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The Retaining Ligament of the Anterior Digastric Muscle

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Abstract

The anterior belly of the digastric muscle (ABDM) is important in numerous esthetic surgeries including rhytidectomy, alteration of the cervicomental angle via partial resection of the ABDM muscle belly, and suprahyoid muscular medialization and suspension. Recently, the connection between the ABDM and the mylohyoid muscle (MH) has been proposed as important for the mechanism of the digastric corset procedure. This report refers to the connection between the ABDM and the MH as a type of retaining ligament of the anterior digastric muscle (RLAD). This report is the first to directly demonstrate the existence of the RLAD, via photograph and video, and document variation in its attachment sites, its composition, and its behavior when traction forces are applied. In addition to the importance of the RLAD in plastic surgery, the RLAD may affect neurovascular structures between the ABDM and MH and serve as a physical barrier separating the submental fascial space from the submandibular fascial space and, therefore, influence the spread of infection.

Keywords

Anatomic variation; Ludwig angina; neck muscles; plastic surgery; rhytidoplasty

An anatomical understanding of anterior belly of the digastric muscle (ABDM) has importance among a variety of esthetic surgeries including rhytidectomy and alteration of the cervicomental angle via partial resection of the ABDM belly.^{1,2} Submental muscular medialization and suspension may also involve tethering the medial borders of the ABDMs

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together when the ABDMs are contributing to an obtuse cervical angle.³ Indeed, the tethering of medialized ABDMs has been performed for over 20 years but has only recently been reported.³ The procedure of medializing of the ABDMs has been referred to as the “digastric corset” procedure for submental rejuvenation.⁴ As the name suggests, the digastric corset procedure involves suturing the ABDMs together at the midline in order to alter the cervicomental angle.^{4,5} Langsdon et al³ reported good success with their “submental medialization and suspension” technique among 87 patients who underwent the procedure. None of the 87 patients required reoperation for hemostasis or evacuation.³ Labbé et al⁴ performed a study among 20 individuals undergoing the “digastric corset” procedure with excellent result as well, noting only 1 patient (5%) of long-lasting edema.

Lindner noted that fluids in the submental space are trapped and “may only with great difficulty pass laterally beneath the ABDM that is tightly applied to the underlying mylohyoid muscle.”⁶ In their 2013 report, Labbé et al described this “tightly applied” connection between the ABDM and the mylohyoid (MH) as a “ligament of adherence between the ABDM and the MH muscle that has not yet been described.”³ This report also referred to the structure binding the ABDM to the MH as both the “digastric retaining ligament” and also the “mylohyoid retaining ligament.”³ They also noted that there was a digastric retaining ligament between the ABDM and the platysma.⁴ They suggested that the mechanism by which the digastric corset procedure worked was by tightening the MH by transmitting tension through the ABDMs to a “mylohyoid retaining ligament” and into the MH, which is effectively pulled upward.⁴

Because the ABDM is important for a number of esthetic surgeries, including the submental muscular medialization and suspension that incorporates the digastric corset, further examination of the adherence between the ABDM and the MH is warranted. Likewise, because the proposed retaining ligaments of the ABDM have not been directly observed, further inspection of their anatomy is needed. Therefore, this report documents an anatomical inspection, via cadaveric dissection, into the existence of retaining ligaments between the ABDM and underlying structures. Because of the confusion regarding nomenclature, this report will refer to the structure connecting the ABDM to nearby structures as the retaining ligament of the anterior digastric muscle (RLAD).

MATERIALS AND METHODS

A population of cadavers used in a medical school gross anatomy course were inspected with the intent of locating structures joining the ABDM to the MH. Some of the cadavers had been dissected in advance by graduate students enrolled in a gross anatomy laboratory course and, therefore, the structures joining the ABDMs to underlying structures may have been destroyed prior to this study. For this reason the report does not include population size or prevalence statistics. The regional anatomy of 3 cadavers was dissected, photographed, and recorded using a digital camera in order to present an anatomical clinical series (Canon PowerShot SX50 HS, 12.1 Megapixel).

RESULTS

Dissection revealed several different anatomical connections between the ABDM and the MH (Fig. 1). However, the anatomy was oftentimes unremarkable, that is, very little fascia present between the ABDM and the MH, even in nondissected specimens. The following examples describe and illustrate some of the RLADs.

Example 1

The RLAD was a well-defined opaque membranous connection between the lateral aspect of the ABDM and the MH (Fig. 1A; see Supplemental Digital Content, Video 1, <http://links.lww.com/SCS/A245>). The connection included the mandible in addition to the MH. The RLAD was both compliant and elastic and allowed for a broad range of motion.

Example 2

The RLAD was a thin membranous connection between the lateral aspect of the ABDM and the MH (Fig. 1B; Supplemental Digital Content, Video 2, <http://links.lww.com/SCS/A246>). The RLAD was flimsy and gentle digital pressure was able to rupture it. Occasionally, similar examples connected the ABDM to the mandible in addition to the MH. Similar examples had varying degrees of translucency, many of which, were discontinuous, particularly in their posterior portion, near the intermediate tendon of the digastric muscle.

Example 3

The RLAD was a combination of thick membranous connections with admixed fascia between the lateral and superior aspect of the ABDM and both the MH and mandible (Fig. 1C; Supplemental Digital Content, Video 3, <http://links.lww.com/SCS/A247>). The lateral aspect of the RLAD was a strong membranous connection to body of the mandible which resisted medial traction applied to the ABDM. The portion of the RLAD connecting the superior aspect of the ABDM to the MH was mainly composed of a dense network of fascia (Fig. 1C; Supplemental Digital Content, Video 3, <http://links.lww.com/SCS/A247>).

DISCUSSION

The ABDM is important in numerous esthetic surgeries including rhytidectomy, alteration of the cervicomental angle via partial resection of the ABDM muscle belly, and suprahyoid muscular medialization and suspension which includes the ABDMs in a digastric corset.¹⁻⁵ Likewise, the ABDM is important in reconstructive plastic surgery. The ABDMs have been included in the submental artery flap procedure for the reconstruction of the lower and mid-face, pharynx, palate, oral cavity, eye socket, nose, columella, tongue, and temporal bone defects as well as the prevertebral space during spine surgery despite controversy.⁷⁻²² Additionally, the ABDM may be transferred in order to reanimate the mouth after palsy of the marginal mandibular branch of the facial nerve, and, likewise, variant ABDM musculature has been proposed for muscle transfer.²³⁻²⁹ Because the ABDM is important in a variety of plastic surgical procedures, detailed knowledge of its association with nearby anatomy is important. This report is the first to demonstrate directly the existence of the

retaining ligament of the anterior digastric muscle and document variation in its attachment sites, its composition, and its behavior when traction forces are applied.

Regarding Anatomical Terminology

Before further discussion of the RLAD, an issue of terminology must first be addressed. With regard to nomenclature, “digastric retaining ligament” and “mylohyoid retaining ligament” were terms interchangeably used by Labbé et al to describe the RLADs.⁴ This report revealed ligamentous connections between ABDM and both the MH and mandible. Because of the diversity in connection sites, we propose the term “retaining ligament of the anterior digastric” in order to allow for more detailed description of attachment sites. For example, a ligamentous attachment between the ABDM and the MH may be described in detail by using the terminology “mylohyoid retaining ligament of the anterior digastric.” Likewise, “mandibular retaining ligament of the anterior digastric” and “platysma retaining ligament of the anterior digastric” could be used to describe connections to nearby structures. Using the term “anterior digastric retaining ligament” assumes the existence of a “posterior digastric retaining ligament.” If one were to describe the ligamentous retaining ligament of the posterior digastric muscle, it would more appropriately be termed the “retaining ligament of the posterior digastric.”

Anatomical Variation

The RLADs illustrated in this report were found in cadavers with normal ABDM anatomy. Normally, the digastric muscle typically has 2 bellies joined by an intermediate tendon; however, variations are common, particularly with regard to the anterior digastric musculature. Muscle bellies may be asymmetrical or supernumerary and exist in a variety of patterns.^{2,30-39} These variant muscles may travel unilaterally or traverse the midline.^{2,30-39} Therefore, variations in ABDM anatomy may potentially reveal equally diverse variation in RLAD anatomy. Variations in ABDM musculature may lead to surgical confusion during muscular medialization and suspension, which includes the ABDMs in a “digastric corset.”⁴ Likewise, variation in RLADs, in normal, nonvariant anterior digastric musculature or variant anterior digastric musculature may lead to surgical confusion and diversity in surgical outcomes between patients.

In addition to the ABDM, the MH has been documented to exhibit anatomical diversity. The MH is often divided into 2 units, anterior and posterior, separated by the sublingual gland, the stylohyoid, or the submandibular salivary duct.⁴⁰ Similarly, the incidence of a “mylohyoid boutonnière,” a hiatus in the muscle belly through which the sublingual or submandibular gland, fat, or blood vessels protrude, has been reported in 77% of individuals, occurring bilaterally in 67% and unilaterally in 33%.⁴¹ Other reported muscular variations include an almost completely absent MH, replaced by the ABDM⁴²; MH continuity with the sternohyoid, stylohyoid, omohyoid, superior pharyngeal constrictor, or the digastric tendon^{42,43}; an accessory MH muscle originating at the left MH line of the mandible and inserting at the body of the hyoid, with anterior fibers inserting on the right side of the hyoid and posterior fibers inserting on the left side⁴⁴; and an MH that did not insert at the hyoid but instead inserted at a tough fibrous pseudo-hyoid midway between the mandible and

hyoid.⁴⁵ Therefore, similar to variation in anterior digastric musculature, variations in MH musculature might suggest diversity in RLAD anatomy.

Relationship to Neurovascular Structures

Both the ABDM and MH are typically innervated by the nerve to MH, a branch from the inferior alveolar nerve of the mandibular division of the trigeminal nerve (CN V₃).⁴⁶ However, a study of 1078 head sides from 539 Japanese cadavers, reported 9 head sides (0.83% of head sides) from 8 cadavers (1.48% of cadavers), to have ABDMs that were supplied by a branch of the facial nerve in addition to the MH nerve.⁴⁷ In such patients, the branch of the facial nerve originated from the stylohyoid branch and entered the ABDM at its superficial surface, as opposed to the MH branch which entered the deep aspect of the muscle.⁴⁷ Therefore, in the presence of an MH retaining ligament of the anterior digastric, the nerve to MH would penetrate the ligament. Likewise, in the presence of a retaining ligament occurring superficial to the ABDM, the occurrence of a facial nerve branch origination from the stylohyoid branch would penetrate the ligament. The presence and composition of the RLADs may obscure these neural structures during surgery. Example 3, for instance, demonstrates an elaborate fascial connection that may obscure view of the neural structure (Fig. 1C, Video 3). Therefore, understanding the RLADs is important to conservation of nerves supplying the nearby musculature.

The controversy regarding the inclusion of the anterior digastric and MH muscles within the submental flap has primarily focused on anatomical variability of the submental artery and the need to ensure adequate perfusion to the skin island.²⁰ Past studies have shown that the submental artery travels deep to the ABDM in 56% to 81% of patients.⁴⁸⁻⁵⁰ These data, when taken in the context of this report, suggest that it is likely the submental artery traverses the MH RLAD along its course. Therefore, the RLAD may have an effect upon the perfusion of the local tissues, due to its relationship with vasculature.

A Physical Barrier Between the Submental and Submandibular Fascial Spaces

A thorough understanding of the cervical fasciae and its extension to the floor of the mouth is critical to properly anticipate and treat infections of the neck and floor of mouth.⁵¹ For example, the most severe of the floor-of-mouth infections—Ludwig angina, results from rapidly expanding cellulitis among the submental, submandibular, and sublingual spaces.^{52,53} Therefore, in order to understand the spread of infection, the anatomical relationships between cervical fascial spaces must be well understood.

The submental fascial space is formed by investing fascia from the superficial layer of deep fascia attaching to the superior border of the hyoid bone, the inferior border of the “transverse ramus” of the mandible, the mental symphysis, and the sheaths of the ABDM.⁶ The space is bounded by the MH superiorly, the superficial cervical fascia inferiorly, the ABDM laterally, and the submandibular space posteriorly.⁵⁴ The “[tight application]” of the ABDM to the MH has been described as the only connection from the submental space to the adjacent submandibular space.⁶

The submandibular fascial space is bounded by the MH superiorly, the ABDM and posterior belly of the digastric inferiorly, laterally by the deep cervical fascia, medially by the

hyoglossus and MH, anteriorly by the submental space, and posteriorly by the hyoid bone.⁵⁴ There is a cleft between the lateral border of the MH and the medial border of the hyoglossus muscle known as the mylohyoid cleft (MC) which contains the deep portion of the submandibular gland, the submandibular (Wharton) duct, lymphatics, the lingual nerve, the hypoglossal nerve, and a branch of the facial artery.^{6,54} Moreover, the MC represents a direct path of extension for any infection between the submandibular and sublingual space.

The sublingual fascial space is bounded superiorly by the mucosa of the floor of the mouth, inferiorly by the MH, medially by the genioglossus and geniohyoid muscles, laterally and anteriorly by the body of the mandible, and posteriorly by the hyoid bone.⁵⁴ A periapical infection of a mandibular molar can directly extend into the sublingual space, subsequently descend into the submandibular space through the MC, and ultimately spread into the submental space.⁵⁵⁻⁵⁷

The RLADs presented in Figure 1A and C (Videos 1 and 3), demonstrate well-formed membranous connections between the MH, mandible, and ABDM, thereby creating physical separation between the submental fascial space and the submandibular fascial space. Lindner⁶ noted that “[collections of blood, pus, and/or serous fluid in [the submental fascial space] are trapped and may only with great difficulty pass laterally beneath the ABDM that is tightly applied to the underlying mylohyoid muscle.” Therefore, the lateral pathway is the only route for submental collection of fluid to escape to the more lateral regions of the suprahyoid area, which has direct association with the floor of the mouth.⁶ Membrane-like RLADs, therefore, serve as mechanical barriers to the spread of infection in addition to the spread of fluids, in general, including botulinum toxin which may be injected into the area and subsequently diffuse.⁵⁸⁻⁶²

Anatomical variation in RLADs may cause variation in the propagation of infection between the submental fascial space to the submandibular fascial space and vice versa among different individuals. Therefore, understanding the anatomy of the RLAD may help with the development of prognoses as well as clinical management of sublingual, submandibular, and submental infections.

The Mechanism of the Digastric Corset Procedure

The observations included in this study shed light on the mechanism of the digastric corset procedure. Labbé et al proposed that the mechanism by which medialization of the digastric musculature ultimately affected the cosmetic result in the neck was that medialization of the ABDMs places tension on the RLADs which, in turn, places tension on the MH muscle which is “pulled upward.” Example 1 (Video 1) from this report demonstrates laxity in the RLAD, which is unlikely to translate forces into the MH during the digastric flap. Example 2 demonstrates a weak, poorly developed RLAD, the integrity of which would not support the forces applied in the digastric corset. Indeed, the medialization techniques reported by Langsdon et al³ and Labbé et al⁴ both note inclusion of the MH into the suturing of the ABDM for stabilization. Including the MH into the suturing would prevent forces from being translated entirely through the RLAD. A particularly strong mandibular attachment was demonstrated in this report in Example 3. Medial traction of the ABDM, in this patient, was resisted mainly by the mandibular RLAD.

The mechanism of the digastric corset procedure may not only be due to traction on the MH by the RLAD, but rather by passive elevation of the MH due to: the tension created by the lateral elasticity of the ABDMs creating a diaphragm which would passively elevate the MH, independent of the existence of any retaining structures; the tension created by the lack of compliance from mandibular RLAD which creates a diaphragm that causes passive elevation of the MH; a combination of the lateral elasticity of the ABDMs and the lack of compliance of the mandibular RLAD creating a flattened diaphragm that passively elevates the MH regardless of any fascial or ligamentous connection between the ABDM and the MH; or tightening of the superficial layer of deep cervical fascia that envelops the ABDM and submandibular glands and creates a tighter diaphragm that passively elevates the MH.

In conclusion, this report is the first to directly demonstrate the existence of the RLAD and document variation in its attachment sites, its composition, and its behavior when traction forces are applied. The RLAD is important in a variety of plastic surgical procedures and may affect neurovascular structures between the ABDM and MH. Likewise, the RLAD acts as a physical barrier separating the submental fascial space from the submandibular fascial space and, therefore, will influence the spread of infection.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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FIGURE 1.

Inferolateral views of the submandibular and submental regions from a series of cadavers exhibiting diverse fascio-ligamentous connections between the anterior belly of the digastric and surrounding structures that can influence regional surgeries as well as the spread of infection between fascial spaces. (A) The right anterior belly of the digastric muscle is reflected inferiorly from its mandibular attachment exposing a well-defined septum-like retaining ligament of the anterior digastric. The retaining ligament joins the lateral aspect of the anterior belly of the digastric muscle to the mid-belly of the right mylohyoid and the mandible. Anteriorly, the retaining ligament has a free edge. (B) A gloved finger is hooked around the medial aspect of the right anterior belly of the digastric muscle in order to visualize a flimsy, transparent, discontinuous retaining ligament. (C) An extensive well-developed retaining ligament travels from the lateral, superior, and medial aspects of the anterior belly of the digastric muscle to the mylohyoid and mandible. The mylohyoid is obscured by the retaining ligament. ABDM, anterior belly of the digastric muscle; MH, mylohyoid muscle; RLAD, retaining ligament of the anterior digastric muscle.