The Functional Anatomy and Innervation of the Platysma is Segmental

Minelli, Lennert; Wilson, Jeremy L; Bravo, Francisco G; Hodgkinson, Darryl J; O'Daniel, T Gerald; van der Lei, Berend; Mendelson, Bryan C

Published in:
Aesthetic Surgery Journal

DOI:
10.1093/asj/sjad148

Facial Surgery

The Functional Anatomy and Innervation of the Platysma is Segmental: Implications for Lower Lip Dysfunction, Recurrent Platysmal Bands, and Surgical Rejuvenation

Aesthetic Surgery Journal
2023, Vol 43(10) 1091–1105

https://doi.org/10.1093/asj/sjad148
www.aestheticsurgeryjournal.com
OXFORD UNIVERSITY PRESS

Lennert Minelli, MD; Jeremy L. Wilson, MBBS, FRACS; Francisco G. Bravo, MD, PhD; Darryl J. Hodgkinson, FACS FRCS(c); T. Gerald O'Daniel, MD, FACS; Berend van der Lei, MD, PhD; and Bryan C. Mendelson, AM, FRCSE, FRACS, FACS

Abstract

Background: Despite the central role of the platysma in face and neck rejuvenation, much confusion exists regarding its surgical anatomy.

Objectives: This study was undertaken to clarify the regional anatomy of the platysma and its innervation pattern and to explain clinical phenomena, such as the origin of platysmal bands and their recurrence, and the etiology of lower lip dysfunction after neck lift procedures.

Methods: Fifty-five cadaver heads were studied (16 embalmed, 39 fresh, mean age 75 years). Following preliminary dissections and macro-sectioning, a series of standardized layered dissections were performed, complemented by histology and sheet plastination.

Results: In addition to its origin and insertion, the platysma is attached to the skin and deep fascia across its entire superficial and deep surfaces. This composite system explains the age-related formation of static platysmal bands, recurrent platysmal bands after complete platysma transection, and recurrent anterior neck laxity after no-release lifting. The facial part of the platysma is primarily innervated by the marginal mandibular branch of the facial nerve, whereas the submandibular platysma is innervated by the "first" cervical branches, which terminate at the mandibular origin of the depressor labii inferioris. This pattern has implications for postoperative dysfunction of the lower lip, including pseudoparalysis, and potential targeted surgical denervation.

Conclusions: This anatomical study, comprised of layered dissections, large histology, and sheet plastination, fully describes the anatomy of the platysma including its bony, fascial, and dermal attachments, as well as its segmental innervation including its nerve danger zones. It provides a sound anatomical basis for the further development of surgical techniques to rejuvenate the neck with prevention of recurrent platysmal banding.

Editorial Decision date: May 9, 2023; online publish-ahead-of-print May 15, 2023.

Dr Minelli is the Tagliacozzi research fellow, Mendelson Advanced Facial Anatomy Course, Australasian Society of Aesthetic Plastic Surgeons, Toorak, Australia. Dr Wilson is a plastic surgeon, Department of Plastic Surgery, Royal Melbourne Hospital, University of Melbourne, Parkville, Australia. Dr Bravo is a plastic surgeon in private practice in Madrid, Spain, and a senior international editor for *Aesthetic Surgery Journal*. Dr Hodgkinson is a plastic surgeon in private practice in Sydney, NSW, Australia. Dr O'Daniel is a plastic surgeon, University of Louisville Department of Surgery (Plastics), Louisville, KY, USA, and a clinical editor for *Aesthetic Surgery Journal*. Dr van der Lei is a professor, Department of Plastic Surgery, University Medical Centre Groningen, University of Groningen, Groningen, the Netherlands, and an international editor for *Aesthetic Surgery Journal*. Dr Mendelson is a plastic surgeon, Mendelson Advanced Facial Anatomy Course, Australasian Society of Aesthetic Plastic Surgeons, Toorak, Australia.

Corresponding Author:
Dr Lennert Minelli, PO Box 592, Toorak, 3142 Victoria, Australia.
Email: Lennert.minelli@gmail.com

Presented at: The International Society of Aesthetic Plastic Surgery (ISAPS) World Congress in Istanbul, Turkey, in September 2022.

Muscle of Fear, Fright, Torture and Complimentary Wrath

Guillaume-Benjamin-Amand Duchenne (de Boulogne), Mécanisme de la physionomie humane; ou analyse électrophysiologique de l'expression des passions, 1862.

Following the introduction of platysma-based surgery by Skoog, Guerrero-Santos, and Connell, the platysma has remained central in lower face and neck rhytidectomy.[1-3] Numerous procedures have been described utilizing the platysma, including lateral suspension, undermining and redraping, imbrication, corset-plication, myotomy, complete transection, partial myectomy, partitioning, and others. Despite 40 years of surgical experience, a significant void remains in the understanding of its surgical anatomy. Clinical phenomena such as platysmal bands and their recurrence even following complete platysma transection, the relationship of the platysma with the depressor labii inferioris (DLI), the exact innervation pattern of the platysma and lower lip, and the cause of postoperative lower lip dysfunction (paralysis and pseudo-paralysis) remain incompletely explained. This study was undertaken to clarify the regional anatomy of the platysma, to improve advanced surgical rejuvenation techniques for the neck.

METHODS

Ethical approval for the project was granted by the Human Ethics Advisory Groups of the University of Melbourne for the feasibility study and the Queensland University of Technology for the definitive study (project numbers 14243 and LR 2021-4306-4761, respectively). A feasibility study was performed on 21 cadavers, 15 embalmed and 6 fresh-frozen (male = 10; female = 11; mean age = 76 years) followed by a definitive study of 34 cadavers. A series of standardized dissections was performed with loupe magnification on 15 fresh (nonfrozen) and 1 embalmed cadavers (male = 9; female = 7; mean age = 78 years; mean BMI = 26). A different technique was utilized on the 2 sides of the same cadaver to better record the fascial layers. To establish the surgical presentation of the platysma and its relevant attachments, a previously described methodological sharp layered dissection technique was employed to investigate the layered anatomy and specifically the platysma.[4] By initially dissecting at the superficial surface and subsequently the deep surface of the platysma from the clavicle up to the uppermost level of the platysma, its attachments to the surrounding structures were thoroughly investigated. During the dissection at the deep surface of the platysma, the nerves entering the platysma were clipped before cutting. After removal of the platysma, the pattern of clipped nerve branches was noted at the side of the deep fascia. Subsequently, the terminal nerve branches were followed proximally by loupe-assisted microdissection until the origin of each nerve branch was discovered.

Finally, objective technical investigations complemented the dissection findings and provided evidence at a microscopic level. Histology was performed on 19 cadavers (male = 13; female = 6; mean age = 81 years).[5] Serial axial head-and-neck samples spaced 7 millimeter apart were investigated in 4 cadavers to investigate the depth and position of the cervical branch of the facial nerve (CBFN) along its trajectory. Submandibular and jowl sections were studied to investigate the attachments of the platysma to the deeper structures (mandible, sternocleidomastoid muscle, digastric muscle, etc). Also, the height of the platysma was determined in 8 cadavers, by measuring the distance of the zygomatic arch to the first platysma muscle fiber, to determine whether the platysma descends with aging. Sheet plastination of the head and neck of 10 fresh cadavers was processed by von Hagens Plastination in the axial, sagittal, and coronal planes utilizing their latest technique (male = 4; female = 6; mean age = 67 years).[6]

RESULTS

Origin and Insertion of the Platysma

The platysma is a thin flat mimetic muscle spanning the anterior neck. It originates from the infraclavicular subcutaneous tissue (ie, superficial fascia) over the deltoid, trapezius, and pectoral muscles, and the clavicular region. It crosses over the sternocleidomastoid muscle (SCM) and the submandibular gland (SMG) in its trajectory toward the lower face. At the cervicomental angle, from hyoid to mastoid, the platysmal fibers make a turn of direction from vertical in the neck to more horizontal in the submandibular area and lower face, a feature that is directly related to bipedalism. The platysmal fibers of both sides decussate in the midline in a variable manner originally described by de Castro and later confirmed by Vistnes and Cotofana.[7-9]

The platysma can be subcategorized according to it topographical position in the face and neck (Figure 1A) or according to its insertion into different facial components as originally done by Lightoller and later popularized by Feldman (Figure 1B).[11,12] The mandibular attachment of the platysma, which forms the majority of the mandibular ligament, was reported in detail in a recent publication.[13] The DLI is effectively a continuation of the platysma at the other side of this mandibular attachment (Figure 2).

A dual function of the platysma exists, whereby contraction of the facial platysma causes a depression of the overlying skin, and contraction of the submandibular and cervical platysma causes a forward and upward movement of the skin,

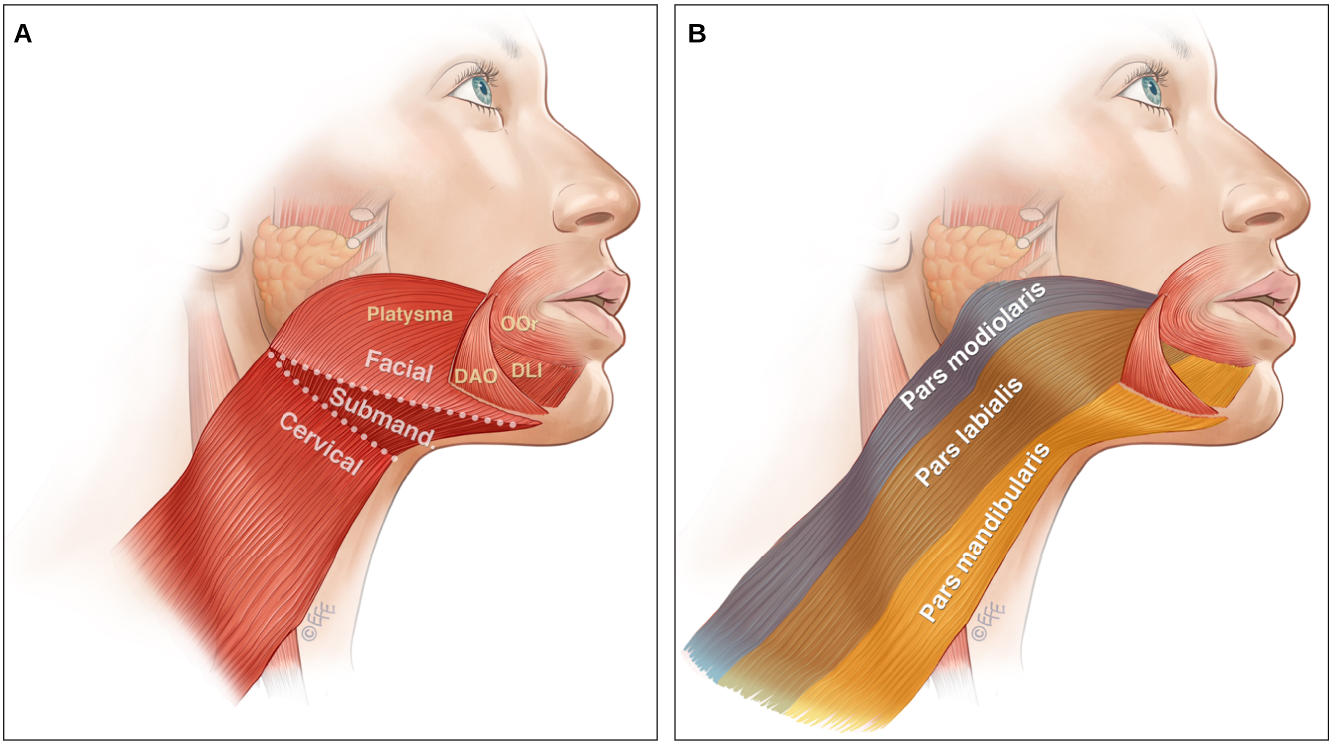

Figure 1. Fresh cadaver dissection after removal of the skin and subcutaneous fat, demonstrating the platysmal anatomy and 2 theoretical subdivision systems of the platysma, the topographic level and the insertion pattern. (A) Subdivision by topographic level: the facial platysma above the mandible, submandibular platysma between the mandible and the hyoid bone, and cervical platysma below the hyoid bone. (B) Subdivision by insertion pattern: The posterior third of the platysma, or pars modiolaris, crosses the mandibular angle to insert into the buccinator and modiolus. The middle third of the platysma, or pars labialis, crosses the body of the mandible and then continues under the depressor anguli oris (DAO) muscle to insert directly into the lower lip dermis and orbicularis oris muscle (OOr). This labial part of the platysma was previously named the depressor labii lateralis by Louarn.[10] The anterior third of the platysma, or pars mandibularis, attaches directly to the mandible, to continue at the opposite side of the mandibular attachment (mandibular ligament) as the depressor labii inferioris (DLI). Artwork created by and published with permission from Dr Levent Efe, CMI.

increasing the diameter of the neck. The most superior extent of the platysma reached a mean of 39 mm from the zygomatic arch (SD = 11 mm, range = 28-59 mm). Because this histological study utilized cadavers between 72 and 89 years old, it was not possible to make observations regarding the hypothesized descent of the platysma with aging.

Superficial and Deep Attachments of the Platysma

In the layered system of the face, the platysma (layer 3) separates the subcutaneous fat of the superficial fascia (layer 2) from the deep fat of the deep fascia (layer 5). The platysma itself is encapsulated by epimysium and perimysium, which envelop the individual fingerlike muscle fibers, effectively separating each of these fibers into its own gliding compartment (Figure 3). The superficial fascia connects the platysmal epimysium to the dermis by retinacula cutis superficiales that are largely perpendicular to the dermis and evenly distributed over the entire platysma. The deep fascia connects the platysmal epimysium to the deeper structures by retinacula profunda which are more parallel with the dermis and organized as multilamellated fascial sheets (Figure 4).[4] The gliding provided by this deep fascia layer has been described in a related article, as have the so-called posterior and perioral adhesion zones.[14] In the perioral adhesion zone, the perioral muscles, including the labial platysma and DLI, insert directly into the dermis (Figure 4).[12] In the posterior adhesion zone, the fibrous parotid capsule adheres to the platysmal epimysium, known as the platysma-auricular fascia and platysma-auricular ligament over the body and tail of the parotid gland, respectively, as described by Furnas and later redefined by Mendelson, and to the SCM fascia, known as the "cervical retaining ligaments" as described by Mustoe and later redefined by Jacono.[15-17-18] Release of this adhesion is necessary in platysmal mobilization, as emphasized by Owsley and Hodgkinson.[19,20]

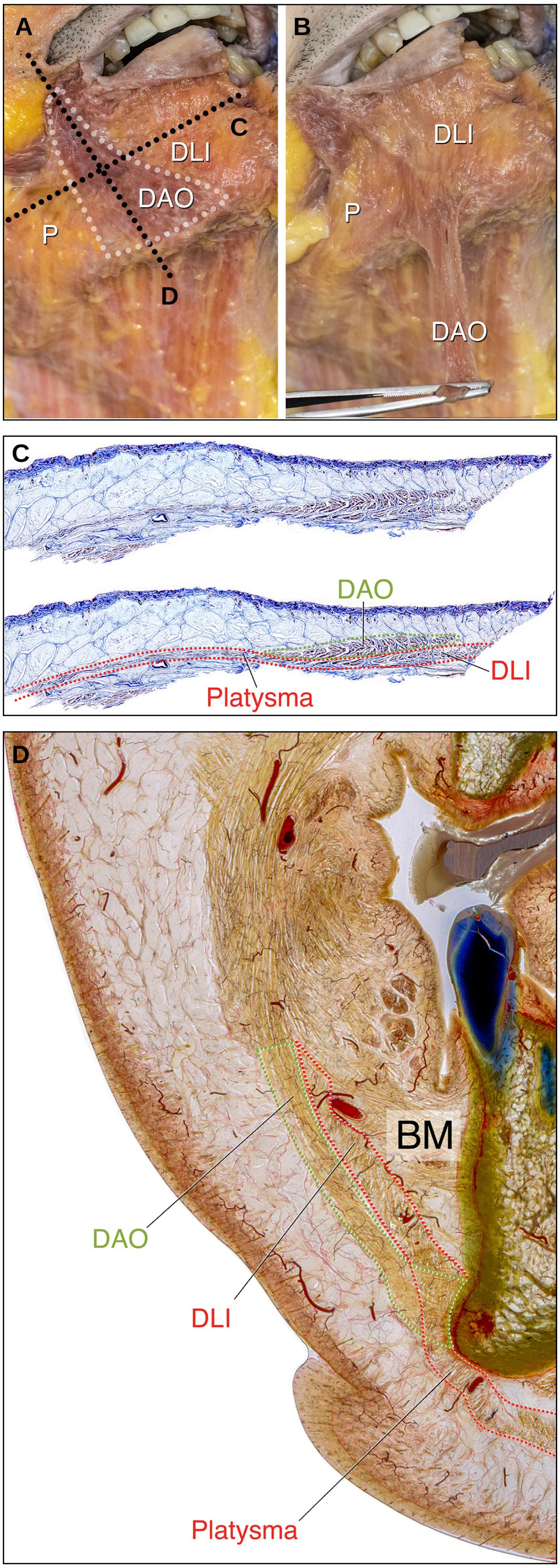

Figure 2. (A, B) Fresh cadaver dissection after removal of skin and subcutaneous fat demonstrating the continuation of the

(continued)

Figure 2. (Continued)
platysma with the depressor labii inferioris (DLI), both lying in the same muscular plane and having a similar direction of muscle fibers, while the depressor anguli oris (DAO) is situated more superficially with muscle fibers that run almost perpendicular to this. (C) Axial histology of the area demonstrates the continuation and identical muscle plane of the platysma and DLI, with the DAO being situated on the top. (D) Coronal sheet plastination through the mandibular ligament demonstrating the continuation of the platysmal muscle fibers with the DLI muscle fibers, despite the fact that macroscopically the 2 muscles seem to insert into the mandible ("stop"). Interestingly, the DAO is seen crossing/intermingling with the platysma and DLI to also insert into the mandible. BM, buccinator muscle, P, platysma.

Innervation of the Platysma

The facial segment of the platysma receives innervation from the marginal mandibular nerve (MMN) and occasionally from buccal branches. In most cases, there is more than 1 MMN branch (Table 1). Proximally, the nerve is covered by the tail of the parotid, which is part of the superficial lobe. The lowermost branch of the MMN, which is usually the main branch, passes below the gonial angle and slowly transitions from deep within to more superficial within the deep fascia. It occasionally crosses just outside the posterior part of the submandibular gland capsule. Where the MMN crosses the rim of the mandible, it is superficial within the deep fascia, just underlying the pars labialis of the platysma, crossing immediately superficial to the facial vein and artery. It passes immediately posterior to the mandibular ligament (within 2 mm) to continue its path cranial to this ligament, sending off terminal branches to the platysma, DLI, depressor anguli oris (DAO), and mentalis (Figures 5A, B, 6). Its terminal branches communicate with the mental nerve, together providing sensory-motor function to the lower lip unit (Figures 5C, 6).

In cases of high-riding platysma, the lower buccal branches send terminal branches to the pars modiolaris of the platysma (Figure 5A). Terminal buccal branches regularly underlie the medial-most platysmal fibers where they approach the buccinator near the modiolus (Figure 7).

The submandibular segment of the platysma receives innervation from both the marginal mandibular nerve and the first CBFN. The trunk of the CBFN exits the parotid gland capsule deep within the deep fascia anterior to the SCM, an average of 5 mm deeper than the platysma (SD = 1.3 mm, range = 3-7 mm), depending on the person's BMI. The first CBFN takes off from the main cervical trunk soon after it exits the parotid gland capsule (Figure 5A). First deep within the deep fascia, the terminal branches gradually transition to a more superficial plane within the deep fascia to run just outside the SMG capsule (Figure 8). Their superficial trajectory anterior to the SMG capsule is always just beneath the pars mandibularis of the platysma (Figures 5B, C, 7, 8). These terminal

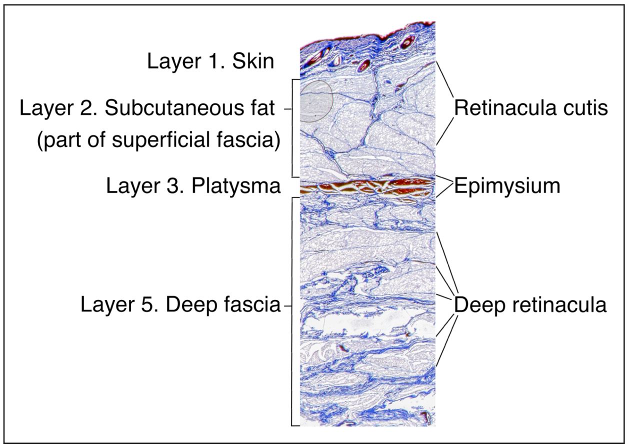

Figure 3. Histology of the neck at the level just inferior to the submandibular gland demonstrating the different layers of the neck. The superficial fascia connects the platysma to the skin by retinacula cutis in the subcutaneous fat that are perpendicular to the platysma and skin, and the deep fascia connects the platysma to the deeper structures by deep retinacula that are largely parallel to the platysma and skin, providing a large amount of gliding.

branches enter the platysma in the submental area near its attachment to the mandible, potentially aiding innervation of the DLI on the facial side of the mandibular ligament (Figure 5B, C).

The cervical segment of the platysma receives innervation from the CBFN. These terminal branches come off the main cervical trunk of the CBFN, which runs deep within the deep fascia along the anterior border of the SCM (Figure 8). These branches reliably anastomose with the transverse cervical nerve (TCN) branches (Figures 5A, 8). There were not any nerves identified innervating the platysma in the posterior triangle of the neck.

DISCUSSION

Function of the Platysma

As described in *Gray's Anatomy*, the platysma "draws the outer portion of the lower lip inferiorly and posteriorly, widening the aperture of the corners of the mouth as in an expression of horror" and "may pull the skin up from the clavicular region, increasing the diameter of the neck."[21] These observations were later formally demonstrated through isolated electrophysiological stimulation by Duchenne, who additionally noted depression of the mandible upon stimulation.[22] The platysma's function when smiling—especially in a "full-denture" smile—was later proposed by Rubin as well as Ellenbogen.[23,24] Although the platysma may aid in this activity, it seems functionally unnecessary for the platysma to span the entire neck for this purpose alone. As part of the panniculus carnosus, the primitive function of the platysma was previously hypothesized to aid in wound healing by causing significant wound contracture, a function that could help to explain the recurrence of platysma continuity after total platysma transection.[25] Moreover, the platysma may have an additional, protective function of shielding the deep neck structures from trauma by breaking the force of impact at the level of the superficial fascia, similar to the way Kevlar breaks the impact of a bullet.

Phylogenesis of the Platysma

The intimate relationship between the platysma and the DLI was beautifully illustrated by Santorini in 1724.[26] Lightoller, and later Fujita, postulated that the platysma and the DLI (quadratus inferioris) were of the same muscle system.[10,27] An embryologic study by Gasser revealed that "the mandibular part of the platysma extends into the mental region where it is continuous with vertically directed muscle cells that extend into the lower lip and represent the depressor labii inferioris muscle."[28] Dingman and Grabb noted platysmal and DLI contraction as a unit despite stimulating only the cervical branches to the submandibular segment of the platysma, later confirmed with EMG studies by Lapatki.[29,30] The current study provides the first microscopic evidence of the continuity of the platysma and the DLI in adults.

Innervation of the Platysma

As a general principle, the facial platysma is innervated by the MMN, whereas the cervical platysma is innervated by the CBFN. The lateral submandibular platysma and the DLI are a watershed area receiving innervation from both.

Buccal Branch

Although anastomoses of the MMN with the buccal branches have been described, as has innervation of the DAO by buccal branches, this study is the first report describing the innervation of the upper segment of the platysma by buccal branches.[31,32] Potential injury can occur during deep-plane dissection extending anterior to the masseter muscle over the buccal area.

Marginal Mandibular Nerve (MMN)

The platysma was traditionally considered to be innervated by the CBFN only. Recognition of the involvement of the MMN in the innervation of the platysma has increased with time.[29,33,34] Although Dingman and Grabb noted only a few terminal branches of the MMN to the platysma, Baker noted it in at least half of cases.[29,33] More recent descriptions have described the facial segment of the platysma receiving branches from the MMN in every case, a finding confirmed by

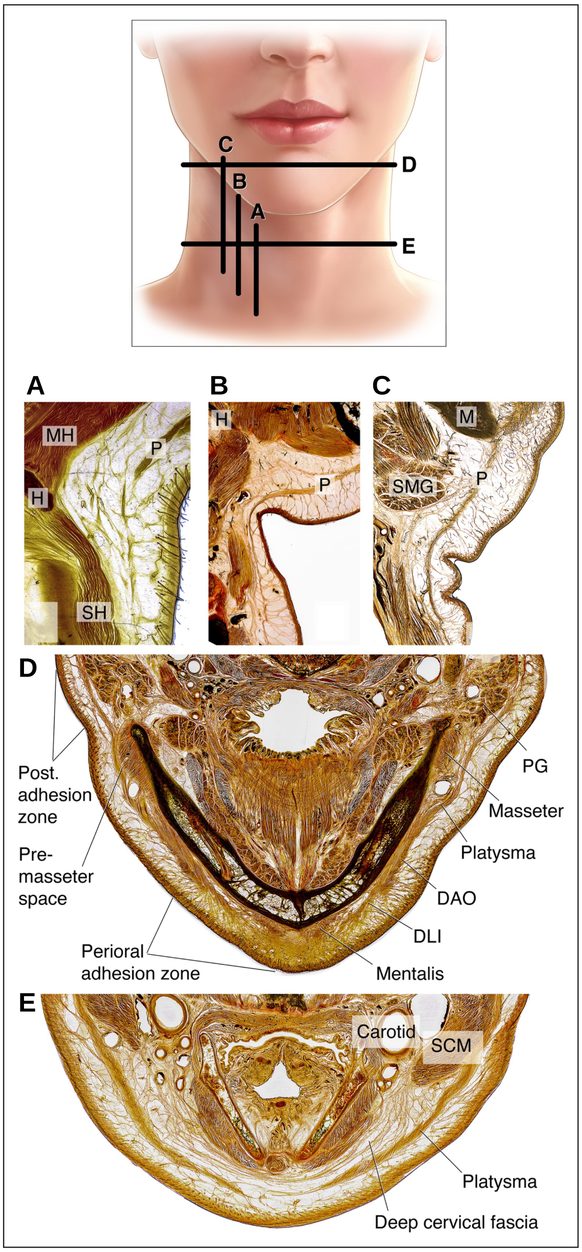

Figure 4. Sheet plastination of the neck demonstrating the connections of the platysma to the skin and the deeper structures by superficial and deep fascia. Sagittal sections (A) at the midline, (B) at lateral extent of hyoid, and (C) over the submandibular gland. (D) Axial section through the lower border of the mandible and lower lip, demonstrating the posterior adhesion zone, and the perioral adhesion zone where the platysma and depressor labii inferioris muscles are seen inserting directly into the skin. (E) Axial section through the thyroid cartilage demonstrating the multilamellated structure of the deep cervical fascia connecting the platysma to the deeper structures. P, platysma; H, hyoid bone; MH, mylohyoid muscle; SH, sternohyoid muscle; M, mandible; PG, parotid gland; SCM, sternocleidomastoid muscle; SMG, submandibular gland; DAO, depressor anguli oris, DLI, depressor labii inferioris.

Table 1 Findings on Facial Nerve Distribution.

Facial nerve branches	Number of cadavers (%)
Buccal branches to platysma	3 (25%)
MMN branches to platysma	12 (100%)
1 branch	3 (25%)
2 branches	6 (50%)
3 or more branches	3 (25%)
CBFN branches to platysma	12 (100%)
1 branch	0 (0%)
2 branches	5 (42%)
3 or more branches	7 (58%)
Buccal branch to MMN anastomosis	8 (67%)
MMN to CBFN anastomosis	3 (25%)
MMN to mental nerve anastomosis	12 (100%)
TCN to MMN anastomosis	1 (8%)
TCN to CBFN anastomosis	12 (100%)

CBFN, cervical branch of the facial nerve; MMN, marginal mandibular nerve; TCN, transverse cervical nerve.

our study.[31] Potential injury can occur in a deep-plane dissection below the pars labialis platysma, either through a lateral neck dissection or a submental dissection. Another possibility of injury is the use of cautery in the posterosuperior aspect of a submandibular gland mobilization, with potential injury of the lowest MMN branch running in the deep cervical fascia just outside the glandular capsule.

Cervical Branch of the Facial Nerve (CBFN)

Salinas et al expertly defined variations in the different branches of the CBFN.[35] The deep cervical fascia however, contrary to their conclusion, is a thick fibrofatty layer, and the CBFN runs deep within this fascia for most of its trajectory.[4] This explains the report of Sinno and Thorne, who demonstrated that even wide subplatysmal undermining does not result in an injury to the main trunk of the CBFN.[36] The depth of the several branches of the CBFN has been described for the first time in this study, as has the fact that the first CBFN reliably penetrates the platysma close to the menton, just below the mandibular ligament. Potential injury can occur in the deep plane under the pars mandibularis platysma, either through a lateral neck dissection or a submental dissection. Another risk for injury is mobilization of the anterior aspect of a submandibular gland with cautery, potentially injuring

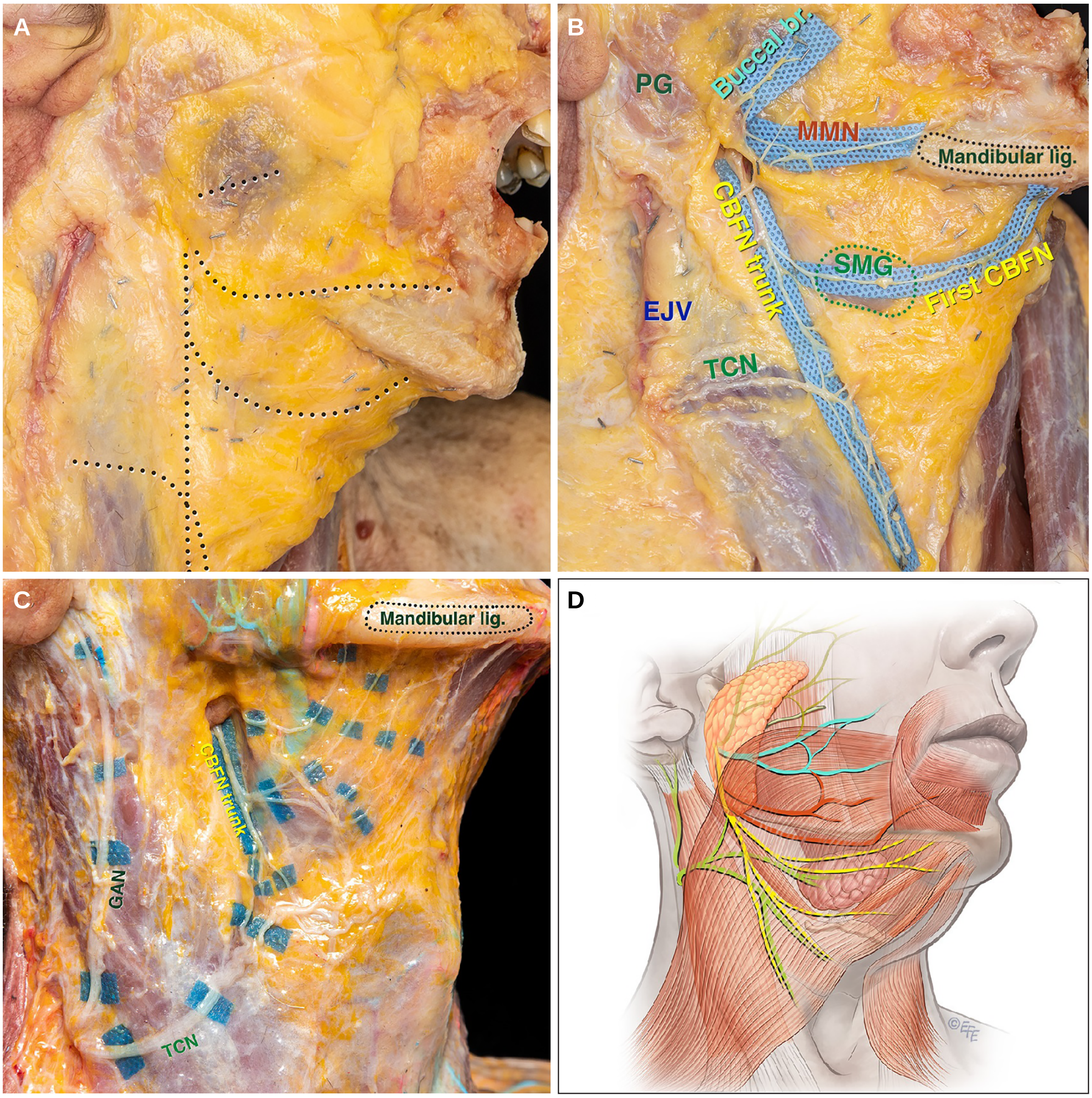

Figure 5. Fresh cadaver dissections demonstrating the innervating branches to the platysma, which have been marked by metal clips. (A) The deep fascia after removal of the platysma demonstrates that the nerves are deep within the deep fascia for most of their trajectory. A dissection on the undersurface of the platysma therefore is safe up to where the nerves come to lie in the most superficial aspect of the deep fascia. (B) Exposing the nerves within the deep fascia demonstrates that (1) the buccal branch sends terminal branches to the platysma; (2) the marginal mandibular nerve (MMN) crosses the mandible and passes the mandibular ligament always within 2 mm; (3) the first cervical branch of the facial nerve (CBFN) comes off the main cervical trunk early after leaving the parotid gland (PG), crosses over the submandibular gland (SMG) just outside of its capsule, to end right below the mandibular ligament, where the platysma, depressor labii inferioris (DLI) and depressor anguli oris (DAO) attach to the mandible; (4) the sensory transverse cervical nerve (TCN) branches reliably communicate, anastomose, or run together with the CBFN. (C) Careful dissection of all the terminal branches of the first cervical branch of the facial nerve (CBFN) demonstrates their multitude, their adjacency to the submandibular gland capsule, and their ends at the mandibular ligament. (D) Illustration of the different buccal, marginal mandibular, and cervical branches that go to the platysma and the DLI. GAN, great auricular nerve; EJV, external jugular vein.

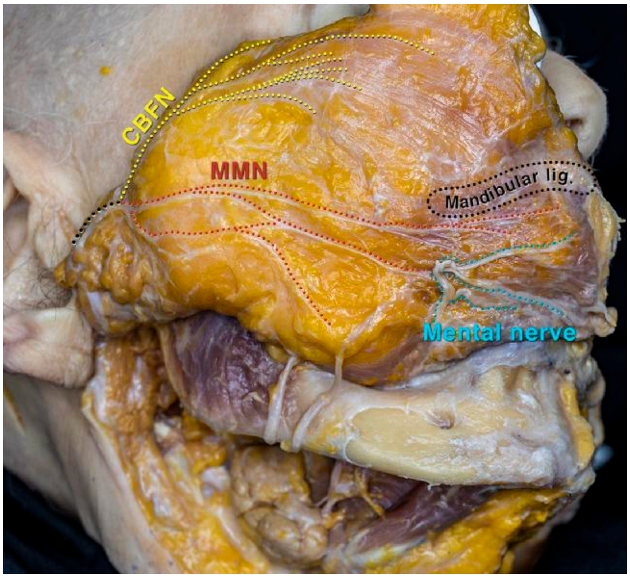

Figure 6. Fresh cadaver dissection demonstrating the results of a deep dissection of the lower face and neck, with the flap turned over 180 degrees to visualize the underside of the flap and the facial nerve branches. The marginal mandibular nerve (MMN) is seen communicating extensively with the mental nerve branches, both innervating the same general area of the lower lip. The terminal parts of the cervical branches of the facial nerve (CBFN) are not clearly visible in this subfascial dissection due to their superficial terminal trajectory.

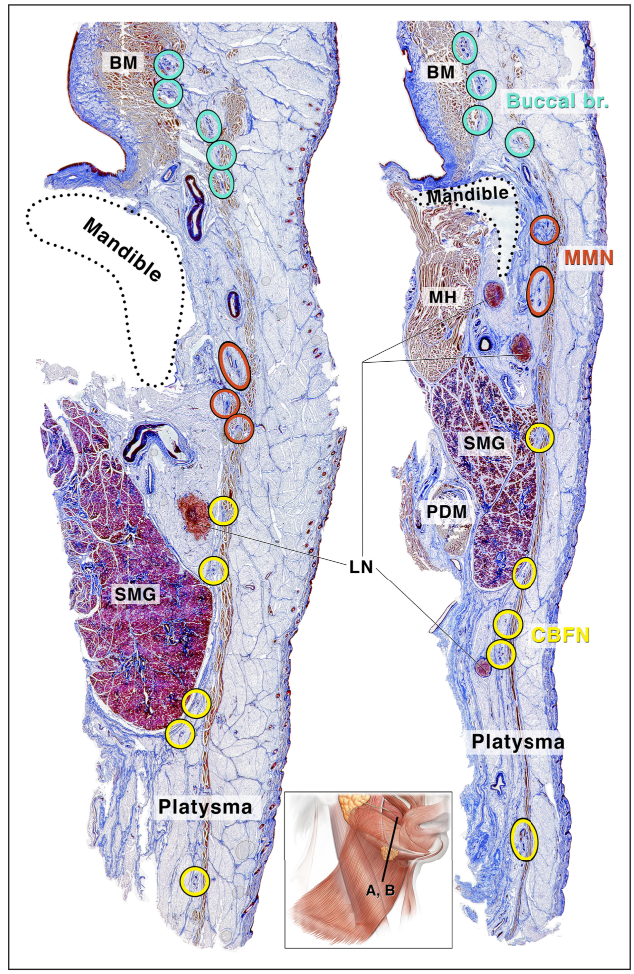

Figure 7. Two large vertical histology sections from the modiolus to the lower neck in 2 different cadavers, crossing the submandibular gland (SMG) and the mandible just posterior to the mandibular ligament, which is therefore not seen. The buccal branches in blue, marginal mandibular nerve (MMN) branches in red, and cervical branches of the facial nerve (CBFN) in yellow are identified. Note the presence of lymph nodes (LN). BM, buccinator muscle; MH, mylohyoid; PDM, posterior digastric muscle.

the first CBFN running in the deep cervical fascia just outside the glandular capsule. The investing layer of the deep cervical fascia, in which these cervical branches run, is often referred to as the subplatysmal fat due to its increased fatty constitution in the submental area.[37] This fat is commonly reduced, potentially injuring the CBFN when the dissection is extended too laterally.

Transverse Cervical Nerves (TCN)

Anastomoses between the TCN and the CBFN and even some MMN branches have been well demonstrated, and were confirmed by this study.[35,38] The role of the TCN and the spinal accessory nerve in motor innervation of the platysma is unclear. In rodents, the platysma has been demonstrated to be additionally innervated by cervical neurons located at the same medullary level as the neurons of the external root of the accessory nerve.[39] In humans, evidence of this potential coinnervation has been provided through clinical cases: platysmal paresis on the affected side of cervical ischemia and viral myelopathy, platysmal myoclonus caused by spinal root stimulation, platysmal dystonia after complete facial nerve palsy, and preserved platysmal function despite transection and transfer of the main cervical trunk of the facial nerve.[40-44] This potential coinnervation should be taken into consideration when exploring the options of surgical denervation of the platysma.

Lower Lip Depressor Dysfunction: Paralysis and Pseudoparalysis

"Pseudoparalysis of the marginal mandibular branch" originally described a phenomenon in which lip depression was lost while lip eversion was preserved and differentiated between an MMN and a CBFN injury. Despite the widespread use of this description, the clinical

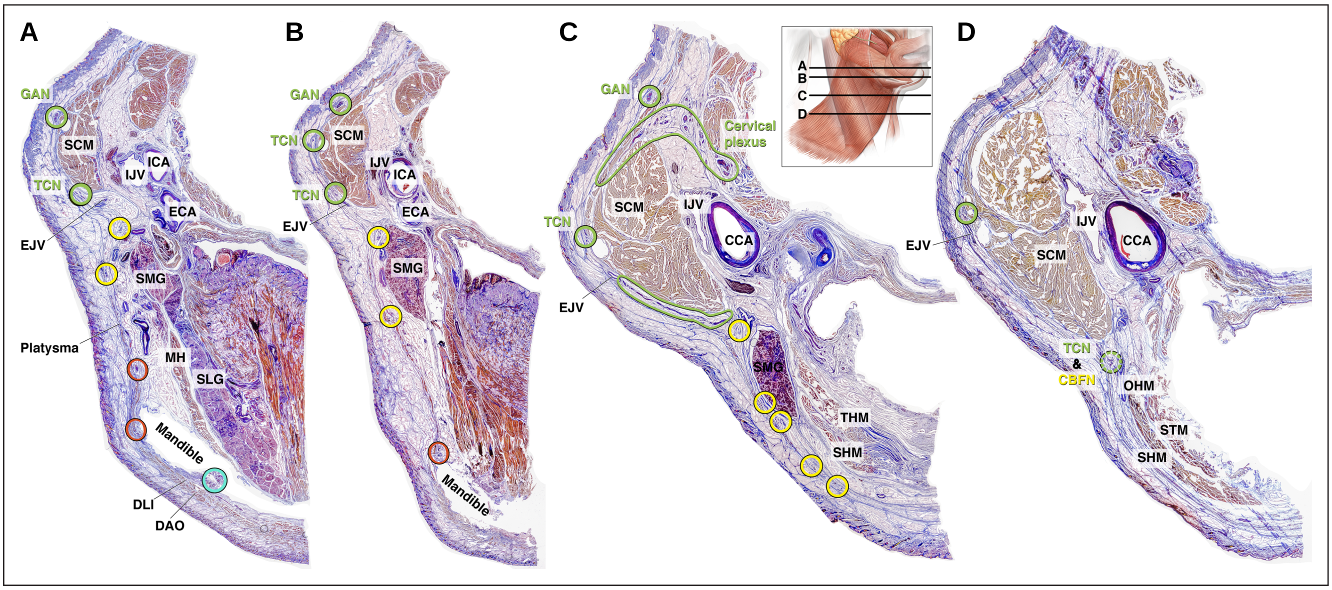

Figure 8. Axial histology sections through the neck at different levels, demonstrating the sensory great auricular nerve (GAN) and transverse cervical nerve (TCN) branches crossing over the sternocleidomastoid muscle (SCM) within the deep fascia, as well as the motoric branches of the facial nerve: marginal mandibular nerve (MMN) branches in red and cervical branches (CBFN) in yellow. (A) At the level of the upper neck (C2-C3). At this proximal location, the main trunk of the CBFN is seen deep within the deep cervical fascia. The MMN branches are seen superficially within the deep fascia, approaching the mandible to cross it. (B) At the level of C3. The main trunk of the CBFN can be seen lying close to, but just outside of, the most posterior aspect of the submandibular gland (SMG) capsule. The MMN can be seen passing the mandibular ligament, within 2 mm underneath the platysma. (C) At the level of C4. The superficial branches of the cervical plexus are seen leaving the prevertebral fascia and branches of the TCN are seen running within the deep fascia over the sternocleidomastoid muscle (SCM). The main trunk of the CBFN is deep within the deep fascia, and anteriorly the more terminal branches are clearly in the most superficial aspects of the deep cervical fascia. Their trajectory in proximity to the SMG capsule is demonstrated. (D) At the level of the lower neck and thyroid cartilage (C5). The main trunk of the CBFN, now joined by branches of the TCN, still runs deep within the deep fascia, not directly subplatysmal. CCA, common carotid artery; DAO, depressor anguli oris; DLI, depressor labii inferioris; ECA, external carotid artery; EJV, external jugular vein; ICA, internal carotid artery; IJV, internal jugular vein; MH, mylohyoid; OHM, omohyoid muscle; SLG, sublingual gland; SHM, sternohyoid muscle; STM, sternothyroid muscle; THM, thyrohyoid muscle.

presentation has not been fully explained.[24] The medical definition of pseudoparalysis is the inability to move a part of the body owing to factors other than those causing actual paralysis, such as pain.[45] Based on the current findings, O'Daniel proposed eight different pathways leading to iatrogenic lower lip depressor dysfunction (Table 2).[46] This clinical situation results when the DLI is denervated, but the mentalis remains active. The current understanding of how the DLI is coinnervated by the first CBFN is that (1) the platysma and DLI are part of the same muscle unit, and (2) the first CBFN ends at the mandibular origin of both platysma and the DLI (mandibular ligament). Injury to the first CBFN explains the isolated DLI/platysma neuropraxia in the presence of a functioning mentalis. Because pseudoparalysis is an inaccurate description of lower lip depressor weakness it is felt that the more general descriptor of "lower lip depressor dysfunction" would be more correct. Regardless of the site of injury, recovery of the lower lip depressor weakness consistently occurs within 12 weeks, secondary to compensatory innervation by the intact MMN.

Recurrent Anterior Neck Laxity

Treatment of anterior neck skin laxity by use of lateral suspension of the platysma and skin without wide release of the area is associated with a high incidence of recurrence.[47] This is explained by our microscopic studies that demonstrate the superficial retinacular fascial attachments of the platysma to the overlying skin and deep fascial attachments of the platysma to the underlying deep musculature. As recently reported, lifting of unreleased tissues results in a change of the ligamentous glide plane architecture, which then does not support gravitational tension and limits tissue movement (Figure 9).[14]

Aging of the Neck

Aging of the neck is related to its highly specific human anatomy, with the head being positioned at a right angle on the neck, causing the platysma to span a concave area.

Table 2 Maneuvers of Risk for Lower Lip Dysfunction.

Maneuvers of risk for lower lip dysfunction (affected nerve)
1. Subplatysmal undermining anterior to the facial vessels (MMN) and anterior to the SMG (CBFN)
2. Coagulation release of mandibular ligament (MMN)
3. Lipofilling in prejowl sulcus (MMN)
4. Hemostatic net (MMN or CBFN)
5. Lateral subplatysmal fat reduction (CBFN)
6. Intracapsular SMG dissection (CBFN)
7. Platysma myotomy and deep fasciotomy (CBFN)
8. Subplatysmal running barbed contouring suture (CBFN)

CBFN, cervical branch of the facial nerve; MMN, marginal mandibular nerve; SMG, submandibular gland; TCN, transverse cervical nerve.

Although pulleys are present over the joints of the extremities, they are not present at the level of the cervicomental angle in the neck. Therefore, repetitive platysma contraction, be it active or resting tone, progressively tensions the muscle forward as the underlying deep fascia stretches over time, obscuring the characteristics of youth. This study was not able to demonstrate the hypothesis that the platysma descends with aging, and this conjecture remains unproven. Platysmal activity is known to aggravate the fine horizontal wrinkles in the neck.[48] This is due to the fact that the platysma is a wide and flat muscle firmly adhered to its overlying thin skin. Similar to what occurs with the frontalis muscle, wrinkle expression lines form on the skin perpendicular to the direction of the underlying muscle fibers.

Resting Tone of the Platysma

With aging, the axonal load of the facial nerve decreases, as does the neuroactivity of the platysma upon forceful contraction, both of which suggest reduced muscle tone.[49,50] However, the evidence of age-related increased muscle tone of other mimetic muscles (eg, the frontalis and the DAO) suggests the opposite.[51] The unconscious resting tone of the platysma has never been studied, but it is know that patients who develop flaccid facial nerve palsy lose previous platysmal bands on the affected side.[52] This confirms the existence of a certain involuntary platysmal resting tone and its role in the formation of platysmal bands.

Platysmal Bands

True static platysmal bands (as opposed to dynamic bands) are the result of the resting tone of the platysma and

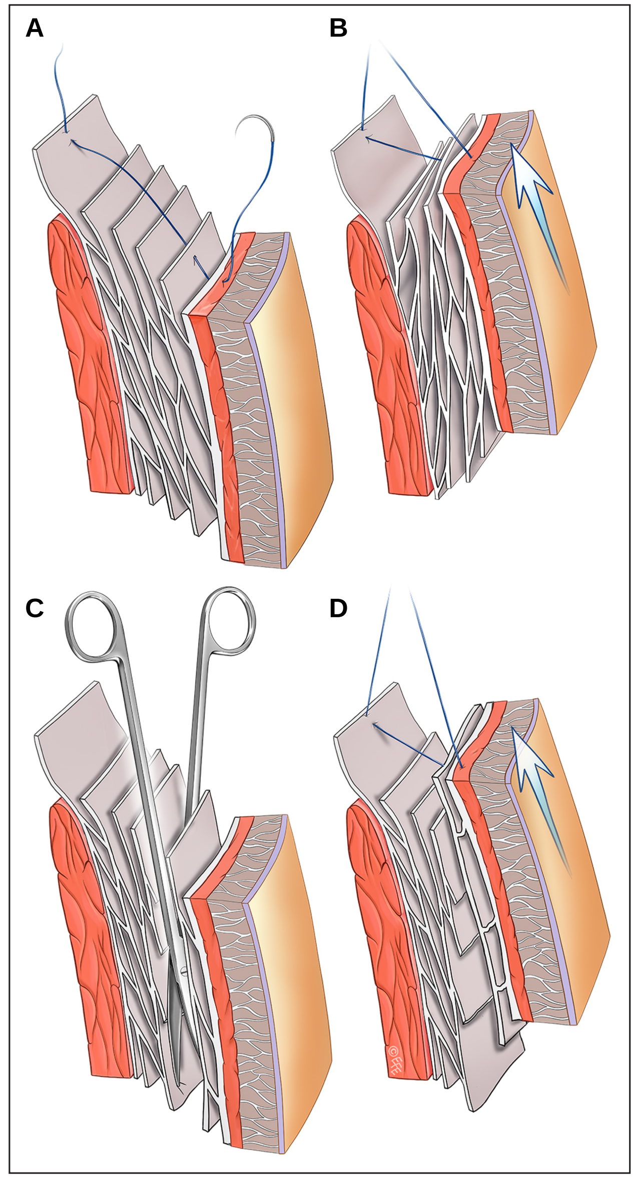

Figure 9. The effect of suspending the platysma without release (above) or with release (below). (A) Before lifting the flap, the retinacula fibers are in an anatomic downward position opposing gravity. (B) After lifting the flap, the retinacula are in a nonanatomic upward position not opposing gravity. The weight of the flap will oppose the longevity of the neck lift result. (C) Dissection of the deep plane releases the retinacula fibers to the platysma. (D) As a result, an unopposed lift is possible, and secondary reattachment of the retinacula fibers is established in the postoperative healing phase, which will then oppose further gravitational pull as was the case preoperatively. Artwork created by and published with permission from Dr Levent Efe, CMI.

age-related laxity of the surrounding fascia, which lead to high-mode buckling (a physics principle that describes why a contractile sheet rolls up when free floating and forms waves or bands in a more restrictive medium) of

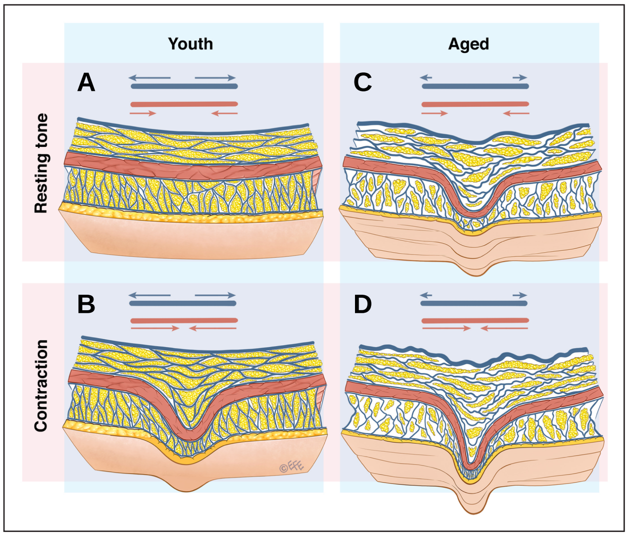

Figure 10. Contraction of the platysma naturally shortens the muscle bringing the ends of the muscle closer and causing the muscle to bunch up ("buckle" in physics), forming bands (illustrated by the red lines). The elasticity of the deep fascia passively provides an opposing force resisting deformation (illustrated by the blue lines). To form a band the platysma needs to overcome this elasticity and recruit sufficient deep fascia to provide the mobility necessary for the localized forward movement of the band. This was recently demonstrated with a CT study by Cotofana.[50] (A) In youth, the short resting tone of the platysma is easily overcome by the tight and elastic deep fascia, preventing banding. (B) Upon contraction, the strong contraction force of the platysma is able to create bands, even in youth. (C) With aging, repetitive movement combined with a loss of elasticity results in an increased laxity of the deep fascia (ie, elongation of the horizontally stacked sheets), similar to a worn-out sleeve, although deep fascial laxity is not as apparent externally as laxity in the superficial fascia layer (eg, jowls). At a given point, the resting tone of the platysma begins to trump the elasticity of the deep fascia. It is at this point that static bands start to become apparent. (D) Even if static bands are not present, mild mimetic activity will produce "dynamic" platysmal bands in the presence of deep fascial laxity. Artwork created by and published with permission from Dr Levent Efe, CMI.

the platysma in areas of local instability (Figure 10).[53] This usually occurs at the anterior and posterior borders of the platysma and/or just lateral to the mandibular ligament, which is the first part of the platysma that is continuous with the lower lip (see labial platysma, Figure 1B).

Recurrent Platysmal Bands After Transection

Complete platysma transection is associated with a significant incidence of recurrent platysmal bands, which seems

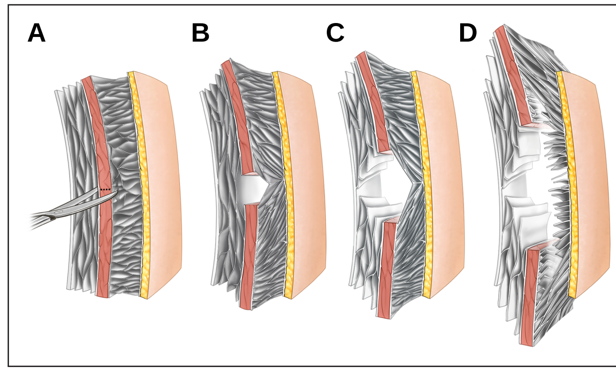

Figure 11. The effect of platysma transection on the transmission of tension upon contraction. (A) Before transection, the muscle is intact and suspended between the skin and the deeper structures by retinacula cutis and deep retinacula respectively. (B) After complete transection, the platysma can still function as one unit, as the tension is effectively transmitted through the skin and the deep fascia, providing a strong connection between the 2 cut ends of the platysma. (C) An additional deep fasciotomy allows the muscle ends to move further apart, but the retinacula cutis are still restricting further widening. (D) Performing a subcutaneous release finally allows the platysma edges to move apart and make the transection more effective. Caution regarding the marginal mandibular nerve (MMN) and first cervical branches (CBFN) is warranted when performing a deep fasciotomy. These steps are principles and can be modified and applied ad libitum. Figure 4B, C further illustrates these details.

paradoxical.[47] Apart from inadequate transection and muscle regeneration, Pelle-Ceravolo reported that even in cases of successful and complete transection, including both the anterior and posterior platysmal fascia, recurrent platysmal bands appeared when both parts of the platysma contract simultaneously.[54]

This phenomenon highlights the difference between platysma and the traditional understanding of muscle function. Complete transection of the platysma does not result in inhibition of its function because, in contrast to skeletal muscles, the platysma is not simply suspended between its origin and its insertion. In addition, the platysma is connected to the superficial and deep fascia by countless retinacula fibers (Figure 11A). This system remains functional after horizontal transection because the muscle can still contract and the tension is mediated through the deep cervical fascia and skin (Figure 11B). This explains recurrent platysmal bands even in the case of successful transection with clearly separated ends of platysma. Apart from surgical resection, most maneuvers only weaken the platysma, and do not completely inhibit its function. Alternative options include:

- widening the gap between the 2 platysmal edges after transection (eg, deep undermining or deep fasciotomy (Figure 11C), wide skin subcutaneous undermining (Figure 11D), or platysmal strip resection)

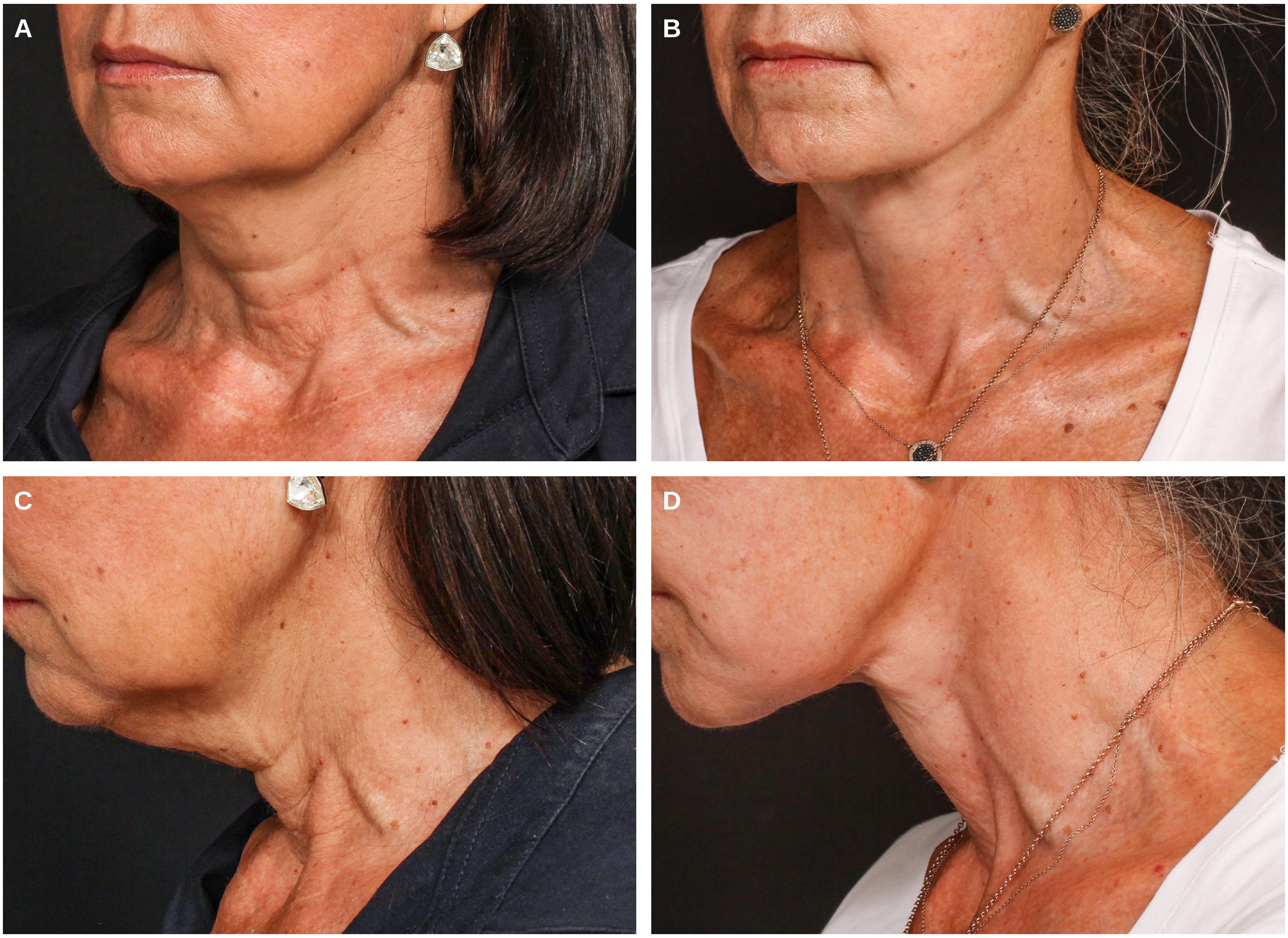

Figure 12. A 55-year-old female (A, C) before and (B, D) 5 years after facelift and neck lift with reduction of subplatysmal fat, anterior digastric muscles and submandibular glands, digastric corset, complete deep cervical fasciotomy, subfascial cervical neck lift and 3-dimensional Z-plasty platysmaplasty with platysmal corset of the submandibular platysma and lateral platysmal suspension to mastoid fascia. The result of the cervical branches (CBFN) denervation or at least weakening by the complete deep cervical fasciotomy and platysmal weakening by the Z-plasty is demonstrated by the complete absence of platysmal bands and fine wrinkles 5 years postoperatively. Images courtesy of Francisco G. Bravo.

- changing the orientation of the platysmal fiber direction (eg, Z-plasty)
- denervation of the platysma (eg, selective neurectomy/neurotomy)
- reducing the recruiting capacity of the platysma (eg, deep fascia tightening, quilting sutures)

Prospects of Surgical Denervation

A recent report revealed that platysmal bands do not develop on the affected side of facial palsy patients.[52] Moreover, surgical denervation has demonstrated therapeutic benefit in platysmal motion disorders.[55] Surgical denervation of frontotemporal branches has recently been described and this principle may apply to the CBFN.[56] A total deep cervical fasciotomy below the level of the hyoid bone between both SCMs transects all lower CBFNs to the cervical platysma while sparing the upper CBFNs to the submandibular platysma and DLI, as proposed by Bravo.[57,58] Preliminary experience with this type of CBFN denervation hints at its potential role in the treatment of platysmal bands as well as fine wrinkles (Figure 12, Video Abstract).

A few important considerations should, however, be kept in mind. The first CBFN should be spared, considering its ending near the menton and potential function related to the lower lip DLI. Additionally, it is important in maintaining adequate tone of the cranial segment of the platysma to avoid submandibular gland protrusion, which is noted in patients after selective neurectomy for the treatment of post–facial paralysis synkinesis.[59] Nerve stimulation may not be helpful intraoperatively, because previous reports have demonstrated lower lip twitching even after stimulation of the TCN branches.[60] Moreover, reinnervation is a complex issue with likely neurotization after simple CBFN transection, precluding a permanent platysma denervation.[61] Therefore, despite its potential role in cervical rejuvenation, further research is warranted before confidently recommending routine caudal platysma denervation during neck lift surgery.

Limitations

In vitro studies can only provide information on the location of the nerves and the natural architecture of the tissues and immediate implications for surgical manipulation, not the functional roles of these nerves nor the long-term effects required to empirically prove longevity in the regenerating and moving living tissues. All deductions regarding nerve function and longevity were based on known physics principles and clinical experience, and may contain errors. In vivo neuro-stimulation studies of the different facial nerve branches will be required to provide conclusive evidence on the functional anatomy of this region. Microscopic studies comparing a younger cohort with an older cohort could provide more conclusive evidence on aging of the platysma and related structures.

CONCLUSIONS

This comprehensive anatomical study has described the surgical anatomy of the platysma, including its bony, fascial, and dermal attachments, as well as its innervation, including danger zones. These findings provide a sound explanation for (1) recurrent anterior neck laxity after no-release lifting, (2) recurrent platysmal banding after total transection of the platysma, and (3) pseudoparalysis of the lower lip. As well they supply a possible explanation for the formation of platysmal bands. This study provides the anatomical basis for the further development of surgical techniques to rejuvenate the neck and prevent recurrent platysmal banding.

Acknowledgments

The authors acknowledge the donors and families of the Body Donor Programs of the University of Melbourne and the Queensland University of Technology who have made this study possible. Specific thanks to Assoc Prof Quentin Fogg from the University of Melbourne for his supervision, Prof Cameron Brown from the Queensland University of Technology for his extensive help with explaining the physics involved in platysmal banding, and Mr Matt Wissemann and Mr Ian Mellor of the Medical Engineering Research Facility for their assistance in the laboratory. Prof Jonathan Cole from the Centre of Postgraduate Research and Education, Bournemouth University, Bournemouth, UK, and Prof Anne Burrows from the Department of Physical Therapy, Duquesne University, Pittsburgh, Pennsylvania, USA, are recognized for sharing their thoughts and experience in personal communications, guiding this work. Ms Erica Mu and Dr Darryl Whitehead from the School of Biomedical Sciences of the University of Queensland are acknowledged for providing the pristine histology outcomes. The authors are grateful for the help of Dr Vladimir Chereminskiy and Mrs Daniela Albinus from von Hagens Plastination for providing high-quality sheet plastination slices. Special thanks to the international authorities Dr Mario Pelle-Ceravolo and André and Luiz Auersvald, as well as our local Mendelson Advanced Facial Anatomy Course faculty members Dr Chin-Ho Wong, Dr Andres Freschi, and Dr Peter Callan for their thorough revision of the manuscript.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

The authors received no financial support for the research, authorship, and publication of this article, including payment of the article processing charge.

REFERENCES

1. Skoog T. *Plastic Surgery: New Methods and Refinements*. WB Saunders; 1974.
2. Guerrero-Santos J, Espaillat L, Morales F. Muscular lift in cervical rhytidoplasty. *Plast Reconstr Surg*. 1974;54(2):127-130. doi: 10.1097/00006534-197407001-00001
3. Connell BF. Cervical lift: surgical correction of fat contour problems combined with full-width platysma muscle flaps. *Aesth Plast Surg*. 1976;1(1):355-362. doi: 10.1007/bf01570270
4. Minelli L, van der Lei B, Mendelson BC. The deep fascia of the head and neck revisited: relationship with the facial nerve and implications for rhytidectomy. *Plast Reconstr Surg*. 2023. doi: 10.1097/prs.0000000000010556. [Epub ahead of print]
5. Minelli L, Bown RGC, Mu EWH, et al. Enhanced study of facial soft tissues using a novel large scale histology technique. *Clin Anat*. 2023;36(1):110-117. doi: 10.1002/ca.23943
6. Hagens GV. Impregnation of soft biological specimens with thermosetting resins and elastomers. *Anatomical Rec*. 1979;194(2):247-255. doi: 10.1002/ar.1091940206
7. de Castro CC. The anatomy of the platysma muscle. *Plast Reconstr Surg*. 1980;66(5):680-683. doi: 10.1097/00006534-198011000-00002
8. Vistnes LM, Souther SG. The platysma muscle: anatomic considerations for aesthetic surgery of the anterior neck. *Clin Plast Surg*. 1983;10(3):441-448. doi: 10.1016/s0094-1298(20)31867-8

9. Davidovic K, Frank K, Schenck TL, et al. Anatomy behind the paramedian platysmal band: a combined cadaveric and computed tomographic study. *Plast Reconstr Surg*. 2021;148(5):979-988. doi: 10.1097/prs.0000000000008414
10. Louarn CL. A new approach to functional anatomy of the lower face: role of the hyoplatysmal ligament, of the platysma and of the depressor labii lateralis. *Ann De Chir Plastique Esthétique*. 2016;61(2):101-109. doi: 10.1016/j.anplas.2015.12.002
11. Lightoller GH. Facial muscles: the modiolus and muscles surrounding the rima oris with some remarks about the panniculus adiposus. *J Anat*. 1925;60(Pt 1):1-85.
12. Feldman JJ. *Neck Lift*. Quality Medical Publishing; 2006.
13. Minelli L, Yang HM, van der Lei B, Mendelson B. The surgical anatomy of the jowl and the mandibular ligament reassessed. *Aesth Plast Surg*. 2023;47(1):170-180. doi: 10.1007/s00266-022-02996-3
14. Minelli L, Brown CP, van der Lei B, Mendelson BC. Anatomy of the facial glideplanes, deep plane spaces and ligaments: implications for surgical and non-surgical lifting procedures. *Plast Reconstr Surg*. 2023. [Epub ahead of print]
15. Furnas DW. The retaining ligaments of the cheek. *Plast Reconstr Surg*. 1989;83(1):11-16. doi: 10.1097/00006534-198901000-00003
16. Mendelson BC, Wong CH. Anatomy of the aging face. In: Neligan PC, ed. *Plastic Surgery*. Elsevier; 2013:78-92.
17. Mustoe TA, Rawlani V, Zimmerman H. Modified deep plane rhytidectomy with a lateral approach to the neck: an alternative to submental incision and dissection. *Plast Reconstr Surg*. 2011;127(1):357-370. doi: 10.1097/prs.0b013e3181f95d66
18. Jacono AA, Malone MH. Characterization of the cervical retaining ligaments during subplatysmal facelift dissection and its implications. *Aesthet Surg J*. 2017;37(5):495-501. doi: 10.1093/asj/sjw274
19. Owsley JQ. SMAS-platysma facelift. A bidirectional cervicofacial rhytidectomy. *Clin Plast Surg*. 1983;10(3):429-440. doi: 10.1016/s0094-1298(20)31866-6
20. Hodgkinson D. Total neck rejuvenation, harnessing the platysma in the lower neck and décolletage. *Aesth Plast Surg*. 2022;46(1):161-172. doi: 10.1007/s00266-020-02068-4
21. Bannister LH, Berry MM, Collins P. *Gray's Anatomy*. 38th ed. Churchill Livingstone; 1995.
22. Hueston JT, Cuthbertson RA. Duchenne de Boulogne and facial expression. *Ann Plas Surg*. 1978;1(4):411-420. doi: 10.1097/00000637-197807000-00009
23. Rubin LR. The anatomy of a smile: its importance in the treatment of facial paralysis. *Plast Reconstr Surg*. 1974;53(4):384-387. doi: 10.1097/00006534-197404000-00002
24. Ellenbogen R. Pseudo-paralysis of the mandibular branch of the facial nerve after platysmal face-lift operation. *Plast Reconstr Surg*. 1979;63(3):364-368. doi: 10.1097/00006534-197903000-00012
25. Greenwood JE. Function of the panniculus carnosus: a hypothesis. *Vet Rec*. 2010;167(19):760-760. doi: 10.1136/vr.c6210
26. Santorini GD. *Observationes Anatomica*. 1724.
27. Fujita T. Uber die Periphere Ausbreitung des N. facialis beim Menschen. *Gegebaurs Morphol Jahrb*. 1934;73(1):578.
28. Gasser RF. The development of the facial muscles in man. *Am J Anat*. 1967;120(2):357-375. doi: 10.1002/aja.1001200207
29. Dingman RO, Grabb WC. Surgical anatomy of the mandibular ramus of the facial nerve based on the dissection of 100 facial halves. *Plast Reconstr Surg*. 1962;29(3):266-272. doi: 10.1097/00006534-196203000-00005
30. Lapatki BG, Oostenveld R, Dijk JPV, Jonas IE, Zwarts MJ, Stegeman DF. Topographical characteristics of motor units of the lower facial musculature revealed by means of high-density surface EMG. *J Neurophysiol*. 2006;95(1):342-354. doi: 10.1152/jn.00265.2005
31. Touré G, de Fremicourt MT, Randriamanantena T, Vlavonou S, Priano V, Vacher C. Vascular and nerve relations of the marginal mandibular nerve of the face. *Plast Reconstr Surg*. 2019;143(3):888-899. doi: 10.1097/prs.0000000000005360
32. Krag AE, Dumestre D, Hembd A, Glick S, Mohanty AJ, Rozen SM. Topographic and neural anatomy of the depressor anguli oris muscle and implications for treatment of synkinetic facial paralysis. *Plast Reconstr Surg*. 2021;147(2):268e-278e. doi: 10.1097/prs.0000000000007593
33. Baker DC, Conley J. Avoiding facial nerve injuries in rhytidectomy: anatomical variations and pitfalls. *Plast Reconstr Surg*. 1979;64(6):781-795. doi: 10.1097/00006534-197912000-00005
34. Rödel R, Lang J. Die peripheren Äste des N. facialis im Wangenund Kinnbereich Anatomie und klinische Konsequenzen. *HNO*. 1996;44(10):572-576. doi: 10.1007/s001060050056
35. Salinas NL, Jackson O, Dunham B, Bartlett SP. Anatomical dissection and modified Sihler stain of the lower branches of the facial nerve. *Plast Reconstr Surg*. 2009;124(6):1905-1915. doi: 10.1097/prs.0b013e3181bceea5
36. Sinno S, Thorne CH. Cervical branch of facial nerve: an explanation for recurrent platysma bands following necklift and platysmaplasty. *Aesthet Surg J*. 2019;39(1):1-7. doi: 10.1093/asj/sjy150
37. Larson JD, Tierney WS, Ozturk CN, Zins JE. Defining the fat compartments in the neck: a cadaver study. *Aesthet Surg J*. 2014;34(4):499-506. doi: 10.1177/1090820(14526406
38. Domet MA, Connor NP, Heisey DM, Hartig GK. Anastomoses between the cervical branch of the facial nerve and the transverse cervical cutaneous nerve. *Am J Otolaryng*. 2005;26(3):168-171. doi: 10.1016/j.amjoto.2004.11.018
39. Chickering JG, Sokoloff AJ. Innervation of propatagial musculature in a flying squirrel, *Glaucomys volans*

(Rodentia, Sciuridae). *Brain Behav Evol*. 1996;47(1):1-7. doi: 10.1159/000113224
40. Ogawa Y, Sakakibara R. Platysma sign in high cervical lesion. *J Neurol Neurosurg Psychiatry*. 2005;76(5):735. doi: 10.1136/jnnp.2004.049296
41. Leon-Sarmiento FE, Calderon A, Hernandez HG. Two Babinski signs in seropositive (HAM) and seronegative tropical spastic paraparesis. *Arq Neuro-psiquiat*. 2008;66-(3b):695-697. doi: 10.1590/s0004-282x2008000500016
42. Uzawa A, Furuya T, Ohtori S, Kuwabara S. Spinal myoclonus selectively affecting the platysma after cervical laminectomy. *Neurology*. 2018;91(1):45-46. doi: 10.1212/wnl.0000000000005746
43. Bertelli J. Platysma motor branch transfer in brachial plexus repair: report of the first case. *J Brachial Plexus Peripher Nerve Inj*. 2007;2(1):e56-e60. doi: 10.1186/1749-7221-2-12
44. Socolovsky MP, Bertelli JA, Masi GD, et al. Surgical anatomy of the platysma motor branch as a donor for transfer in brachial plexus repair. *Surg Radiol Anat*. 2008;30(8):669-674. doi: 10.1007/s00276-008-0372-z
45. Birch R. *Surgical Disorders of the Peripheral Nerves*. 2nd ed. Springer; 2011.
46. O'Daniel TG. Guide to safe submandibular gland reduction. *Presented at the 2022 Annual Meeting and 13th International Symposium of Facial Plastic Surgery, October 20, 2022, Washington DC*.
47. Pelle-Ceravolo M, Angelini M, Silvi E. Complete platysma transection in neck rejuvenation. *Plast Reconstr Surg*. 2016;138(4):781-791. doi: 10.1097/prs.0000000000002604
48. Wu WTL. Microbotox of the lower face and neck. *Plast Reconstr Surg*. 2015;136(5S):92S-100S. doi: 10.1097/prs.0000000000001827
49. Hembd A, Nagarkar P, Perez J, et al. Correlation between facial nerve axonal load and age and its relevance to facial reanimation. *Plast Reconstr Surg*. 2017;139(6):1459-1464. doi: 10.1097/prs.0000000000003376
50. Engerer N, Frank K, Moellhoff N, et al. Aging of the neck decoded: new insights for minimally invasive treatments. *Aesth Plast Surg*. 2022;46(4):1698-1705. doi: 10.1007/s00266-022-02961-0
51. Knize DM. An anatomically based study of the mechanism of eyebrow ptosis. *Plast Reconstr Surg*. 1996;97(7):1321-1333. doi: 10.1097/00006534-199606000-00001
52. Trévidic P, Criollo-Lamilla G. Platysma bands: is a change needed in the surgical paradigm? *Plast Reconstr Surg*. 2017;139(1):41-47. doi: 10.1097/prs.0000000000002894
53. Kudrolli A, Chopin J. Tension-dependent transverse buckles and wrinkles in twisted elastic sheets. *Proc Royal Soc*. 2018;474(2214):20180062. doi: 10.1098/rspa.2018.0062
54. Pelle-Ceravolo M, Angelini M, Silvi E. Treatment of anterior neck aging without a submental approach. *Plast Reconstr Surg*. 2017;139(2):308-321. doi: 10.1097/prs.0000000000003030
55. Laskawi R, Rohrbach S, Rödel R. Surgical and nonsurgical treatment options in patients with movement disorders of the platysma. *J Oral Maxil Surg*. 2002;60(2):157-162. doi: 10.1053/joms.2002.29810
56. Viterbo F, Fonseca E, Magnani LV, Neto BFM. Temporal branch ablation for the treatment of facial rhytids: a new surgical technique. *Aesthet Surg J*. 2022;43(1):NP19-NP27. doi: 10.1093/asj/sjac178
57. Bravo FG. Reduction neck lift: the importance of the deep structures of the neck to the successful neck lift. *Clin Plast Surg*. 2018;45(4):485-506. doi: 10.1016/j.cps.2018.05.002
58. Bravo FG. Neck contouring and rejuvenation in male patients through dual-plane reduction neck lift. *Clin Plast Surg*. 2022;49(2):257-273. doi: 10.1016/j.cps.2021.12.002
59. Azizzadeh B, Irvine LE, Diels J, et al. Modified selective neurectomy for the treatment of post-facial paralysis synkinesis. *Plast Reconstr Surg*. 2019;143(5):1483-1496. doi: 10.1097/prs.0000000000005590
60. Brennan PA, Elhamshary AS, Alam P, Anand R, Ammar M. Anastomosis between the transverse cervical nerve and marginal mandibular nerve: how often does it occur? *Br J Oral Maxillofac Surg*. 2017;55(3):293-295. doi: 10.1016/j.bjoms.2016.08.025
61. Schroegendorfer KF, Hacker S, Nickl S, Vierhapper M, Nedomansky J, Haslik W. Latissimus dorsi breast reconstruction: how much nerve resection is necessary to prevent postoperative muscle twitching? *Plast Reconstr Surg*. 2014;134(6):1125-1129. doi: 10.1097/prs.0000000000000739