Range of Movement and Strength in Oral Motor Therapy: A Retrospective Study

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ABSTRACT: *This article details recent results from a large scale study on oral motor intervention with 223 subjects presenting with developmental delays ranging from mild to severe as a consequence of varying disorder entities. The specific purpose of this study was to determine the effect of range of movement on "strength measures" for lip and cheek variables. Statistical analyses are presented for the data set collected from an early intervention center. The effectiveness of oral motor treatment is elucidated.*

KEYWORDS: *Oral motor, range of movement, strength, lip, cheeks*

Oral motor skills play an important role in child development and are essential in feeding and speech development (Griggs, Jones, & Lee, 1989; Krick & VanDuyn, 1984; Morris, 1989; O'Brien, Repp, Williams, & Christopherson, 1991). Oral motor skills include the functioning of the lips, cheeks, jaw, and tongue. The lips are important in producing speech sounds intelligibly, and along with the cheeks, draw liquid into the oral cavity and retain it in the cavity (Morris, 1989; Morris & Klein, 1987). The tongue is also essential for articulation, and is important for sucking, protrusion, and lateral movements during chewing and eating (Morris, 1989; O'Brien et al., 1991). If the child has feeding difficulties, it can result in malnutrition (Miller, 1976) and can interfere with physical and social development (Ottenbacher, Bundy, & Short, 1983). Feeding problems are common in the pediatric population and occur in developmentally delayed children as well as in normally developing children. It has been reported that problems occur with disabled children in as much as one third of the population (O'Brien et al., 1991).

Oral motor abnormalities can occur with a variety of diagnoses. Kumin (1994) conducted a survey on children with Downs Syndrome, ages birth to four years. It was reported that 26% had tongue thrust, 23% had weak facial muscles, 11% had problems with chewing, and 13% had problems with swallowing. Neurologically disordered children often display common characteristics in oral motor skills, which can include a poor swallowing reflex, inefficient breathing patterns, an inappropriate suck pattern, and hypotonia (Morris, 1989). Children with cerebral palsy have been reported to have poor head control, a detained swallow reflex, a reflexive tongue thrust, are incapable of closing their mouths, and are unable to chew (Growth and nutrition..., 1990). Oral motor control and swallowing difficulties have severe effects on feeding in this population, especially when minimal cognitive awareness is an issue (Helfrich-Miller, Rector, & Straka, 1986). Results from a study by Krick & Van Duyn (1984) suggest a relationship between oral motor impairment and growth retardation in children with cerebral palsy. Also associated with oral motor dysfunction is the placement of long-term tracheostomy tubes. It is reported that these children experience a less mature feeding pattern, swallowing pattern and tongue tip movement (Kamen & Watson, 1991).

Due to this disordered feeding, physicians may suggest tube feeding, which while it may seem beneficial, but may bypass the problem at its source. The amount of sensory input and perception in the oral cavity decreases as soon as tube feedings are initiated (Morris, 1989). Normal infants receive continuous oral stimulation; when feeding is absent, the mouth appears to become hypersensitive. With children who are tube fed, desensitization does not occur, resulting in a hypersensitive gag reflex, which only reinforces the child's discomfort and contributes to the problem (Kamen, 1990; Morris, 1989). The child's mouth becomes unaware of "pleasurable" associations, and anything that approaches the mouth is stressful and hazardous. The frequency of sucking, swallowing, and exploring that the child engages in decreases and therefore takes longer, if ever, to progress from basic to mature patterns. As a result, oral motor skills development are variously precluded (Kamen, 1990; Morris, 1989; Morris & Klein, 1987). To be effective, any program designed to increase oral motor function and prepare the child for transition from tube feeding to oral feeding, should begin while the child is being tube fed (Kamen, 1990; Morris & Klein, 1987; Morris, 1989; Wolf & Glass, 1992). Shapiro (1986) and Archambault (as cited in Gisel, 1991) reported that neural structures of the brain involved with oral motor function appear to be plastic within the first two years of life; however, after two years of age this plasticity disappears. Therefore, when tube feeding is used the first two years of life, the development of appropriate oral motor patterns and coordination during feeding are at risk. The child is also deprived of important sensory, motor, and proprioceptive information (Kamen, 1990).

Oral motor dysfunction has been managed by a variety of techniques in which appliances, surgery, and therapy are included. The effectiveness of oral motor therapy was first researched in the 1970s. However, few studies have been conducted (Ottenbacher et al., 1983). Buehler (1973) developed a corrective feeding program for handicapped children using tactile preparation. Results indicated success; however, it is unclear whether these results were "significant." In 1978, McCracken treated 11 clients, over a two-year span, according to a treatment program she developed. Results demonstrate considerable improvements, but only on three of the clients. A study by Hanrahan (as cited in Ottenbacher, et al., 1983) reported that developmental changes occurred in certain areas of feeding behavior; however, it differed for each of the three subjects. In 1980, Leonard, Trykowski, & Kirkpatrick studied the sucking rate of 5 high-risk neonates and how a quick manual stretch to the masseter and buccinator muscles affected it. Improvement on nutritive sucking from the stretch stimulus was concluded. Ottenbacher, Scroggins, & Wayland (1981) investigated the treatment techniques of Rood and Mueller on 20 severely and profoundly retarded subjects. They did not find statistically significant improvements over a 13-week period. Ray, Bundy, & Nelson (as cited in Ottenbacher et al., 1983) conducted a study on an 11-year old boy with spastic cerebral palsy and mental retardation to prevent drooling and to motivate mouth closure. It was concluded that the "absence or presence of treatment was related to the amount of drooling." In 1986, Helfrich-Miller et al. (as cited in Gisel, 1991) reported that swallowing mechanisms functioned more quickly and were more productive after treatment in six profoundly retarded patients with cerebral palsy.

The majority of oral motor therapy practiced by speech-language pathologists has focused on improving the component of strength. The hypothesis of interest here is that an underlying component to strength is related to range of movement. The contention is that functional strength can be achieved only when there is sufficient range of movement. The purpose of this study is to focus on the effect range of movement has on strength for the lips and cheeks as determined by the measuring instruments described in this study.

METHOD

Subjects

The study sample consisted of 223 persons, ranging in age from birth to 36 months, who received oral-motor treatment at an Easter Seals Early Intervention Center in Orlando, Florida. The children were determined to have oral-motor deficits after receiving an extensive oral motor assessment by a licensed speech-language pathologist (SLP), who recorded baseline measurements using a criterion-based clinical tool, the Beckman Oral Motor Protocol (Beckman, 1986). Assessment was defined as consisting of the evaluation of normal and abnormal patterns of the lips, tongue, jaw, and cheeks for eating, drinking, facial expression, and speech to determine which functional skills a client may require intervention, for which abnormal patterns would need to be inhibited, or for which compensation would be needed (Beckman, 1986).

All subjects had been diagnosed with developmental delay due to a variety of differing disorders. The disorders ranged from mild to severe and included Trisomy 21, Cerebral Palsy, Pierre Robin Sequence, and impairments caused from prematurity, complications at birth, drug exposure, and other mixed etiologies. (See Appendix for a complete listing of disorders).

Sample data for all subjects (n=223; 127 males and 96 females) consisted of a case history, which included feeding histories, diagnoses, and physical examination results. Clinical histories and physical examinations were obtained prior to all oral motor treatment procedures. A speech-language pathologist interviewed parents or primary caregivers. Information from interviews included primary feeding and/or speech concerns, functional skills, and previous diagnoses.

All oral motor initial evaluations were performed by one speech-language pathologist (D.B.). Baseline measures were obtained according to the protocol of Beckman. Children were upright and in sitting positions for all examinations for infants and those requiring posterior head support who were upright and seated on the examiner's lap.

Data collection consisted of baseline measurements from the initial examination, treatment session scores, final accuracy measurements achieved before discharge, gain scores, total number of sessions, and total number of sessions to achieve an accuracy measure of 80% or greater in any area of a total of twelve domains. The domains included range of movement (ROM) measurements of the upper and lower lip bilaterally, and the upper and lower cheek bilaterally; and strength measurements of the upper and lower lip and posterior cheeks bilaterally (see Table 1). All subjects selected for this section of the study (n=216) obtained an initial accuracy level of less than 80% on the Beckman Oral-Motor Evaluation for range of movement and strength for the lips and cheeks. Subjects from the original population (n=223) were eliminated from participation (n=7) if their baseline measurements for lip and cheek ROM or strength were at an 80% accuracy level or higher, and were entered into the data base as "M" (missing). Statistical procedures are described in the Results section.

Materials, Procedures, and Measures

The Beckman Oral-Motor Protocol was used to obtain baseline measurements, daily treatment data, and final discharge measurements. Data were obtained from the initial evaluation (baseline measurements), daily treatments, monthly progress reports, interim summaries (every 6 months), and final discharge summaries. All data were expressed in ratio form, and converted to percentages.

Assessments and Treatments were conducted at the Easter Seals Early Intervention Center. Treatment was conducted by either a certified SLP, an assistant SLP licensed in the state of Florida, or graduate students currently enrolled in the Communicative Disorders program at the University of Central Florida and working as volunteers at Easter Seals. All clinicians were trained and certified based on Beckman's Oral-Motor Seminar.

The Beckman Oral-Motor Protocol was used to measure ROM for the upper and lower lips and cheeks bilaterally, strength of the upper and lower lips, and posterior cheeks bilaterally. The guideline procedures are as follows:

ROM for the Lips

ROM for the lips is determined by:

(1) Protrusion: 1/4" away from gum at midline

(2) Elongation: 1/4" past the end of teeth, if no teeth, past the end of gumline

(3) Note hypermobility – range greater than 1/2"

If ROM is below 1/2", the ROM was defined as inadequate, and was measured as 0%.

ROM for the Cheeks

ROM for the cheeks is determined by:

(1) Supported movement toward midline for the upper (1/4" toward midline at the nasolabial fold) and lower cheeks (1/4" at the corner of the lower lip) on both left and right sides

(2) If present 1/4", ROM is adequate; if not present on first trial, repeat two more times for a score of x/3

Lip Strength

Test for strength:

(1) Stretch response at pink edge of lip at left, right, and center points

(2) Probe 3 points at upper lip and 3 points at lower lip, then repeat

(3) Determine ratio for upper lip (x/6) and lower lip (x/6)

Posterior Cheek Strength

Determine strength:

(1) Pulse out from the lower gum line 3/8", once per second

(2) Feel for muscle response – change in state from flaccid to firm

(3) Provide 5 pulses in 5 seconds

(4) Determine ratio x/5

All of the data were collected and verified under the direct supervision of the first author or an on-site certified SLP. The clinician performing the oral-motor intervention was seated either on a bolster or on the floor facing a mirror. The child was placed on the lap of, or in front of, the clinician also facing the mirror. With the dominant hand, the clinician reached around the child to perform interventions. The inferior hand was placed under the child's chin with the child's head against the clinician's chest for appropriate head support. When possible, an assistant entertained the child and recorded the individual measurements determined by the clinician, expressed in ratio form. When no assistant was available, the clinician recorded the data. Measurements were determined based on the above procedures.

At month's end, all ratios were converted to percentages, means were calculated, and included in a monthly progress report. All goals achieving an 80% accuracy rate or better were considered for termination. Clinicians were instructed to check the accuracy ratings of the last three therapy sessions. If those three sessions averaged 80% or better, the goal was discontinued, and a new goal was determined (as applicable). If the mean was less than 80%, the goal was continued for an additional month to better ensure maintenance.

After six months, an interim summary was calculated. Measurements taken from the monthly progress reports were averaged and compared with baseline measurements to determine the percentage of gain scores, if any. Summaries of monthly and interim performance levels, including all percentages, were written in narrative form and mailed to the client's parents or legal guardians.

Inter-rater Reliability

The consistency in scoring the test protocol, as a function of examiner, was evaluated. Eight samples of oral-motor interventions (ROM stretch for the upper and lower lips, posterior cheek stretch bilaterally, upper and lower lip strength, and posterior cheek strength bilaterally) were used. Under the direct supervision of the first author, two graduate students trained to use the protocol performed the interventions, and scored each subject's performance on the protocol. Eight scores relating to the eight interventions were obtained for each subject. Each of the two graduate students performed the interventions on four different subjects and recorded 8 scores per individual subject (total of 32 scores obtained by two graduate students each rendering a total of 64 scores collected by the graduate student). The first author then performed the same 8 interventions on each client, and expressed the 64 measurements in ratio form. All measurements (n=64) were converted to percentages and compared among the judges.

Percentage agreement, based on item-by-item comparisons between the examiners, was computed using descriptive statistics. An inter-rater reliability rate of 92.1% was established.

RESULTS

Data Analysis

The data consisted of pre- and post- treatment variations for 216 subjects, total number of therapy sessions, pre-test scores derived from baseline measurements, and post-test scores achieved before discharge in the 12 domains previously mentioned (ROM measurements of the upper and lower lip bilaterally, and upper and lower cheek bilaterally; strength measurements of the upper and lower lip, and posterior cheeks bilaterally). Means, standard deviations, and ranges were obtained for 24 variables (representing the dependent pre- and post-variables), as shown in Table 1. A commercial software package (SAS) was used to perform 12 paired t-tests comparing pre-treatment scores with post-treatment scores. The significant alpha level was set at 0.008 (.1/12) for each individual comparison, which sets the overall alpha level at .1 or 10% error. The mean number of sessions held was 53.25 with a standard deviation (SD) of 39.18 ranging from 2 sessions to 185. The subjects' mean age pre-treatment was 19.17 months (SD=10.24) ranging from 1 month to 58 months, and post-treatment age ranged from 8 months to 76 months with a mean of 35.77 (SD=7.94).

A t-test for pre- and post differences (Table 2) was run on selected dependent variables (ROM and Strength measures). T-values ranged from –3.6 to –20.43 with all p-values = 0.0001. One dependent variable, ROM of the lower lip-elongation, had the highest T-value at –3.60 with a p-value of 0.004. All ROM and strength variables were significant at the pre-set alpha level, 0.008. All dependent variables showed a significant difference for pre- to post-measures. With the given p-value, the null hypothesis, that there is no difference between pre- and post treatment measurements, is rejected; thus the alternative hypothesis, that there is a difference between pre- and post- treatment measures, is accepted.

A correlational analysis was run for all ROM and Strength measures (Post). Four dependent ROM variables were found to be significantly correlated to two Strength variables. Results from the correlational analysis revealed that the Beckman intervention for ROM-Elongation for the upper lip was significantly correlated to strength for the upper and lower lips with R=0.23733 (p=0.0005) and R=0.22900 (p=0.0008), respectively. In addition, the dependent variable for ROM-prolongation of the lower lip was significantly correlated to strength for the upper and lower lips with R=0.18126 (p=0.0082) and R=0.18175 (p=0.0080), respectively. None of the ROM baseline findings for the cheeks were correlated to any strength measure.

A multiple regression analysis was run, with the dependent variables created by summing the post scores for each of the four specific areas (i.e., Lip ROM, Cheek ROM, Lip Strength, & Cheek Strength). Independent variables were age, total number of sessions, gender, and a sum pre-score for that area. The regression analysis was run to determine whether 'X' (sum pre-score) can predict 'Y' (sum post-score). Results of the analysis show that the only variables that were significant in predicting post-scores were the pre-score variables for Cheek ROM, Lip ROM, and Cheek Strength. The following variables were shown to be significant for predicting post lip strength at an alpha level of 0.008 or less: cumulative pre-score, age, and total number of sessions.

DISCUSSION

This retrospective study attempts to answer two very important questions: a) Is oral-motor treatment effective? and b) If ROM improved, did strength improve? The first question was answered with a simple t-test for pre- and post-measures. Oral-motor treatment utilizing the Beckman Protocol for Assessment & Intervention (Beckman, 1986) is proven to be efficacious with all dependent variables being significant for differences between pre- and post-measures with all p-values <= 0.0004 for a sample size of 214 subjects.

The second research question proposes that there is an underlying component to ROM, i.e., strength. Although Lip ROM (post) significantly correlated to Lip Strength (post), leading one to hypothesize that ROM is an underlying component to strength, no other correlations between ROM and strength for the remaining dependent variables for the lips and cheeks were found to be significant. Other variables, in addition to ROM, may be responsible for increasing strength measures. Other variables such as diagnosis and skills for other structures may play a part in the results found here.

The multiple regression analysis shows that by obtaining a cumulative sum score (e.g., all four Cheek ROM pre-measurements = 1 pre score), versus separate pre-scores for each ROM measure, one will be able to predict post-score performance using this protocol.

Overall, this study has a definitive answer for the first research question: oral-motor treatment is effective. This study does not clearly answer the second research question: whether ROM is the underlying component to strength. Although the correlational analyses for pre- and post-measures indicate that ROM is a component of Strength for the lips, no other correlations were found indicating the same conclusion for the cheeks. Future studies should analyze the relationship diagnosis and impact of ROM on other skills such as tongue control, in addition to other possible variables.

The current study presented here is strong in the sense that it (1) proves the effectiveness of oral-motor treatment, and (2), is a large scale study that covers a broad range of disorders/diagnoses, thus showing that oral-motor treatment is effective for a multitude of populations. In addition, this is a retrospective study, which decreases the possibility of researchers making a Type I error. Also, all clinicians must hold a certificate for Beckman Oral-Motor Assessment & Intervention. This adds to the reliability of the judges' scoring. Some "pitfalls" to the current research include the fact that this was a clinical trial versus an experimental research study. In addition, the number of sessions per week that each subject received was not consistent (i.e., some clients had only one visit per month, whereas others received eight treatment sessions in a month's time). Overall, this study adds to the current, but small, body of literature on oral-motor treatment effectiveness for children. This study is distinct from those in the past in that the current research is large-scale, and includes a multitude of diagnoses; thus the results of this study may generalize to include other populations not presented here.

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Table 1

Pre- and Post-Domains & Descriptive Statistics

Variable	**Number**	**Mean**	**SD**
LROM El. Upper	216	0.8314815	0.3626808
LROM Pro. Upper	216	0.8437963	0.3462993
LROM El. Lower	216	0.9259259	0.2624997
LROM Pro. Lower	216	0.8903241	0.3048421
CROM Lt. Upper	216	0.6883333	0.4414816
CROM Lt. Lower	215	0.8634419	0.3365247
CROM Rt. Upper	216	0.6749519	0.4456505
CROM Rt. Lower	216	0.8686574	0.324556
L. Strength Upper	216	0.3189120	0.3675940
L. Strength Lower	216	0.2967551	0.3723663
C. Strength Lt.	213	0.2130516	0.3168471
C. Strength Rt.	213	0.1906573	0.3184982
LROM El. Upper	213	0.982770	0.1229677
LROM Pro. Upper	213	0.9879343	0.1025130
LROM El. Lower	214	0.9821963	0.0821046
LROM Pro. Lower	213	0.9869953	0.1069049
CROM Lt. Upper	216	0.9849074	0.1006444
CROM Lt. Lower	216	0.9900463	0.0889499
CROM Rt. Upper	216	0.9825000	0.1110217
CROM Rt. Lower	216	0.9903241	0.0878126
L. Strength Upper	214	0.8618224	0.2420452
L. Strength Lower	214	0.8358178	0.2596086
C. Strength Lt.	213	0.7193897	0.3391625
C. Strength Rt.	213	0.7353991	0.3228053

Note. L= lip; C = cheek; ROM = range of movement; El = elongation; Pro = prolongation; Lt = left; Rt = right.

Table 2

Tests for Pre- to Post-Differences

Variable	T	Prob>T
LROM El. Upper	-5.7726099	0.0001
LROM Pro. Upper	-5.6677562	0.0001
LROM El. Lower	-3.6036880	0.0004
LROM Pro. Lower	-4.54836303	0.0001
CROM Lt. Upper	-10.1568948	0.0001
CROM Lt. Lower	-5.7585140	0.0001
CROM Rt. Upper	-10.4179726	0.0001
CROM Rt. Lower	-5.4524994	0.0001
LSTR Upper	-20.4388432	0.0001
LSTR Lower	-19.9439670	0.0001
CSTR Lt.	-18.3510474	0.0001
CSTR Rt.	-20.1282936	0.0001

Note. L = lip; C = cheek; ROM = range of movement; STR = strength; El = elongation; Pro = prolongation; Lt = left; Rt = right.

Appendix. Diagnoses.

Diagnosis	N	Diagnosis	N
Trisomy 21	57	Global Developmental Delay	2
No Diagnosis	41	Lissencephaly	2
Premature	15	Macrocephaly	2
Microcephaly	8	Near Drowning	2
Drug Exposure	7	Prader-Willi Syndrome	2
Hydrocephalus	4	William's Syndrome	2
Hypotonia	4	Agenosis of Corpus Callosum	1
Seizures	4	Anoxia	1
VSD	3	Apnea	1
Ankyloglossia	2	Apraxia & Dysarthria	1
Cerebral Atrophy	2	Aspiration	1
Cerebral Palsy	2	Autotrophic Recessive Gene	1
Cleft Lip	2	Bleeding of Placenta	1
Cleft Lip & Palate	2	BPD	1
Failure to Thrive	2	Brain Bleed	1
Fragile X	2	Brain Not Fully Developed	1

Diagnosis	N
Breech Baby	1
Bruxism	1
Cardiac Arrest	1
Chromosome 18q	1
Cleft Lip	1
Cleft Tongue	1
CMV	1
Compression Syndrome	1
Craniostenosis	1
Cyanotic @ Birth	1
Drug Exposure	1
Ear Infections	1
Encephalitis	1
Enlarged Ventricles	1
Epilepsy	1
Hearing Loss	1
Heart Problem	1
Intracranial Bleed	1
Intrauterine Growth Retardation	1
Leukomalaysia	1
Malignant Hypotonia	1
Maternal Herpes	1
Meningitis	1
Microphthsnous	1
Noonan's Syndrome	1
Occipital Encephaloale	1
PDD	1
Peter Syndrome	1
Pierre Robin Sequence	1
Sensory Defensiveness	1
Sepsis	1
Shunt at Birth	1
Soto's Syndrome	1
Spina Bifida	1
Spinal Meningitis	1
Stroke	1
TBI	1
TEF	1

Diagnosis	N
Tetrology of Fallot	1
Thalassemia	1
Thinning of the Corpus Callosum	1
Translocation of the 9th & 10th Chromosome	1
Trisomy 6q	
Umbilical Cord around Neck	1