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POSTER 4: MULTITASKING PROPERTIES OF SOME OROFACIAL MUSCLES

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ABSTRACT

In recent years many studies on the anatomy and neurophysiology of muscles of the face and mouth have revealed a much more complex ability of muscles to "multitask". Apart from being involved in sucking, swallowing, chewing and speaking, some muscles are also involved in the patency of the airways during sleep, the postural position of the jaw during physical activities, the promotion of nasal breathing, or stress relief, just to name a few functions. In this brief review, some additional properties of the genioglossus (GG), the palatoglossus (PG), the masseters (MM) and the orbicularis oris (OO) will be reviewed.

KEYWORDS: genioglossus, palatoglossus, masseters, orbicularis oris, breathing, sleep, posture, stress.

INTRODUCTION

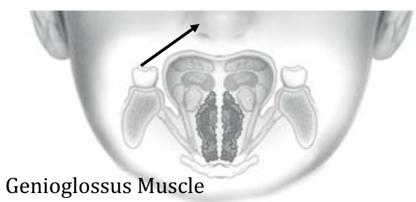
Speech-language pathologists and myofunctional therapists usually consider orofacial muscles from the point-of-view of sucking, swallowing, chewing and speaking, but several orofacial muscles have other interesting purposes. This article will focus only on 4 muscles: The genioglossus, the palatoglossus, the masseters and the orbicularis oris. It should come to no surprise that these four muscles in particular adapt their function to "serve" breathing first and foremost. Therefore, considering these muscles through the lens of breathing helps the clinician identify and appreciate the common function that ties these (and other) orofacial muscles.

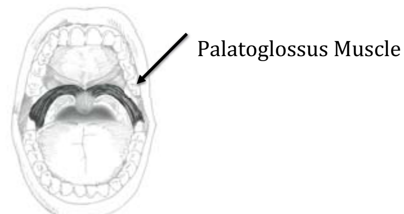
Genioglossus (GG)

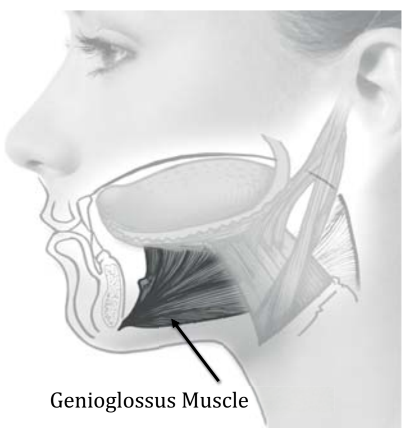
The genioglossus (GG) is an extrinsic single tongue muscle, mainly responsible for *tongue thrust*, as it moves the tongue toward the origin of the muscle, which is the genial tubercle in the lingual face of the mandible. The GG is regulated by the 12th pair of cranial nerves, in plexus with the Vagus nerve (10th), receiving information from both the swallowing and the breathing central pattern generators in the brain and making the GG both a *swallowing and a breathing muscle* (Sawczuck & Mosier, 2001; Saboisky, Butler, Fogel, Taylor, Trinder, White, & Gandevia, 2006; McFarland & Lund, 1994; McFarland & Lund, 1995). Its purpose is to assist the propulsion of food into the esophagus but most importantly to keep the upper airway open at all times. The GG has sensors for negative pressure (such as during snoring or sleep apnea) and excessive CO2, which triggers the anterior thrust of the tongue to increase airway space (Fogel, Malhotra, & White, 2004, Mortimore, Mathur, & Douglas, 1995; Napadow, Chen, Weeden, & Gilbert, 1999). It is considered a "*dilator muscle*", that is active in the supine position and during sleep (Arens & Marcus, 2003; Mathur, Mortimore, Jan, & Douglas,1995; Malhotra, Pillar, Fogel, Edwards, Ayas, Akahoshi, Hess, & White, 2002; Jordan, White, Lo, Wellman, Eckert, Yim-Yeh, Eikermann, Smith, Stevenson, & Malhotra, 2009; Popovic & White, 1995).

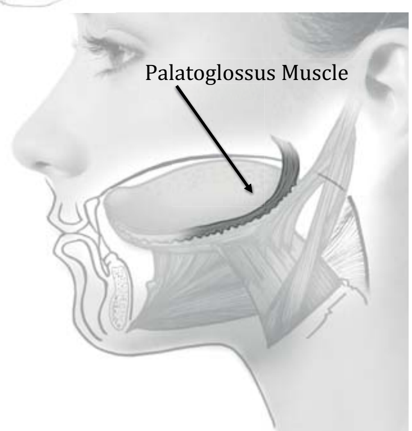
During evaluation, it's important to distinguish between a tongue thrust due to a restricted lingual frenum or a tongue thrust due to breathing issues, during the day and during the night.

A tongue thrust behavior that originate in poor nasal breathing will surely require a multidisciplinary approach to address the primary dysfunction, in which myofunctional therapy is one of the modalities to be implemented.









Picture courtesy of: Kristie K Gatto (2016) Understanding the Orofacial Complex: The Evolution of Dysfunction. Outskirts Press, Parker, CO. 2016.

A therapeutic approach is to promote the stable resting position of the tongue against the palate achieved by creating an area of negative pressure during swallowing that can be maintained even for prolonged periods (Engelke, Jung, & Knosel, 2011) daytime and nighttime. Other exercises for the genioglossus are described in Guimarães, Drager, Genta, Marcondes, & Lorenzi-Filh, 2009.

Palatoglossus (PG)

The palatoglossus (PG) are paired muscles that originate from the raphe between the hard and soft palate and inserts in the posterior lateral sides of the tongue. When activated it pulls the back of the tongue up and the soft palate forward, therefore increasing the free space in the airway (Patil, Schneider, Marx, Gladmon, Schwartz, & Smith, 2006; Sant'Ambrogio, Tsubone, & Sant'Ambrogio,1995; Shea, Edwards, & White, 1999). Although it functions as an extrinsic tongue muscle, usually it's not considered as such, as it is innervated by the Vagus nerves (10th), making it a *breathing muscle*. This pair of muscles is more active when laying supine and breathing nasally, and it's also considered a "*dilator*" muscle which is crucial for optimal sleep breathing (Arens & Marcus, 2003; Mathur et al.,1995; Malhotra et al., 2002; Jordan et al., 2009; Popovic & White, 1995).

During the evaluation of a patient, the ability to create a suction with the tongue within the oral cavity would guide the therapy. The negative pressure created in the oral cavity, will maintain the palatoglossus and the soft palate in a physiologically optimal position for nasal breathing.

Masseters (MM)

Clearly the masseters (MM) are very important for chewing, being the "crushers" of food. In fact, if the masseters are not activated in biting, that indicates posterior dental malocclusion. However, the MM (like the temporalis muscles) are the only orofacial muscles that have a crisp "stretch reflex" similar to skeletal muscles (Clark, 2003; Miles, Flavel, & Nordstrom, 2004), making them an important postural system, in which the tone of the MM allows for optimal jaw position during activities such as running, jumping or walking (Miles, 2007). Thanks to the stretch reflex, and unlike other orofacial muscles, their repeated activity in chewing and clenching causes an increase in the muscle mass. The MM are active in chewing and clenching, which are functions considered natural stress relievers (Gómez, Ortega, Horrillo, & Meana, 2010; Hori et al., 2005). They are also active in bruxing (Gallo, Gross & Palla, 1999), which is involved in micro-arousals to limit the damage of sleep apnea, as the function of the MM depends on, and it is influenced by breathing (Hyama, Ono, Ishiwata, Kuroda, & Ohyama, 2003). Finally, the MM are involved with strength exertion (as in weight lifting or bearing down) and with expression of aggression. Excessive chewing and clenching may become a parafunction with deleterious effects on oral structures and functions.

During evaluation, the MM can be assessed with just clenching, chewing on various foods with increasingly harder consistency or, in research, chewing on "colorimetric beads" that allows us to visually measure the pressure of the masseters (Escudiero-Santos, 2006).

Prevention of the masseters' dysfunction should be a therapeutic goal facilitated by encouraging breastfeeding, which promotes optimal muscle function and development, and by encouraging the introduction of appropriate chewable foods in weaning. If therapy is required, it may address the hyper-functions (such as chewing gum, clenching when stressed, or sleep bruxing) or the hypo-functions (such as dental malocclusion, habitual soft textured diet, or open mouth posture), in a multidisciplinary manner. Therapy may focus on the masseters' function in cases of TMJ rehabilitation, facial pain or post-surgery resection, which is best accomplished within a multidisciplinary treating team (De Felício, Ferreira, Medeiros, Rodrigues Da Silva, Tartaglia, & Sforza, 2011; Tartaglia, Lodetti, Paiva, De Felicio, & Sforza, 2011). Chewing proper food and sham chewing with silicon wafers or latex/rubber tubes are also strategies used to recover masseters' function.

Orbicularis Oris

Apart from the orbicularis oris' fundamental purpose of sealing off the mouth during sucking, suckling, chewing and swallowing and in speech articulation, it is involved in providing optimal breathing when the nasal passages are somewhat congested (Busanello-Stella, Blanco-Dutra, Corrêa, & Silva, 2015) and during sleep (Eastwood, Curran, Smith, & Dempsey, 1998; Fitzpatrick, McLean, Urton, Tan, O'Donnell, & Driver, 2003). Also, when closed, lips aide in the proper positioning of the jaw, and therefore of the tongue. When the lips are open, the jaw is open which results in excessive freeway space that may be damaging for the temporomandibular joints. The somatosensory cortex of the brain (as well as the somatosensory motor cortex) has connections from individual lips (upper and lower) but also from lips together (Toda & Taoka, 2002). The latter projection is as large as the projected connection from the whole face (Baumgartner et al, 1992), thus neurologically dictating the importance of keeping the lips closed. Moreover, the orbicularis oris has some stretch reflex (Clark, 2003) suggesting that closed lips are also part of the postural system that keeps the jaw in the proper position.

During evaluation, the ability to breathe nasally, normally, should be assessed and mouth opening at night should be inquired. The ability to keep the tongue up against the palate in a suction should also be assessed, as the proper tongue position aids the proper closure of the orbicularis oris (Engelke, Jung, & Knosel, 2011). Multidisciplinary therapy for lip closure involves addressing possible allergies and some significant malocclusions, proper nasal breathing training, possible sensory-kinesio-taping, and myofunctional therapy. Myofunctional therapy has been expanding its applications as the intricate functions (and dysfunctions) of orofacial muscles has become more and more apparent, either through publication of recent studies or through novel connections between well know articles published long time ago. A new appreciation of the multiple functions of orofacial muscles may assist the clinician in considering additional variables when assessing patients; when determining a course of action; when coaching preventative strategies, and when making a referral. Above all, the clinician should assess nasal breathing, compatibly within his or her scope of practice, in order to identify and/or rule out breathing difficulties that may impact orofacial muscles. Current *standard of care* requires the clinician to consider all of these variables, because muscle physiology is an ever expanding field and therapists can now find so many more ways to help their patients than ever before.

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