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The Thyrohyoid Muscle: A Crucial Player in Deglutition and Vocalization

El Músculo Tirohioideo: Un Actor Crucial en la Deglución y la Vocalización

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SUMMARY: The thyrohyoid muscle is one of the four infrahyoid muscles. Its role in vocalization and deglutition could be often overlooked, despite its crucial participation in these processes. Unlike other infrahyoid muscles, the thyrohyoid muscle receives innervation from the first cervical spinal nerves which contributes to its unique function. Its primary action involves hyolaryngeal elevation during swallowing, contributing to the opening of the upper esophageal sphincter. In conjunction with other muscles, it also protects the airway and facilitates the passage of food into the esophagus. Variations in the muscle's thickness may exist, and its function can be influenced by chewing habits. Weakened muscles involved in swallowing are often associated with dysphagia, a common complication in stroke and brain-injured patients. Advanced imaging techniques and sleep studies have provided insights into the dynamics and frequency of swallowing. This review explores the anatomic structures, function in action, diagnosis and clinical implications of this muscle. Overall, understanding the significance of the thyrohyoid muscle enhances our comprehension of the intricate interplay of laryngeal muscles during vocalization and deglutition.

KEY WORDS: Thyrohyoid muscle; Anatomy; Deglutition; Vocalization; Dysphagia.

INTRODUCTION

The infrahyoid muscles are a group of muscles located below the hyoid bone in contrast to the suprahyoid counterparts (Truong *et al*., 2022; Kim *et al*., 2023). They are sometimes called as strap muscles in the neck due to their characteristic forms in the neck region. They also belong to the extrinsic laryngeal muscles with others, since they are located around the larynx. Vocalization and deglutition involve intricate coordination of multiple muscles within the larynx including infrahyoid and other intrinsic muscles of larynx, each playing a crucial role in achieving precise movements (Leung *et al*., 2023). Understanding the individual actions of these muscles is vital for comprehending their combined impact. Among them, the thyrohyoid muscle, despite its importance, has often been overlooked and its true significance underestimated. Although it has been primarily recognized as a hyoid bone depressor and part of the larynx depression mechanism after swallowing based on their location (Ko *et al*., 2021), the unique neural supply and function of the thyrohyoid muscle warrant closer examination.

Through meticulous dissections, this review aims to not only recapitulate the anatomy of the thyrohyoid especially focused on the innervation but illuminate its essential role during deglutition and phonation as well (Seo *et al*., 2021). The specific action of the muscles facilitates to seal the upper orifice of the larynx to prevent food entry during swallowing and to modify the laryngeal airway during phonation. By exploring the anatomy and the function of the thyrohyoid muscle, we can better appreciate its significant contribution to this process. Failure of the normal functions lead to sequalae such as dysphagia or dysphonia. From simple palpation to the advanced imaging techniques employed for proper diagnosis will be discussed with some clinical implications of dysfunction.

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General Anatomy

The infrahyoid muscles, including the sternohyoid, sternothyroid, thyrohyoid, and omohyoid muscles, play roles in speech, swallowing, and mastication (Nayak & Vasudeva, 2022). Of these muscles, the sternohyoid, sternothyroid, and thyrohyoid consist of a single belly, whereas the omohyoid muscle comprises a superior belly, an inferior belly, and an intermediate tendon. Innervation of these muscles has been roughly described as the *ansa cervicalis* or hypoglossal nerve along it according to the traditional literature. The platysma muscle is positioned between the strap muscles and subcutaneous tissue.

The infrahyoid is located below the hyoid bone and around the larynx (Fig. 1). The larynx, positioned at the midline of 3rd cervical vertebra through 6the cervical vertebra, serves as the connection between the pharynx and the trachea. It performs essential functions in respiration, phonation, and swallowing, encompassing a cartilaginous skeleton, muscles, mucosal lining, ligaments, and membranes (Jacobsen *et al*., 2023). The larynx has both intrinsic and extrinsic muscles. The infrahyoid belongs to the latter and the movement of the thyrohyoid is closely associated with the larynx.

The thyrohyoid, situated within the anterior triangle of the neck, is relatively small compared with other infrahyoid muscles. It is a quadrilateral-shaped skeletal muscle, similar to but shorter than the other infrahyoid. Thus, all are described as neck strap muscles. It represents a superior continuation of the sternothyroid muscle and contributes to the movement of the hyoid bone and larynx. Its origin can be traced to the oblique line of the thyroid cartilage, ascending upwards to attach to the lower margin of the greater horn of the hyoid bone and the adjacent part of the body of the hyoid bone.

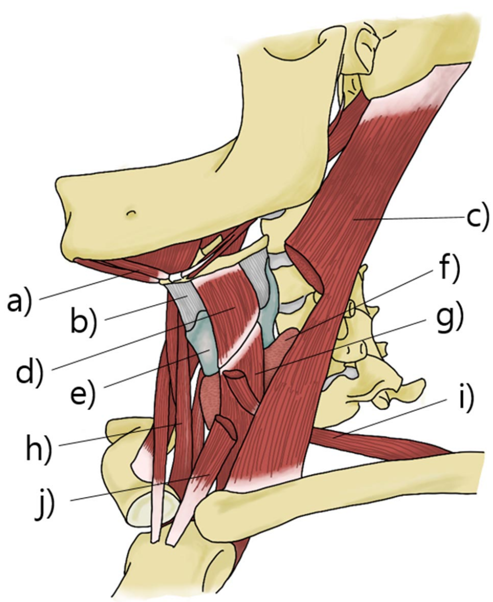

Fig. 1. Suprahyoid and Infrahyoid muscles a) anterior belly of digastric muscle, b) thyrohyoid membrane, c) sternocleidomastoid muscle, d) thyrohyoid muscle, e) thyroid cartilage, f) thyroid gland, g) sternothyroid muscle, h) sternohyoid muscle, i) inferior belly of omohyoid muscle, j) sternal head of sternocleidomastoid muscle.

The anterior cervical space lies deep to the sternocleidomastoid muscle and infrahyoid muscles. It encompasses the front and lateral aspects of the visceral space and is posteriorly associated with the carotid space. Within the anterior cervical area, the superficial layer consists of the two strap muscles, the sternohyoid and omohyoid muscles, whereas the deeper layer comprises the sternothyroid and thyrohyoid muscles (Mnatsakanian & Al Khalili, 2023). These muscles are enclosed by the superficial layer of the deep cervical fascia, which also envelops the sternocleidomastoid muscle at the sides (Gervasio *et al*., 2010).

The thyrohyoid exhibits notable anatomical relationships with neighboring structures. It is positioned deep to the superior belly of the omohyoid muscle and sternohyoid muscle. Classifications of the thyrohyoid muscles have been proposed based on their relationships and overlaps with the omohyoid and sternohyoid muscles (Sonoda & Tamatsu, 2008). The thyrohyoid membrane, an expansive fibroelastic layer, is one of the extrinsic membranes of the larynx. It connects the upper margin of the thyroid cartilage to the hyoid bone. The central portion of the membrane, known as the thyrohyoid ligament, is relatively thicker and links the superior thyroid notch or laryngeal notch to the hyoid. The lateral surfaces of the membrane feature an aperture through which the internal branches of the superior laryngeal nerves, the superior laryngeal artery, and lymphatics pass (Jacobsen *et al*., 2023). Pertinent understanding the anatomical relationships of the thyrohyoid muscle with its surroundings is essential for its identification and preservation during surgical procedures and for comprehending its role in the complex movements and functions of the larynx and hyoid bone.

The thyrohyoid muscle and the thyropharyngeal portion of the inferior constrictor muscle of the pharynx exhibit symmetrical ventral and dorsal characteristics at the oblique line. X-ray measurements have indicated an average angle of 36 degrees for their origins. Based on these measurements and previous electromyographic findings, both muscles can be considered functionally bipennate. Histologic studies suggest that the origin zone at the oblique line structurally resembles a periosteal–diaphysary tendinous insertion (Fischer & Tillmann, 1991).

The thickness of the thyrohyoid may vary between the left and right sides, potentially influenced by chewing habits (Ishii, 1990). Ultrasonography can be used to identify the thyrohyoid muscle (Gervasio *et al*., 2010), and no significant differences in muscle thickness have been found among different groups (Cheon *et al*., 2016). Muscle thickness has been shown to exhibit a positive correlation with height, weight, and BMI in all groups, with the highest correlation observed with weight, although no significant correlation with age has been found (Matsuo & Palmer, 2008). Advanced imaging techniques, such as 320-row area detector computed tomography, enable detailed visualization of laryngopharyngeal structures and facilitate quantitative kinematic analysis of pharyngeal swallowing (Okada *et al*., 2013).

Various variants of the infrahyoid muscles, including the cleidohyoid muscle, have been reported in the literature (Tubbs *et al*., 2016).

Traditionally, the muscles' primary functions are thought to involve depressing the hyoid bone based on its location but when the hyoid bone is fixed usually by suprahyoid, it elevates the larynx (Buchanan, 1868). The thyrohyoid muscle receives motor fibers from the cervical plexus, specifically the nerve to thyrohyoid, derived from the anterior rami of the first cervical spinal nerve (C1). This innervation pattern distinguishes the thyrohyoid muscle from the other infrahyoid muscles, which are innervated by the ansa cervicalis (Standring, 2016). The blood supply to the thyrohyoid muscle is primarily derived from branches of the superior thyroid artery, with additional contributions from the lingual artery. Lymphatic drainage occurs both above and below the vocal folds, with lymph from above draining through the superior laryngeal vein to the deep cervical lymph nodes, and lymph from below draining along the inferior thyroid vein to the upper tracheal lymph nodes.

Embryologic Development

During embryonic development, the thyrohyoid muscle, along with other laryngeal structures, originates from the fourth and sixth pairs of pharyngeal arches. The cartilaginous and muscular components of the larynx, including the thyrohyoid muscle, derive from these arches. The superior laryngeal nerve, a branch of the vagus nerve (CN X), supplies the part of the larynx that develops from the fourth pharyngeal arch, whereas the recurrent laryngeal nerve, also a branch of the CN X, innervates the part derived from the sixth pharyngeal arch. This embryologic origin emphasizes the shared developmental pathways between the thyrohyoid muscle and other laryngeal structures. The innervation by the superior and recurrent laryngeal nerves further highlights the complex interactions that shape the formation and function of the larynx and its associated muscles, including the thyrohyoid.

Innervation

The thyrohyoid muscle receives innervation from branches of the hypoglossal nerve. The first branch emerges approximately 10 mm distal to the branching point of the superior root of the ansa cervicalis, whereas the second branch arises about 5 mm distal to the first branch. The first branch contributes slightly to the second branch, creating a neural loop. Both branches originate near the origin of the lingual artery and terminate at the lateral margin of the thyrohyoid muscle (Ballard *et al*., 2023).

Fibers originating from the first and second cervical nerves (C1 and C2) join the hypoglossal nerve and partially separate from it in the superior root of the ansa. This superior root also contains ascending fibers derived from the inferior root components, typically the second and third cervical nerves. These ascending fibers, along with the C1 and C2 fibers that remain in the hypoglossal nerve, provide innervation to the thyrohyoid and geniohyoid muscles. Even after branching off, cervical nerve fibers can still be observed within the hypoglossal nerve (Banneheka, 2008). The superior root and the thyrohyoid branch of the hypoglossal nerve diverge from the nerve in the vicinity of the occipital and lingual arteries, respectively (Sakamoto, 2019).

Regarding variations of related nerves with thyrohyoid, the inferior branch of the superior laryngeal nerve (ibSLN) can be divided into three or two branches before penetrating the thyrohyoid membrane in 72.22 % and 27.78 % of cases, respectively. The trifurcated ibSLN is more common than the bifurcated variant in both sexes and on both sides of the neck. In over 80 % of cases, the ibSLN penetrates the thyrohyoid membrane at a distance of approximately 0.1–0.9 cm from the posterior margin of the thyrohyoid muscle and 0.1–1.2 cm from the superior margin of the thyroid cartilage (Paraskevas *et al*., 2012). In another reported anatomical variation of the recurrent laryngeal nerve, the nerve lies in a lateral position and descends from a superior position on the thyrohyoid muscle before entering the larynx medially (Harsha & Padha, 2022).

Roles and Function

The thyrohyoid muscle performs important functions in the movement and stabilization of the hyoid bone and larynx. Its primary role is to depress and fixate the hyoid bone, contributing to various actions, including swallowing and speaking. Additionally, when the hyoid bone is stabilized by other muscles, the thyrohyoid muscle can raise the larynx, which is particularly relevant during activities such as singing high-pitched notes and swallowing, although the primary function of the epiglottis is indisputable.

Swallowing

The thyrohyoid muscle plays a crucial role in hyolaryngeal elevation during swallowing (Leelamanit *et al*., 2002). It forms part of the infrahyoid muscle group, which transfers power from the suprahyoid muscle group to the cricothyroid complex, allowing for the opening of the upper esophageal sphincter (Matsuo & Palmer, 2008). During the process of normal swallowing, the hyolaryngeal complex experiences upward and forward contraction, which is facilitated by the suprahyoid muscles that elevate the hyoid bone and the thyrohyoid muscle, leading to laryngeal elevation (Pearson Jr. *et al*., 2012).

Swallowing comprises three phases: the oral, pharyngeal, and esophageal phases. During the oral phase, the tongue propels the food bolus to the back of the mouth, initiating the swallowing reflex. Closure of the nasopharynx and mouth, followed by glottal closure, occurs. The suprahyoid and thyrohyoid muscles contract, lifting the hyoid bone and causing laryngeal elevation, respectively. The epiglottis is compressed by the tongue and tilted downward. As the larynx is raised upward and forward, a slight vacuum is created in the upper esophagus and lower pharynx, facilitating the passage of the bolus. The pharyngeal constrictor muscles contract to propel the bolus into the esophagus. Mechanisms such as closure of the glottic sphincter, depression of the epiglottis, elevation of the thyrohyoid complex, and relaxation of the cricopharyngeal muscle are crucial for preventing food from entering the trachea (Flores *et al*., 1982).

Different types of thyrohyoid bursts during swallowing were noted and categorized based on their relationship with cycle phases. These types, namely staying in the opening phase, continuing from the opening phase to the closing phase, or beginning in the closing phase and ending in the opening phase, occur with frequencies of 66 %, 20 %, and 14 %, respectively. The duration of the opening phase and the burst durations in the jaw opening muscles during swallowing cycles are consistently longer compared with licking cycles, irrespective of the timing of the swallow (Uchida *et al*., 1994).

Dysphagia refers to a medical condition characterized by difficulty or discomfort in swallowing. Individuals with dysphagia may experience challenges in moving food, liquids, or saliva from the mouth to the stomach. This difficulty can arise from various causes, including muscular or neurological issues that affect the normal swallowing process. Dysphagia can manifest in different forms, and its severity can vary. Some common symptoms of dysphagia include choking, coughing, a sensation of food sticking in the throat, pain while swallowing (odynophagia), regurgitation, or unintentional weight loss. The condition can significantly impact a person's ability to eat and drink comfortably, leading to potential nutritional and hydration issues.

It a common significant complication in stroke patients, disrupts the proper passage of food material from the oral cavity to the stomach due to neurological or structural disorders (Martino *et al*., 2005). Weakened muscles involved in swallowing contribute to reduced laryngeal elevation, commonly causing dysphagia in individuals with brain injuries and potentially leading to subglottic aspiration during swallowing (Beom *et al*., 2011). Interestingly, in patients with cleft lip and palate, compensatory mechanisms involving the thyrohyoid muscles in the pharyngeal stage may compensate for the weakness of the geniohyoid and mylohyoid muscles in the oral phase, resulting in the premature transfer of the bolus to the pharynx (Nagaoka & Tanne, 2007).

Contrary to the expectation, the thyrohyoid is not strongly associated with respiratory and masticatory processes (McFarland & Lund, 1993). Huffing, coughing, and swallowing play protective roles in preventing airway aspiration. Studies comparing the physical properties of these actions found differences in the activities of the external oblique and suprahyoid muscles during huffing or coughing compared with swallowing, suggesting similarities between huffing and coughing in terms of their expiratory function Although swallowing and vomiting are antagonistic motor acts, swallowing can immediately follow vomiting, indicating a close relationship between the central processes involved in generating these behaviors (Umezaki *et al*., 1998a).

Swallowing during sleep

During sleep, the frequency of swallowing usually decreases. The frequency of swallowing decreases as sleep stages deepen, and there is no swallowing activity during deep sleep The amplitude of suprahyoid and thyrohyoid electromyography (EMG) activity reaches its lowest level during REM sleep stage (Sato & Nakashima, 2007). Swallowing is infrequent during sleep and can be absent for extended periods, especially in older individuals.

Although muscle tone is generally inhibited during REM sleep, swallowing can still occur during this stage in association with spontaneous electroencephalographic arousal. Swallows often occur before and after inspiration.

These swallowing patterns during sleep have implications for aspiration-related conditions in the elderly (Sato & Nakashima, 2006, 2009; Sato *et al*., 2016, 2018).

Transection of the hypoglossal nerve reduces swallowing pressure at the oropharynx, but the placement of acrylic material on the hard and soft palates may restore the diminished swallowing function caused by hypoglossal nerve damage. Transection of the recurrent laryngeal nerve leads to a reduction in negative pressure at the upper esophageal sphincter during swallowing (Tsujimura *et al*., 2018).

Animal models, including rabbits, cats, and rats, have been extensively used to investigate the mechanism of swallowing, focusing particularly on the thyrohyoid muscle (Meng *et al*., 1999; Naganuma *et al*., 2001; Spearman *et al*., 2014). Studies in rabbit models have demonstrated that sectioning the pharyngeal branch of the vagus nerve can disrupt laryngeal elevation, primarily achieved by the thyrohyoid, geniohyoid, and mylohyoid muscles (Fukushima *et al*., 2003). Similar studies have been conducted in equine, porcine, and ovine models (Ross *et al*., 1995; Zantingh *et al*., 2013; Gierbolini-Norat *et al*., 2014). In pig models, the timing of thyrohyoid muscle activity has been shown to vary depending on the Infant Mammalian Penetration and Aspiration Scale, highlighting the importance of studying the pathophysiology of swallowing dysfunction induced by recurrent laryngeal nerve lesions (Gross *et al*., 2018).

The application of functional electrical stimulation to the XII/C1 nerve complex using a nerve cuff electrode has demonstrated the potential to induce laryngeal elevation. Stimulation at specific locations can elicit thyroid–hyoid approximation and hyoid elevation, emphasizing the involvement of the thyrohyoid, geniohyoid, and mylohyoid muscles in laryngeal elevation during swallowing (Hadley *et al*., 2013).

Phonation (Vocalization)

Phonation or vocalization refers to the production of sound in the larynx through the vibration of the vocal folds. During phonation, the vocal folds come together, and as air from the lungs passes through, they vibrate, producing sound. The pitch and quality of the sound are determined by factors such as the tension of the vocal folds and the rate of vibration. Dysphonia is a term used to describe an abnormality in the production of sound during speech. It is a general term encompassing various voice disorders that affect the pitch, loudness, or quality of the voice. Dysphonia can manifest as hoarseness, breathiness, strained or rough voice, and changes in pitch. It can result from various causes, including structural issues in the vocal folds, neurological problems, inflammation, or functional factors.

The thyrohyoid muscle has been found to contribute to voice production (Finnegan *et al*., 2003; Azizi Ata *et al*., 2022). The vertical position of the larynx during phonation is primarily influenced by the activity of the thyrohyoid and sternothyroid muscles (Shipp, 1975). Typically, the contraction of the strap muscles leads to a decrease in the fundamental frequency (F0) of phonation. The contraction of the sternohyoid and sternothyroid muscles is associated with increased subglottic pressure, a shorter cricothyroid distance, elongated vocal folds, and higher F0 and vocal intensity. However, the thyrohyoid muscle is associated with decreased subglottic pressure, a wider cricothyroid distance, shortened vocal folds, and lower F0 and vocal intensity (Hong *et al*., 1997).

The posterior cricoarytenoid muscle generally plays a role in opening the laryngeal airway, with additional contributions from the cricothyroid, geniohyoid, mylohyoid, sternothyroid, and middle constrictor muscles. However, the thyrohyoid, cricothyroid, sternohyoid, and inferior constrictor muscles are also involved in closing the laryngeal airway (Konrad *et al*., 1984).

Diagnosis

Laryngeal palpation has been used to assess thyrohyoid posture during rest and phonation. Although it is a reliable measure, no significant correlation has been found between palpation ratings and other measures, limiting its usefulness in predicting laryngoscopic findings or voice diagnoses. However, laryngeal palpation may still provide valuable information on extrinsic laryngeal muscle tension and guide treatment planning. Further research is needed to explore its validity and the impact of other factors on thyrohyoid posture (Harris *et al*., 2023). Palpation of extrinsic laryngeal muscles can enhance diagnostic accuracy by providing information about internal laryngeal postures, particularly for diagnosing muscle misuse voice disorders, such as muscle misuse dysphonia (MMD) type 3 (anteroposterior supraglottic compression) (Angsuwarangsee & Morrison, 2002).

Angsuwarangsee & Morrison (2002) attempted to establish a standard clinical evaluation tool for assessing extrinsic laryngeal muscular tension through palpation as well as its relationship with various voice disorder diagnoses, particularly MMD and the presence of gastroesophageal reflux (GER). They developed a tension grading system for four muscle groups, including the thyrohyoid muscle, and found a strong association between thyrohyoid muscle tension and both GER and MMD. In another study, the thickness of the thyrohyoid muscle was found to change with neck posture, increasing when the neck is flexed due to enlargement of the muscle belly and decreasing when the neck is extended due to reduction of the muscle belly (Cheon *et al*., 2016).

Ultrasound imaging is a noninvasive tool that complements clinical swallowing assessments, and advanced ultrasound systems have shown promising reliability (Winiker *et al*., 2021). In particular, laryngeal sonography is useful for identifying laryngeal structures and vocal fold movement in children (Klinge *et al*., 2016).

Videoendoscopic and videofluorographic examinations are reliable diagnostic tools for detecting swallowing disorders. In a study on patients with recurrent aspiration pneumonia due to severe obstructive sleep apnea, the high rate of uncoordinated deglutition was revealed by videoendoscopic and videofluorographic examinations during wakefulness and time-matched digital recordings of polysomnography and surface EMG of the thyrohyoid and suprahyoid muscles related to swallowing during sleep. The risk of aspiration-related diseases were improved after using continuous positive airway pressure therapy (Sato *et al*., 2021). Computer image analysis of videofluoroscopic examinations revealed dynamic movements of the larynx during swallowing, indicating the coordination of the downfolding of the epiglottis, anterior displacement of the hyoid bone, and thyrohyoid approximation. These findings suggest that as the larynx elevates and the hyoid bone moves forward, the upper portion of the epiglottis is pulled below the horizontal by the traction exerted by the lateral ligaments (Vandaele *et al*., 1995). Several studies have aimed to identify target muscles for electrical stimulation and dysphagia exercises to improve swallowing function (Leelamanit *et al*., 2002; Beom *et al*., 2011).

In patients diagnosed with primary muscle tension dysphonia (pMTD), it is common to observe tension and hyperfunction in the extrinsic laryngeal muscles (ELMs). However, the lack of quantitative physiological metrics hinders the study of ELM movement patterns for accurate pMTD diagnosis and treatment monitoring. Encouragingly, motion capture technology has emerged as a promising tool for studying ELM kinematics. It allows for the differentiation of ELM tension and hyperfunction in individuals with pMTD while exploring potential relationships with clinical voice metrics (Hogue *et al*., 2023). During early expiration, it has been observed that the majority of thyrohyoid motoneurons exhibit either activity or shortened antidromic latencies (Umezaki *et al*., 1998b).

Clinical Implications

Nonsurgical approaches for deglutition-related issues. Patients with dysphagia, including stroke patients, experience kinematic effects and reduced strength in laryngeal and infrahyoid muscles, resulting in impaired swallowing function (Li *et al*., 2023). In addition, decreased hyoid bone motion and epiglottic rotation contribute to swallowing dysfunction in dysphagic patients (Pearson Jr. *et al*., 2013).

Various exercise methods, such as the Shaker exercise, tongue press exercise, chin tuck against resistance (CTAR) exercise, and submandibular push exercise, have been introduced to strengthen swallowing muscles. In a comparative study, the submandibular push exercise demonstrated superiority in inducing selective contractions of the suprahyoid and infrahyoid muscles. However, the CTAR and Shaker exercises also proved effective in this regard (Chang *et al*., 2021). The Shaker exercise, an extensively researched therapeutic intervention, has shown significant improvement in upper esophageal sphincter (UES) opening and anterior laryngeal excursion during swallowing in patients with UES dysfunction (Shaker *et al*., 2002). This positive outcome is attributed to the strengthening of the suprahyoid muscles, including the thyrohyoid muscle, which plays a role in facilitating UES opening (Cook *et al*., 1989).

Electrical stimulation of the thyrohyoid muscle during swallowing has shown promise in improving dysphagia by reducing laryngeal elevation (Leelamanit *et al*., 2002). Indeed, this noninvasive approach actively assists swallowing and may serve as an alternative treatment option. Transcutaneous neuromuscular electrical stimulation (TNMES) combined with conventional swallowing therapy has yielded notable clinical improvement in poststroke dysphagia (PSD). Optimal electrode placement for TNMES should target suprahyoid muscles or both suprahyoid and thyrohyoid muscles (Doan *et al*., 2022). Sequential four–channel TNMES targeting suprahyoid, thyrohyoid, and other infrahyoid muscles has also shown significant clinical improvement in dysphagia treatment in terms of the videofluoroscopic dysphagia scale, penetration–aspiration scale (PAS), and kinematic analysis, highlighting the potential of this novel functional electrical stimulation system (Lee *et al*., 2021).

The existing literature emphasizes the effectiveness of various therapeutic approaches, including exercise methods and electrical stimulation techniques, in the treatment of dysphagia. Targeting specific muscles, such as the suprahyoid and thyrohyoid muscles, has been shown to enhance swallowing function. However, further research is warranted to optimize the placement of electrodes, explore additional benefits of electrical stimulation, and investigate the long-term effects of these interventions on swallowing outcomes.

Surgical approaches and others. Reduced hyolaryngeal elevation, often observed after radiation therapy, affects swallowing function. The suprahyoid and longitudinal pharyngeal muscles, along with the thyrohyoid muscle, are involved in elevating the hyolaryngeal complex during swallowing (Pearson Jr. *et al*., 2013). Hyoid excursion and thyrohyoid approximation are crucial components in the process of swallowing saliva, liquid, and puree. Thyrohyoid muscles are also commonly involved in neck surgeries, such as pharyngo-laryngectomy or arytenoidectomy (Gehanno *et al*., 1996). Laryngoplasty techniques are compared between thyrohyoid and cricothyroid approach for treatment of vocal paralysis and the former demonstrated superior results (Woo *et al*., 2013). Laryngeal reinnervation may be required in cases of recurrent laryngeal nerve injury during surgical procedures, with the thyrohyoid muscle serving as an alternate donor nerve (Graham & Smith, 2020). When the ansa cervicalis is absent owing to previous surgeries, the tiny nerve of the thyrohyoid muscle may be a preferred alternative (Prades *et al*., 2021). Rerouting the thyrohyoid nerve can reduce the length of nerve grafts in laryngeal reinnervation procedures. Moreover, the reliable and consistent characteristics of this nerve make it an invaluable anatomical foundation for such surgical interventions (Crampon *et al*., 2019).

Modified thyrohyoid suspension techniques, combined with uvulopalatopharyngoplasty, have yielded superior surgical outcomes in patients with obstructive sleep apnea (Panah *et al*., 2023). In addition, laryngohyoid suspension procedures have demonstrated improvements in swallowing safety, as measured through the PAS and the NIH Swallow Safety Scale (Johnson *et al*., 2017). Nevertheless, further research is required to evaluate the therapeutic potential and long-term outcomes of these procedures.

Miscellaneously, in forensic investigations, anterior neck hemorrhages have been found to occur due to prone positioning and other factors, highlighting the need for comprehensive analysis beyond postmortem hypostasis (Bingham-Abujasen *et al*., 2023). Therefore, further research is warranted to explore additional therapeutic approaches and investigate the functional and anatomical aspects of the thyrohyoid muscle in such cases.

CONCLUSION

The thyrohyoid muscle holds clinical significance in various contexts. Understanding its anatomical and functional aspects is crucial for accurate diagnosis and appropriate treatment. The muscle's role as a target for nerve blocks further highlights its relevance in surgical procedures and airway management. In summary, although often considered subsidiary, the thyrohyoid muscle plays important roles in various functions and structures of the neck. It actively participates in the elevation and depression of the hyoid bone and larynx, contributing to actions such as swallowing, vocalization, and airway control. The distinctive innervation of the thyrohyoid muscle by the nerve to the thyrohyoid distinguishes it from other infrahyoid muscles. Its anatomical relationships with surrounding structures, blood supply, and lymphatic drainage further underscore itsclinical significance. Overall, comprehensive understanding of the anatomy and function of the thyrohyoid muscle is essential for diagnosing and managing various clinical conditions and ensuring successful surgical interventions in the neck region.

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RESUMEN: El músculo tirohioideo es uno de los cuatro músculos infrahioideos. A menudo podría pasarse por alto su papel en la vocalización y la deglución, a pesar de su participación crucial en estos procesos. A diferencia de otros músculos infrahioideos, el músculo tirohioideo recibe inervación de los primeros nervios espinales cervicales, lo que contribuye a su función única. Su acción principal implica la elevación hiolaríngea durante la deglución, contribuyendo a la apertura del esfínter esofágico superior. Junto con otros músculos, también protege las vías respiratorias y facilita el paso de los alimentos al esófago. Pueden existir variaciones en el grosor del músculo y su función puede verse influenciada por los hábitos de masticación. Los músculos debilitados involucrados en la deglución a menudo se asocian con disfagia, una complicación común en pacientes con accidente cerebrovascular y lesión cerebral. Las técnicas de imagen avanzadas y los estudios del sueño han proporcionado información sobre la dinámica y la frecuencia de la deglución. Esta revisión explora las estructuras anatómicas, la función en acción, el diagnóstico y las implicaciones clínicas de este músculo. En general, comprender la importancia del músculo tirohioideo mejora nuestra comprensión de la intrincada interacción de los músculos laríngeos durante la vocalización y la deglución.

PALABRAS CLAVE: Músculo tirohioideo; Anatomía; Deglución; Vocalización; disfagia.

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