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OROFACIAL MYOFUNCTIONAL THERAPY IN DYSARTHRIA: A STUDY ON SPEECH INTELLIGIBILITY

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ABSTRACT

Various types of orofacial myofunctional disorders co-exist with speech problems in individuals with dysarthria. Controlled studies stating the efficacy of orofacial myofunctional therapy (OMT) in dysarthric individuals are very scant. The present study was undertaken to examine the efficacy of OMT in twelve patients diagnosed with mild to moderate dysarthria following right hemisphere brain damage. Pre-therapy assessment focused on existing orofacial myofunctional problems and speech intelligibility in the clients. The goals of OMT were to increase strength and mobility of buccal, facial, labial, and lingual musculature. No speech intervention was provided while OMT was in progress. Post-therapy measures indicated significant improvements in the stated goals as well as in speech intelligibility for single words. Patients observed functional improvements in swallowing functions too. A high positive correlation was found between speech intelligibility and diadochokinetic rate. Clinical implications regarding use of OMT in dysarthria are discussed.

Key words: orofacial myofunctional therapy, speech intelligibility, dysarthria

INTRODUCTION

Dysarthria refers to a family of different speech disorders of muscular strength, speed, and/or coordination of the peripheral speech musculature consisting of the laryngeal/respiratory system for phonation, the velopharyngeal system for resonation, and the labial, lingual, and mandibular muscles responsible for articulation (Aronson, 1997). Causes of dysarthria include vascular, demyelinating, neuromuscular junction, muscle, degenerative, toxic/metabolic, and infections diseases, trauma, and neoplasms. The preferred treatment includes treatment of all systems (phonatory, articulatory, resonatory, and respiratory) to enhance intelligible utterances (Freed, 2000). To achieve functional gains in speech intelligibility, traditional articulation treatments (Darley, Aronson, & Brown, 1975) are considered along with specific oral-motor exercises (Rosenbek & LaPointe, 1985).

Speech intelligibility problems in dysarthria include indistinct and labored articulation; irregular articulatory breakdowns; slow rate of articulatory movements; fluctuations of articulation accuracy; loss of automatic articulatory movements (Duffy, 1995). Coarticulatory movements are also difficult due to poor oral motor control (Rosenbek & LaPointe, 1985). The degree of speech intelligibility in overall communication is an important consideration. Speech intelligibility is based not only on the articulation of speech sounds, but also upon prosodic elements of pitch inflection, stress, timing, rhythm, and rate. Other associated skills and controls that should be weighed, are: breath control, vocal abilities, postural controls, and control of extraneous movements or postures, which may compete or distract in the communication act.

An orofacial myofunctional disorder is any pattern involving oral and/or orofacial

musculature that interferes with normal growth, development or function of structures or calls attention to it (ASHA, 1993). Orofacial myofunctional disorder variables are classified as lingual, labial, dental and skeletal factors, soft tissue differences, oral habits, mouth-breathing, lips-apart rest postures, and speech differences (Kellum, 1994). Speech-language pathologists are required to work on labial-lingual posturing (ASHA, 1989) and they should also be able to collaborate with other professionals in assessment and management of oral myofunctional disorders (ASHA, 1991 b).
Oromyofunctional disorders in adults with dysarthria include involvement of oropharyngeal musculature, leading to speaking, swallowing, and chewing deficits; decrease in oral hygiene leading to dental problems; difficulty in retaining dentures and other appliances; reduced strength and mobility of articulators; xerostomia; increased salivary production; aging of the oral peripheral systems; muscle weaknesses due to cranial nerve damage; incoordinated movements of articulators; increased or decreased muscle tone(Adams, 1997; Cannito & Marquardt, 1997; Duffy, 1995; Rosenbek & La Pointe, 1978; Wertz, 1978; Yorkston, Beukelman, & Bell, 1988).

Individuals with dysarthria following cerebrovascular accidents demonstrate various speech, language, cognition, and orofacial myofunctional deficits. Damage to the right hemisphere of the brain results in a cluster of cognitive-linguistic impairments characterized by attention deficits, neglect, discourse deficits, pragmatic disorders, poor inferencing abilities, and semantic processing deficits (Myers, 1997). Other than cognitive-linguistic impairments, patients do demonstrate varying degrees of speech problems. One of the speech problems is known as upper motor neuron (UMN) dysarthria. It is associated with damage to the upper motor neurons that carry impulses to the cranial and spinal nerves that supply the speech muscles. Unilateral strokes or other unilateral lesions cause noticeable dysfunction of the lower face and imprecise lingual articulation, whereas bilateral cortical lesions cause spastic dysarthria (Duffy, 1995). Unilateral UMN dysarthria often accompanies apraxia or aphasia of speech when the damage occurs in the left hemisphere of the brain. When the right hemisphere is damaged, this dysarthria often co-occurs with cognitive-linguistic impairments.

Unilateral UMN dysarthria is almost exclusively a disorder of articulation (Freed, 2000), characterized by imprecise consonants, slow/imprecise/irregular alternate motion rates, and irregular articulatory breakdowns. Besides errors in the articulatory system, harsh voice quality, slow rate of speech, mild hypernasality, reduced loudness, and erroneous stress patterns are also observed. Specific orofacial myofunctional problems associated with unilateral UMN dysarthria due to unilateral stroke in the right hemisphere include central facial weakness at rest or during volitional movements, tongue weakness, palatal weakness, drooling, swallowing problems, hypernasality, imprecise consonants, slow and impaired diadochokinetic alternating motion rate (Duffy, 1995).

OMT has been reported to be successful in improving various levels of functioning of orofacial muscles. OMT has been effective in improving morphology and functions of the muscles in mouth-breathing patients with no nasal airway obstruction (Schievano, Rontani, & Berzin, 1999). Improvements in breathing, feeding, oral-facial habits, buccal hygiene, corporal posture, orofacial muscle balance, lip strength, lip closure, tongue placement, swallowing pattern, and speech articulation have been evidenced following oromyofunctional therapy (Bacha & Rispoli, 1999; Benkert, 1997; Bigenzahn, Fischman, & Mayrhofer-Krammel, 1992; Hahn & Hahn, 1992; Landis, 1994; Robertson, 2001).

There exists scant research on efficacy of oromyofunctional therapy in the domain of speech intelligibility in adults with UMN dysarthria due to right hemisphere damage. Various patterns of oromyofunctional disorders exist in adults with UMN dysarthria, most of which interfere with speech intelligibility. The purpose of this study is to examine the influence of OMT on speech intelligibility and a speech diadochokinetic task, without direct articulatory drills, using pretherapy-posttherapy comparisons.

METHOD

Participants

Twelve right-hemisphere damaged (RHD) subjects from the local hospital and long-term care homes participated in the study. All RHD individuals had a mean age range of 74.7 years (S.D. = 5.9). They had experienced one single right hemisphere stroke as supported by their medical history and CT scan findings. Cause was ischemic in all cases. They did not have any significant neglect and visuoperceptual limitations as reported by the Neurologist. No apparent cognitive problem was noted while scoring the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975). The average score was 23.6 (S.D. = 1.5). Only RHD participants without aphasia participated in this study. The RHD participants did have a left-sided paresis along with mild to moderate dysarthria of speech as measured by the Frenchay Dysarthria Assessment (Enderby, 1983). All participants passed a pure tone hearing-screening test. All of them had received rehabilitation services (physical and occupational therapies) for a period of at least three months before the time of study. Only six RHD subjects received speech therapy for about six weeks secondary to swallowing and language problems. Out of twelve, four clients spoke English as a second language, as they belonged to Asian countries.

Baseline measures

Orofacial examination (Aronson, 1997) included structural examination of mouth, teeth, tongue, hard palate, and soft palate. Motor Examination included the following: 1. Mouth (rest, smiling, rounding, puffing) 2. Mandible (depression, elevation, strength) 3. Tongue (rest, protrusion, lateral wiggle, strength) 4. Soft palate (at rest, on phonation, gag) Speech examination dealt with phonation of vowel sounds, respiration for speech purposes, resonation, and articulation of single words. The alternating motion rate (AMR) was assessed using real time pitch program of computerized speech lab (CSL 4300 B). In AMR testing, the clients were required to produce stops in succession (e.g. /pa pa pa /; /ta ta ta/; and /ka ka ka/). The clients were asked to repeat the monosyllables and time taken to utter twenty monosyllables were taken into consideration for measurement of AMR. This is the time-by-count measurement of AMR (Fletcher, 1972).

Speech testing

Three types of speech samples were collected from each client. The client read a set of ten sentences and twenty words chosen from the assessment of intelligibility of dysarthric speech (Yorkston & Beukelman, 1984) (See Appendix I & II). To calculate percentage speech intelligibility for single words and sentences, number of intelligible utterances was identified, which was divided by the total number of utterances. Utterances were considered as unintelligible when they were characterized by addition, distortion, substitution, and omission errors. Suprasegmental features (stress, intonation, rate, and rhythm) were not taken into consideration while calculating speech intelligibility. A conversational sample was also included for analysis. A five-point rating scale (Ray, 2002) was used to measure speech intelligibility of conversational samples. A score of 4 indicates 100 % intelligibility (normal); a score of 3 indicates 70-90 % (minimal problems); a score of 2 indicates 50-70 % (mild problems); a score of 1 indicates 30-50 % (moderate to severe problems); and a score of 0 indicates 0-30 % intelligible speech (severe to profound problems).

Two judges who were not familiar with the clients rated all pretherapy as well as posttherapy conversational samples on a five-point intelligibility rating scale. One of the judges transcribed utterances in single word and sentence samples to calculate the percentage speech intelligibility. For reliability purposes, another judge transcribed 50% of the total utterances.

Treatment procedures

While treating dysarthric patients, Dworkin (1991) suggested establishment of adequate orofacial postures, integration of orofacial reflexes, improvement of orofacial muscle strength, and improvement of range, speed, timing, and coordination of orofacial muscle activities. Therapy focused on oral sensory stimulation, and increasing orofacial muscle tone and strength of lips, tongue, jaws, and cheeks (Dworkin, 1991; Freed, 2000; Gangale, 1993) (See Appendix III). Treatment was provided two days in a week for a period of two months. Each session lasted for about forty-five minutes.

The goals were to increase strength, mobility, and control of jaw, tongue, and lips (Duffy, 1995). The entire treatment protocol consisted of six phases: 1. Awareness of muscles of the tongue, cheek, lips, and jaw with the help of illustrations; 2. Exercises for tip of the tongue; 3. Exercises for posterior end of the tongue; 4. Improvement of labial seals; 5. Tongue resting postures. 6. Exercises for the jaw. 7. Exercises for the cheek musculature.

RESULTS AND DISCUSSION

The speech evaluations (see Table 1) performed before and after oromyofunctional therapy were compared and the results showed that the speech intelligibility scores for single words improved significantly, without direct intervention. The t-test was administered, which indicated a significant improvement in speech intelligibility ($p<0.001$). Though qualitative improvements were noted in sentence and conversational speech intelligibility, the results however did not reach the levels of significance. This may be attributed to sentence length and complexity. Clients were not able to self-monitor their speech effectively. For rating speech intelligibility in conversational samples, a five-point rating scale was used (See Table 2). The Wilcoxon signed rank test was administered, which indicated no significant difference in conversational speech intelligibility (z score = 0.44; P= 0.65). This may be due to limited number of treatment sessions provided to all clients. Though the judges were asked to focus on articulation of words rather than prosodic features while rating the conversational sample, their ranking was influenced by rate, stress, and intonation patterns.

Lip and tongue competency improved in 10 out of 12 clients. Clients noticed marked improvement in swallowing functions as a result of OMT. Functional improvements were noticed in compensatory articulatory postures, chewing, bolus manipulation, and posterior swallows. Five out of twelve clients had dental problems that were treated by the dentists. These patients showed maximum gains in speech intelligibility as well as in swallowing functions following the intervention.

A significant correlation was found between AMR and speech intelligibility. Correlation coefficient of AMR with speech intelligibility was 0.82, which clearly indicated that slower AMRs led to reduced speech intelligibility. Ziegler & Wessel (1996) studied sixteen patients with cerebellar atrophy and with Friedrich's ataxia and reported significant correlations of diadochokinetic syllable rate with both perceived severity of dysarthria ($r = 0.83$) and speech intelligibility ($r =0.77$). Ziegler (2002) also found high correlations between

Table 1

Average speech intelligibility scores (%) and AMR (time-by-syllable counts in seconds) before and after treatment

Tasks	Pretherapy score	Posttherapy score
1. Single word intelligibility	70.2	91.8
2. Sentence intelligibility	65.6	73.8
3. AMR	2.13	2.88

Table 2

Comparison of conversational speech intelligibility scores on a five-point rating scale obtained by the clients before and after OMT

Scores	Pretherapy	Posttherapy
0	0	0
1	0	0
2	8	6
3	4	6
4	0	0
Total number of subjects	12	12

diadochokinetic rate and degree of speech impairment. Langmore & Lehman (1994) suggested that severity of dysarthria is largely due to slower movement of the orofacial structures. AMR for twenty repetitions of monosyllables range from 3-4 seconds in normal individuals (Fletcher, 1972). In this study, average AMR during pretherapy assessment was 2.13 seconds for twenty monosyllables and 2.88 seconds during posttherapy assessment. Repetition of /pa/ was the fastest, followed by /ta/ and then /ka/. Though the difference between pretherapy and posttherapy AMR was not significant at 0.05 levels, qualitatively it was found that muscle stretching and strengthening exercises led to an increase in movement of articulators as measured by AMR, which enhanced speech intelligibility. According to Wohlert & Hammen (2000), a gain in lip muscle activity leads to increased speech rate and loudness that in turn enhance speech intelligibility.

Interjudge reliability was assessed by computing Pearson product-moment correlation between pairs of judges' scores. Reliability coefficients for speech intelligibility ratings were 0.94 for pretherapy and 0.90 for posttherapy conversational speech samples. Interjudge reliability was higher for single words and sentences as compared to conversational speech. A qualitative analysis indicated that factors influencing treatment outcomes depended on neurological conditions, age, team approach, personal traits, cognitive/mental status, family support, and use of customized treatment strategies. In this study, two individuals had left side neglect, which further complicated the treatment process. This neglect was present in oral musculature too. Orosensory exercises and self-monitoring helped the client achieve the goals. Clients with good family support were highly motivated and did better with the therapeutic exercises.

CONCLUSIONS AND CLINICAL IMPLICATIONS

OMT treatment paradigms are highly instrumental as special forms of treatment for disorders of articulation. They have been shown to address many of the sensory and motor needs of clients diagnosed with various types of speech disorders. The results in this study suggest that oromyofunctional therapy is effective in improving speech intelligibility in clients with dysarthria.

Speech therapists work with dysarthric clients to develop basic and useful communication skills. The speech-language pathologist's main therapeutic goal is the improvement of speech intelligibility in clients with dysarthria. If abnormalities of posture, tone, and strength are modified (Rosenbek & La Pointe, 1985) and compensatory movements of articulators are facilitated, most speech intelligibility goals are accomplished. Assessment of diadochokinetic rate to measure outcomes of OMT is very important for motor speech disorders, as it is a very sensitive index of motor speech impairments. It also requires maximum performance. Speech-language pathologists (SLP) may be able to stimulate better orofacial myofunctional gains if treatment is accompanied by principles of behavioral modification. SLPs need to be adept in the art of altering behaviors, extending control of stimuli and responses, and establishing maintenance (Hanson, 1988).

LIMITATIONS AND FUTURE RESEARCH

This study targeted only UMN dysarthria. Future studies based on treatment outcomes should be able to focus on other types of dysarthria, for example, hypokinetic dysarthria, ataxic dysarthria, lower motor neuron dysarthria, spastic dysarthria, etc.

In this study only the articulatory system was studied in order to judge speech intelligibility. The respiratory, phonatory, and resonatory systems need to be studied in order to understand the impact of OMT on speech intelligibility. Other aspects of speech related to suprasegmentals (rate, stress, intonation, and rhythm) should be measured in order to understand the varied outcomes of OMT. More follow-up studies are needed to establish the long-term outcomes of OMT. More treatment efficacy research is needed in the area of oromyofunctional disorders to provide clinical information to professionals working with adults having neurological impairments.

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Appendix I

Selected items from single word intelligibility list (Assessment of intelligibility of dysarthric speech, Yorkston & Beukelman, 1984)

1. floor
2. group
3. pretty
4. bread
5. dress
6. glitter
7. creature
8. street
9. strange
10. reserve
11. depress
12. contract
13. globe
14. shark
15. tired
16. cross
17. defend
18. decide
19. stream
20. grape

Appendix II

Selected sentences (Assessment of intelligibility of dysarthric speech, Yorkston & Beukelman, 1984)

1. Negative experiences somehow manage to force their way into our minds.
2. When looking over something, you should give it a good look.
3. He believed it was not the answer to all his questions.
4. Keeping the herds separate required electrical shock, chemicals, and special fences.
5. By the end of the year, the inflation rate had spiraled.
6. Each time you walk along our beach, you discover something new.
7. The nurses and the hospital administration acted admirably during the incident.
8. He rewarded the ape with peanuts and oranges for its work.
9. The patient became nervous while he waited for the doctor's arrival.
10. According to the rules, you shouldn't end a sentence with a preposition.

Appendix III

Sample exercises used during treatment

Jaw muscle strengthening:

- Opening and closing of mouth, emphasizing on increasing the strength of the closure (Freed,2000)
- Biting on a resistance wedge constructed from tongue blades (Dworkin, 1991)
- Closing mouth against pressure on the chin (Freed, 2000)
- Strengthening the back jaw for closure, using a wash cloth between the client's teeth and tugging on the cloth to provide resistance (Gangale, 1993)

Cheek muscle strengthening:

- Blowing exercises using candles
- Sucking exercises using straws
- Whistling to strengthen inner cheek musculature
- Keeping the "t" of chewy tube inside the mouth and pulling the tube outward to improve stretching and strengthening of inner cheeks, resistance for improved lip rounding, and lip seal (Gangale, 1993)

Lip muscle strengthening:

- Use of button and string (Dworkin, 1991)
- Puckering of lips for at least 20 seconds
- Maintaining protrusion of both lips while smiling to strengthen both lips and cheeks
- Rounding the lips while applying pressure on the corners of the mouth laterally
- Smiling with open jaws with both upper and lower teeth clenched, to improve strength of lips and cheeks (Gangale, 1993)
- Holding a teaspoon or tablespoon between the lips for 30-40 seconds as tolerated
- Placing tongue depressor horizontally between the lips to strengthen inner cheeks and lip seal

Tongue muscle strengthening:

- Pressing the tongue against a surface such as the tongue depressor
- Pushing the inner lips out with the tongue while running the tongue around the lips to strengthen base and midsections of tongue
- Applying and sustaining downward pressure on the tip and dorsum of the tongue with a tongue depressor to strengthen the tongue
- Opening the mouth wide and placing the tips of the tongue on the upper lip to improve tongue and jaw strength

Oral sensory stimulation:

- Oral massage using a toothbrush or toothette inside the individual's cheeks to bring awareness to the muscles of mastication (internal and external pterygoid muscles)
- Tongue massage depending on the muscle tone
- Stimulation of lateral hard palate and alveolar ridge to help improve awareness of positioning for various speech sounds
- Lip massage to stimulate flaccid tissue and orbicularis oris muscle
- Raising and lowering the tongue while licking lips smeared with jelly

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