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Original Article

Anatomy Section

An Anatomical Study of Extratemporal Ramification of Facial Nerve in the Patey's Plane of Parotid Gland and its Relation to Retromandibular Vein

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ABSTRACT

Introduction: Expression is an art. Our facial expressions are brought out by the subcutaneously placed facial muscles. They are supplied by the facial nerve. Preservation of the facial nerve during rhytidectomy, parotidectomy and other cosmetic and therapeutical surgeries makes the study of facial nerve anatomy compulsory.

Aim: To emphasise on the anatomy of facial nerve and its branches and its relation to retromandibular vein in the Patey's plane of Parotid gland.

Materials and Methods: This was a cross-sectional observational study, conducted for a period of two years from September 2013 to August 2015 in the Department of Anatomy of Karpaga Vinayaga Institute of Medical Sciences and Research Centre. Fifty cervicofacial halves were used for this study. The following parameters were observed- number of trunks of the anterior division of facial nerve from the stylomastoid foramen and its distance upto its furcation point, number of ramus of facial nerve and the number of branches from each ramus, relation of facial nerve to retromandibular vein and communication of facial nerve's terminal branches and its branching pattern. All the data was tabulated in the Microsoft Excel and the mean±standard deviation were calculated for all relevant distances of the trunk and the branches.

Results: In all 50 specimens, one trunk of facial nerve entered the parotid gland and divided into two rami, namely temporofacial and cervicofacial rami. The distance of the trunk from stylomastoid foramen to its bifurcation point measured in the range of 0.8 to 1.8 cm, with a mean of 1.28±0.31 cm. In all the 50 specimens, temporal and zygomatic branches were given from temporofacial ramus and marginal mandibular and cervical branches were given from cervicofacial ramus. The buccal branch was given from both the rami in 42 specimens and from temporofacial ramus in eight specimens. The facial nerve was lateral to the retromandibular vein in 49 specimens. In one specimen, the retromandibular vein was present between facial nerve branches. Four types of branching pattern of facial nerve were observed. Type I was observed in eight specimens, Type II was observed in 20 specimens, Type III in 14 specimens and Type IV in eight specimens.

Conclusion: To contribute to the field of anatomy of Facial nerve and its variations, this study was accomplished. Hence, promoting an integrated approach for a better clinical outcome.

Keywords: Branching pattern, Cervicofacial rami, Facio-venous plane, Stylomastoid foramen, Temporofacial rami

INTRODUCTION

Expression is an art. Highly developed psychic area of human brain expresses emotional behaviour through the contraction of facial muscles, which are therefore called the muscles of facial expressions [1]. The facial muscles are subcutaneous in position and represents morphologically remnants of Panniculus carnosus. Embryologically, they are derived from the mesoderm of the second branchial arch and supplied by the facial nerve, which is the nerve of that arch [1].

The seventh cranial nerve has an intracranial-intrapetrous part till the stylomastoid foramen and later on it is called as extracranial part [1]. The facial nerve then curves anteriorly and enters the posteromedial surface of the parotid gland. Before entering the gland, it gives off the posterior auricular nerve and a small branch which divides to supply the posterior belly of digastric and the stylohyoid muscle [2].

Within the parotid gland, the nerve runs forward for about 1 cm superficial to the retromandibular vein and external carotid artery, and then divides into an upper temporofacial and lower cervicofacial trunks [1]. From the temporofacial ramus, temporal and zygomatic branches are given, and marginal mandibular and cervical branches are from the cervicofacial ramus. The buccal branch can arise from both the ramus or from any of the rami.

A proper knowledge of the course, variations and relations of the facial nerve to its related anatomical structures are mandatory to ensure a successful outcome in various surgical procedures like parotidectomy. Facial nerve injury is a potential complication of parotid gland surgery owing to the close relation between the gland and the extratemporal course of facial nerve [3].

The present study was conducted in the interest of facial nerve anatomy to study the course, branches and variations of Facial nerve from stylomastoid foramen through the Patey's facio-venous plane of the parotid gland.

MATERIALS AND METHODS

This was a cross-sectional observational study conducted for a period of two years from September 2013 to August 2015 in the Department of Anatomy of Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Maduranthagam. Fifty cervicofacial halves from cadavers of our department were used for this study purpose.

Inclusion criteria: Healthy cervicofacial halves from embalmed cadavers used for dissection were utilised for this study.

Exclusion criteria: Specimens with any pathology like tumour, previous surgeries on face, cuts, or any other deformities on face were excluded from this study.

The following parameters were observed in this study:

- Number of trunks of the anterior division of facial nerve at its exit from the stylomastoid foramen.
- Number of ramus of facial nerve in the parotid gland.
- Distance of the anterior division of facial nerve from its origin to its furcation in the Parotid gland.
- Relation of facial nerve to retromandibular vein.
- Number of branches from the ramus of facial nerve.
- Communication of facial nerve's terminal branches and its branching pattern.

The available branching pattern in this present study were classified and compared with Davis RA et al., [4] classification. Davis RA et al., has classified the branching pattern of facial nerve into six types [4].

- Type I: No major anastomosis between branches of facial nerve. Two divisions- temporofacial and cervicofacial division branch out from the trunk of facial nerve.
- Type II: Anastomosis between temporofacial branches only.
- Type III: Single anastomosis between temporofacial and cervicofacial branches.
- Type IV: Anastomosis between temporofacial branches and also between temporofacial and cervicofacial branches.
- Type V: Double anastomosis between temporofacial and cervicofacial divisions.
- Type VI: Complex plexiform anastomosis between the branches.

Dissection was done according to Cunningham's manual of Practical Anatomy [2], and the procedure is summarised below.

The skin of the face was reflected carefully. The surface of parotid gland was exposed and its duct was followed to the buccinator muscle. One of the branches of the facial nerve was traced back through the gland to the trunk of the nerve and then other branches were traced and its communications were observed. The trunk of the facial nerve was traced back to the stylomastoid foramen. The parotid gland was removed in piece meal, exposing the retromandibular vein. The structures passing through the parotid gland are retained while removing the glandular substances.

Digital Vernier Calliper, measuring tape and dissection instruments were utilised for the accomplishment of this study.

STATISTICAL ANALYSIS

The collected data was entered in the Microsoft Excel and the mean distance of the main trunk of the anterior division of facial nerve from stylomastoid foramen to its bifurcation point and standard deviation were calculated.

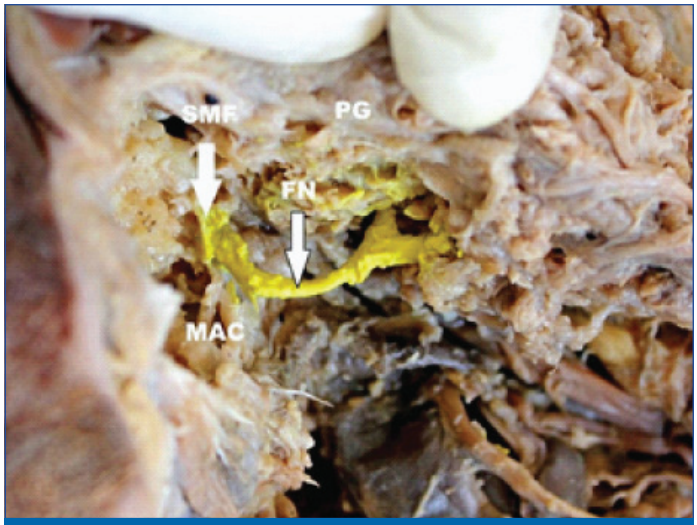
RESULTS

From the stylomastoid foramen, there was only one trunk of the anterior division of facial nerve in 100% of the specimens [Table/Fig-1]. The main trunk of the facial nerve on entering into the parotid gland divided into an upper temporofacial and lower cervicofacial trunks in all 50 specimens studied. The distance of the main trunk of the anterior division of facial nerve from stylomastoid foramen to its bifurcation point measured in the range of 0.8 to 1.8 cm. The mean distance was 1.28±0.31 cm.

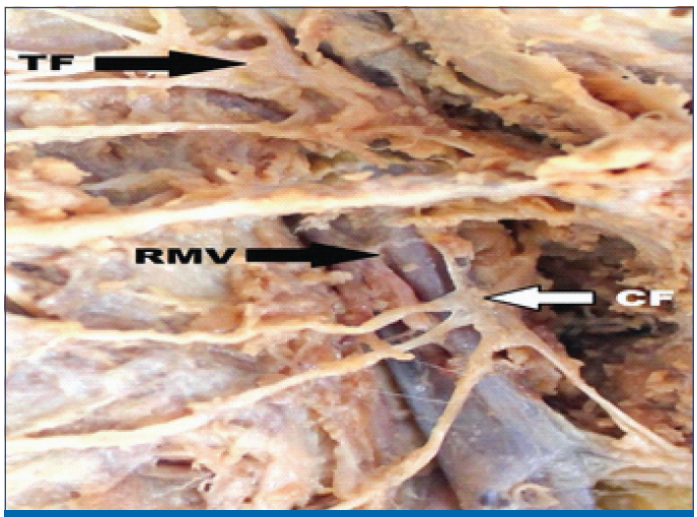
In the present study, the facial nerve was found lateral or superficial to the retromandibular vein in 98% of specimens (49 specimens) [Table/Fig-2]. In 2% of specimens (one specimen), the retromandibular vein was present between the branches of facial nerve [Table/Fig-3].

In all 50 specimens, the two ramus of the facial nerve gave rise to five branches namely the temporal, zygomatic, buccal, marginal mandibular and cervical. The temporofacial ramus gave rise to temporal and zygomatic branches and from cervicofacial ramus marginal mandibular and cervical branches were given off in all specimens. The buccal branch of facial nerve was given off from both the ramus in 42 specimens, and in eight specimens from the temporofacial ramus. The branching pattern of the terminal branches of anterior division of facial nerve was observed and communication between the branches was noted resulting in Pes anserinus pattern. Four types of branching and communications were observed.

Type I: In the present study, in eight specimens (16%), communications between the branches of temperofacial divisions were observed.

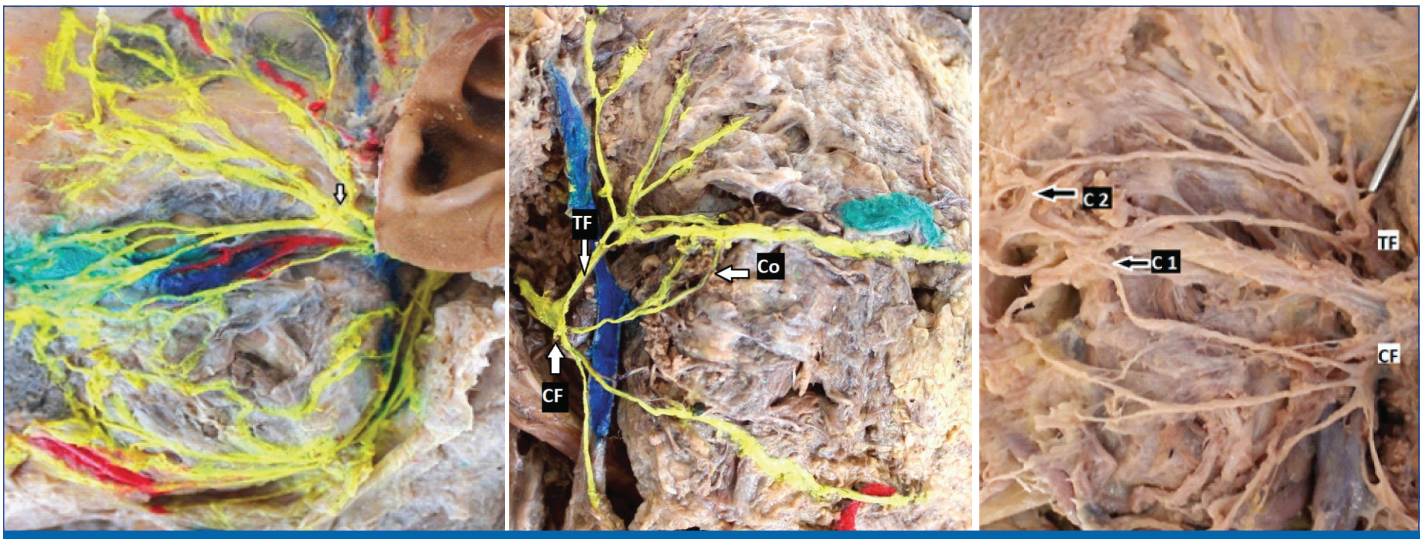


[Table/Fig-1]: Facial nerve trunk is seen exiting the stylomastoid foramen and enters the Parotid gland.
FN: Facial nerve; MAC: Mastoid air cells; PG: Parotid gland; SMF: Stylomastoid foramen



[Table/Fig-2]: Facial nerve and its branches superficial to retromandibular vein.
TF: Temporofacial ramus; RMV: Retromandibular vein; CF: Cervicofacial ramus

[Table/Fig-3]: Facial nerve branches superficial and deep to retromandibular vein.
FN: Facial nerve; RMV: Retromandibular vein



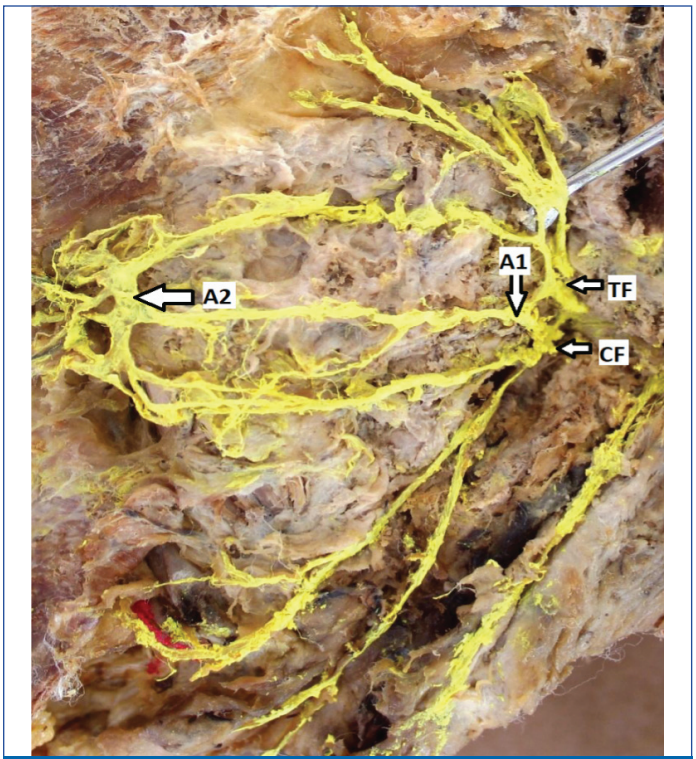
[Table/Fig-4]: Type I branching pattern: shows presence of a loop (arrow in picture) between branches of temporofacial ramus and temporal and zygomatic branches are arising from the loop; **[Table/Fig-5]:** Type II branching pattern: single communication (Co) between temporofacial (TF) and Cervicofacial (CF) branches; **[Table/Fig-6]:** Type III branching pattern: Anastamosis (C 1) between branches of temporofacial (TF) and Cervicofacial (CF) rami is seen. Also, Communication between temporofacial branches (C 2) is also seen. (Images from left to right)

Presence of loop arising from the temporofacial ramus was observed in five specimens (10%), from which temporal and zygomatic branches were given [Table/Fig-4].

Type II: In 20 specimens (40%), single anastamosis between the branches of temporofacial and cervicofacial ramus were observed [Table/Fig-5].

Type III: In 14 specimens (28%), anastamosis between the branches of temporofacial and cervicofacial ramus were observed. Communications between the branches of temporofacial ramus were also present [Table/Fig-6].

Type IV: In eight specimens (16%), double anastomosis between the branches of temporofacial and cervicofacial rami were observed. In two of the eight specimens (4%), the zygomatic, buccal and a branch of marginal mandibular nerve formed an arc like loop, from which nerve branches were given to the facial muscles [Table/Fig-7].



[Table/Fig-7]: Type IV branching pattern: Double anastomosis (A1 and A2) between branches of temporofacial (TF) and Cervicofacial ramus (CF).

The number and percentage of the above four types of branching pattern of facial nerve on right and left sides are shown in [Table/Fig-8].

Type	Side	
	Right	Left
Type I	3 (6%)	5 (10%)
Type II	13 (26%)	7 (14%)
Type III	6 (12%)	8 (16%)
Type IV	2 (4%)	6 (12%)

[Table/Fig-8]: The four types of branching pattern of facial nerve on right and left-sides.

DISCUSSION

The anatomy of extratemporal course of facial nerve, its branching pattern, relation to neighbouring structures and their variations are vital for a safe surgical procedure. Iatrogenic facial nerve injury occurs most commonly in temporomandibular joint replacement, mastoidectomy, and parotidectomy [5]. Landmarks play a vital role in identifying the facial nerve during surgeries like parotidectomy.

Alomar OSK [6] in his study has aimed at identifying the Facial Nerve Trunk (FNT) in relation to fixed landmarks like Tragal pointer and tip of mastoid process and has published three types of classification:

Type I: Single FNT with two main divisions, cervicofacial and temporofacial- 78.2%

Type II: Single FNT which gave direct terminal branches without two main divisions- 15.2%

Type III: Separate Double FNT, each gave direct branches- 6.6%

Botman JW and Jongkees LB have stated that the facial nerve can split into two or three trunks within the mastoid segment that exit separately out of osseous foramen [7]. Katz AD and Catalano P has reported the presence of major and minor trunks in three cases [8]. Such observations have considerable importance in surgeries, and these observations are not reported in the present study.

The present study shows in all 50 specimens, a single ramus of anterior division of facial nerve entering into the parotid gland, which bifurcated into temporofacial and cervicofacial ramus, which is the type 1 classification of Alomar OSK [6] study. Type 2 and Type 3 classification of his study are not reported in this present study. Trifurcation of FNT as reported by Salame K et al., is not reported in the present study [9].

Kwak HH et al., have reported an average of 13 mm distance between the stylomastoid foramen and the furcation point of facial nerve in the parotid gland [10]. Pather N and Osman M have reported the range of distance of facial nerve from stylomastoid foramen to its bifurcation point in parotid gland to be 8.6 mm to 22.8 mm [11]. Alomar OSK has stated 3 types based on the FNT length as 'A' (0.1 to 1 cm) in 54.3%, 'B' (1.1 to 2 cm) in 41.3%, 'C' (2.1 to 3 cm) in 4.4% of patients [6].

In the present study, the length of the facial nerve from the stylomastoid foramen till its bifurcation point in the parotid gland is in the range of 0.8 cm to 1.8 cm and the mean is 1.28±0.31 cm. The identification of the FNT, its length and their variations using different landmarks are considered as important steps in Parotidectomy [6]. Kopuz C et al., have stated that, in 90% of cases retromandibular vein is medially related to the upper and lower divisions of FNTs [12]. In 10% of cases, the retromandibular vein is medial to the upper trunk, whereas it's lateral to the lower trunk. Dingman RO and Grabb WC has reported that 98% of retromandibular vein lies medial to the facial nerve and in 2% of cases, retromandibular vein lies lateral to facial nerve [13]. Mahore D et al., has reported four different variations of the retromandibular vein in relation to the facial nerve in a total of 32 Parotidectomy procedures [14]. In 28 surgeries, the retromandibular vein was medial to the facial nerve. In the present study, facial nerve is present lateral to the retromandibular vein in 98% of cases. In 2% of cases, facial nerve branches are found both medial and lateral to the retromandibular vein, partially correlating with other authors.

Such variations between the relation of facial nerve and retromandibular vein can pose a threat of injury to the structures during surgeries resulting in profuse bleeding as well facial paralysis owing to facial nerve injury. Hence, meticulous dissection with full knowledge is the key of successful parotidectomy [14]. Davis RA et al., is a pioneer who has studied the facial nerve branching pattern in 1956 and have reported pes anserinus pattern of branching [4]. Six types of branching pattern are described by them.

Type I and Type VI of Davis RA et al., study is not found in the present study, Type II of Davis RA et al., (20%) study corresponds to Type I (16%) of present study, Type III of Davis RA et al., (28%) study corresponds to Type II (40%) of present study, Type IV of Davis RA et al., (24%) study corresponds to Type III (28%) of present study, Type V of Davis RA et al., (9%) study corresponds to Type IV (16%) of present study [4].

Embryologically, all cranial nerves except for the olfactory and optic nerves arise from the brain stem [15]. The seventh cranial nerve arises from the mesencephalic part of rhombencephalon. By the third week of gestation, facioacoustic primordium is formed, which is the precursor of seventh and eighth cranial nerves. The facioacoustic primordium is attached just cranial to the otic vesicle in the mesencephalon.

The formation, branching pattern and relations of the facial nerve to the neighboring structures get established during the first three months of gestation. The ossification of the facial canal is not complete during birth and the nerve is more superficial at its exit in the stylomastoid foramen during birth. The full development of the facial nerve may extend upto four years after birth. The full course of the extratemporal ramification of the facial nerve, from its exit at stylomastoid foramen to its course and relations in the Parotid gland with the retromandibular vein and its terminal branching pattern along with its communications are studied completely in present study, however the terminal branches of facial nerve, its landmarks and its related structures and to compare the difference between the right and left-sides should be done in large prospective study.

Limitation(s)

The study results could not be analysed in terms of male and female gender because of unequal Cadaver availability of both sexes.

CONCLUSION(S)

The occurrence of retromandibular vein, in between the facial nerve branches as observed in the present study may result in bleeding from the vessels in patients during avulsion of the facial nerve in surgical procedures or any accidental damages to the nerve. This study has been conducted on the interest of bringing out the fact that, variations of the facial nerve are multiple and a sound knowledge of this fact is mandatory for surgeons to avoid iatrogenic complications in clinical procedures. The greater the communication between the branches of facial nerve, greater will be the chance of recovery from facial paralysis. Thereby an integrated approach is mandatory for a better clinical outcome.

Declaration: The images used in this article are from the first author thesis work, which is published in a repository online.

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