The Effects of a Massage and Oro-facial Exercise Program on Spastic Dysarthrics' Lip Muscle Function

Young-Jin Hwang* · Ok-ran Jeong · Ho-Joon Yeom*****

ABSTRACT

This study was to determine the effects of a massage and oro-facial exercise program on spastic dysarthric patients' lip muscle function using an electromyogram (EMG). Three subjects with Spastic Dysarthria participated in the study. The surface electrodes were positioned on the Levator Labii Superior Muscle (LLSM), Depressor Labii Inferior Muscle (DLIM), and Orbicularis Oris Muscle (OOM). To examine lip muscle function improvement, the EMG signals were analyzed in terms of RMS (Root Mean Square) values and Median Frequency. In addition, the diadochokinetic movements and the rate of sentence reading were measured. The results revealed that the RMS values were decreased and the Median Frequency moved to a high frequency area. Diadochokinesis and sentence reading rates were improved.

Keyword : dysarthria, massage, oro-facial exercise, sEMG, lip muscle

1. Introduction

Spastic dysarthria is caused by bilateral upper motor neuron damage to the pyramidal and extrapyramidal systems (Duffy, 1995). Bilateral upper motor neuron damage affects articulation, phonation, resonance, and respiration (Dayley, et al., 1975). In general, individuals with spastic dysarthria demonstrate a number of different speech errors.

In spastic dysarthria, the speech is characterized by imprecise articulation, monopitch, loudness, and poor prosody. The speech errors in spastic dysarthria result from spasticity, slowness, and weakness in the speech musculatures. This may be because the strength of construction of speech movements is reduced, and sustaining contractions are weak (Netsell, et al., 1979). In general, bilateral damage to the upper motor neuron results in increased muscle tone in the articulators, which may be most evident in the hyperadduction of the vocal folds during phonation (Darley et al., 1975).

* Yonsei University Wonju Christian Hospital
** Dept. of Speech Pathology, Daegu University
*** Dept. of Biomedical Engineering, Yonsei University

Several nonspeech oral mechanism findings are frequently associated with spastic dysarthria. Dysphagia and drooling are also common. They occur most likely due to the decreased frequency of swallowing or the poor control of secretions. Individuals with spastic dysarthria often show anxiety and depression (Gangale, et al., 1993).

From this point of view, treatment of spastic dysarthria can focus on concentrating on reducing the increased muscle tone and strengthening speech musculature.

However, few research studies have examined the effectiveness of reducing the increased muscle tone and strengthening speech musculature in the treatment of spastic dysarthria. Massage and stretching can be useful in reducing muscle spasticity and oro-facial exercise can improve lip and cheek muscle strength (Gangale, et al., 1993).

The present study, therefore, systematically investigated the effects of a massage and oro-facial exercise program on spastic dysarthric patients' lip muscle function using EMG.

2. Methods

Subjects

Three subjects with spastic dysarthria participated in this study. All subjects were native speakers of Korean with no known reading problems. The participants had been clinically diagnosed by either a qualified neurologist or neurosurgeon as having a traumatic brain injury (TBI). All subjects were reported to have Rancho Los Amigos Level of Cognitive Function Scale Ⅶ. They were all at least 6 months post TBI (mean time of post-TBI=32 months). The characteristics are presented in Table 1.

Table 1. Subjects' characteristics

subject	Gender	Age	Years after TBI	Type of dysarthria	Lesion sites	Degree of consonants imprecision
1	M	35	3;0	spastic	Lt. thalamus Rt. basal ganglia both frontal lobe midbrain	mild
2	M	21	2;6	spastic	Traumatic subarachnoid hemorrhage Traumatic intraventricle hemorrhage	severe
3	M	20	2;6	spastic	Traumatic subarachnoid hemorrhage Traumatic intraventricle hemorrhage	moderate

Materials

The massage and oro-facial exercise program is a compilation of therapy strategies to improve oral-motor and facial strength and tone.

The massage and oro-facial exercise program consisted of 2 portions. One was massage and stretching exercise, and the other was oro-facial exercise.

Table 2 show the program.

Table 2. The massage and oro-facial exercise program

	단계	Program characteristic	Main Activity	Preparation
lip	I - 1	massage	upper lip stretch	polyglove
cheek	I - 2	massage	massage of cheeks	polyglove
cheek	I - 3	massage	buccal cavity pull 1	polyglove
cheek	I - 4	massage	buccal cavity pull 2	polyglove
cheek	I - 5	massage	cheek stretch	polyglove
chin	I - 6	massage	chin massage	polyglove
jaw	I - 7	massage	jaw muscle massage	polyglove
lip	II - 1	lip muscle exercise	kissing exercise	polyglove
lip	II - 2	lip muscle exercise	lip hold	handkerchief
lip	II - 3	lip muscle exercise	upper lip movement	biogut, tongue depressor
lip	II - 4	lip muscle exercise	lip vibration	
lip/cheek	II - 5	lip muscle exercise	lip and cheek toner	stop watch
lip/cheek	II - 6	lip muscle exercise	cheek puff lip purse	
lip	II - 7	lip muscle exercise	lip press	
lip	II - 8	lip muscle exercise	lower lip extension	
lip	II - 9	lip muscle exercise	teeth and pursed lip strengthener	thread, button
lip	II - 10	lip muscle exercise	lip and cheek stretch	
lip	II - 11	lip muscle exercise	inner cheek jaw stretch	
lip	II - 12	lip muscle exercise	upper lip exercise	
lip	II - 13	lip muscle exercise	upper lip curl	

Procedures

Surface electrodes were used a disposable 4-Disk Electrodes with 1.0 m Leads (Nicolet Biomedial. Inc. U.S.A). A reference electrode (Nicolet Biomedial. Inc. U.S.A) was placed on the forehead. sEMG signals were checked before recording and monitored throughout the

experiment to ensure that the signals were clear and free of noise impact.

sEMG signals were amplified, filtered (passband 20-400 Hz, stopband 60 Hz), and digitized at a sampling rate of 1,000 Hz per channel.

The surface electrodes were positioned on the skin as shown in Figure 1. After shaving, the skin was cleaned with an alcohol-soaked swab before positioning.

The surface electrodes were positioned on LLSM, DLIM, and OOM. When surface electrodes were positioned on LLSM and DLIM. The EMG signals were collected while the subjects were producing /pa/, /pi/, and /pe/. When the surface electrodes were positioned on OOM, the EMG signals were collected on /po/ and /pu/.

(A) (B)

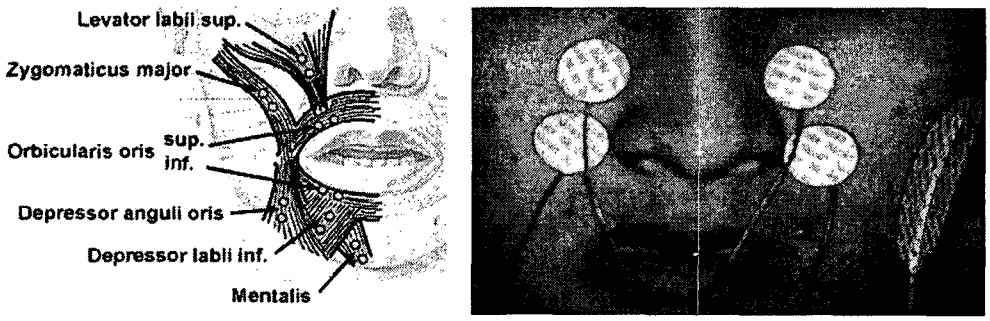

Figure 1. Topographical relationship between the surface electrodes and underlying muscles (A). Locations of the surface electrodes (B).

Muscle activity was quantified by calculating the RMS values of the signals.

The analysis of the RMS values was conducted by the Acqknowledge ver 3.72 program (Biopac System Inc. CA. U.S.A). The Median Frequency data was obtained using a fast moving Fourier transformation (FFT). The analysis of the Median Frequency was performed by the Matlab ver 6.1 program (The MathWorks, Inc., MA, U.S.A).

In addition, the diadochokinetic test and sentence reading rate were evaluated.

3. Results

This study was to determine the effects of a massage and oro-facial exercise program on spastic dysarthric patients' lip muscle function using an EMG.

Figure 2 and Figure 3 illustrate the EMG recordings and the improvement patterns of a subjects muscle activities.

The results were like the following:

First, the massage and oro-facial exercise program appeared to decrease RMS values of LLSM, although they did not reach a statistical difference. An excessive activation of LLSM was partially observed. These findings were in agreement with Abbs & Gracco (1983). Abbs & Gracco had reported that an unanticipated mechanical perturbation was inflicted on the lip muscles during the bilabial explosive consonant /p/ or /b/.

<before treatment> <after treatment>

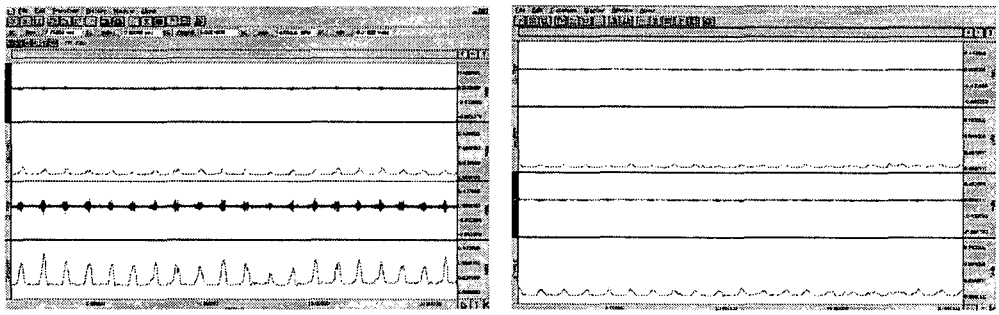

Figure 2. EMG recordings of the LLSM activity of subject 3 during repetition of /pa/.

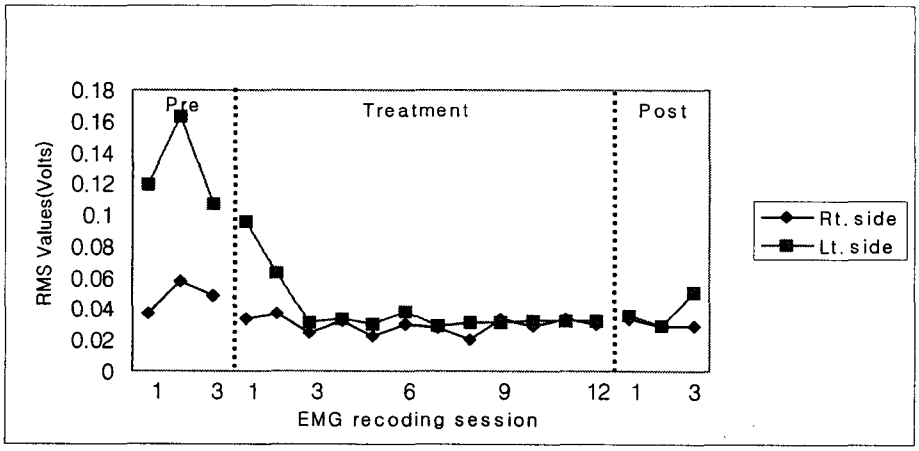

Figure 3. EMG recordings of the LLSM activity of subject 3 during repetition of /pa/.

Table 3. Pearson correlation coefficient between LLSM and the syllables

Pre-treatment		subject 1	subject 2	subject 3
/pa/	correlation	0.522	-0.854	0.682
	p values	0.478	0.348	0.522
/pi/	correlation	- 0.951*	0.796	0.995
	p values	0.049	0.414	0.063
/pe/	correlation	0.981*	-0.432	0.996
	p values	0.019	0.715	0.054
Post-treatment				
/pa/	correlation	0.807**	0.253	0.445
	p values	0.000	0.363	0.097
/pi/	correlation	0.757**	0.483	0.573*
	p values	0.001	0.068	0.026
/pe/	correlation	0.526*	0.360	0.877**
	p values	0.044	0.187	0.000

*p<0.05 **p<0.01

The massage and oro-facial exercise program seemed to decrease the RMS values of DLIM, although they did not reach a statistical difference. The RMS values of OOM also tended to decrease even though they did not show a statistical difference.

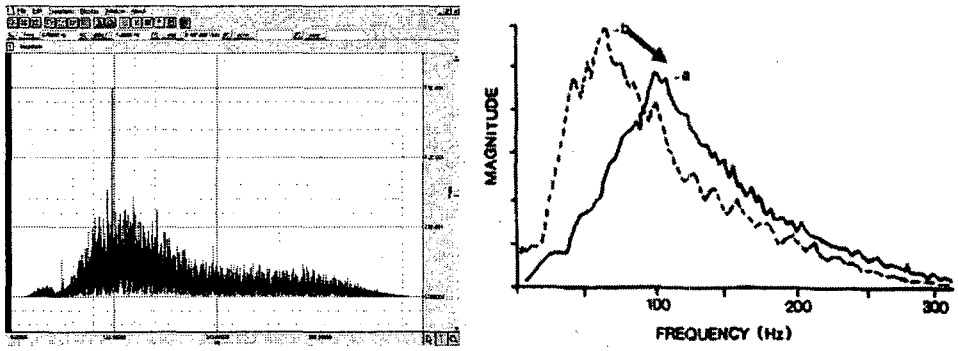

Figure 4. Median frequency data was obtained using a fast moving Fourier transformation (left). First median frequency moved to a higher frequency area as fatigue was decreased (right)

Second, the massage and oro-facial exercise program elicited a higher Median Frequency on LLSM, DLIM, and OOM.

Third, the Massage and Oro-facial Exercise Program resulted in improved Diadochokinesis.

Table 4. Pearson correlation coefficient between RMS values and diadochokinesis during pre-treatment.

pre-treatment		diadochokinesis		
		subject 1	subject 2	subject 3
LLSM /pa/ (Rt. side)	correlation	0.600	-0.768	-0.673
	p values	0.400	0.443	0.530
LLSM /pa/ (Lt. side)	correlation	-0.145	0.989	0.082
	p values	0.855	0.095	0.948
DLIM /pa/ (Rt. side)	correlation	-0.381	0.594	-0.147
	p values	0.619	0.595	0.906
DLIM /pa/ (Lt. side)	correlation	-0.217	0.509	-0.676
	p values	0.783	0.660	0.527
OOUL /po/ (Rt. side)	correlation	-0.805	0.057	-0.998*
	p values	0.195	0.963	0.038
OOUL /po/ (Lt. side)	correlation	-0.404	0.933	0.736
	p values	0.596	0.234	0.473
OOLL /po/ (Rt. side)	correlation	-0.362	0.881	0.899
	p values	0.185	0.314	0.289
OOLL /po/ (Lt. side)	correlation	0.330	-0.629	0.349
	p values	0.230	0.567	0.773

*p<0.05

Table 5. Pearson correlation coefficient between RMS values and diadochokinesis during post-treatment.

Post-treatment		diadochokinesis		
		subject 1	subject 2	subject 3
LLSM /pa/ (Rt. side)	correlation	0.637*	0.323	0.186
	p values	0.008	0.241	0.506
LLSM /pa/ (Lt. side)	correlation	0.555*	0.776**	0.765**
	p values	0.026	0.001	0.001
DLIM /pa/ (Rt. side)	correlation	0.019	0.252	0.789**
	p values	0.946	0.366	0.000
DLIM /pa/ (Lt. side)	correlation	0.395	0.518*	0.819**
	p values	0.145	0.048	0.000
OOUL /po/ (Rt. side)	correlation	0.251	0.112	0.608*
	p values	0.366	0.692	0.016
OOUP /po/ (Lt. side)	correlation	0.312	0.570*	0.762**
	p values	0.258	0.026	0.001
OOLL /po/ (Rt. side)	correlation	-0.362	0.027	-0.479
	p values	0.185	0.924	0.071
OOLL /po/ (Lt. side)	correlation	0.330	0.554*	0.280
	p values	0.230	0.032	0.312

*p<0.05, **p<0.01

Fourth, the massage and oro-facial exercise program resulted in improved sentence reading rates.

Table 6. Pearson correlation coefficient between diadochokinesis and sentence reading rates

		Sentence Reading Rates		
Pre-treatment		**subject 1**	**subject 2**	**subject 3**
diadochokinesis	**correlation**	-0.309	0.926	0.926
	p values	.0691	0.246	0.247
Post-treatment				
diadochokinesis	**correlation**	0.718**	0.527*	0.896**
	p values	0.003	0.043	0.000

*p<0.05, **p<0.01

4. Discussion

Spastic dysarthria is usually the result of 3 conditions affecting the articulators: weakness, reduced range of movement, and reduced speed of movement. Reducing spasticity in the lips through massage and stretching may result in increased speed and range of movement during speech. Weakness in the lips through oro-facial exercise also may increase strength.

However, a systematic and objective research study has not been conducted as of yet.

An anecdote reported by Dworkin (1991) introduced that speakers with spastic dysarthria may benefit from relaxation exercises more than those with other types of dysarthria types, but whether such relaxation actually facilitates speech is uncertain. Similarly, stretching exercises of the articulators have some face validity for speakers with spastic dysarthria but have not been investigated. Rosenbek and LaPointe (1985) suggest that relaxation exercises may help to improve muscle tone in patients with spasticity or rigidity. For example, shaking the head and the open jaw to create lateral movements of the jaw may help loosen jaw movement for speech. Chewing movements to promote relaxation may help decrease mild muscle hypertonus in the jaw and tongue.

Stretching exercises have been noted to prevent joint and muscle contractions and also modulate spasticity (Merritt, 1981). Stretching exercises such as sustained maximum jaw opening, sustained maximum tongue protrusion, retraction or lateralization or sustained maximum lip retraction, pursing and puffing may have some effect on increasing range of motion and decreasing the effects of spasticity on speech. Since stretching the articulators is a necessarily voluntary and not passive activity, it may also contribute to increasing strength. Stretching may be most applicable for those with spasticity. The possible

strengthening effect of stretching might help some patients with weakness (Duffy, 1995).

The use of strengthening exercises to improve articulation is controversial. It is certainly possible to engage in activities that might increase strength in the articulators. The lip can be rounded, puffed, and closed isometrically with or without clinician-provided resistance. Bohannon and Walsh (1991) studied the relationship between active range of motion deficits and muscle strength and tone of the elbow in patients with hemiparesis. In this study, they suggested that strengthening exercises may help to decrease muscle tone. However, Yorkston and Bell (1988) noted the absence of data on the effect of strengthening exercises on articulatory adequacy and concluded that there are probably only a small number of patients for whom strengthening exercises are appropriate.

Therefore, this study was done to determine the effects of a massage and oro-facial exercise program on spastic dysarthric patients' lip muscle function using an EMG. The results indicate that as muscle tone improved, the RMS values of LLSM, DLIM, and OOM tended to decrease even though they did not show a statistical significance. They may have shown statistical significance with more subjects. Except for subject 1, in all subjects, Median Frequency of LLSM, DLIM, and OOL moved to a higher frequency area. Therefore, the subjects showed an improves diadochokinetic rate and sentence reading rates.

Therefore, it can be concluded that the massage and oro-facial exercise program seemed to be effective in improving lip muscular function of spastic dysarthric patients.

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▲ Young-jin Hwang.
Yonsei University Wonju Christian Hospital
162 Ilsan-dong, Wonju, 220-701, KOREA
Tel: +82-33-741-1428
e-mail: speech2002@naver.com

▲ Ok-ran Jeong
Dept. of Speech Pathology
Daegu University
2288 Daemyung-dong Nam-ku
Daegu, 705-033 KOREA
Tel: +82-53-650-8274
e-mail: oj@daegu.ac.kr

▲ Ho-joon Yeom
Dept. of Biomedical Engineering
Yonsei University
234 Maejiri Heungup-myon
Wonju, 220-710 KOREA
Tel: +82-33-760-2807
e-mail: hojoonmk@hanmail.net