Int. J. Morphol.,
43(5):1612-1618, 2025.

Cadaveric Anatomical Study of the Supraorbital and Supratrochlear Nerve

Estudio Anatómico Cadavérico del Nervio Supraorbitario y Supratroclear

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HERNÁNDEZ, C. J. M.; AREVALO, A. A. & CABRERA, F. J. A. Cadaveric anatomical study of the supraorbital and supratrochlear nerve. *Int. J. Morphol., 43(5)*:1612-1618, 2025.

SUMMARY: The objective of this study was to characterize key anatomical aspects of the supraorbital nerve (SON) and supratrochlear nerve (STN), including their emergence patterns, relationship with the corrugator muscle, and topographic variables, aiming to provide useful references for clinical and surgical procedures in the fronto-orbital region. A descriptive study was conducted on 20 formalin-fixed adult cadaveric hemifaces. The SON and STN were dissected, and data were collected on their emergence patterns, number of terminal branches, relationship with the corrugator supercilii muscle, and foramen diameter (when present). Additionally, 20 dry skulls were analyzed to identify the emergence pattern of the SON and measure its distance from vertical and horizontal lines based on the nasion. The SON emerged through a notch in 55 %, through a foramen in 30 %, and exhibited anatomical variants in 15 % of cases. For the STN, notches predominated (72.20 %). The most frequent pathway was above the corrugator supercilii muscle for the SON and through the muscle for the STN. The SON had an average of 3–4 branches per side, and the STN, 2 branches. In dry skulls, the SON was located 7 mm from the vertical line and 26 mm from the horizontal line. The findings highlight relevant anatomical variability and provide useful references for surgical and anesthetic procedures in an understudied population.

KEY WORDS: Supraorbital Nerve; Supratrochlear Nerve; Cadaver; Anatomy.

INTRODUCTION

The supraorbital and supratrochlear nerves are the two terminal branches of the frontal nerve, which itself is a terminal branch of the ophthalmic nerve—the first division of the trigeminal nerve. Both nerves provide sensory innervation to the conjunctiva, the upper eyelid, and the skin of the frontal region.

The supraorbital nerve (SON) and the supratrochlear nerve (STN) have been identified as frequent sites of peripheral nerve compression involved in refractory migraine, which has led to the development of surgical decompression techniques (Chepla *et al*., 2012; Mangialardi, 2020), and more recently, neurostimulation therapies as complementary treatment options for this patient group (Vaisman *et al*., 2012; Reed *et al*., 2015). These approaches aim to release the peripheral sensory branches of these nerves, which are considered potential triggers of migraine pain.

On the other hand, the course and anatomical relationships of the SON and STN are of particular importance in surgical approaches to the orbitofrontal region—such as brow lifts or blepharoplasties in plastic surgery (Gil *et al*., 2017), transorbital access to the anterior cranial fossa in neurosurgery (Morrison *et al*., 2023; Plou *et al*., 2024; Zaid, 2021), as well as in anesthetic blocks involved in such procedures (Vaisman *et al*. 2012), and in corneal neurotization techniques used in ophthalmology to treat neurotrophic keratopathy (Kikuta *et al*., 2020). In all these contexts, proper identification of these nerves is essential to prevent postoperative pain, dysesthesias, or even functional complications. It is also worth noting the increasing use of endoscopic approaches, which demand even more precise anatomical knowledge due to the reduced surgical field and proximity to critical neurovascular structures (Filipovic *et al*., 2017, 2018; Kim *et al*., 2023).

Classical anatomy has established the mid-pupillary line as a reliable landmark for topographing the emergence point of the supraorbital nerve (Cuzalina & Holmes, 2005). However, considerable interindividual anatomical variability observed in the frontoorbital region has

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Received: 2025-06-02 Accepted: 2025-08-27

motivated recent studies aimed at refining and complementing anatomical knowledge of this area, enabling more precise and reproducible characterization. This contributes to improving the safety and effectiveness of surgical and anesthetic procedures involving this nerve. In this regard, detailed knowledge of the anatomy of the SON and the STN is essential for both surgical planning and the safe and effective execution of various procedures in fields such as neurosurgery, plastic surgery, and orbitofacial surgery, as mentioned.

Accordingly, the present study aims to provide new anatomical data on the supraorbital and supratrochlear nerves in a South American population, specifically Uruguayan, which has not previously been documented in the literature. An assessment of the emergence routes of the supraorbital nerve was conducted in order to establish accurate anatomical references applicable to this population and to clinical practice. To the best of our knowledge, this is the first study to describe these variables in a sample of Uruguayan origin, thereby enriching comparative knowledge with other populations previously studied in Asia, Europe, and North America.

MATERIAL AND METHOD

A descriptive observational study was conducted involving the dissection of 20 sides from 10 adult cadaveric heads (*ex situ*), previously fixed in a formaldehyde-based solution. These specimens were provided by the Departamento de Anatomía, Facultad de Medicina, Universidad de la República, Montevideo, Uruguay, through its official Body Donation Program.

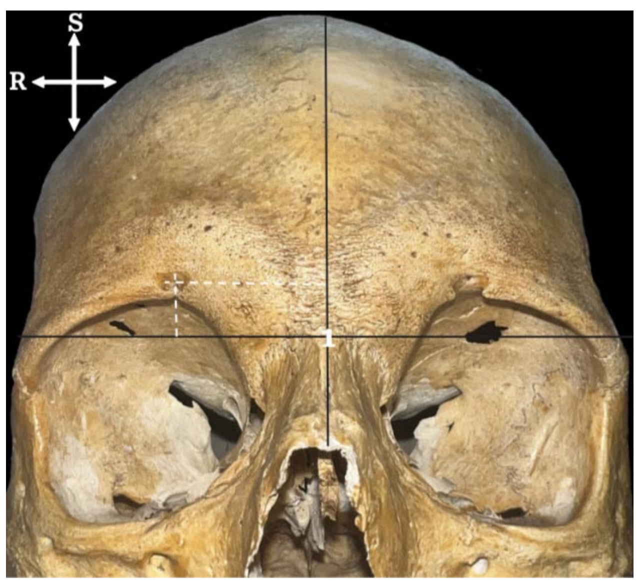
All cadavers were Caucasian adults aged between 60 and 70 years, with no history of trauma, surgical procedures, or facial malformations. The study was approved by the Ethics Committee of the Facultad de Medicina, Universidad de la República, in accordance with current ethical guidelines for cadaveric research.

Exclusion criteria included significant environmental deterioration of the specimen, which prevented data collection in three cases. The variable "sex" was not recorded, as the heads were *ex situ* and did not allow certainty about biological sex.

Dissection of the supraorbital and supratrochlear regions was performed to observe the course of the SON and STN. A vertical incision was made from the lateral orbital rim to the hairline, followed by a horizontal incision across the hairline to the midline, and a third incision down to the root of the nose, thus creating a flap with a hinge over the upper eyelid. Skin was carefully elevated, preserving the superficial musculoaponeurotic system. The frontal belly of the occipitofrontalis, the corrugator supercilii, and the orbicularis oculi muscles were identified as key reference structures for guiding the dissection.

Once the supraorbital and supratrochlear nerves were identified, their emergence at the superior orbital rim was traced. For each nerve on each side, the following variables were recorded: type of osseous emergence (classified as notch without band, notch with band, single foramen, double foramen, or mixed), number of terminal branches, relationship with the corrugator supercilii muscle, and diameter of the emergence orifice.

To improve accuracy in localizing the SON emergence, additional measurements were made on 20 dry skulls also from the Departamento de Anatomia, Facultad de Medicina.. All skulls belonged to Caucasian adults, with no data available on age or sex. On each side of each skull, the emergence point of the SON was located relative to a horizontal line passing through the nasion and a vertical line corresponding to the midsagittal plane (Fig. 1). The nasion is a key topographic landmark located at the junction of the internasal and frontonasal sutures, easily palpable during clinical examination. Only the SON was analyzed on dry skulls, since classical anatomical descriptions and prior studies indicate that the STN does not consistently leave identifiable osseous marks to determine its emergence



Fi. 1. Skull. Frontal view of a dry bone specimen. R: Right side of the specimen; S: Superior aspect of the specimen. 1: Nasion; Black lines: horizontal and vertical anatomical landmarks; White dotted lines: distance from the SON emergence site to the vertical and horizontal lines.

point. Unlike the SON, whose emergence is typically associated with distinct bony structures such as notches or foramina on the superior orbital rim, the STN generally follows a more medial and superficial path, emerging through soft tissues without defined osseous landmarks (Saylam *et al*., 2009). Therefore, reliable anatomical criteria for STN localization in dry skulls could not be established.

All measurements were performed by a single observer using a digital caliper. In cases where the diameter was less than 1 mm, a value of 0.5 mm was assigned for statistical purposes.

Categorical variables (e.g., type of emergence, presence of band, relationship with corrugator muscle) were compared between sides using the chi-square test, or Fisher's exact test when expected frequencies were less than 5. Quantitative variables (e.g., number of branches, diameters, and distances) were analyzed using paired t-tests when normally distributed, or the Wilcoxon signed-rank test otherwise. Statistical significance was set at $p < 0.05$.

RESULTS

Supraorbital Nerve (SON): (Tables I and II). For the SON, 6 foramina (30 %) and 11 notches (55 %) were observed, along with 2 cases (10 %) of accessory foramina (double foramen) and 1 case (5 %) of a mixed pattern (notch and foramen). No statistically significant differences were found between sides (p = 0.406). Among the hemifaces with a notch (including the mixed case), 9 (75 %) showed a fibrous band. No significant difference was found between right and left sides regarding the presence of this structure (p = 0.370).

The average number of terminal branches of the SON was 4 (range: 2–9) on the right side and 3 (range: 2–6) on the left, with no statistically significant difference between sides (p = 0.391).

Regarding the relationship with the corrugator supercilii muscle, 71.80 % of branches passed over the muscle, 2.80 % passed beneath, and 25.40 % penetrated it. No significant differences were found between sides (p = 0.500).

The mean diameter at the emergence site was 4.00 mm, with no significant side differences (p = 0.267).

Supratrochlear Nerve (STN): (Tables I and II). For the STN, 13 notches (72.20 %) and 5 foramina (27.80 %) were observed. No statistically significant differences were found between sides (p = 0.596). Among the notches, 12 (92.30 %) had a fibrous band. Again, no significant differences were found between sides for this variable (p = 0.600).

The average number of STN branches was 2 (range: 1–5) on the right side and 2 (range: 1–3) on the left, with no statistically significant differences (p = 0.157).

The most common relationship between STN branches and the corrugator muscle was penetrating (16 %), followed by a submuscular path (18.40 %). No branches passed above the muscle. A statistically significant difference was found between sides, with more deep courses on the right and exclusive penetrating courses on the left (p = 0.033).

The mean diameter at the emergence site was 0.67 mm, with no significant differences between sides (p = 0.317).

Some of these anatomical features and variations for each nerve are illustrated in the dissections performed by the authors (Figs. 2 and 3).

Table I. Anatomical characterization of the supraorbital and supratrochlear by side.

Measurement	Right SON	Left SON	p-value	Right STN	Left STN	p-value
Type of emergence (%)	Foramen: 45,5 % Notch: 36,4 %	Foramen: 22,2 % Notch: 66,7 %	0,406	Foramen: 27,8 % Notch: 72,2 %	Foramen: 11,1 % Notch: 88,9 %	0,596
Average number of branches (range)	4 (2–9)	3 (2–6)	0,391	2 (1–5)	2 (1–3)	0,157
Presence of fibrous band (%)	36,4 %	62,5 %	0,370	63,6%	83,3 %	0,600
Relationship with corrugator supercilii muscle (%)	Over: 71,8 % Penetrating: 27,3 % Beneath: 4,5 %	Over: 62,5 % Penetrating: 18,8 % Beneath: 0 %	0,500	Over: 0 % Penetrating: 70,8 % Beneath 29,2 %	Over: 0 % Penetrating: 100 % Beneath: 0 %	0,033
Average diameter of the foramen (mm; SD, range)	5,04 ± 3,78 (0,5-12)	3,37 ± 4,81 (0,5–15)	0,267	0,63 ± 0,45 (0,5–2,0)	0,75 ± 0,61 (0,5–2,0)	0,317

Skulls: In dry skulls, 9 notches (45 %), 8 foramina (40 %), and 3 double foramina (15 %) were found. A statistically significant difference in emergence pattern was observed (p = 0.005), with a predominance of osseous emergence on the right side and notches on the left.

The distance to the horizontal line ranged from 3 to 14 mm (mean: 7 mm), and the distance to the midline (vertical) ranged from 19 to 35 mm (mean: 26 mm). No statistically significant differences were found between sides in either measurement, although the vertical distance showed a trend toward significance (p = 0.051)

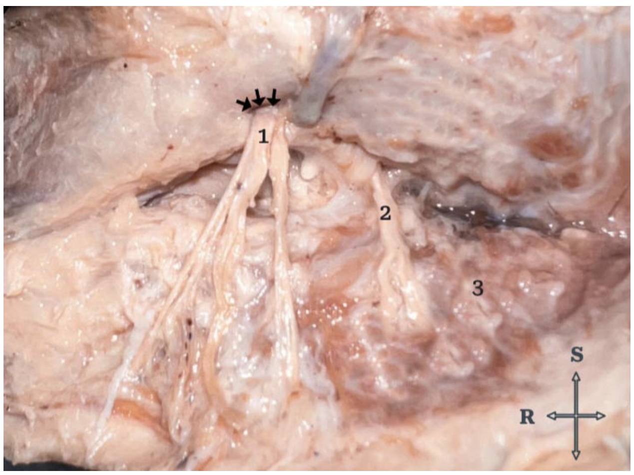


Fig. 2. Frontal view of the right orbit. R: Right side of the specimen. S: Superior aspect of the specimen. 1: Supraorbital nerve; 2: Supratrochlear nerve; 3: Corrugator supercilii muscle; Arrowheads: supraorbital foramen.

Fig. 3. Frontal view of the right orbit. R: Right side of the specimen; S: Superior aspect of the specimen. 1: Supraorbital nerve; 2: Supratrochlear; 3: Corrugator supercilii muscle; 4: Fascial band; Arrowheads: supraorbital notch.

DISCUSSION

This study met its primary objective of thoroughly describing the anatomy of the supraorbital nerve (SON) and supratrochlear nerve (STN) in the supraorbital region through cadaveric dissection.

In our sample, the SON emerged through a notch in 55 % of cases, through a foramen in 30 %, and less frequently with accessory or mixed patterns. Haladaj *et al*. (2019) reported a notch frequency of 69.9 % and foramen frequency of 28.9 % in a Caucasian population, while Pruksapong *et al*. (2021) in a Thai population, described an even distribution between both types of nerve emergence. Complementarily, Voljevica *et al*. (2022) found a predominance of notches (73.8 %) over foramina (26.2 %) in a sample of Bosnian skulls and observed the coexistence of both in 23 % of cases and accessory foramina in 16.6 %. These differences suggest a potential influence of ethnic and sex-related factors in the morphology of the SON's exit point. The variability in shape, number, and location of the emergence site may have clinical implications in anesthetic and surgical procedures in the orbital region, where accurate identification of the nerve's path is crucial to avoid injury. Pourtaheri & Guyuron (2018) found that patients with a foramen (where the nerve is more fixed) experienced more intense and prolonged migraines than those with a notch.

A significant finding in our study was the frequent association between the notch and a fibrous band (75 % of cases), representing a potential anatomical compression point. Fallucco *et al*. (2012) observed a band in 86 % of notches analyzed and proposed a morphological classification into simple, partially ossified, and septated types. Compression at this site is considered anatomically comparable to a "mini carpal tunnel," potentially triggering neuropathic symptoms due to tension on the neurovascular bundle.

In our series, the SON presented an average of three to four terminal branches, while the STN showed an average of two. This branching pattern is consistent with Haladaj *et al*. (2019) who noted frequent bifurcation of the SON into medial and lateral branches, with deep and superficial subdivisions. Ha *et al*. (2024) also classified emergence patterns into six distinct types, providing a systematic view of SON anatomical diversity in surgical practice. The

Table II. Topographic relationship between the supraorbital nerve and each of the anatomical landmarks.

Measurement	Right side	Left side	p-value
Mean distance to the midline (mm)	28,8 ± 4,6 (21–35)	23,5 ± 3,6 (18–29)	0,051
Mean distance to the horizontal line (mm)	7,0 ± 2,1 (5–11)	7,0 ± 3,7 (3–14)	1,000

presence of multiple branches should be considered when planning nerve blocks or resections in facial plastic surgery.

Another relevant aspect was the relationship between the SON and STN branches and the corrugator supercilii muscle. In our study, 25.35 % of SON and 16 % of STN branches pierced the corrugator. Starkman & Sherris (2017) observed that 100 % of STNs passed through the corrugator in their series, supporting the theory of dynamic compression during muscle contraction. This intramuscular trajectory may facilitate nerve entrapment and explain clinical improvement in patients treated with surgical decompression or botulinum toxin. Moreover, Van Vlasselaer *et al*. (2024) using a 3D model, showed significant individual variability in the SON's trajectory and its distance from reference planes, highlighting the need for individualized approaches for procedures such as nerve blocks or neuromodulation

The average diameter of the SON in our study was 4 mm, considerably larger than that of the STN (0.67 mm). In previous studies, Haladaj *et al*. (2019) reported an average diameter of 1.56 mm for the SON and 0.95 mm for the STN. This difference may be due to the fact that we measured the bony emergence diameter, whereas other authors measured the nerve's caliber.

The measurements obtained from dry skulls (26 mm from the midline and 7 mm from the orbital rim) align with those of Pourtaheri & Guyuron (2018), who found average distances of 2.25 cm for notches and 2.74 cm for foramina from the midline. Pruksapong *et al*. (2021) and Ha *et al*. (2024) also reported similar values in Asian populations, and Van Vlasselaer *et al*. (2024) through 3D analysis, confirmed these distances relative to the cranial curvature and anatomical landmarks such as the orbitomeatal plane.

Altogether, our findings reinforce the importance of regional anatomical studies and support the clinical application of this research in fields such as plastic surgery, neurosurgery, and ophthalmology. To the best of our knowledge, this is the first study to analyze the anatomy of the SON and STN in a cadaveric sample from the Uruguayan population. Unlike other studies focused on Asian, European, or North American populations, this research provides anatomical data relevant to the regional context, enriching comparative knowledge on the variability of these nerves, which is especially relevant in procedures such as migraine decompression, transorbital approaches, nerve blocks, and corneal neurotization.

Regarding internal validity, the use of a standardized dissection protocol, clear anatomical variable definitions, and reliable measurement tools minimized technical variability and improved reproducibility. Additionally, appropriate statistical analysis and explicit identification of methodological limitations strengthen the internal consistency of the study. As for external validity, although the results derive from a Uruguayan sample, the analyzed structures are evolutionarily conserved, and their trajectories and relationships have shown consistent patterns across international studies. The clinical applicability of the findings in common surgical and anesthetic procedures reinforces the study's practical relevance beyond the local scope, offering useful references for professionals across specialties.

Like any cadaveric anatomical study, this work presents limitations. First, the sex of the specimens was not recorded, preventing analysis of potential anatomical differences between males and females, as reported in previous studies. Additionally, the total number of hemifaces analyzed was limited; while sufficient to detect general patterns, it does not allow generalization to the Uruguayan population or subanalysis by age or other variables. Another relevant limitation was the inability to measure certain nerves due to environmental deterioration of the specimen, which may have affected the observed frequency of trajectories or number of branches.

Despite these limitations, the findings provide relevant anatomical data for an understudied population and suggest several future research directions. It would be valuable to conduct studies with a larger sample size and documented sex to evaluate anatomical differences more accurately. Furthermore, detailed exploration of the intraorbital course of the SON and STN through careful dissection within the orbital cavity would be of great interest; this region, which houses both nerves before their emergence through the supraorbital notch or foramen, is closely related to critical muscular and vascular structures. Exploring it would complement current anatomical knowledge and contribute to safer orbital approaches and a better understanding of potential deep compression points. Likewise, using vascular injection techniques or studies on fresh cadavers could provide detailed information on the relationship between the supraorbital and supratrochlear vessels and their respective nerves. Moreover, correlating anatomical findings with high-resolution imaging in living patients could help validate surface references for nerve localization in surgical or anesthetic settings. Finally, clinical-anatomical studies integrating nerve trajectories with clinical manifestations or therapeutic outcomes — for example, in refractory migraine or corneal neurotization procedures — would represent a natural extension of this research toward practical medical application

CONCLUSION

This study allowed for the detailed description of SON and supratrochlear nerve STN anatomy in the supraorbital region through cadaveric dissection, identifying their courses, variations in emergence site, number of terminal branches, and anatomical relationships with neighboring structures such as the corrugator supercilii muscle. Relevant individual differences were observed, and useful topographic landmarks were established for the surgical localization of these nerves, highlighting that their emergence points are not constant.

These findings are particularly important in the context of procedures such as anesthetic nerve blocks, forehead lifts, corneal neurotization, and surgical decompression for refractory migraine.

To the best of our knowledge, this is the first study to describe these structures in a sample from the Uruguayan population, contributing to regional anatomical knowledge and offering a useful reference framework for surgeons and clinicians from various specialties.

ACKNOWLEDGMENTS

The authors sincerely thank those who donated their bodies to science, enabling anatomical research and education. The results of such research can potentially increase scientific knowledge and improve patient care. Therefore, these donors and their families deserve our highest respect.

HERNÁNDEZ, C. J. M.; AREVALO, A. A. & CABRERA, F. J. A. Estudio anatómico cadavérico del nervio supraorbitario y supratroclear. *Int. J. Morphol., 43(5)*:1612-1618, 2025.

RESUMEN: El objetivo de este estudio fue caracterizar aspectos anatómicos clave del nervio supraorbitario (NSO) y el nervio supratroclear (NST), incluyendo sus patrones de emergencia, su relación con el músculo corrugador y variables topográficas, con el fin de proporcionar referencias útiles para procedimientos clínicos y quirúrgicos en la región frontoorbitaria. Se realizó un estudio descriptivo en 20 hemicaras de cadáveres adultos fijadas en formalina. Se diseccionaron el NSO y el NST y se recopilaron datos sobre sus patrones de emergencia, número de ramas terminales, relación con el músculo corrugador superciliar y diámetro del foramen (cuando existía). Además, se analizaron 20 cráneos secos para identificar el patrón de emergencia del nervio supraorbitario y medir su distancia a las líneas verticales y horizontales con base en el nasión. El nervio supraorbitario emergió a través de una escotadura en el 55 %, a través de un foramen en el 30 % y presentó variantes anatómicas en el 15 % de los casos. En el NST, predominaron las escotaduras (72,20 %). La vía de acceso más frecuente fue por encima del músculo corrugador superciliar para el nervio supraorbitario y a través del músculo para el NST. El nervio supraorbitario presentó un promedio de 3 a 4 ramas por lado, y el NST 2 ramas. En los cráneos secos, el nervio supraorbitario se localizó a 7 mm de la línea vertical y a 26 mm de la horizontal. Los hallazgos resaltan una variabilidad anatómica relevante y proporcionan referencias útiles para procedimientos quirúrgicos y anestésicos en una población poco estudiada.

PALABRAS CLAVE: Nervio supraorbitario; Nervio supratroclear; Cadáver; Anatomía.

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