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Neuroanatomical Study

Facial-zygomatic triangle: a relationship between the extracranial portion of facial nerve and the zygomatic arch

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Summary

Background. This study was conducted to clarify the relationships between the extracranial portion of the facial nerve (EFN) and the zygomatic arch (ZA).

Method. Four cadaveric heads (8 parotid regions), examined under 3–40× magnification, were dissected from lateral to medial to expose the EFN.

Findings. In a vertical plane just anterior to the tragus, the distance from the superior edge of the ZA to the facial nerve (FN) is, on average, 26.88 mm. The FN then courses superiorly and anteriorly, crossing the ZA 18.65 mm anterior to the tragus on average. Thus, three points can be used to depict a triangle: A, at the level of the anterior border of the tragus, just above the superior edge of the ZA; B, 26 mm below A; and C, 18 mm anterior to A. This so called *facial-zygomatic triangle* represents the area where surgical dissection can be performed with no risk of damaging the FN. Thus, the closer one stays to the tragus, the lesser the risk of damaging the FN below the ZA. If the incision is carried out on a vertical plane closer to the tragus, the skin can be safely cut up to 2 cm below the ZA.

Conclusion. The facial-zygomatic triangle is a very useful superficial landmark to avoid FN damage when working below the ZA.

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Introduction

The pterional craniotomy (fronto-temporal-sphenoidal craniotomy) is one of the most widely used approaches in neurosurgery [10]. Over the last decades, major advances in skull base surgery have been achieved by applying, among other notions, the concept of extensive bone removal as a way to minimise brain retraction [23]. The orbito-zygomatic approach has thus been devised as a natural extension of the pterional approach.

In this later approach, the incision usually starts above the superior edge of the ZA, just anterior to the tragus [10]. Conversely, when performing an orbito-zygomatic approach, the incision should be enlarged below the ZA [23]. This manoeuvre, though, may damage the EFN.

Many papers describing the anatomy of the FN [2, 4, 7, 8, 12, 13, 17, 18, 20] can be found in the literature, and as many deal with the ideal surgical technique to avoid injury to the fronto-temporal branch of the FN [5, 8, 9, 13, 15, 17–20, 22]. However, no study has addressed the relationships of the FN below the ZA.

Here, we aim to describe the surgical anatomy of the EFN below the ZA and establish a safe area for surgical work.

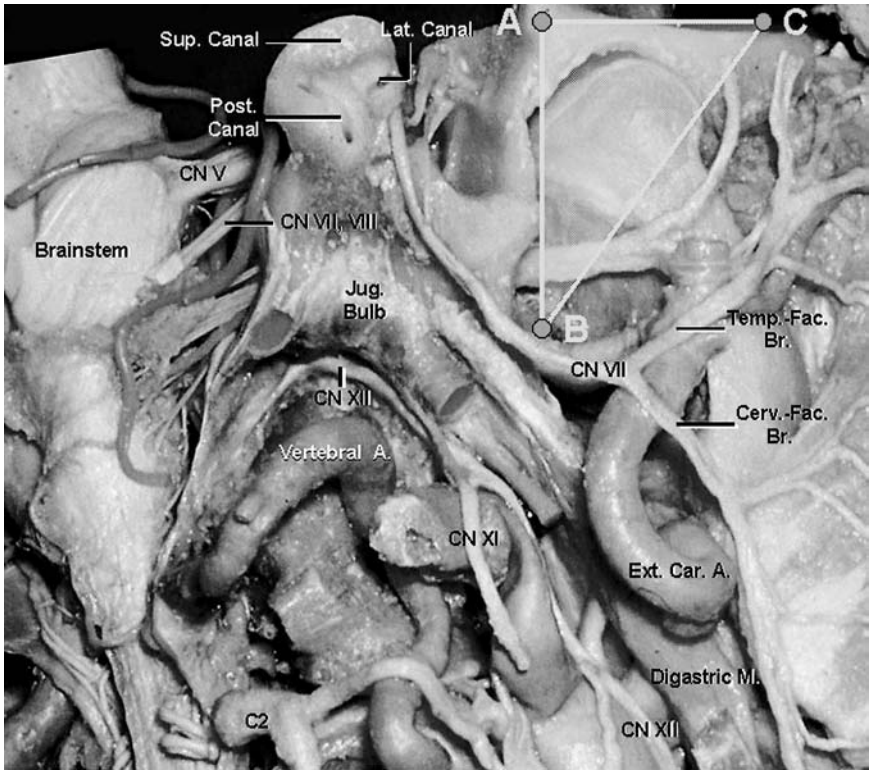

Fig. 1. Structures surrounding the EFN; lateral view, right side. Both the mastoid portion of the temporal bone and the parotid gland have been removed. The facial-zygomatic triangle is formed by the connection of three points (*yellow triangle*). (A) At the level of the anterior border of the tragus, just above the superior edge of the ZA; (B) on the same vertical plane as A, just superior to the FN; and (C) at the level where the posteriormost branch of the FN crosses the superior border of the ZA. The FN and its temporal branch are inferior and anterior to this triangle. A = Artery; Br = branch; Cerv = cervical; CN = cranial nerve; Ext = external; Fac = facial; Jug = jugular; Lat = lateral; M = muscle; Post = posterior; Sup = superior; Temp = temporal

Table 1. *Measurements of the facial-zygomatic triangle*

Measurements	Average (mm)	Range (mm)
Distance A–B*	26.88	23–34.2
Distance A–C*	18.65	15.9–25.1

* See Fig. 1.

Methods and materials

The parotid regions of four formalin-fixed, silicon-injected cadaveric heads (8 FN) were sampled. Dissection of the EFN, from the stylomastoid foramen up to the FN bifurcation, was performed under surgical microscope magnification (3-40×). A caliper (accuracy, 0.02 mm; Draper, Japan) was used for measurements.

A triangle, which we called the *facial-zygomatic triangle*, was depicted by joining three points (Fig. 1), as determined by our anatomical observations (Table 1). This triangle allows for a safe caudal extension of the skin incision without damaging the FN.

Results

Anatomical considerations

Facial nerve

From the brainstem up to its terminal branches, the FN consists of six portions: cisternal, meatal, labyrinthine, tympanic, mastoid, and extracranial.

The extracranial portion starts where the FN exits the stylomastoid foramen. At this point, the nerve runs anteriorly and superiorly into the parotid gland from behind. At the level of the tragus, the FN courses almost horizontally and divides into the temporo-facial and cervico-facial trunks, which then branch into the temporal, zygomatic, buccal, marginal mandibular, and cervical rami (Fig. 2). When we move anteriorly along the ZA, the temporal branch is the first to be found, crossing inferiorly to superiorly and posteriorly to anteriorly to the ZA. The temporal branch usually branches into three rami, called anterior, middle and posterior. The anterior ramus innervates the corrugator supercilii and orbicularis oculi muscles, and is named orbicularis ramus. The middle ramus innervates the frontalis muscle, and is called frontal ramus. The posterior ramus, named auricularis ramus, innervates the auricular muscles and does not have importance in man. From their origin, the rami of the temporal branch have an anterior–superior course, crossing the zygomatic arch to distribute to the muscles of the superior third of the face (Fig. 2). Thus, the most posterior ramus of the temporal branch (frontal ramus), crosses the arch at an average distance of 18.65 mm anterior to the tragus.

Our measurements have shown that the average distance just anterior to the tragus between the superior edge of the ZA and the FN is 26.88 mm.

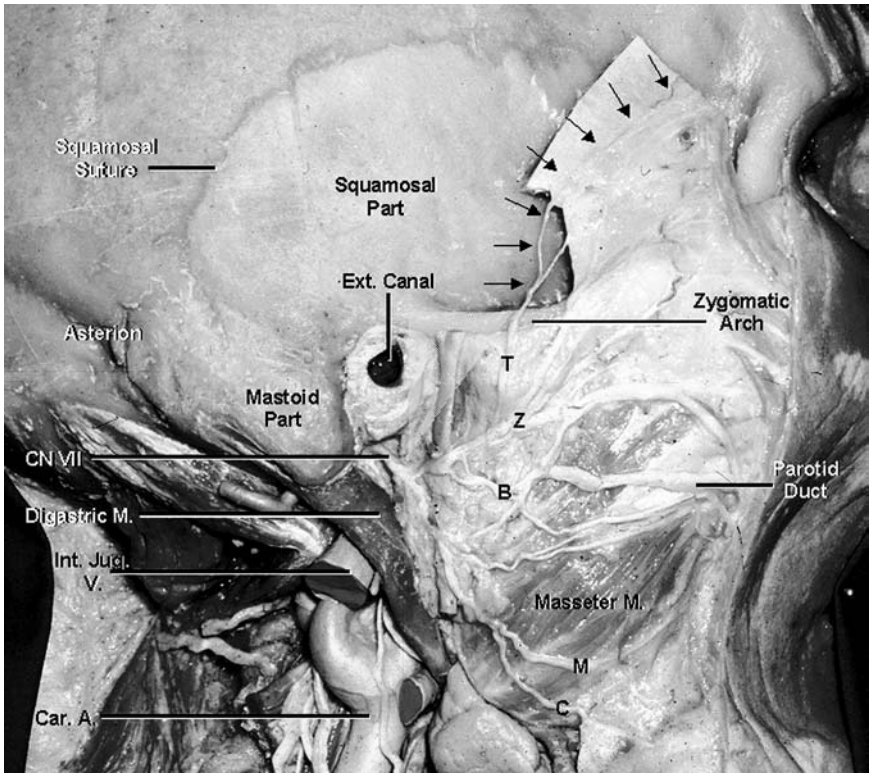

Fig. 2. Lateral view of another specimen, right side. Removal of the ear, superficial muscles and parotid gland exposes the extracranial portion of the facial nerve as well as the zygomatic arch, the posterior belly of the digastric muscle, the masseter muscle, the carotid artery and the internal jugular vein. The facial-zygomatic triangle was represented by yellow color. The most posterior temporal branch of the facial nerve (frontal ramus) is pointed by black arrows. A = Artery; Car = carotid; Ext = external; Int = internal; Jug = jugular; M = muscle; R = ramus; V = vein. The branches of the facial nerve are represented by letters: B = buccal; C = cervical; M = marginal mandibular; T = temporal; Z = zygomatic

Zygomatic arch

The zygomatic arch is formed by the union of the zygomatic process in the temporal bone and the temporal process in the zygomatic bone (Fig. 3). It is located at the level of the middle fossa floor and provides attachment to the masseter muscle. The temporal's muscle

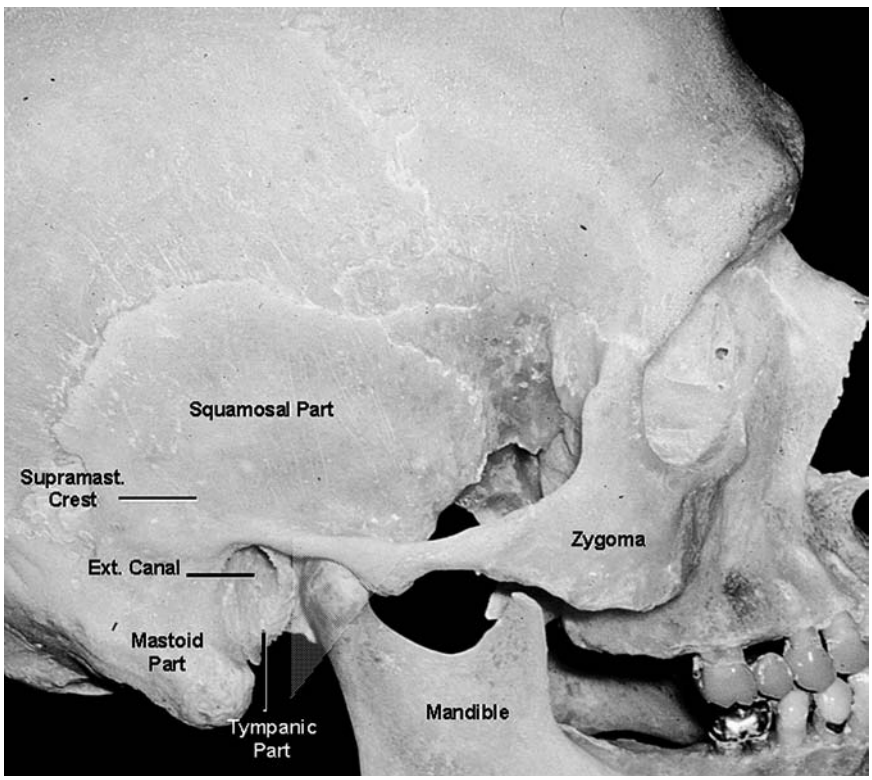

Fig. 3. Osseous relationships; lateral view, right side. The facial-zygomatic triangle is represented in yellow. The ZA is formed by the union of the zygomatic process in the temporal bone and the temporal process in the zygomatic bone. Ext = External; Supramast = supramastoid

runs deeply through to the ZA on its way towards its attachment to the superior temporal line.

Facial-zygomatic triangle

The facial-zygomatic triangle can be drawn by connecting three points (Fig. 1); A, at the level of the anterior border of the tragus, just above the superior edge of the ZA; B, on the same vertical plane of A, just superior to the FN; and C, on a horizontal plane, at the level where the posteriormost branch of the FN crosses the superior border of the ZA. Thus, the average A–B distance is 26.88 mm, and the average A–C distance is 18.65 mm (Table 1). This triangle, based on the anatomical relationships of the EFN, may represent the area where surgical dissection can be performed with no risk of damaging the facial nerve.

Discussion

Much research has been devoted to the anatomy of the EFN above the ZA [2, 8, 9, 15, 17, 18, 20, 23]. Moreover, a constellation of different procedures-including the interfascial and subfascial techniques-have been reported to protect the temporal trunk at surgical dissection [2, 4, 7, 13, 15, 17, 19, 22]. Nevertheless, the anatomy of the FN below the ZA, particularly from the point of view of a surgeon performing a craniotomy in that area, still needs elucidation. Many questions, including how safely an inferiorly extended skin incision can be performed, or how anterior to the tragus the incision can be placed, still remain unanswered.

The anatomy and relations of the temporal branch of the FN have been well documented. Furnas [11] described the temporal branch as running between the

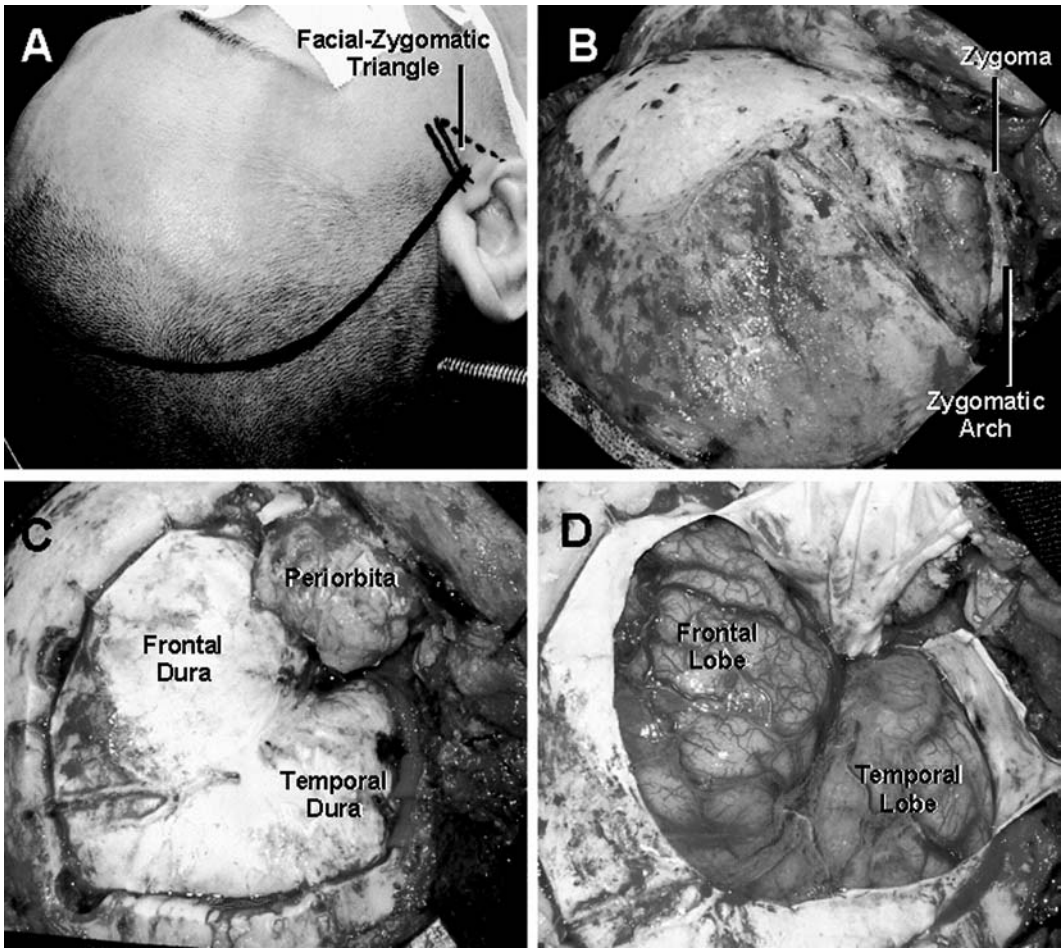

Fig. 4. Surgical pictures illustrating the initial steps for an orbito-zygomatic approach. (A) The skin incision starts some millimeters below the inferior border of the ZA and finishes at the level of the contralateral pupil line. The facial-zygomatic triangle has been drawn on the skin to guide the inferior extension of this incision. (B) The orbital rim, the zygomatic bone and the ZA were exposed, using an interfascial dissection. (C) A three-piece orbito-zygomatic craniotomy was performed, and the frontal and temporal dura, as well as the periorbita, were exposed. (D) The dura mater was opened, exposing the surface of the brain

lower aspect of the earlobe and the lateral edge of the eyebrow. Lei *et al*. [15] described a line representing the trajectory of the temporal branch starting 0.5 cm below the tragus, passing 1.5 cm above the lateral end of the eyebrow. Correia and Zani [8] located the temporal branch between two lines, one connecting the earlobe to the lateral end of the eyebrow and the other connecting the earlobe to the lateral end of the highest forehead crease. Ishikawa [14] suggested that the temporal branch with all its rami are located below a curved line drawn between a point 7 cm posterior to the lateral canthus, on the superior border of the ZA, and a point 4 cm superior to the lateral canthus.

Al-Kayat and Bramley [3], after having dissected 54 facial regions, found that the average distance from the external acoustic meatus to the posteriormost branch of the FN over the ZA was 20 mm. Bernstein and Nelson [6] found that the posterior ramus of the temporal nerve branch was 1.8 cm from the auricle-scalp junction. Gosain *et al*. [13] described similar results, with an average distance of 17 mm. In our study, the average distance from a point just anterior to the tragus to the posteriormost branch of the FN was 18.65 mm.

Zabramsky *et al*. [23] described that the scalp incision for an orbito-zygomatic craniotomy should start 10 mm anterior to the tragus, at the level of the inferior border of the ZA. They also noted that the incision should be limited inferiorly in order to avoid injuring the FN. Abdel Aziz *et al*. [1] proposed that the skin incision in the preauricular region for the orbito-zygomatic approach should extend 5 mm below the inferior border of the ZA. Shigeno *et al*. [21] suggested that, for an orbito-zygomatic approach, ''a curvilinear coronal scalp incision is made well below the zygomatic arch, taking care to avoid damaging the facial nerve''.

The orbito-zygomatic approach has nowadays become the most popular approach among skull base neurosurgeons [1] (Fig. 4). Although aware of the need of exposing the zygomatic arch and bone, surgeons are still unsure about how far inferiorly and anteriorly the preauricular portion of the incision can be extended. That uncertainty is particularly evident when treating patients with generous subcutaneous tissue, where the incision should be extended more than a few millimeters below the ZA to obtain adequate exposure.

Pérez-Rull *et al*. [16] found that the FN was located approximately 17 mm below the ZA, over the mandibular condyle. We have found that, on a vertical plane just anterior to the tragus, the FN is located on average 26.88 mm below the superior border of the ZA. However, when the incision is moved anteriorly, the distance from the ZA to the FN is shorter. Thus, the closer one stays to the tragus, the lesser the risk of damaging the FN below the ZA. If the incision is carried out on a vertical plane closer to the tragus, the skin can be safely cut up to 2 cm below the ZA.

The ZA and the tragus are easily located by palpation or direct visualisation in most patients. Therefore, the facial-zygomatic triangle described here is a superficial landmark that can be easily determined to avoid lesions of the FN when working below the ZA.

Conclusions

The facial-zygomatic triangle is a useful landmark to safely guide the surgical extension of the skin incision into the infra-zygomatic area. By using this technique, the closer to the tragus the skin incision is carried out, the lesser the risk of transecting the FN or any of its branches.

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Comment

"Difficult" lesions located in the Central Skull Base may benefit from antero-lateral craniotomies enlarged with orbital and/or zygomatic osteotomies [1, 2]. Such extended approaches entail a high risk to insult the facial nerve (f.n.) at several levels of its extracranial portion. Therefore establishing clearcut landmarks for better f.n. avoidance – as achieved by this nice anatomical-surgical work – is of practical interest.

In such approaches, f.n. is particularly at risk in the pretragal region when the skin incision is extended inferiorly to expose the zygomatic arch. The temporal branch, mainly its posterior most ramus, is at risk where it crosses the zygomatic arch. Its frontal branch can be stretched, interrupted or avulsed during division and retraction of the cutaneous flap.

Drawing on the skin, prior to tracing skin incision, the triangle defined by the authors should help avoiding injury of the facial trunck and its temporal branch. We would have preferred that the triangle by named with its three landmarks: facial-tragal-zygomatic triangle.

Then the frontal branch has to be spared thanks to a prudent dissection passing, not subcutaneously, but either interfascially [3] or underneath the fascia temporalis [3], with care not to overuse coagulation for hemostasis.

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