OMD

OROFACIAL MYOFUNCTIONAL DISORDERS: Assessment, Prevention and Treatment

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Orofacial Myofunctional Disorders (OMDs) are disorders pertaining to the face and mouth and may affect, directly and indirectly, chewing[1], swallowing[2, 3], speech[4, 5, 6], occlusion[7, 8, 9, 10], temporomandibular joint movement[11, 12], oral hygiene[13, 14], stability of orthodontic treatment[15, 16, 8, 17], facial esthetics[18, 9], and facial skeletal growth[19, 20]. Orofacial Myofunctional Disorders may have an impact on treatment by orthodontists, dentists, dental hygienists, speech-language pathologists and other professionals working in the same anatomical and physiological area.

Most OMDs can be easily assessed by dentists and orthodontists and, in many cases, they can be prevented, especially in young children with deciduous dentition still in place, thus promoting a more harmonious growth of the orofacial complex. When OMDs are identified in older children, teenagers and adults, a multidisciplinary approach of their treatment would ensure the best care results, by involving the orthodontist, the orofacial myologist, the dental hygienist and other professionals such as ear-nose-throat specialists, allergists and osteopathic physicians to name a few.

With the unprecedented expansion of medical knowledge and the need to become highly specialized, medical and health professionals are often unaware of the contributions offered by another disciplines in the treatment of patients with multiple disorders. For instance, a speech pathologist might find it difficult to address the correction of certain speech sounds like /s, z/ or /ch, j, sh/ when the child has no habitual nasal breathing, no lip competence, has an excessive anterior overjet or wears a bulky oral appliance. Conversely, an orthodontist might be frustrated by an unstable occlusion, stubborn anterior open bites or unexpected treatment relapses. The natural bridge is Orofacial Myology or the study of orofacial myofunctional disorders and its application, orofacial myofunctional therapy, which has been around in various forms for many decades.

What are OMDs? The most common are:

- Oral breathing or lack of habitual nasal breathing;
- Habitual open mouth posture and lack of lip seal with patent nasal passages;
- Reduced upper lip movement, with or without a restricted labial frenum;
- Restricted lingual frenum, from borderline to ankyloglossia;
- Anterior or lateral tongue thrust at rest (static posture);

- Low and forward tongue position at rest, usually accompanied by an increased vertical dimension;
- Inefficient chewing related (or not) to temporomandibular joint (TMJ) disorders or malocclusion;
- Atypical swallowing, with or without a tongue thrust (dynamic posture);
- Oral habits, like excessive or non-age appropriate sucking (bottles, sippy cups, pacifiers, the tongue, fingers or clothes), biting (lips, the tongue, cheek, fingernails, cuticles or pens) and chewing (gum or gummy candies);
- Oro-facial habits like touching one's face, mouthing of fingers or objects, licking lips or leaning on one's hand;
- Forward position of the head at rest, during chewing and during swallowing.

Just like in orthodontics the ideal dentition should be in Class I, with perfect occlusal interlocking, smooth protrusion, retrusion and lateralization, with the temporomandibular joint (TMJ) in an optimal centric position. So, from the functional perspective of an Orofacial Myologist, the ideal situation is: optimal nasal breathing, therefore an appropriate lip seal, an appropriate vertical space between the dental arches, the tongue usually resting against the palate, relaxed facial muscles, correct chewing and age appropriate swallowing. Once the "norm" is established it's easier to determine variations and abnormalities.

AIRWAYS FIRST AND FOREMOST

Obstruction of the nasal airways is the most important etiological factor in OMDs. Healthy children who develop normally tend to keep their lips closed at rest, breathing nasally. Mouth breathing becomes a necessity when the nose is congested or anatomically compromised. However, the benefits of nasal breathing, such as humidification, filtration and the warming of the air are lost in oral breathing. Nasal breathing is positively correlated to lip seal, the appropriate development of the orofacial structures[21, 22, 23, 24] and a correct tongue position[20]. Nasal breathing also contributes to a more desirable facial outlook[9]. Even a cursory visit to any art or history museum can attest that through history people have been represented in classic paintings or statues with a proper lip seal at rest.


Fig. 1

Lip seal, determined by proper nasal breathing, is useful to orthodontists as lips, along with cheeks, form the natural retainers for the dental arches[25]. A lack of lip seal may therefore be identified as an OMD that needs to be addressed (Fig.1).

Not all instances of a lack of a lip seal indicate a nasal problem. In many cases patients are able to comfortably breathe through the nose but, at some point in the past, they developed a habit of breathing orally, maybe after a prolonged period of nasal congestion. Now a necessity has become a habit and unless the habit is replace by another habit (lip seal), there is less chance that the nasal breathing pattern is re-established.

Although there are some easy assessment tools and techniques, it's always a good policy to have a patient with oral breathing, or a habitual open mouth posture, to undergo a full ENT evaluation to ascertain the patency of the anterior and posterior nasal passages. Although orthodontists or dentists can easily identify hypertrophic or enflamed tonsils restricting the airways, an ENT is the proper professional to evaluate and manage the oral airways. Hypertrophic tonsils may drastically reduce the posterior oral space, therefore affecting breathing and promoting the anterior position of the tongue at rest ("tongue thrust"), which is often related to malocclusion[26, 27].

Nasal patency can be easily assess by the following:

Rosenthal Test: The patients are asked to close their mouth and breath nasally for one minute (or 20 breaths), if the nose is patent the task should be easily accomplished.

Gudin Test: The examiner pinches the patients' nose for one second and then lets go of one nostril at the time, observing whether or not there is a spontaneous flaring of the nares. People who breathe orally tend to have a depressed or absent flaring of the nares.

Nasal mirror: This allows a gross estimation of nasal patency, but requires at least a basic understanding of nasal breathing physiology.

A person with restricted or no nasal breathing tends to exhibit head postural changes[28], a lowered mandible, a high palatal vault and constricted maxillary vault, a forward and low tongue position, increased vertical dimension, reduced facial muscle activity or a hyperactive mentalis muscle and grimaces during swallowing.

Often the patient presents a noticeable forward head posture, that is an attempt by the body to create more pharyngeal space for breathing. A forward head posture, although it provides a better breathing situation, in the long run is usually linked to postural changes, muscle pain[29] and occlusal alterations[30].

UPPER LIP FRENUM

The lack of a lip seal is usually linked to a habitual open mouth posture or oral breathing, but during a growth and development phase it

may be related to a still-developing or underdeveloped upper lip. The upper lip grows until about age 12 in girls and about age 17 in boys[31], so a lack of a lip seal in a 7-year-old child is not necessarily pathological, although the lips may still need to be "trained" to stay closed together.

The lip seal means that there should be no space between the lips at rest, in fact there should be a saliva seal between them. When there is a noticeable space (like 5+ mm), apart from habit and lip growth, there is the possibility that the upper central labial frenum is too restricted and that the upper lip is prevented from reaching its full motion and providing a comfortable seal. A restricted upper lip frenum may also be thick enough or attached low enough to contribute to central incisor diastema. Moreover, a lack of a lip seal has been linked to air exposure gingivitis[32, 13].

LINGUAL FRENUM

In the last decade, there has been an emphasis in properly assessing the lingual frenum and to determine at what point the restriction (tongue-tie) is significantly affecting functions like:

- Breastfeeding
- Oral clearance of food (buccal cleaning)
- Optimal speech
- Optimal chewing
- Optimal swallowing
- Social activities (playing musical instruments, kissing, etc)

A tongue-tie is one of those OMDs easily overlooked and yet it may be involved in puzzling delays in achieving orthodontic or orofacial myofunctional therapy results[33, 34, 35] (Figs. 2-4). In severe tongue-tie cases (ankyloglossia) (Fig.5) the tip of the tongue assumes a heart shape, or the tongue is unable to touch the upper or lower molars, or it "bunches up" in protrusion by relying heavily on the transverse muscles and less on the superior longitudinal muscles. However, it's easier to miss a short frenum with posterior attachment because the tip of the tongue looks fine, but the dorsum of the tongue does not lift adequately for a normal swallow.

An easy way to assess the severity of a tongue-tie is to measure the maximum aperture of the mouth, from the edge of the upper incisors to the edge of the lower incisors, and then ask the patient to place the tip of the tongue against the incisors papilla and take the same measurement. If the second measurement is less that 50% of the first measurement then either a therapeutic "stretch" (which is actually a re-patterning of the tongue muscles) or a surgical release should be considered. More comprehensive protocols to assess the severity of the tongue-tie and the functions it affects have been developed by Marchesan[33, 34, 35] and are recommended for their accuracy and ease of consultation.

LOW TONGUE REST POSITION

Although the "normal" rest position of the tongue is still somewhat controversial, from a therapeutic standpoint, it is accepted that the tip should rest against the incisal papilla and the back of the tongue should rest against the posterior portion of the palate. In a minority of people the tip of the tongue lays down, below the lower incisors, with no repercussion to surrounding structures. There are some exceptions to the most common position of the tongue tip up, notably in the presence of TMJ pain, in which keeping the tongue low could actually induce excessive masticatory muscles activation[36, 37].

The correct tongue rest posture (a static position) against the palate implies nasal breathing, as it is not conducive to effective oral breathing. When the body needs more air, however, the tongue is kept low in the jaw and the jaw is more likely to be pushed forward. A low tongue rest posture is another OMD that is easy to identify and often comes accompanied by other issues. Proffit [38, 39] found that a low intensity pressure but with a long duration, as in the case of a tongue thrust at rest, may affect the dentition and impact orthodontic treatments, when constant pressure is exerted by the tongue within the mandible, as opposed to within the palate and maxilla.

A low tongue at rest in preschoolers and school-age children (Figs. 6-8) is often accompanied with speech misarticulations mostly affecting the sibilants /s, z/ as they are then produced with the tongue between the teeth as in /th/ (think, this)[40, 41, 42, 2]. Finally, a low tongue rest position is also accompanied with increased vertical dimension and changes in the craniofacial dentoskeletal structures[43, 44, 45, 46].

"TONGUE THRUST"

The very concept of a "tongue thrust" has been controversial for decades, probably because of misunderstandings and different nomenclature used by professionals, as opposed to the nomenclature used by parents and patients. A

tongue thrust is very easy to identify, both during swallowing and during speech (dynamic tongue pattern). The ease with which this OMD is identified led to the belief, in the past, that a tongue thrust was the cause of open bites, although studies indicated the opposite[8, 9, 47, 48] that the tongue finds an open space and occupies it, often preventing the teeth from erupting properly.

An anterior tongue thrust is a natural occurrence in babies and in young children and tends to naturally disappear with the emergence of the permanent dentition. The infantile type of swallowing, with a forward direction of pressure, should evolve into a more mature swallow pattern in which the direction of the pressure is upward, toward the palate. However, in many individuals this shift does not occur naturally (Figs.9 & 10), due to several factors, the most important of which are the absence of proper habitual nasal breathing and the presence of hypertrophic tonsils and adenoids[49]. When tonsils are so hypertrophic that the airways are drastically reduced, the child has no alternative but to keep the tongue low and forward to be able to breathe more comfortably (obligatory tongue thrust).

The presence of an anterior tongue thrust is indeed linked to an anterior open bite and/or an excessive overjet[47, 48, 43, 44], speech misarticulations affecting /s, z/, poor Eustachian tubes clearance (therefore the insufficient aeration of the middle ear)[50], the instability of swallowing mechanisms[3] and TMJD[11, 12].

However, in some cases, a tongue trust may be one of the signs and symptoms of a sleep disorder, when the body tries to keep the tongue out of the way and therefore opening up the posterior airways. The proper distinction between a developmental tongue thrust and an adaptive tongue thrust is the co-presence of other signs and symptoms of sleep disorders, such as tongue scalloping, nocturnal bruxism, daytime sleepiness among many others[51, 52]. In cases of suspected sleep disorders the tongue thrust would not be the object of therapy but would be regarded as a symptom of something more serious, which would require proper referrals to be addressed.

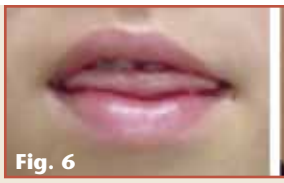
Fig. 6


Fig. 7


Fig. 8


Fig. 9


Fig. 10

A tongue thrust may be related to a posterior crossbite (unilateral or bilateral) or posterior open bite (unilateral or bilateral). Once again, the tongue may find a space created by mixed dentition and with its own intrinsic tone prevents or delays the eruption of the permanent teeth, creating or maintaining a posterior open bite[53, 8, 9]. In the case of a crossbite, the tongue may not be resting up against the palate, but instead exerting lateral constant pressure against the mandible and lower teeth.

The natural pressure of the cheeks, accompanied by the absence of a counter presence of the tongue at rest, may be enough to cause a transverse collapse of the maxilla and the emergence of a crossbite. In some cases, when the tongue exhibits an asymmetric tone (one side significantly stronger than the other half), it's possible to see also a unilateral crossbite, on the stronger side of the tongue.

CHEWING DISORDERS

Chewing is a highly complicated function involving several soft and hard structures, cranial nerves and muscular valves. It's the perfect coordination between the jaw, chewing muscles, cheeks, lips, tongue and soft palate, all moving in timed concert, moving the food (bolus) between the teeth, preparing it for propulsion through the oropharynx into the esophagus. Normal chewing is with the lips closed to prevent spills of liquids and chewed food, while the food is soaked and amalgamated by saliva, crushed by teeth and prevented from prematurely falling into the pharynx by the gentle contact between the soft palate and the tongue.

Good chewing also implies good nasal breathing. In presence of reduced or absent nasal breathing, chewing becomes a struggle as breathing always take precedence over anything else. Because breathing is a struggle, the food is not properly chewed, it's not soaked by saliva properly and it's not properly swallowed. Anecdotally, patients who cannot chew properly tend to drink lots of liquids to wash down the food. Also, because of the poor chewing and the larger food fragments ingested, patients often exhibit texture aversion, in which they refuse to eat certain foods and tend to prefer foods that are soft and with uniform consistency (like fast food).

Some chewy foods with tough consistency are thought to aggravate existing a TMJD. Dysfunctions of the TMJ, like a reduced mouth opening, reduced lateral movement and reduced anteroposterior movement, clicking or pain, also affects chewing. Sometimes asking patients about their chewing (and chewing habits) can reveal unsuspected problems with the TMJ. Also, chewing can be temporarily impaired after orthognathic surgery, until the range of motion and strength of motion of the mandible is restored.

ATYPICAL SWALLOWING

Along the continuum of swallowing there is:

- Normal swallowing (or optimal swallowing)
- Atypical swallowing (affecting oral preparation and the oral phase of swallowing)
- Dysphagia (disodered swallowing)
- Aphagia (absence of swallowing).

Aphagia is a life-threatening medical condition managed mostly by physicians. Dysphagia, or dysfunctional swallowing, may be temporary or permanent and is usually treated by specially trained speech pathologists working with a team with physicians and dieticians.

Children undergoing orthodontic treatment might present atypical swallowing. The patient is usually well nourished, therefore the swallowing is functional (or it would be classified as dysphagia) but it's not yet "optimal". Atypical swallowing is fairly easy to detect, as the tongue tends to push forward to create a seal with the lips, the teeth are not in occlusion and the face presents a grimace by contracting the mentalis muscle, or the orbicularis oris or the buccinator in the cheeks. Often the lips are also open and the tongue pushes outside the lips.

Malocclusions are often present in patients with atypical swallowing [3, 8, 9, 2] because the tongue pressure is exerted forward or laterally, as opposed to upward, toward the palate. The palate has a shape designed to accommodate the tongue at rest and during swallowing, therefore, when the tongue is secured against the palate and the teeth are in occlusion, the orofacial muscles exerts the proper tension to implement a swallow that is fast and efficient[56]. A proper swallow against the palate also activates the muscles that twists open the Eustachian tubes, contributing to the aeration and drainage of the middle ear[57, 50]. The purpose of orofacial myofunctional therapy is to help the patients achieve "optimal" swallowing or a "normal range", as the concept of what constitutes a "normal" swallowing is still controversial.

Fig. 11

NOXIOUS OROFACIAL HABITS

Not everything that goes in the mouth is necessarily noxious or bad. It depends on frequency, duration and intensity. The higher these three factors are, the more likely the habit has deleterious consequences for the growth and development of the orofacial complex and for the positive outcome of the orthodontic or orofacial myofunctional treatment.

Sucking one's fingers may not be significant unless it's done daily, for hours at time and with enough intensity to often cause an abnormal growth of the finger. Situations in which identification and modification of intensity, duration and frequency are crucial are: thumb and finger sucking[58, 59, 60, 61, 62], propping the jaw on one's hand[63], in addition to excessive gum chewing and nail biting[64], to name a few.

Lip licking is also a significant oral habit. When lips get dry (because of dehydration or oral breathing) patients feel the need to lick them, thus getting short-term relief but causing long-term lip and perioral skin irritation due to the acids present in the saliva. This habit can trigger a spiral of chapped lips, lip licking, more chapped lips and more lip licking. If the patient is already exhibiting an anterior tongue thrust, adding the lip licking habit is certainly unhelpful.

Oral habits usually preserve an infantile pattern of movement (Fig. 11), force the mandible into unnatural positions for a prolonged period of time or with great force (as is nail biting). Oral habits are comforting to patients therefore they create (and maintain) a craving for such unhealthful behaviors. Eliminating or greatly reducing these orofacial habits takes specific skills of applied behavior modification and the purpose of therapy is to replace an old habit, like thumb-sucking, with a new habit, like lips closed and tongue resting on the palate. Treating OMDs in general requires a specific set of skills and specific knowledge, usually the purview of orofacial myofunctional therapists[65, 66, 9].

PREVENTION

Preventing OMDs has a positive effect in both micro-economies (people) and in macro-economies (countries). In terms of a micro-economy it's easier to eliminate noxious habits or pathological conditions earlier on and to assist in the harmonious growth of the orofacial complex of patients[2, 42, 67]. The orofacial complex grows to its full potential when there are no interferences along the way[68] and it's comforting to see that multiple organizations, including the American orthodontic Society or the American Academy of Pediatric Dentistry are drawing attention to prevention of OMDs.

These disorders require a multidisciplinary intervention where the pediatrician, the ENT, the pedodontist, the orthodontist, and the orofacial myologist work together to ensure that the growth and development of the orofacial complex takes place naturally and appropriately. In some cases, other professionals may be needed to complete the team, such as a speech-language pathologist, a dental hygienist, an osteopathic physician, a nutritionist, a gastroenterologists and/or allergist, so that the real causes of an orofacial myofunctional disorder are identified and corrected as soon as they develop[40, 41, 69]. A team of professionals who understand and appreciated one another's contribution to the patient's wellbeing may be able to arrest and reverse the

cascading effect that certain situations may cause.

For instance, an allergy that has not been addressed may cause nasal congestion, which may cause a chronic open mouth posture, which is linked to poor palatal development and TMJ instability, which is linked to less than ideal orthodontic results, prolonged use of retainers and even sleep disorders and surgery. Parental involvement and the patient's preferences and values are crucial variables, as often some dietary and life-style changes are needed to arrest the noxious cascade, and these changes need to be implemented by the patient.

Preventing OMDs benefits patients, orthodontists, and third party payers because it intercepts situations that could derail the normal growth and development of a harmonious orofacial complex. Preventing OMDs also makes sense in the global health discourse, because millions of people are emerging from poverty world-wide and they are exposed to the same perks of more affluent countries and therefore they may develop OMDs at an unprecedented number, although the economic ability to take care of the consequences is not growing on par with the disorders.

Finally, in cases where an orofacial myologist is not available, an array of oral appliances and habit trainers have been employed for years[70, 71]. However, in cases where multiple OMDs are present or undiagnosed, results have been mixed at best[62, 72], as the habit tends to persist once the appliance is removed and the patients have not been taught the correct tongue posture.

TREATMENT OF OMDs

Just like when orthodontic treatment is dictated by anatomical and physiological constraints, so too is orofacial myofunctional therapy because the changes in functions are dictated by anatomical constraints (like a restricted palate shape or a restricted lingual frenum) and by physiological constraints (like the absence or reduction of nasal breathing).

The principles of therapy are:

- Eliminating or drastically reducing orofacial noxious habits by modifying their duration, frequency and intensity.
- Changing orofacial muscle movements to the desired and optimal pattern.
- Ensuring the generalization of a correct pattern and function (same optimal behavior in different contexts)
- Ensuring the habituation of a correct pattern and function (same optimal behavior in different times)

All these principles are implemented through motivational techniques[73] customized by the therapist and honed by professional experience[74, 75]. Some techniques imply self-awareness and patient education[76, 77, 78] while other techniques derive from the field of dysphagia treatment[79, 56] or speech articulation treatment[80, 5]. From a neurophysiological standpoint, the patients need to internalize the correct pattern of orofacial movements, and keep approximating to that behavior through repetition over time, for the results to be stable[81, 82, 83, 84, 85, 86].

In recent years studies have been conducted on the minimum number of therapy sessions necessary to cause a physiological change in orofacial muscles and on the need to build in follow-ups in the therapy cycle to identify and correct possible functional relapses[87]. There are very specific neurophysiological principles behind the process of acquisition of a correct muscle pattern, its generalization and habituation[88, 89, 90, 91, 92, 93, 94, 95]. Interrupting therapy too soon may cause a regression and disappearance of the newly acquired functional pattern[96, 87], just like interrupting orthodontic treatment too soon may invalidate the gains to date.

Orofacial myofunctional therapy requires specific skills because the muscles of the face and mouth are different, anatomically and physiologically, from muscles of the limbs and the trunk. Orofacial muscles share multiple functions like breathing, eating, speaking, exploring etc. and those functions are implemented by changing the position or shape of the muscles. However, even the most skilled therapist might face some OMDs that cannot be eliminated by orofacial myofunctional therapy alone, but may require a coordinated intervention by the orthodontist first, as in the case of a restricted palate (a maxillary transverse deficiency), an excessive overjet or an open bite.

A visit to an oral surgeon may also be the first step in treatment, in the case of a restricted lingual frenum, while other times the first step might be the need to see the allergist, the ENT or the osteopathic physician. Therefore a multidisciplinary approach is absolutely necessary[97] as the timing of the various therapies needs to be decided as a team, after a full evaluation of the patient is completed and a list of goals has been approved by the patient. Myofunctional therapy may occur before orthodontics, during orthodontics or after orthodontics. Just like form and function influence each other, orthodontics and orofacial myofunctional therapy also influence each other.

Identifying OMDs, striving to prevent them or treating them in a multidisciplinary approach should be a part of the standard of care in a dental or orthodontic office, in orofacial myology and in speech pathology as the anatomical changes brought forth by the orthodontist's treatment are more stable when muscles and function patterns are optimized. Conversely, appropriate functions happen in appropriate spaces and so speech pathologists or orofacial myologists need to work closely with orthodontists as they are expanding palates or reducing excessive overjets before starting myofunctional therapy.

By being aware of the intricate relationship between orofacial structures and orofacial functions orthodontist and other professional working within the same area can coordinate care with an orofacial myofunctional therapist for the benefit of the patient and treatment success and stability.