

Intraparotid Branching Pattern of Facial Nerve- A Cadaveric Study from Tamil Nadu, India

S SUGANYA¹, AMUDHA GOVINDARAJAN²

ABSTRACT

Introduction: Facial Nerve (FN) is the main motor nerve of muscles of facial expression. As it courses, within the parotid gland, the FN divides into divisions and then into terminal branches. Various surgical procedures of this region may inadvertently injure the FN owing to its variant branching pattern, resulting in facial asymmetry.

Aim: To analyse the branching pattern of FN in the parotid region of Indian origin.

Materials and Methods: This was a descriptive, cross-sectional study done on 50 embalmed cranial halves, in the Department of Anatomy, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India from October 2020 to March 2022. Well-embalmed and preserved adult cadavers irrespective of age, sex and side were included. After piece meal dissection

of the parotid gland, the Facial Nerve Trunk (FNT) was identified and its branching pattern studied and classified according to Davis RA et al., classification. The data thus, obtained was analysed using statistical software Statistical Package for the Social Sciences (SPSS) 21.0.

Results: The FNT bifurcated in 98% and trifurcated in 2% specimens. The branching pattern of FN based on Davis RA et al., system showed a frequency as follows: Type I: 0%, Type II: 8%, Type III: 26%, Type IV: 16%, Type V: 48% and Type VI: 2%.

Conclusion: Type V branching pattern showed the highest frequency. Results inferred from this study might help surgeons in anticipating the variant course, branching and interconnections of the FNT in the parotid region and thus, may aid in minimising iatrogenic nerve injuries to avoid unnecessary facial disabilities.

Keywords: Bifurcation, Facial palsy, Nerve injury, Ramification, Variation

INTRODUCTION

The seventh cranial nerve is FN, which is the main motor supply of muscles of second pharyngeal arch, mainly to the muscles of facial expression. FN exits the cranium through the stylomastoid foramen [1]. Then, it runs anterior to the posterior belly of the digastric and lateral to the external carotid artery and styloid process before terminating into its final motor branches in the parotid gland. FNT usually bifurcates into temporofacial and cervicofacial divisions within the substance of the parotid gland. These two divisions further branch out to give off the five terminal branches of FN namely, temporal, zygomatic, buccal, marginal mandibular and cervical branches [2]. The trunk and branches of FN are injured in certain surgical procedures involving parotid gland, surgical repair of temporomandibular joint, plastic surgeries involving elevation of Superficial Musculo Aponeurotic System (SMAS) and face lift procedures [3]. During surgical exploration of face and parotid region, surgeons usually identify one of the terminal branches of facial nerve and proceed with retrograde identification of FNT within the parotid, so as to avoid injury to the FNT. But the variations in the branching pattern and anastomoses between the branches of FN are very diverse [4,5].

Numerous authors have come up with different types of classification systems for the mode of division and branching pattern of FNT. Few of them are McCormack LJ et al., (1945) [6], Dargent M and Duroux PE (1946) [7], Davis RA et al., (1956) [4], Katz AD and Catalano P (1987) [8], Kopuz C et al., (1994) [9], Tsai SC and Hsu HT (2002) [10], and Kwak HH et al., (2004) [11]. In the year 1956, Davis RA et al., did dissection of 350 hemifacial halves and classified the branching pattern of the FN into six types. In almost all specimen, the FN trunk divided into an upper temporofacial and a lower cervicofacial divisions [4]. They confirmed that the cervical and marginal mandibular branches of the FN were usually arising from

the lower division, while the buccal branch generally arose from the lower division and sometimes also from the upper division [4]. Many studies on FN done across the globe based on Davis RA et al., classification had documented varying frequencies of branching patterns of FN [4,12-16]. Such differences are probably due to various racial backgrounds which further makes comparisons between different studies within the same population much more complex [12].

Thorough understanding of such relevant anatomy and wide variations of FN furcation and branching pattern in the parotid region is necessary to help the surgeons to anticipate them intraoperatively during surgical procedures. Various studies on this have been done across the world for the same reasons. Most of these studies were based on Davis RA et al., classification which was based on dissection of around 350 specimens [12-16]. So the current study also followed the same classification system to enable in comparing with other studies. The present study aimed at describing the termination and branching pattern of FNT in Indian ethnic group of Tamil Nadu, India.

MATERIALS AND METHODS

This was a descriptive, cross-sectional study done in the Department of Anatomy, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India, from October 2020 to March 2022, after obtaining ethical approval from the Institutional Human Ethics Committee (21/405).

Inclusion criteria: Well-embalmed and preserved adult cadavers irrespective of age, sex and side.

Exclusion criteria: Any cadaver with anomalies of face, disfigurements, injuries of the face and already dissected cadavers. All the available 50 cadavers during that period which fit into the inclusion criteria were used for the study.

Conventional Dissection Method

The dissection was performed as per Cunningham's manual. The cadaver was positioned in supine with a block placed under the head so as to elevate it to the required angle. The face skin was incised along the midline and reflected laterally. Most of the facial muscles were detached. The fascia overlying the parotid gland was incised just in front of the auricle from the zygomatic arch to the angle of the mandible. The dissection of the fascia was done with care looking for the nerves, vessels and the duct of the gland which emerge at the borders of the parotid. The zygomatic branches of the FN were dissected first as they passed deep to the zygomatic muscles and studied in detail. At the anterior border of the parotid gland, the buccal branch of the FN was identified and was traced upto the buccinator. The marginal mandibular branch of FN was traced from the lower border of the parotid gland to the level of depressor anguli oris. Then the anterior and posterior divisions of retromandibular vein and the cervical branch of FN were traced. The retromandibular vein and external carotid artery were then identified, on further removal of the parotid parenchyma [17].

Piece meal dissection of the the parotid gland was done to observe the manner of division of FNT and the branching pattern of the terminal branches and their communications. The branches were dissected meticulously and recorded based on the classification by Davis RA et al., [4]. Identifying finer branches and their inter connections was quite difficult. Data thus, obtained was properly photographed, documented and analysed and presented using diagrams, tables, and figures.

As per Davis RA et al., [4], the termination of FN and its branching pattern in the parotid gland is classified into six major types. This classification was followed in the present study as follows:

Type I: No anastomosis between the temporofacial division and cervicofacial division.

Type II: Anastomosis only between the branches of the temporofacial division.

Type III: Single anastomosis between the branches of the temporofacial and cervicofacial divisions.

Type IV: Combination of type II and III.

Type V: Double anastomoses between the branches of the temporofacial and cervicofacial divisions.

Type VI: Complex numerous anastomoses between the two divisions, where the buccal branch receives many fibres from the mandibular branch and cervicofacial division.

STATISTICAL ANALYSIS

The data thus obtained was analysed using statistical software SPSS 21.0. Results were expressed in terms of proportions and percentages.

RESULTS

In the current study comprising 50 specimens, all the specimens (100%) had only one FNT, 49 specimens (98%) showed bifurcation of the FNT into two divisions, namely the temporofacial and the cervicofacial. One specimen (2%) showed trifurcation of the FNT with temporofacial and cervicofacial divisions with an intervening buccal branch arising directly from the trunk [Table/Fig-1].

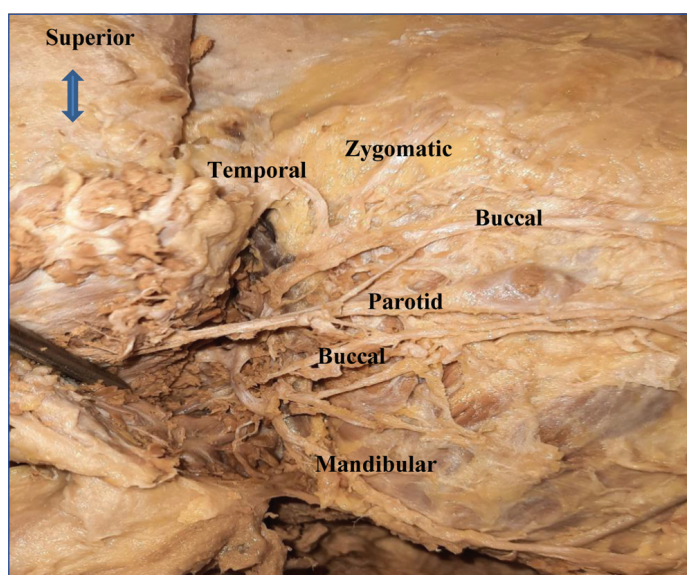
The terminal branches were described from above downwards. The temporal branch was seen emerging from the superior border of the parotid gland and ran upwards over the zygomatic arch giving around one to five further branches. The zygomatic branch too had one to three smaller branches, which usually coursed below the zygomatic arch on its way to the lower part of the orbicularis oculi muscle. The buccal branch presented the most variable origin. It was seen parallel to the parotid duct. In 44 specimens (88%), the buccal branch was seen to arise independently from both the divisions and in 5 specimens (10%), it had contributions from both



[Table/Fig-1]: Trifurcation of facial nerve trunk.

the divisions to form a single buccal branch and one specimen (2%) had a buccal branch directly originating from FNT in addition to two individual branches arising from the two divisions of FNT. Extensive anastomoses were observed within the numerous distal branches of the buccal branch and also between the buccal branch and the adjacent terminal branches of FN. The marginal mandibular branch, as its name implies was seen in close proximity to the lower border of mandible, usually below and in three cases above the base of the mandible. It usually was seen as a single branch, but in three specimen it had two branches and one specimen had three branches. The cervical branch, on its way to innervate platysma, was found to divide to upto three branches. Regarding the five terminal branches, the temporal and the zygomatic branches arose from the upper temporofacial division and the marginal mandibular and cervical branches from the lower cervicofacial division in all specimens (100%). Also there were extensive anastomoses between the branches of facial nerve.

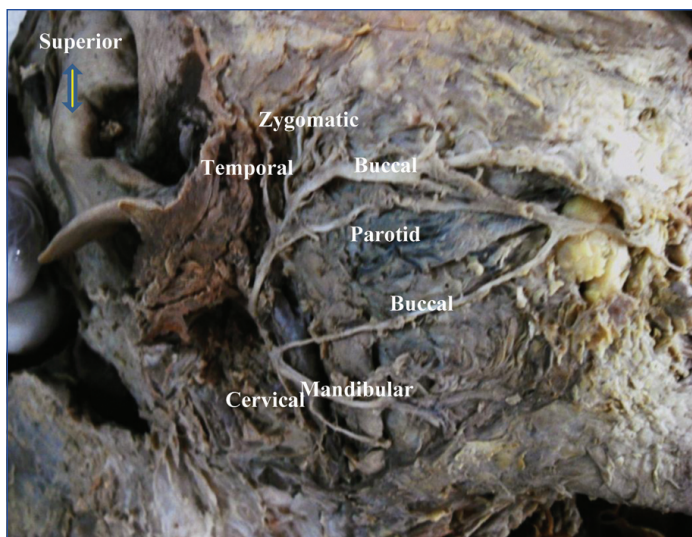
The branching pattern of FNT observed in the present study fit into either of types I to VI described by Davis RA et al., [Table/Fig 2-6] [4]. Type I branching pattern was not detected in the specimen studied. The frequency of the pattern is shown in [Table/Fig-7].



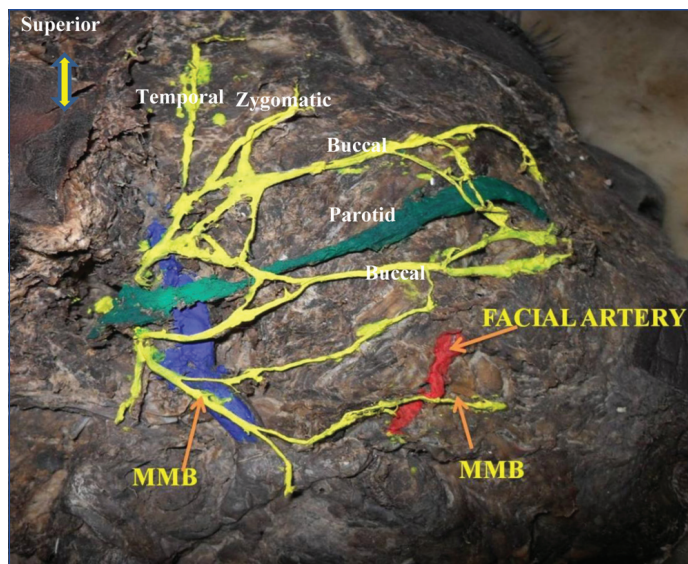
[Table/Fig-2]: Type II branching pattern.

DISCUSSION

The mode of division of FNT and its final branching pattern in the parotid region is yet a baffling encounter for ENT surgeons and general surgeons operating on the parotid gland since the prevalence of transient facial palsy amounts to 16 to 66% following such surgeries. Many such studies on FN show a wide range of variations. This study too had few interesting variations in the FN branching.

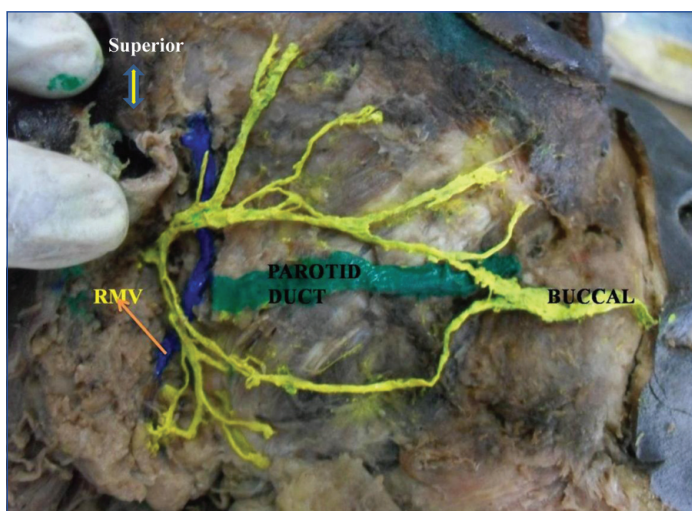


[Table/Fig-3]: Type III branching pattern.



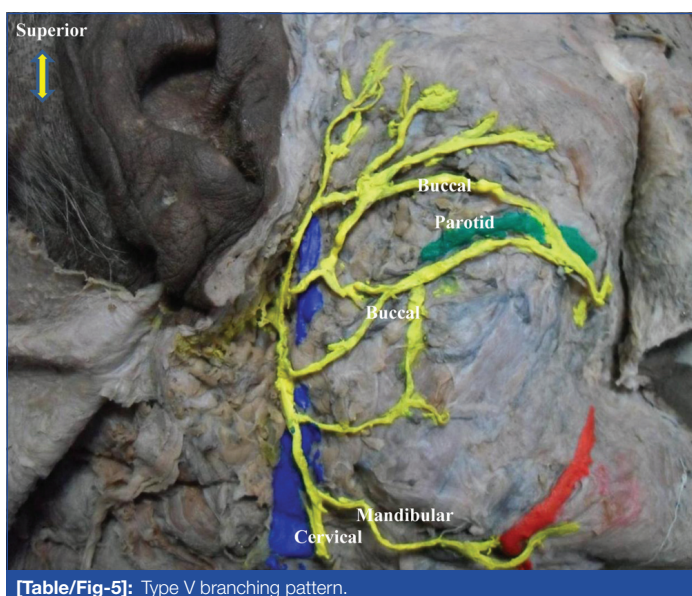
[Table/Fig-6]: Type VI branching pattern.

MMB: Marginal mandibular branch



[Table/Fig-4]: Type IV branching pattern.

RMV: Retromandibular vein



[Table/Fig-5]: Type V branching pattern.

Type	No. of specimens	Percentage
Type I	0	0
Type II	4	8
Type III	13	26
Type IV	8	16
Type V	24	48
Type VI	1	2

[Table/Fig-7]: Shows the frequency of branching pattern in the current study based on Davis RA et al., classification [4].

with 3% [13], Myint K et al., with 4.4% [14], Salame K et al., with 2.2% [18], Khoa TD et al., with 6.7% [19] and Kalaycioglu A et al., registered a 18.75% trifurcation in dissection of foetal cadavers [20]. [Table/Fig-8] shows the frequency of mode of division of FNT as documented by different authors in studies involving different races [4,8-14,18,21,22].

There are numerous studies on the branching pattern of FN based on Davis RA et al., classification [4]. The data obtained from such studies of various ethnic groups have been summed up and studied. According to Davis RA et al., [4], type III, followed by type IV and II were the commonest among Caucasians. Katz AD and Catalano P had done a similar study among Caucasians and again found that type III was the commonest, but followed by type I [8]. Park IY and Lee ME study [21] in Koreans, Myint K et al.,'s study [14] in Malaysians and Thuku FM et al., [12] on Africans yielded results very similar to that of Davis RA et al., with type III being the commonest followed by type IV [4]. But a study on Thai population by Weerapant E et al., [15] showed type V as the commonest, followed by VI and III. Among two studies done on Indians by Malik NU et al., [16] and Rana S et al., [13], there is a wide difference in the branching pattern. Malik NU et al., [16] had document a highest frequency of type I pattern which is the least common type in literature, followed by type III and II. According to Rana S et al., [13], type II was commonest among Indians, followed by IV. Ekinici N study [22] yielded results similar to that of Malik NU et al., [16].

However, in the present study conducted among Indians, type V was the commonest accounting for 48%. Next commonest were types III (26%) and IV (16%). Type VI was 2% and type I branching pattern was observed in none of the specimen, with similar result by Weerapant E et al., [15]. Comparing with studies on Indian ethnic group, most results except for the commonest type go hand in hand with that of Rana S et al., [13], but has gross difference with that of Malik NU et al., [16] probably owing to the differences in the ancestry of the wide population of the very vast Indian subcontinent. [Table/Fig-9] shows the branching pattern of FN documented in various studies [4,8,12-16,21,23].

Many researchers across the world have studied the mode of division or furcation of FNT over the past 60 years among different populations. Only Rana S et al., had documented a 2% occurrence of undivided FNT [13]. No other studies including the current study have come across such a variation. The vast majority of these studies have documented the bifurcation of FNT into temporofacial and cervicofacial divisions ranging from 80-100%. Current study too had a bifurcation of FNT in 98% of the specimens. The trifurcated FNT was observed in 2% of the specimens in the current study as like that of Rana S et al.,

Study	Racial group	Single %	Bifurcation %	Trifurcation %	Sample size	Place
Davis RA et al., 1956 [4]	Caucasians	--	100	--	350	USA
Park IY and Lee ME, 1977 [21]	Korean	--	95.6	4.4	111	Korea
Katz AD and Catalano P, 1987 [8]	Caucasians	--	100	---	100	USA
Myint K et al., 1992 [14]	Malaysian	--	96.2	3.8	79	Malaysia
Kopuz C et al., 1994 [9]	Turkey	--	82	18	50	Turkey
Ekinci N, 1999 [22]	Turkey	--	81.4	18.6	27	Turkey
Salame K et al., 2002 [18]	Israel	--	97.8	2.2	46	Israel
Tsai SC and Hsu HT, 2002 [10]	Thailand	--	100	--		Thailand
Kwak HH et al., 2004 [11]	Korea	--	86.7	13.3	30	Korea
Thuku FM et al., 2018 [12]	Kenya	--	80	20	40	Kenya
Rana S et al., 2017 [13]	Indian	2	95	3	100	India
Current study, 2022	Indian	--	98	2	50	India

[Table/Fig-8]: Frequency of mode of division of facial nerve trunk observed by various authors in studies on various races, expressed in percentage [4,8-14,18,21,22].

Authors	Davis RA et al., [4]	Katz AD et al., [8]	Park IY and Lee ME [21]	Myint K et al., [14]	Weerapant E et al., [15]	Thuku FM et al., [12]	Malik NU et al., [16]	Rana S et al., [13]	Khaliq BA et al., [23]	Present study
Year	1956	1987	1977	1992	2010	2018	2016	2017	2017	2022
Place	USA	USA	Korea	Malaysia	Thailand	Kenya	India	India	India	India
Population studied	Caucasian	Caucasian	Korean	Malaysian	Thai	African	Indian	Indian	Indian	Indian
Sample size	350	100	111	79	100	40		100	35	50
Type I	13	24	6.3	11.39	1	25	40	9	34.2	0
Type II	20	14	13.5	15.19	10	22.5	15	39	14.2	8
Type III	28	44	33.4	34.18	20	17.5	25	20	25.7	26
Type IV	24	14	23.4	18.98	18	15	10	25	11.4	16
Type V	9	3	6.3	7.59	29	5	5	6	8.5	48
Type VI	6	0	17.1	12.67	21	15	5	1	5.7	2

[Table/Fig-9]: Branching pattern of facial nerve into six types, documented in various studies based on Davis system of classification [4,8,12-16,21,23].

Most standard surgical textbooks are based on the branching pattern of FN according to Western population. But research work on various population groups yield numerous variant branching pattern with anastomoses and reanastomoses among the divisions and terminal branches of FN making it very complex indeed. Injury to even a small terminal branch might cause disfigurements. Also, presence of anastomotic loops give hope of successful reconstruction in patients who had sustained traumatic FN injuries. Hence, such regional studies are imperative for safer surgical practices to improve better outcomes and to reduce morbidity.

Limitation(s)

Sample size was small so that, there is need to increase the sample size and to look for symmetry in facial halves of a cadaver. There is also need for a prospective study in parotidectomised patients.

CONCLUSION(S)

The current study showed a bifurcation of FN and type V branching pattern based on Davis RA et al., classification as the commonest among the studied Indian population [4]. Newer reports on the variant anatomy of FN branching might prove helpful, especially to budding surgeons in avoiding untoward nerve injuries.

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REFERENCES

- Steinberg DA. Scientific neurology and the history of the clinical examination of selected motor cranial nerves. *Semin Neurol*. 2002;22(4):349-56.
- Moore K, Dalley AF, Agur A. *Clinically Oriented Anatomy*. 6th ed. Baltimore, MD: Lippincott Williams and Wilkins. 2010:945-47.
- Anbusudar K, Arumugam B. Anatomical study on intra parotid course of facial nerve and its terminal branches. *JEMDS*. 2013;2(12):1828-29.
- Davis RA, Anson BJ, Budinger JM, Kurth LR. Surgical anatomy of the facial nerve and parotid gland based upon a study of 350 cervicofacial halves. *Surg Gynecol Obstet*. 1956;102(04):385-12.
- Khaliq BA, Nisar J, Yousuf A, Maqbool T, Ahmad R. Facial nerve branching pattern as seen in parotidectomy in Kashmiri population: Our experience. *Int J Otorhinolaryngol Head Neck Surg*. 2017;3:95-97.
- McCormack LJ, Cauldwell EW, Anson BJ. The surgical anatomy of the facial nerve with special reference to the parotid gland. *Surg Gynecol Obstet*. 1945;80:620-30.
- Dargent M, Duroux PE. Gives anatomical about morphology and some reports of intraparotid facial nerve. *Press Med*. 1946;37:523-24.
- Katz AD, Catalano P. The clinical significance of the various anastomotic branches of the facial nerve. Report of 100 patients. *Arch Otolaryngol Head Neck Surg*. 1987;113(09):959-62.
- Kopuz C, Turgut S, Yavuz S, Ilgi S. Distribution of facial nerve in parotid gland: Analysis of 50 cases. *Okajimas Folia Anat Jpn*. 1994;70(06):295-99.
- Tsai SC, Hsu HT. Parotid neoplasms: Diagnosis, treatment, and intraparotid facial nerve anatomy. *J Laryngol Otol*. 2002;116(05):359-62.
- Kwak HH, Park HD, Yoon KH. Branching patterns of the facial nerve and its communication with the auriculotemporal nerve. *Surg Radiol Anat*. 2004;26(06):494-500.
- Thuku FM, Butt F, Guthua SW. An anatomic study of the FN trunk and branching pattern in an african population. *Craniomaxillofac Trauma Reconstruction Open*. 2018;2:e31-e37.
- Rana S, Akhtar UB, Atif S, Javaid Z. Terminal branching pattern of facial nerve seen in adult cadavers: An anatomical study. *APMC*. 2017;11(04):310-15.
- Myint K, Azian AL, Khairul FA. The clinical significance of the branching pattern of the facial nerve in Malaysian subjects. *Med J Malaysia*. 1992;47(02):114-21.
- Weerapant E, Bunaprasert T, Chokrungranon P, Chentanez V. Anatomy of the facial nerve branching patterns, the marginal mandibular branch and its extraparotid ramification in relation to the lateral palpebral line. *Asian Biomed*. 2010;4(04):603-08.
- Malik NU, Verma D, Varshney S, Shareef M, Shweta Gupta S. Facial nerve branching pattern as seen in parotidectomy in Indian population- A single center experience. *Eur J Pharm Med Res*. 2016;3(03):359-61.
- Cunningham. *Cunningham's manual of practical Anatomy*. 16th edition. New York. Oxford University Press. 2018;178.
- Salame K, Ouaknine GE, Arensburg B, Rochkind S. Microsurgical anatomy of the facial nerve trunk. *Clin Anat*. 2002;15(02):93-99.
- Khoa TD, Bac ND, Luong HV, Anh TN. Anatomical characteristics of facial nerve trunk in Vietnamese adult cadavers. *Open Access Maced J Med Sci*. 2019;7(24):4230-38.
- Kalaycioglu A, Yeginoglu G, Ertemoglu C, Uzono O, Kalkisim SM. An anatomical study on the facial nerve trunk in fetus cadavers. *Turk J Med Sci*. 2014;44:484-89.

- [21] Park IY, Lee ME. A morphological study of the parotid gland and the peripheral branches of the facial nerve in Koreans. *Yonsei Med J.* 1977;18(01):45-51.
- [22] Ekinci N. A study on the branching pattern of the facial nerve of children. *Kaibogaku Zasshi.* 1999;74(04):447-50
- [23] Khaliq BA, Nisar J, Yousuf A, Maqbool T, Ahmed R. Facial nerve branching pattern as seen in parotidectomy in Kashmiri population: Our experience. *Int J Otorhinolaryngol Head Neck Surg.* 2017;3(01):95-97.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Anatomy, PSGIMSR, Coimbatore, Tamil Nadu, India.
2. Professor and Head, Department of Anatomy, PSGIMSR, Coimbatore, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. S Suganya,
A1F7, RR Darshan Apartments, GV Residency, Sowripalayam,
Coimbatore, Tamil Nadu, India.
E-mail: suganss02@gmail.com

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