

Styloid Process Is the Robust Landmark for Identification of the Facial Nerve during Parotid Surgery

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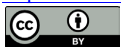
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Abstract

Objective: To identify the facial nerve trunk (FNT) very easily, quickly and accurately considering the styloid process as the robust anatomically consistent landmark during parotid surgery. **Patients and Methods:** This prospective study was conducted between January 2010 to December 2022 at a Tertiary care hospital. It included 130 patients: 84 (65%) males and 46 (35%) females with a mean age of 43.52 ± 15.63 years. Patients presented with pleomorphic adenoma (90), chronic sialectasis (05), parotid cyst (03), parotid sinus (01), mucoepidermoid carcinoma (28), adenoid cystic carcinoma (02) and squamous cell carcinoma (01) were subjected to superficial parotidectomy and total parotidectomy. The outcome was evaluated regarding the clinical success of facial nerve function that considered the location of the styloid process in the triangle technique for identification of the FNT during parotid surgery. **Results:** All 130 patients underwent superficial and total parotidectomy. The facial nerve trunk was successfully identified as the location of the styloid process in the triangle technique in all the patients with no intra-operative complications. Operative time ranged from 50 to 180 minutes with a mean time 90.70 ± 15.68 minutes. Dysfunction of the angle of the mouth due to the deficit of the marginal mandibular nerve (MMN) was noted in 5 patients (3.8%), 02 had difficulty in eye closure (1.5%). No patient reported surgical site infection, skin flap necrosis and hematoma in this series. **Conclusion:** Styloid process is the prominent robust landmark in the triangle technique for the identification of facial nerve trunk with relative ease, safety and accuracy in the parotid surgical procedure. This can be a very useful method to locate the FNT and minimize facial nerve injury during parotid surgery.

Keywords

Facial Nerve Trunk, Identification, Styloid Process, Parotid Surgery

1. Introduction

The facial nerve is one of the most important structures encountered during parotidectomy. The neurovascular structures that pass through the parotid gland from lateral to medial are the facial nerve, retromandibular vein, external carotid artery, superficial temporal artery and maxillary artery [1] [2]. The greater auricular nerve emerges along the posterior aspect of the sternocleidomastoid muscle at the Erb's point, ascends vertically across the oblique sternocleidomastoid muscle and its branches enter the gland from the neck and remain superficial [3]. Parotid surgery is warranted for benign and malignant neoplasm, chronic inflammatory diseases, sialolithiasis, intra-parotid cysts/sinuses and lymphadenopathy, and many other diseases. The methods of identification of the facial nerve and its importance are aptly described by many eminent surgeons using various anatomical landmarks during parotidectomy [4]. In this article styloid process is considered the very consistent robust anatomical landmark in the triangle technique in conjunction with the tragal cartilage to tragal pointer and the origin of the posterior belly of the digastric muscle at the mastoid tip.

Facial nerve and the parotid gland

The facial nerve exits from the stylomastoid foramen slightly posterior to the styloid process and anteromedial to the mastoid process [5]. The main trunk is approximately 1.3 cm in length, enters into the parotid gland and divides into cervico-marginal and zygomatico-temporal branches; and of course, buccal branches (upper and lower buccal) remain common in both the divisions. The cervico-marginal branches supply the muscles of the mouth and neck; and zygomatico-temporal branches supply the muscles of the forehead and eye. The facial nerve arbitrarily divides the gland into superficial and deep lobes [6].

Methods of locating the facial nerve

“He who devotes himself to surgery must be versed in the science of anatomy. Those who lack a good grasp of anatomy are prone to serious and even fatal mistakes.” Al-Zahrawi (936-1013 A. D).

The preservation of the facial nerve is one of the most important aspects of a successful parotid surgery because of its critical functions and intimate relation with the parotid gland [7]. It requires great precision because the surgeon has to locate and operate around these important structures. However, there are several ways to locate the facial nerve such as the anterograde approach with the identification of the main trunk and the retrograde approach with the identification of its branches to reach the main trunk [7]. Nevertheless, detection of the facial nerve becomes a crucial point in parotid surgery. The following anatomical landmarks are the key to locating the facial nerve trunk (anterograde) [8].

1) Tragal pointer (TP): The nerve lies approximately 1.0 - 1.5 cm deep and slightly anterior and inferior to the tip of the tragal cartilage.

2) Posterior belly of the digastric muscle (PBDM): The nerve lies approximately 1.0 cm deep to the medial attachment of the posterior belly of the digastric muscle to the digastric groove of the mastoid bone.

3) Tympanomastoid suture (TMS): Facial nerve trunk is situated 3 mm inferior to the suture to the stylomastoid foramen.

4) Styloid process (SP): The nerve trunk is found inferolateral to it.

The retrograde approach of the nerve trunk through one of the branches of the facial nerve [9].

1) Marginal mandibular branch: it courses the deep surface of the tail of the parotid and is often reliably found at the angle of the mandible.

2) Buccal branch: it runs parallel to and 1 cm below the arch of the zygoma traveling toward the corner of the mouth.

3) Zygomatic branch: any one of the ophthalmic branch where they cross the arch of the zygoma near the upper anterior corner of the gland.

4) Retromandibular vein: This vein is also used as a landmark when evaluating imaging studies, as this vein marks the division of the deep and superficial lobes. This relationship is important as it approximates the depth of the facial nerve which lies superficially.

Besides all those described above, the following points are also considered for facial nerve identification.

1) Parotid-mastoid fascia (PMF): The fascia is incised as the final step before identifying the trunk of the facial nerve. The nerve is found within fat deep to the parotid-mastoid fascia and localized employing the landmarks noted above [9] [10].

2) The facial nerve stimulator/monitor helps to localize the nerve through stimulation with the observation of facial movement [11].

3) Partial removal of the mastoid process is done by chisel, rongeur, or drill to identify nerve in the mastoid [12].

4) Gamma probe: It is used to identify a sentinel lymph node (Tc^{99} injection done several hours before). The sentinel node was overlying the lower division of the facial nerve, warranting identification and preservation of the nerve [11] [12] [13].

It is evident from the published literature that there are so many landmarks used to identify the facial nerve trunk because of its variable and inconsistent position. So parotid surgeons have yet to reach a consensus regarding the safety and reliability of each of these landmarks [14].

Abbreviations

Facial nerve trunk (FNT), Tragal pointer (TP), Posterior belly of the digastric muscle (PBDM), Tympanomastoid suture (TMS), Styloid process (SP), Parotid-mastoid fascia (PMF), Stylomastoid foramen (SMF), Digastric Groove (DG), Mastoid process (MP), Retromandibular Vein (RMV), Mastoid tip (MT), Facial nerve (FN).

2. Material and Methods

Design: Prospective study

Duration: January 2010 to December 2022

Setting: Tertiary care hospital

Study number: 130 patients with different parotid diseases underwent parotid surgeries.

Landmarks: A triangle was made from 1) the tragus to the mastoid tip anteriorly, 2) along the long axis of the tragus to the styloid process and 3) from the mastoid tip crossing the insertion of the posterior belly of the digastric muscle to the styloid process.

Facial nerve trunk identification: The three most easily identifiable and anatomically constant landmarks were selected and their respective distance from the **styloid process** was measured. The facial nerve trunk was identified at the point of convergence of the lines from the tragal pointer and mastoid tip across the PBM to the **styloid process**.

Surgical technique

1) A modified cosmetic incision was made starting 1 to 2 cm above the tragus and approaching the neck behind the tragus in the external auditory canal making a sinuous curve.

2) The approach to the trunk of the facial nerve involves 3 steps.

- First step, the 3 anatomical landmarks were identified.
- The first landmark was at the center of the tragal cartilage.
- From that, a line was traced to the tip of the MP, which was the second landmark.
- The third landmark was the SP, and the reference triangle was delineated.

The second step was to make a surgical triangle that started along the long axis from the center of the tragal cartilage crossing the TP to the SP and the third step started from the MP to SP crossing the PBDM that was marked the convergent point at the SP. The predicted position of the facial nerve was located at the reference angle of the surgical triangle lateral to the SP. All references were chosen by means of dissection and palpation; not by objective measurements. Once identified, the facial nerve was freed until its trunk and its major 2 divisions were individualized.

3. Results

The distribution of sex is shown in **Table 1**.

130 patients presented in different ages which is shown in **Table 2**.

Parotid surgery was done in 130 patients with different diseases that depicted in **Table 3**.

The facial nerve trunk (FNT) was located at the site of convergence in all 130 patients that shown in **Table 4**.

It has been observed in this study that the facial nerve exited the skull through the stylomastoid foramen for a length of 1.3 cm approximately; and divide in 2

Table 1. Shows sex distribution (n = 130)

Sex	Number (130)	Percentage (%)
Male	84	65
Female	46	35

Table 2. Shows age of the patients (130)

Age in years	Number (130)	Percentage (%)
Up to 10	01	00.8
11 to 20	02	01.5
21 to 30	04	03
31 to 40	08	06.2
41 to 50	64	49.2
51 to 60	45	34.6
61 to 70	06	04.7

Table 3. Reveals the diagnosis of the patients (130)

Diagnosis	Number (130)	Percentage (%)
Pleomorphic adenoma	90	69.3
Mucoepidermoid carcinoma	28	21.5
Sialetasis	05	03.8
Parotid cyst	03	02.3
Parotid sinus	01	0.8
Adenoid cystic carcinoma	02	1.5
Squamous cell carcinoma	01	0.8

Table 4. Shows the distance of the facial nerve trunk from TP, MT and PBDM.

Tragal cartilage to Mastoid tip	9.5 ± 1.5 mm
Tragal pointer to styloid process	17.5 ± 1 mm
Posterior belly of digastric from mastoid tip to styloid process	7.5 ± 1.5 mm
Tragal pointer to facial nerve trunk	13 ± 1.2 mm
Posterior belly of digastric to facial nerve trunk	6.5 ± 0.5 mm

main divisions cervico-marginal and zygomatico-temporal branches; and of course, buccal branches (upper and lower buccal) remain common in both the divisions within the parotid gland in all 130 patients.

The styloid base was present and was found in all the patients. A triangle was made from tragal cartilage to mastoid tip with a mean distance of 9.5 ± 1.5 mm. The mean distance between tragal pointer to styloid process was 17.5 ± 1 mm, posterior belly of digastric from mastoid tip to styloid process was 7.5 ± 1.5 mm, tragal pointer to facial nerve trunk was found 13 ± 1.2 mm and posterior belly of digastric to facial nerve trunk was 6.5 ± 0.5 mm. The facial nerve was located at

the exact convergence between the tragal pointer to styloid process and posterior belly to styloid process posterolateral to the styloid process at the exit point of the stylomastoid foramen.

4. Discussion

The facial nerve trunk exits from the stylomastoid foramen and travels for a short distance of approximately 1.3 cm enters into the parotid gland [8] [15]; and divides into upper zygomatico-temporal and cervico-marginal branches superficial to the retromandibular vein (**Figure 1**) with a common buccal branch to supply the ipsilateral face, eye, forehead, temporal region and upper neck. This nerve is arbitrarily but not anatomically dividing parotid gland into superficial and deep lobes [16].

The shortest FNT and its branches are intimately related to the parotid gland, so facial nerve injury is the most common complication of parotid surgery [17].

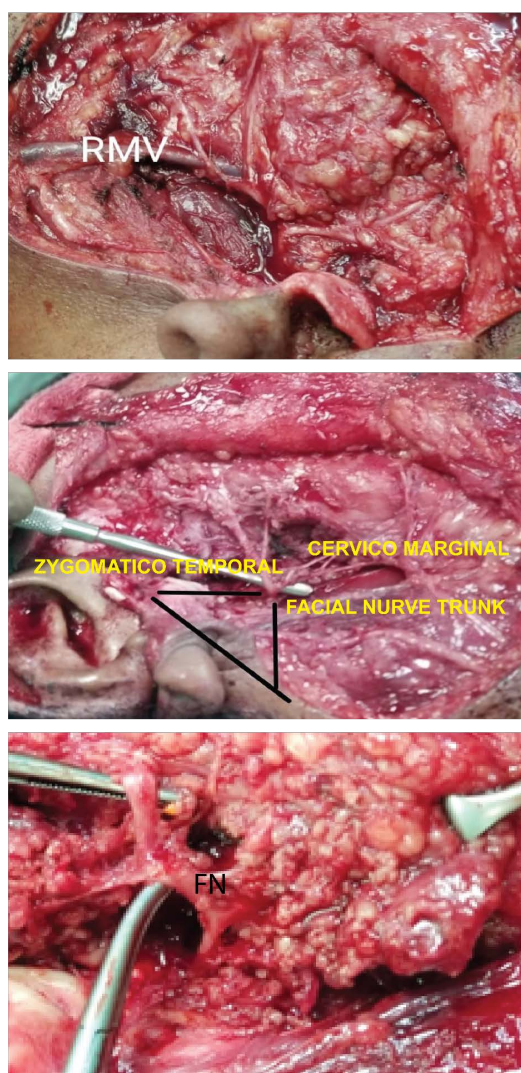


Figure 1. Shows the surgical steps to identify the facial nerve trunk and its branches. FN = Facial Nerve.

The paramount importance is the identification of the facial nerve during parotidectomy is a paradigmatic procedure [15] [17]. Both the main trunk and peripheral branches must be identified and preserved to prevent permanent aesthetic sequelae and medico-legal actions related to facial paralysis [18]. In this study facial nerve trunk was identified with relative ease, safety and accuracy.

There are different ways of identification of the facial nerve such as antero-grade, retrograde, facial nerve monitor/stimulator, gamma probe, etc. [8] [9] [10] [11] [12] [13]. The most common and easy technique for identifying the FNT at its point of exit from the stylomastoid foramen till its division in the parotid gland is the preferred method of getting the facial nerve [19]. In this study a triangle technique is used where styloid process was the key landmark to locate the FNT (**Figure 1** and **Figure 2**).

Anatomically, a very constant landmark for the facial nerve is the stylomastoid foramen (SMF) situated posterolateral to the styloid process, but it is very difficult to find this foramen as it is mainly a palpatory landmark and most importantly because it remains surrounded by thick fascia which is continuous with the periosteum of skull base, and during surgery excessive dissection in this area can damage the facial nerve [20]. In this study, the styloid process was taken as a very handy palpatory landmark to locate the FNT from the SMF (**Figure 2** and **Figure 3**).

Although tragal pointer (**Figure 4**) is considered a very popular landmark and the nerve usually lies approximately 1.0 - 1.5 cm deep and slightly anterior and inferior to the tip of the tragal cartilage (TC) [21] [22]. The only drawback of the tragus is that it is a cartilaginous structure that is mobile, asymmetrical having a blunt and irregular tip. In our study styloid process was considered a robust and consistent landmark with the SMF, TC and TP.

In this study mastoid process (MP) was considered mainly a palpatory landmark; the process lies deep in the insertion of the sternocleidomastoid muscle (SCM). The posterior belly of the digastric muscle (PBDM) lies medial to SCM

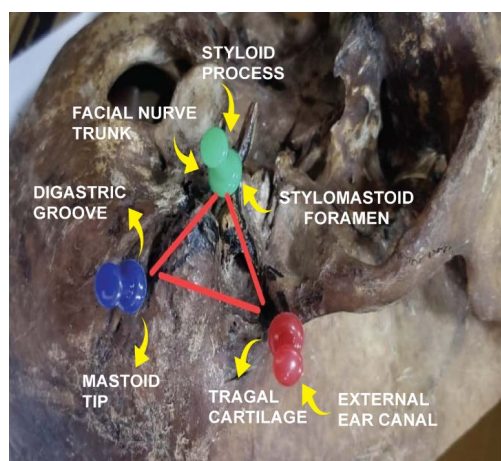


Figure 2. Shows the triangle made on the dry bone to get the location of the facial nerve trunk.

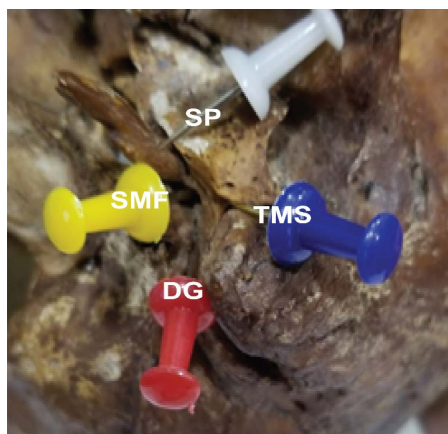


Figure 3. Shows the anatomical landmarks in a dry skull bone. SP = Styloid Process, SMF = Stylomastoid foramen, TMS = Tympanomastoid suture DG = Digastric Groove.

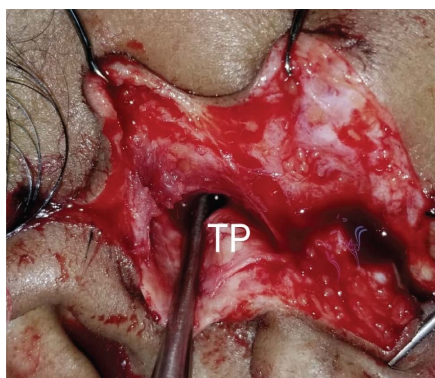


Figure 4. Shows the location of the tragal pointer. TP = Tragal Pointer, RMV = Retromandibular Vein.

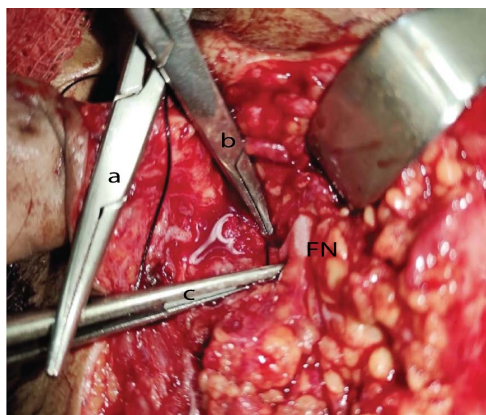


Figure 5. Depicts the triangle to identify the facial nerve trunk during surgical procedures. (a) Tragal cartilage to mastoid tip (b) Tragal cartilage to styloid process (c) Mastoid tip to styloid process. FN = Facial nerve.

(**Figure 1**, **Figure 2** and **Figure 5**). The FNT lies approximately 1.0 cm deep to the medial attachment of the posterior belly of the digastric muscle to the digastric groove of the mastoid tip, which is easily identifiable by drawing a line from the MT along the PBDM to the styloid process which corresponds to the other

published literature [21] [23] [24] [25].

The present study set out to locate the ease and accuracy of facial nerve identification using the triangle formed by the tragal cartilage, the mastoid tip and the styloid process. The FNT was accurately and quickly found at the point of convergence of the long axis from the TP to SP and from MT across the PBDM to styloid process (**Table 4**). For easy and prompt identification of the nerve trunk, the surgeon needs to systematically look for the anatomical landmarks.

5. Recommendations

The proposed surgical triangle and the angle at the point of convergence inferolateral to the SP was practically the anatomical orientation that could make surgery around the parotid region safer and quicker. This approach offers substantial advantages when compared with other methods described in the published literature so far. It evaluates nerve position accurately; the 3 anatomical landmarks are easy to identify and the styloid process is easily located by palpation during surgery and is not distorted by the pathologic conditions.

6. Conclusion

The styloid process is the consistent, prominent, and easily identifiable anatomical landmark by using the triangle technique described in this article that allows fast and safe identification of the facial nerve during parotid surgery. practically operative identification of the facial nerve trunk is a step-by-step procedure in which identification of the anatomic landmarks is highly advisable. The final success of the operation depends to a vast extent on the safe handling of the facial nerve and its branches as well as the cautious use of bipolar diathermy during the surgical procedure.

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Conflicts of Interest

No conflict of interest.

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