

Information About Orofacial Myofunctional Disorders for Professionals and Parents

ABSTRACT

This informational report is intended to provide information about the field of orofacial myology and to update some selected patient diagnosis and treatment issues of possible interest.

What are Orofacial Myofunctional Disorders?

Many of you may not be familiar with the term “orofacial myofunctional disorders”, often abbreviated as OMDs. Orofacial myofunctional disorders include one or a combination of the following:

1. abnormal thumb, finger, lip, and tongue sucking habits
2. an inappropriate mouth-open lips-open resting posture problem
3. a forward interdental rest posture of the tongue problem
4. a forward rest position of the tongue against the maxillary incisors problem
5. a lateral, posterior interdental tongue rest posture problem
6. inappropriate thrusting of the tongue in speaking and/or swallowing.

What are the Consequences of OMDs?

These abnormal habit patterns, functional activities, and postures can open the dental bite beyond the normal rest position. This can result in a disruption of dental development in children and over-eruption of selected teeth in adults.

Over time, dental malocclusion, cosmetic problems, and even changes in jaw growth and position are observed in some patients with OMDs. Examples of changes that can result from a chronic open mouth rest posture include an increased vertical height of the face, a retruded chin, a downward and backward growth of the lower face (rather than downward and forward), and flaccid and hypotonic lips (Proffit, 1986).

A prime example of an OMD, familiar to all pediatricians and dentists, is a retained sucking habit or use of a sippy cup. While it is tempting to ignore such habits since some children do outgrow them, many children do not spontaneously discontinue noxious habits and will need help in eliminating the habits. The behavioral approaches of the myofunctional clinician are effective in eliminating thumb and finger and other associated sucking habits (VanNorman, 1997; 1999).

The general rule in dentistry, and affirmed in pediatrics, is that oral habits should be addressed and eliminated prior to the eruption of the adult incisors, or by age 6 (Hanson and Mason, 2003). Without habit elimination, a maxillary posterior cross bite and an anterior open bite, or other malocclusions, will likely occur. For all habit patterns that may affect the developing dentition, orofacial myologists are ready to work collaboratively with physicians and dentists in the selection process of children who will not outgrow an ingrained habit pattern and will need professional help in habit cessation.

Is There Commonality among OMDs?

As you read this, it is expected that your lips are closed but your teeth do not touch; that is, your normal dental rest position is characterized by a small open space between upper and lower teeth. This normal resting space is referred to as the dental freeway space, or inter-occlusal space. It measures 2-3 mm at the molars, and 4-6 mm at the incisors (Sicher and DuBrul, 1970).

The common denominator of orofacial myofunctional disorders is that all OMDs result in a change in the vertical dimension, or freeway space. The OMD, whether digit habit or altered oral posture, causes the mandible to hinge open slightly, while also increasing the resting inter-occlusal space between the upper and lower jaws and teeth. Only a slight increase in resting freeway space for hours per day is needed to initiate continued and unwanted vertical tooth eruption (Proffit, 1986; Mason, 1988).

Conversely, some patients have a habit pattern of clenching that involves keeping teeth together, or bite closed, for hours per day. Closure of the normal freeway space for extended periods can lead to dental trauma and dysfunction of the temporomandibular joint apparatus (Sicher and DuBrul, 1970). Altogether, a disruption of the normal resting dental freeway space, either too far open or closed, leads to negative consequences in dental eruption or the position of teeth.

What Can Orofacial Myofunctional Therapy Do about Freeway Space Variations?

A primary goal of orofacial myofunctional therapy (OMT) is to recapture a normal freeway space dimension by eliminating deleterious sucking habits, retro-positioning a forward interdental tongue posture, teaching a closed lips nasal breathing posture, retraining and eliminating a tongue thrust, or normalizing (opening) a closed dental rest posture. A variety of exercises is involved which are based on individual evaluation and treatment protocols.

A key challenge in the evaluation process is to identify the multi-factorial causes of the OMD; the primary factor being nasal airway interference linked to structural issues such as enlarged tonsils. Other causative factors include unresolved sucking habits, and

airborne issues associated with allergies. Most often, a team approach to diagnosis and management of OMDs will be needed which may include physicians and dentists, orthodontists, allergists, or ENT specialists.

The role of the airway

There is no controversy about the relationship of unresolved airway issues and the appearance and maintenance of oral habits patterns and postures described as OMDs. However, there is controversy concerning the overuse of the term “mouth breathing” based solely on the clinical observation of a lips-apart, mouth-open rest posture. It is now well accepted in pediatrics and dental science that mouth breathing is a physiologic term that should reflect, in most instances, the results of an aerodynamic assessment of the airway (Warren & DuBois, 1964; Watson, Warren & Fischer, 1968). There is not a strong correlation between the facial appearance of a child and a mouth breathing habit (Vig et al, 1981). A careful assessment of the airway is needed to merit the diagnosis of mouth breathing (Mason & Riski, 1983; Riski, 1983).

It is well known in dentistry and pediatrics that many children have poor oral hygiene. It is not as well known or recognized clinically, however, that many children also have poor nasal hygiene. Aerodynamic assessments of the airway have confirmed poor nasal hygiene in children who are suspected of being mouth breathers. The simple task of blowing the nose has been shown to reduce nasal airway resistance by up to 50% and, in many cases, has served to eliminate the facial posturing perceived by some to be mouth breathing (Hanson and Mason, 2003).

True instances of mouth breathing can link demonstrable airway interferences with tongue postural and functional activities. Enlarged tonsils and adenoids, allergic rhinitis, and growth variations in the orofacial and pharyngeal complex of structures can influence behavioral and postural adaptations. The clinical implications are several between observations made of facial and oral postures and behaviors and conditions involving the airway: a tongue forward rest posture or a tongue thrust swallow should serve as a clue to evaluate the posterior airway for some unresolved airway issue. In other instances, tongue thrusting and abnormal tongue posturing may signal the presence of a retained sucking habit.

The possible contributions of orofacial-pharyngeal-nasal airway interferences need to be fully evaluated before myofunctional therapies are initiated to resolve oral functions and postures. The interdisciplinary impact of airway interferences will naturally involve physicians and dentists in collaborative diagnostic and treatment planning procedures with orofacial myologists. One of the purposes of the IAOM is to facilitate interdisciplinary dialogue, exchange of information, and research opportunities that can benefit patients of mutual concern.

What about the IAOM?

As the professional organization dedicated to the advancement of techniques to remediate OMDs, the IAOM includes a membership largely derived from the professions of speech-language pathology and dental hygiene. Some dental specialists are active and supporting members of the organization. The IAOM holds an annual meeting where clinical papers, research reports, tutorials, and information from members and allied fields are presented and discussed. The leadership of the IAOM is derived from the results of voting decisions of the membership.

Those speech-language pathologists and dental hygienists who desire to provide services with OMDs are encouraged by the IAOM to enroll in IAOM-sponsored continuing education courses and to successfully navigate through a supervised clinical process before becoming designated as an IAOM Certified orofacial myologist (COM). The educational and certification processes of the IAOM are major focuses of activities within the organization. The IAOM also supports a peer-reviewed professional journal, the *International Journal of Orofacial Myology* that publishes an annual issue. The IAOM encourages members to engage in clinical research.

How Does Orofacial Myofunctional Therapy (OMT) Differ from Dental Treatment?

While the theoretical tenets of OMDs are derived from dental science, OMT is not dental treatment. An important distinction between dentistry and orofacial myology should be recognized: ***Dentists and orthodontists are primarily concerned with teeth-together relationships, while orofacial myofunctional therapists are concerned with teeth-apart postures and behaviors.*** This distinguishes the muscle retraining work of the OMT from the dental-occlusal and jaw manipulations of dental/orthodontic providers. It also highlights how therapy procedures can aid in the creation or restoration of an oral environment and appropriate vertical dimension wherein normal processes of dental development can occur (Mason, 2005).

Controversies involving OMDs

You may have been exposed to some misconceptions about OMDs that have been perpetuated over the past 50 years. Some examples of inaccurate perceptions that you may have heard include:

- Tongue thrusting is a primary cause of dental malocclusion. Actually, thrusting is an adaptation to rather than a cause of malocclusion (Proffit, 1973).
- People swallow 2,000 times per day. Actually, the mean number of swallows per day for adults is 585, while for children, the range is from 800 to 1,000 (Flanagan, 1964; Lear, Flanagan, and Moorrees, 1965).
- A tongue thrust swallow represents an excessive pressure (1-7 pounds per swallow). Swallow pressures average @ 50 grams/cm² (Proffit, 1973). You will recall that there are 454 grams in a pound.
- The pressures generated by swallows add up or compound throughout the day. This is incorrect; they do not.
- A tongue thrust represents an orofacial “muscle imbalance.” No one ever demonstrates muscle balance between the tongue and lips, so the notion of a patient having muscle “imbalance” as a reason for initiating therapy is misleading and incorrect.

The misperceptions listed above are the result of unsupported speculations and inadequate research among dental clinicians during the initial stages of interest in OMDs. Through efforts within the IAOM, such misconceptions are being addressed and corrected.

Important note: All of the misconceptions cited above have in common a faulty visual image involving the importance of the horizontal plane of space with OMDs that has been perpetuated and continues to be discussed by some. Many clinicians have, historically and inaccurately, envisioned that the teeth are positioned in the middle of a dynamic muscle force field, with the muscles of the tongue on one side, and the opposing and balancing muscles of the lips and facial expression on the other. This false view of the tongue and lips being in a muscular tug of war in the horizontal plane of space where an OMD is present presumes incorrectly that the prize from this perceived competition is control of dental position.

It has been difficult for clinicians to perceive how dental stability, or lack of, is primarily **controlled in the vertical** rather than horizontal dimension. It remains a continuing challenge to purge the clinical image of a horizontally-directed muscular control competition between the tongue, lips and facial muscles and to understand how the vertical dimension influences behaviors such as OMDs in the horizontal plane. A key to understanding how the vertical dimension influences the horizontal is to add hours per day (duration) to this equation; that is, vertical changes that influence the horizontal plane with OMDs take place over time, hours per day, while the short bursts of a horizontally-directed tongue thrust swallow or thrusting during speech lack the duration to account for dental changes.

In children with OMDs, a rest posture with tongue forward and lips apart opens the freeway space beyond the normal range, hours per day, and triggers vertical eruptive activity resulting in malocclusion. In short, when an OMD rest posture variation is present hours per day, **the vertical controls the horizontal** and untoward changes in the dentition are seen. The suggestion offered to clinicians is: **with OMDs, think vertically, not horizontally**. The details of why the horizontal plane and OMDs such as tongue thrusting do not account for dental changes will be elucidated in the sections to follow.

A Myofunctional View of the Tongue

Various applications of “functional appliances” in orthodontics have been well articulated and documented in the orthodontic literature. Physicians may be familiar to some extent with some of the removable appliances designed to influence jaw growth and dental eruption. One such appliance is the “activator” (Woodside, 1977), which is based upon principles emphasized by Harvold (1974) regarding the “functional occlusal plane” and the role played by its manipulation with an activator appliance in the correction of certain malocclusions.

For the non-orthodontist reading this, please permit a short tutorial about the theory behind tooth eruption and its manipulation vertically with functional appliances: The functional occlusal plane represents the functional table of posterior occlusion, the level and inclination of which normally is the result of neuromuscular, growth, and developmental forces acting on the dentition (Harvold, 1974). **It should be noted that in normal dental eruption, maxillary posterior teeth follow a downward and forward curvilinear path, while mandibular posterior teeth erupt vertically in harmony with the vertical growth of the lower face** (Woodside, 1977). Enlow and Hans (1996) point out that mesial and vertical drift also occur in addition to eruption as a basic growth function that helps to place the teeth anatomically as the jaws lengthen and widen. Vertical drift can be modified by orthodontic intervention, including functional appliances and can also be influenced negatively by habit patterns that increase the interocclusal space; thus, a relationship has been established and recognized between OMDs and the dental freeway space).

Manipulation of the functional occlusal plane with an activator appliance can be done by inhibiting eruption of maxillary posterior teeth and permitting the mandibular posterior teeth to erupt vertically. Such manipulations with a removable functional appliance can change a Class II malocclusion into a Class I. An activator appliance could also be designed to create a Class II malocclusion from a Class I by inhibiting mandibular posterior eruption and encouraging maxillary downward and forward eruption (Harvold, 1974). This would not be a desirable situation to create with an appliance, but is exactly what the tongue is capable of accomplishing as a myofunctional disorder.

An important concept and clinical reality that deserves recognition is that **the tongue can also serve as a functional appliance** by opening the freeway space and encouraging differential eruption, leading either to an anterior open bite or a Class II Division 1 malocclusion. The term “differential eruption” denotes a situation where, for example, posterior dental eruption is encouraged by opening the freeway space beyond the normal range, while at the same time, anterior dental eruption is inhibited by a resting interdental tongue posture; hence, the accelerated posterior eruption and inhibited anterior eruption are described as a combined process of differential vertical eruption.

If the tongue demonstrates a myofunctional disorder by habitually resting forward between the incisors and, concurrently, the mandible is hinged open slightly, an open bite can result (Proffit, 1986, Alexander, 1999). While posterior teeth supraerupt by increasing the posterior freeway space, anterior teeth are impeded in eruption by the inter-incisal presence of a tongue tip at rest. This process is characterized by excessive opening of the posterior freeway space for extended periods.

In considering the tongue as a functional appliance, tongue posture can also encourage the development of a Class II malocclusion in some patients. If a forward tongue position is accompanied by the tongue covering the occlusal surfaces of all lower teeth, (the sides of the tongue splaying laterally over the occlusal surfaces of lower posterior teeth), much like an activator design to correct a Class II malocclusion, continued vertical eruption of maxillary teeth can proceed as the freeway space is enlarged and the lower teeth are impeded in eruption by the resting tongue. Over time, a Class II malocclusion can develop.

Envision a flaccid, floppy tongue when at rest covers lower anterior and posterior teeth. Myofunctional therapy exercises can tone or otherwise impact the tongue so that it can rest within the confines of the dental arches, and even appear smaller after treatment. In

such instances, muscle exercises are needed to help the tongue adapt to the environment in which it resides.

The concept that **the tongue can act as a functional appliance** is a tenet of orofacial myology and one which is compatible with current orthodontic theory and experience with various functional appliances. This concept has not been widely disseminated or appreciated in dentistry and needs to be recognized and embraced, especially among orthodontists.

What Then Is the State-of-the-Art Regarding OMDs?

Tongue Thrusting

Let's start with the truth about tongue thrusting, since this behavior has been inappropriately highlighted in the past. Here are some well-researched conclusions about swallowing and tongue thrusting revealed from the research of Proffit and colleagues (see References under Pressure Transducer Studies) using miniature pressure transducers placed in carrier appliances fit on the teeth and palate.

- Children are either right-tongued or left-tongued in speaking and swallowing. Typically, the back of the tongue only (not the tip) on one side contacts the maxillary posterior teeth, or supporting alveolar bone, during saliva swallowing. This posterior "sidedness" preference is noted in the production of sounds like /s/ that normally involve a movement or positional sensation with the tongue tip (i.e., the back of the tongue acts as a hinge to direct and stabilize the tongue tip to some arbitrary vertical position). Of interest - there is no correlation between tonguedness and handedness.
- Children's saliva swallows are characterized by variability from one swallow to the next.
- There are as many as 10 transitional saliva swallow patterns from an infant swallow to an adult swallow. Changes in saliva swallows are related to oropharyngeal development. Morphological influences that may account for transitional swallow stages in children include: (1) changes in the airway—size and growth of tonsils and adenoids; (2) differential growth of the tongue—the tongue grows faster than the mandible to which it is attached; (3) height of the mandibular ramus and posterior tongue; (4) length of the soft palate; (5) dental eruption and exfoliation; and (6) neuromotor maturation (Mason, 1988).
- Adult saliva swallows are stable and highly predictable in pressure pattern and maxillary contact area.
- Horizontally-directed tongue pressures during saliva swallowing are insufficient in force and duration to displace teeth. The amount of pressure against the upper incisors during a swallow for a tongue thruster is usually between 25-50 grams/cm² (Proffit, 1973).
- A tongue thrust definitely does not produce pounds of pressure against the teeth.
- Vertically directed tongue pressures during swallowing decrease with the magnitude of an open bite (Wallen, 1974).
- Tongue and lip pressures never balance during a swallow. Tongue pressures are always several times higher (i.e., there is no muscle balance).
- Tongue and lip pressures during swallowing do not correlate well with tooth position. Many tongue thrusters have normal occlusion.
- The duration of tongue and lip pressures during swallowing do not balance out over time.
- Orthognathic surgery patients adapt swallowing tongue pressures and contacts to pre-op levels within one year after surgery. In spite of whether there is stability or relapse of structures subsequent to surgery, the tongue adapts to the environment in which it resides with regard to tongue pressures and contacts (Proffit et al studies, 1967-1978; see Pressure Transducer Studies in the Reference List)

Resting Posture of the Tongue

In addition to tongue thrusting, here are some conclusions, revealed from research, about the resting posture of the tongue.

- In the horizontal plane, resting tongue and lip pressures do not balance out over time. There is never any balance of tongue and lip muscles.
- When there is an anterior interdental rest posture of the tongue, for hours per day, dental eruption is disturbed and a process of differential dental eruption can be triggered (Mason, 1988; Mason and Proffit, 1974; Proffit, 1986).
- Differential dental eruption, resulting from an interdental tongue tip at rest with mandible hinged open, involves a combination of inhibiting anterior dental eruption while accelerating posterior eruption and vertical drift (Proffit, 1986). Differential eruption is not solely a process of teeth eruption. Posterior teeth over-erupt and the alveolar bone follows along by a process of vertical drift. Teeth don't erupt vertically out of their sockets; rather, teeth and alveolar bone drift together (Enlow and Hans, 1996). At the same time, anterior teeth are kept from erupting by an interdental rest position of the tongue (Proffit, 1986).
- It only takes @ 15 gr/cm² of continuous interdental resting pressure to inhibit the eruption of anterior teeth, while for posterior teeth; the figure is @ 35 gr/cm² (Proffit, 1986).
- An anterior interdental rest posture of the tongue, or a rest position of the tongue tip against the maxillary incisors continuing for hours per day, can lead to an anterior open bite or incisor flaring, respectively. Duration of pressure is a key. Only light continuous postural or orthodontically applied forces, or intermittent orthodontically applied pressures are needed to move teeth (see References under Dental Equilibrium). Note: Intermittent orthodontic pressures, such as applied by waxing and waning force applications against a tooth or teeth with retainer springs, differ from the infrequent intermittent forces of tongue thrust swallows that have not been shown to result in movement of teeth. Duration is a key, even for intermittent orthodontic force applications.

Why Then Do Teeth Remain in a Stable Position, Either in Normal Occlusion or Malocclusion?

The answer from dental science involves consideration of equilibrium theory. Muscle balance or imbalance is not the same as dental equilibrium.

As Proffit (1978) points out, for the dentition to be maintained in a stable position, some sort of equilibrium would need to be involved to facilitate stability of the dental arches. Proffit and others have identified a myriad of influences that combine to account for dental equilibrium. These influences include: 1) intrinsic pressures – periodontal fibers and gingival fibers; 2) external pressures – habits, and orthodontics; 3) soft tissue pressures of the lips, cheek and tongue; and 4) tooth contacts – masticatory and swallowing.

The freeway space is one of several contributors to the dental equilibrium. When the freeway space is disturbed or changed in the presence of an OMD, vertical and horizontal dental consequences will be expected to follow.

Tooth position stability, or dental equilibrium, as well as the resting freeway space, involves a cortical control mechanism mediated by the maxillary and mandibular branches of the trigeminal (V) cranial nerve to and from the trigeminal nucleus in the pons. A host of biochemical events surrounding the periodontal membrane space serve to monitor and also allow changes in tooth positions from long periods of continuous or intermittent orthodontic force applications against the dentition (see Davidovitch et al. under Dental Equilibrium in the References).

If a normal occlusion is disturbed by an airway issue or habit pattern, the dental equilibrium is disrupted. This can lead to an altered occlusion, or malocclusion, and can remain stable in an altered state of equilibrium until the airway issue or habit pattern is addressed.

It is well-known and accepted in dental science that resting tongue pressures are important determinants of dental change and malocclusion, while tongue thrusting is not a primary cause. A tongue thrust, when accompanying a forward interdental tongue rest posture, can potentially exacerbate a developing malocclusion, but tongue thrusting alone is not linked to dental change (Proffit, 1986).

What's New with OMDs, OMT, and the IAOM?

Orofacial myofunctional therapy procedures with OMDs are effective, consistent, and successful. As the discipline of orofacial myology grows and thrives, changes in terminology and perspectives are occurring within the IAOM to reflect the evolving State-of-the-Art. Some selected changes are shared here:

- Therapy has been recast as **orofacial rest posture therapy**. This change in perspective identifies the impact of oral posturing on dental changes, and the adaptive, opportunistic nature of the functional activity of tongue thrusting. Even so, we recommend that a tongue thrust should be corrected where there is an associated cosmetic problem or an accompanying interdental tongue tip forward rest posture.
- We advise orofacial myologists, physicians and dentists to exercise caution in labeling of a patient as a mouth breather, especially in the absence of aerodynamic testing and verification. A lips-apart, mouth-open rest posture is **not** necessarily mouth breathing (Hanson and Mason, 2003).
- The concept of the freeway space is an important component associated with OMDs. This importance of the freeway space with the development of OMDs distinguishes the focus of orofacial myofunctional therapists (OMTs) from orthodontists and dental treatment. A primary goal of orofacial myologists is to recapture or establish a normal dental freeway space.
- Working to achieve lip competence is an important aspect of OMT. In many instances, therapy to achieve a resting lip seal can obviate the need for tongue therapy and can also lead to a normal freeway space dimension.
- The current view in orofacial myology is that a tongue thrust and forward interdental resting posture of the tongue serve as clues that there is likely a retained sucking habit or unresolved airway issue. Such patients are in need of referral to pediatricians, family physicians, allergists, or ENT specialists for definitive evaluation of the airway as appropriate.
- We advise discontinuing the use of the inaccurate term muscle imbalance. Instead, we recommend a focus on, and dialogue pertaining to tongue rest and functional patterns.
- In clinical reports, we recommend prefacing the term tongue thrust with an adjective wherever possible, such as transitional, obligatory, adaptive, neuromotor, even cosmetic.
- We now recommend disuse of the term excessive pressure as applied to OMDs. Thrusting for example, does not involve excessive pressures against the teeth (Proffit, Sarver and Fields, 2006).
- The term pattern is a better term to use to describe a tongue thrust. Many orthodontists respond negatively to the historical (and inaccurate) focus and overemphasis on thrusting rather than resting tongue posture.
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What does the future hold for the field of orofacial myology?

One of the aspirations for the continued evolution and elucidation of variables associated with orofacial myofunctional disorders is for OMTs to participate more fully in the multidisciplinary activities and interests of other fields. The field will change and adapt as research and clinical applications in medical and dental fields find applications to OMDs, and vice versa.

As an example of a multidisciplinary area of current interest, we are mindful of the exciting ongoing research activities with nasal nitric oxide, a pluripotent and highly reactive free radical gas manufactured primarily in the paranasal sinuses that may be involved in the regulation of, among many things, unilateral nasal airway resistance (Ferguson and Eccles, 1998). The implications to airway

interference and the therapy efforts to establish and maintain a nasal pattern of breathing by OMTs signals the need for a team approach to understanding the individual problems that patients may exhibit.

Our interest in the posterior airway and its influence on anterior oral postures and functions will remain a focus of our clinical and research interests. The possible role for the orofacial myologist in working with sleep-related problems is currently under discussion and study. Some preliminary results suggest that working to exercise the tongue and to tone or strengthen the tongue may help to alleviate the symptoms or sleep apnea.

The many opportunities and challenges ahead for the field of orofacial myology can be addressed successfully with improved communication and collaborations involving those physicians and dentists who have mutual interests and intertwined roles to play with individual patients. It is our hope that this web page may have elevated your understanding of the field of orofacial myology and some of the ongoing activities, goals, and theoretical bases involved.

We invite your participation with us. Your ideas, support and enthusiasm for shared interests can help to advance the goals and activities of the field of orofacial myology and better serve those patients of yours who may benefit from our services.

Summary

Working with orofacial myofunctional disorders continues to represent a challenging and exciting area of clinical endeavor. The field is continuing to evolve, as evidenced from the terminology and conceptual emphases described here.

Orofacial myofunctional therapy is not speech therapy. OMT is therapy to correct muscle function problems which influence dental occlusion; facial shape; chewing; swallowing; and tongue, lip, and jaw resting posture. Not all individuals who have a tongue thrust have a speech problem and not all who have a speech problem have a tongue thrust.

Orofacial myologists are willing participants on interdisciplinary teams. Our members have already established collaborative clinical interests and interactions with university-related teams and with general dentists, dental specialists with TMJ disorders, orthodontists, oral and maxillofacial surgeons, pediatricians, allergists, ENT specialists, cranio-osteopaths, and craniofacial pain management physicians and dentists. The rapidly evolving field of orofacial myology maintains a commitment to collaborative interactions with potential referral resources in medicine and dentistry.

The **References** that follow include studies and texts cited in this update for dentists and physicians. Included as well are a list of recommended classic studies by Proffit and colleagues from dental science that have documented related oral functions. Selected reference texts are cited as resources that provide background information from dental science regarding OMDs, dental development, and orofacial growth and development.

For those dental and medical professionals who may develop a specific interest in OMDs, especially pediatricians, allergists and ENT specialists, the leading orthodontic text by Proffit, Sarver, and Fields (2006) is recommended. It is an excellent resource. The Hanson and Mason text (2003) is specific to OMDs.

References

Articles Specific to OMD Theory and Practice

Mason, R.: (Ed.) Orofacial myology: Current trends [Special Issue], *International Journal of Orofacial Myology*, 14, 1, March, 1988.

Mason, R.: A retrospective and prospective view of orofacial myology. *International Journal of Orofacial Myology*, 31, November, 2005.

Swallow Frequency

Flanagan, J.B.: Observations on the incidence of deglutition in man and measurement of some accompanying forces exerted on the dentition by perioral and lingual musculature. Master's thesis. Forsyth Infirmary, Harvard University, 1964.

Lear, C.S.C., Flanagan, J.B., and Moorrees, C.F.A.: The frequency of deglutition in man. *Archives Oral Biol.*, 10:83-99, 1965.

Efficacy of Treatment: Does Myofunctional Therapy Work?

Alexander, C.D.: Open bite, dental alveolar protrusion, Class I malocclusion: a successful treatment result. *American Journal of Orthodontics and Dentofacial Orthopedics*, 116, 5, 494-500, 1999.

Andrianopoulos, M.V., and Hanson, M.L.: Tongue thrust and the stability of overjet correction. *Angle Orthodontist*, 57, 2, 121-135, 1987

Christensen M., and Hanson, M.L.: An investigation of the efficacy of oral myofunctional therapy as a precursor to articulation therapy for pre-first grade children. *Journal of Speech and Hearing Disorders*, 46, 160-167, 1981.

Cooper, J.S.: A comparison of myofunctional therapy and crib appliance effects with a maturational guidance control group. *American Journal of Orthodontics*, 72, 333-334, 1977.

Hahn, V., and Hahn, H.: Efficacy of oral myofunctional therapy. *International Journal of Orofacial Myology*, 18, 21-23, 1992.

Hanson, M.L., and Andrianopoulos, M.V.: Tongue thrust and malocclusion. *International Journal of Orofacial Myology*, 20, 9-18, 1982.

Ohno, Y., Yogosawa, F. and Nakamura, F.: An approach to openbite cases with tongue thrusting habits with reference to habit appliances and myofunctional therapy as viewed from an orthodontic standpoint. *International Journal of Orofacial Myology*, 7, 3-10, 1981.

Smithpeter, J., and Covell, D. Jr.: Relapse of anterior open bites treated with orthodontic appliances with and without orofacial myofunctional therapy. *American Journal of Orthodontics and Dentofacial Orthopedics*, 137, 5, 605-614, 2010.

Toronto, A.S.: Long-term effectiveness of oral myotherapy. *International Journal of Orofacial Myology*, 1, 132-136, 1975.

Umberger, F.G., and Johnston, R.: The efficacy of oral myofunctional and coarticulation therapy. *International Journal of Orofacial Myology*, 23, 3-9, 1997.

Van Norman, R.A.: Digit-sucking: a review of the literature, clinical observations and treatment recommendations. *International Journal of Orofacial Myology*, 12:14-34, 1997.

Van Norman, R.A.: *Helping the Thumb-Sucking Child*. Avery Publishing Group, NY, 1999.

The Airway

Ferguson, E.A. and Eccles, R.: Relationship between nasal nitric oxide concentration and nasal airway resistance. *Rhinology*, 36, 3, 120-123, 1998.

Mason, R., and Riski, J.: Airway interference: a clinical perspective. *International Journal of Orofacial Myology*, 9, 9-11, 1983

Riski, J.: Airway interference: objective measurement and accountability. *International Journal of Orofacial Myology*, 9, 12-15, 1983.

Vig, P., Sarver, D.M., Hall, D.J., and Warren, D.W.: Quantative evaluation of nasal airflow in relation to facial morphology. *American Journal of Orthodontics*, 79, 263-272, 1981.

Warren, D.W., and DuBois, A.: A pressure-flow technique for measuring velopharyngeal orifice area during speech. *Cleft Palate Journal*, 1, 52-71, 1964.

Watson, R.M., Warren, D.W., and Fischer, N.D.: Nasal resistance, skeletal classification and mouth breathing in orthodontic patients. *American Journal of Orthodontics*, 54, 367-379, 1968.

Recommended Reference Texts

Enlow, D.H., and Hans, M.G.: *Essentials of Facial Growth*, W.B. Saunders, Philadelphia, 1996.

Hanson, M.L., and Mason, R.M.: *Orofacial Myology: International Perspectives*, C.C. Thomas, Springfield, IL, 2003.

Harvold, E.: *The activator in interceptive orthodontics*. C.V. Mosby, St. Louis, 1974.

Proffit, W.R.: *Contemporary Orthodontics*, C.V. Mosby, St. Louis, 1986.

Proffit, W.R., and Fields, H.: *Contemporary Orthodontics*, 3rd Edition, C.V. Mosby, St. Louis, 2000.

Proffit, W.R., Sarver, D.M., and Fields, H. W.: *Contemporary Orthodontics*, 4th Edition, C.V. Mosby, St. Louis, 2006.

Sicher, H., and DuBrul, E.L.: *Oral Anatomy*, 5th Edition, C.V. Mosby, 1970.

Woodside, D.G.:The activator. In T.M.Grabner and B.Neumann, *Removable Orthodontic Appliances*. W.B.Saunders, Philadelphia 1977

Selected Pressure Transducer Studies by Proffit and Colleagues

Brown, W., McGlone, R., and Proffit, W.R.: Relationship of lingual and intra-oral air pressures during syllable production. *J. Speech Hearing Res.*, 16, 1973, 141-151.

Mason, R.M., and Proffit, W.R.: The tongue thrust controversy: Background and recommendations. *J. Speech Hearing Disorders*, 39, 2, 1974, 115-132.

McGlone, R., and Proffit, W.R.: Correlation between functional lingual pressures and oral cavity size. *Cleft Palate J.*, 9, 1972, 229-235.

McGlone, R.E., and Proffit, W.R.: Patterns of tongue contact in normal and lisping speakers. *J. Speech and Hearing Research*, 16, 3, September, 1973, 456-473.

McGlone, R., Proffit, W.R., and Christiansen, R.: Lingual pressures associated with alveolar consonants. *J. Speech Hearing Res.*, 10, 1967, 606-614.

Proffit, W.R.: Lingual pressure patterns in the transition from tongue thrust to adult swallowing. *Arch. Oral Biol.*, 17, 1972, 555-563.

Proffit, W.R., Chastain, B., and Norton, L.: Linguo-palatal pressures in children. *Am. J. Orthodontics*, 55, 1969, 154-166.

Proffit, W.R.: Muscle pressure and tooth position: A review of current research. *Australian Orthodont.*, 3, 1973, 104-108.

Proffit, W.R., and Norton, L.: The tongue and oral morphology: Influences of tongue activity during speech and swallowing. In *Speech and the Dentofacial Complex: The State of the Art, ASHA Reports 5*. American Speech and Hearing Association, Washington D.C., 1970, 106-115.

Proffit, W.R., Palmer, H., and Kydd, W.: Evaluation of tongue pressure during speech. *Folia Phoniatica*, 17, 1965, 115-128.

Proffit, W.R., and Mason, R.M.: Myofunctional therapy for tongue-thrusting: background and recommendations. *J. Amer. Dental Assoc.*, 90, February, 1975, 403-411.

Wallen, T.R.: Vertically directed forces and malocclusion: A new approach. *J.Dental Res.*, 53, 1974, 1015-1022.

Dental Equilibrium

Davidovich, Z., Montgomery, R., Eckerdal, O., and Gustafson, G.: Demonstration of cyclic AMP in bone cells by immunohistochemical methods. *Arch. Oral Biol.*, 19, 1976, 305-315.

Davidovitch, Z., and Shamfeld, J.: Cyclic AMP levels in alveolar bone of orthodontically-treated cats. *Arch.Oral Biol.*, 20, 1975, 567-574.

Davidovich, A., and Montgomery, P.: Cellular localization of cyclic AMP in periodontal tissues during experimental tooth movement in cats. *Calcified Tissue Res.*, 19, 1976, 317-329.

King, G.J., and Keeling, S.D.: Orthodontic bone remodeling in relation to appliance decay. *Angle Orthod.*, 65, 1995, 129-140.

King, G.J., Keeling, S.D., McCoy, W.A., and Ward, T.H.: Measuring dental drift and orthodontic tooth movement in response to various initial forces in adult rats. *Amer. J. Orthod. Dentofacial Orthoped.*, 99, 1991, 456-465.

King, G.J., Latta, L., Rutenberg, J., Ossi, A., and Keeling, A.: Effect of appliance removal on alveolar bone turnover in rats. *J. Dental Res.*, 74, 1995, 927 [Abstract].

Proffit, W.R.: Equilibrium theory revisited: Factors influencing position of the teeth. *Angle Orthod.* 48, 3, 1978, 175-186.

Growth and Development/Morphology

Creekmore, T.D.: Inhibition of stimulation of the vertical growth of the facial complex: its significance to treatment. *Angle Orthod.*, 37, 1967, 285-297.

Harvold, E.P. :(Chapter 2), Growth changes. *The Activator in Interceptive Orthodontics*, C.V. Mosby: St. Louis, 1974.

Ingervall, B., and Eliasson, G.B.: Effect of lip training in children with short upper lip. *Angle Orthod.*, 52, 3, 1982, 222-233.

Mason, R.M., and Serafin, D.: The tongue: Interdisciplinary considerations. Chapter 38, in Serafin, D., and Georgiade, N.G: *Pediatric Plastic Surgery*, volume 2, C.V. Mosby, St. Louis, 1984, 711-732.

Pepicelli, A., Woods, M., and Briggs, C: The mandibular muscles and their importance in orthodontics: A contemporary review. *Am. J. Ortho Dentof. Orthoped.*, 128, 2005, 774-780.

Satomi, M.: The relationship of lip strength and lip sealing in MFT. *Int. J. Orofacial Myology*, 27, 2001, 18-23.

Schudy, F.F.: Vertical growth versus anteroposterior growth as related to function and treatment. *Angle Orthod.* 34, 1964, 75-93.

Thuer, U., and Ingervall, B.: Pressure from the lips on the teeth and malocclusion. *Amer. J. Orthod.*, 90, 3, 1986, 234-242.

Vig, P.S., and Cohen, A.M.: Vertical growth of the lips: A serial cephalometric study. *Amer. J. Orthodont.*, 75, 4, 1979, 405-415.

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