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Topographic methods to expose the exiting points of supratrochlear, supraorbital, and zygomaticotemporal nerves

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Background/aim: We evaluated the relations of the exiting points of supratrochlear (STN), supraorbital (SON), and zygomaticotemporal (ZTN) nerves with certain landmarks to provide improved anatomic knowledge.

Materials and methods: The twenty-eight hemifaces of 5 fresh frozen and 11 embalmed heads (5 female and 11 male cadavers) were dissected. Distance and angular measurements were made between the exiting points of the nerves to the midline, lateral, and medial canthi. Comparisons of side, sex, and cadaver groups were evaluated.

Results: Mean values were determined for all parameters. There was no difference between side measurements. There were significant differences between sexes and cadaver groups regarding STN and lateral canthus in both sides. The angle of the ZTN to the lateral canthus was found to be higher in embalmed cadavers than in fresh frozen ones.

Conclusion: This study is the first to supply both distance and angular measurements to reach the exact locations of the nerves. Quantitative and topographic information about the localizations of the STN, SON, and ZTN is crucial for forehead lifting and migraine treatment, as well as for injection and local surgical interventions.

Key words: Supraorbital nerve, supratrochlear nerve, zygomaticotemporal nerve, angular measurement, cadaver

1. Introduction

Supratrochlear (STN) and supraorbital (SON) nerves are the terminal branches of the frontal nerve. The STN courses in the roof of the orbit and exits between the supraorbital foramen and the trochlea at the frontal notch. The SON exits from the supraorbital notch or foramen (1). These nerves supply the conjunctiva, the upper eyelid, the mucosa of the glabella, and the skin of the lower forehead close to the midsagittal line (1–4). The zygomaticotemporal nerve (ZTN) is the terminal branch of the maxillary nerve. It passes through the temporal bone, pierces the temporalis and temporal fasciae, and innervates the skin over the temple (1,5–8).

Knowledge of the localizations of the STN, SON, and ZTN nerves is crucial for botulinum toxin and topiramate injections and for ophthalmologic and facial plastic surgeries, particularly in forehead and brow lifts and for frontal sinus and cancer surgeries (2,9–14). In recent years, migraine surgery, defined by Bahman Guyuron in 2000, has received wide attention and has been frequently used (3–5,15,16). Migraine surgery comprises decompression and avulsion of the peripheral nerves (frontal, temporal, nasal, and occipital sites), which are believed to be the trigger points of migraines (3–8,16,17). In these procedures, the exact localization of these nerves becomes crucial. This study was designed to provide detailed anatomic knowledge of the exiting points of the STN, SON, and ZTN nerves preoperatively for relevant surgeries.

2. Materials and methods

The study was conducted on the 28 hemifaces of 5 fresh frozen and 11 embalmed heads of 5 female and 11 male cadavers with no visible external abnormalities on their faces. The age of the cadavers was between 35 and 94 years. These cadavers were obtained from the collection of the Department of Anatomy of Mersin University. All procedures were performed according to the Helsinki Declaration of 1964.

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An incision was first made between the two temporal regions passing through the anterior hairline. The incisions were extended to the tragus on each side. The forehead scalp was deviated to the supraorbital lines. Cheek skin was then dissected and reflected downward.

The landmarks for the region of interest were determined as follows: deep to corrugator supercilii muscle and supraorbital and supratrochlear foramina/notches were identified first. The exit point of the ZTN, which courses superficially over the zygomatic arch and proceeds toward the lateral canthus, was examined. The exit points of the STN, SON, and ZTN were marked with pins. The midline was accepted as the line connecting the midpoints of the glabella and the nasal base. The horizontal line connecting the lateral and medial canthi was also determined (Xline). Measured distances and angles were as follows:

- The distances from the exit point of the STN to the midline, medial canthus, and lateral canthus (Figure 1).
- The distance between the exit point of the SON and the midline (Figure 1).
- The distance between the perpendicular lines passing through the exit points of the STN and SON.
- The distance between the exit point of the ZTN and the lateral canthus (Figure 1).
- The angle between the two lines: one connecting the exit point of the STN to the lateral canthus and the Xline. Similarly, the angle between the other two lines: one connecting the exit point of the SON to the lateral canthus and the Xline (Figure 1).
- The angle between the two lines: one connecting the exit point of the STN to the medial canthus and the Xline. Similarly, the angle between the other two lines: one connecting the exit point of the SON to the medial canthus and the Xline (Figure 1).
- The angle of intersection between the line coursing from the exit point of the ZTN to the lateral canthus and the Xline (Figures 1 and 2).

A digital caliper was used for distance measurements and a goniometer was used for angle measurements.

2.1. Statistics

A Shapiro–Wilk test was used to control the normality of the continuous measurements. Continuous variables were expressed by mean, standard deviation, and minimum–maximum values. An independent samples t-test was used for group comparisons of sex and fresh frozen/embalmed cadavers. The paired sample t-test was used to compare sides. SPSS 11.5 was used for data analyses, and $P < 0.05$ was accepted as significant.

3. Results

The mean and standard deviations of the measured parameters are given in Table 1. Comparisons were made between data obtained from the side measurements of the same cadaver, sex, and fresh frozen/embalmed cadavers.

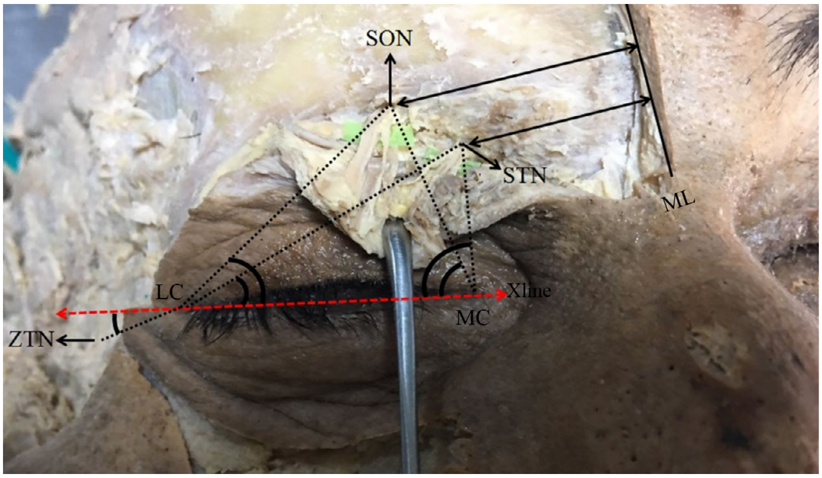

Figure 1. Photograph showing measured parameters related to certain landmarks.
Distances between the exit point of the STN to the midline, medial canthus, and lateral canthus.
Distance between the exit point of the SON and the midline; distance between the exit point of the ZTN and the lateral canthus.
Angles of the STN and the SON to the lateral canthus; angles of the STN and SON to the medial canthus; and ZTN to the lateral canthus.
STN: Supratrochlear nerve; SON: supraorbital nerve; ZTN: zygomaticotemporal nerve; ML: midline; LC: lateral canthus; MC: medial canthus.

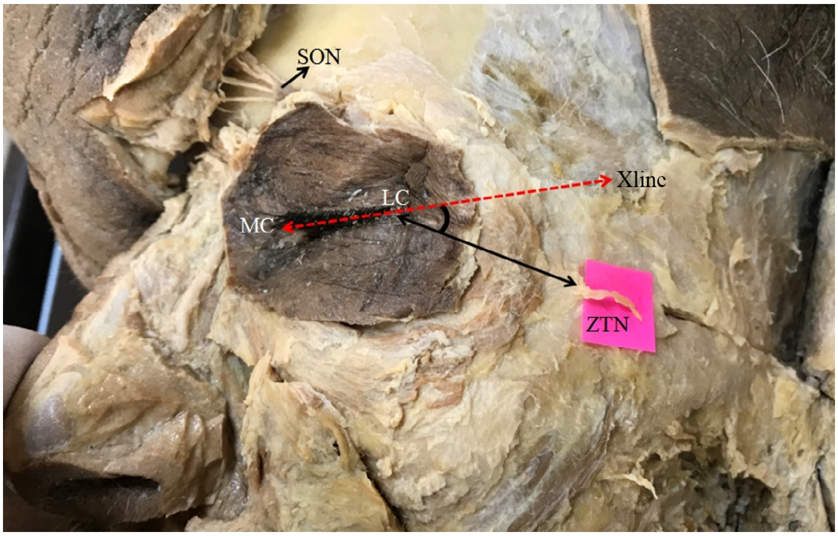

Figure 2. Photograph showing topographic measurements of the ZTN to certain landmarks.
Angle of the ZTN to the lateral canthus and the Xline; distance between the ZTN and lateral canthus.
SON: Supraorbital nerve; ZTN: zygomaticotemporal nerve; LC: lateral canthus; MC: medial canthus.

Table 1. Location of supraorbital, supratrochlear, and zygomaticotemporal nerves related to landmarks.

	Mean ± SD (mm)	Min–max (mm)
STN-mid-dis	17.36 ± 3.26	11.76–24.63
STN-lc-dis	36.23 ± 4.02	26.50–42.60
STN-lc-ang	26.25 ± 7.55	17.00–46.00
STN-mc-dis	18.60 ± 3.36	14.00–29.12
STN-mc-ang	85.42 ± 9.83	62.00–97.00
SON-mid-dis	26.04 ± 3.74	19.27–35.90
SON-lc-ang	43.50 ± 6.27	30.00–62.00
SON-mc-ang	65.28 ± 10.45	24.00–91.00
STN-SON-dis	9.24 ± 3.92	0.90–19.30
ZTN-lc-dis	23.81 ± 4.81	15.50–32.81
ZTN-lc-ang	29.47 ± 4.22	23.80–39.00

STN: Supratrochlear nerve; SON: supraorbital nerve; ZTN: zygomaticotemporal nerve; mid: midline; lc: lateral canthus; mc: medial canthus; dis: distance, ang: angle.

There were no statistically significant differences between the data, except those given in Table 2.

4. Discussion

The STN, SON, and ZTN are branches of the trigeminal nerve, which are characterized by sensory innervation of the frontal and anterotemporal parts of the face. In Botox injections, surgical treatment of migraine, and blepharoplasty surgery, determining the localization of relevant neurovascular bundles composes the basis of treatment. Many methods, such as three-dimensional computed tomography and magnetic resonance imaging, have been used to expose the exiting points of these nerves. It is known to be important that angle measurement are

Table 2. Comparison of certain parameters between sexes and cadaver groups.

	Mean ± SD (mm)	Min–max (mm)	Mean ± SD (mm)	Min–max (mm)	P
	Male		Female		
STN-lc-dis-L	37.47 ± 3.06	31.10–41.16	32.99 ± 4.86	26.50–38.39	0.047
STN-lc-dis-R	38.22 ± 2.63	33.23–42.60	32.69 ± 4.01	29.40–38.20	0.012
	Embalmed cadaver		Fresh frozen cadaver		
STN-lc-ang-L	32.30 ± 7.21	22.00–46.00	19.40 ± 2.60	18.00–24.00	0.002
STN-lc-ang-R	27.25 ± 4.52	23.00–33.00	19.40 ± 3.78	17.00–26.00	0.008
STN-mc-ang-L	80.80 ± 9.76	65.00–93.00	92.60 ± 4.27	85.00–95.00	0.006
ZTN-ang-R	35.50 ± 3.53	33.00–38.00	27.48 ± 2.79	23.80–31.20	0.023

STN: Supratrochlear nerve; ZTN: zygomaticotemporal nerve; lc: lateral canthus; mc: medial canthus; dis: distance; ang: angle; L: left; R: right; P: significance value.

required to determine the coordinate of the structures, in addition to distance measurements. Although the exit points of these nerves to several landmarks have been mentioned in the literature, this study is the first to combine distance and angle measurements to get objective results. Similar methods have been used to determine anatomic localizations of terminal branches of the facial nerves, the hypoglossal nerve, and the infraorbital and mental branches of the trigeminal nerve (18–21). The Pitanguy line reveals the topographical course of the frontal branch of the facial nerve (21). In face lifting procedures, the fascia around the region specifically gets complicated above the zygomatic zone; thus, precise knowledge of the nerve's exiting point is of utmost importance for surgeons in order to avoid iatrogenic injuries. The possible exiting points of the STN and SON should be well known when entering the forehead in endoscopic forehead lifting. Damage to the STN and SON may result in insensibility in the skin of the forehead or tingling and itching (22). Growing neuroma has also been reported after peripheral nerve injury (23–25).

The distance between the exiting point of the STN and the midline was reported in previous studies as 0.866 ± 0.103 cm (10), 1.6 to 2.3 cm (26), and 0.85 to 2.67 cm (2). The distance was found to be 1.74 ± 0.32 cm in the present study. No statistically significant sex, side, or cadaver group difference was found for that distance. Distances from the STN to the medial and lateral canthi are mentioned for the first time in the present study. We found a statistically significant difference between female and male cadavers regarding the distance between the STN and the lateral canthus. In male cadavers, this distance was longer than in female cadavers on both sides ($P < 0.05$). Considering this significant difference in males may be critical during surgery on the STN.

In the present study, the distance of the SON to the midline was found as 2.60 ± 0.4 cm, and this is compatible with previous studies, which reported a range of 1.93 ± 0.21 to 3.2 cm (4,10,11,20,27). There was no difference between sexes, sides, or cadaver groups. However, in the study conducted by Cheng et al. in the Chinese population (27), the distance to the midline was found to be larger in men. The distance between the STN and SON at the supraorbital rim was also reported as 1.06 ± 0.10 cm (10), 0.75 ± 0.23 cm (2), and a mean of 1.53 cm (14), which are similar to our finding of 0.92 ± 0.39 cm.

The ZTN is reported to be the least studied peripheral nerve in the literature (5,7). Avulsion neurectomy and decompression of the ZTN has been reported to be equally effective on migraine headaches (7,28). Its location is important for botulinum toxin injections. Totonchi et al. reported the distance between its exit and the lateral canthus to be between 12 and 31 mm (6), compatible with our result of 23.81 ± 4.81 mm. The angle between the exit point and the lateral canthus may provide extra anatomic knowledge about its location.

We have not encountered any data about angle measurements regarding these nerves in the literature. As a new approach, not only directional distance but also angle measurements were evaluated in this study. Both measurements will show the exact location of the nerve exiting point. It was determined that the difference was remarkable in the angle between the STN and lateral canthus on both sides ($P < 0.05$). The angular differences in cadaver groups are probably due to the effects of the fixating solution.

In conclusion, this anatomic study aimed to provide quantitative and topographic information about the localizations of the STN, SON, and ZTN. The data may be helpful particularly for migraine treatment, but also for injection procedures and local surgical interventions.

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