Original Research Paper

Volume - 13 | Issue - 08 | August - 2023 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Anatomy & General Surgery

FACIAL NERVE TRUNK VARIATIONS IN BENIGN PAROTID GLAND TUMORS- A COMBINED SURGICAL AND ANATOMICAL STUDY

Dr Upasna	Associate Professor, Department of Anatomy, Rajindra Hospital, Patiala, Punjab – 147001
Dr Ashwani Kumar	Professor and Head, Dept of General Surgery, Rajindra Hospital, Patiala, Punjab – 147001
Dr Parth Dhamija	Senior Resident, Dept of General Surgery, Rajindra Hospital, Patiala, Punjab – 147001.
Dr Prasanth Nagarajan	Assistant professor, Dept of General Surgery, Saveetha Medical College and Hospital, Thandalam, Chennai- 600086.
Dr Anusha Bhat	Junior Consultant, Apollo Hospital, Newtown, Kolkata, West Bengal- 700160

ABSTRACT **Introduction:** The facial nerve is seventh cranial nerve out of the twelve pairs of cranial nerves. It is a mixed nerve with motor component having more significance than its sensory counterpart. The nerve has a close relation to parotid gland where it's injury can occur during superficial parotidectomy. Various landmarks have been described for its identification in the parotid tissue. **Aim:** The aim is to study the relationship of facial nerve with various landmarks along with its variations in parotid tumours. **Material and Methods:** This was a prospective study which included 25 patients who underwent superficial parotidectomy in department of surgery and 50 cadaveric dissections in anatomy department of Rajindra Hospital, Patiala. The variations were grouped into 6 groups as described by Davis et al(1) and into 5 groups as described by Dargent and Duroux(2). Data was reported in terms of mean, standard deviation (SD) and percentages and was analyzed using SPSS version 22 and Microsoft Excel with the help of chi square, Fischer exact test etc. **Results:** The study showed that as per Davis et al (1), the most common type was type I and least common type was type V in cadavers whereas in live surgeries, type I and II were the most common and type IV, V and VI being the least common. Tympanomastoid suture was the most consistent and reliable landmark for the identification of the nerve. **Conclusion:** The present study establishes the variations in the branching patterns of the facial nerve as per Davis et al (1956)(1) and Dargent an Duroux (1946)(2) classification systems with tympanomastoid suture being the most reliable landmark followed by posterior belly of digastric.

KEYWORDS : Facial Nerve, Variations, Parotid tumour, Landmarks, Tympanomastoid Suture

INTRODUCTION

The facial nerve is the 7th cranial nerve, one of the most important mixed nerves in the human body which carries a great significance for the anatomist, the surgeon and the clinician. The facial nerve has two parts: the facial nerve proper which is motor to facial muscles and nervus intermedius which is the sensory and parasympathetic part of facial nerve. After coming out through the stylomastoid foramen, the facial nerve enters the parotid gland through its posteromedial surface. It divides into its five terminal branches, namely temporal, zygomatic (both derived from temporofacial branch), buccal nerve, marginal mandibular and cervical nerves (all three being derived from cervicofacial branch). The terminal branches come out through the anteromedial surface of the parotid gland. All of the muscles of facial expression are supplied by the facial nerve, with the exception of the levator palpebrae superioris, which is supplied by the oculomotor nerve[1,3-4] . Iatrogenic injury to the facial nerve is commonly encountered during surgery of the mandibular and parotid regions. Facial nerve injury is the most common complication of parotid surgery especially after Superficial as the two structures i.e.,parotid gland and facial nerve, are intimately related to each other. It has always been a challenge for the surgeon to carefully dissect the facial nerve and its branches without injuring them. The facial nerve along with the accompanying vessels creates a potential plane which lies in between the deep and superficial lobes of the parotid gland [5]. Dissection in this plane is never possible until and unless the surgeon identifies the nerve and proceeds along the nerve and its branches[6].

To locate the facial nerve trunk and allow for anterograde approach, a number of anatomical landmarks have been used such as tympanomastoid suture, tragal pointer, posterior belly of the digastric muscle etc[7]. Anterograde dissection or proximal surgical identification technique is aimed at identifying the facial nerve trunk before its bifurcation into temporofacial and cervicofacial division and is the preferred method of dissecting the facial nerve[8].

This study includes cadaveric dissection to study the anatomy of facial nerve and its branches. Cadaveric dissection plays a better role in the study of facial nerve when compared to live surgeries because detailed study of facial nerve and its branches is possible only in specimens as there is a risk of injury to the nerve in live surgeries when attempted to explore more than what is needed. Also one can have a more detailed study in cadaveric specimens when compared to live surgeries because of the time factor, where prolonged surgery can lead to increased post operative complications[1,9-10].

There are significant anatomical variations of the facial nerve which includes: (1) Length of the facial nerve trunk. (2) Variable course of the facial nerve trunk which makes its identification unreliable with the help of a single landmark (3) Bifurcation or Trifurcation of the facial nerve trunk before giving the terminal branches (4) The branching pattern of the terminal branches of the facial nerve. makes the retrograde dissection technique difficult and more challenging[3].

Various studies have been done for the better understanding of the same. While some studies suggest that the tympanomastoid suture is the best landmark for identification of facial nerve[9-11], other studies suggest that posterior belly of digastric is also a consistent landmark for the identification of the nerve[7-8]. Thus, there is no conclusive evidence for a single best landmark for the identification of facial nerve. This study also is an attempt to determine the best landmark that aids in the identification of facial nerve thus minimizing the chances of injury to the facial nerve and its branches.

AIMS AND OBJECTIVES

The aim of the study was to identify the facial nerve trunk variations in benign parotid gland tumors. The three most easily identifiable and anatomically constant landmarks were selected for demonstration in live surgery and the findings will be corroborated with that of the anatomical cadaveric dissections.

- To study the relationship of facial nerve with various bony landmarks.
- To identify the facial nerve trunk variations in benign parotid gland tumors.

MATERIAL AND METHODS

This was a Prospective study which included 25 patients who underwent Superficial Parotidectomy in Surgery department and a total of 50 cadaveric dissections of normal or enlarged parotid in Anatomy department at Rajindra Hospital and Govt. Medical College, Patiala between August 2017 to November 2019. Information about pattern of the facial nerve branching and other anatomical findings in the parotid gland associated with facial nerve were recorded. The variations were grouped into six groups namely type I, II, III, IV, V and VI as described by Davis et al (1956)(1).

After exposing the facial nerve, distance between the main trunk and various landmarks were measured using a digital calliper and recorded in millimeters. The following distances were recorded:

1. Distance between the main trunk of facial nerve to the posterior superior most margin of the posterior belly of digastric muscle (PBD).
2. Distance between the main trunk of facial nerve to the inferior end of the lateral margin of the tympanomastoid (TMS) suture.
3. Distance between the main trunk of facial nerve to the most inferior and anterior point of the tragal pointer (TP).
4. Distance between the main trunk of facial nerve to the lateral most point of the tip of transverse process of axis (TPA).

RESULTS

Cadaveric Dissections:

A total of 50 cadaveric specimens were dissected among which 29 were male (Right-15, Left- 14) and 21 were female (Right- 17, Left- 4) cadavers. The following findings were recorded.

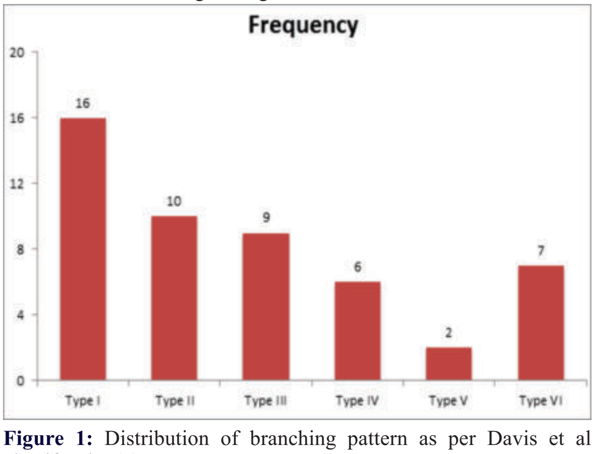

Figure 1: Distribution of branching pattern as per Davis et al classification(1):

As depicted in Figure 1, the most frequent type of branching pattern was found to be type I encountered in 32% of the dissections. The least common type was type V found in only 4% of specimens.

Table/Figure 2: Table Showing Distance Of Facial Nerve From Various Landmarks In Cadaveric Specimens

	N	Mean (in mm)	S.D (in mm)	Variance (in mm)
PBD	50	8.582	2.860	8.180
TMS suture	50	3.736	1.629	2.656
Tragal Pointer	50	12.436	4.026	16.213
Transverse Process of Axis	50	24.406	4.299	18.485

The mean distance was shortest between the TMS suture and the FN trunk of 3.74+/-1.63mm. The mean distance was longest between the transverse process of axis (TPA) and the FN trunk of was 24.41+/-4.23mm.

The mean distance cannot be used to conclude as to which is the most consistent landmark.In our study, variance of the distances was used to assess the most stable or consistent landmark, since it is a better reflection of the variables in all the 50 cadavers. The variance was minimum for the distance between TMS suture and FN trunk of 2.66mm. The variance was maximum for the distance between the transverse process of axis (TPA) and the FN trunk of 18.48mm. From, the above table it is evident that the TMS suture is the most consistent landmark(Table/Figure 2).

Trifurcation of the facial nerve trunk was seen in 1(2%) of the 50 specimens dissected. All other specimens (98%) were found to have bifurcation of the facial nerve. Quadrifurcation was not seen in any of the specimens dissected.

Live Surgeries

A total of 25 live surgeries(superficial parotidectomy) among which 17 were male and 8 were female patients . The following findings were recorded.

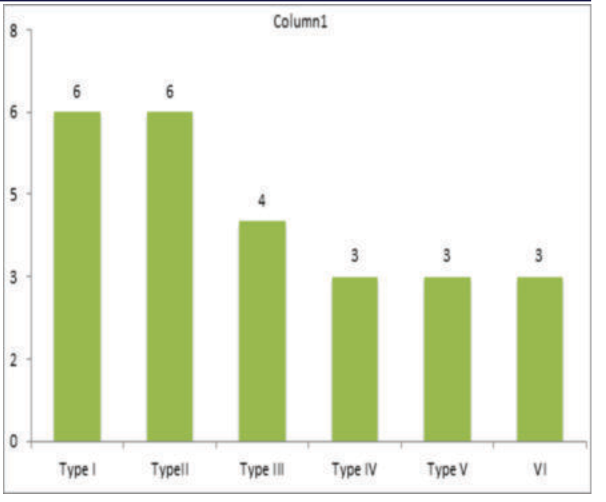

Figure 3: Distribution Of Branching Pattern As Per Davis Et Al Classification(1)

The most frequent types were found to be type I and type II , each found in 24% of the patients. The least common types were type IV, Type V and Type VI each found in only 12% of patients(Figure 3).

Table/Figure 4: Table Showing Distance Of Facial Nerve From Various Landmarks In Live Surgeries

	N	Mean (in mm)	S.D (in mm)	Variance (in mm)
PBD	25	8.472	1.866	3.485
TMS suture	11	4.300	1.462	2.140
tragal pointer	25	13.440	2.405	5.788

As described earlier, the mean distance is the average distance between two landmarks in 25 live surgeries. It does not depict about the distribution of variables in 25 patients. Therefore, the mean distance cannot be used to conclude as to which is the most consistent landmark. Therefore, variance of the distances was used as to assess the most stable or consistent landmark, since it is a reflection of the variables in all the 25 patients. The variance was minimum for the distance between TMS suture and FN trunk of 2.14mm. The variance was maximum for the distance between the tragal pointer (TP) and the FN trunk of 5.79mm. From the above table, it is evident that the TMS suture is the most consistent landmark , followed by the Posterior belly of digastric muscle(Table 4).

All the 25 patients who underwent surgery had bifurcation of the facial nerve trunk. No trifurcation or quadrifurcation of the Facial nerve trunk was seen.

DISCUSSION

The extra temporal course of facial nerve is highly varied and complex. These variations have been illustrated in different studies since 1940s. This study also confirms the anatomical variations of facial nerve, that are commonly encountered in the surgery of the mandibular and the parotid regions. In the present study, 50 cadaveric dissections and 25 live surgeries were done and the branching patterns were classified as per classification given by Davis et al (1956)[1].The distances were measured between various landmarks and facial nerve to conclude the most consistent landmark.

The most common type of branching pattern in our cadaveric dissections was type I (32%). The most common type were type I (24%) and II (24%) in live surgeries. On the contrary, type III was the most frequent type encountered in 28 % of the specimens in Davis et al [1]study. The least common type was type V (4%) in cadavers whereas the least common type were type IV, type V and type VI (12% each) in live surgeries. This was similar to the study by Davis et al(1) where, type V and type VI were the least common types with incidence of 9% and 6 % respectively.

The frequency of Type I was found to be higher than most of the previous studies namely, Park and Lee[12], Katz et al[13], Myint et al[14] and Kopuz et al[15]. But, type I was found to be the least common type in the study done by Park and Lee[12].

Table/Figure 5 : Comparison Of Different Types Of Branching Patterns Of Facial Nerve With Earlier Studies (as Per Davis Et Al 1956 Classification)(1)

Type	Davis et al. 1956[1]	Bernstein and Nelson 1984[16]	Park and Lee 1997[12]	Myint et al. 1992[14]	Weerapanta et al. 2010[17]	Present study (cadavers)	Present study (live surgeries)
I	44 (13%)	3 (9%)	7 (6.3%)	9 (11.4%)	1 (1%)	16(32%)	6(24%)
II	71 (20%)	3 (9%)	15 (13.5%)	12 (15.2%)	10 (10%)	10(20%)	6(24%)
III	99 (28%)	8 (25%)	37 (33.4%)	27 (34.2%)	20 (20%)	9(18%)	4(16%)
IV	82 (24%)	7 (19%)	26 (23.4%)	15 (19%)	18 (18%)	6(12%)	3(12%)
V	32 (9%)	8 (22%)	7 (6.3%)	6 (7.6%)	29 (29%)	2(4%)	3(12%)
VI	22 (6%)	6 (16%)	19 (17.1%)	10 (12.7%)	21 (21%)	7(14%)	3(12%)
TOTAL	350	35	111	79	100	50	25

In the present study, comparison of right and left sides both in cadavers and live surgeries did not have any significant difference in the variation of the branching pattern(1). The results from our study tallies with Kopuz et al[15] and Kalaycioğlu et al[18] on bilateral configurations. This could be of surgical relevance in case of bilateral surgical procedures in order to predict the opposite side configurations. The present study didn't show any significant difference in the variation of branching patterns between genders.

The tympanomastoid suture line can be palpated as a hard ridge deep to the cartilaginous portion of the external auditory canal. The facial nerve emerges from the stylomastoid foramen which is a direct continuation of tympanomastoid suture line. Tympanomastoid suture can be identified without much difficulty in the cadavers but in live surgery direct visualization of the suture is practically not possible since it is a palpatory landmark.

Table/Figure 6 : Comparison Of Distance Between Tympanomastoid Suture, Posterior Belly Of Digastric And Tragal Pointer From Facial Nerve Trunk With Different Studies

Name of the study	Cadavers/Live surgeries	Distance of TMS from facial nerve trunk	Distance of Posterior belly of digastric from facial nerve trunk	Distance of Tragal pointer from facial nerve trunk	Best Landmark(s) concluded
De Ru et al (2001)(19)	Cadavers	Mean – 2.7mm	Mean – 4.5mm	Mean – 8.0mm	Tympanomastoid Suture
Witt et al (2005)(11)	Cadavers	Mean – 1.8 mm	Mean –10.7mm	-	Tympanomastoid suture
	Live surgeries	Mean – 2.0 mm	Mean – 12.4mm		
Pather et al(2006)(7)	Cadavers	Range –4.9 to 18.6mm Mean –10.0mm	Range –9.7 to 24.3mm Mean –14.6mm	Range – 24.3 to 49.2mm Mean –34.0mm	Posterior Belly Of Digastric Muscle,Tragal Pointer And Transverse Process Of Axis
Rea et al(2010)(10)	Cadavers	Range – 2.1 to 3.6mm Mean – 2.5mm	Range – 2.5 to 9.2mm Mean – 5.5mm	Range – 3.4 to 11.3mm Mean – 6.9mm	Tympanomastoid Suture
Bushey et al(2011)(9)	Cadavers	Range – 3.3 to 9.2mm Mean – 4.9 mm	-	-	Tympanomastoid suture
Muhleman et al(2012)(20)	Cadavers	Mean – 2.5+/-0.4mm	Mean – 5.5+/- 2.1mm	Mean – 6.9 +/- 1.8mm	-
Nishanthi et al (2006)(21)	Cadavers	-	-	Mean – 10.1 mm	-
Saha et al(2013)(8)	Cadavers	Mean – 3.5mm	Mean – 7.4mm	Mean – 16.6mm	Posterior Belly Of Digastric Muscle
	Live surgeries	Mean – 3.87mm	Mean – 8.0mm	Mean – 16.3mm	
Present study	Cadavers	Mean – 3.7mm	Mean – 8.6mm	Mean – 12.4mm	Tympanomastoid Suture
	Live surgeries	Mean – 4.3mm	Mean – 8.5mm	Mean – 13.4mm	

In our study, we found the tympanomastoid suture to be the most consistent landmark lying at a mean distance of about 3.7mm (cadavers) and 4.3mm (live surgeries) from the facial nerve trunk (Table/Figure 6).The results of our study were in agreement with the studies done by De Ru et al[19], Witt et al[11], Rea et al[10] and Bushey et al[9]. On the other hand, a study by Pather and Osman[7] done on 40 adult cadavers to compare the reliability of various landmarks namely TP, Posterior belly of Digastric Muscle, Tympanomastoid suture, External Auditory Meatus, styloid process, angle of mandible and transverse process of axis revealed contrasting results in which the posterior belly of digastric muscle, Tragal Pointer and TPA were concluded as most reliable landmarks. The mean distance in their study from the facial nerve to the tympanomastoid suture was 10.0mm.

The posterior belly of digastric muscle is a soft tissue landmark, therefore its position is subject to variation when the muscle is retracted, altering the position of neck and when the muscle is displaced by the growing tumour itself.

In the present study, the mean distance between the posterior belly of digastric muscle and the facial nerve in cadavers was 8.6mm and in live surgeries was 8.5mm. It was comparable to that of the study done by Saha et al [8] where the mean distance was 7.4mm in cadavers and 8.0mm in live surgeries.

Our result was contrary to that of the study done by Pather and Osman[7] where posterior belly of digastric muscle, Tragal Pointer and Transverse Process of Axis were declared as the consistent and reliable landmark. Saha et al[8] in their study concluded posterior belly of digastric muscle to be the best landmark in the identification of facial nerve. Other studies done by De Ru et al [19], Witt et al[11] , Rea et al[10] concluded tympanomastoid suture as the best landmark.

The tragal pointer is being used in identifying the facial nerve because it points directly to the facial nerve while the latter exits the stylomastoid foramen. The disadvantage of the tragal pointer is that there is observer variation in defining the direction of the tragal pointer, since it is asymmetrical, mobile and has a blunt irregular tip that can change with retraction while performing the procedure[7,20].

In the present study, the tragal pointer was situated at a mean distance of 12.4mm from the facial Nerve trunk in cadavers and 13.4mm in live surgeries that was comparable to that of the value observed in a study done by Nishanti et al[21] that showed a mean distance of 10.1mm.

The transverse process of axis (TPA) is palpated after the retraction of the sternocleidomastoid muscle as a protrusion on the lateral side of the neck. In the present study, the distance between the transverse process of axis and the facial nerve was measured in all 50 cadavers and the mean distance was found to be 24.4mm. Though the transverse process of axis has not been evaluated as a landmark for the identification of the facial nerve in many of the studies, the study done by Pather and Osman[7] has demonstrated that the mean distance between the facial nerve trunk and the transverse process of axis was 16.9mm and also concluded it to be one of the reliable and consistent landmark in the identification of facial nerve.

CONCLUSION

The present study establishes the variations in the branching patterns of the facial nerve as per Davis et al (1956)(1) and Dargent an Duroux (1946)(2) classification systems. From our study it was also concluded that , the Tympanomastoid suture was the most consistent and reliable landmark to identify the facial nerve followed by the Posterior belly of digastric muscle.

REFERENCES

1. Davis, R. A. (1956). Surgical anatomy of the facial nerve and parotid gland based upon a study of 350 cervicofacial halves. *Surg Gynecol Obstet*, *102*, 385-412.
2. Dargent, M., & Duroux, P. E. (1946). * DONNEES ANATOMIQUES CONCERNANT LA MORPHOLOGIE ET CERTAINS RAPPORTS DU FACIAL INTRA-PAROTIDIEN. *PRESSE MEDICALE*, *54*(37), 523-524.
3. Tubbs, R. S., Shoja, M. M., & Loukas, M. (Eds.). (2016). *Bergman's comprehensive encyclopedia of human anatomic variation*. john Wiley & sons.
4. Kochhar, A., Larian, B., & Azizzadeh, B. (2016). Facial nerve and parotid gland anatomy. *Otolaryngologic Clinics of North America*, *49*(2), 273-284.
5. Lore and medina : An Atlas of Head and Neck Surgery. 4/E(ex)(2009).
6. Grewal, D. S. (2014). *Atlas of Surgery of the Facial Nerve: An Otolaryngologist's Perspective*. JAYPEE BROTHERS PUBLISHERS.
7. Pather, N., & Osman, M. (2006). Landmarks of the facial nerve: implications for parotidectomy. *Surgical and Radiologic Anatomy*, *28*, 170-175.
8. Saha, S., Pal, S., Sengupta, M., Chowdhury, K., Saha, V. P., & Mondal, L. (2014). Identification of facial nerve during parotidectomy: a combined anatomical & surgical study. *Indian Journal of Otolaryngology and Head & Neck Surgery*, *66*, 63-68.
9. Bushey, A., Quereshy, F., Boice, J. G., Landers, M. A., & Baur, D. A. (2011). Utilization of the tympanomastoid fissure for intraoperative identification of the facial nerve: a cadaver study. *Journal of oral and maxillofacial surgery*, *69*(9), 2473-2476.
10. Rea, P. M., McGarry, G., & Shaw-Dunn, J. (2010). The precision of four commonly used surgical landmarks for locating the facial nerve in anterograde parotidectomy in humans. *Annals of Anatomy-Anatomischer Anzeiger*, *192*(1), 27-32.
11. Witt, R. L., Weinstein, G. S., & Rejto, L. K. (2005). Tympanomastoid suture and digastric muscle in cadaver and live parotidectomy. *The Laryngoscope*, *115*(4), 574-577.
12. Park, I. Y., & Lee, M. E. (1977). A morphological study of the parotid gland and the peripheral branches of the facial nerve in Koreans. *Yonsei medical journal*, *18*(1), 45-51.
13. Katz, A. D., & Catalano, P. (1987). The clinical significance of the various anastomotic branches of the facial nerve: report of 100 patients. *Archives of Otolaryngology–Head & Neck Surgery*, *113*(9), 959-962.
14. Myint, K., Azian, A. L., & Khairul, F. A. (1992). The clinical significance of the branching pattern of the facial nerve in Malaysian subjects. *Med J Malaysia*, *47*(2), 114-21.
15. KOPUZ, C., TURGUT, S., YAVUZ, S., & ILGI, S. (1994). Distribution of facial nerve in parotid gland: analysis of 50 cases. *Okajimas folia anatomica Japonica*, *70*(6), 295-299.
16. Bernstein, L., & Nelson, R. H. (1984). Surgical anatomy of the extraparotid distribution of the facial nerve. *Archives of Otolaryngology*, *110*(3), 177-183.
17. Weerapant, E., Bunaprasert, T., Chokrungvaranont, P., & Chentanez, V. (2010). Anatomy of the facial nerve branching patterns, the marginal mandibular branch and its extraparotid ramification in relation to the lateral palpebral line. *Asian biomedicine*, *4*(4), 603-608.
18. Kalaycioğlu, A., YEGİNOĞLU, G., Öksüz, C. E., Uzun, Ö., & Kalkişim, Ş. N. (2014). An anatomical study on the facial nerve trunk in fetus cadavers. *Turkish journal of medical sciences*, *44*(3), 484-489.
19. De Ru, J. A., Van Benthem, P. P. G., Bleys, R. L., Lubsen, H., & Hordijk, G. J. (2001). Landmarks for parotid gland surgery. *The Journal of Laryngology & Otology*, *115*(2), 122-125.
20. Muhleman, M., Wartmann, C., Hage, R., Matusz, P., Shoja, M., Tubbs, R. S., & Loukas, M. (2012). A review of the Tragal Pointer: anatomy and its importance as a landmark in surgical procedures. *Folia Morphologica*, *71*(2).
21. Nishanthi, H. T., Hewapathirana, I. S., & Nanayakkara, C. D. (2006). Surgical anatomy of the facial nerve trunk. *Asian J Oral Maxillofac Surg*, *18*, 259-262.