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Morphology and variability of the facial nerve trunk depending on the branching pattern, gender, anthropometric type and side of the head in Moldovan population

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Background: *Knowledge concerning variability of the facial nerve trunk (FNT) direction after its exit through the stylomastoid foramen is of a great clinical significance for maxillofacial surgeons, otorhinolaryngologists, oncologists, specialists in plastic and aesthetic surgery. The aim of our study was to establish the variation of the FNT direction and its peculiarities depending on the branching pattern, gender, anthropometric type and side of the head.*

Materials and methods: *The direction of the FNT and its branching pattern were studied on 75 dissected hemifaces of adult formalised cadavers (59 male/ /16 female), and the morphometry of the FNT length, width and bifurcation angle was carried out.*

Results: *Seven branching patterns of the facial nerve were established: type I — 18.7%, type II — 14.7%, type III — 20%, type IV — 14.6%, type V — 5.3%, type VI — 18.7%, and type NI — 8% (bizarre types). The FNT had a descending direction in 73.3% of cases; ascending FNT — 9.3% (including 5.3% of very short diffuse branching trunks and 1.3% of arch-shaped FNT); horizontal FNT — 10.7%; number variants — 6.7%. The male/female ratio of the descending FNT was 69.5%/87.4%; ascending — 10.2%/6.3%; horizontal — 11.9%/6.3%; number variants — 8.4% (only in male). The right/left ratio of the descending FNT was 62.9%/82.5%; ascending — 11.4%/7.5%; horizontal — 11.4%/10%; number variants — 14.3% (only on the right side). The ratio of the descending FNT in mesocephalic type (MCT)/brachycephalic type (BCT)/dolichocephalic type (DCT) was respectively 70.6%/100%/66.7%; ascending — 12.1%/0%/0%; horizontal — 12.1/0%/11.1%. Numerical variants in MCT — 5.2%, in DCT — 22.2%. The mean number of FNT in MCT/BCT/DCT was respectively 1.07/1.0/1.22.*

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Conclusions: *Three main directions are characteristic of the FNT: the descending, ascending and horizontal ones, which vary depending on the branching pattern, gender, shape and side of the head.* (Folia Morphol 2023; 82, 4: 791–797)

Key words: facial nerve, branching types, variation, peculiarities, morphometry

INTRODUCTION

The facial nerve morphology, its variability and specific features are subject of interest of many researchers all over the world. Nevertheless, the majority of the published papers describe only the variability of the facial nerve branching types, its connections and topography of the parotid plexus towards neighbouring anatomical structures [1–4, 6, 8, 10–12]. Non-articles were found on the variability of the facial nerve trunk (FNT) direction depending on the gender, anthropometric type and side of the head, or branching pattern.

Taking into consideration that the rate of the parotid tumours, polytrauma with involvement of the head and neck regions, as well as the demand for plastic surgery and rejuvenating procedures have increased lately, it is imperative to have a new approach towards the facial nerve morphology.

The purpose of our study was to establish the direction and morphological peculiarities of the FNT depending on the branching pattern, gender, anthropometric type and side of the head.

MATERIALS AND METHODS

The variability and morphological peculiarities of the FNT were studied on 75 hemifaces of adult formalised cadavers (59 male/16 female) in the period 2014–2022. The direction, length, width, bifurcation angle, number variation of the FNT and branching pattern of the facial nerve were analysed.

Each cadaver was carefully examined on presence of any deformities or damages of the soft tissues of the face and only the hemifaces with intact soft tissues were used for our study.

Ahead of dissection, the longitudinal and transverse dimensions of each head were measured. The longitudinal dimension was measured between the glabella and opisthocranion and the transverse one between the right and left euryons.

The anthropometric type of the head was established according to the formula:

$$\frac{Transverse\ diameter \times 100}{Longitudinal\ diameter}$$

The male specimens were represented by 59 (78.7%) hemifaces, and the female ones by 16 (21.3%) hemifaces. The right side hemifaces constituted 40 (53.3%) samples and the left ones — 35 (46.7%). The male/female ratio of the right specimens was 82.9%/17.1% and those of the left — 75%/25%. In male individuals the ratio of the right/left hemifaces was 49.2%/50.8% and in female it was 37.5%/62.5%.

The majority of the dissected samples, 58 (77.3%) hemifaces, belonged to the mesocephalic type (MCT). The brachycephalic type (BCT) was represented by 8 (10.7%) hemifaces and the dolichocephalic type (DCT) included 9 (12%) hemifaces. The ratio of the male/female hemifaces depending on the anthropometric type of the head for MCT was 81.3%/62.5%, for BCT — 6.8%/25% and for DCT — 11.9%/12.5%. The right/left ratio of samples in MCT was 77.2%/77.5%, in BCT — 11.4%/10% and in DCT — 11.4%/12.5%.

The branching patterns of the facial nerve were determined according to Davis classification [2]. In our study, each of those six classical patterns of branching had an atypical subtype, but type III had two atypical subtypes. For a relevant statistical analysis each atypical subtype was added to the corresponding classical type of branching and all the uncommon types were included into the "type NI" (non-identified in the specialised literature types).

The quantitative and qualitative variables were analysed using the Microsoft Excel 2016 processing programme and methods of descriptive and inferential statistics.

The indicators of variability were calculated using the following formulas:

1. Standard deviation (*s*): function STDEV

$$s = \sqrt{\frac{\sum(X_i - \bar{X})^2}{n-1}} \quad (1)$$

where: $\sum$ — sum; X_i — individual value of the X variable; $\bar{X}$ — arithmetic mean; n — number of cases.

2. Coefficient of variation (CV):

$$CV = \frac{s}{\bar{X}} \quad (2)$$

where: s — standard deviation; $\overline{X}$ — arithmetic mean; CV ≤ 10% homogenous population; 10% < CV ≤ 20% relatively homogenous population; 20% < CV ≤ 30% relatively heterogeneous population; 30% < CV heterogeneous population.

For the arithmetic mean of the quantitative variables the confidence interval (CI_{95}), with a safety level (p) of 0.95 and significance level (α) of 0.05 was calculated.

$$CI_{95} = \bar{X} \pm z \times SE \quad (3)$$

where: $\overline{X}$ — arithmetic mean; z — value for a confidence interval of 95% (equal to 1.96); SE — standard average error.

$$SE = \frac{s}{\sqrt{n}} \quad (4)$$

where: s — standard deviation; n — number of cases.

For that purpose the predefined Excel CONFIDENCE function was used, that determines the confidence interval $z \times SE$.

To compare the observed frequencies with the estimated frequencies the analysis of the qualitative variables frequency was performed using the non-parametric χ^2 test.

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e} \quad (5)$$

where: $\sum$ — sum; f_o — observed value; f_e — estimated value.

The measures of location were calculated using QUARTILE function: the first quartile (Q_1); the second quartile (Q_2); the third quartile (Q_3); the interquartile range (IQR): $Q_3 - Q_1$.

For distribution of the variables and symmetry measurement, the predefined Excel SKEW function was used.

$$\alpha = \frac{\sum_{i=1}^{n} \left(\frac{X_i - \bar{X}}{s}\right)^3}{n} \quad (6)$$

where: $\sum$ — sum; X_i — individual value of the X variable; $\overline{X}$ — arithmetic mean; s — standard deviation; n — number of cases; $\alpha = 0$ symmetric distribution; $\alpha < 0$ distribution with the tail to the right; $\alpha > 0$ distribution with the tail to the left.

In order to analyse the dispersion, the one-way ANOVA for comparing the means of three or more independent samples was used.

By the callipers were measured the length and width of the FNT and by a protractor was measured the degree of its bifurcation angle. All the measurement have been taken by the same observer.

Table 1. The mean values of the dimensions of the head depending on the gender

	Length of the head [mm]	Width of the head [mm]	Cephalic index
Male	195.5	150.3	76.9
Female	188.0	147.2	78.3
Difference	7.5	3.1	–1.4
P	0.000	0.001	0.004

Ethical consideration

The cadavers belonged to the Department of Anatomy and Clinical Anatomy of Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova.

The protocol for the research project has been approved by the Ethics Committee of Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova (minute No. 1 of 19.09.2014), and it was conducted at the Department of Anatomy and Clinical anatomy in full accordance with the Declaration of Helsinki.

RESULTS

The mean length (mm) of the heads for MCT was 194.21 ± 4.85, for BCT — 189.28 ± 4.42 and for DCT — 195.71 ± 4.01, statistically significant, p = 0.01.

In MCT the mean width (mm) of the heads was 149.91 ± 2.83, in BCT — 152.30 ± 3.22 and in DCT — 145.41 ± 3.00, highly statistically significant, p < 0.000.

The cephalic index in mesocephalic individuals had a mean value of 77.2097 ± 1.03, in brachycephalic people — 80.4674 ± 0.28 and in dolichocephalic ones — 74.3004 ± 0.53, and a very high statistical significance was established, p < 0.0000.

A significant difference in the mean values of the head dimensions depending on the gender was established for all the variables (Table 1).

Seven branching patterns of the facial nerve were established. Type I was determined in 18.7%, type II — 14.7%, type III — 20%, type IV — 14.6%, type V — 5.3%, type VI — 18.7%, and type NI — 8%. The male/female ratio of the branching pattern for type I was 20.3%/12.5%, type II — 10.2%/31.3%, type III — 23.7%/6.3%, type IV — 13.6%/18.8%, type V — 5.1%/6.3%, type VI — 16.9%/25.0% and type NI was present only in male with a rate of 10.2%, p = 0.48.

For our purpose, the extratemporal part of the facial nerve was divided into three segments: the premandibular (FNT and its primary divisions), intrap-

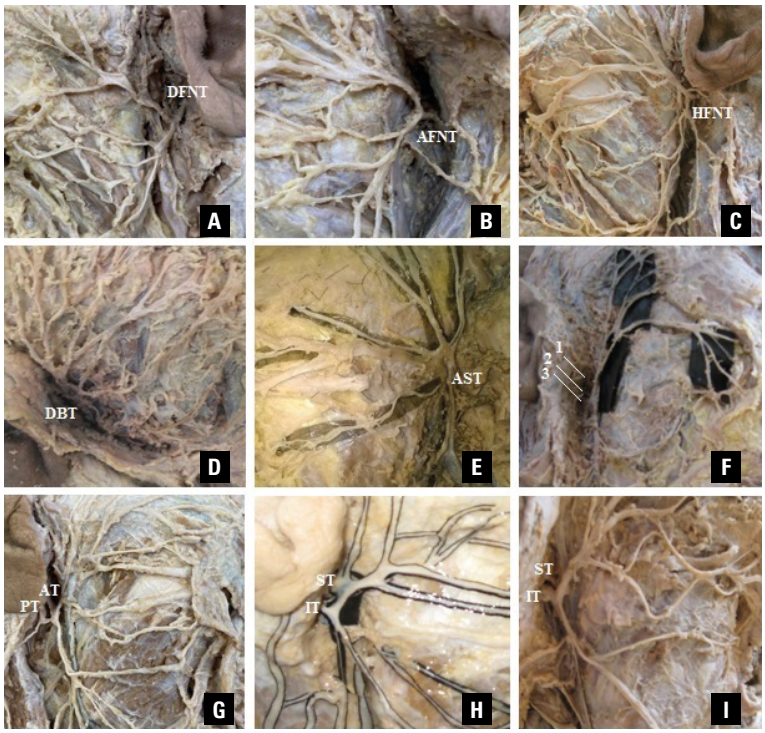

Figure 1. Morphological variability of the facial nerve trunk on the premandibular segment; **A.** Descending facial nerve trunk (DFNT); **B.** Ascending facial nerve trunk (AFNT); **C.** Horizontal facial nerve trunk (HFNT); **D.** Very short diffuse branching trunk (DBT); **E.** Arch-shaped trunk (AST); **F.** Triple trunk; 1 — superior trunk; 2 — middle trunk; 3 — inferior trunk; **G, H, I.** Double trunk; AT — anterior trunk; PT — posterior trunk; ST — superior trunk; IT — inferior trunk.

arotid (parotid plexus within the parotid gland) and postparotid (terminal divisions of the parotid plexus).

A range of peculiarities concerning FNT direction, number, length, width and angle of bifurcation were identified on the premandibular segment of the facial nerve.

Three main directions of the FNT were established: the descending, ascending and horizontal ones. The descending direction was marked out in 73.3%, the ascending one — in 9.3% and the horizontal — in 10.7%. Among the ascending FNT in 5.3% were determined very short diffuse branching trunks and in 1.3% an arch-shaped trunk was found (Fig. 1).

All the directions of the FNT were characteristic of both male and female. The descending FNT had a male/female ratio of 69.5%/87.4%, the ascending — 10.2%/6.3% and the horizontal one — 11.9%/6.3%. Number variants constituted 8.4% and were found only in male.

The right/left ratio of the descending FNT was 62.9%/82.5%; ascending — 11.4%/7.5%; horizontal — 11.4%/10%, and in 14.3%, only on the right hemifaces, were determined numerical variants.

Depending on the anthropometric type of the head, only in MCT were identified all the directions of the FNT. Thus, descending FNT was pointed out in 70.6%, and each of the ascending and horizontal positions were revealed in 12.1%. Numerical variants were found in 5.2% (Fig. 1).

In brachycephalic individuals only the descending direction of the FNT was established. In dolichocephalic individuals the descending FNT was present in 66.7% of cases, in 11.1% it had a horizontal position, and no ascending FNTs were found. Number variants were determined in 22.2%. The χ^2 test for FNT direction depending on the anthropometric type of the head was not statistically significant, $p = 0.25$.

The mean length of the FNT in male was 11.3 mm (5–21 mm) and in female — 10.4 mm (5–16 mm), $p = 0.289$. A similar mean length of 11.1 mm was determined for both right (5–18 mm) and left (5–21 mm) hemifaces, $p = 0.981$. In mesocephalic individuals the mean length (mm) of the FNT was 10.9 ± 2.87, in brachycephalic individuals — 12.3 ± 3.54 and in dolichocephalic ones — 10.9 ± 2.54, $p = 0.474$. The mean length (mm) of the FNT depending on the branching pattern for type I was 12.21 ± 3.33, type II — 11.00 ± 2.54, type III — 11.33 ± 2.93, type IV — 10.27 ± 3.85, type V — 11.50 ± 2.08, type VI — 10.07 ± 2.06 and type NI — 11.50 ± 3.11, $p = 0.578$.

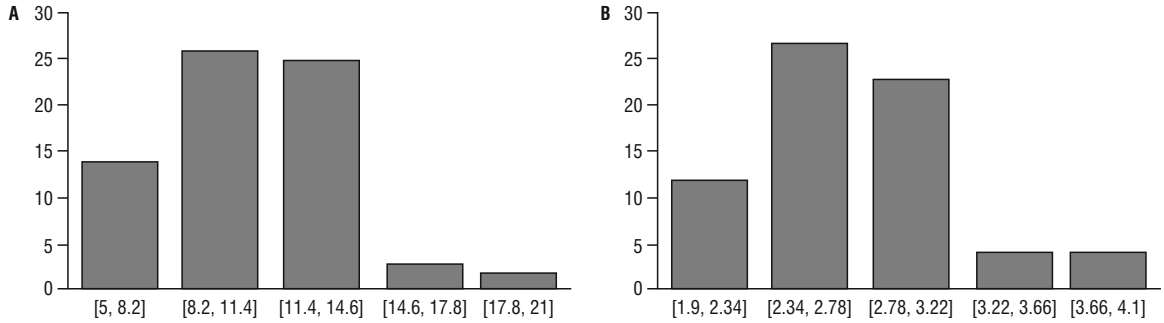

Figure 2. Curves of the central tendency and frequency distribution of the facial nerve trunk length (**A**) and width (**B**).

The mean width of the FNT was 2.7 mm for both male (1.9–4.1 mm) and female (1.9–3.8 mm) cadavers, p = 0.629. The same mean value of 2.7 mm of the FNT width was established for both right (1.9–4.0 mm) and left (1.9–4.1 mm) hemifaces, p = 0.868. The width of the FNT was variable depending on the anthropometric type of the head. In MCT the mean width (mm) was 2.75 ± 0.49, in BCT — 2.81 ± 0.42, and in DCT — 2.40 ± 0.24, p = 0.151. Depending on the branching pattern the mean width (mm) of the FNT varied as follows: type I — 2.71 ± 0.49, type II — 2.64 ± ± 0.37, type III — 2.70 ± 0.31, type IV — 2.82 ± 0.55, type V — 2.75 ± 0.34, type VI — 2.71 ± 0.57 and type NI — 2.95 ± 0.80, p = 0.950.

The curves of the central tendency and frequency of the FNT length and width distribution showed an asymmetry with the tail to the right (Fig. 2).

The mean value of the FNT bifurcation angle in male was 120.3° (40–180°) and in female — 142.7° (92–180°), statistically significant, p = 0.050. The right/left ratio of the mean bifurcation angle was 127.4° (40–180°)/121.2° (74–180°), p = 0.483. In MCT the bifurcation angle had a mean of 124.98° ± ± 34.17, in BCT — 119.14° ± 41.37, and in DCT — 123.89° ± 35.83, p = 0.919. The bifurcation angle was statistically significant depending on the branching pattern, p = 0.005 (Table 2).

The bifurcation of the FNT was determined in 84% of cases, the trifurcation in 6.6%, the quadrifurcation in 2.7%, the pentafurcation in 4%, and the hexafurcation in 2.7%. In all the cases of the FNT numerical variation, the trunks were connected to each other and then bifurcated.

The numerical variants of the FNT were represented by double trunk in 5.3% and triple trunk in 1.3% (Fig. 1). The mean value of the FNT number variation was 1.1 FNT, p = 0.261. On the right side the mean was 1.2 FNT, and on the left — 1.0 FNT, p = 0.019.

Table 2. Angle of the facial nerve trunk bifurcation depending on the facial nerve branching pattern

Type of branching	Mean value ± standard deviation [°]	Mean value ± 95% confidence interval [°]
Type I	103.7 ± 23.67	103.7 ± 13.39
Type II	156.8 ± 29.24	156.8 ± 17.28
Type III	125.4 ± 37.97	125.4 ± 21.49
Type IV	108.7 ± 25.78	108.7 ± 15.98
Type V	135.7 ± 22.50	135.7 ± 25.46
Type VI	118.5 ± 35.03	118.5 ± 20.70
Type NI	135.4 ± 36.16	135.4 ± 31.70

Depending on the anthropometrical type of the head the mean number of the FNT in MCT was 1.07 ± ± 0.32, in BCT — 1.00 ± 0.00, and in DCT — 1.22 ± ± 0.44, p = 0.311. Depending on the branching pattern the mean value of the FNT number for types I, IV, V and VI was 1.00 ± 0.00, and for the types II, III and type NI were established the following mean values: type II — 1.09 ± 0.30, type III — 1.20 ± 0.56, type NI — 1.33 ± 0.52, p = 0.192.

DISCUSSION

The majority of papers that concern the facial nerve branching pattern are based on 6 types reported by Davis et al. [2]. Nevertheless, the branching pattern of the facial nerve includes a wider range of variation, thus, Pitanguy et al. [14] and Stankevicius et al. [18] have identified 8 branching patterns, 11 types were described by Kopuz et al. [8] and 12 types were established by Martínez Pascual et al. [10]. In the current study 14 types were determined, including atypical ones, initially classified as intermediate types [1], but finally redistributed and reclassified into 7 types.

Three main directions of the FNT were established in the current study and according to our observation

they depended on variation of the mastoid segment of the facial canal, but it is not excluded, that those variants may even depend on variability of the stylomastoid foramen [5].

According to different sources, the length of the FNT is variable, thus, Wilhelmi et al. [20] reported a length between 5–15 mm, Kwak et al. [9] — 13.0 ± ± 2.8 mm, Khoa et al. [7] — 14.1 mm, Salame et al. [16] — 16.44 ± 3.2 mm, and the highest mean value of 17.0 ± 4.54 mm was established by Pacheco-Ojeda et al. [13]. In our study the mean length of the FNT was 11.1 ± 0.7 mm.

The width of the FNT is also variable. According to Martínez Pascual et al. [10] the width is 2.16 ± ± 0.49 mm, Khoa et al. [7] reported 2.5 mm and Salame et al. [16] 2.66 ± 0.55 mm. In the current study the mean width was 2.7 ± 0.1 mm.

Usually the FNT bifurcates into the temporofacial and the cervicofacial divisions [6, 10, 17]. Khoa et al. [7] obtained an angle of the FNT bifurcation of 91.2°. In our study the mean value in male was 120.3° and in female 142.7°, $p = 0.050$.

In some cases a trifurcation, or even multifurcation of the FNT is found [7–9, 12, 18, 19]. The reported incidence of the FNT bifurcation is about 80%, the trifurcation — 14% and numerical variants are found in 6% of cases [8, 18, 19]. In the current study the bifurcation of the FNT was established in 84% of cases (including 6.7% of number variation), trifurcation was established in 6.6% and multifurcation in 9.4% of cases. In cases of the facial canal dehiscence a double or triple FNT is present [8, 15, 19].

CONCLUSIONS

Three directions were characteristic of the FNT: descending, ascending and horizontal ones. The descending FNT prevailed in female with a male/female ratio of 0.79:1. The ascending and horizontal directions of the FNT were higher in male individuals. For the ascending FNT the male/female ratio was 1.62:1, and for the horizontal one — 1.89:1. The highest rate of the FNT direction variability was characteristic of MCT and the lowest one for BCT. The descending FNT prevailed in all the anthropometric types. The length of the FNT was variable on all the examined criteria. The width of the FNT was the same for both genders and both sides of the head, but variable depending on the anthropometric type of the head and branching pattern. The angle of bifurcation was higher in female cadavers; on the right hemifaces; in MCT and in individuals with type II branching pattern. The numerical variants were found only in male cadavers and only on the right hemifaces, but they were variable dependent on the anthropometric type of the head and pattern of branching.

Conflict of interest: None declared

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