly higher in the OPD group compared with the control group. Further analyses indicated that sEMG parameters at the 3 mL swallowing volume, in particular infrahyoid muscle group maximum amplitude, were the best predictors of OPD.

Applications

Although these results indicate that the diagnostic performance of sEMG is not good enough to replace the VFSS, sEMG can be considered as an initial screening tool due to its non-invasive nature and low cost. As the first clinical study to apply sEMG for detecting OPD in cerebral palsy, the authors believe the results demonstrate the feasibility of using sEMG as a screening method and can be a reference for further investigation of the method in patients with cerebral palsy.

Terminology

OPD is defined as difficulty in the oral and/or pharyngeal phases of swallowing, which includes tolerance of secretions/saliva control and food/liquid, is a relatively common clinical condition that can have serious consequences. For a VFSS, the patient swallows hard and/or soft foods and liquids that are mixed with barium. Fluoroscopy of the swallowing function is performed. sEMG uses electrode placed on the skin to detect the electrical potential generated by muscle cells when these cells are electrically or neurologically activated.

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In this paper the authors evaluate sEMG as a new helpful tool for the screening and early diagnosis of dysphagia in patients with cerebral palsy: the conclusion of the authors is that sEMG may be useful in the diagnosis of OPD. Evaluation of OPD due to brainstem stroke by sEMG was already reported, but this paper is the first to assess sEMG as a screening tool in cerebral palsy. The paper is well presented and written in a well English.

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