The clinical significance of the branching pattern of the facial nerve in Malaysian subjects

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Summary

Fine dissection was carried out in 79 facial halves from formalin fixed Malaysian adult cadavers of various races, to trace the extracranial part of the facial nerve and its peripheral branches. The facial nerve trunk, after leaving the stylomastoid foramen was located at a depth of 1 to 2 cm from the skin in the vagino-mastoid angle. It bifurcates at the posterior border of the ramus of the mandible and in 3.8% trifurcation was found. Mean distance of bifurcation from the angle of the mandible was 28.06 mm and 81.0% were within the range of 21 to 35mm. The branching patterns were classified into six types, and the frequency of occurence was type I 11.39%, type II 15.9%, type III 34.18%, type IV 18.98%, type V 7.59% and type VI 12.67%. Type I, a classical text book pattern was found to be one of the least common patterns. There is no significant difference in percentage of each type between the present study and that of Koreans, though some differences with Caucasians were noted in three uncommon types. The frontal branch could be outlined between the two diverging lines from the earlobe to the lateral ends of the eyebrow and the highest frontal crease. Posterior to the facial artery, the mandibular branch was seen passing below the inferior border of the mandible in 20%; anterior to the artery, this nerve divides into one to four branches. In almost all the cases, branches to the mentalis and the depressor labii inferioris muscles and infrequently branches to the depressor angular oris were seen below the inferior border of the mandible. Therefore, the incision of the platysma muscle close to this border in face lift operations would put these branches at risk and may cause a deformity of the lower lip.

Key words: Facial nerve; branching patterns

Introduction

The challenge to head and neck surgeons in parotid surgery is adequate removal of the tumour with functional and anatomical preservation of all branches of the facial nerve whenever possible.[1,4,7,11] Since the procedure has become common, attention has been focused on the importance of an exact description of the anatomy of the facial nerve with special reference to its relation to the parotid gland.[13] Furthermore, plastic surgeons need a clear knowledge on the pattern of branching and anastomosis of the intra and extraparotid parts of the facial nerve, as even the slightest post-operative facial deformity could lead to legal problems.

Although the intraparotid anatomy of the facial nerve [2,4,7,14] and the branching pattern of its peripheral branches [1,11,13] were well documented in Caucasians [1,4,7] and Koreans,[11] no consistent description has been given, even in the text books of Anatomy.[8,15] Moreover, it was found that the temporofacial and mandibular branches of the facial nerve are prone to injury [3,6,9,13] because, these branches are related

to a proportionately lesser amount of subcutaneous tissue, greater number of operations in these regions for temporal flap [3,6,13] and face lift [9] operation, lack of an accurate description of the course of these branches [10] and also they rarely have an anastomosis with other branches of the facial nerve. [4,5,10,11] The aim of the present investigation is not only to confirm the previous findings on the branching pattern of the facial nerve, but also to study the pattern in Malaysian subjects as there is no such report in the available literature. Thus, it might help to reduce operative injuries to the facial nerve in Malaysian subjects.

Materials and Methods

The present study was made in the department of Anatomy, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur. The materials for this study were a collection of seventy-nine facial halves from formalin fixed Malaysian adult cadavers comprising a combination of various races, Indians, Chinese and Orang Asli. None of the cadavers had facial defects and the jaws were fully closed.

The facial nerve was dissected from its emergence from the stylomastoid foramen and its facial branches were traced very carefully through the parotid gland and beyond it distally. The posterior auricular branch of the facial nerve was not included in the study.

The pattern of branching and anastomosis of the peripheral branches of the facial nerve was observed and recorded. The angle of the mandible, a point where the inferior border of the mandible meets its posterior border [15] was taken as a landmark.[1,4,11] With a pair of dividers, the shortest distance from the bifurcation of the facial nerve to the angle of the mandible was measured to the nearest millimeter. The measurement was made by each author seperately and mean distance was taken from three readings. The depth of the nerve trunk at its emergence from the stylomastoid foramen was measured by taking the shortest distance from the skin and the mean of the three seperate readings was taken.

A detailed study of the direction and course of the temporal branch was made in all facial halves including its fine terminal branches supplying the muscles. However, such study on the mandibular branch could be made in sixty-eight facial halves as it was not possible to trace their terminal branches in eleven facial halves and thus not included in this study.

Statistical analysis of the results was evaluated by the chi-square goodness of fit or Fisher's exact test (Yates) where appropriate. The level of significance was set at $P<0.05$.

Results

Course of the facial nerve trunk

In the present investigation in Malaysian adult cadavers, the facial nerve trunk immediately upon leaving the stylomastoid foramen was located at a depth of 1 to 2 cm from the skin in the "vagino-mastoid angle", the bony angle formed by the vaginal process of the tympanic bone and the mastoid process (Fig.1). The nerve came into relationship with the parotid gland as it curved forward, concaved superomedially lateral to the styloid process, the external carotid artery and the retromandibular vein. It then entered the deep surface of the posterior part of the parotid gland. No trunk was seen descending lower than the tip of the ear lobe.

Bifurcation of the facial nerve trunk

When the nerve reached the posterior border of the ramus of the mandible, it turned forward at almost a right angle and bifurcated into the upper bigger temporofacial division and a lower smaller cervicofacial division. The upper division was almost double the size of the lower one. In three facial halves (3.8%; two on the right and one on the left) trifurcation was seen; the lowest branch being the smallest.

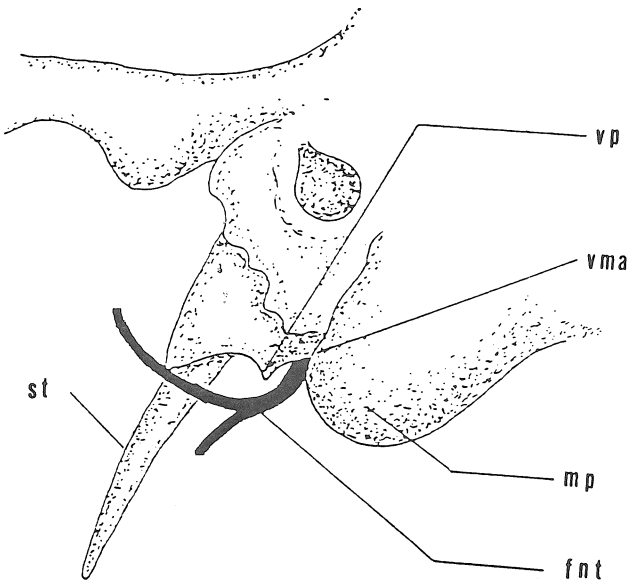

Fig. 1 :
Facial nerve trunk at the vagino-mastoid angle

fnt : *facial nerve trunk*
st : *styloid process*
mp : *mastoid process*

Distance from the angle of the mandible to the bifurcation of the facial nerve

In 64(81.0%) of the seventy-nine facial halves, the bifurcation of the facial nerve was between 21 and 35 mm above the angle of the mandible (Table I).

Table I
Distance from the angle of the mandible to the bifurcation of the facial nerve

Distance in mm	Number (%)
11–15mm	3 (3.8%)
16–20mm	6 (7.6%)
21–25mm	12 (15.2%)
26–30mm	30 (38.0%)
31–35mm	22 (27.8%)
36–40mm	6 (7.6%)
Mean = 28.06mm	**Total = 79(100.0%)**

The branching and anastomosis patterns of the facial nerve (Fig 2).

The branching patterns of the facial nerve were classified according to the method introduced by Davis et al[4]; which is as follows:-

Type I : absence of an anastomosis between the temporofacial division and cervicofacial division.
Type II : anastomosis among the branches of the temporofacial division only.
Type III : single anastomosis among the branches of the temporofacial division and cervico-facial division.

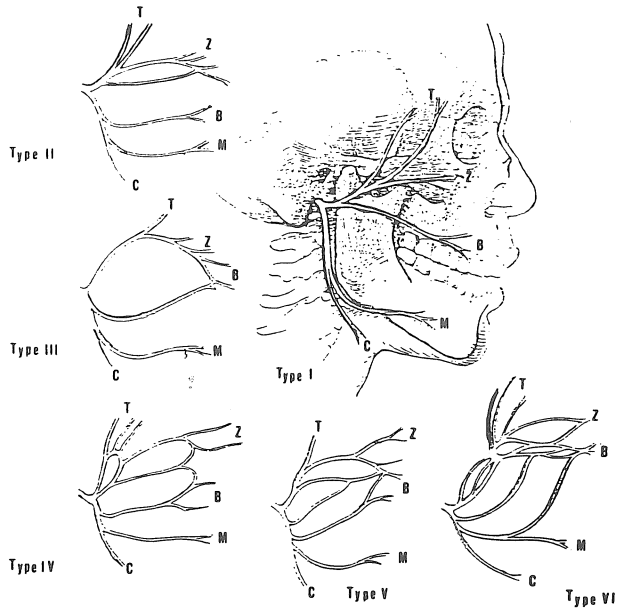

Fig. 2 :
Six basic types of the branching patern of the facial nerve according to the classification of Davis et al.

T : *temporal branch*
B : *buccal branch*
Z : *Zygomatic branch*

Type IV : combination of type II and III.
Type V : double anastomosis between the temporofacial division and cervicofacial division.
Type VI : complex multiple anastomosis between the two divisions, where the buccal branch receives many anastomotic fibres from the cervicofacial division and the mandibular branch.

As it was impossible to get the exact pattern of each type classified by Davis et al,[14] the closest pattern was taken for classification in the present study.

The branching pattern of 27 facial nerves (34.18%) were found to be of type III pattern, 15(18.98%) belonged to type IV, 12(15.19%) showed type II, 10(12.67%) were type VI, 9(11.39%) type I and 6(7.59%) followed type V (Table II).

The percentage of type III, the most common type, differs significantly from the rest of the types, except type IV. However, percentage of type V, the least common type, differs significantly only from type III and IV, the two most common types (Table II). In each type no significant difference was noted between left and right.

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The temporal branch

The temporal branch, the uppermost branch of the temporofacial division was seen crossing the superior border of the zygoma at the point where a vertical projection of the anterior temporal hairline descends to cross the zygoma. The temporal branch was noted in a gentle inclining curve across the temporal region, passing near the upper and outermost point of the eyebrow. In no instance did it pass more than 2 cm above this point.

Table II
Different types of branching pattern of facial nerve on each side, their total number and percentage

Type	Right	Left	Total	%	
I	4	5	9	11.39%	(e)
II	6	6	12	15.19%	(c)
III	15	12	27	34.18%	(a)
IV	8	7	15	18.98%	(b)
V	3	3	6	7.59%	(f)
VI	4	6	10	12.67%	(d)

'a' differs significantly from 'c – f' by $P < 0.003$.
'f' differs significantly from 'a' and 'b' by $P < 0.04$.

The mandibular branch

The mandibular branch was studied in sixty-eight facial halves. Posterior to the facial artery, about 20% that is eight (23.5%) on the right and six (17.6%) on the left of the mandibular branches were seen to pass below the inferior border of the mandible forming an arch, with its lowest point being 1 cm or less below this border.

Anterior to the facial artery, the location and the number of the mandibular branches innervating the mentalis and the depressor labii inferioris muscles were variable. The branches to the mentalis muscle were located below the inferior border of the mandible in almost all cases on both sides. However only a few of the branches innervating the depressor labii inferioris were below the mandible and many were seen above its lower border. Although most of the branches to the depressor angular oris were seen above the inferior border, infrequently they were found below it.

In 68 facial halves, the mandibular branch consisted of a single branch in 7 cases (20.4%) on the right side and 8 cases (23.3%) on the left, 2 major branches in 22 cases (64.1%) on the right side and 20 (58.2%) on left, 3 major branches in 3 cases (8.74%) on the right and 4 (11.7%) on the left and 4 major branches on each side in 2 cases (5.8%).

Discussion

To avoid injury to the facial nerve during parotid surgery one has to locate the point of bifurcation which is along the posterior border of the mandible; thus it is important to know the distance between the angle of the mandible and the bifurcation of the facial nerve.[11] Mean distance was found to be 28.06 mm (ranging from 11–40 mm) in the present study in Malaysian subjects, whereby 81.0% were between 21 to 33 mm from the angle of the mandible. The study in Caucasians by Mc Cormack et al.[9] showed that the range was from 14 to 46.9 mm with an average of 34 mm and that by Davis et al[4] ranged

from 25 to 45 mm with an average of 32 mm. However, in Koreans, Park and Lee[11] observed that the average distance was 28.8 mm and that the range was from 12.1 to 39.8 mm. Therefore, these showed that there is a significant variation even amongst the Caucasians. A longer distance between the bifurcation of the facial nerve and the angle of the mandible in Caucasians could be due to a larger stature, a bigger and stronger jaw or a combination of both factors in them when compared to Asians.

Trifurcation of the facial nerve trunk was found in three facial halves (3.8%) in the present study. Park and Lee[11] however reported 4.4% in their series. Thus, the surgeon should bear in mind that even after finding two main facial nerve trunks, a third minor trunk could still be present and exposed to injury.

In the present investigation of seventy-nine facial nerve dissections, six types of branching pattern is being presented to alert the surgeons that there are various branches and anastomosis of the facial nerve which they might encounter during parotid or facial surgery. Although most of the findings were classified into 6 types,[1,4,11] Katz & Catalano[7] reported five types, type I to type V only in their study (Table III).

Table III
The percentage of branching pattern of the facial nerve in Caucasian, Korean and Malaysian subjects

Type	Davies et. al. (1956)	Park & Lee (1977)	Bernstein & Nelson (1984)	Katz & Catalano (1987)	Present findings (1991)	P values
I	13%	6.3%	9%	24%	11.39%	*P<0.03
II	20%	13.5%	9%	14%	15.19%	NS
III	28%	33.4%	25%	44%	34.18%	NS
IV	24%	23.4%	19%	14%	18.98%	NS
V	9%	6.3%	22%#	3%	7.59%#	#P<0.01
VI	6%	17.1%	16%	0%+	12.67%+	+P<0.0006

NS = not significant.
P<0.05 = level of significance.

Type I, branching pattern, a classical pattern shown in most of the text books of anatomy[8,15] is in fact one of the least common patterns seen by most researchers. Although it is uncommon, it is clinically important since if any branch is sacrificed, there can be resultant paralysis of the muscles as there is no anastomosis between the branches.

Type II, the so-called zygomatic loop, allows for the possible sacrifice of the buccal division after the zygomatic branches have been removed as there is an additional buccal branch.

Type III, the so-called buccal loop, with a more extensive anastomosis to the buccal division, allows the surgeons a greater safety margin and fortunately it is the most common type reported in every study.[1,4,7,11]

Type IV, with multiple loops, comprised 18.9% of our series. It is within the range of other findings and found to be the second most common pattern. Due to the multiple loop anastomosis, Katz & Catalano [7] reported that there was a recovery of the lower lip paresis after the mandibular branch had been sacrificed because of the contribution from the buccal branch.

Type V, although showing an extensive anastomosis in the upper part of the face had no additional contribution to the mandibular branch. Thus, surgeons should take precaution in surgery of the mandibular region even though it is the least common pattern in most of the reports.

Type VI, had the most complicated pattern with an anastomosis between every branch except the cervical. It was found in 12.67% in Malaysian subjects which should be considered as within the range of the other findings.

Although there was no significant difference in percentage between the three most common types of the present study and those of the Caucasians, there exist significant difference in the remaining three uncommon types. However, no significant difference was noted between the present study and that of the Koreans (table III). This could be probably because of similar racial origin as many of the cadavers in this study were Orang Asli and of Chinese origin.

The temporal branch from the temporofacial division is one of the branches of the facial nerve most commonly damaged in plastic surgery due to the scant subcutaneous tissue protecting it.[3] To avoid such damage, the surgeon could outline the path of this branch on the skin before the operation. This nerve is found between two diverging lines starting from the earlobe. The anterior line is drawn to the lateral end of the eyebrow and the posterior line to the lateral end of the highest frontal crease. The frontalis branch of the superficial temporal artery at the level of the lateral border of the frontalis muscle which gives a descending branch to the muscle can be used as a guide as it usually coincides with the penetration of the nerve into the muscle.

The recent modification during face lift operations with incisions in the platysma put the terminal branches of the mandibular branch of the facial nerve lying below the mandible at risk. The incision of the platysma in such operations should be a few centimeters below the inferior border of the mandible. As most inferior terminal branches of the mandibular branch supply the mentalis muscle, lesion of these branches will not affect the lip. The branch above supplies the depressor labii inferioris and cutting this branch may not create a significant weakness of the lower lip. However, the higher branches supplying the depressor angular oris which infrequently lie below the mandible, if injured, may cause a weakness of the lower lip movements. This is very likely to happen because a greater number of the mandibular branches do not receive the anastomotic fibres from the buccal branch. The facial artery should be a good landmark for this nerve as the pulsations of this vessel can be readily palpated and be used as a guide for planning incisions in this region.

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