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Bony landmarks of the facial nerve trunk in a select kenyan population: a cadaveric study

Abstract

Background: Parotid gland surgery requires surgeons to have a thorough knowledge of the extracranial anatomy of the facial nerve (FN). Although several studies have documented the various bone landmarks with reference to the trunk of the facial nerve, data from the Black African population is scarce, hence the purpose of this study.

Methodology: This was a descriptive cross-sectional study. Twenty fresh cadavers (40FNs) were dissected during post- mortem examinations at the Kenyatta National Hospital in Nairobi, Kenya.

Data analysis and presentation: Descriptive analysis was done and presented using frequency diagrams, tables and graphs. Statistical tests included the Mann Whitney U, Wilcoxon signed rank, Spearman and Pearson coefficient frequency tests.

Results: Regarding the morphometric data of the FN, the length of the nerve was 16.14mm (+/- 3.28), the distance from the FN trunk to the tragar pointer (TP) was 9.87mm (SD+/- 2.41), tympanomastoid suture (TMS) 5.81mm (+/- 1.28), external auditory meatus (EAM) 15.64mm (+/- 2.74), posterior belly of the digastric muscle (PBDM) 8.09mm (+/-1.78), styloid process (SP) 16.48mm (+/- 5.47) and angle of the mandible 37.98 (+/- 4.45). The SP was missing in 9 (22.9%) of the hemifacial dissections.

Conclusion: In this study, the TMS and PBDM were the most accurate landmarks in the location of the FN trunk.

Keywords: bone landmarks; facial nerve; variations

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Introduction

The anatomy and variations of the FN are key in-patient diagnosis and management for clinicians and surgeons.[1,2] Various specialties, for example, craniofacial surgeons, otologists, maxillofacial surgeons, plastic, and neurosurgeons may need to explore and expose the trunk of the FN as it emerges from the stylomastoid foramen up to its furcation, a common site of injury.[3–9] The anatomic variability of the FN dictates the choice of surgical approach by the surgeon.[1,9] A detailed anatomy of the FN and caution is imperative to guard the integrity and function of the nerve, therefore, the surgeon ought to be comfortable with a variety of techniques in keeping with these variations.[2]

To aid in the identification of the FN, both soft tissue and bony landmarks have been suggested to assist surgeons intraoperatively.[2,8,10–16] Despite this, there remains a debate as to the most efficient method of tracking down the nerve.[3,9] The FN trunk has been studied in relation to the following landmarks: the PBDM, styloid process (SP), mastoid process (MP), tympanomastoid suture (TMS), tragar pointer (TP) and the bony ridge at the anteroinferior margin of the external auditory meatus (EAM).[13–15,17] It appears that the search is still on in looking for a more predictable landmark for identification of the FN as none of the ones already mentioned are more reliable than the others.[11–16,18,20,21] Nevertheless, bone landmarks are a more superior anatomical guide for locating the FN unlike soft tissue ones which show variability.[13] Previous surgery, scarring and distortion from tumors deforms soft tissue anatomy making it challenging to plan surgical access and procedures.[12]

Using a preauricular incision, the FN and its branches was outlined by Al Khayat and Bramley, in which no significant variations were noted with respect to age and gender.[19] Measurements were made from the FN to most used surgical indicators including the PBDM (5.5±-2.1mm), TP (6.9±-1.8mm), the junction between bone and the cartilaginous EAM (10.9±-1.7mm), and the TMS (2.5±-0.4mm). This data concluded that the TMS was the most reliable surgical landmark for identification of the main trunk of the FN.[11] Their study also showed statistical significance of the values between genders and the two bone landmarks, EAM and TMS. In females, the FN was farther away to landmarks previously reported.[11] Racial diversity may interpret the various cranial morphology but fails to elucidate all the other variations (differences in gender and laterality) in literature. A paucity of data exists in regards to bone landmarks such as: the angle of the mandible, SP, MP, and EAM with respect to their distance and location of the trunk of the FN.[22,23] The aim of this investigation was to record the variations and bridge the existing knowledge gap in a black population of cadavers at the Kenyatta National Hospital mortuary.

Material and methods

This was a descriptive cross-sectional study using a population of forty (40 sides = 20 cadavers), calculated using a formula proposed by Varkevisser et al.[24] The study was done at the Kenyatta National Hospital Mortuary which serves as the largest referral public hospital in Kenya, predominantly a black racial population. The Committee of the Kenyatta National Hospital/University of Nairobi Ethics granted study approval (P112/03/2014). Prior to all the autopsies', informed consent was obtained from the next of kin and documented. Only fresh cadavers that met the inclusion criteria were included. The exclusion criteria included cadavers which had malformations, injuries, or pathologies of the head and neck region. A routine standard coronal incision was used, followed by a mastoid-to-mastoid incision and an apron one along the cervical aspect of the neck. It is noteworthy, that these incisions are those used for routine autopsies and the resultant scars were cosmetic. Once the MP was identified and the parotid gland exposed, the dissection proceeded further to the TMS, EAM, and TP. These landmarks were used to identify the FN trunk as it exited from the stylomastoid foramen. A pair of dividers and flexitape were used to measure the distance between the FN trunk and these bone landmarks and subsequently transferred to a measuring ruler calibrated in millimeters. Intra- observer variability was assessed, measuring twice every fifth specimen. Incisions were sutured cosmetically. SPSS version 25.0 was used to code the data. Descriptive tests were used to present data using frequency diagrams and tables. Tests used to determine the significance between males and females, right and left FNs, included: the Student's t-test, Wilcoxon signed-rank, and Mann–Whitney U tests. Finally, for determining the dependent and independent variables, the Spearman rank order correlation and Pearson's product moment correlation were used, the significance was set at $p< 0.05$.

Results

Among the twenty fresh cadavers, 40 FN were dissected, among whom, 12 (60%) were male, while 8 (40%) females. The span of the FN at its exit point from the foramen as it bifurcated was 16.14 mm (+/- 3.28). The following were the measurements of the nerve with respect to the bone landmarks: the TP 9.87mm (+/- 2.41), TMS 5.81mm (+/- 1.28), EAM 15.64mm (+/- 2.74), PBDM 8.09 mm (+/- 1.78), SP 16.48mm (+/- 5.47), and angle of the mandible 37.98 mm (+/- 4.45). In 9 (22.9%) of the hemi-sections, the cranial SP was absent (Table 1). Morphometric data revealed a negligible distinction in the averages and standard deviation between the right and left sides. The average length of the FN trunk on the right was 16.15mm and on left, 16.13mm. The distance between the FN trunk and the angle of the mandible showed the largest dissimilarity in the average length of 36.95mm (SD=4.76) on the left and 39mm (3.96) on the right which was statistically significant (p=0.020). The independent sample t Test used to assess and analyze the outcomes between genders failed to show remarkable statistical significance in the length of the FN trunk and the distance measured from the various landmarks. As for the association between the left and right of the main trunk of the FN, the connection between the left and right of the FN trunk was ascertained which showed a (Spearman's ρ) positive correlation but, was not statistically significant (rs = 0.081, p =0.735). Pearson's r showed a positive correlation with statistical significance between the left and right sides in the length of the FN trunk and the following bone land marks (.000), TP 0(.003), TMS (0.000) EAM (0.000), SP (0.000), PDMS (0.003) and the angle of the mandible (0.001) (Table 2).

Table 1 Length of Facial nerve trunk and its distance to the landmarks.

	Statistics					
Variable	N	M	SEM	SD	Variance	Range
Length of trunk (mm)	40	16.14	.52	3.28	10.77	11.00
TP	40	9.87	.38	2.41	5.80	11.90
TMS	40	5.81	.20	1.28	1.64	6.00
EAM	40	15.64	.43	2.74	7.50	12.00
PBDM	40	8.09	.28	1.78	3.15	7.0
Styloid process	31	16.48	.98	5.47	29.98	22.50
Angle of mandible	40	37.98	.70	4.45	19.77	18.00

TP, tragal process; TMS, temporomastoid process; EAM, external auditory meatus; Posterior belly of digastric muscle (pbdm) to various landmarks (with sem with standard error of the mean, sd-standard deviation values, variance and range

Table 2 Descriptive statistics of the left and right sides of Facial nerve trunk to the landmarks SD Standard deviation

	Statistics						
Left Side					Right side		t-test
	N	M	SD	N	M	SD	P
Length of trunk (mm)	20	16.13	3.09	20	16.15	3.55	.965
TP	20	9.83	2.94	20	9.90	1.80	.893
TMS	20	5.75	1.26	20	5.88	1.33	.555
EAM	20	16.03	2.74	20	15.25	2.75	.088
PBDM	20	8.05	1.79	20	8.13	1.81	.830
Styloid process	15	16.20	5.52	16	16.75	5.60	.862
Angle of mandible	20	36.95	4.76	20	39.00	3.96	.020*

Discussion

The length of the FN trunk shows variation as documented by various authors and in this population the length was 16.15±(3.28) mm amidst the range recorded but more towards a longer span (Table 3).[18,25–31] The dissimilarities in the length of the FN trunk amongst the studies could be explained that some data was obtained from formalin fixed cadavers and others intraoperatively during parotidectomies. Data from the current study was from postmortems done on fresh cadavers, therefore, our values are representative and reliable. The accuracy of the length of the FN has a relevance during surgical anastomosis and nerve grafts. However, very few studies have shown racial dissimilarities in its length.[8,17,22,27]

Table 3 A comparison of the Facial Nerve trunk in various studies

Author	Length (mm)
Thanh N.V et al.[25]	22.4
Ekinci et al.[26]	22.4
Holt.[27]	21
Naidoo et al.[23]	20.4
Nishanthi et al.[28]	18.51
Kandari et al.[30]	18.51
Salame et al.[18]	16.44
This study	16.15
Khoa et al.[36]	14.1
Pather et al.[8]	14
Kwak et al.[1]	13
Dias et al., 2008	13
Dargent and duroux, 1946	13
Rodrigues 2009	10
Cannon et al.[31]	9.38

Various bony and soft tissue have been suggested for identification of the trunk of the FN. The bony landmarks appear to be more dependable due to their rigid anatomical location and the ease with which they can be identified intraoperatively.[12,23]

In this population, the length between the FN trunk and PBDM was 8.09 mm a distance shorter than that reported in a study done in cadavers in Pretoria but longer than the one done in Caucasians.[8,11] Al Qahtani et al. found the PBDM to have been on the second reliable landmark in locating the trunk of the FN ($\bar{x}$ distance of 9.03 ± 2.33mm).[32] However, the length varied from 6 to 12.5mm and it had the highest standard deviation amongst the rest of the landmarks (TMS, TP, EAC, MT).[32] On the other hand, most surgeons have expressed locating the PBDM with ease as it lies in the same position as the trunk and the nerve, so reports tend to vary amongst studies. Caution must be exercised intraoperatively during parotidectomy or other procedures when retracting since neck positioning may be susceptible to nerve distortion. Moreover, there is considerable variability in the attachment of the PBDM to the mastoid, which explains the reasons in its inconsistency and, therefore, the rationale why it may not be considered a reliable landmark.[11] The PBDM can be augmented by the TP in addition to the tympanomastoid suture (TMS) line to aid in identification of the FN trunk.[29]

The lower most medial projection of the cartilaginous TP anterior position and direction due to its mobility, asymmetry, and blunt irregular tip.[13] The span of the TP to FN trunk was noted to be have been 9.8±2.41mm, not the shortest reported of 6. 37mm so far, however higher distances of 34 mm have been recorded by other authors (Table 4).[9,31] Due to the blunt and wide angle of the TP various researchers use contrasting positions of reference for measurements and other authors have expressed that the TP may not always point to the nerve.[10,11,13] It is generally agreed the closer one remains to the tragus, the lesser chances of iatrogenic injury to the nerve.[32]

Table 4 Length of the facial nerve trunk to tp in various studies

Study	Trunk to TP(mm)
Saha et al.	16.61(14-21
Pather et al.[8]	34(24.3-49.2
Cannon et al.[31]	6.37(5.84-68)
Wong[17]	18.6±6
De Ru et al.[14]	8.4±6.
Rea et al.[11]	6.91.8
Current	9.87±2.41

TMS has an invariable location and is one of the most precise and accurate landmarks for locating the FNs has been documented by many authors.[34] The shortest distance between the FN and TMS recorded is 1.8mm. However, this reference is utilized mainly for intracranial or imaging diagnostic measurements.[32] In our study population, the TMS was found to have been 5.81mm from the trunk, well within similar values previously documented.[8,11,32,35] Literature reports the nerve lies within 2.5,6-8, 10 0.5-1mm, or 3mm medial or inferior to TMS. Some authors claim that the TMS is consistent and reliable, therefore, should be used as a bone landmark to identify the FN as it cannot be displaced easily. However, some authors have stated otherwise.[14,15]

The angle of the mandible is round and not sharp making it a challenging point to locate and measure. This landmark is crucial for two nerves namely, the marginal mandibular and cervical branches of the FN prone to injury during parotidectomies. This bony landmark is easy to locate and requires minimal surgical exposure. In addition, it has displayed reasonable reliability with respect to localization of the FN trunk.[23] The longest length recorded between the trunk and angle of the mandible is 50mm in a Caucasian population.[33] In our study, the length was 37.98mm, smaller compared to the Vietnamese and South Koreans. Unlike in the Asians reported to have a short length between the FN trunk and the angle of the mandible was 28.06mm (Table 5).[36–38] This could be attributed to the larger stature and larger mandibles of Caucasians in comparison to Asians, which may offer a probable explanation for the present group.[6,37] However, for this population, the measurements between the FN trunk and angle of the mandible showed dissimilarity with statistical significance perhaps a parameter inconsistent for the surgeon to intraoperatively.

Table 5 Comparison of the distance of the facial nerve trunk to the angle of the mandible amongst various populations

Population	Author	Range(x)mm
Malaysian	Myint et al.[37]	28.06
Kenyan	This study	37.98
Vietnamese	Thanv et al.[25]	38.66
Vietnamese	Khoa et al.[36]	40.8
South Korean	Park& lee et al.[6]	12.1-39.8(28.88)
Caucasian	McCormack et al.[38]	14-46.9(34)
South Africans	Pather et al.[8]	25.3-48.69(38.1)
North Americans	Dais et al.[4]	25-45(32)
South Korean	Naidoo et al.[23]	26-55.9(44)

The SP, a bone landmark, shows variability, both in length and curvature rendering it unreliable.[20] One of the most anatomically diverse landmarks is the SP. In a South African study the distance of the FN trunk to SP was recorded to have been 4.3-18.6 ($\bar{x}$ =9.8mm).[8,19] Comparatively, in the present study, it was observed to have an average of 16.48mm much longer in length. This is as expected because of unreliability of the SP, as was the observation in this population (22.5%) confirming its reputation for not measuring up as a landmark.[11] In 2022, the SP gained credibility as being a sturdy landmark in the Borle's triangle technique utilized for the location of the FN trunk with dexterity and precision during surgery of the parotid gland. A technique quite applicable in preserving the integrity of the facial nerve.[39,40] Makeieff et al. stated that although various landmarks have been documented, however, to pinpoint the FN trunk attributed to its unpredictable location makes it challenging to reach an agreement.[41]

Conclusion

In this study, the TMS and PBDM were the most accurate landmarks in the location of the FN trunk. The MP, SP, TP and PBDM can still be used with certainty using the triangle to assist in locating the facial nerve. It is incumbent upon the surgeon to use the information provided in order to be comfortable with swift and systematic dissection of the landmarks with accuracy that require exposure of the FN trunk.

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None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Author roles

Dr Butt: Research Study Concept and Manuscript preparation, Dr Thuku: Data Collection Prof Guthua : study supervisor, Prof Chindia Study Supervisor, Ms Shamim Butt: Data Interpretation and Manuscript Editing

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