The Great Auricular Nerve in Fetuses

El Nervio Auricular Mayor en Fetos

Pathmavathie Pillay; Prawesh Partab; Lelika Lazarus & Kapil S. Satyapal

SUMMARY: The great auricular nerve (GAN) is the largest branch of the superficial cervical plexus that winds around the posterior border of the sternocleidomastoid muscle, accompanied by the external jugular vein. Forty fetuses (right side: 40/80; left: 40/80) with gestational ages between 15 to 28 weeks were microdissected to document the anatomy of the GAN. The results obtained were classified as: i) Incidence and morphometry: GAN was present in 100% of the fetal specimens with average length on the right and left sides recorded as 12.65 ± 2.14 mm and 12.55 ± 2.82 mm respectively. ii) Course: GAN was located parallel to the transverse cervical nerve and the external jugular vein. Duplicate external jugular veins were observed in 5% (4/80) with GAN located anterior to one of the tributaries; iii) Branching Pattern: 16% (13/80) of specimens depicted a single branch. Duplicate branches in 67% (54/80) (referred to as Type I: anterior and posterior branches and 33% (26/80) referred to as Type II: anterior and posterior branches; iv) Variation: the transverse cervical nerve formed a communication with GAN, inferior to the parotid gland in 1%. The anatomical knowledge of the course, bifurcation pattern and variations of GAN may prevent complications during surgical procedures such as parotidectomies.

KEY WORDS: Great auricular nerve; Fetuses; Branching pattern; Anatomical variation.

INTRODUCTION

Nerve trunks develop into the superficial & deep parts of the cervical plexus during the fourth week of gestational development. The great auricular nerve (GAN) is the largest ascending branch arising from the loop between the ventral ramus of the second and third cervical nerves or directly from the ventral ramus of the third cervical nerve (Biglioli *et al.,* 2002; Standring, 2008). It winds around the posterior border of the sternocleidomastoid muscle, pierces the deep fascia and ascends under the superficial musculo-aponeurotic system and platysma muscle, accompanied by the external jugular vein (Pantaloni & Sullivan, 2000; Standring). It divides into anterior and posterior branches as it emerges from beneath the posterior border of the sternocleidomastoid muscle and these branches ascend diagonally across it towards the parotid gland.

In addition, Biglioli *et al.* suggested that the bifurcation of these two terminal branches occurs in the proximity of the inferior pole of the parotid gland and may be located within or outside the gland. Prior to this bifurcation a collateral branch arises from GAN and runs to the skin of the mastoid region and the posterior surface of the auricle. The anterior branch pierces the inferior pole of the parotid gland and exits anteriorly to innervate the skin overlying the parotid gland (Rouviere, 1959) and the angle of the mandible (Hollinshead, 1974). The posterior branch passes to the posterior margin of the glandular parenchyma, destined for the skin over the mastoid process, the postero-inferior surface of the auricle, the lobule, and concha (Cummings, 2003; Moore & Dalley, 1999; Patel *et al.*, 2001; Biglioli *et al.*).

It has been suggested by Biglioli *et al.*, that the cutaneous innervation over the region of the mastoid process and the submandibular triangle of the neck is supplied by GAN. Rogers & Jacob (1992) reported that GAN supplied the skin just posterior to the pinna of the ear and Moore & Dalley stated that GAN innervates the parotid sheath.

However, Ellis & Fieldman (1993) described the nerve as having three terminal branches viz. auricular; mastoid and facial that supplies the lower two-thirds of the ear and lateral surface of the lobule; skin over the mastoid process and the skin over the masseter and parotid gland, respectively. Zumeng *et al.* (2006) stated that GAN trifurcated above the mandibular angle into anterior auricular, posterior auricular and lobular branches.

Department of Clinical Anatomy, Faculty of Health Sciences, University of KwaZulu-Natal, Durban, South Africa.

It has been reported that communications between GAN and the transverse cervical nerve as well as some cranial nerves exist viz. The anterior branch of GAN sends small branches into the parotid gland and this connects to the facial nerve as they lie on and within the substance of the parotid gland (Ginseng & Eicher, 2000). In a recent study conducted by Brennan *et al*. (2008), an unusual communication between GAN and the marginal mandibular branch of the facial nerve was observed.

The posterior branch of the GAN joins the auricular branch of the vagus nerve, and posterior auricular branch of the facial nerve behind the ear (Rouvière) and communicates with the lesser occipital nerve (Wyburn-Mason, 1953; Standring *et al*.). Therefore, it appears that sensory fibres from the GAN are carried into the trigeminal area with the facial nerve (Wyburn-Mason). Biglioli *et al*. reported an anastomosis between the anterior branch of GAN and the transverse cervical nerve. The precise anatomical knowledge of the course, bifurcation pattern & variations of GAN may prevent surgical complications therefore the aim of the study was to document the anatomy of GAN and variations encountered.

MATERIAL AND METHOD

Forty fetuses (gestational age: 15 to 28 weeks) (right side: 40/80; left: 40/80) were obtained from the Department of Clinical Anatomy, University of KwaZulu-Natal in accordance with the National Health Act 61 of 2003 and Human Tissue Act 65 of 1983: Ethical Clearance No: BF 156/07. Fetal cadaveric specimens with signs of injuries, trauma or pathology in the lateral and posterior compartments of the neck were excluded. The detailed dissection of the posterior triangle of the neck was completed using standard Carl Ziess Stemi DV4 micro-dissecting instruments, and the anatomical course of the GAN, and variations were recorded and photographed using a Canon digital camera. In addition, the GAN length was measured using a Wilson Wolpert Digital vernier caliper (0 – 150mm).

RESULTS

a) **Incidence.**The GAN was present in 100 % of the specimens bilaterally.

b) **Mophometry.** The average length of the GAN on the right and left sides were 12.65 ± 2.14 (7.82 – 17.16) mm and 12.55 ± 2.82 (7.60 – 18.28) mm, respectively.

c) **Course.** The GAN appeared as a large ascending branch of the superficial cervical plexus. It pierced the investing layer of cervical fascia, ascended under the superficial musculo-aponeurotic system and the platysma muscle; thereafter it emerged from beneath the posterior border of the sternocleidomastoid muscle. It had a superficial antero-superior course on the sternocleidomastoid muscle, crossing it diagonally to penetrate the parotid gland in all specimens [80/80 (100%)] of the specimens. Furthermore, in its course, the GAN was located parallel to the transverse cervical nerve and the external jugular vein (Fig. 1).
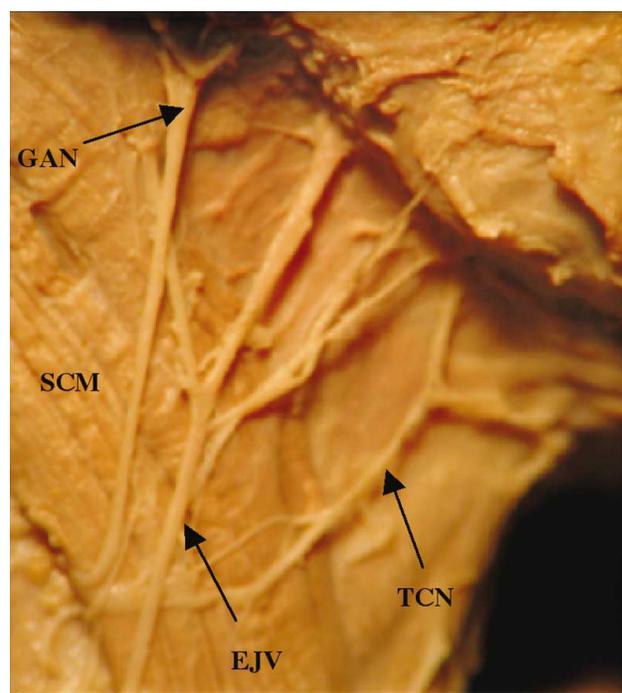

Fig. 1. Right anterior view of neck depicting the course of the great auricular nerve. GAN: Great Auricular nerve; SCM: Sternocleidomastoid muscle; EJV: External jugular vein; TCN: Transverse cervical nerve.

In 4/80 (5%) of the specimens, duplicate external jugular veins were observed; in these specimens the GAN was located anterior to one of the tributaries (indicated by dotted circle) (Fig. 2). The GAN innervated the inferior one-third of the ear in 37/80 (46%) of the specimens; and the superior two-third of the ear in 43/80 (54%).

d) **Branching patterns**. Immediately, after emerging from beneath the posterior border of the sternocleidomastoid muscle, the GAN divided into two large and distinct branches in 67/80 (84%) of the fetal specimens. In 13/80 (16%) of the specimens the GAN remained as a single branch (Fig. 3).

The following branching patterns were observed:

Single: As the GAN emerged on the sternocleidomastoid muscle it continued as a single branch in 13/80 (16%) of specimens; this branch divided at the inferior pole of the parotid
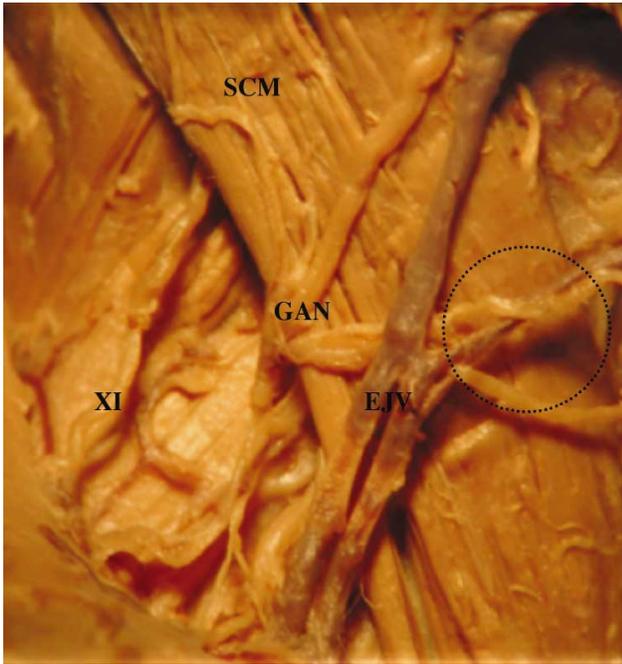

Fig. 2. Right anterior view of neck depicting the great auricular nerve relation to the external jugular vein. GAN: Great auricular nerve; SCM: Sternocleidomastoid muscle; EJV: External jugular vein; XI: Accessory nerve.
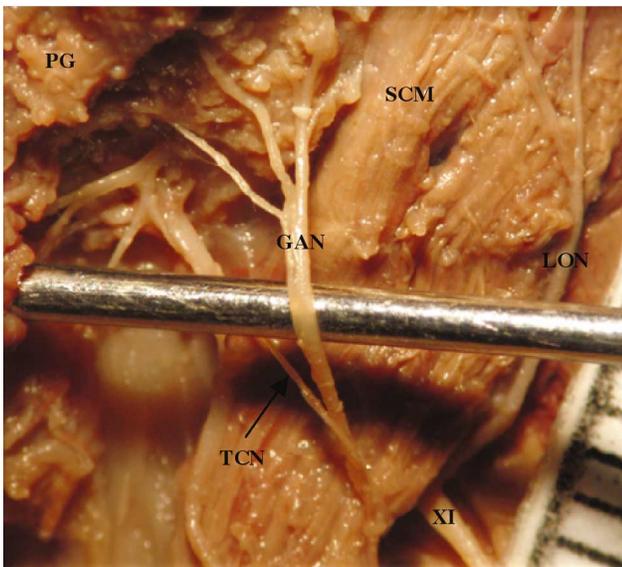

Fig. 3. Left anterior view of the single branching pattern and distribution of the great auricular nerve. GAN: Great auricular nerve; LON: Lesser occipital nerve; PG: Parotid gland; SCM: sternocleidomastoid muscle; XI: Accessory nerve; TCN: Transverse cervical nerve.

gland into minute branches and were distributed to the parotid fascia as well as to the inferior part of the ear.

Duplicate: Immediately after emerging from the posterior border of the sternocleidomastoid muscle, the GAN divided into two main branches in 54/80 (67%) of the fetuses. These branches are referred to as Type I: anterior and posterior branches (Fig. 4). The anterior branch divided into smaller branches that were distributed to the parotid fascia and the posterior branches supplied the area over the mastoid region.
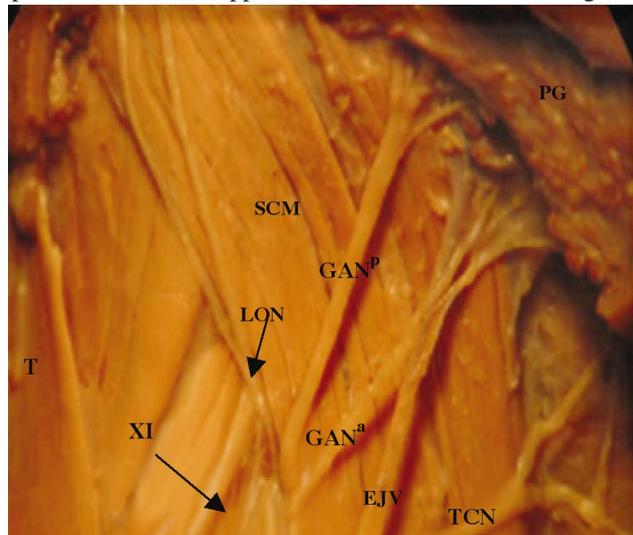

Fig. 4. Right anterior view of Type I branches of the great auricular nerve. SCM: Sternocleidomastoid muscle; GANa: Anterior branch of great auricular nerve; GANp: Posterior branch of great auricular nerve; PG: Parotid gland; TCN: Transverse cervical nerve; EJV: External jugular vein; T: Trapezius muscle; XI: Accessory nerve.
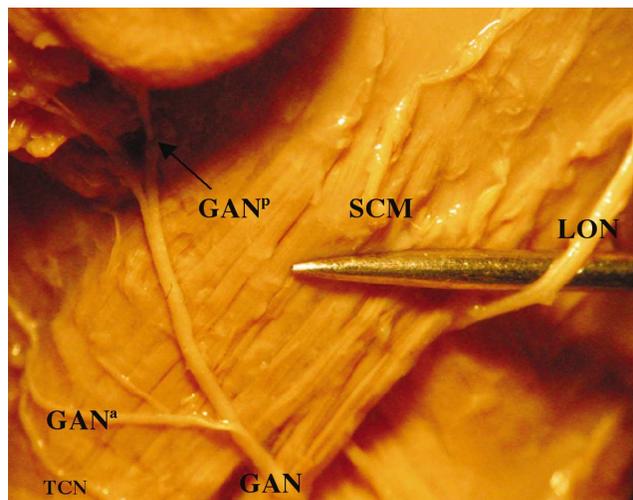

Fig. 5. Left anterior view of Type II branches of the great auricular nerve. SCM: Sternocleidomastoid muscle; GAN: Great auricular nerve; GANa: Anterior branch of Great Auricular nerve; GANp: Posterior branch of great auricular nerve; LON: Lesser occipital nerve; TCN: Transverse cervical nerve.
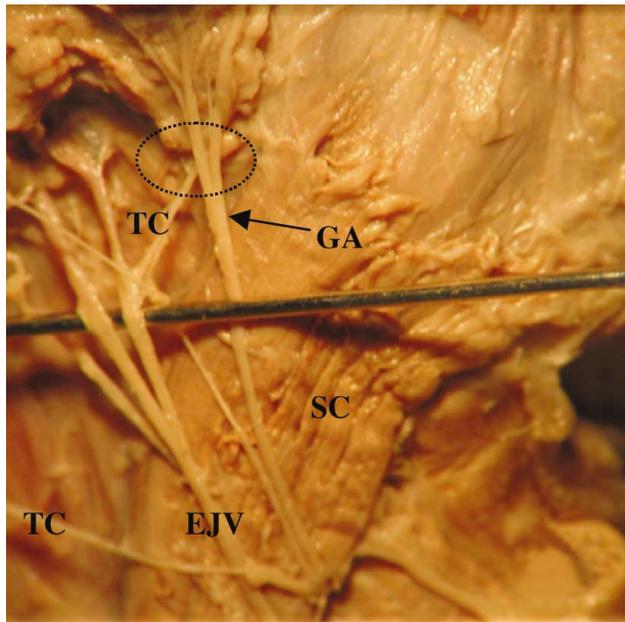
Fig. 6. Left anterior view of the communication between great auricular nerve and the transverse cervical nerve. TCN: Transverse cervical nerve; GAN: Great auricular nerve; EJV: External jugular vein; SCM: Sternocleidomastoid muscle.

In 26/80 (33%) of the specimens the GAN bifurcated into anterior and posterior branches at about the midpoint of the sternocleidomastoid muscle (Fig. 5); these branches are referred to as Type II: anterior and posterior branches.

e) Variation. On the left side in 1/80 (1%) of the fetal specimens, the transverse cervical nerve divided into three branches, with the uppermost branch forming a communication with the GAN, inferior to the parotid gland (indicated by circle) (Fig. 6).

DISCUSSION

The GAN is an ascending branch of the superficial cervical plexus that pierces the investing layer of cervical fascia, to emerge from beneath the posterior border of the sternocleidomastoid muscle (Biglioli *et al.*; Strandring *et al.*). It then had a superficial antero-superior course on the sternocleiodmastoid muscle, crossing it diagonally to penetrate the parotid gland (Pantaloni & Sullivan; Standring *et al.*). In addition, in its course GAN was constantly parallel to the transverse cervical nerve and the external jugular vein. It has been reported by Zohar *et al.* (2002) that the anatomical descriptions of GAN vary:

it has been described as a sensory nerve by Zohar *et al.*, "a superficial nerve supplying the skin" by Hollingshead and as a nerve "terminating in the external fascia of the parotid gland" by Moore & Dally. The results obtained in this study concur with Moore & Dally. Yokoshima *et al.* (2004), stated that the GAN is considered a significant anatomical landmark to identify structures such as the accessory nerve. This allows for easy identification of the accessory nerve in the posterior triangle of the neck and may be a useful to reduce the risk of surgical injury.

In this investigation the GAN arose predominantly from a common trunk with the lesser occipital nerve which arose from the third cervical ventral ramus in fetuses [59/80 (74%)] which correlates with standard anatomical (Standring *et al.*) and some surgical (Biglioli *et al.*) texts. In the presence of the single branching pattern, the GAN emerged from beneath the posterior border of the sternocleidomastoid muscle, crossed the anterior border as a single branch; thereafter dividing into minute branches at the inferior pole of the parotid gland that innervated the parotid fascia and the inferior third of the ear.

Additionally, in this study, the GAN bifurcated into two main branches viz, anterior and posterior as it crossed the anterior border of the sternocleidomastoid muscle. Occasionally, the GAN divided into anterior and posterior branches at the inferior border of the parotid gland which concurs with the findings by Biglioli *et al*.

The anterior branch of the GAN pierces the inferior pole of the parotid gland innervating the skin overlying the parotid gland; and the posterior branch passed along the posterior margin of the gland, destined for the skin over the mastoid process, the posteroinferior surface of the auricle, and the lobule of the ear. In 1/80 (1%) of the fetal specimens depicting a single branching pattern, the GAN divided at the inferior pole of the parotid gland into minute branches; one of these branches formed a connection with the transverse cervical nerve. This finding has been previously reported by Biglioli *et al.*, on adult specimens and has been recommended that in order to avoid injury to the GAN during facial rejuvenation surgery and parotidectomy, knowledge of these communications may be crucial.

It has been suggested by numerous authors (Patel *et al.*; Yokoshima *et al.*; Zumeng *et al.*) that the GAN is usually damaged at the inferior border of the parotid gland during parotidectomy: therefore anatomical knowledge of the course and bifurcation pattern may prevent complications during surgical procedures.

RESUMEN: El nervio auricular mayor (NAM) es el ramo más grande del plexo cervical superficial que gira alrededor del margen posterior del músculo esternocleidomastoideo, acompañado de la vena yugular externa. Cuarenta fetos (lado derecho: 40/80; izquierdo: 40/80), con edades gestacionales de 15 a 28 semanas fueron microdisecados para describir la anatomía del NAM. Los resultados obtenidos se clasificaron en: i) Incidencia y morfometría: NAM estaba presente en el 100% de las muestras fetales con una longitud media de los lados derecho e izquierdo de 12,65±2,14mm y 12,55±2,82mm, respectivamente. ii) Curso: NAM se encuentra paralelo al nervio cervical transverso y la vena yugular externa. Duplicación de las venas yugulares externas se observaron en el 5% (4/80) con el NAM situado por delante de uno de los afluentes, iii) Patrón de ramificación: 16% (13/80) de las muestras presentaba una solo ramo. Ramos duplicados en el 67% (54/80) de Tipo I, ramos anterior y posterior y, el 33% (26/80) Tipo II, ramos anterior y posterior, y iv) Variación: el nervio cervical transverso formando una comunicación con NAM, inferior a la glándula parótida en el 1%. El conocimiento anatómico del curso, patrón de bifurcación y variaciones del NAM pueden prevenir las complicaciones durante los procedimientos quirúrgicos como la parotidectomía.

PALABRAS CLAVE: Nervio auricular mayor; Fetos; Patrón de ramificación; Variación anatómica.

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Correspondence to:
Professor KS Satyapal
Department of Clinical Anatomy
School of Medical Sciences, Faculty of Health Sciences
Westville Campus, College of Health Sciences
University of KwaZulu-Natal
Private Bag X54001, 4001, Durban
SOUTH AFRICA

Email: satyapalk@ukzn.ac.za