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Clinical outcomes of orofacial myofunctional therapy in children without concurrent orthodontia

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Abstract

Purpose: Orofacial Myofunctional Therapy (OMT) addresses impairments in breathing, swallowing, chewing, and/or speech by eliminating maladaptive oral behaviors (e.g., poor position of the tongue and noxious habits); however, there is little evidence regarding its clinical effectiveness separate from concurrent orthodontia. The present study sought to explore early changes in tongue strength, dentition/palatal shape, and orofacial behaviors following OMT in the absence of orthodontic treatment.

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Clinical Outcomes of Orofacial Myofunctional Therapy in Children without Concurrent Orthodontia

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Purpose: Orofacial Myofunctional Therapy (OMT) addresses impairments in breathing, swallowing, chewing, and/or speech by eliminating maladaptive oral behaviors (e.g., poor position of the tongue and noxious habits); however, there is little evidence regarding its clinical effectiveness separate from concurrent orthodontia. The present study sought to explore early changes in tongue strength, dentition/palatal shape, and orofacial behaviors following OMT in the absence of orthodontic treatment.

Method*:* Two participants (7 y/o male and 8 y/o female) participated in eight-weeks of OMT following a two-week healing period post-frenectomy. Outcome measures of this single case experiment included: anterior and posterior maximum isometric tongue pressure (MIP), orthodontic measures of anterior open bite, and the total Orofacial Myofunctional Evaluation with scores (OMES).

Results*:* Participant 1, but not Participant 2, demonstrated significant post-treatment gains in both anterior and posterior tongue strength ($p \leq .04$), which were also accompanied by lowered palatal height (by 2 mm) at post-treatment. Both participants demonstrated a trend toward improved OMES following eight-weeks of OMT.

Conclusions: This study demonstrates the potential for early gains in both orofacial structure and function secondary to eight-weeks of OMT without concurrent orthodontia; however, gains seem limited by the eight-week interval and related to candidacy and/or adherence to the program. As the OMT program often lasts a year, future research might investigate if orofacial structure and behavior improve to a greater extent as the program progresses or if behavior improvements manifest in structural adaptation in the long-term.

Introduction

Orofacial myofunctional disorders (OMDs) are abnormal patterns of facial and/or mouth movements resulting in maladaptive positioning of the tongue and/or the jaw while at rest, speaking, and/or swallowing (American Speech-Language-Hearing Association [ASHA], 2018). According to the Academy of Orofacial Myofunctional Therapy (AOMT), orofacial myofunctional therapy (OMT) is a rising technique within dental, medical, and speech-language pathology fields to treat OMDs and thus, "to correct breathing, swallowing, and chewing disorders; normalize freeway space; help stabilize the bite; and eliminate noxious oral habits…" (AOMT, 2018). OMT uses behavior modification techniques to retrain the muscles underlying disordered orofacial posturing/structure and aerodigestive behaviors (Moeller, 2012).

Despite growing interest in OMT programs among rehabilitation/habilitation professionals and more recently expanded certification standards in speech-language pathology, which include "structure and function of orofacial myology," there remains a lack of evidence regarding clinical outcomes of OMT (Council for Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language and Hearing Association, 2018 Smithpeter & Covell, 2010). The literature supporting OMT is largely limited to case reports, single case research, and emerging pilot RCTs. This lack of large-scale research is a current barrier to its wide adoption in clinical settings (Smithpeter & Covell, 2010). Furthermore, the majority of the studies have not controlled for concurrent orthodontic treatment (e.g. palatal expansion) or recovery from oral surgery (e.g. frenectomy) (van Dyck et al., 2016; Villa et al., 2017). Thus, it is unknown to what extent OMT may uniquely impact orofacial structure and function including tongue strength and anterior open bite (van Dyck et al., 2016; Villa et al., 2017).

The purpose of this single case experiment was to explore the potential for early clinical gains in tongue pressure generation, anterior open bite, and aerodigestive behaviors using a Orofacial Myofunctional Evaluation tool (OMES) in children with OMDs following a two-week healing period post-frenectomy and without concurrent orthodontic treatment or dental reconstruction. Results may advance our understanding of how quickly and to what extent orofacial muscle re-education may occur during OMT and may independently influence orofacial behaviors and dental/palatal structure.

Method

Institutional Review Board approval for the present study was obtained from the University of Northern Iowa. This single case experimental design (SCED) involves repeated probe measurements as this type of design is: (1) effective for evaluating the success of a treatment program with a small number of participants and (2) especially useful when evaluating the effectiveness of an intervention when employing subjective interpretation of a professional, such as the OME, rather than solely quantitative data (Krasny-Pacini & Evans, 2018; Lee & Cherney, 2018).

Participants

Two participants were recruited from a midwest private practice that were referred for OMT by orthodontists for concerns of tongue thrust and tethered lingual tissue (i.e., ankyloglossia) necessitating frenectomy. Two participants assented and their parent/guardian(s) consented for the study.

Participant 1. A 7-year, 3-month old male presented with ankyloglossia, mouth breathing, open anterior bite and abnormal occlusal relationships, hypertrophy of tonsils, snoring and sleep disorders. Parents reported concerns that included snoring, recurring ear infections, and food aversions. No PE tubes, asthma, or allergies were reported. Tonsils and adenoids were present.

Participant 2. A 8-year, 1-month old female presented with ankyloglossia, reverse articulation of opposing teeth, mouth breathing, dentofacial functional abnormalities, nocturnal enuresis, sleep disorder including bruxism during sleep, seasonal allergic rhinitis, lip tie, and hypertrophy of tonsils. Upon oral motor examination, labial range of motion was found to be within normal limits, but labial strength was impaired. Parents reported difficulty swallowing foods with frequent throat clearing and large bites while eating. Parents also expressed concern regarding snoring and audible breathing during sleep, restless sleeping, sleeping on her side with head hyperextended, drooling, and bruxism.

Initial Evaluation

At the initial evaluation, prior to the frenectomy, a speech-language pathologist (SLP) also certified in OMT collected case history and probe measures were collected at the beginning and end of the session. Participants and guardians were also trained at the initial evaluation on a lingual stretching protocol to be completed for two weeks directly following the frenectomy to promote tissue healing. Following two-weeks of healing post-frenectomy, participants began the OMT program. Probe measures were also obtained at the start of the first OMT session for a total of three time points prior to intervention to establish baseline performance.

Probe Measures

During OMT, probe measures were obtained at two-week intervals: on even weeks for Participant 1 (5 data points) and odd weeks for Participant 2 (4 data points). Probe measures were also obtained following eight weeks of OMT (i.e., at post-treatment testing). Probe measures included: the OME, tongue strength (i.e., maximum isometric tongue pressure), lingual swallowing pressure during saliva swallows, and a calculated percent of maximum tongue pressure (PMTP) used during swallowing.

Orofacial Myofunctional Evaluation with Scores (OMES). The OMES (Appendix A) is a valid and reliable instrument for rating the appearance, posture, and mobility across the lips, tongue, cheeks and jaws, as well as the behaviors of breathing, chewing, and swallowing for children ages 6 to 12 years of age (Felicio & Ferreira, 2008). Maximum total score for OMES was 69.

Tongue strength. Maximum Isometric tongue Pressure (MIP), or tongue strength, was the greatest positive pressure (in kilopascals [kPa]) achieved across three tongue presses as measured by the Iowa Oral Performance Instrument (IOPI) model 2.2. MIP was obtained at both anterior (i.e., MIPA) and posterior (i.e., MIPP) lingual regions. Anterior placement of the tongue bulb was behind the central incisors and posterior placement was in line with the lower first molars (Pitts et al., 2017).

Lingual Swallowing Pressure. Peak lingual swallowing pressure was measured in kPa using the Iowa Oral Performance Instrument (IOPI) model 2.2 and averaged across three saliva swallows at each anterior (i.e., LSPA) and posterior (i.e., LSPP) lingual region (Pitts et al., 2017).

PMTP. Percent of Maximum Tongue Pressure was calculated by dividing LSP by MIP and multiplying by a factor of 100 at both anterior (i.e., PMTPA) and posterior (i.e., PMTPP) lingual regions (Pitts et al., 2018).

Open Anterior Bite (OAB) Measures

Pre- and post-treatment measures of OAB were obtained from orthodonists prior to the start of OMT and after 8 weeks of OMT, respectively.

Oral Myofunctional Therapy (OMT) Program

The OMT program included weekly therapy sessions with an OMT certified SLP with each session lasting approximately one hour in duration. Sessions targeted isometric and isotonic exercises of the tongue and lips with specific strengthening of the tongue conducted progressively along the antero-posterior length of the tongue. OMT also included the retraining of lip and lingual rest position and of swallowing/chewing behaviors. Exercises were introduced systematically and weekly (Table 1) with home exercises assigned weekly. The goal of the program was to reduce both the symptoms and appearance of the myofunctional disorder.

Table 1

Oral Myofunctional Therapy (OMT) Protocol

Week(s)	Treatment Targets
1	Last baseline and explanation of treatment process
1-3	Strengthening of the tongue and lips
4-5	Retraining the swallowing process
6	Strengthening the anterior tongue region
7-8	Strengthening the mid- and posterior tongue regions

Note. Participants completed weekly sessions with an orofacial myofunctional therapy (OMT) certified speech-language pathologist.

Data Analyses

Baseline trend and phase contrasts were conducted with a Tau-*U* calculator (Vannest et al., 2016) across all probe measures and a generalization measure of OAB was descriptively analyzed for change between pre-/post-testing.

Results

Probe Measures

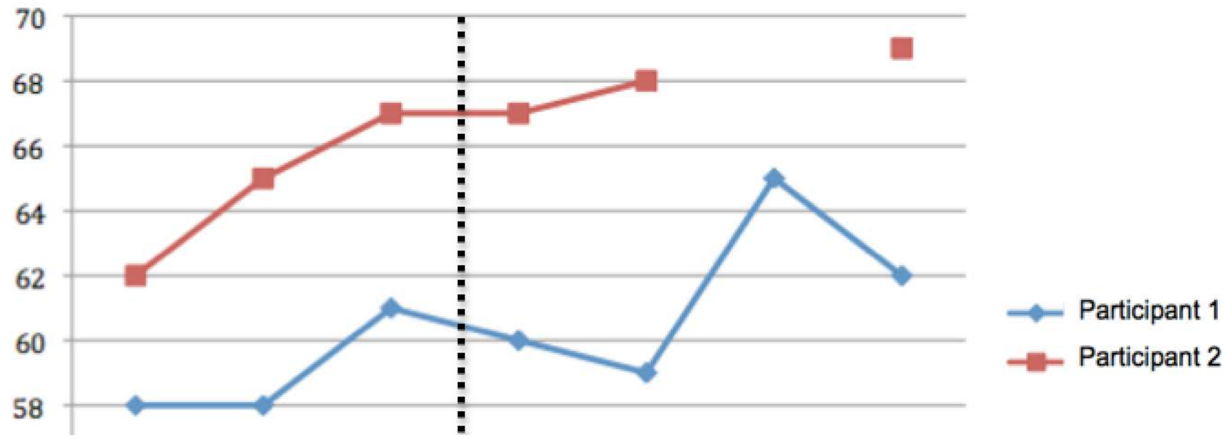
None of the probe measures demonstrated significant baseline trend ($p > 0.05$), thus, indicating stability in baseline performance on all measures prior to OMT participation.

OMES. Figure 1 illustrates the total score of OMES across baseline and treatment probes for both participants. No significant trend in OMES performance was found for Participant 1 across the three baseline probes (both with TAU $U = .667$, $p = .296$ with 90% confidence interval (CI) [-0.05, 1] and a trend toward an increase in performance was noted at post-treatment (TAU $U = .667$, $p = .157$ with 90% confidence interval (CI) [-1.11, .89].

No significant trend in OMES performance was found for Participant 2 across the three baseline probes (both with TAU $U = 1$, $p = .117$ with 90% confidence interval (CI) [-1.38, .62] and a trend toward an increase in performance was noted at post-treatment (TAU $U = .889$, $p = .081$ with 90% confidence interval (CI) [-0.051, 1].

Figure 1

Graph of OMES Total Score and Trend Line Across Baseline and Treatment Probes.



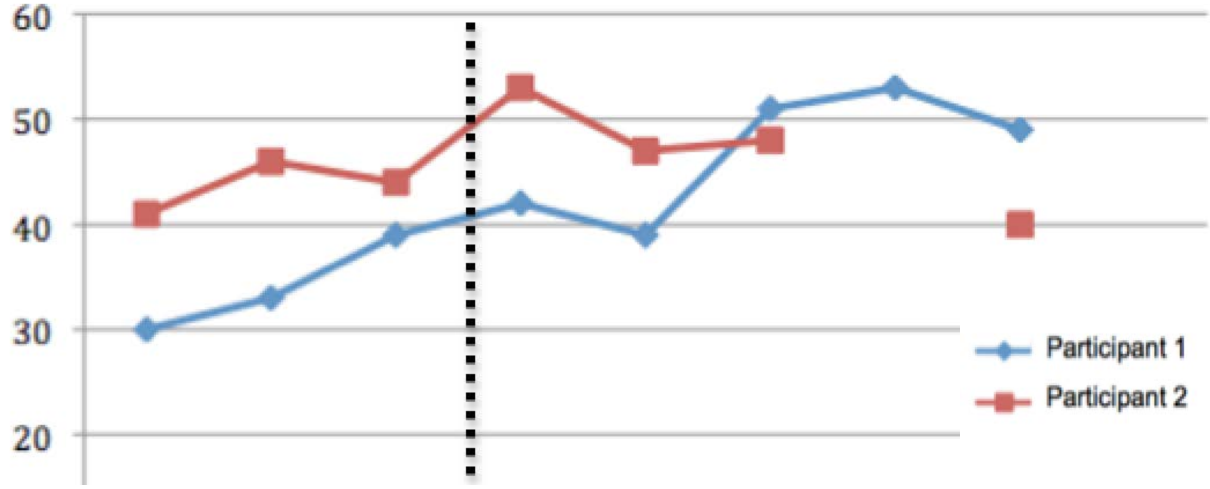
Note. Y-axis reflects total score of Orofacial Myofunctional Evaluation with Scores (OMES). Baseline ends at dashed vertical line.

Tongue Strength. No significant trends in MIPA and MIPP were found for Participant 1 across the three baseline probes (TAU *U* = 1, *p* = .117 with 90% confidence interval (CI) [-1.05, .95]; TAU *U* = -.333, *p* = 0.602 with 90% confidence interval (CI) [-1.72, -0.28], respectively). Significant post-treatment gains occurred for both MIPA (TAU *U* = .933, *p* = 0.037 with a 90% CI [-0.20, 1.20]) and MIPP (TAU *U* = 1.000, *p* = 0.025 with a 90% CI [-0.74, 1.26]).

No significant trends in MIPA and MIPP were found for Participant 2 across the three baseline probes (TAU *U* = .333, *p* = .602 with 90% confidence interval (CI) [-0.717, 1]; TAU *U* = -.333, *p* = 0.602 with 90% confidence interval (CI) [-1.00, .717], respectively). Significant post-treatment gains in tongue strength were not evident for either the anterior or posterior oral tongue (*p* = .288).

Figure 2

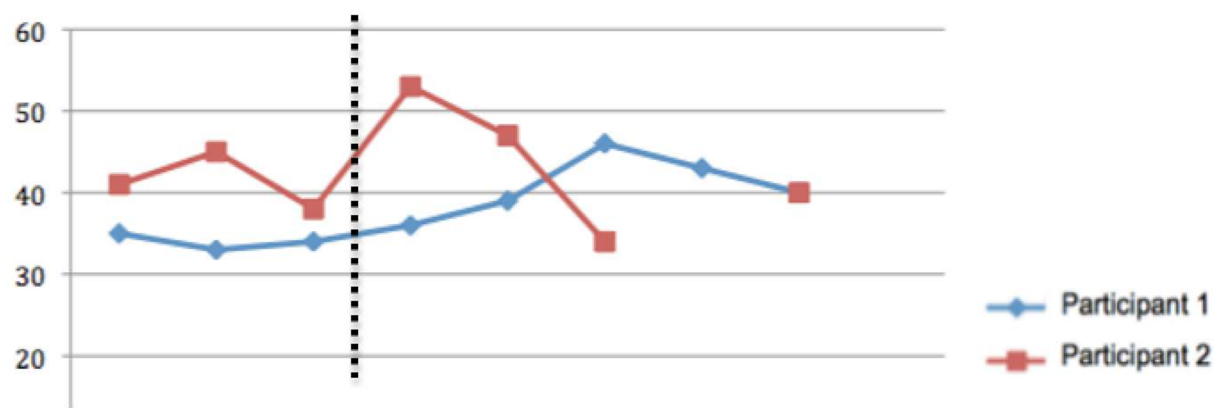
Graph of Anterior Tongue Strength and Trend Line Across Baseline and Treatment Probes.



Note. Y-axis is reported in kilopascals (kPa). Baseline ends at dashed vertical line.

Figure 3

Graph of Posterior Tongue Strength and Trend Line Across Baseline and Treatment Probes.



Note. Y-axis is reported in kilopascals (kPa). Baseline ends at dashed vertical line.

Lingual Swallowing Pressure. No significant trends in LSPA or LSPP were found for Participant 1 across the three baseline probes (both with TAU *U* = .333, *p* = .602 with 90% confidence interval (CI) [-1.72, -0.28] and neither LSPA nor LSPP demonstrated a significant change from baseline (TAU *U* = 0.600, *p* = .180 with 90% confidence interval (CI) [-1.14, .86]; TAU *U* = .733, *p* = 0.101 with 90% confidence interval (CI) [-1.00, 1] respectively.

No significant trends in LSPA and LSPP were found for Participant 2 across the three baseline probes (TAU *U* = .333, *p* = .602 with 90% confidence interval (CI) [-0.717, 1]; TAU *U* = -.333, *p* = 0.602 with 90% confidence interval (CI) [-1.00, .717], respectively), and neither LSPA nor LSPP demonstrated a significant change from baseline (TAU *U* = -0.250, *p* = .596 with 90% confidence interval (CI) [-1.00, .52]; TAU *U* = .667 *p* = 0.157 with 90% confidence interval (CI) [-0.11, 1] respectively.

PMTP. No significant trends in PMTPA or PMTPP were found for Participant 1 across the three baseline probes (both with TAU *U* = .333, *p* = .602 with 90% confidence interval (CI) [-1.72, -0.28] and neither PMTPA or PMTPP demonstrated a significant change from baseline (TAU *U* = 0.333, *p* = .456 with 90% confidence interval (CI) [-1.40, .60]; TAU *U* = .200, *p* = 0.654 with 90% confidence interval (CI) [-1.47, .40] respectively.

No significant trends in PMTPA or PMTPP were found for Participant 2 across the three baseline probes (TAU *U* = .333, *p* = .602 with 90% confidence interval (CI) [-0.717, 1.00]; TAU *U* = 0, *p* = 1 with 90% confidence interval (CI) [-1.00, 1.00], respectively. Neither PMTPA or PMTPP demonstrated a significant change from baseline (TAU *U* = -0.333, *p* = .480 with 90% confidence interval (CI) [-1.00, .44]; TAU *U* = .833, *p* = 0.08 with 90% confidence interval (CI) [.058, 1.00] respectively.

OAB Measures

Pre- and post-treatment OAB measures obtained from the orthodontist are reported in Table 2. Pre- and post-treatment images of the anterior bite and the hard palate are included in Figure 6.

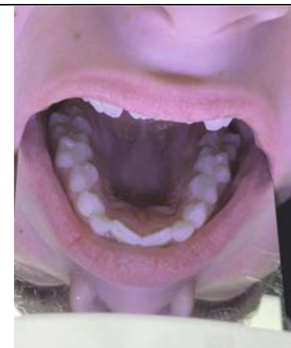
Table 2

Orthodontic Measures of Anterior Open Bite (AOB)

Participant	Pre-Treatment Orthodontic Measures	Post-Treatment Orthodontic Measures
1	Lingual #A-J = 27 mm	Lingual #A-J = 27mm
	Palate lingual margin of #A = 17 mm	Palate lingual margin of #A = 15mm
	#A-J incisal = 2.5 mm	#A-J incisal = 0.5 mm
	Occlusal #B-S = 2 mm	Occlusal #B-S = 1.5 mm
	Incisor to Incisor (Overjet) = 2 mm	Incisor to Incisor (Overjet) = 1.5 mm
2	Gum line from posterior molar to molar = 31 mm	Lingual #A-J = 27mm
		Palate lingual margin of #A = 17 mm
	Inciser to Inciser (Overjet) = 3 mm	

Note. A = upper right second molar.
J = upper left second molar.
B = upper right first molar.
S = lower right first molar.

Figure 6. *Pre- and Post-Treatment Images of Anterior Bite and the Hard Palate.*

Participant 1 Baseline			
Participant 1 Post-Tx			
Participant 2 Baseline			
Participant 2 Post-Tx			

Discussion

This single-case experiment explored short-term changes in oromotor structure/function (i.e., OMES and OAB measures), tongue strength, and lingual swallowing pressure following 8-weeks of OMT in two children with myofunctional disorders post-frenectomy. The study was novel as concurrent orthodontic intervention was excluded and tongue strength was measured at both the anterior and posterior oral tongue regions. Small descriptive gains and trends were noted at post-treatment, particularly for Participant 1, and caution should be exercised to not over-generalize these preliminary results.

Baseline probes demonstrated stability across the three collection time points, which strengthens any attribution of change to OMT participation. A baseline of three measurements was established a-priori by the researchers rather than five time points to: (1) reflect standard of care wait-time intervals between OMT referral and treatment following a frenectomy, (2) allow for appropriate healing post-frenectomy without testing maximal pressure generation of the tongue, and (3) to not delay treatment. The lack of significant trend across the baseline measures of tongue strength also suggests that the healing course after the frenectomy did not influence baseline pressure generation performance.

Overall, OMES total scores of both participants demonstrated a trend of improvement throughout the eight-weeks of OMT. Notably, the ratings of tongue position, noxious habits, visual assessment of dentition (i.e., bite), and palatal width/height were the most changed throughout the course of treatment. These specific items of the OMES do theoretically relate to the weekly therapy targets (i.e., tongue and swallowing training) as well as homework assigned (e.g., reduction of noxious habits) during the first eight-weeks of OMT, which may reflect principles of treatment specificity. However, these improvements were not statistically significant, which may have been due to the short treatment interval (i.e., eight-weeks). Nevertheless, it remains to be determined if these gains may have had clinical significance for the participants, especially long-term.

Orthodontic measures suggest the first participant had a lowered palatal vault at post-treatment as well as reduced open bite and overjet; however, the palatal width remained unchanged. The change in vault without a change in width was not expected, as the lowering of the palate would also likely widen the palate to accommodate the tongue. Perhaps the improved rest position of the tongue was both lower and posterior, thus removing constant pressure from the vault and sides of the upper palate. It would have been interesting to measure the width between the lower molars to see if there was accommodation in the lower oral cavity potentially due to a lower tongue resting position. Orthodontic measures obtained for the second participant were not comparable between the pre- and post-assessments and cannot be interpreted in regard to treatment-related change as a result.

It was not surprising that the first participant also showed significant gains in tongue strength for OMT specifically targets tongue strength in six of the eight weeks of treatment and also includes lingual strengthening as part of a home program. Participant 1 also exhibited improvement in both anterior and posterior tongue strength. The demonstration of gains in posterior tongue strength is a novel finding herein. Our results suggest posterior tongue pressures should be included as outcome metrics in future studies to look at differential changes along the length of the tongue secondary to OMT.

In contrast, the second participant did not show significant changes in either anterior or posterior tongue strength, as tongue strength was maintained between baseline and post-treatment testing. The lack of gain in strength may be attributed in part to a higher tongue strength performance at baseline for both the anterior and posterior tongue, thus, creating a ceiling effect for gains secondary to exercises without resistance load. Perhaps lingual exercises with programmatic increases in resistance may have resulted in further strengthening. Additionally, adherence to the home exercises were not externally monitored beyond parent report and may have mediated gains in tongue strength. It was a positive finding that tongue strength did not decrease at the end of eight-weeks of OMT when following a frenectomy. It would be worrisome to see a reduction in strength, which would raise concern for scarring, reduced range of motion, and/or poor healing following the release of the tethered lingual tissue.

Across the OMT program, no significant changes were evident in either lingual swallowing pressure during saliva swallows (LSPs) or in the percent of tongue strength used during saliva swallows (PMTPs) for either participant. The lack of response of swallowing pressures to OMT may reflect the combined volitional and reflexive control of swallowing patterns. Although the aspects of oral transit may be influenced by cortical control, such as swallowing pressure generation, perhaps these patterns may require more than eight-weeks of intervention to result in consistent behavior modification (Mistry & Hamdy, 2008). In the current OMT program, retraining of swallowing patterns consisted of only one week of direct treatment compared to isometric strengthening which spanned six week. Perhaps more time spent on retraining swallowing patterns within the program would result in modifications of lingual swallowing pressures.

Home exercise programs were provided within the OMT framework to both participants; however, compliance was solely monitored via parental report. Parental report suggested Participant 1 was consistently completing home exercises; Participant 2 was not. The participation in home exercises would change the treatment intensity across the eight-weeks and likely influenced participant outcomes. It is unknown which individual and/or family factors may have played a role in the results of the study.

Limitations and Future Research

Future research may help address some of the limitations found in the present study by more precisely tracking adherence and accuracy of the home exercise program. It would also be interesting to include a larger sample and investigate individual and family characteristics that could mediate gains in the OMT program, as well as help determine optimal candidacy. Longitudinal monitoring would be beneficial, as the OMT program often lasts a year and is employed at a time of significant growth and development, especially for the mouth and dentition. Orofacial structural and behavior modifications may be more evident as the program progresses or the behavior improvements may contribute to the maintenance of structural changes in the long-term. It would be interesting to examine long-term outcomes of patients who complete the OMT program who have not had orthodontic intervention

Conclusions

Preliminary results suggest small, descriptive gains in tongue strength at both anterior and posterior lingual regions and in oromotor structure/function (i.e., slightly lowered palatal vault and improved OMES scores) may occur even within the beginning eight-weeks of OMT with adherence to a home exercise program. Caution should be exercised to not over-generalize these preliminary results for optimal candidates for OMT. The most appropriate developmental period to participate in OMT remains to be established. The unique contribution of OMT to oromotor structure and function in the context of both continual oral development as well as necessary orthodontic treatments has yet to be difficult to establish.

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Appendix A

Appearance and Posture

Lips Posture		**Scores**
Normal lips closure	Normal	(3)
Lips Closure with effort	Activity increased of lips and Mentalis Muscle	(2)
Absence of the lips closure (lips incompetence)	Light dysfunction	(2)
	Severe Dysfunction	(1)
Vertical Mandibular Posture		**Scores**
Normal posture	With freeway space	(3)
Occlusion of the teeth (or)	Without freeway space	(2)
Open mouth	Light dysfunction	(2)
Excessive open mouth	Severe dysfunction	(1)
Cheeks Appearance		**Scores**
Normal		(3)
Increased volume or flaccid/dropping	Light dysfunction	(2)
	Severe dysfunction	(1)
Face Appearance		**Scores**
Symmetry between right and left side	Normal	(3)
Asymmetry	Light Dysfunction	(2)
	Severe Dysfunction	(1)
Tongue Posture		**Scores**
Contained in the oral cavity	Normal	(3)
Between dental arches	Adaptation or dysfunction	(2)
	Excessive protrusion	(1)
Palate Appearance		**Scores**
	Normal	(3)
Decreased width	Light	(2)
	Severe	(1)

Mobility

Performance **Lip Movements**

	Protrusion	Retrusion	Lateral to right	Lateral to left
Precise	(3)	(3)	(3)	(3)
Lack of precision	(3)	(2)	(2)	(2)
Severe inability	(1)	(1)	(1)	(1)

Performance **Tongue Movements**

	Protrusion	Retrusion	Lateral to right	Lateral to left	Elevation	Depression
Precise	(3)	(3)	(3)	(3)	(3)	(3)
Lack of precision	(2)	(2)	(2)	(2)	(2)	(2)

Severe inability	(1)	(1)	(1)	(1)	(1)	(1)

Performance **Jaw Movements**

	Opening	Closing
Precise	(3)	(3)
Lack of precision	(2)	(2)
Severe inability	(1)	(1)

Performance **Cheek Movements**

	Inflate	Suck	Retract	Transfer air from left to right
Precise	(3)	(3)	(3)	(3)
Lack of Precision	(2)	(2)	(2)	(2)
Severe inability	(1)	(1)	(1)	(1)

Functions

Breathing **Scores**

Nasal	Normal	(3)
Oral	Light dysfunction	(2)
	Severe dysfunction	(1)