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REVIEW

Neurovascular structures of the mandibular angle and condyle: a comprehensive anatomical review

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Abstract
Background Various surgical interventions including esthetic surgery, salivary gland excision, and open reduction of fracture have been performed in the area around the mandibular angle and condyle. This study aimed to comprehensively review the anatomy of the neurovascular structures on the angle and condyle with recent anatomic and clinical research.
Methods and results We provide detailed information about the branching and distributing patterns of the neurovascular structures at the mandibular angle and condyle, with reported data of measurements and proportions from previous anatomical and clinical research. Our report should serve to help practitioners gain a better understanding of the area in order or reduce potential complications during local procedures. Reckless manipulation during mandibular angle reduction could mutilate arterial branches, not only from the facial artery, but also from the external carotid artery. The transverse facial artery and superficial temporal artery could be damaged during approach and incision in the condylar area. The marginal mandibular branch of the facial nerve can be easily damaged during submandibular gland excision or facial rejuvenation treatment. The main trunk of the facial nerve and its upper and lower distinct divisions have been damaged during parotidectomy, rhytidectomy, and open reductions of condylar fractures.
Conclusion By revisiting the information in the present study, surgeons will be able to more accurately prevent procedure-related complications, such as iatrogenic vascular accidents on the mandibular angle and condyle, complete and partial facial palsy, gustatory sweating (Frey syndrome), and traumatic neuroma after parotidectomy.

Keywords Facial artery · Facial nerve · Marginal mandibular branch · Mandibular angle · Mandibular condyle

Introduction

Arterial tributaries from the external carotid artery (ECA) and nervous branches of the facial (FN), trigeminal, and cervical nerves innervate the area around the mandibular angle and condyle. Esthetic surgery, salivary gland tumor excision, and open reduction of fractures are performed in the mandibular angle and condyle region. Due to the intricate and various distribution patterns of the neurovascular structures in that area, traditional depictions in many textbooks are too simple and inaccurate for surgeons to effectively prevent iatrogenic neurovascular complications during procedures. The present review aims to provide exact anatomical information of the arteries and nerves around the mandibular angle and condyle and to revisit related clinical implications of the anatomical structures.

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Literature study

To perform a comprehensive anatomical review, the present study revisited previous anatomical studies about the nerves and arteries around the mandibular angle and condyle. Our review constituted four parts consisting of (1) the arteries around the mandibular ramus, (2) the nerves around the mandibular ramus, (3) the arteries around the mandibular condyle and (4) the nerves around the mandibular condyles. Each part concluded the detailed anatomical information delineated by previous studies with the clinical implication, especially surgical complication.

Angular branches from external carotid artery and facial artery around the mandibular ramus

The facial artery (FA) originates from the ECA inside the mandibular ramus at a level about 8 mm superior to the carotid bifurcation [56, 60]. The artery branches from a common trunk with the lingual artery in approximately one in five cases [39]. The FA turns outward below the antegonial notch of the mandible and it emerges on the face at the point about 2 cm anterior to the gonion, as it ascends toward the nasion with various branching patterns [33]. Inside the mandible, the artery issues the ascending palatine artery (APA) and submental artery (SMA). Additionally, the FA gives off other small branches to the medial pterygoid muscle (MPt) inside the mandibular ramus [34]. After it emerges, the FA provides muscular branches to the masseter muscle (MST) [64]. Not only the FA, but also the ECA, gives off branches inside and outside the ramus to the Mpt and MST.

Arterial branches inside the mandibular ramus

General descriptions have presented that the pterygoid arteries from the maxillary artery (MA) feed the pterygoid muscles [45, 56]. However, the FA or ECA also issue arterial branches distributing the MPt near the mandibular angle. Huang et al. described that the APA consists of glossal, tonsilar, and hamular branches, and these branches supply blood to the area inside the ramus [22]. Kwak et al. determined that the gonial branches from the FA (gonial muscular branch) occur in 20 % of cases, and that the arterial tributaries of the tonsillar branch (anterior muscular branch) occur in 90 % of cases, supplying blood to the MPt and the APA. In their study, the APA was observed in all cases, as originating from the FA (80 %) or ECA (20 %) at the level of the gonion. They reported that the APA seemed to be a dominant artery to the MPt inside the ramus, similar to the study of Huang et al. [22]. The gonial muscular branch branched from the FA before the ramification of the APA, and the anterior muscular branch was ramified from the tonsillar branch after the ramification. In latter cases, the tonsillar branch originated from the FA (72 %) or the SMA (28 %). Other pterygoid branches ramified directly from ECA about 2 cm superior the gonion in 80 % of cases. The area 1.5 cm anterior to the gonion is supposed to be dangerous; where the pterygoid branches from the FA or SMA distribute. Additionally, it is also important that the SMA and tonsillar branch are ramified near the passing area of the FA through the inferior border of the mandible.

Arterial branches outside the mandibular ramus

After passing through the antegonial notch, the FA ascends along the MST toward the nasion, following a tortuous course [67]. Marinho et al. [42] reported that not only the masseteric branch of the MA but also that there are branches from the FA and ECA distribute to the MST. Hwang et al. [28] documented that the masseteric branch directly branches from the ECA, a branch they deemed the middle masseteric artery. The transverse facial artery (TFA) from the superficial temporal artery (STA), a terminal branch of the ECA, coursed forward across the upper part of the MST [56, 66]. Not only the TFA but also other smaller branches (MbECAs), which were directly ramified from the ECA, distributed to the MST, closer to the gonion [64]. Won et al. [64] reported that the MbECA was observed in 56 % of cases, and its average width was 1.0 mm. Thus, vascular accidents involving this artery would result in rather significant postoperative bleeding without a confirmation of arterial intactness.

The premasseteric artery (PMA) ramifies from the FA and it ascends upward along the anterior border of the MST, after its emergence on the face [40]. The PMA gives off branches (MbPMA) to the anterior portion of the MST, especially its superficial layer [64]. Several tiny branches from the FA (MbFA) entered the anteroinferior portion of the MST. There is a gonial branch from the FA, which directly distributes to the MST. Observation of the intramuscular vascularization of the MST using muscle clearing has shown that the MbECA mostly supplies the angular area superior to the gonion, and that the MbFA supplies the area anterior to the gonion in the superficial layer of the MST. The MbTFA distributes to the angular area around the gonion in the deep layer [64]. Knowledge of the intramuscular distribution of respective arteries is crucial to ligate vessels during hemostatic procedures, including mandibular angle reduction with an excision of the MST.

The arterial branches inside and outside the mandibular angle can be summarized in Table 1 and Fig. 1.

Table 1 Arteries around the mandibular angle

Arteries inside the mandibular ramus[a]	
Direct pterygoid branch (dPtbr)	From external carotid artery
Gonial muscular branch (Gobr)	From facial artery
Ascending palatine artery (APA)	From facial artery (80 %) or external carotid artery (205)
Anterior muscular branch of tonsilar branch (aMusbr)	From facial artery (72 %) or submental artery (28 %)
Arteries outside the mandibular ramus[b]	
Masseteric branch (MbTFA)	From transverse facial artery
Masseteric branch (MbECA)	From external carotid artery
Masseteric branch (MbFA)	From facial artery
Masseteric branch (MbPMA)	From premasseteric artery of facial artery

The arteries herein and their abbreviation are also described in Fig. 1

[a] Noted on the basis of the study of Kwak et al. [34]

[b] Noted on the basis of the study of Won et al. [64]

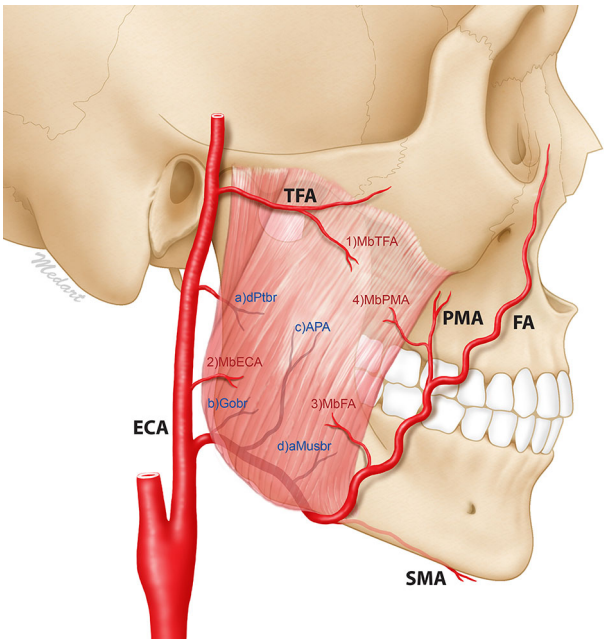

Fig. 1 The arteries giving off branches to the mandibular angle area. *ECA* external carotid artery, *FA* facial artery, *SMA* submental artery, *PMA* premasseteric artery. The masseter muscle is presented. The arteries indicated by MbTFA, MbECA, MbFA and MbPMA with red Figs. (1–4) are located outside the mandibular angle and the arteries indicated by dPtbr, Gobr, APA and aMusbr with *blue alphabet letters* (a–d) are located inside the mandibular angle. The abbreviations of these arteries are noted in Table 1 (color figure online)

Innervation on the mandibular angle area

The mandibular nerve (V3) branch of the trigeminal nerve gathers sensation of the lower face and the buccal, while the marginal mandibular branches (Mbr) of the FN distribute to the facial expression muscles of the lower face [65, 69]. In the case of the sensory nerve, the mandibular angle area is known to be innervated by the great auricular nerve (GAN) from the superior cervical plexus as well as the trigeminal nerve [15, 30]. The Mbr, motor nerve bundle, proceeds along the inferior border of the mandible, through the areas around the gonion and the FA emergence point on the face.

Marginal mandibular branch of facial nerve: motor fibers on the angle

The FN exits the stylomastoid foramen and proceeds forward about 1–2 cm as a single trunk (or with another minor trunk) within the petrotympanic fissure [21, 35, 52]. The FN then mostly bifurcates into the upper (temporofacial division) and lower trunks (cervicofacial division). The lower division divides into the Mbr and cervical branch (Cbr). It has been reported that the cervicofacial trunk and its branches lie above or at the level of the mandibular angle in 40 % of cases [17]. In particular, the Mbr has been known to run very close to the gonion (Fig. 2) [17, 23, 31]. Saylam et al. reported that the Mbr proceeds superior to the inferior border of the mandible in 74 % of cases, and Woltmann et al. reported that the Mbr passes upward through the inferior border of the mandible in 57.7 % of cases [53, 63].

The distance between the gonion and the Mbr seems to be less than 1 cm. Kim et al. and Hwang et al. reported the distance between the gonion to the Mbr averages 3.4 and 3.5 mm, respectively [25, 31]. The neck's position may alter the location of the Mbr during surgery [1]. Hwang et al. [25] reported that the distance between the inferior

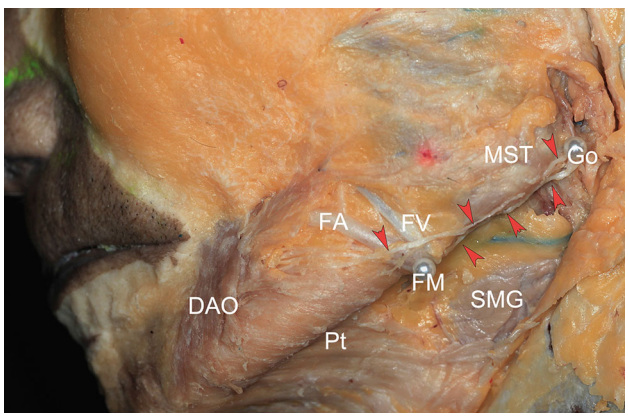

Fig. 2 Marginal mandibular branch in close distance to the gonion of the mandibular angle. *Red arrows* indicate marginal mandibular branch of facial nerve. *Go* gonion, *DAO* depressor anguli oris muscle, *Pt* platysma muscle, *MST* masseter muscle, *SMG* submandibular gland, *FA* facial artery, *FV* facial vein, *FM* intersection point of FA on inferior border of mandible (color figure online)

border of the mandible and the MBr at the one-fourth point from the gonion to the menton increased during contralateral rotation of the head in fresh cadavers. The distance between the nerve and border was 6.0 mm after the increase by rotation. In that instance, the Mbr could be more than 1 cm superior to the gonion. Kim et al. suggested that the area 19.8 mm superior and 7.4 mm inferior to the gonion in males and 15.4 mm superior and 8.1 mm inferior in females is the dangerous zone for the Mbr injury in surgery [31].

The intersection point (MF point) of the inferior border of the mandible and the FA has been regarded as an important landmark for the indication of the MBr. It has been reported that the distance between the MF point and the Mbr was about 4–5 mm [25, 31].

The number of Mbr twigs has been known to be between 1 and 4, and the most common number of twigs is 2 [3, 17, 31, 61]. Farahvash et al. reported that they observed multiple twigs of Mbr in only 2 of the 42 specimens and they suggested that the branches, which are regarded as the Mbr in the research reporting multiple twigs of the Mbr would be the buccal branch (Bbr) of the FN [17]. Actually, however, there is a report of two branches of Mbr, one of which crossed the FA deeply and the other crossed it superficially at close proximity [31]. Regardless whether a branch is Mbr or Bbr, termination and course of the FN branches are really important. An injury on the FN branch on the MF point or the gonion might result in palsy of lower facial muscles, and thus careful manipulation should be performed on the inferior border of the mandible near the gonion.

Narayanan et al. described a "nerve-free window" between Bbr and Mbr of the FN at the anterior edge of the parotid gland [49]. Since the two branch groups tended to divide there, the anteroparotid approach may be recommended to treat condylar fractures. However, Kwak et al. reported that the Bbr and Mbr are anastomosed in 34.6 % of cases [35]. Consequently, we cannot guarantee the area between Bbr and Mbr at the angular area of the mandible is truly "nerve-free".

Submandibular gland excision and facial nerve injury

Submandibular gland (SMG) excision has been performed broadly in cases of benign and malignant salivary gland tumors. The Mbr is the most frequently damaged nerve during SMG excision. Smith et al. reported that temporary and permanent Mbr injury during submandibular SMG surgery occurred in 36 and 12 % of cases, respectively, while lingual nerve injury and hypoglossal nerve injury occurred in 2–5 % [55]. Mbr injury can cause facial muscle palsy around the corner of the mouth and asymmetry of the lower face [8]. Thus, Shaheen suggested three methods to prevent the nerve damage: (1) a lower incision at the level of the hyoid bone, (2) a clear identification and retraction of the Mbr at the level of parotid tail, and (3) a division and traction of the facial vessels and identification of the Mbr [20]. The location and course of the Mbr in the vicinity of the antegonial notch could be identified by its relationship with the FA.

Great auricular nerve: a sensory nerve on the angle

The GAN is the largest nerve of the four major cutaneous nerves from the superior cervical plexus. The GAN emerges on the anterior border of the sternocleidomastoid muscle (SCM) and ascends superoanteriorly toward the mandibular ramus and auricular area (Fig. 3). Ella et al. documented that the GAN distributes to the mandibular angle area in 97 % of cases. Thus, it is a vulnerable nerve during surgical manipulation on the mandibular angle. Amputation of the GAN could result in dysesthesia, otalgia, or traumatic neuroma [2, 7, 44, 72].

Lefkowitz et al. documented that the GAN mostly coursed over the upper one-third of the SCM, and Ozturk et al. also reported that the GAN crossed the upper one-

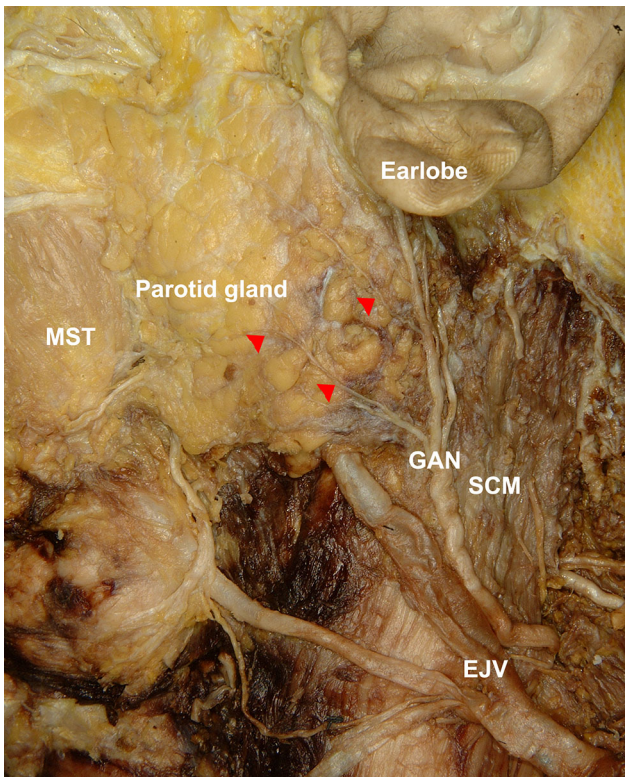

Fig. 3 Great auricular nerve distributing retromandibular area after ascending anteriorly passing over the sternocleidomastoid muscle. *GAN* great auricular nerve, *MST* masseter muscle, *SCM* sternocleidomastoid muscle, *EJV* external jugular vein. *Red arrowheads* indicate twigs of the GAN that locates retromandibular area (color figure online)

third of the muscle in more than half of the cases (53.9 %) [38, 50]. It was reported that the GAN was located about 1 cm posterior to the external jugular vein and 5 cm anterior to the external auditory meatus at the anterior border of the SCM [47, 50]. Hence, it is quite possible that the GAN lies between the mandibular angle and the upper one-third of the SCM.

Additionally, the GAN communicates with the V3 branches of the facial nerve branches. Whereas little has been revealed about functional feature of nervous connection between them, the close embryologic and phylogenic relationship between the pharyngeal apparatus and superior cervical segment in the mammals might be associated with anastomosis and overlap between the cranial and spinal nervous components [15].

Sometimes an injury or amputation of the GAN is inevitable during parotidectomy, and it has been regarded as an insignificant problem, whereas the FN injury has been known to cause more catastrophic complications, including permanent facial palsy [72]. However, Ozturk et al. reported that GAN injury can cause severe pain, although the probability is low, around 0–2.6 % of cases [50]. Amputation of the GAN during parotidectomy has been reported to occur as a traumatic neuroma in 6 % of patients undergoing parotid gland surgery [46]. Additionally, GAN injuries are known to occur at a rate of 6 % during rhytidectomy procedures, and minimally invasive techniques can increase the incidence of injury [2]. Thus, the GAN should be meticulously preserved during surgical intervention, if possible.

Arteries around the condylar process of the mandible

The ECA divides into the STA and the MA below the temporomandibular joint (TMJ). The STA ascends as it crosses the TMJ and the zygomatic arch. The STA issues the TFA that proceeds forward about 1 cm below the zygomatic arch. The STA and TFA can be easily palpated in most cases. The MA passes deep to the condylar neck of the mandible. The MA issues the deep auricular artery, anterior tympanic artery, and middle meningeal artery near the condylar neck. These arteries supply blood to the retrodiscal tissue for nutrient supply for the TMJ structure. Not only the MA, but also the ECA, STA, and TFA give off branches to the TMJ [11].

Transverse facial artery proceeding over the masseter

Yang et al. reported that the TFA ramified posterior to the ramus of the mandible as a single branch in 70.5 % of cases, and it divided into superior and inferior trunks after proceeding another 1 cm [66]. In more than half of the cases, the upper trunk of the TFA is located at the same or above the level of the temporofacial trunk of the FN. The researchers also reported that the perforator branch of TFA upper trunk perforated the anterior third of the MST in most cases. Won et al. described that the branch from the deep temporal branch of the MA supplies the anterior portion of the MST [34]. That is, the TFA and MA, which are passing superficial and deep to the condylar process of mandible, respectively, could anastomose at the anterior portion of the MST. Additionally, the branch from the FA may be connected with the TFA [66]. Thus, from an anatomical perspective, an oozing of blood near the condyle after injury might persist despite the ligation of the TFA, since a distal segment can be supplied from the MA of the FA after the anastomosis.

Superficial temporal artery ascends through the condylar area

The STA ascends 2–5 cm after ramification from the ECA and it splits into the frontal and parietal branches; the former proceeds forward and upward toward the frontal belly of the occipitofrontalis [37]. Kwak et al. reported that a muscular branch of the MST from the STA above the ramification of the TFA occurs in 36 % of cases [64]. It seems to be ramified from the TFA from the STA in front of the mandibular neck, while other masseteric branches from the TFA originate as it traverses the parotid gland between the zygomatic arch and parotid duct.

Clinically, iatrogenic or traumatic injury can cause an aneurysm or pseudoaneurysm of the head vessels. Conner et al. reported that 85 % of traumatic pseudoaneurysms of the face and temple occur in the STA [10]. The development of an aneurysm can be delayed weeks to years after the traumatic injury. Arterial expansion after post-traumatic development can lead to rupture of the artery [11].

Nerve distribution around the condylar process of the mandible

The axons of the FN innervate to the facial expression muscles and the main trunk of the FN transverses the ECA and it divides into 4–5 main divisions within the vicinity of the condyle of the mandible (Figs. 4, 5) [1, 51, 52]. The auriculotemporal nerve (ATN) is a sensory branch of the mandibular nerve and the nerve passes over the neck of the mandible and zygomatic arch (Fig. 6).

Facial nerve trunk and its major branches at the condylar area

Mostly, the FN bifurcates into upper temporofacial and lower cervicofacial divisions [35]. Within the parotid

gland, the FN divisions issue numerous twigs of four or five groups as they lie superficial to the TFA branches (Fig. 4) [66]. The FN constitutes a complicated plexus, and they anastomose with twigs from other cranial nerves, and as a result, it is very difficult to provide a nerve-free safe zone within the condylar area for the prevention of FN branch injury (Fig. 5) [1, 6, 12, 13, 24, 26, 35, 68, 70, 71]. Laurentjoye et al. recommended that three cutaneous reference lines from the tragus could serve as safe nerve-free area for dissection; the tragus-lateral canthus line for Tbr, the tragus-ala nasi line for Zbr and the tragus-lip corner line for Bbr [36]. However, Yang and Yoo reported that the FN branches formed a loop or plexiform on the condylar area in 52 % of patients, and thus, superficial landmarks cannot be provided for the FN branches within the condylar area [71]. In the case of the Tbr, which crosses the condyle and zygomatic arch, de Bonnecaze et al. found that there is no actual safe area in the temporal region [6]. The Bbr generally proceeds forwards below the orbit as it distributes to the midface musculature of the upper lip, cheek, and nose area. While the Bbr rarely branches from the main trunk of the FN, it almost forms a Y shape from the branches of the upper and lower trunks. Numerous studies have reported

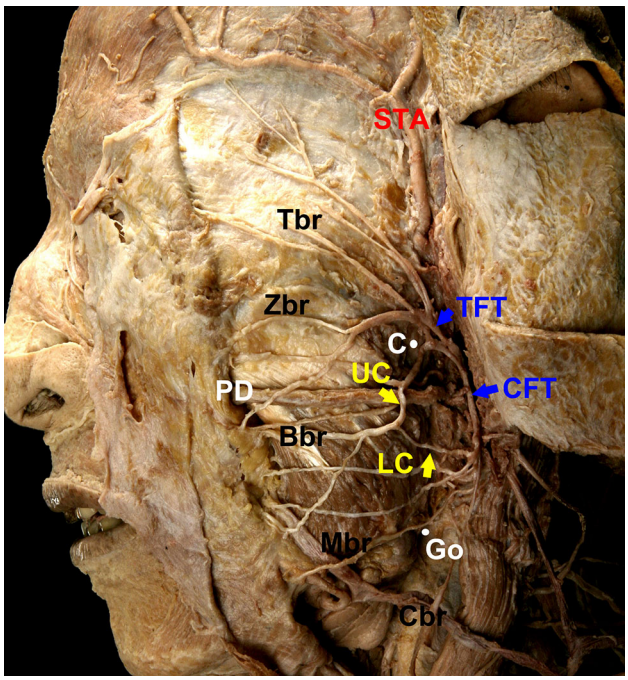

Fig. 4 Facial nerve trunk and its five branch groups. *Tbr* temporal branch of the facial nerve (FN), *Zbr* zygomatic branch of the FN, *Bbr* buccal branch of the FN, *Mbr* marginal mandibular branch of the FN, *Cbr* cervical branch of the FN, *TFT* temporofacial trunk (or upper trunk) of the FN, *CFT* cervicofacial trunk (or lower trunk) of the FN, *UC* upper branch from the TFT forming the Bbr, *LC* lower branch from the cervicofacial trunk (or lower trunk) of the FN forming the Bbr, *C* mandibular condyle, *Go* gonion, *PD* parotid duct, *STA* superficial temporal artery

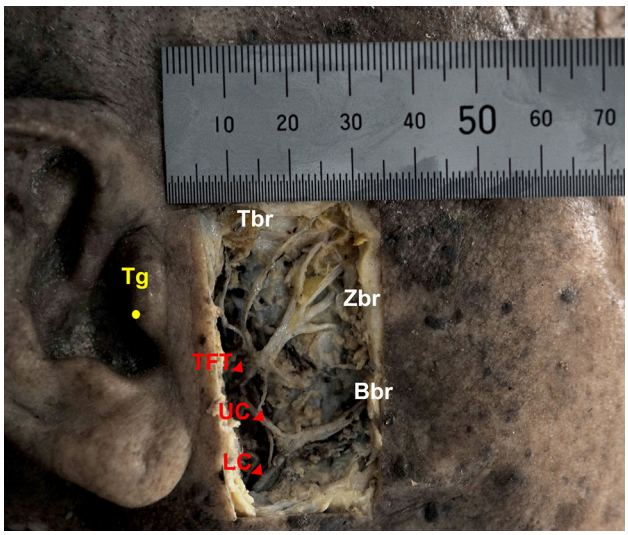

Fig. 5 Nervous plexus of facial nerve trunks and divisions at the condylar area. *Tbr* temporal branch of the FN, *Zbr* zygomatic branch of the FN, *Bbr* buccal branch of the FN, *TFT* temporofacial trunk (or upper trunk) of the FN, *UC* upper branch from the TFT forming the Bbr, *LC*, lower branch from the cervicofacial trunk (or lower trunk) of the FN forming the Bbr, *Tg* tragus

that the Bbr reconnects with the Zbr in about 87–100 % of cases [5, 35, 62].

Considering the Sihler's staining study of Yang et al., the distribution of the FN would be thought to form a non-linear branching pattern over a two-dimensional area [68]. There were many studies that provided the intersection points of the FN with superficial landmarks regarding the complexity of FN ramification (Table 2) [6, 17, 23, 58, 71]. Tayfur et al. delineated that there were an average of 3.7 branches of TBr which crossed the level of the zygomatic arch [58]. de Bonnecaze et al. reported that the area 22.6–26.1 mm anterior to the tragus at the level of the superior part of the zygomatic arch and 27.5–30.4 mm anterior to the tragus at the level of the inferior part of the arch are dangerous areas, where the FN branch existed in the case of more than 85 % of patients [6]. Hwang et al. described that the Tbr is located 21.5–35.4 mm anterior to the root of the helix at the zygomatic arch [27]. Farahvash et al. reported that the first intersecting Tbr branch on the zygomatic arch is located about 20 mm anterior to the tragus, the second one is located about 27–28 mm anterior to the tragus, and the third is located about 39–36 mm anterior to the tragus [17]. They also reported that the bifurcation of upper and lower division of the FN is located about 1.5–1.6 mm anterior to a line through the tragus and gonion. Yang and Yoo reported that the FN passed over a vertical line anterior 2 cm to the tragus, on one point in 24 %, two points in 48 %, and three points in 28 %. The FN nerves crossed

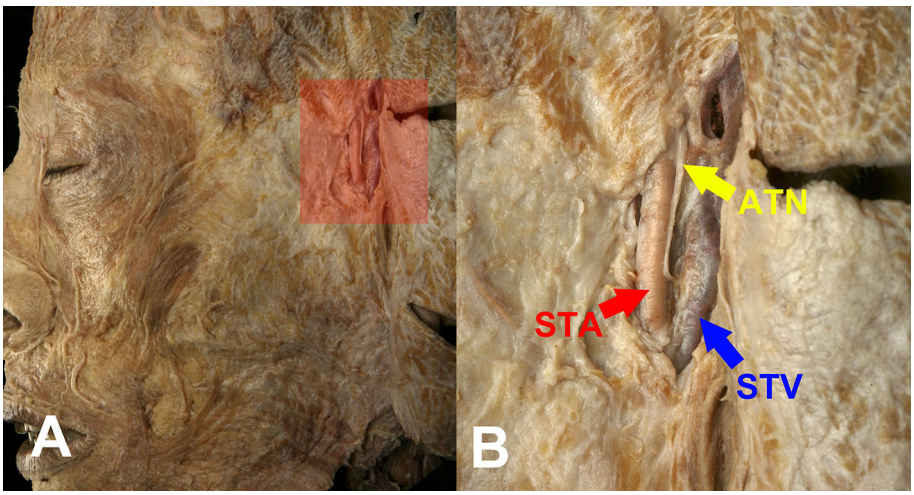

Fig. 6 Auriculotemporal nerve with superficial temporal artery and vein. **a** *Red colored area* indicates neurovascular bundle including auriculotemporal nerve (ATN), superficial temporal artery and vein (STA and STV). **b** Magnified image of *red colored area* of **a** (color figure online)

Table 2 Location of the temporal and zygomatic branches of the facial nerve at the condylar area

References	Reference level	Landmark point	Objects	Distance (mm)
de Bonnecaze et al. [6]	Superior level of zygomatic arch	Tragus	Temporal br.[a]	27.5–30.4 (>85 %)
	Inferior level of zygomatic arch			22.6–26.1 (>85 %)
Farahvash et al. [17]	Zygomatic arch	Tragus (upper border)	First temporal br.[a]	20.62 (Right)
				21.33 (Left)
			Second temporal br.[a]	28.05 (Right)
				27.60 (Left)
			Third temporal br.[a]	35.00 (Right)
				35.67 (Left)
Yang and Yoo [71]	Ala-Tragus line	Tragus	Temporal br.	23.7
			Zygomatic br. (single intersection)	36.7
			Zygomatic br. (double intersection)	25.7 (anterior br.)
				32 (posterior br.)
Tayfur et al. [58]	Zygomatic arch	Tragus	Most posterior Temporal br.	24
			Most anterior temporal br.	42
Hwang et al. [24]	Zygomatic arch	Root of the helix	Temporal br.	21.5–35.4
Gosain et al. [23]	Zygomatic arch	External acoustic meatus	Temporal br.	10–39

The number presented as a single number is mean distance

[a] The objects were noted as frontal branches in the original articles

this vertical line 0.5–2 cm inferior to the tragus [71]. They also documented that the FN branches proceed between the tragus and lowermost point of earlobe and that several twigs of the Tbr and Zbr cross the tragus-ala nasi line 24–38 mm anterior to the tragus. Considering these studies, there is a high probability of encountering FN branches in the area 2–4 cm anterior to the tragus at the vicinity of the condyle.

Complicated ramification and abundant anastomosis of the FN branch could serve as fibers deliver motor control information bypassing via plexiform network, in the cases of nerve injury [14, 36, 43, 59, 68]. Thus, the injury of nerve twigs on these nervous plexiform area might result in minimal loss of function [49]. However, the proximal part of FN lies on the condylar area as a small number of thick divisions. An injury of the main trunk or large divisions of

the FN on the condylar area would result in irreversible serious palsy on broad area of the face.

Clinical implications of the facial nerve at the condylar area

The FN can be damaged during rhytidectomy, parotidectomy, and reduction of a condylar fracture. In the cases of condylar fracture, many surgeons prefer an open reduction for the fracture with various surgical approaches. There are many reports about facial nerve damage after a preauricular or retromandibular incision for the reduction of condylar fractures [16, 41, 57]. The FN and ATN lie within or deep to the temporoparietal fascia, which is one of the SMAS (superficial musculoaponeurotic system) structures [56]. The parotid sheath is connected to the platysma muscle and it lies beneath the SMAS. The initial surgical approach should be performed as to avoid injury of the Tbr and Zbr, heeding this layered relationship [49].

Additionally, the FN branches near the condyle should be preserved during removal of parenchyma of parotid gland. Musani et al. reported that temporary FN dysfunction occurred in 26.3 % of 235 patients after parotidectomy and permanent FN dysfunction occurred in 1.7 % [48]. In particular, the removal of a tumor at the anterior and superior portion of the deep lobe of parotid gland presents a higher risk of temporary or permanent FN dysfunction [29]. The risk is closely related to the Tbr and Zbr within the vicinity of the mandibular condyle. The Tbr has been regarded as the most vulnerable branch of the FN during the parotidectomy [9]. Finding the main trunk of the FN before removing parotid gland tissue, and tracing its divisions and twigs meticulously would be the safest method to prevent FN injury during parotidectomy procedures. Hence, it is important to discover the course and location of the nerve near the condyle, regardless of the branching pattern of the FN within the parotid gland.

Auriculotemporal nerve at the condylar area and Frey syndrome

Schmidt et al. described that the ATN passes in direct contact with the medial aspect of the mandibular neck at a level of about 7 mm (range 0–13 mm) inferior to the superior condyle [54]. Fernandes et al. also reported that the ATN proceeded 10–13 mm inferior and 1–2 mm posterior to the superior surface of the mandibular condyle [18]. The nerve distributes to the skin of auricle, external acoustic meatus, and temporal region. It also delivers postganglionic parasympathetic fibers, which synapse with preganglionic fibers of the lesser petrosal nerve of glossopharyngeal nerve at the otic ganglion. The parasympathetic component via the ATN plays a role in the secretion of the parotid gland [56].

Sometimes, the parasympathetic fibers within the ATN reconnect with not only parotid gland, but also with sweat glands after parotidectomy or open reduction of a condylar fracture. This causes gustatory sweating (sweating while eating foods) and it has been known as auriculotemporal syndrome or Frey syndrome. Although the condylar fracture is very frequent in mandibular fractures, the Frey syndrome occurs very rarely [19]. It has been recommended to approach the condylar area via a retroauricular or intraoral incision to prevent ATN or FN injury during the reduction of a condylar fracture or correction of TMJ ankylosis [4, 32].

Conclusion

The ECA and FA issue various branches into the internal and external aspects of the mandibular ramus at the angular area. The Mbr proceeds forward through area within 10 mm around the gonion, the posteroinferior point of the mandibular angle. The GAN distributes to the angular and parotid regions. The ECA, STA, TFA, and MA give off various branches passing medial and lateral to the mandibular neck and condyle. The FN trunk and ATN proceed near the condyle. The neurovascular structures of the mandibular angle and condyle area are vulnerable during esthetic surgeries, such as mandibular angle reduction and rhytidectomy; removal of tumors, such as parotidectomy and submandibular gland excision; and the TMJ approach for reduction of condylar fractures and correction of TMJ ankylosis. Comprehensive anatomical information in the present study could help surgeons prevent injury to the described neurovascular structures during procedures.

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