The Great Auricular Nerve Trigger Site: Anatomy, Compression Point Topography, and Treatment Options for Headache Pain

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Background: Peripheral nerve decompression surgery can effectively address headache pain caused by compression of peripheral nerves of the head and neck. Despite decompression of known trigger sites, there are a subset of patients with trigger sites centered over the postauricular area coursing. The authors hypothesize that these patients experience primary or residual pain caused by compression of the great auricular nerve.
Methods: Anatomical dissections were carried out on 16 formalin-fixed cadaveric heads. Possible points of compression along fascia, muscle, and parotid gland were identified. Ultrasound technology was used to confirm these anatomical findings in a living volunteer.
Results: The authors' findings demonstrate that the possible points of compression for the great auricular nerve are at Erb's point (point 1), at the anterior border of the sternocleidomastoid muscle in the dense connective tissue before entry into the parotid gland (point 2), and within its intraparotid course (point 3). The mean topographic measurements were as follows: Erb's point to the mastoid process at 7.32 cm/7.35 (right/left), Erb's point to the angle of the mandible at 6.04 cm/5.89 cm (right/left), and the posterior aspect of the sternocleidomastoid muscle to the mastoid process at 3.88 cm/4.43 cm (right/left). All three possible points of compression could be identified using ultrasound.
Conclusions: This study identified three possible points of compression of the great auricular nerve that could be decompressed with peripheral nerve decompression surgery: Erb's point (point 1), at the anterior border of the sternocleidomastoid muscle (point 2), and within its intraparotid course (point 3). (*Plast. Reconstr. Surg.* 149: 203, 2022.)

Peripheral nerve decompression surgery for head and neck nerve trigger sites, colloquially known as migraine surgery, can effectively address migraine headaches caused by compression of peripheral nerves.[1–5] Peripheral nerve compression headaches are thought to be a physiologically distinct clinical entity from traditional migraine headaches in that nerve compression headaches have an extracranial origin.[6] Extracranial nerve compression sites include bony or fascial compression (i.e., supraorbital foramen or notch/supraorbital nerve), blood vessels (i.e., superficial temporal artery/auriculotemporal nerve; occipital artery/greater occipital nerve), and muscle (corrugator muscle/supratrochlear

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nerve).[7–24] There has been substantial evidence that surgery and targeted botulinum toxin injection can ameliorate or eliminate headaches in these known trigger sites.[1–3,25–28]

Despite decompression of known trigger sites, it is the senior author's (J.E.J.) experience that there is a subset of patients with postauricular and posterior temporal pain who are inadequately treated with current, known peripheral nerve decompression techniques. These patients endorse focal pain centered over the posterior aspect of the ear coursing along the postauricular sulcus. We hypothesize that these patients experience headache symptoms caused by compression of the great auricular nerve (nervus auricularis magnus).

The anatomical course of the great auricular nerve has been well established; the great auricular nerve arises from the ventral cervical rami C2 and C3 emerging at the posterior border of the sternocleidomastoid muscle at Erb's point (also referred to as the "nerve point of neck") to travel cranially along the sternocleidomastoid muscle and divide into anterior and posterior branches inferior to the posterior aspect of the earlobe.[29–32] However, no prior anatomical study has examined the course of the great auricular nerve in relation to possible sites of compression as a source of peripheral nerve compression headaches. This study is the first to characterize the course of the great auricular nerve as it relates to possible sites of compression contributing to nerve compression headaches and introduce the use of ultrasound for identification of the great auricular nerve at described locations.

We present our findings of possible sites of compression of the great auricular nerve based on a cadaveric anatomy study. We report the anatomical course of the great auricular nerve and possible sites of compression in relation to external and internal anatomical landmarks. The latter are referenced to ultrasound findings detailing the anatomical course of the great auricular nerve in relation to sites of compression. These results are used to propose possible future peripheral nerve decompression techniques and targets for chemodenervation for headaches caused by great auricular nerve compression.

MATERIALS AND METHODS

This study was carried out on 16 formalin-fixed cadaveric heads (eight female and eight male) ranging in age from 78 to 89 years. The individuals gave their written informed consent

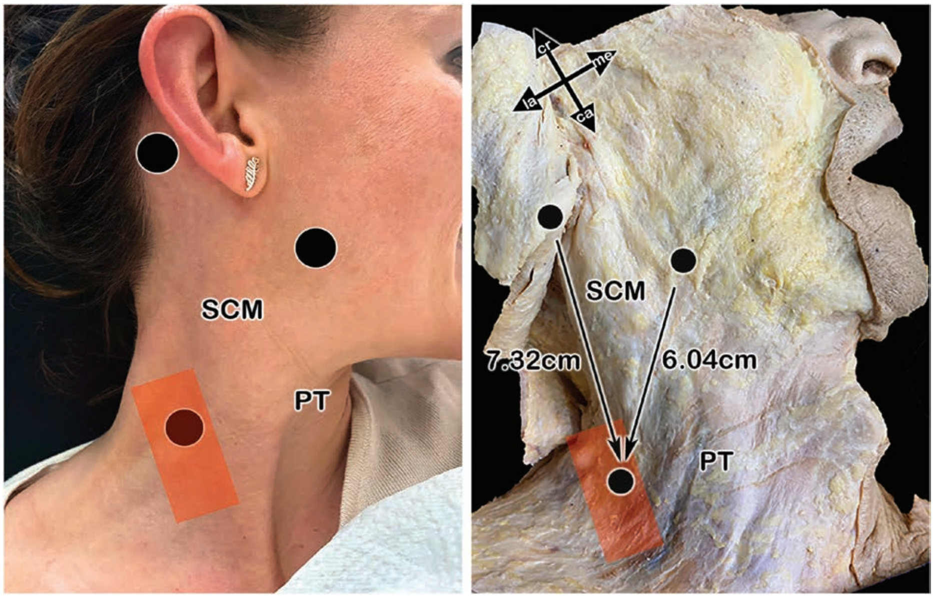

Fig. 1. Overview of the palpable anatomical landmarks (mastoid, angle of mandible) on a volunteer and a dissected body donor including important topographic measurements (Erb's point to the mastoid process at 7.32 cm on the right and Erb's point to the angle of mandible at 6.04 cm on the right). The *orange square* indicates the "area nervosa" (an area of possible penetration of the sensory nerves of the cervical plexus through the superficial cervical fascia). *Orange square* including *black dot* represents Erb's point (nerve point of the neck). *SCM*, sternocleidomastoid muscle; *PT*, platysma.

for their use for scientific purposes before death. According to Austrian national law, scientific institutions (in general institutes, departments, or institutes of medical universities) are entitled to receive willed bodies through a specific legacy, which is a special form of last will and testament. No bequests are accepted without the donor having registered their legacy and been given appropriate information on which to make a decision based on written informed consent (policy of ethics); therefore, an ethics committee approval was not necessary.[33]

Cadaveric Dissections

The shaven heads were placed in supine position and each head was marked in the following manner: the mastoid process and angle of the mandible, which were easily palpable, were marked (Fig. 1).

A median incision was made through the skin beginning from the suprasternal notch (incisura jugularis sterni) cranially to the mandible and farther to the orbit using a no. 20 blade. Dissecting from medial to lateral, the skin and subcutaneous tissue were removed.

The superficial cervical fascia was carefully incised at the crossing of the posterior borders to the sternocleidomastoid muscle and the platysma and reflected medially. Care was taken not to disrupt any of the sensory nerves at Erb's point.[34] After identification of the great auricular nerve, its course was followed to its terminal anterior and posterior branches until their entrance into the parotid gland. The number of great auricular nerve branches were identified. The great auricular nerve was measured in relation to the following landmarks: Erb's point to the mastoid process, Erb's point to the angle of the mandible, and the posterior aspect of the sternocleidomastoid muscle to the mastoid process. Data were transferred into a Microsoft Excel database (Microsoft Corp., Redmond, Wash.) and mean distances to anatomical landmarks were calculated (Fig. 2).

Ultrasonographic Approach

Using an 18-MHz hockey-stick probe (Venue; GE, Graz, Austria), the great auricular nerve was sonographically identified in a live volunteer and followed throughout its course for verification of our measurements using the specific anatomical landmarks. Possible sites of compression were noted in reference to above-mentioned anatomical landmarks (Figs. 1 and 3 through 6).

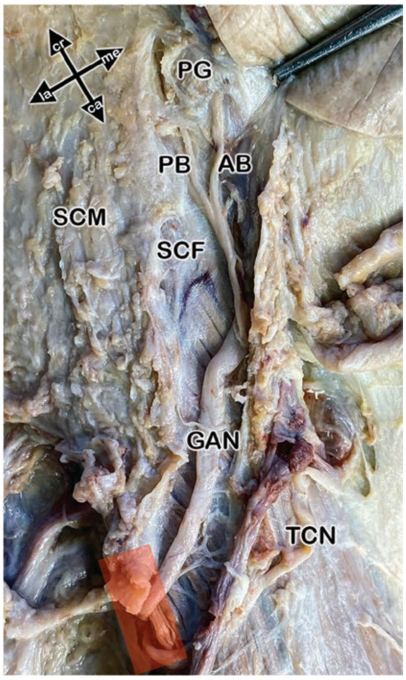

Fig. 2. Anatomical dissection of the great auricular nerve. The figure shows the topographic course of the great auricular nerve beginning at Erb's point with its penetration of the superficial cervical fascia, its course cranially along the sternocleidomastoid muscle and within the superficial cervical fascia, and its branching in the anterior and posterior branch before entering the parotid gland. *Orange square* represents Erb's point. *GAN*, great auricular nerve; *TCN*, transversus colli nerve; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PB*, posterior branch; *AB*, anterior branch; *PG*, parotid gland.

RESULTS

Cadaveric Dissections

The following mean measurements of the great auricular nerve related to the anatomical landmarks were found: Erb's point to the mastoid process was measured at 7.32 ± 0.94 cm on the right and 7.35 ± 0.59 cm on the left, Erb's point to the angle of the mandible was measured at 6.04 ± 1.05 cm on the right and 5.89 ± 0.59 cm on the left, and the posterior aspect of the sternocleidomastoid muscle to the mastoid process was measured at 3.88 ± 1.05 cm on the right and 4.43 ± 1.54 cm on the left. No gender differences could be detected. Two branches of the great auricular nerve were identified in each dissection (Table 1).

Possible sites of compression of the great auricular nerve were identified: when penetrating the superficial layer of the cervical fascia (Erb's point), when entering the dense connective tissue near the anterior border of sternocleidomastoid

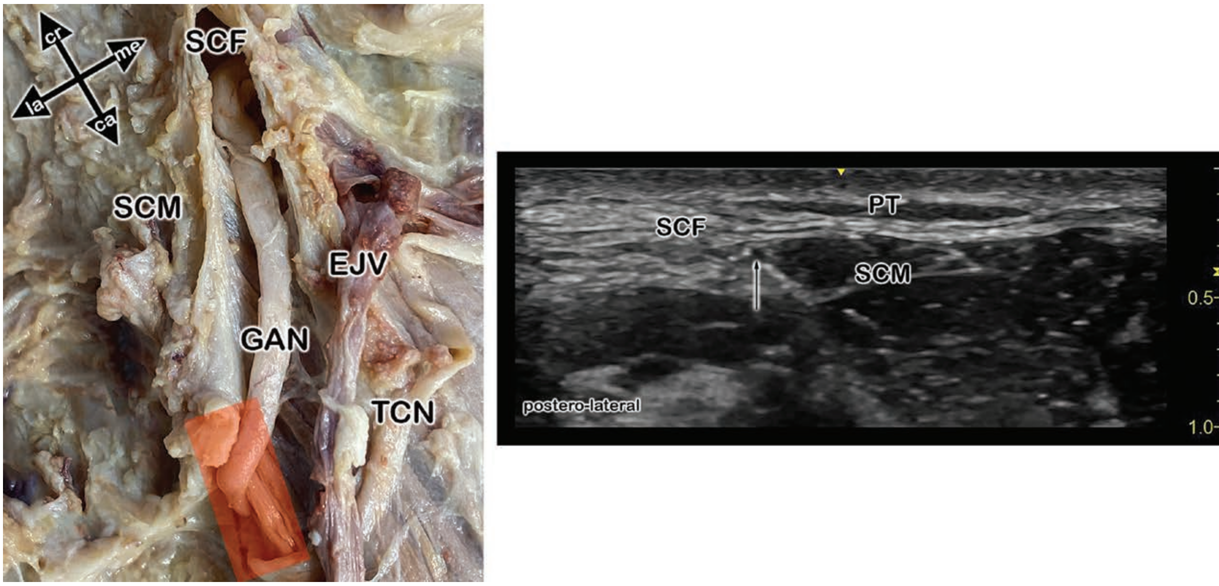

Fig. 3. Dissection and ultrasonography of the first possible site of compression of the great auricular nerve. This figure shows the first possible site of compression of the great auricular nerve when penetrating the superficial cervical fascia at Erb's point using ultrasonography and body-donor dissection. *Orange square* represents Erb's point; *black arrow* indicates the great auricular nerve while penetrating the superficial cervical fascia; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PT*, platysma; *TCN*, transversus colli nerve, *EJV*, external jugular vein.

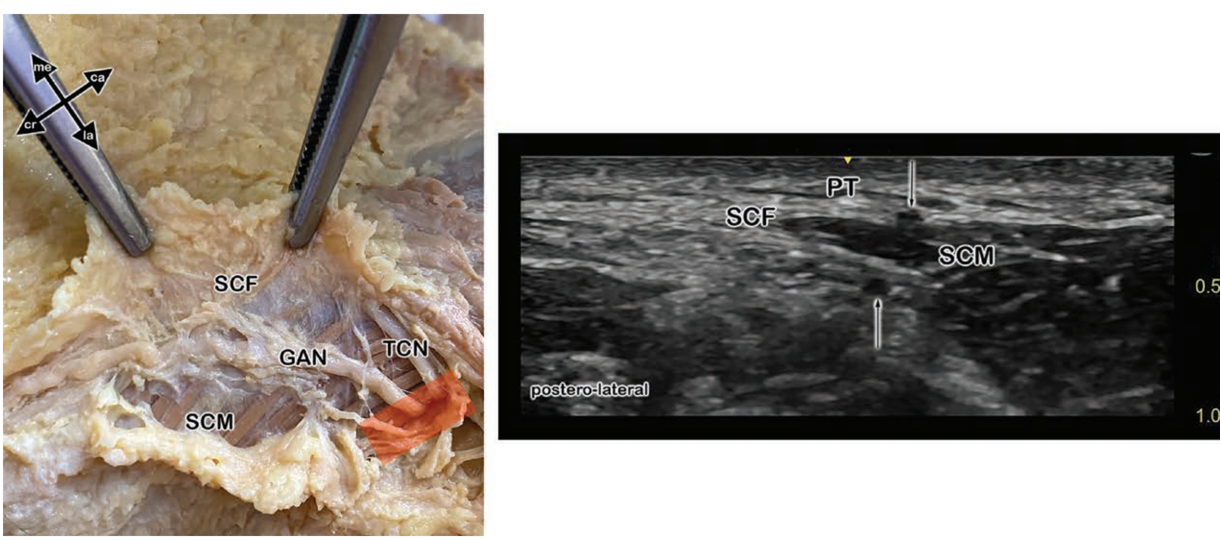

Fig. 4. Dissection and ultrasonography of the second possible site of compression of the great auricular nerve. This figure shows the second possible site of compression of the great auricular nerve when entering the dense connective tissue near the anterior border of the sternocleidomastoid muscle using ultrasonography and body-donor dissection. *Black arrows* show great auricular nerve within the superficial cervical fascia of the sternocleidomastoid muscle, one indicating the great auricular nerve lying deep to the sternocleidomastoid muscle because of ultrasound section of the nerve. *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PT*, platysma; *TCN*, transversus colli nerve; *orange square*, Erb's point.

muscle (before entering the parotid gland), and within its intraparotid course (Figs. 2 through 5).

Ultrasonographic Approach

The ultrasonographic approach demonstrated that all possible sites of compression of the great auricular nerve could be visualized using ultrasound (Figs. 3 through 6). The specific anatomical landmarks for visualization of the great auricular nerve were as follows: Erb's point, which is palpable during contraction of the platysma where the great auricular nerve crosses the posterior border of the

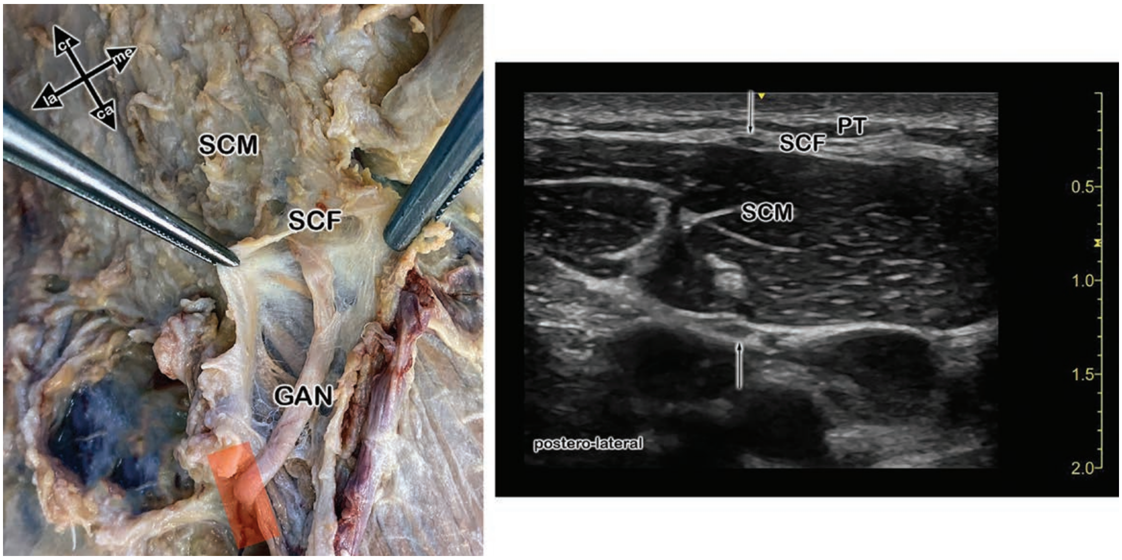

Fig. 5. Dissection and ultrasonography of the great auricular nerve within the superficial cervical fascia. This figure shows the great auricular nerve more cranially (before its branching) traveling within the dense connective tissue of the superficial cervical fascia. Black arrows indicate that great auricular nerve within the superficial cervical fascia on the sternocleidomastoid muscle and the great auricular nerve lying deep to the sternocleidomastoid muscle because of ultrasound section of the nerve. *Orange square*, Erb's point; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PT*, platysma.

sternocleidomastoid muscle. [**See Video (online)**, which shows the entire course of the great auricular nerve including its possible sites of compression. The ultrasound scan begins by identifying the great auricular nerve at Erb's point, following the nerve cranially lying on the sternocleidomastoid muscle and within the superficial cervical fascia until its entry into the parotid gland. *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle.] The visualization of the great auricular nerve (and its branches) was possible at the external, dorsal border of the sternocleidomastoid muscle penetrating the superficial cervical fascia and farther along its ascending course on the surface of the sternocleidomastoid muscle until its entrance into the parotid gland. The intraglandular position of the great auricular nerve branches could also be visualized (Figs. 3 through 6).

DISCUSSION

This study is the first to identify the possible sites of compression of the great auricular nerve as related to peripheral nerve compression headaches based on cadaveric anatomy studies and ultrasonography. Our findings demonstrate that the possible sites of compression for the great auricular nerve are at Erb's point (point 1), at the anterior border of the sternocleidomastoid muscle in the dense connective tissue before entry into the parotid gland (point 2), and within its intraparotid course (point 3). All three possible sites of compression could be identified using ultrasound.

The great auricular nerve has long been implicated in neuroma pain secondary to injury during rhytidectomy.[29,35–39] This pain has been likened to migraine pain.[35,40] In 1978, Lewin and Tsur noted that patients who have experienced transection of the great auricular nerve during rhytidectomy may complain of "migraine-like headaches" related to neuroma pain or nerve regeneration.[40] Ozturk et al. reported that transection to the great auricular nerve during rhytidectomy should be repaired intraoperatively to avoid painful neuroma formation.[29] Injury to the posterior branch of the great auricular nerve has also been well described during parotidectomy.[41,42] This is generally associated with transient anesthesia or paresthesias and can have a negative effect on long-term quality of life.[43] Great auricular nerve neuralgia has also been reported after insertion of a cardiac pacemaker and likened to a tic douloureux phenomenon because of neuroma formation within the cervical plexus and has been treated with great auricular nerve blocks.[31,44,45] Paresthesia and neuroma pain related to great auricular nerve injury is a well-documented phenomenon related to operative intervention in the head and neck region.

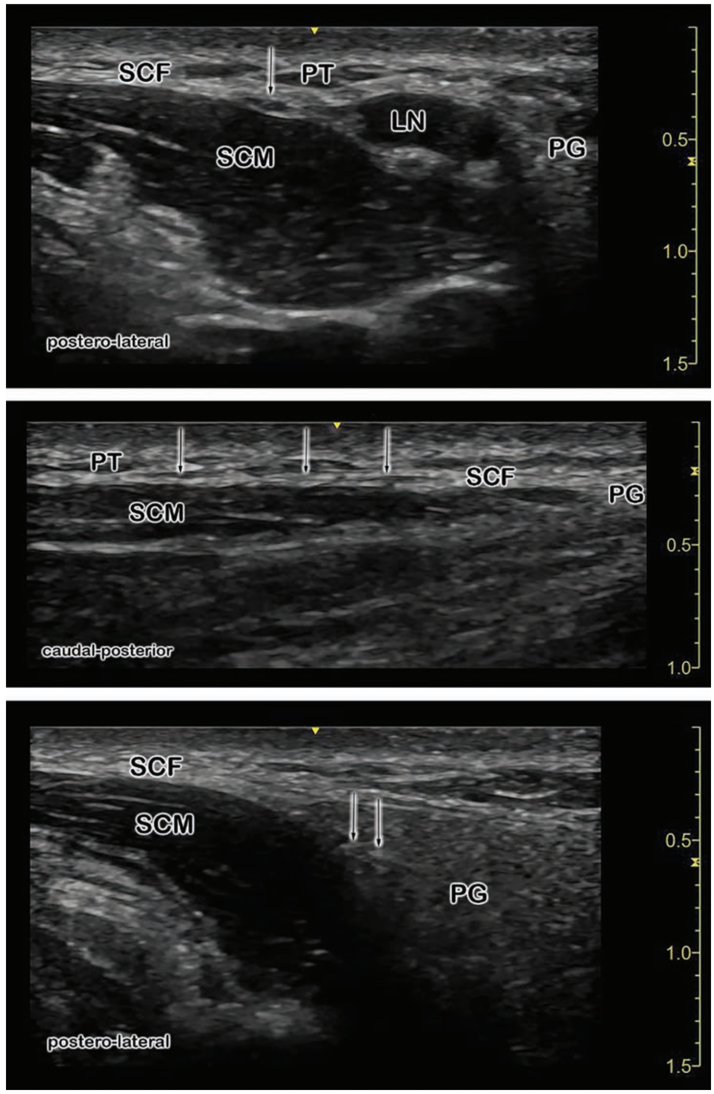

Fig. 6. Ultrasonography of the third possible site of compression of the great auricular nerve: the *black arrow* indicates the great auricular nerve before entering the parotid gland in cross-section, in longitudinal section of the nerve within the superficial cervical fascia, and in cross-section within the parotid gland already branched. *LN*, lymph node; *PG*, parotid gland; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PT*, platysma.

However, the role that the great auricular nerve plays in peripheral nerve compression headaches has, as of yet, been unexplored.

To date, four trigger sites—zygomaticotemporal branch of the trigeminal nerve, greater occipital nerve, lesser occipital nerve, and third occipital nerve—have been implicated in temporal and occipital peripheral nerve compression migraine headaches.[2,25–28] These peripheral nerve compression sites can be surgically addressed with significant improvement in headache pain.[1–5] The zygomaticotemporal branch of the trigeminal nerve is typically treated with neurectomy but can also be decompressed.[8,13,46] The lesser occipital nerve and third occipital nerve trigger sites are also typically treated with neurectomy, but can also be decompressed through lysis of fascial bands, partial muscle resection, and vessel ablation.[9,20,22,47–50] The greater occipital nerve is typically decompressed along six known anatomical sites of compression.[14,51] Despite decompression of these trigger sites, we have observed that a subset of patients have persistent pain in the area corresponding

Table 1. Great Auricular Nerve Measurements Related to the Anatomical Landmarks Including the Average and Standard Deviations and the Number of Branches Evaluated

			GAN Point (Erb's Point to the Mastoid)		GAN Point (Erb's Point to the Angle of the Mandible)		Mastoid to SCM		
Body Donor	No.	Sex	Right (cm)	Left (cm)	Right (cm)	Left (cm)	Right (cm)	Left (cm)	No. of Branches
1	0	Male	7.00	Cannot measure	8.00	Cannot measure	2.00	Cannot measure	2.00
2	0	Female	6.00	Cannot measure	5.00	Cannot measure		Cannot measure	2.00
3	7035	Female	6.00	8.00	6.00	5.50	4.50		2.00
4	7062	Female	7.00	7.00	5.30	5.40	4.50	4.00	2.00
5	7119	Male	8.00	7.50	4.50	5.00	5.00	5.00	2.00
6	7043	Male	Cannot measure	8.00	Cannot measure	5.50	Cannot measure	7.50	2.00
7	6144	Male	7.50	7.50	6.50	6.50	2.20	2.20	2.00
8	6117	Female	9.40	Cannot measure	4.60	Cannot measure	Cannot measure	Cannot measure	2.00
9	7114	Male	Cannot measure	8.00	Cannot measure	6.00	Cannot measure	3.30	2.00
10	7040	Female	7.30	7.50	5.90	6.00	4.20	Cannot measure	2.00
11	7029	Male	8.50	Cannot measure	6.80	7.00	2.50	Cannot measure	2.00
12	7154	Female	7.20	Cannot measure	6.50	Cannot measure	3.70	Cannot measure	2.00
13	7009	Female	6.00	7.00	5.50	5.50	5.00	5.00	2.00
14	6149	Male	7.00	6.00	6.50	6.50	4.50	4.00	2.00
15	7064	Female	8.00	Cannot measure	8.00	Cannot measure	3.50	Cannot measure	2.00
16	7059	Male	7.50	7.00	5.50	Cannot measure	5.00	Cannot measure	2.00
Average			7.31	7.35	6.04	5.89	3.88	4.43	
Standard deviation			0.94	0.59	1.05	0.59	1.05	1.54	

GAN, great auricular nerve; SCM, sternocleidomastoid muscle.

to the known sensory distribution of the great auricular nerve. Based on this, we sought to characterize the anatomical course of the great auricular nerve and possible sites of compression. Based on the surgical treatment of the previously detailed four occipital trigger sties, our findings suggest that the great auricular nerve can be decompressed at Erb's point (point 1) and at the anterior border of the sternocleidomastoid muscle in the dense connective tissue before entry into the parotid gland (point 2). We also demonstrate the clinical utility of ultrasound in the diagnostic workup of great auricular nerve–related peripheral nerve compression headaches. These findings provide a framework for future studies and interventions to target great auricular nerve–related peripheral nerve compression headaches.

Our study is limited in that our anatomical dissections were performed in cadaver specimens; clinical correlations must be approached cautiously. We conducted 32 dissections (bilateral) on 16 unique cadaver specimens to account for inherent variability in human anatomy; however, further anatomical studies detailing possible sites of compression of the great auricular nerve are needed to corroborate our findings. In addition, our cadaver specimens were not known to have suffered from great auricular nerve–related peripheral nerve compression headaches; therefore, we cannot comment on specific anatomical variations that may be encountered in patients with great auricular nerve–related peripheral nerve compression headaches. Lastly, our cadaver specimens were also not known to have suffered from vascular-related peripheral nerve compression, which has been shown to be a potential cause in occipital nerve–triggered headaches.[52] It would be interesting in the future to determine whether abnormal vascular and nerve anatomical relationships play a role in the cause of great auricular nerve–related peripheral nerve compression headaches. Further studies focused on diagnostic workup, criteria, and treatment for great auricular nerve–related peripheral nerve migraine headaches are needed.

CONCLUSIONS

This study identified possible sites of compression of the great auricular nerve as related to peripheral nerve compression migraine headaches based on cadaveric anatomy studies and ultrasonography. Our findings demonstrate three possible sites of compression of the great auricular nerve: at Erb's point (point 1), at the anterior border of the sternocleidomastoid muscle in the dense connective tissue before entry into the parotid gland (point 2), and within its intraparotid course (point 3). These sites of compression were verified using ultrasound on a living volunteer. These findings present an opportunity for further investigation to diagnose and treat patients suffering from great auricular nerve–related peripheral nerve compression migraine headaches.

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