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FUNCTIONAL OUTCOMES OF OROFACIAL MYOFUNCTIONAL THERAPY IN CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

Though some anecdotal evidence supports the efficacy of orofacial myofunctional therapy in cerebral palsy and other disorders, controlled studies are very scant. This study was undertaken to examine the efficacy of orofacial myofunctional therapy in sixteen children diagnosed with spastic cerebral palsy. Following baseline measures, all children participated in a four-month therapy program, consisting of training the tongue, lips, and jaw muscles for adequate posturing and functioning. Post-therapy measures indicated significant improvement in functioning of lips, tongue, and jaw. Speech intelligibility of words also improved significantly as measured by two judges using a five-point rating scale. A significant correlation was found between tongue functioning and improvement in speech intelligibility; however no significant correlation was obtained between functioning of lips/jaw and speech intelligibility. Clinical implications regarding use of orofacial myofunctional therapy with cerebral palsied children are discussed.

Key words: orofacial myofunctional therapy, speech intelligibility, cerebral palsy

INTRODUCTION

Cerebral Palsy is a developmental disability of neurological origin that often results in abnormal motor movements. The major speech problem seen in cerebral palsy is dysarthria. Early definitions (e.g., Travis, 1971) described dysarthria as an “articulatory disorder due to impairment of the part of central nervous system which directly controls the muscles of articulation”. Not only is articulation effected, but other aspects of speech production- respiration, phonation, resonance, and prosody- are also impaired. The preferred treatment includes therapy for 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).

Platt, Andrews, Young, and Quinn (1980) suggested two estimates of speech intelligibility, viz. diadochokinetic syllable rates and percentage consonants correct (pcc). All of their subjects diagnosed with dysarthria due to cerebral palsy were judged to be 50 % intelligible at the time of initial testing. Diadochokinetic rate was 2.9 syllables per second, which is very slow as compared to normal individuals. The average diadochokinetic rate for single syllable repetition for normal children aged 6-13 years is 6.2 syllables per second (Fletcher, 1972). Only 78 % of phonemes were transcribed as correctly articulated. Errors in production included both vowels and consonants. Children with spastic cerebral palsy have stiff and jerky movements because their muscles are too tight. They have a hard time moving from one position to another. More than 50% of cerebral palsied children have this type of problem. Coarticulatory movements are also difficult due to poor oral-motor control (Rosenbek & LaPointe, 1985).

Other reports describing children with cerebral palsy clearly state more place and manner problems with consonants as compared to vowels (Irwin, 1961). Irwin (1963) further noted that fricatives and glides were more difficult as compared to stops. According to Rutherford (1939) and Byrne (1959), sounds that are most frequently misarticulated in spastic and athetoid children are the lingua-alveolar fricatives and the lingua-palatal glides. Errors of substitution, omission, and distortion errors predominately characterized their speech. Phonological processes, for example, gliding, stopping, and final consonant deletion, were quite common.

Among many factors contributing to speech production problems, maladaptive postures and structures adversely affect speech production in children with cerebral palsy. For example, hyperextension of the mandible results in malpositioning of the lips and tongue, making it difficult to produce various speech sounds (Palmer, 1948). Speech rehabilitation with cerebral palsied children usually deals with training lips, cheeks, tongue, palate, and vocal bands (Blumberg, 1955). 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. Speech therapy plans should be broad enough to give attention in an integrated way to clients' physical, psychological, and social factors, which have either direct or indirect importance for speech and language (Egland, 1964).

In this study, all children with cerebral palsy were diagnosed as having orofacial myofunctional disorders characterized by anterior bites, and faulty tongue and lip posturing. 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 itself (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 orofacial myofunctional disorders (ASHA, 1991 b).

Myofunctional therapy has been reported to be successful in improving morphology and function of the muscles in mouth-breathing patients without nasal airway obstruction (Schievano, Rontani, & Berzin, 1999). It has been found to be effective in treating a skeletal class III open bite assisted by chewing activities and tooth-positioner (Kondo & Aoba, 2000). 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 orofacial myofunctional therapy (Bacha & Rispoli, 1999; Bigenzahm, Fischman, & Mayrhofer-Krammel, 1992).

There exists scant research on the value of orofacial myofunctional therapy for developmental dysarthria (Benkert, 1997). Various patterns of orofacial myofunctional disorders (Kellum, 1994) exist in children with cerebral palsy. According to Mysak (1980), goals of articulation therapy are to increase speed, range, and accuracy of tongue, lips, and jaws movements. Therapy deals with an ability to move articulators in isolation from other body parts and make specific and speedy articulatory movements. In this study, specific functional movements of articulators (i.e., tongue, jaw, and lips) were targeted. The purpose of this study was to develop an understanding of the efficacy of orofacial myofunctional therapy in improving the resting posture and functioning of speech articulators (tongue, jaw, and lips)**;** and, also to examine the effect of this therapy in facilitating intelligible utterances in children with cerebral palsy, without direct speech therapy.

METHOD

Participants

Sixteen children in the age range of 7-10 years (mean age 8.6), diagnosed with mild to moderate spasticity, were included in the study. Out of sixteen children, seven were females. All subjects were selected from a school for cerebral palsy in India. All children belonged to middle class families whose parents agreed to bring their children to school and participate in the training process. All children were learning English as a second language, which was introduced at the age of three years. The native languages were Hindi, Punjabi, and other dialects of Hindi spoken in the northern part of India. Parents gave verbal consent to perform informal speech assessments in both languages. They also agreed to do pullout sessions for their children in order to participate in orofacial myofunctional therapy. As per the medical reports obtained from pediatricians, all children showed delayed development of motor milestones, primitive or exaggerated reflexes, abnormal muscle tone, abnormal posture, and abnormal neurological exams. In coordination between respiratory, swallowing, and speech movements was also noted. All subjects had specific swallowing problems at various stages, especially in the oral preparatory and the oral stage, due to abnormal tongue movements. Out of sixteen, twelve subjects demonstrated mild to moderate anterior bites. Subjects had either diplegia or quadriplegia, and only one subject had a hemiplegia. All subjects had a congenital diagnosis of cerebral palsy. Causes were perinatal trauma (e.g., delayed labor, breech delivery, asphyxia, head injury, and spinal infections). All subjects had an average intelligence quotient, as measured by the Raven's Colored Progressive Matrices for Children (Raven, 1947), administered by the psychologist. All passed a pure-tone hearing screening at 25 dBHL bilaterally. All subjects were able to comprehend simple instructions, although expressive language problems varied from mild to a moderate delay, as reported in the records.

BASELINE MEASURES

Orofacial examination

An orofacial examination was performed for all subjects, which included a brief case history, orofacial muscle and airway examination, examination of lips, teeth, tongue, and palatal region (Creaghead, Newman, & Secord, 1989). The tongue appeared to be large in relation to the dental arch in all children and all of them showed abnormal resting position of their tongues. Tongue was carried low, forward, and sometimes between the teeth. Anterior and posterior movements of the tongue were restricted. Overall tongue movements appeared to be sluggish. Diadochokinetic testing was performed and all children showed a moderately slow rate of movement of articulators. Eight out of twelve subjects had dental appliances to correct Class II malocclusions. Fifteen out of sixteen were pseudo-mouth breathers. They breathed through the nose while keeping the lips in an open position. Assessments were also performed for hard palate, soft palate, and velopharyngeal insufficiency. All subjects demonstrated varied amounts of lip incompetence. Lip incompetence is defined as a lips-apart resting posture or the inability to achieve a lips-together resting posture without muscle strain (ASHA, 1993). A four-point rating scale was used to create baseline measures regarding functioning of lips, jaw, and tongue. A score of 3 indicates maximum alteration in functions; 2 indicates moderate alteration; 1 indicates mild alteration; and a score of 0 indicates normal functions. Two speech-language pathologists and one occupational therapist independently scored the data on functioning of tongue, lips, and jaw.

Speech testing

Twenty functional words falling under most common semantic categories were selected for testing the children in English (see Figure I) and their native languages. These words represented all consonants from two languages. A five-point rating scale was used to measure speech intelligibility. 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 transcribed the speech samples based on distortion, omission, and substitution errors. A summary of the articulatory errors, before and after treatment, is in Figure II.

Treatment procedures

Based on the above findings, an orofacial myofunctional treatment program was designed to focus on a lip-closed, tongue-in-palate resting posture, along with facilitation of appropriate muscle movements of jaw, lips, and tongue to facilitate accurate oral postures for articulation of speech sounds. Treatment was provided five days in a week for a period of four months. Treatment was conducted for a duration of twenty-five minutes. Each child was provided individual therapy for fifteen minutes each session, followed by a group treatment session that lasted for ten minutes. Parents were involved in therapy and were provided with home-based exercise programs**.** Parental participation is very important to demonstrate positive outcomes of therapy (Robertson, 2001; Zimmerman, 1988). A physical therapist or an occupational therapist always provided assistance with sitting postures during the entire course of treatment. Since tongue, lips, and jaw maximally contribute to speech intelligibility, specific exercises to strengthen these articulators were selected (Dworkin, 1991) for intervention The entire treatment protocol consisted of six phases: 1. Awareness of muscles of the tongue, lips, and jaw with the help of colored pictures, and explanation of the sequence of treatment along with home-practice guidelines; 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. Exercises for lips, tongue, and jaw are in Figure 3. No traditional articulation treatment was provided to improve speech intelligibility other than routine classroom instructions for carrying out specific academic tasks.

During the first phase of treatment, correct resting postures of tongue and lips were judged and verified by an orthodontist. The child was made aware of various articulators with illustrations, followed by explanations of treatment exercises. All exercises were performed 4-5 times daily. Children were provided positive reinforcement (verbal and tangible) for 10 seconds, 40 seconds, 1 minute, and until 2 minutes for maintaining appropriate lip and tongue postures. Family education was provided with the help of an occupational therapist, who helped with sitting and feeding postures. Home-practice guidelines were provided to the parents for encouraging correct lip and tongue postures. Parents were educated regarding treatment goals and procedures**.** They were instructed to provide positive rewards to their children when they were able to hold their tongues on the alveolar ridge directly behind the two upper central incisors.

Figure 1

Word list

Flower	Chalk
Nose	Kite
Hand	Snake
Cat	King
Drum	Ladder
Pencil	Rock
Book	Tree
Fish	Monkey
Zebra	Duck
Ship	Basket

Figure 2

Average articulatory errors (%) in English and native languages before and after treatment

Phonemic category	Pre Therapy Score	Post Therapy Score
<u>Place of articulation</u>		
Bilabial	60 %	55 %
Labiodental	65 %	60 %
Linguadental	70 %	50 %
Alveolar	80 %	60 %
Palatal	70 %	65 %
Velar	50 %	45 %
Glottal	30 %	30 %
<u>Manner of articulation</u>		
Stop	50 %	40 %
Fricative	70 %	60 %
Affricate	70 %	60 %
Liquid	60 %	55 %
Glide	50 %	45 %
Nasal	60 %	55%

Figure 3

<u>Lip Exercises</u>

1. Active lip stretch: The child is required to stretch upper lip by trying to cover the upper teeth as much as possible.
2. Lip closure: The child is instructed to pull both lips together in order to close the mouth.
3. Lip seal: The child is asked to puff his cheeks and hold the air by keeping his lips closed.
4. Holding button in the mouth with the lips, while the clinician pulls the button with the help of string attached to the same.
5. Lip pucker and smile.
6. To enhance lip sealing, lips are put together with a tongue depressor in between. The child is encouraged to hold the tongue depressor for at least 2-3 minutes.

<u>Jaw exercises</u>

1. Opening and closing of mouth.
2. Rotary movements of the jaw.

<u>Tongue exercises</u>

1. The child is asked to curl the tongue and touch the soft palate.
2. The child is asked to perform rotary movements with his tongue by licking around the lips.
3. The child is instructed to touch the nose with the tongue.
4. The child is asked to maintain a tongue posture by sticking the tongue on the gum ridge.

Apart from the above exercises, passive tongue stretching exercises were performed in which the clinician gently grasps the child's tongue with a gauze pad and carefully pulls it straightforward until resistance is felt. This protruded position is held for 10 seconds. Passive lip stretching exercises were also performed in which the clinician grasps one of the lips gently with a gauze pad and carefully pulls in, out and away from the face, holding the position for about 10 seconds. Passive exercises were used because hypertonicity was noted in all children (Dworkin, 1991).

RESULTS AND DISCUSSION

Fifteen out of sixteen subjects showed functional improvement in lip and tongue postures as seen by two speech therapists, the parents, one occupational therapist, and an orthodontist. Only one subject was resistant to orofacial myofunctional treatment as evaluated by the orthodontist and two speech-language pathologists. The Wilcoxon Signed Rank Test indicated a p value of 0.012 indicating a significant improvement in performance following therapy in functioning of the articulators (tongue, lips, and jaw) (Table 1). Approximately 80 % of subjects were able to improve their tongue resting postures. Lip competency improved in 100 % of the subjects. Parents reported marked improvement in breathing patterns and swallowing functions as a result of this treatment. Children were able to demonstrate substantial amount of nose breathing with their tongues inside their mouth. They were able to show functional improvements in chewing, bolus manipulation, and posterior swallows, as observed by their parents, during assisted feeding.

The speech evaluations performed before and after orofacial myofunctional therapy were compared and the results showed that speech intelligibility scores improved significantly, without direct intervention. The Wilcoxon Signed Rank Test indicated a p value of 0.0023 indicating a significant improvement in speech intelligibility scores in English (Table 2) following therapy, even though speech intelligibility was not targeted directly in therapy. Speech intelligibility in native languages could not be judged due to lack of expertise in the dialects that were spoken by 40 % of the subjects. Lingua-alveolar and lingua-dental sounds were qualitatively judged to be more intelligible as compared to the previous audio-recordings, by two speech-language pathologists.

Spearman's correlation coefficient was used to examine the relationship between speech intelligibility and functional aspects of the speech articulators (tongue, lips, & jaw). Spearman's correlation coefficient of 0.40 ($p < 0.05$) was found between tongue functioning and speech intelligibility scores. A 0.40 was obtained that was found to be significant at 0.05 level. No significant correlations were found between lip/ jaw functioning and speech intelligibility scores. This clearly indicates that the tongue is the most important articulator that contributes maximally to speech intelligibility (Darley, Aronson, & Brown, 1975).

Interjudge reliability of speech intelligibility ratings was found to be 0.96 for pretherapy as well as for posttherapy speech samples. Interjudge reliability was 0.91 for pretherapy as well as for posttherapy measurement of functioning of articulators.

An average diadochokinetic rate of 2.5 syllables per second was observed following treatment, as compared to the previous average rate of 2.12 syllables per second. A 't' test indicated no significant improvement at 0.01 level of significance. The range across subjects was between 2.1 and 3.6. The pretreatment diadochokinetic rate is close to Platt et al. (1980). A study by Hale, Kellum, Richardson, Messer, Gross, and Sisakun (1992) indicated that individuals with orofacial myofunctional disorders related to dentalized rest and swallow postures, exhibited slower oral diadochokinesis.

All twelve out of sixteen children with anterior open bites demonstrated difficulty producing fricative and affricate sounds. Their tongues were moved in an anterior direction during the production of these sounds in order to assist in the necessary refining of the air stream. They also showed habitual low and forward tongue resting posture induced by the open-lip posture that contributed to distortions during speech sound productions (Barret &

Table 1.
Comparison of scores of lips, tongue and jaw functions obtained by number of subjects before and after orofacial myofunctional therapy.

	Lips		Tongue		Jaw	
Score based on a 4-point rating scale						
0	0	2	0	0	0	0
1	7	11	0	4	2	7
2	7	2	8	9	5	6
3	2	1	8	3	9	3
Total number of subjects	16	16	16	16	16	16

Table 2.
Comparison of speech intelligibility scores obtained by number of subjects before and after orofacial myofunctional therapy.

Score based on a 5-point rating scale	Pre therapy	Post therapy
0	3	1
1	10	7
2	3	5
3	0	3
4	0	0
Total number of subjects	16	16

Hanson, 1978). Compensatory articulatory patterns were noted for bilabials in these children.

CONCLUSIONS AND CLINICAL IMPLICATIONS

The results of this study suggest that orofacial myofunctional therapy is effective in treating functional deviations in articulators. Not only does it impact the oral postures and functions in a positive way, it also leads to improved speech intelligibility, despite the absence of formal speech therapy.

Speech therapists work with children with cerebral palsy to develop basic and useful communication skills. Children who have the potential to articulate speech sounds with an optimum voice are encouraged to build on their existing speech skills by training the muscles of speech. This training is generally based on orofacial myofunctional principles.
Exercises for articulators may be used with cerebral palsied children along with traditional articulation treatment in order to derive maximum benefits.

Other than just concentrating on oral motor structure and functions, speech-language pathologists should adequately plan to foster the child's adoption of a comfortable and correct posture <u>prior</u> to traditional speech and language therapy. Abnormal body positions and postures interfere with neuromuscular development and aggravate the child's neuromuscular dysfunction. Hence it is important to get help from a physical therapist or an occupational therapist to control handling and positioning which facilitate development of motor control for feeding, communicating, and classroom activities.

Because of the multifaceted nature of orofacial myofunctional disorders, in addition to a physical therapist or occupational therapist, it is important that speech-language-pathologists work with orthodontists, otorhinolaryngologists, oral surgeons, and psychologists in managing individuals with orofacial myofunctional disorders. In today's multidisciplinary world, therapists, parents, and medical professionals (i.e., pediatrician, orthodontist, neurologist) must work collaboratively in orofacial myofunctional therapy program. Speech rehabilitation is carried out most effectively when it is coordinated with other therapies, based on individualistic patterning of needs.

Speech-language pathologists (SLP may be able to see better orofacial myofunctional gains if this treatment is accompanied by principles of behavioral modification. SLPs need to be adept in the act of altering behaviors, extending control of stimuli and responses, and establishing maintenance (Hanson, 1988). Treating clients who are resistant to traditional speech therapy is a real challenge. They need to continue to refine skills necessary for appropriate prognostication and treatment of orofacial myofunctional disorders.

More inservice training is needed in the area of orofacial myofunctional disorders to provide information to professionals and paraprofessionals working with cerebral palsied children. More conferences need to be scheduled with the family members so that they can observe and participate in orofacial myofunctional therapy to promote greater understanding of the child's problems and effective method of dealing with these problems.

LIMITATIONS AND FUTURE RESEARCH

There can be no overall specific treatment plan for intervention of speech disorders associated with cerebral palsy because of its heterogeneous nature. Duration of intervention and therapeutic activities need to be customized according to the type and severity of cerebral palsy. Since this study contains only a small group of individuals, conclusions from therapy outcomes cannot be generalized to all children with cerebral palsy. Hence a larger cohort is needed. This study only targeted children who have been diagnosed with spasticity. Future studies based on treatment outcomes should be able to focus on other types of cerebral palsy.

In this study only articulation of speech sounds was studied in order to judge speech intelligibility. Other quantitative speech parameters (i.e., vocal fundamental frequency, variations of pitch, mean vocal intensity, variations of vocal intensity, and speech rate) should be studied in order to understand the varied outcomes of orofacial myofunctional therapy on objective measures of speech intelligibility. More longitudinal studies are needed to establish the outcomes of orofacial myofunctional therapy in children with cerebral palsy. It would be a worthwhile effort to study specific gains in structural deformities as result of orofacial myofunctional therapy.

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