Review Article

The innervation of the scalp: A comprehensive review including anatomy, pathology, and neurosurgical correlates

William J. Kemp III, R. Shane Tubbs¹, Aaron A. Cohen-Gadol

Department of Neurological Surgery, Goodman Campbell Brain and Spine, Indiana University, Indianapolis, IN,¹Department of Pediatric Neurosurgery, Children’s Hospital, Birmingham, AL, USA

E-mail: William J. Kemp III - wjkemp@indiana.edu; R. Shane Tubbs - shane.tubbs@choys.org; *Aaron A. Cohen-Gadol - acohenmd@gmail.com

*Corresponding author

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INTRODUCTION

Comprising five layers, the scalp is bound by the face anteriorly and the neck laterally and posteriorly. The skin is the first layer. The second layer is connective tissue, which is a thin layer of fat and fibrous tissue with a thickness of 4–7 mm.[¹] The third layer is the galea aponeurotica, which exists as a tough layer of dense fibrous tissue that extends between the frontalis and occipitalis muscles.[¹] Deep to these layers, the loose areolar connective tissue comprises collagen bundles and houses the major blood vessels of the scalp. This layer is laterally attached to the zygomatic arch and mastoid processes and posteriorly attached to the superior nuchal line. This layer provides the separation plane for surgical flaps and traumatic avulsions.[¹] The final layer is the pericranium, which is the periosteum of the skull. This layer ends laterally with the origin of the temporalis fascia along the superior temporal line and provides nutrient supply to the bone.[¹,¹⁸]

Various nerves innervate the human scalp. Some of these are derived from cranial nerves, some from dorsal spinal rami, and others from ventral spinal rami. The supratrochlear and supraorbital nerves originate from the ophthalmic division of the trigeminal nerve.[¹⁵] The greater occipital nerve (GON) travels up to the vertex. The lesser occipital nerve (LON) innervates skin behind the ear.[¹⁵,²⁷] The third occipital nerve (TON) may also provide some innervation.[¹⁶] The zygomaticotemporal nerve, arising from the maxillary division of the trigeminal nerve, innervates the skin of the temple. The auriculotemporal nerve, derived from the mandibular
division of the trigeminal nerve, innervates the posterior portion of the skin of the temple.\[^{15}\]

Pathologies such as migraines and neuralgias involving scalp innervation are disabling for many patients. Disruption of these nerves during surgery via direct disturbance or neurovascular compromise, inappropriate intraneural local anesthetics, nerve traction, or nerve compression by scar tissue can lead to painful, recurring headaches. Therefore, this paper will provide a comprehensive review of the anatomy, embryology, pathology, and neurosurgical application of the knowledge of the innervation of the scalp.

**ANATOMY OF THE INNERVATION OF THE SCALP**

The supraorbital nerve [Figures 1 and 2], a terminal branch of the frontal nerve, courses through the supraorbital foramen or notch and innervates the skin from the forehead to the lambdoidal suture.\[^{5}\] Ascending on the forehead, the nerve terminates into medial and lateral branches. The medial branch perforates the corrugator supercili and frontalis muscles while the lateral branch perforates the galea aponeurotica.\[^{5}\] The supraorbital nerve also innervates the upper eyelid, the conjunctiva of the eye, and the frontal sinus.\[^{5,15}\]

**The supratrochlear nerve**

The supratrochlear nerve [Figures 1 and 2], also a branch of the frontal nerve, innervates the lower part of the forehead. The nerve exits the orbit approximately 16 mm lateral to the midline and 7 mm below the supraorbital upper margin between the superior oblique muscle and supraorbital foramen. The nerve courses up the forehead and ascends beneath the frontalis muscle and also provides innervation to the conjunctiva and the skin of the upper eyelid.\[^{15}\]

The lesser occipital nerve

The LON [Figures 3 and 4] originates from the ventral rami of spinal nerves C2 and C3 and courses to the occipital area in a parallel fashion with the posterior margin of the sternocleidomastoid muscle (SCM).\[^{6,27}\] The LON pierces the deep fascia near the cranium to course superiorly above the occiput to supply the skin and join with the GON. Pain in the region supplied by the LON often manifests as a cervicogenic headache resulting from physical exertion. Injection of the LON can be done inferior to the medial groove of the mastoid process and 1 cm superior to the mastoid tip. This nerve is also 2.5 cm lateral to the occipital artery over the occiput and 7 cm lateral to the external occipital protuberance. According to Tubbs et al.,\[^{27}\] the LON branches into medial and lateral parts at approximately the midpoint between the inion and the intermastoid line.

**The greater occipital nerve**

The GON [Figures 3 and 4] originates from the medial branch of the dorsal ramus of the C2 spinal nerve and may intercommunicate with branches from the dorsal branch of the C3 spinal nerve. On average, the GON lies 4 cm lateral to the inion. The nerve courses backward between the first and second cervical vertebrae. It then courses between the inferior capitis oblique and semispinalis capitis muscles.\[^{1,4,10,15}\] According to Bovim et al.,\[^{2}\] the GON pierces the trapezius muscle in 45% of cases, the semispinalis muscle in 90% of cases, and the inferior oblique muscle in 7.5% of cases. These locations where the GON pierces the various muscles can potentially cause nerve compression. After traveling through the semispinalis muscle, the nerve runs with the occipital artery, which usually lies just medial to this nerve. The GON provides cutaneous innervation to most of the posterior scalp.\[^{1,2,4,10}\] Effective nerve block can be achieved at a point 2–5 cm laterally and 2–3 cm below or above the inion. Sometimes the GON may require

![Figure 1: Lateral schematic view of the nerves innervating the scalp. The superciliary arch is covered by the eyebrow](image1)

![Figure 2: Anterior view of branches supplying the scalp, including the supraorbital, supratrochlear, and zygomaticotemporal nerves](image2)
blocking at multiple sites along the intermastoid line about 15–25 mm from the midline.\(^1\) After the occipital artery is palpated, the injection is applied just lateral to the artery to inject the GON. The needle is then directed slightly laterally between the scalp and skull, and after negative aspiration, further injection is completed to assure inclusion of the LON in the field block. The injection mixture includes bupivicaine, lidocaine, and tiamcinolone. If rhizotomy of C2 is contemplated, the injection is applied along the facet joint and fluoroscopy is used for localization. If the patient fails to achieve pain relief, magnetic resonance imaging (MRI) or computed tomography (CT) may be reasonable to exclude occult pathology. The results of the above therapies are variable based on patient selection and involve psychological factors.

The third occipital nerve
The TON [Figure 3], the superficial medial branch of the third cervical dorsal ramus, courses around the dorsolateral surface of the C2–C3 facet joint, which receives innervation from the TON. Typically, the TON is approximately 5 mm lateral to the inion. According to Tubbs \textit{et al.},\(^{26}\) small branches were found to cross the midline and communicate with the contralateral TON inferior to the inion in 66.7% of patients. After supplying innervation to the semispinalis capitis muscle, the TON contributes a communicating branch to the GON. Leaving the muscle, the TON becomes cutaneous to innervate an area of skin below the superior nuchal line. The TON trunk becomes subcutaneous, on average, 5 cm inferior to the inion. This trunk is also related to the nuchal ligament.\(^{26}\) Compression of the TON is characterized by positive response to TON blocks, restricted neck movements, and facet tenderness. Patients with whiplash injuries often experience TON neuralgia.\(^{26}\)

The zygomaticotemporal nerve
The zygomaticotemporal nerve [Figure 2] is one of the two branches of the zygomatic nerve that arises from the maxillary division of the trigeminal nerve, and courses through the zygomaticotemporal foramen and temporalis muscle to eventually penetrate the temporal fascia 10 mm posterior to the frontozygomatic suture and 22 mm above the upper margin of the zygomatic arch. At this location, the zygomaticotemporal nerve innervates a small area of the forehead and temporal areas.\(^ {15}\) Nerve block of the zygomaticotemporal nerve is performed 10–17.5 mm posterior to the frontozygomatic suture and 22–24.8 mm above the zygomatic arch.\(^ {15}\)

The auriculotemporal nerve
The auriculotemporal nerve arises from the posterior trunk of the mandibular division of the trigeminal nerve. Passing medial to the temporomandibular joint, the nerve courses deep to the lateral pterygoid muscle to supply parasympathetic fibers to the parotid gland. This nerve innervates the tragus and anterior portions of the ear in addition to the posterior portion of the temple.\(^ {12}\) At some sites, the nerve is helically intertwined around the superficial temporal artery, providing a potential trigger point for migraine headaches.\(^ {12}\) Nerve block for this nerve can be performed at the level of and 10–15 mm anterior to the upper origin of the helix of the ear.\(^ {15}\)

The great auricular nerve
The great auricular nerve (GAN) [Figure 3] can be identified as it emerges from the posterior border of the
The GAN ascends either on the anterior or on the posterior external surface of the muscle.[11] Tubbs et al.[27] reported that the GAN may have a mastoid branch that is, on average, 9 cm lateral to the inion. On average, this branch would lie 1 cm superior to the mastoid tip. This nerve may experience damage in certain procedures such as retromastoid approaches to the posterior cranial fossa in addition to being possibly implicated in trigeminal neuralgia cases.[27]

EMBRYOLOGY

The facial primordia, the frontonasal, maxillary, and mandibular prominences, form the boundaries of the primitive oral opening. The frontonasal prominence forms facial areas above the external nares and tip of the nose. The ophthalmic (V1) division of the trigeminal nerve innervates structures derived from this prominence. The first branchial arch divides into the maxillary and mandibular prominences.[16] The maxillary division (V2) and mandibular division (V3) of the trigeminal nerve innervate their respective prominences.[16] The frontonasal prominences differentiate into the superior portion, forming the forehead and interorbital areas of the face and dorsum of the nose, and the inferior or nasal portion.

In the 3rd week of development extending to the 8th week, three germ layers, namely the ectoderm, endoderm, and mesoderm, catalyze the formation of specific organs and tissues. Cells of the paraxial mesoderm organize into blocks on both sides of the midline to form somitomeres and further organize into somites. Forming in the cephalic region first, the somites appear in the occipital area by day 20. Together, there are 4 occipital, 8 cervical, 12 thoracic, 5 lumbar, and 8 coccygeal somite pairs.[17]

By the 4th week, cells in the ventral and medial region of somite become polymorphic to form sclerotomes that form the vertebral column. The cells in the dorsolateral region of somite comprise the dermatome, which forms the dermis and subcutaneous tissue in that segment.

A dermatome represents an area of skin supplied by a single nerve. According to Dubuisson,[6] the “cutaneous field of the C2 spinal root overlaps the C1 and C3 dermatomes, the trigeminal dermatomes, and the territory of the lower cranial nerves innervating the ear.” The occiput, the neck, and submental regions comprise the C2 dermatome. The C3 dermatome can span from the clavicle to the mandible and extend to the ear.[7] Patients with C3 nerve root compression present with radiating pain, dysesthesia, and numbness that refers to C3 pain dermatome behind and over the ear, the pinna, and the angle of the mandible.[21]

As mentioned previously, the GON, the LON, and the TON supply the nervous innervation to their respective occipital areas in the scalp. The GON, originating from the dorsal ramus of C2, innervates the C2 dermatome.[9] The TON, originating from the dorsal ramus of C3, innervates the C3 dermatome.[9] The LON is a sensory branch of the ventral ramus of C2. The GAN and transverse cervical nerve are sensory branches of the ventral rami of C2–C3. At the root level, dorsal and ventral segments are segregated into sensory and motor fibers, respectively. However, at the spinal nerve and rami levels, sensory and motor fibers are found mixed. Therefore, cutaneous fibers, as described herein, may arise from dorsal or ventral rami. Together, the LON, GAN, and transverse cervical nerve arise from the cervical plexus and innervate the anterior and lateral regions of the neck.[9]

OCCIPITAL NEURALGIA AND TREATMENT

Occipital neuralgia is typified by intense pain localized to the occipital skin area typically innervated by the GON and LON. The pain radiates unilaterally from the frontal, orbital, and periorbital regions.[5] When physicians encounter cases of occipital pain, occipital neuralgia should be considered in the differential diagnosis. However, other conditions must be ruled out, such as cervical arthritis, nerve compression, whiplash trauma, or Chiari I malformations. Occipital neuralgia is likely caused by the close anatomical relationship between the GON and more proximal structures such as the ligaments and the deep back muscles.[4,13,15,23,27]

The TON may also contribute to the onset of occipital neuralgia. Exclusively innervating the C2–C3 facet joint, the TON may become entrapped. This entrapment can occur since the atlanto-occipital and atlanto-axial joints lie ventral to the spinal nerves. The facet joints are located behind the intervertebral joints at the level of the intervertebral disc. In surgical approaches to the craniocervical region, the surgeon should be aware of the TON’s relationship and proximity. According to Tubbs et al.[26] midline retraction in this particular region may place tension on the TON both superficially at its cutaneous branches and deeper near its facet branches. Tension placed on the TON may contribute to postcraniotomy headaches. This can be due to local cutaneous nerve irritation or compression or due to traction on the deeper branches of the nerve near the facet joint. To decrease the tension on the TON, surgeons may choose to occasionally release the midline retractors.

Some treatments may not effectively treat occipital neuralgia. These treatments include nonsteroidal anti-inflammatory drugs (NSAIDS), steroids, triptans, opioids, antiepileptics, and antidepressants. Occipital nerve block, chemical or radiofrequency ablation, or transcervical electrical nerve stimulation are minimally invasive methods used to treat occipital neuralgia. Injections are
specific areas of the scalp were anatomized. According to Pinosky et al., these injections alleviated sharp or shooting pain for patients during most of the trial period. Surgical options include dorsal rhizotomy, nuchal muscle release, occipital neurectomy, and microvascular decompression. Dorsal rhizotomy and microvascular decompression will be discussed. One potential culprit of occipital neuralgia is the proximity of the occipital artery to the GON.

**MIGRAINE TRIGGER SITES**

Migraine, a significant progenitor of pain in the United States, affects 28 million people. In a study performed by Calandre et al., specific areas of the scalp were manually palpated to elicit migraines. The specific areas studied were the medial border of the supraciliary arch near the insertion of frontalis muscle fibers, the medial part of the anterior and proximal fibers of the temporalis muscle, and the medial part of the middle fibers of the temporals muscle. Other palpated areas included the suboccipital area where the thick neck muscles insert, the occipital area surrounding the emergence of Arnold’s nerve (auricular branch of the vagus nerve), and the medial area of the superior trapezius in the neck. Accordingly to their study, 42.6% of the trigger points were found in temporal areas and 33.4% in suboccipital areas. Janis et al. alleviated the debilitating symptoms of migraine using botulinum toxin to identify frontal, temporal, and occipital trigger points. Patients with multiple trigger points received surgical decompression of the nerves. Most of the patients reportedly experienced significant improvement in their pain.

**NEUROSURGICAL APPLICATIONS**

**Scalp nerve block**

The management of postoperative pain, despite being a significant challenge for the clinician and patient, remains poorly understood. Since most patients experience significant pain following craniotomy, clinicians often prescribe drug regimens to provide analgesic relief. During craniotomy, the pins of the head clamp are placed into the periosteum, and this process may result in increases in blood pressure and heart rate. Eventually, there may be an increase in intracranial pressure. Blockade of scalp innervation with bupivacaine may provide the patient with relief since both the superficial and deep layers of the scalp are anesthetized. According to Pinosky et al., systolic, diastolic, mean arterial pressure, and heart rate all remained at normal levels using bupivacaine in contrast to their increased levels in the control group during scalp block, head pinning, and 5 minutes after head pinning.

According to Nguyen et al., propivacaine scalp block is effective in decreasing postoperative pain for 48 hours in patients undergoing supratentorial craniotomy. The authors believed that scalp block acts via a “preemptive mechanism.” Since the supraorbital nerve provides sensory innervation to the upper eyelid, forehead, and scalp, its block may be beneficial. As mentioned previously, the GON may be selectively blocked to treat occipital neuralgia. To ensure chances for successful surgery, the surgeon must be conscious of the locations where the GON pierces the muscles, specifically the semispinalis capitis, trapezius, and obliquus capitis inferior muscles. These three areas comprise possible locations for nerve entrapment, thereby causing pain for the patient. There are few complications with this type of block because of the nerve’s superficial location in the skin.

**Scalp nerve block during awake craniotomy**

During special procedures such as awake craniotomies, the patient must remain sufficiently free of pain and be conscious to cooperate with brain mapping. Scalp nerve blocks may be performed for the supraorbital nerve, supraorbital nerve, auriculotemporal nerve, GON, LON, and GAN.

An awake craniotomy most commonly involves a curvilinear incision starting in front of the ear and curving behind the hairline. We have routinely blocked the above-mentioned nerves and noticed more patient comfort during surgery, which is paramount for patient cooperation (by reducing the need for intravenous sedation) and ultimately accurate cortical mapping. This “regional” scalp nerve block maximizes the patient’s comfort during head clamp placement and incision as well as craniotomy.

**Surgical decompression and rhizotomy**

In regard to neuralgias, clinicians have a variety of options when treating patients. Injection of botulinum toxin has been shown to provide relief for its duration. This toxin acts by binding to high-affinity recognition sites on the presynaptic cholinergic nerve terminals, and thereby blocks the release of acetylcholine. Another choice is surgical decompression, particularly when the supraorbital nerve, supraorbital nerve, zygomaticotemporal nerve, and GON are involved.

Decompression of the GON has been shown to be 62% effective in alleviating pain related to occipital neuralgia. However, a significant percentage of patients still remain refractory to surgical intervention. In light of these patients, some studies have attempted to find explanations. One answer may be the relationship between the auriculotemporal nerve and the superficial temporal artery. Auriculotemporal neuralgia is typified by paroxysmal attacks of pain in the preauricular area, spreading over the temple region. According to Janis et al., in 34% of the cranial halves, there was a direct...
relationship found in the soft tissues of the temporal region. Since this nerve–artery relationship is quite variable among patients, the authors suppose that it might be overlooked as a potential migraine trigger point. During procedures such as lateral suboccipital craniotomy, the LON can be injured, leading to hypesthesia and paresthesia in the occipital region and the posterior part of the auricle. Traveling along the surface of the SCM, the LON typically runs along the caudal part of the surgical field approximately 2–3 cm from the caudal end of the skin incision. The connective tissue surrounding the LON can be dissected to allow the nerve to be mobilized. Occasionally it is impossible for the nerve to be moved in order to have a successful surgery.[8]

Another potential option for treatment for occipital neuralgia is a dorsal rhizotomy at C1–C3. C1–C3 dorsal rootlets may be sectioned intradurally.[6] However, this may be unfavorable to the patient since a complete upper cervical rhizotomy will result in total loss of scalp sensation. Sectioning of the specific sensory roots may not consistently relieve the pain. The rate of long-term relief tends to decrease with time.[20]

CONCLUSIONS

In light of this review and neurosurgical correlates, neurosurgeons should be aware of the anatomy of the nerves providing sensory innervation to the scalp. This knowledge will better enable the neurosurgeon to operate effectively and efficiently to minimize postoperative pain and maximize postoperative recovery.

REFERENCES

1. Becser N, Bovim G, Søstad O. Extracranial nerves in the posterior part of the head: Anatomic variations and their possible clinical significance. Spine 1998;23:1435-41.
2. Bovim G, Bonamico L, Fredriksen TA, Lindboe CF, Stolt-Nielsen A, Søstad O. Topographic variations in the peripheral course of the greater occipital nerve. Spine 1991;16:475-8.
3. Calandre EP, Hidalgo J, García-Leiva JM, Rico-Villademoros F. Trigger point evaluation in migraine patients: An indication of peripheral sensitization linked to migraine predisposition? Eur J Neurol 2006;13:244-9.
4. Cornely C, Fischer M, Ingianni G, Isenmann S. Greater occipital nerve neuralgia caused by pathological arterial contact: Treatment by surgical decompression. Headache 2011;51:609-14.
5. Cuzalina AL, Holmes JD. A simple and reliable landmark for identification of the supraorbital nerve in surgery of the forehead: An in vivo anatomical study. J Oral Maxillofac Surg 2005;63:25-7.
6. Duboisson D. Treatment of occipital neuralgia by partial posterior rhizotomy at C1-C3. J Neurosurg 1995;82:581-6.
7. Foerster O. The dermatomes in man. Brain 1933;56:1-39.
8. Fujimaki T, Son JH, Takahashi S, Ishii T, Furuya K, Mochizuki T, et al. Preservation of the lesser occipital nerve during microvascular decompression for hemifacial spasm. J Neurosurg 2007;107:1235-7.
9. Gilroy AM, MacPherson BR, Ross LM. Atlas of Anatomy. 1st ed. New York: Thieme Medical Publishers, Inc; 2008.
10. Guvenc M, Akyer P, Sayhan S, Teshk S. The importance of the greater occipital nerve in the occipital and suboccipital region for nerve blockade and surgical approaches: An anatomic study on cadavers. Clin Neurol Neurosurg 2011;113:289-94.
11. Hayman LA, Shukla V, Ly C, Taber KH. Clinical and imaging anatomy of the scalp. J Comput Assist Tomogr 2003;27:454-9.
12. Janis JE, Hafez DA, Ducic I, Ahmad J, Wong C, Hoxworth RE, et al. Anatomy of the auriculotemporal nerve: Variations in its relationship to the superior temporal arterial and implications for the treatment of migraine headaches. Plast Reconstr Surg 2010;125:1422-8.
13. Janis JE, Hafez DA, Reece EM, McCluskey PD, Schaibb TA, Guyuron B. Neuromas in cutaneous nerves: Implications for migraine headaches. Plast Reconstr Surg 2010;126:1996-2001.
14. Janis JE, Dhaniak A, Howard JH. Validation of the peripheral trigger point theory of migraine headaches: Single-surgeon experience using botoxum toxin and surgical decompression. Plast Reconstr Surg 2011;128:123-31.
15. Jeong SM, Park KJ, Kang SH, Shin HW, Kim H, Kee HK, et al. Anatomical consideration of the anterior and lateral cutaneous nerves in the scalp. J Korean Med Sci 2010;25:517-22.
16. Jinkins JR. Atlas of neuroradiologic embryology, anatomy, and variants. 1st ed. Philadelphia: Lippincott Williams and Wilkins; 2000.
17. Kumar R. Textbook of Human Embryology. 1st ed. New Delhi: I.K. International Publishing House Pvt. Ltd; 2008.
18. Larrabee WF, Makielski KH, Henderson JL. Surgical Anatomy of the Face. 2nd ed. Philadelphia: Lippincott Williams and Wilkins; 2004.
19. Nguyen A, Girard F, Boudreault D, Fugere F, Ruel M, Mouldjian R, et al. Scalp nerve blocks decrease the severity of pain after craniotomy. Anesth Analg 1991;93:1272-6.
20. Onofrio BM, Campa HK. Evaluation of rhizotomy: Review of 12 years' experience. J Neurosurg 1972;36:751-5.
21. Poletti CE. Third cervical nerve root and ganglion compression: clinical syndrome, surgical anatomy, and pathological findings. Neurosurgery 1996;39:941-9.
22. Pinosky ML, Fishman RL, Reeves ST, Harvey SC, Patel S, Palesch Y, et al. The effect of bupivacaine scalp block on the hemodynamic response to craniotomy. Anesth Analg 1996;83:1256-61.
23. Sahai-Srivastava S, Zheng L. Occipital neuralgia with and without migraine: Difference in pain characteristics and risk factors. Headache 2011;51:124-8.
24. Sinha PK, Koshy T, Gayatri P, Smitha V, Abraham M, Rathod RC. Anesthesia for awake craniotomy: A retrospective study. Neurol India 2007;55:376-81.
25. Taylor M, Silva A, Cottrell C. Botulinum toxin type-A (BOTOX) in the treatment of migraine headaches. Plast Reconstr Surg 2010;126:1996-2001.
26. Tubbs RS, Mortazavi MM, Loukas M, D’Antoni AV, Shoja MM, Chern JJ, et al. Third occipital nerve in the occipital and suboccipital region for nerve blockade and surgical approaches: An anatomic study on cadavers. Clin Neurol Neurosurg 2011;113:289-94.
27. Tubbs RS, Sarver EG, Wells J, Blount JP, Oakes WJ. Landmarks for the identification of the cutaneous nerves of the occiput and nuchal regions. Clin Anat 2007;20:235-8.
28. Ward JB. Greater occipital nerve block. Semin Neurol 2003;23:59-62.