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Anatomic and histological study of great auricular nerve and its clinical implication

Hun-Mu Yang [a], Hee-Jin Kim [b], Kyung-Seok Hu [b,*]

[a] *Department of Anatomy, College of Medicine, Dankook University, Cheonan, South Korea*
[b] *Division in Anatomy and Developmental Biology, Department of Oral Biology, Yonsei University College of Dentistry, Seoul, South Korea*

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Summary *Background:* The great auricular nerve (GAN) is often sacrificed during parotidectomy, rhytidectomy, and platysma flap operation. Transection of the nerve results in a wooden numbness of preauricular region, pain, and neuroma. The aim of this study was to describe the branching patterns and distribution area of the GAN.
Methods: Twenty-five embalmed, adult hemifacial Korean cadavers (16 males, nine females; mean age 62.5 years) were used in this study. The branching of the GAN was determined through careful dissection. The histological structure of the GAN was also examined by harvesting and sectioning specimens, and then viewing them with the aid of a light microscope.
Results: The branching pattern of the anterior, posterior, deep, and superficial branches of the GAN could be classified into five types: type I (20%), where the deep branches arose from the anterior branch; type II (24%), where all branches originated at the same point; type III (28%), where the deep branch arose from the posterior branch; type IV (8%), where the superficial branches arose from the posterior branch; and type V (20%), where the anterior and posterior branches ran independently. A connection between the GAN and the facial nerve trunk was observed in all specimens, and a connection with the auriculotemporal nerve was observed in a few specimens. The total fascicular area of both regions decreased from proximal (1.42 mm^2) to distal (0.60 mm^2). There were 2.5 and 5 fascicles in the proximal and distal regions, respectively.
Conclusion: The results reported herein will help toward preservation of the GAN during surgery in the region of the parotid gland. Furthermore, the histologic findings suggest that the GAN would be a good donor site for nerve grafting.

* Corresponding author. Room 601, Department of Oral Biology, Yonsei University College of Dentistry, 50 Yonseiro, Seodaemun-gu, Seoul 120-752, South Korea. Tel.: +82 2 22283047; fax: +82 2 3938076.
E-mail address: hks318@yuhs.ac (K.-S. Hu).

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Introduction

The great auricular nerve (GAN) is the largest of the four cervical cutaneous nerves. It emerges through the superficial cervical fascia on the posterior border of the sternocleidomastoid muscle (SCM), and distributes to the mandibular angle, the skin over the parotid gland, the parotid gland, and the skin of the auricle.[1] Clinically, iatrogenic or inevitable amputation of the GAN during rhytidectomy or parotidectomy would incur significant complications such as dysesthesia or allodynia in the involved skin area, otalgia, discomfort on cold exposure, and traumatic neuroma.[2–7]

McKinney and Gottlieb (1980) reported that the GAN was positioned deep to the layer containing the superficial musculoaponeurotic system (SMAS), and thus manipulating the SMAS during facelift surgery was thought to be relatively safe.[6] However, there have been numerous reports of GAN impingements during facelift surgery. Ozturk et al. (2012) found that injury to the GAN can result in more severe distress than injury to cutaneous nerves in other areas, although the incidence of GAN injury is low, reportedly ranging from 0% to 2.6%.[7] Barbour et al. (2013) reported that GAN injury is a common complication, occurring at a rate of 6% during rhytidectomy, and that a recently introduced, minimally invasive technique for producing a short scar has an increased risk of GAN injury.[2] In addition, it was reported that the rate of sensory disorders resulting from nerve damage during parotidectomy has increased significantly.[3]

Traumatic neuroma can also occur after amputation of the GAN.[4,8,9] Moss at al. (2000) reported that traumatic neuroma following sacrifice of the GAN occurred at a rate of 6% after surgery on the parotid gland, while de Chalain and Nahai (1995) described a large neuroma at the distal end of a transected GAN in a 56-year-old female patient that was detected 9 years after full rhytidectomy.[4,9]

On the other hand, the GAN is known to be a good donor nerve because it is easily accessible due to its convenient location beneath the platysma muscle, and it can be harvested during nerve graft surgical procedures of the head and neck region without the necessity for additional surgery. Its relatively large cross-sectional area renders the GAN a frequent candidate for replacing the facial nerve (FN), inferior alveolar nerve, and accessory nerve.[10–15]

The purpose of this study was to describe the branching patterns of the GAN and its topographic relationships to other nearby structures, with the aim of providing critical reference data for surgical procedures to the head and neck. Furthermore, the histomorphometric characteristics of the GAN were explored in the context of nerve grafting.

Materials and methods

In total, 25 sides of formalin-fixed necks from Korean cadavers (11 bilateral specimens, three unilateral specimens) were used in this study. The subjects included 16 males and nine females, with an average age of 62.5 years. The precise course of the GAN and the extent of its innervation and communication were established by careful dissection of these cadaveric specimens, which had no history of trauma or any surgical procedures on the face and neck.

The dissections were performed with the specimens in the oblique lateral position. The parotid fascia and the superficial cervical layer were exposed by dissection of the whole dermal layer from the neck to the face. The cervical cutaneous nerves were particularly carefully dissected and sketched, with special attention being paid to the course of the GAN on the SCM muscle. Along with the course of the GAN, the nerve branches were exposed clearly, and further fine dissection was performed to identify the fine nerve branches of the GAN on the parotid fascia and the nerve branches to the auricle. In addition, after removal of the skin from the anterior and posterior aspects of the specimens, the fine nerve branches from the GAN could be identified. The distribution area of the GAN to the auricle was also explored through the dissection.

At the parotid region, the parotid parenchyma was removed and the region dissected further to expose the FN trunk and its divisions, and the fine terminal nerve branches from the GAN. The communicating nerve twigs among the nerve branches of the GAN, the FN, and the nerve branches of the trigeminal nerve were examined. All of the microdissections were performed with the aid of a surgical microscope (OPMI, Zeiss, Germany).

Sections were prepared for histomorphometric analysis by first harvesting the intraparotid terminal nerve branches of the GAN (including the FN trunk) from five specimens, and from the point at which the GAN emerges at the posterior border of the SCM (i.e., the proximal region of the GAN) and the region prior to the furcation point of the GAN on the SCM (i.e., the distal region of the GAN) from 10 dissected specimens. These specimens were postfixed for 72 h with 4% paraformaldehyde and then embedded in paraffin wax. Transverse 5-μm-thick sections were mounted on glass slides, and then stained with hematoxylin–eosin and Luxol fast blue. Histologic observations were performed with the aid of a light microscope, and photographs were taken.

No distinction was made between the male and female cadavers. All photographs and diagrams in this article are of structures viewed from the left side of the specimen.

Results

In all specimens, the GAN ascended toward the parotid gland from the posterior border of the SCM. In terms of the topographic relationship with surrounding structures, the GAN emerged from the posterior border of the SCM, and was located behind the external jugular vein in every case.

The GAN divided into the anterior and posterior branches in its course on the SCM. The anterior branch then further divided into the superficial and deep branches. The superficial branch distributed to the skin and surface of the parotid gland, while the deep branch entered the parenchyma of the parotid gland. The branching patterns of these nerve branches could be classified into five categories (Figure 1):

- Type I – The GAN divided into the anterior and posterior branches, and then the anterior branch bifurcated into