Otology & Neurotology
23:393–396 © 2002, Otology & Neurotology, Inc.

Sensory Auricular Branch of the Facial Nerve

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Goal: To better describe the anatomy of the sensory auricular branch of the facial nerve.
Background: Clinical experience and the medical literature suggest that the facial nerve supplies sensory fibers to the external auditory canal and pinna. The anatomic distribution of these fibers remains poorly defined.
Methods: Ten cadaveric temporal bone dissections with photographic documentation, two clinical cases, and histologic examination of a candidate nerve fiber were collected.
Results: The anatomic distribution and histologic confirmation of a facial nerve branch coursing through the posterior wall of the external auditory canal is described. Mean (±SD) measurements along the mastoid segment of the facial nerve from the short process of the incus and chorda tympani nerve origin to the auricular branch origin were 11.6 ± 1.4 mm (range 9–13 mm) and 3.9 ± 3.0 mm (range 0–8 mm), respectively. Sacrifice of this nerve in a patient resulted in posterior external auditory canal and inferior conchal bowl hypesthesia.
Conclusion: The anatomy of a facial nerve branch coursing through the external auditory canal is presented. The anatomic and functional findings of this study suggest that this nerve represents an auricular sensory branch. Understanding these anatomic details may help in identifying the main trunk of the facial nerve in surgery, preventing postoperative external auditory canal hypesthesia, as well as understanding the significance of Ramsay-Hunt Syndrome and Hitselberger's Sign. **Key Words:** Facial nerve—Sensory auricular branch—External auditory canal—Pinna.

Otol Neurotol **23**:393–396, 2002.

Both clinical experience and experimental evidence suggest that the facial nerve provides sensory innervation to the outer ear, including the pinna and external auditory canal (EAC). In 1914, J. Ramsay Hunt proposed the cutaneous distribution of an auricular branch of the facial nerve by analysis of cases of pure herpes zoster oticus in which facial paralysis was associated with an eruption limited to an area on the pinna and the posterior aspect of the EAC. It was also noted that early in the course of this disorder, patients usually experienced intermittent pain localized to the external ear (1). Subsequently, Hitselberger and House observed that patients with tumors encroaching on the facial nerve within the internal auditory canal frequently had a sensory deficit along the posterior aspect of the EAC. This important clinical finding led these authors to the conclusion that hypesthesia of the EAC may be an early sign of an acoustic tumor (i.e., Hitselberger's sign) (2).

On the basis of this clinical information, numerous anatomic descriptions state that the facial nerve gives at least three branches during its descent through the mastoid: the chorda tympani nerve, the nerve to the stapedius muscle, and the sensory auricular branch supplying the external ear (3,4). Furthermore, nerve branches to the posterior belly of the digastric, stylohyoid, and postauricular muscles also arise in this region, most often as the nerve exits the stylomastoid foramen (4). Whereas the course of the chorda tympani nerve and the branch to the stapedius muscle are well documented in the literature, the sensory auricular branch of the facial nerve remains poorly defined.

Transmastoid surgical procedures often require progressive thinning of the posterior wall of the EAC to identify the descending segment of the facial nerve and to access various anatomic locations within the temporal bone. During these procedures, we have frequently noticed a nerve branch arising from the descending facial nerve proximal to the point at which the chorda tympani nerve originates. This nerve courses through the posterior osseous EAC in an inferior and lateral direction. The objective of this study was to better describe the anatomic and functional significance of this facial nerve branch.

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Supported in part by the National Institutes of Health Grant No. K23 DC00187.

Presented at the spring meeting of the American Neurotology Society, Palm Springs, California, U.S.A., May 13, 2001.

MATERIALS AND METHODS

Cadaveric temporal bone dissection

Ten human cadaveric temporal bones preserved in formaldehyde solution were selected at random for inclusion in the study. The dissection was carried out by use of standard otologic instruments with the surgical microscope. The dissection was begun with a cortical mastoidectomy and continued with progressive thinning of the posterior wall of the EAC with identification of the main trunk of the facial nerve, the chorda tympani nerve, and the presumed sensory auricular branch of the facial nerve. The sensory auricular branch was most frequently identified at its origin just superior to the chorda tympani takeoff. The nerve usually coursed superiorly and laterally for a variable distance at the apex of the facial recess and then turned laterally and inferiorly, passing posteriorly to the chorda tympani nerve to arborize near the bony cartilaginous junction of the inferior EAC.

In an effort to better characterize the location of the sensory auricular branch of the facial nerve, measurements were made relative to the tip of the short process of the incus and the chorda tympani nerve. Millimeter-calibrated graph paper was trimmed into strips and used to measure the length of the defined anatomic segments. For the purposes of this study, four anatomic points were defined (Fig. 1): I, tip of the short process of the incus; C, chorda tympani nerve origin at the fallopian canal; B, origin of the auricular branch of the facial nerve; and B′, the point of intersection between the chorda tympani nerve and the auricular branch of the facial nerve. Measurements were made between 1) B and I along the fallopian canal (i.e., BI), 2) C and I along the fallopian canal (i.e., CI), 3) B and C along the fallopian canal (i.e., BC), and 4) at the point where the chorda tympani nerve crosses the auricular branch of the facial nerve in the posterior wall of the EAC (i.e., B′C). Means, standard deviations, and ranges were computed for the various measured distances.

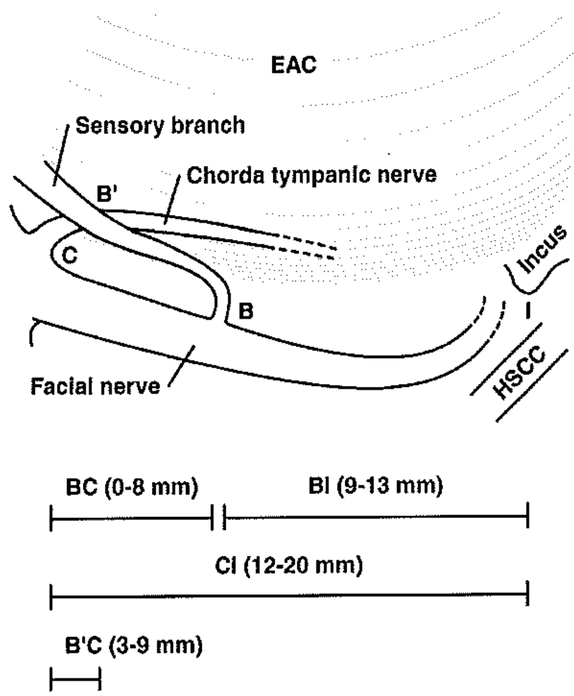

FIG. 1. Course of facial nerve through the mastoid with the described anatomic points and segments. I, tip of the short process of the incus; C, chorda tympani nerve origin at the fallopian canal; B, origin of the auricular branch of the facial nerve; B′, point of intersection between the chorda tympani nerve and the auricular branch of the facial nerve; HSCC, horizontal semicircular canal.

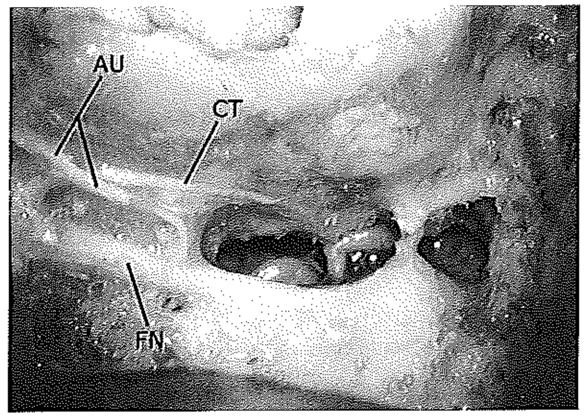

FIG. 2. Microscopic photograph of a left human cadaveric temporal bone after dissection of the mastoid with identification of the vertical portion of the facial nerve (FN), the chorda tympani nerve (CT), and the auricular branch of the facial nerve (AU).

Clinical cases

Two clinical cases are presented that delineate the anatomic distribution of the auricular branch of the facial nerve as well as the sensory deficit imparted by its sacrifice. The first patient underwent intentional sacrifice of this nerve branch during a skull base procedure, and the second patient had inadvertent sacrifice of this nerve branch during thinning of the EAC.

RESULTS

Cadaveric temporal bone dissection

Figure 2 shows a microscopic photograph of a left human cadaveric temporal bone after dissection of the mastoid with identification of the vertical portion of the facial nerve, the chorda tympani nerve, and an auricular branch of the facial nerve. In this case, the auricular branch arises superiorly to the origin of the chorda tympani nerve, courses laterally, and then turns inferiorly to pass posteriorly to the chorda tympani nerve. The auricular branch of the facial nerve was identified in all temporal bones dissected, although there was considerable variation in the size of the nerve as well as in the initial direction of the takeoff of the nerve. In some cases, the nerve coursed in a superior direction before turning inferiorly (Fig. 3), whereas in other cases the nerve coursed laterally and inferiorly (Fig. 2). In only one case was the auricular branch seen passing anteriorly to the chorda tympani nerve.

Table 1 shows the values for the measurements obtained from the dissected temporal bones. Generally, the distance between the incus and the auricular branch ori-

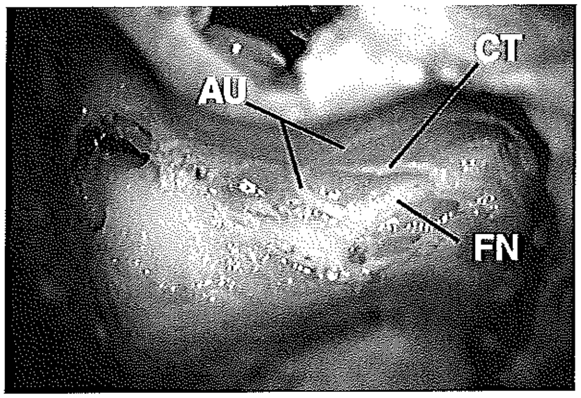

FIG. 3. Microscopic photograph of a right human cadaveric temporal bone after dissection of the mastoid with identification of the vertical portion of the facial nerve (FN), the chorda tympani nerve (CT), and the auricular branch of the facial nerve (AU). In comparison with Figure 2, the AU arcs somewhat more superiorly before coursing laterally and inferiorly.

gin (i.e., BI) was relatively constant, with a mean (±SD) of 11.6 ± 1.4 mm (range 9–13 mm). By contrast, the mean (±SD) distances from both the short process of the incus and the auricular branch origin to the chorda tympani nerve origin (i.e., BC and CI) were quite variable (mean BC = 3.9 ± 3.0 mm [range 0–8 mm]; mean CI = 15.5 ± 2.6 mm [12–20 mm]), implying that the chorda tympani nerve originates in a variable position along the descending segment of the facial nerve. This observation is consistent with those of previous investigators (5). In 3 of 10 cases, the origin of the auricular nerve was indistinguishable from that of the chorda tympani nerve.

Clinical cases

Case 1

A 36-year-old man with profound unilateral sensorineural hearing loss was seen to have a large glomus jugulare tumor involving the infratemporal skull base and osseous labyrinth. He underwent a postauricular infratemporal fossa approach, necessitating removal of the EAC. The auricular branch of the facial nerve was identified and removed for histologic analysis, which confirmed a normal peripheral nerve.

TABLE 1. *Distance measurements (mm) between incus, chorda tympani nerve, and auricular branch of the facial nerve*

Nerve segment	Mean distance + SD	Range
BI	11.6 ± 1.4	9–13
BC	3.9 ± 3.0	0–8
CI	15.5 ± 2.6	12–20
B′C	6.2 ± 1.8	3–9

BI, tip of short process of incus to auricular branch origin; BC, chorda tympani nerve origin to the auricular branch origin; CI, chorda tympani nerve origin to the short process of the incus; B′C, chorda tympani nerve origin to the point of intersection with the auricular branch of the facial nerve.

Case 2

A 54-year-old woman had unilateral profound sensorineural hearing loss and Ménière's disease refractory to medical therapy. She elected treatment with a transmastoid labyrinthectomy. During thinning of the posterior aspect of the osseous ear canal, the auricular branch of the facial nerve was identified and inadvertently removed, while the integrity of the ear canal bone and skin were maintained. Postoperatively, the patient experienced hypesthesia in the inferior and posterior aspects of the EAC and conchal bowl, which was confirmed by physical examination.

DISCUSSION

The findings of this study provide an anatomic description of the sensory auricular branch of the facial nerve as initially proposed by Hunt in 1914 and later reported by Hitselberger and House in 1966 (1,2). First, 10 cadaveric temporal bone dissections illustrated a small nerve branch arising from the vertical segment of the facial nerve between the second genu and the chorda tympani nerve origin. This nerve branch usually arcs laterally and courses inferiorly away from the fallopian canal to supply the posterior and inferior EAC at the region of the osseous-cartilaginous junction. Biopsy of the presumed nerve from a patient undergoing an EAC-sacrificing procedure confirmed normal peripheral nerve tissue. Finally, removal of the nerve during a procedure in which the integrity of the osseous and soft tissue EAC was maintained demonstrated a sensory deficit in the posterior EAC and conchal bowl, implying a sensory function for this nerve.

In the early 1900s, J. Ramsay Hunt described the dermatomal distribution of 14 cases of isolated herpes zoster oticus associated with facial paralysis and observed that the vesicular eruption varied considerably in size and distribution, although it most often involved some portion of the inferior pinna and the posterior EAC (1). He proposed the course of the sensory fibers of the facial nerve to travel with the motor fibers within the fallopian canal, ultimately reaching the auricle by way of the auricular branch of the vagus nerve (i.e., Arnold's nerve), the postauricular nerve (i.e., sensory auricular branch), or the motor fibers destined for the innervation of the intrinsic muscles of the external ear. Unfortunately, no description of the anatomy of these nerve branches was included.

Later in the century, Hitselberger and House described hypesthesia of the EAC as an early sign of acoustic tumors, although complete auricular anesthesia was never encountered (2). The observations of these investigators support those of Hunt and others that suggest that multiple nerves (trigeminal, facial, glossopharyngeal, vagus, cervical nerves C1 and C2) provide sensation to the external ear. In their writings, they also stated that they frequently noticed branches arising both from the vertical segment of the facial nerve and from the chorda tympani nerve coursing through the bone of posterior

EAC wall. As in our study, these authors performed biopsies of the nerve branches confirming the presence of nerve fibers. Further detailed anatomic descriptions of these EAC branches from the facial nerve were lacking.

May has described patients who experienced severe pain while the region of the posterior EAC was being drilled during facial nerve surgery performed under local anesthesia. It was assumed in these cases that the pain was caused by surgical manipulation of the afferent fibers carried with the chorda tympani nerve and sensory branches of the facial nerve. Again, anatomic details were lacking (4).

Aside from the above-mentioned clinical reports, to our knowledge no detailed anatomic studies in humans clearly decipher the origin of the sensory nerve fibers within the facial nerve that provide innervation to the external ear. Moreover, significant confusion exists regarding the interrelationship between the sensory auricular branch of the facial nerve and the auricular branch of the vagus nerve (i.e., Arnold's nerve). According to an experimental study by Foley and DuBois performed in cats, sensory innervation to the EAC is, in part, provided by afferent fibers from both the vagus and the facial nerves (6). The sensory fibers of the facial nerve originate in the pons and travel distally within the main trunk of the nerve, constituting some 10% to 15% of the total number of facial nerve neurons. The sensory component of the vagus nerve arises as Arnold's nerve, a single nerve that courses from the superior ganglion of the vagus nerve and passes posteriorly over the dome of the jugular bulb to enter the anterior aspect of the fallopian canal just proximal to the chorda tympani nerve origin. At this point, the two sensory contributions fuse to form one nerve, which exits the sheath as the auricular nerve to provide sensation to the EAC and auricle. By contrast, others report that the auricular branches of both the facial nerve and the vagus nerve may provide separate innervation to the auricle and EAC through other pathways (7).

Numerous questions remain to be answered regarding the sensory auricular nerve branch described herein. Intuitively, surgical sacrifice of this nerve during procedures close to the EAC should result in hypesthesia or anesthesia in the posterior region of the EAC and conchal bowl. Because our study reported on only one clinical case of nerve sacrifice with EAC preservation, future investigations should attempt to better elicit the true incidence of this particular observation. Moreover, detailed histopathologic analysis should be performed to better assess the fiber caliber, origin, and branching patterns. Finally, future studies should also attempt to decipher the various contributions of the facial nerve and the vagus nerve to this auricular nerve branch.

CONCLUSIONS

The present study details the anatomic and functional significance of the sensory auricular branch of the facial nerve. This nerve arises from the main trunk of the descending facial nerve proximal to the origin of the chorda tympani nerve and supplies sensory fibers to the posterior EAC and the inferior portions of the pinna. Understanding the anatomy of the sensory auricular branch of the facial nerve may be helpful in identifying the main trunk of the facial nerve during surgical dissections of the mastoid as well as understanding the significance of Ramsay Hunt Syndrome, Hitselberger's Sign and possibly some idiopathic cases of otalgia.

Acknowledgments: The authors thank Arlene Villarrubia Hidalgo for her tireless assistance in helping us perform this project in the University of Miami School of Medicine, Department of Otolaryngology, Microsurgery Training Center. They also thank Thomas J. Balkany, M.D., for his helpful guidance and support of this project.

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