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Kimberly K. Benkert

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The Effectiveness of Orofacial Myofunctional Therapy in Improving Dental Occlusion

Kimberly K. Benkert, R.D.H., M.P.H., C.O.M.

Collaboration and integration are terms widely used today to represent the coming together of various professionals with similar goals to affect, enhance, facilitate, or maximize desirable outcomes. Health care professionals within the specialty area of orofacial myology have collaboratively provided orofacial myofunctional therapy services in this manner for many years. Orofacial myologists traditionally have come from the regulated professions of dental hygiene, dentistry, speech pathology, and other allied health professions. This integration of primary health care service providers stimulates the exchange of interdisciplinary theory and clinical technique through professional diversity.

Through the decades, the underlying basic philosophy of orofacial myofunctional therapy (OMT) has remained consistent (Barrett and Hanson, 1978; Hanson and Barrett, 1988); however, the focus and perspective have undergone significant expansion (Annunciato, 1995; Barnes, 1990; Benkert, 1995; Kellum and Grant, 1997; Leao and Sheiham, 1995; Riski, 1983; Riski, 1988; Light, 1995; Takada, Yashiro, Sorihashi, Morimoto, and Sakuda, 1996; and Yamaguchi and Sebata, 1995).

Orofacial myofunctional therapeutic goals are directed toward the establishment of optimal functional relationships between the orofacial muscle complex, temporomandibular joint (TMJ), myofascial connective tissues, and associated neurological systems. The end result is a balanced, stable, habituated, and pain-free homeostatic environment.

Individualized patient care is based on outcome-related goals formulated through assessment, evaluation, diagnosis, treatment planning, and therapeutic implementation. In the early days, patients were taught a few swallowing exercises and sent on their way, hoping they would habituate the new patterns without follow-up or re-evaluation. Clinicians were not well trained and did not provide comprehensive treatment services. Today, trained orofacial myologists recognize the importance of functional resting postures of the tongue, lips, and mandible and address the overall problems resulting from orofacial myofunctional disorders (OMDs).

Orofacial myofunctional therapy techniques are applicable to many disorders due to its interdisciplinary nature. OMT techniques and principles can be used independently or cooperatively to treat disorders involving mouth breathing and rest postures of the tongue, lips and mandible; lip incompetence; temporomandibular joint (TMJ) and temporomandibular muscle dysfunction (TMD); tongue thrust swallowing; head, neck and mandibular postural deviations; chewing/swallowing/feeding disorders; stretching of tight lingual or labial frenums; digit sucking habits; incorrect articulation speech patterns; oral dyspraxia; and parafunctional habits including bruxing and clenching.

Coordination with other health professionals regarding the timing of OMT and other treatment modalities should be based on an individualized needs assessment and diagnostic examination. The timing of the various treatments may impact the duration of the therapeutic program, its difficulty level, and its success. Factors which must be evaluated in determining timing of therapy include age and maturity level, growth and development, dentofacial form and stability, motivation and peer pressure, and coordination of additional treatment modalities with dental, medical, or speech professionals.

Many OMDs may influence or create dental malocclusions. Open bites and overjets are most often cited in the literature, but OMDs can result in dental arch discrepancies, uneven wear of tooth surfaces, chewing difficulties and disruption to the integrity and functioning of the TMJ (Benkert, 1995; Enlow, 1982; Hanson and Barrett, 1988; and Woodall, 1993). A positive influence on the occlusion occurs as a direct result of successful OMT services and habituation of new resting posture and swallowing patterns (Barnes, 1990; Curl, 1993; Daglio, Schwitzer, and Wuthrich, 1993; Gisel, Applegate-Ferrante, Benson, and Bosma, 1996; Light, 1995; Padovan, 1995; and Sasaki and Shibasaki, 1994).

Investigative Purpose

The early attempts to link "tongue thrust" swallow patterns with dental malocclusions originated with Walter Straub (1962) who was seeking a solution to "orthodontic relapse". Many studies (Rogers, 1961; Werlich, 1962; Peat, 1968; Hanson and Andrianopoulos, 1987) have established a relationship between orofacial myofunctional disorders and malocclusion; although in most cases, they have stopped short of declaring a cause-effect relationship.

Most orofacial myologists would agree that the primary purpose of their therapy is to establish a stable oral environment which is conducive to normal, optimal growth and development - ***not to move teeth***. However, many years of clinical experience indicate that teeth ***do*** move as a result of OMT (Pierce, 1978 and Snow, 1993).

The purpose of this study is to present data and appropriate statistical analysis to confirm or deny the effectiveness of orofacial myofunctional therapy in improving dental occlusion. The study is designed to answer the following questions:

1. Does dental occlusion improve as a result of OMT?
2. Does OMT improve dental open bites?
3. Does OMT improve dental overjets?

Philosophical Basis

Following ASHA's negative Position Statement in 1975, scientific research and publication began to replace anecdotal reports of success and failure of "tongue thrust therapy". Professionals and their respective associations now have policies and position statements in support of orofacial myofunctional therapeutic concepts, research and practice (ASHA, 1991; ADHA, 1992; AAO, 1993; IAOM, 1993 and 1997). An aggregate of quantitative and qualitative research continues to build and reinforce the scientific body of knowledge based on collaboration and integration of interdisciplinary knowledge and skills.

Enlow (1982) describes the necessity of achieving a state of functional equilibrium to unite form and function harmoniously. Balance is achieved through counterpart principles of craniofacial growth and functional development (Owen, 1983). In a series of four articles, Moss (1997a,b,c,d) revisited the functional matrix hypothesis (FMH) which he developed as an advancement to the functional equilibrium conceptual framework (Moss and Salentijin, 1969a,b). As a means of introduction, Enlow writes, "***This*** (theory) is the one that will be referred to for decades to come, and ***the*** one graduate students now will discuss in their seminars."

The functional matrix concept explains the genomic (intrinsic) and epigenetic (extrinsic, also called environmental) influence on growth and development. The various matrices reviewed and described originally supported the genomic theory of genetic regulation and predetermination as the causative or control factor in morphogenesis. The four Moss 1997 articles evaluate the FMH from a more anatomic base. The mechanisms of cellular mechanotransduction and biologic network theory were introduced as additional extrinsic (external or environmental) matrices. A dialectical analysis addressed the need to reevaluate the FMH and place a greater emphasis on the epigenetic (external) matrices. This significant shift places more emphasis on the functional and environmental aspects than prior theoretical constructs. Moss (1997b,c) also refers to the differentiation of cells in craniofacial development being under epigenetic (functional) influence. When the functional matrix translates information from the periosteal stimulus change may be imposed at the structural level via signals to the skeletal unit (bone) cells. The extrinsic musculoskeletal loadings may create rapid change and be noted clinically. The addition of an extracellular matrix deformation theory also states the dynamic process of deformation potential in the formative and developmental processes. Epigenetic mechanisms are attributed with acting as levers that create a chain reaction of information that translates back to the cellular level and imposes the change (Moss, 1997b,c).

A review of the periosteal functional matrix process explains what happens from the mechanical load on bone deposition (+) and resorption (-). Osteoblast (+) and osteoclast (-) selective changes account for resorption accompanying the deposition process. Predictable directional growth and development occur when theory dynamics transpire into a harmonious, balanced environment. Dysfunction mitigates balance and homeostasis, thereby creating and encouraging incongruent, unpredictable change. Moss (1997d) states, "It remains only to note the truism that, for muscle as for bone, mechanical epigenetic factors, broadly termed function (or exercise), significantly control musculoskeletal growth, development, and maintenance of structural and physiological attributes." As an end assessment to the FMH thesis and antithesis, Moss (1997d) offers a solution statement similar to those who support the basic philosophies of orofacial myofunctional therapy. He concludes, "Together they (genomic and epigenetic) provide the necessary and sufficient causes for the control (regulation) of morphogenesis. Nevertheless, epigenetic processes and events are the immediately proximate causes of development, and as such they are the primary agencies".

Enlow (1982), Graber and Swain (1985), Wilkins (1994) and Woodall (1993) describe craniofacial development and changes in the dentition as being governed by the overriding factors of pressure and tension exerted on the facial bones and periodontium. Anatomic, physiologic, neurotrophic, environmental, and functional influences govern the bony remodeling process. These effects place pressure and tension on the periosteum sending neurogenic signals through the periodontal membrane. The prevailing adaptive capacity of the periodontal membrane assists in maintaining the occlusal homeostatic environment to prevent extrinsic pressure and tension overload on the periodontium. The "sling" effect of the periodontal membrane acts as the "safety net" to absorb pressure and tension.

The forces of incorrect functional behavior or maladaptive muscle activity on the craniofacial structures of the facial bones, periodontium of the maxilla and/or mandible, periodontal membrane, or temporomandibular joint and surrounding capsule create change through selective expression or inducement. The change and vulnerability in the environment affect the overall stability of the orofacial complex to remain resistive to negative loading change. The frequency, intensity, and duration of functional/parafunctional behaviors and habits are significant in causing maladaptive change (Annunciato, 1995; Benkert, 1995; Enlow, 1982; Gelb, 1977; Hanson and Barrett, 1988; Moss, 1997a,b,c,d; Wilkins, 1994; and Woodall, 1993). Excessive forces on the periodontal membrane and soft tissue matrix affect a remodeling of the facial structures and negatively alter the growth and development process. This explains the adverse effect of

OMDs on children and adolescents. In adults, the inability to resist the overriding influences of muscle forces or functional behaviors on already fully developed processes also generates change. Conversely, removal of the negative forces by muscle retraining has the potential to partially or completely reverse the defective process.

Skepticism and debate continue, however, regarding the role of orofacial myology as a primary or collaborative intervention modality for orofacial myofunctional disorders. The "form versus function" controversy continues to cloud the issue of OMT as a preventive, early interceptive, or corrective form of treatment, especially in the developing and mixed dentition stages. Many dentists, orthodontists, and other health care professionals still use age or other self-inferred guidelines as a basis to refer or not refer patients. Unfortunately, an article still being widely quoted by dental professionals, (Proffit and Mason, 1975) stated that "even in the presence of malocclusion, therapeutic intervention for swallowing variations is not indicated before puberty. (Maturational age is more important than chronological age)."

Pierce (1988), on the other hand, substantiates the value of early intervention, along with other authors (Benkert, 1995; Edger, 1985; Hanson and Barrett, 1988; Ingervall and Eliasson, 1984). Referral, evaluation, and treatment are effective in arresting abnormal influences and allowing the growth and developmental processes to continue on a more normal track (Daglio, Schwitzer, and Wuthrich, 1993; Magnusson, 1989; Parker, 1989; Prosterman, Fisher, and Gornitsky, 1995; Varrela and Alanen, 1995).

As stated previously in the reference to Straub's pioneering efforts, too often a state of instability or relapse following orthodontic treatment triggers a referral to the orofacial myologist. Articles such as Denison (1989) ignore the potential negative effects of orofacial muscle dysfunction until relapse occurs. It is at that point when muscle function becomes a consideration and options for correction are considered. Even then, unfortunately, no mention is made of OMT or other therapeutic measures which could facilitate a stable oral environment. Huang, Justus, Kennedy, and Kokich (1990) address the deleterious forces leading to relapse; however, they make no mention of therapeutic intervention methods for correcting tongue posture or position. Their article evaluates the use of crib appliances and reinforces that correction of open bites by this mechanical means is generally not successful when tongue, lip, and mandibular rest posture or orofacial muscular imbalance is left untreated.

Textbooks reviewed stress the necessity of evaluating oral muscle function/dysfunction in treatment planning and implementation to insure harmony and long term stability of the dentition (Enlow, 1982; Graber and Swain, 1985; Hanson and Barrett, 1988; Morgan, House, Hall and Vamvas, 1982; Wilkins, 1994; and Woodall, 1993).

Enlow (1982) states "… the conformation of the bone and the craniofacial relationships are determined by such factors as mouth breathing, excessive masticatory function, and so forth". He further states, "Although the evidence is still not complete, most workers now feel that function plays a more dominant role in the determination of mandibular size and conformation than was previously thought".

Varrela and Alanen (1995) state "Malocclusions seem to be related to various disturbances in the functional balance of the oral and facial musculature. From the clinical point of view, the most important element of the new perspective is that most of the malocclusions orthodontists are treating today are environmentally induced, and, at least in theory, preventable. Prevention can, therefore, be considered as a potential alternative for active treatment."

Several investigations reported in the literature have used longitudinal data to measure changes in dental occlusion in relatively small groups of patients who received OMT. Hanson and Hanson (1975), Hanson and Andrianopoulos (1981), Hanson and Andrianopoulos (1987), and Kellum, Hale, Sisakun, Messer, Benson, Gross, and Bishop (1989) all documented positive outcome correlations of occlusal change resulting from OMT.

Hypothesis, Sampling Methods and Measurements

Purpose: The purpose of this retrospective study is to determine if dental occlusion improves when patients receive orofacial myofunctional therapy. Descriptive and inferential statistics are used for data analysis and discussion.

Null Hypothesis Statement: Orofacial myofunctional therapy has no effect on dental malocclusion, tooth movement of open bite, and/or tooth movement of overjet.

Sampling Methods and Measurements: A study sample of 100 records was selected randomly through a convenience sampling process from more than 3,500 records of patients seen in private practice for orofacial myofunctional therapy between the years of 1985 and 1997. All subjects or legal guardians signed an informed consent form or were informed at the initial examination that patient record information might be used for educational and research purposes with anonymity preserved. No compensation was provided to patients selected for inclusion.

Inclusion criteria: To be included in the study, patient records had to have the following components:

- Dental malocclusion in either the posterior and/or anterior regions
- Tooth-by-tooth measurements taken at the time of the initial examination, utilizing the definitions and techniques described in this study
- An open bite on three or more teeth, greater than 1 mm (one millimeter) at time of initial examination and

beginning of therapy

- An overjet on three or more teeth, greater than 1 mm at time of initial examination and beginning of therapy
- Time frame between the initial examination and beginning of treatment date did not exceed two months
- Therapy began and was completed as prescribed at the initial examination
- A minimum of one recall/recheck appointment occurring one year or more after completion of therapy
- Record indicated if orthodontics occurred before, during, or after OMT was completed
- Record indicated if patient referral was due to orthodontic relapse
- Record indicated if no other interventions were required after completion of OMT due to achieving a normal occlusion and functionally balanced orofacial musculature
- Final measurements of open bite and overjet were taken prior to dismissal of the patient from the therapy recall/recheck phase

Random selection continued until 100 patient records were drawn which met the inclusion criteria. A total of 158 records were reviewed to yield the desired 100 records for the study.

Exclusion criteria: Patient records were excluded due to the following:

- Records missing any of the inclusion criteria information
- Open bite and/or overjet measurements were not taken on a tooth-by-tooth basis at the beginning and near the end of treatment
- An untreated airway interference remained at completion of therapy
- An untreated ankylosed lingual frenum remained at completion of therapy
- Patients were seen solely for a digit sucking habit
- Patients were seen solely for temporomandibular muscle dysfunction
- Permanent tooth measurements were excluded if less than half erupted at time of examination (based on eruption tables)
- Records prior to 1985 excluded due to changes in data recording methods

Description of Therapeutic Intervention

The individuals in the study had completed an orofacial myofunctional therapy program in the office of the author/investigator. Therapy was individualized according to patient needs and included exercises designed to strengthen or tone the muscles of the tongue, lips, and face; to eliminate any associated oral habits; to correct the resting posture of the tongue, lips, and mandible; and to teach and habituate correct chewing and swallowing patterns. If indicated, additional exercises were provided to improve range of motion of the TMJ and capsular area and to reduce pain and tenderness associated with TMD.

The therapy program consisted of the following:

- An intensive phase (12 - 28 weekly visits, based upon need)
- A habituation phase (2 - 6 monthly and/or quarterly visits)
- Recall/recheck phase (1 - 4 biannual and/or annual visits)

Specific treatment techniques are described in detail in various textbooks and therapy manuals (Benkert, 1995; Barrett and Hanson, 1978; Hanson and Barrett, 1988; Garliner, 1976; Pierce, 1993; and Zickefoose, 1989).

Measurement Definitions and Techniques

At the time of the initial examination, occlusion was classified using both molar and canine relationships and recorded according to Angle's classification of occlusion. Open bite and overjet measurements were taken with a Williams periodontal probe on a tooth-by-tooth basis. The measurements for open bite and overjet were taken while occluded to create a consistent centric baseline.

The traditional method of describing open bite and overjet is based only on measurements of the anterior six teeth (canine-to-canine). The following definitions of open bite and overjet provide a method to measure the relative change and overall affect on the entire arch based on a tooth-by-tooth analysis.

Open bite, as defined for this study, is a failure of any tooth in the anterior and/or posterior to meet its antagonist in the opposite arch. Open bite measurements were taken for any erupted tooth, in the entire arch, where the occlusal or incisal contact was lacking and an opening existed between maxillary and mandibular teeth greater than 1/8 mm. The periodontal probe was placed parallel to the buccal/facial surface of the tooth and maintained perpendicular to the incisal or occlusal surface. A vertical measurement was taken, from the incisal edge-to-incisal edge and/or occlusal cusp tip-to-occlusal cusp tip, at the largest point of opening on a tooth-by-tooth basis in any area where an opening was present.

Overjet, as defined for this study, is the horizontal change in a buccal or a lingual direction of the incisal or occlusal table creating a horizontal difference between the inner and/or outer articulation point between the maxillary and mandibular teeth. Measurements were taken for any erupted tooth where the horizontal distance between the (inner) buccal/labial surface of the maxillary teeth and the (outer) buccal/labial surface of the mandibular antagonist had a distance greater than 1 mm. In the posterior, measurements of a distance greater than 1 mm were taken from the buccal-occlusal surface of the mandibular teeth to the juncture of contact with the maxillary antagonist. The horizontal distance recorded was for the (buccal/lingual) overjets and/or (anterior/posterior) cross-bites. Cross-bites were recorded as a negative number. An edge-to-edge occlusion in the anterior and/or posterior was recorded as zero overjet and zero open bite. In areas where a tooth was in an open bite and overjet position, the open bite was measured as previously stated. The overjet measurement was taken as stated above with a tongue depressor held parallel to the facial or buccal tooth surface to create a vertical stabilizer and point of reference (the measurement instrument and the tongue depressor created a 90 degree angle).

Patient records were categorized into five groups:

- B: Patients who received orthodontics **before** beginning OMT
- B.R: Patients who received orthodontics **before** OMT and were referred for therapy due to orthodontic **relapse**
- D: Patients who received orthodontic treatment **during** OMT (this included those who began prior to, but continued with treatment through the intensive and habituation phase of OMT)
- A: Patients who began orthodontic intervention **after** the conclusion of the intensive and habituation portion of the OMT program or prior to the last recall/recheck appointment
- N: Patients who received **no** orthodontic intervention prior to, during, or after OMT (patients were diagnosed by dental sources following OMT and confirmed that orthodontic treatment was no longer necessary due to correction of the dentition)

Results

The gender distribution of the sample was 60 females and 40 males. The mean age was 14.19 years for the overall sample with a standard deviation of 7.87. For presentation purposes, the 100 study subjects were grouped into age-ranges that were multiples of five years (e.g., 5, 10, 15, ..., 40) with each age-range being Ò 2.5 years on each side of the "base" age (Figure 1).

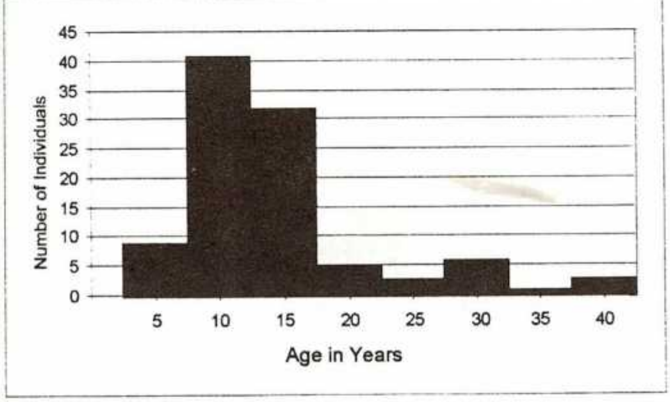

Figure 1 - Age Distribution of 100 Subjects.

The age-ranges having the largest numbers in the sample were the 10. Ò 2.5 (7.5 - 12.5) year olds and the 15. Ò 2.5 (12.5 - 17.5) year olds. Age distribution was fairly consistent between females and males (Figures 2 and 3).

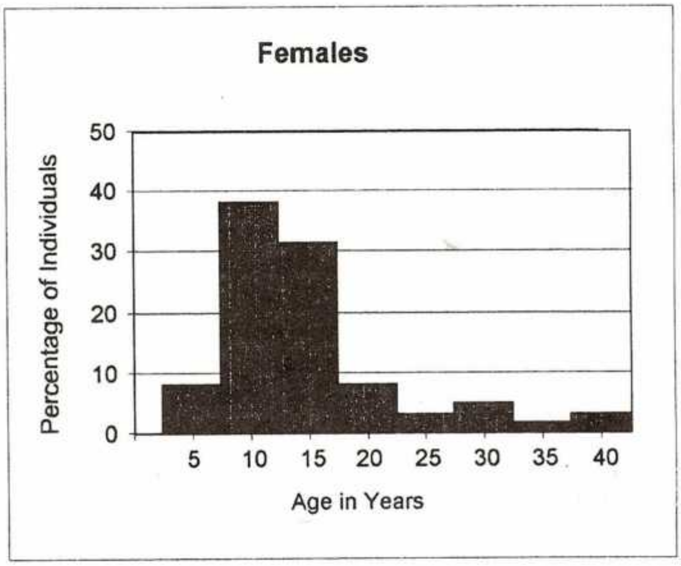

Figure 2 - Age Distribution of 60 Female Subjects.

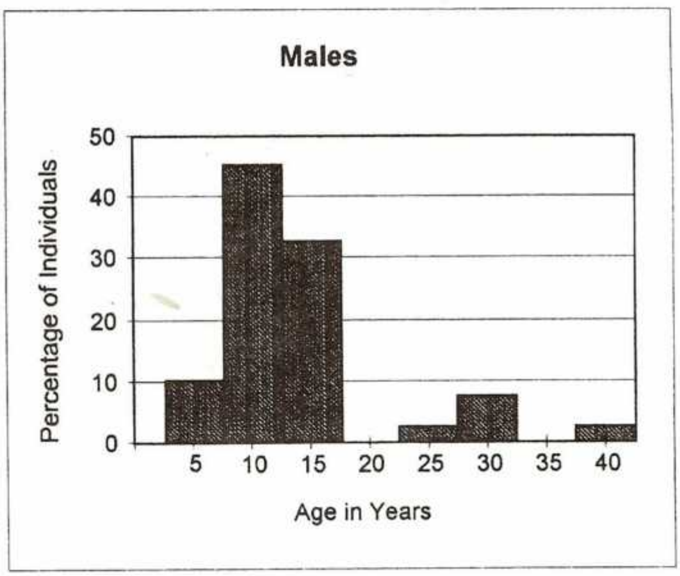

Figure 3 - Age Distribution of 40 Male Subjects.

The mean age of females was 14.6 years with a standard deviation of 7.98, and for males was 13.5 years with a standard deviation of 7.76. The 100 patient sample did not include any males in the 20. Ò 2.5 (17.5 - 22.5) and the 35. Ò 2.5 (32.5 - 37.5) age-ranges.

The subjects served as their own controls. A comparison was made of the open bite and overjet measurements before and after OMT treatment. The open bite and overjet were compared independently since not all subjects in the study had both measures. A t-test statistic of a paired two-test sample was used to evaluate the open bite and overjet respectively.

The open bite, n = 90, had a mean measurement of 1.82 mm before treatment and a mean of 0.31 mm after treatment. The standard deviation for the open bite measure was 1.27 before and 0.51after treatment. The calculated value of the paired, two sample t-statistic was 11.67 with a resulting p-value substantially less than 0.0001 (Table 1).

t-Test: Paired Two Sample for Means

	Open Bite Before	*Open Bite After*
Mean	1.82289	0.31422
Variance	1.62087	0.25922
Observations	90	90
Pearson Correlation	0.29069	
Hypothesized Mean Difference	0	
df	89	
t Stat	11.67348	
P(T<=t) one-tail	6.0762E-20	
t Critical one-tail	1.66216	
P(T<=t) two-tail	1.2152E-19	
t Critical two-tail	1.98698	

Table 1 - Analysis of Measurements Before/After Treatment: Open Bite.

The overjet, n = 91, had a mean measurement of 3.07 mm before treatment and 1.61mm after treatment. The standard deviation for the overjet measure was 1.35 before treatment and 1.21 after treatment. The calculated value of the paired, two sample t-statistic was 11.06 with a resulting p-value substantially less than 0.0001 (Table 2).

t-Test: Paired Two Sample for Means

	Overjet Before	*Overjet After*
Mean	3.07099	1.60835
Variance	1.81692	1.46724
Observations	91	91
Pearson Correlation	0.51826	
Hypothesized Mean Difference	0	
df	90	
t Stat	11.05892	
P(T<=t) one-tail	9.2711E-19	
t Critical one-tail	1.66196	
P(T<=t) two-tail	1.8542E-18	
t Critical two-tail	1.98667	

Table 2 - Analysis of Measurements Before/After Treatment: Overjet.

A t-test was used to determine if a significant difference existed between females and males of "before and after" open bite and/or overjet measurements. No significant differences were determined between females and males for improvement in measurement of open bite

t-Test: Two-Sample Assuming Unequal Variances

	Females	*Males*
Mean	1.43306	1.70917
Variance	1.07892	2.03145
Observations	54	36
Hypothesized Mean Difference	0	
df	59	
t Stat	-0.99888	
P(T<=t) one-tail	0.16097	
t Critical one-tail	1.67109	
P(T<=t) two-tail	0.32193	
t Critical two-tail	2.00100	

Table 3 - Analysis of Treatment Outcome Measures by Gender: Open Bite.

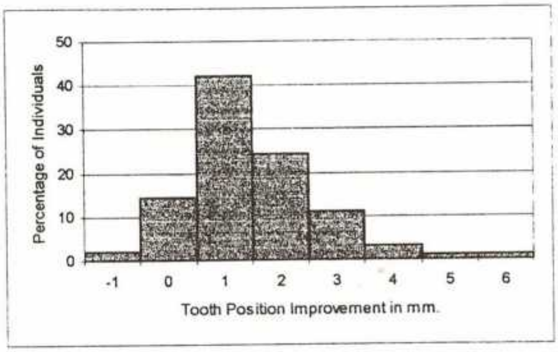

Figure 4 - Treatment Outcomes for 90 Subjects: Open Bite.

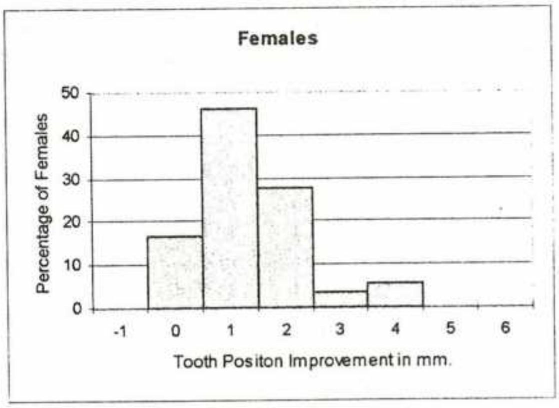

Figure 5 - Treatment Outcomes for 54 Female Subjects: Open Bite.

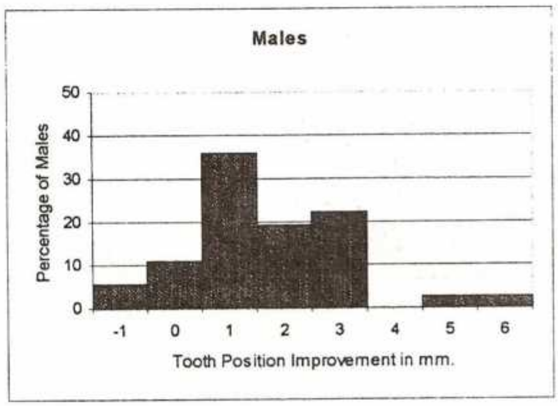

Figure 6 - Treatment Outcomes for 36 Male Subjects: Open Bite.

tooth position (Table 3, Figures 4, 5, and 6).

Also, no significant differences were determined between females and males for improvement in measurement of overjet tooth position (Table 4, Figures 7, 8, and 9).

t-Test: Two-Sample Assuming Equal Variances

	Females	*Males*
Mean	1.38981	1.68697
Variance	1.29083	1.71810
Observations	53	38
Pooled Variance	1.46846	
Hypothesized Mean Difference	0	
df	89	
t Stat	-1.15364	
P(T<=t) one-tail	0.12587	
t Critical one-tail	1.66216	
P(T<=t) two-tail	0.25174	
t Critical two-tail	1.98698	

Table 4 - Analysis of Treatment Outcome Measures by Gender: Overjet.

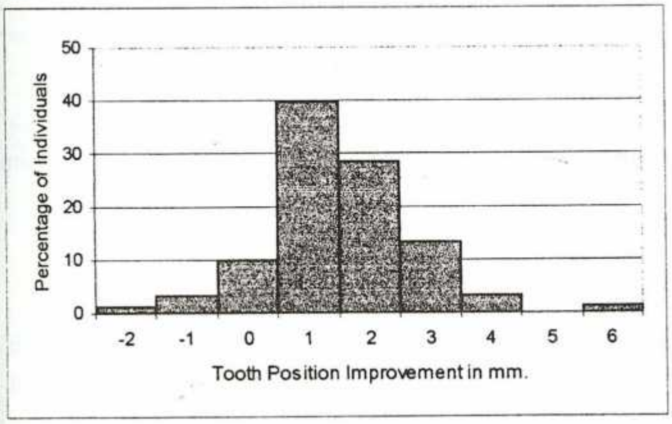

Figure 7 - Treatment Outcomes for 91 Subjects: Overjet.

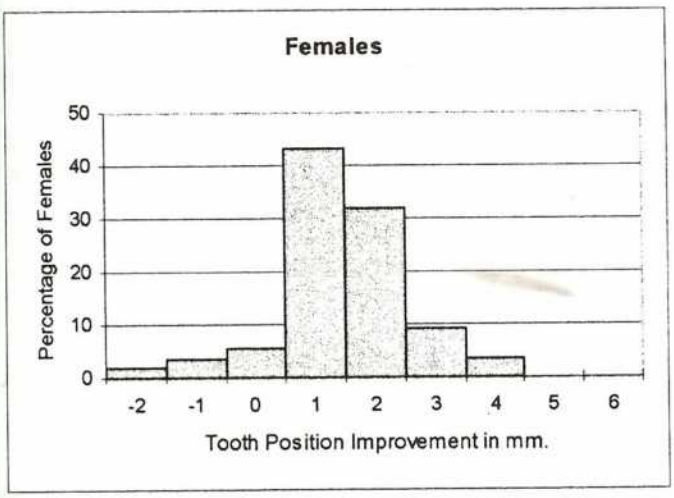

Figure 8 - Treatment Outcomes for 53 Female Subjects: Overjet.

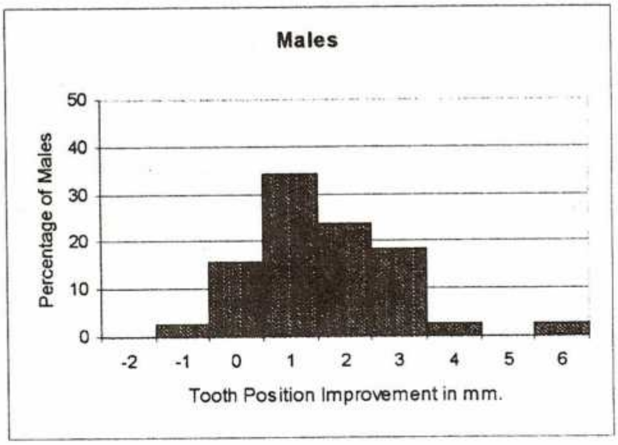

Figure 9 - Treatment Outcomes for 38 Male Subjects: Overjet.

The effect of timing for orthodontic treatment and orofacial myofunctional therapy was also considered in the study design. The timing factor under investigation was to determine if there is an optimal point to begin an OMT program and/or orthodontics, when both are initially indicated. The mean improvement in open bite (Table 5) and overjet (Table 6) were subjected to an analysis of variance (ANOVA) for each of the five treatment categories described above (**B**, **B.R**, **D**, **A**, and **N**).

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
B	16	15.36000	0.96000	0.95080
B.R	13	15.27500	1.17500	1.35191
D	17	25.81000	1.51824	1.09245
N	21	40.09000	1.90905	1.59057
A	23	42.38000	1.84261	1.73032

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	12.08755	4	3.02189	2.17969	0.07809	2.47901
Within Groups	117.84257	85	1.38638			
Total	129.93012	89				

Table 5 - Analysis of Variance: Open Bite.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
A	23	36.31500	1.57891	2.19514
B	13	13.32500	1.02500	1.89081
B.R	11	13.53000	1.23000	0.57974
D	23	42.04000	1.82783	1.45113
N	21	32.55500	1.55024	0.87785

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6.38548	4	1.59637	1.08733	0.36796	2.47774
Within Groups	126.26191	86	1.46816			
Total	132.64739	90				

Table 6 - Analysis of Variance: Overjet.

The p-values for the ANOVA test for both the open bite and the overjet do not indicate significant differences among the five groups at alpha = 0.05. That is to say, no individual sequence of treatments was found to be more effective than the others in improving dental occlusion of the open bite and/or overjet.

To rule out changes in occlusion resulting from orthodontics, Group **B** (ortho before OMT) and Group **D** (ortho during OMT) were combined to provide a sample of OMT patients with prior or concurrent orthodontic intervention. Group **A** (ortho after OMT) and Group **N** (no ortho) were combined to provide a sample of patients whose OMT occurred without any orthodontic intervention. For the overjet measures, there was no significant difference between the defined groups (Table 7).

However, for the open bite measures, the improvement for the combined **A** and **N** groups was greater than that for the combined **B** and **D** groups, with a p-value of 0.0237 (Table 8).

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
B and D	36	55.36500	1.53792	1.71336
A and N	44	68.87000	1.56523	1.53161

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.01477	1	0.01477	0.00915	0.92402	3.96346
Within Groups	125.82672	78	1.61316			
Total	125.84148	79				

Table 7 - Grouped Analysis of Variance: Overjet.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
B, D	33	41.17000	1.24758	1.07218
A, N	44	82.47000	1.87432	1.62621

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7.40720	1	7.40720	5.32960	0.02372	3.96847
Within Groups	104.23669	75	1.38982			
Total	111.64389	76				

Table 8 - Grouped Analysis of Variance: Open Bite.

Scatter plots were used to graphically present tooth position improvement as a factor of patient age for open bite (Figure 10) and for overjet (Figure 11).

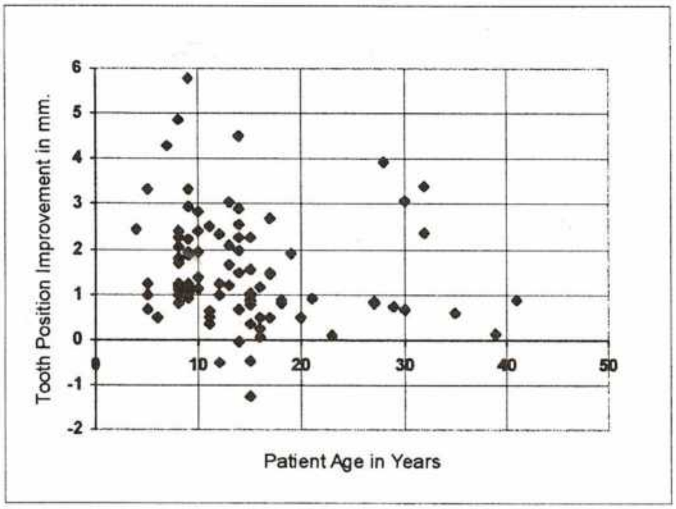

Figure 10 - Scatter Plot of Tooth Position Improvement by Age for 90 Subjects: Open Bite.

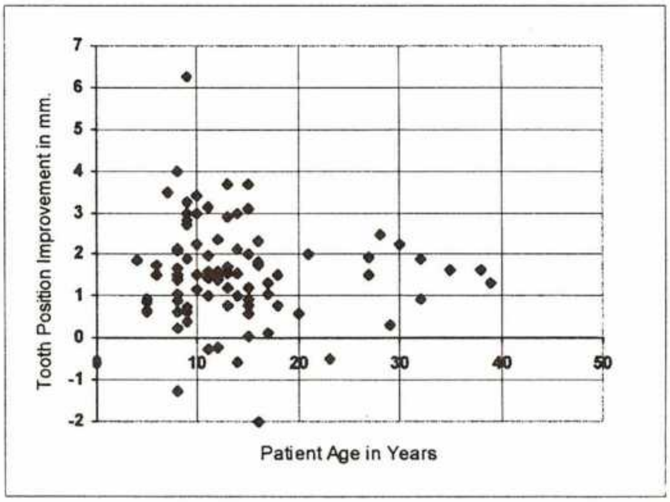

Figure 11 - Scatter Plot of Tooth Position Improvement by Age for 91 Subjects: Overjet.

Regression analysis of open bite (Table 9) and overjet (Table 10) was performed. The open bite analysis shows there is no significant correlation between patient age and average tooth position improvement. In both open bite and overjet, less than 2.5% of the documented improvement can be attributed to patient age at the time of treatment. The

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.155250
R Square	0.024102
Adjusted R Square	0.013013
Standard Error	1.200372
Observations	90

ANOVA

	df	SS	MS	F	Significance F
Regression	1	3.131638	3.131638	2.173402	0.143984
Residual	88	126.798485	1.440892		
Total	89	129.930123			

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.890023	0.266943	7.080239	3.35007E-10
Age	-0.024176	0.016399	-1.474246	0.143984

Table 9 - Regression Analysis of Age and Tooth Position Improvement: Open Bite.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.046724
R Square	0.002183
Adjusted R Square	-0.009028
Standard Error	1.219494
Observations	91

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.289593	0.289593	0.194728	0.660081
Residual	89	132.357798	1.487166		
Total	90	132.647390			

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.618163	0.268639	6.023562	3.76449E-08
Age	-0.007578	0.017173	-0.441280	0.660081

Table 10 - Regression Analysis of Age and Tooth Position Improvement: Overjet.

Pearson correlation coefficient is -0.155 (n=90) for the open bite and -0.047 (n=91) for the overjet. Neither of these is significant at an alpha =0.05. (Extracted from tables 9 and 10.)

Discussion

Statistical analysis demonstrates quantitatively that tooth movement occurs as a result of orofacial myofunctional therapy. The three questions in this study's purpose were all answered affirmatively.

The age group distribution presented in Figure 1 is consistent with the population reported in the literature and anecdotally cited from clinical reports by orofacial myologists. Recent trends reflect an increase in the incidence of patients older than 17.5 years. This can be explained by attitudinal changes in today's society about improved function, adult orthodontic/orthopedic correction, and cosmesis. Today, an increased awareness of TMDs contributes to early identification and intervention. Prevention and early interception of orofacial muscular dysfunction greatly increase the potential for normal growth and development. OMT before, during, or after orthodontic treatment assists in achieving long term stability for the corrected oral environment.

The statistical tests comparing the mean measurements of open bite and overjet before and after treatment demonstrate that OMT creates a positive, predictable improvement in dental occlusion. The p-value less than 0.0001 implies that the null hypothesis, which states that "orofacial myofunctional therapy has no effect on dental malocclusion, tooth movement of open bite, and/or tooth movement of overjet" must be rejected.

Gender was not a factor in improvements in dental occlusion. The results shown in Table 3 and Figures 4, 5, and 6 quantify that both the females and the males demonstrated similar patterns of improvement in open bite. Likewise, Table 4 and Figures 7, 8, and 9 display similar patterns of improvement in overjet.

It can be further substantiated by review of group A and N, consisting of these individuals who received no concurrent or prior interventions, that positive, significant change to the total relative oral environment occurred with a p-value less than .0001. (Tables 1a and 2a)

Analysis of Measurements Before/After Treatment: Open Bite Groups A and N Only

t-Test: Paired Two Sample for Means

	Open Bite Before	Open Bite After
Mean	2.13045	0.31159
Variance	2.08588	0.28698
Observations	44	44
Pearson Correlation	0.38789	
Hypothesized Mean Difference	0	
df	43	
t Stat	9.06181	
P(T<=t) one-tail	7.8613E-12	
t Critical one-tail	1.68107	
P(T<=t) two-tail	1.5723E-11	
t Critical two-tail	2.01669	

Table 1a

Analysis of Measurements Before/After Treatments: Overjet Groups A and N Only

t-Test: Paired Two Sample for Means

	Overjet Before	Overjet After
Mean	3.32602	1.81682
Variance	1.93217	1.61081
Observations	44	44
Pearson Correlation	0.56593	
Hypothesized Mean Difference	0	
df	43	
t Stat	8.05091	
P(T<=t) one-tail	2.0079E-10	
t Critical one-tail	1.68107	
P(T<=t) two-tail	4.0158E-10	
t Critical two-tail	2.01669	

Table 2a

As noted, the ANOVA performed on mean improvements does not show statistically significant differences attributable to the treatment sequences previously described (**B**, **B.R**, **D**, **A**, and **N**). The study was designed to consider the independent effects of OMT on the dentition using self-controls, thereby avoiding the potential denial of treatment for anyone selected for study purposes. The analysis of variance between the **B** and **D** group and the **A** and **N** group created a natural separation of individuals who received orthodontics and those who did not receive orthodontics. Group **B.R** was eliminated from the analysis of variance since those patients had received orthodontics and were referred because of relapse of the environment. Due to the inability to measure the open bite and overjet prior to their original orthodontics and subsequent relapse, it was determined the lack of controls incorporated more unknown variables than the other four groups. The **B** and the **B.R** group were similar only in the fact that each had received orthodontics. While the **B.R** group was referred due to relapse of the prior orthodontics, the **B** group was referred to assist in stabilization of the orofacial environment following debanding and prior to significant symptoms of relapse.

OMT treatment is a primary contributing factor to tooth movement in patients with orofacial myofunctional disorders. The analysis of the combined groups **B** and **D**, when compared to that of the combined groups **A** and **N**, does not show a synergistic enhancement due to prior or concurrent orthodontic treatment (Tables 7 and 8). Treatment outcomes for patients who had orthodontics after completion of OMT (Group **A**) are essentially the same as those for patients with no orthodontic intervention (Group **N**). This indicates that improvements in tooth position were achieved because of the orofacial myofunctional therapy.

One might suspect that the older the patient, the less likely that spontaneous tooth improvement would occur, particularly past the "growth and development" stages. The scatter plots for open bite (Figure 10) and for overjet (Figure 11) demonstrate that age is basically irrelevant in predicting tooth movement. This study statistically demonstrates that patients at any age can experience some degree of tooth movement while enrolled in an OMT treatment program.

Summary

The most significant findings of this study definitively establish the beneficial effects of orofacial myofunctional therapy on improving dental occlusion, decreasing dental open bite, and decreasing dental overjet. The results reported are actually quite conservative because of the method of measuring. Measuring and recording every tooth unquestionably dilutes the results which would have been achieved if only the anterior teeth had been used in the calculations. Some may question the small millimeter change as being significant. The change is reflective of the overall relative value change of incorporating all teeth within the dental arches and not limiting the analysis to only the anterior teeth. The secondary findings of the study confirm that age is not necessarily a factor in predicting success of a therapy program. Further, this study indicates that improvement of open bite and overjet can result from OMT without prior or concurrent orthodontic intervention.

Orofacial myofunctional therapy, from a public health standpoint, is a classic form of primary prevention to improve the overall health and well-being of the individual. The end result of OMT therapeutic programs is the establishment of new neuromuscular patterns, correction of functional and resting postures, correction of chewing / swallowing / feeding patterns and elimination of deleterious behaviors. Stabilization and maintenance of therapeutic goals become part of the lifelong learning and change process.

Orofacial myofunctional therapy utilizes knowledge and skills acquired through multidisciplinary education and training. Licensed professionals, from dental hygiene, dentistry, speech pathology, medicine, nursing, and other allied health professions with advanced education and training in orofacial myofunctional therapy have demonstrated expertise in providing collaborative, integrated, and interdisciplinary primary care.

Reference to earlier research works and anecdotal reports of ineffectiveness unfortunately perpetuate and reinforce the dichotomous quandary of form and function. Instead, recognition of the interrelationship of form and function, as conjoint fundamental processes, would encourage more pro-active patient referrals for orofacial myofunctional therapy services. This would allow the specialty area of orofacial myology to further validate the effectiveness of OMT on tooth movement in a positive, collaborative. and beneficial manner.

Acknowledging the small sample size in this study may encourage other clinicians to conduct future research in this area. Additional research is needed on the physiologic adaptive capacity of the orofacial environment. Developmental aspects of orofacial and jaw neurophysiology, especially in children, are scant in the literature. Treatment recommendations for specific dental malocclusions are based on many factors. Each malocclusion classification presents opportunity for OMT research.

A major research dilemma for the practicing clinician is the moral and ethical responsibility of providing treatment when dysfunction is diagnosed. Designing a study and identifying a "control group" is difficult due to the unethical aspect of knowingly withholding therapy when the benefits are statistically proven and available. A study design using the sample as its own control can infer and demonstrate validity. The next logical test is replication of this study to determine the level of reliability.

This issue of the ***I.J.O.M.*** addresses the effectiveness of orofacial myology treatment in improving speech articulation, eliminating digit sucking, and improving dental occlusion. It is time the professions of dental hygiene, dentistry, medicine, and speech pathology move forward and acknowledge current substantive research and literature that supports the philosophies of prevention, early interception (intervention), and corrective treatment.

The dark ages of disbelief only remain dark as long as we forget to turn on the light. Shedding light on the effectiveness of OMT and tooth movement requires patient referral, treatment, and follow-up. It is then patients will experience long term success, stability, and habituation of the orofacial myofunctional complex.

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