ORIGINAL ARTICLE (APMC – 439) DOI: 10.29054/APMC/17.439

Terminal Branching Pattern of Facial Nerve Seen in Adult Cadavers: An Anatomical Study

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ABSTRACT

Introduction: There are twelve cranial nerves and seventh one is the Facial cranial nerve, which supplies the muscles of facial expression. It gives of five terminal branches, which form a plexus with in the parotid gland. These branches exhibit variations in their branching pattern. Detection of the main trunk of facial nerve and its branches is important in all surgeries of this area, to avoid any injury that may lead to the loss of function of this nerve. This study has elaborated the branching and communications among the terminal branches of facial nerve in parotid gland. **Objectives:** To study the anatomical variations in the terminal branching and communicating pattern of the seventh cranial nerve and to observe the division pattern of the facial nerve trunk in parotid area. **Study Design:** It was carried out at Department of Forensics and Department of Anatomy in King Edward Medical University Lahore. **Period:** The study commenced in March 2014 after approval of the synopsis by the Advance Studies and Research Board of KEMU and was successfully completed in December 2015. **Methodology:** Dissection of one hundred hemi-faces in the Departments of Forensic and Anatomy at King Edward Medical University Lahore. Adult cadavers of both sexes were included and with mutilated face were excluded. A Descriptive Cross-sectional type of study. Collected data was analyzed in SPSS 13. Simple frequency/percentages tables and charts were used to presents the outputs. Chi-Square, Student t-test and ANOVA were used. **Results:** Branching and Communicating Pattern according to occurrence were: Type I, 9%, Type II, 39%, Type III, 20%, Type IV, 25%, Type V, 6%, Type VI, 1%. 95% cases showed bifurcation. **Conclusion:** Most common branching pattern was Type II (39%), and least common was Type VI (1%). Surgery of Zygomatic region must be done carefully due to complexity of branching in this area.

Keywords: Facial Nerve, branching pattern, parotid gland

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Submitted for Publication: 13-11-2017 *Accepted for Publication: 06-12-2017*

Article Citation: Rana S, Akhtar UB, Atif S, Javaid Z. Terminal Branching Pattern of Facial Nerve Seen in Adult Cadavers: An Anatomical Study. APMC 2017;11(4):311-5.

INTRODUCTION

The facial nerve is a mixed peripheral nerve, and is most commonly affected in neurology. Anatomy and embryology of the facial nerve is intricate. A basic knowledge of developmental anatomy is obligatory to figure out and foresee variations encountered by the surgeon. The course of this nerve and its terminal variations must be kept in mind.

The intricate anatomic division pattern of the facial nerve, the dramatic deformities consequentially from its injury and its decisive role in facial expressions have enthused numerous anatomic and exploratory studies on the nerve.[1-3] The choice of the surgical approach is very linked to the parotid surgery because the practical significance of the branches of facial nerve and the intense anatomic randomness of the parotideal area.[4]

The facial nerve emerges from the base of the skull at the stylomastiod foramen. Here the facial nerve lies 0.9 mm from the posterior belly of the digastric muscle and 11mm from the bony external acoustic meatus.[4] The facial nerve and its terminal branches always lie in one plane, so by this the facial nerve separates the parotid gland into a deep and a superficial lobe. There is no anatomical plane between these two lobes.[5, 6]

Facial nerve paralysis is a stressful complication of parotid surgery.[7] The loss of potential to move the face has both the communal and functional consequences for the patient. In Edinburgh, Scotland, at a facial paralysis clinic, a total 22,954 patients were surveyed and over 50% were found to have a noteworthy degree of psychological pain and social removal as an outcome of their facial paralys.[8] Parotid surgery can at best be complicated and at worst catastrophic. The spirit of the matter remains in the functional conservation of the facial nerve (FN), through proper detection and conservation of the nerve during surgery.[9]

METHODOLOGY

This study was conducted at the Department of Forensic, KEMU Lahore. One hundred facial halves

of unknown fresh adult cadavers of both genders, aged 24 to 70 years were dissected in the post martom room of forensic department. It was a descriptive cross-sectional study and convenient sampling technique was used for sampling.

Any trauma, injury, previous scarring or damage to the side of the face was excluded. Ethical clearance was taken from the ethical committee of King Edward Medical University, Lahore.

Out of these 100 specimens 9 were of female and 91 were of males. 58 left and 42 right facial halves were dissected. All the dissections were performed in a lateral side position, so that the preauricular region for dissection was showing. A pre-auricular skin incision was given. This incision was extended from 10 mm superior to the tragal cartilage to a point 20 mm inferior to the angle of the mandible, to avoid any damage to the marginal mandibular nerve.[10] Once the incision was given, skin flap was raised and further, subcutaneous tissue was dissected. After the elevation of the flaps, anterior border of sternocleidomastoid muscle was dissected up to the mastoid process. Posterior belly of the digastric muscle was visualized. Then the cartilaginous segment of external auditory canal was dissected to the bony segment. The facial nerve trunk was visualized distal to the stylomastoid foramen and was dissected peripherally. Dissection of the parotid gland was done bit by bit thus avoiding any injury to the underlying facial nerve and its terminal branches and also the reteomandibular vein. To identify the facial nerve main trunk, two methods were adopted. First the parotid gland was identified and then by doing a very fine dissection, entrance of the facial nerve in the parotid gland was acknowledged. And then later on facial nerve was dissected and located up till its emergence from the sylomastoid foramen. In second method tragal cartilage was identified, and then by removing the cartilage and also at the same time keeping in site the location of mastoid process, facial nerve main trunk was identified. These two methods were used as anterograde dissection of the facial nerve. Most of the dissections were done in a retrograde fashion. First the buccal branch of facial nerve was identified. Further dissection was done and all other branches of facial nerve were located. The main trunk of the facial nerve was identified up till its emergence from the stylomastoid foramen.[11] The difference between the nerve and the parotid duct was made clear by thoroughly observing the thread like nature in case of a nerve and by acknowledging the patency and tube-like nature of the duct. Buccal branch was easy to identify due to its larger size and its location, being near to the parotid duct.

Devis et al[12], in 1956 recorded the terminal branching pattern of the facial nerve. He observed following six types of branching patterns:

Type I: There was no anastomosis between terminal branches of facial nerve.

Type II: There was an anastomotic association between branches of temporofacial division.

Type III: Only a single anastomosis was present between temporofacial and cervicofacial division.

Type IV: It was a combination of type II & III.

Type V: Two anastomotic rami were present, from cervicofacial division to intercede with branches of temporofacial division.

Type VI: A plexiform arrangement, in which a mandibular branch was sending a twig to join any branch of temporofacial division.

Keeping in consideration these above-mentioned descriptions of the six types of patterns described by Devis,[12] in this study frequency of branching pattern of the facial nerve was observed in our population.

For the precise location and dissection of the nerve, magnifying loupes of model (NEITZ, BLS-3) were used. Photographs were taken by using digital camera (Olympus, 12 Megapixels).

Non-Probability Sampling Technique was used for the collection of samples for this study. This was a Descriptive Cross-sectional type of study. Specimens were collected in a study period of one year, and a Non-probability convenient Sampling technique was used. The data collected was inserted in SPSS 13.0 version. Chi Square Test, Student t-test and ANOVA was applied on the collected data to get the results. Also, the correlations between variables were observed by using the ANOVA.

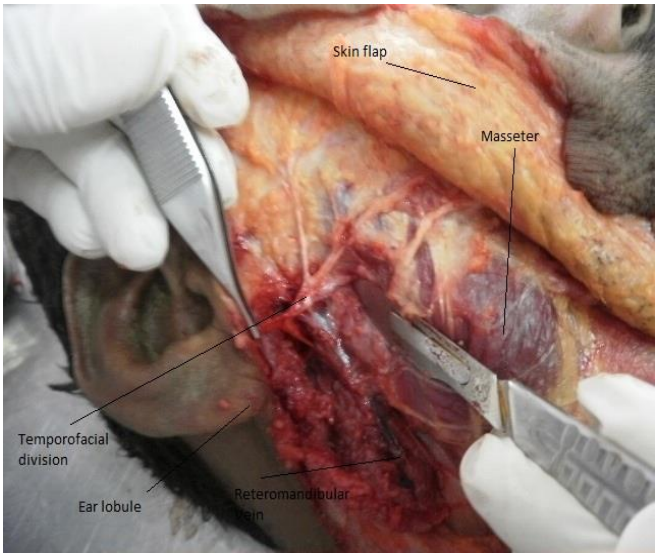

Figure 1: Upper division of Facial nerve:

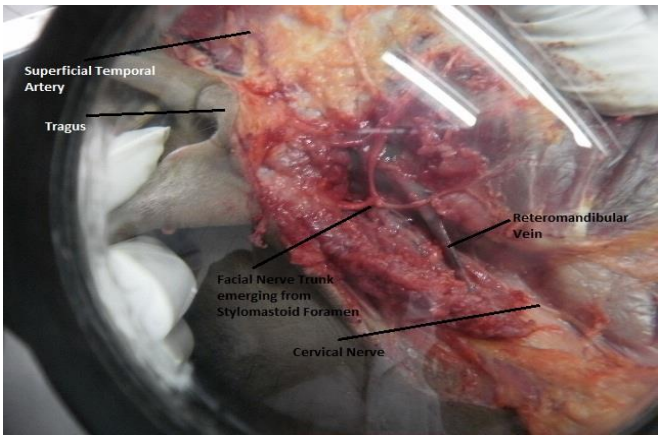

Figure 2: Facial nerve trunk bifurcation & lying superficial to reteromandibular vein:

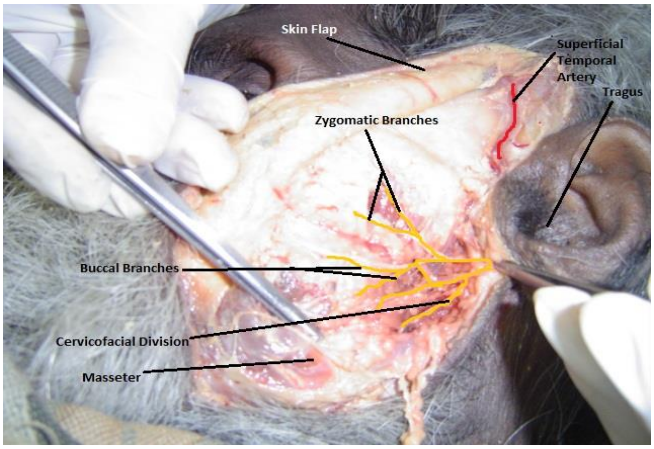

Figure 3: Buccal & Zygomatic branches emerging from temporofacial division of facial nerve

RESULTS

Terminal Branching pattern Type:

Out of the total 100 specimens, 9 cases (9%) were of Type I, 39 cases (39%) were of Type II, 20 cases (20%), were of Type III, 25 cases (25%), were of Type IV, 6 cases (6%), were of Type V, and only I case (1%), was of Type VI (Table 1).

Table 1: Frequencies and percentages of branching and communicating pattern of facial nerve

Pattern Type	Number	Percentage %
Type I	9	9
Type II	39	39
Type III	20	20
Type IV	25	25
Type V	6	6
Type VI	1	1

Table 2: Correlation between the main FN trunk division and age

No. of FN Trunk Divisions	No. of Cases	Mean age +/-SD (yr)	Range (yr)	P-value
1	2	26.00+/-2.82	24- 28	0.043
2	95	45.46+/-14.90	20-75	
3	3	30.00+/-5.00	25-35	
Total	100	44.61+/-15.024	20-75	

P-value is ≥ 0.05

Table 3: Divisions of the main facial nerve trunk

FN Trunk Divisions	Number of Cases(N)	Percentage%
Single Trunk	2	2%
Bifurcation	95	95%
Trifurcation	3	3%
Quadrification	—	—

Table 4: Comparison of studies showing the terminal branching pattern of facial nerve

Studies	Type I %	Type II %	Type III %	Type IV %	Type V %	Type VI %
Present Study	9	39	20	25	6	1
Khaliq et al (2016)	34.2	14.2	25.7	11.4	8.5	5.7
Malik et al (2016)	40	15	25	10	5	5
Weerapant (2010)	1	10	20	18	29	21
Alkan (2002)	16	11.8	20	44	12	—
Devis (1956)	13	20	28	24	9	6

Table 5: Comparison of studies showing the division of Facial nerve trunk

Studies	Single Trunk %	Bifurcation %	Trifurcation %	Quadrification%
Present Study	2	95	3	—
Kawk (2004)	—	86.7	13.3	—
Devis (1956)	—	100	—	—
Khaliq et al (2016)	91.4	8.57	—	—
Kalaycioğlu A et al (2014)	—	81.3	18.8	—

DISCUSSION

The rationale of the present study is to bring to light the different patterns of intraparotid allocation and anastomosis of facial nerve so as to give guideline map for the operating surgeons to diminish postoperative morbidity associated with the facial nerve injury during surgery. Classification of the terminal branching pattern of the Facial nerve is done by Devis et al.[12] He proposed six communicating patterns of peripheral branches of the Facial nerve. Type I or the straight branching pattern was 9% in present study. The frequency of Type I in literature is not that much different from the present study.[12,13] Other studies had shown greater incidence of Type I prevalence even up to 35.5% and 40% respectively.[14,15] Type I is clinically significant given that if anterior branch is sacrificed, there can be consequential paralysis of the muscles as there is no anastomosis between the other branches. Most prevalent type in the present study is Type II i: e 39%, in which a Zygomatic loop is formed. Second most prevalent Type in the present study was Type IV with 25% in which multiple anaostomosis can be seen within the temporofacial branches and also a single communication between the temporofacial and cevicofacial divisions and this is in accordance with the other study in literature.[12]

In the present study Type VI (1%), which shows multiple and complex anastomosis among the branches of the two upper and lower divisions, is the least prevalent type and this is in accordance with the other studies in literature.[12,14,15] Type VI was not even seen in many studies.[13] In another study[16] they observed 21% of Type VI, being the second most prevalent type in this study. These all studies show that the communicating pattern is independent of age, gender and the region. Many of these studies are done on Koreans, Caucasians and Asians. But it seems to be no relation between these factors and the communicating patterns of the peripheral branches of the facial nerve. Comparison of different studies is shown in Table 4 regarding the communicating pattern of terminal branches of facial nerve.

In other studies[17,18] they observed that the connection between the lower branches of facial nerve to be far less frequent then the connections between the upper branches of the FN. Davis[12] reported 6.3% of the cases in which MMB communicated with the buccal branch and Kawk[19] reported this communication in 42% of the cases.

Extratemporal segment of the facial nerve is concerned in the parotid area, FN show great variance in its branching and communicating pattern, but this variance has nothing to do with the race or region.

Division of the main facial nerve trunk into its upper and lower divisions can take place either before entering the parotid gland or within the parotid gland. The bifurcation and the location of the bifurcation of the nerve trunk may be variable not only between one individual and another, but also between the two sides of the main individual.[12] In present study, 2 cases (2%) have single main facial nerve trunk, which further divided into the plexiform pattern giving five terminal branches of the facial nerve. Bifurcation seen in 95 cases (95%) and trifurcation is seen in 3 cases (3%) of the total specimen (Table 3). No case showing quadrification is observed. These results are very much in coincidence with the results in literature shown in Table 5.

CONCLUSION

Surgeons exploring this part of the face must be conscious enough with the diversity of the branching pattern of the facial nerve. Incisions given for the parotidectomies and other surgical procedures of this area must be about 1 cm superior to the tragal cartilage and almost 2 cm lower to the inferior border of the mandible. This type of incision can be given without risking any branch of the facial nerve. Compared to the earlier studies done on adults and children, outcome of this study was not very much in difference. However, there was a difference in the prevalence of Type II in this study and in the previous studies. These results showed that the surgeries involving the zygomatic area should be performed with special care. Facial nerve geography during parotidectomy is always a distinct and a challenging mission for the surgeon because of unknown and capricious alterations or variations in the branching pattern of the facial nerve. Side of the face had no significant effect on the type of the branching and communicating pattern. In present

study gender difference did not affect the type of communicating pattern of Facial Nerve.

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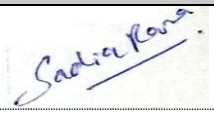
Dr. Sadia Rana Assistant Professor of Oral Biology Sharif Medical & Dental College, Lahore	Research concept, Data analysis, Manuscript preparation	
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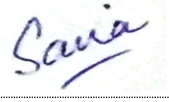
Dr. Saira Atif Associate Professor of Oral Biology CMH Medical & Dental College, Lahore	Reference writing, Statistical analysis	
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