The Anatomical Relation of The Greater Occipital Nerve to The Trapezius, Semispinalis Capitis and Obliquus Capitis Inferior Muscles

ความสัมพันธ์ทางกายวิภาคศาสตร์ของเส้นประสาท Greater occipital กับกล้ามเนื้อ Trapezius, Semispinalis capitis และ Obliquus capitis inferior

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ABSTRACT

Anatomy of the greater occipital nerve (GON) is important for performing medical procedures, to avoid the injury. The GON of 50 cadaveric heads were dissected and the relation to each of the three muscles including trapezius, semispinalis capitis and obliquus capitis inferior were observed. Three types of piercing to the subcutaneous tissue were found. The percentages of the GON piercing the trapezius muscle (type I), its aponeurosis (type II) and between trapezius and sternocleidomastoid muscle (type III) were 2%, 67% and 31% respectively. In addition, 95% of the GON pierced the semispinalis capitis muscle (type A), 2% pierced its tendinous band (type B) and 3% traveled between its medial fibers and the nuchal ligament. 94% of the GON turned around the lower edge of the obliquus capitis inferior muscle (type X), while 6% pierced the lower edge of this muscle (type Y).

บทคัดย่อ

กายวิภาคศาสตร์ของเส้นประสาท greater occipital (GON) มีความสำคัญในการใช้หลีกเลี่ยงการบาดเจ็บของเส้นประสาท การวิจัยนี้จึงได้ศึกษากายวิภาคศาสตร์ของ GON ที่มีความสัมพันธ์กับกล้ามเนื้อ 3 มัด ได้แก่ กล้ามเนื้อ trapezius กล้ามเนื้อ semispinalis capitis และกล้ามเนื้อ obliquus capitis inferior จากการศึกษาในร่างอาจารย์ใหญ่ 50 ร่าง โดยการสังเกต พบว่า GON มีความสัมพันธ์กับกล้ามเนื้อ trapezius 3 แบบ ซึ่งเปอร์เซ็นต์ที่ GON แทงทะลุกล้ามเนื้อ trapezius (type I), แทงทะลุ aponeurosis ของกล้ามเนื้อ trapezius ออกมาสู่ชั้น subcutaneous tissue (type II) และแทงทะลุ aponeurosis ระหว่างกล้ามเนื้อ trapezius กับกล้ามเนื้อ sternocleidomastoid คิดเป็น 2%, 67% และ 31% ตามลำดับ นอกจากนี้ 95% มีความสัมพันธ์กับกล้ามเนื้อ semispinalis capitis โดยแทงทะลุกล้ามเนื้อ semispinalis capitis (type A), 2% แทงทะลุ tendinous band ของกล้ามเนื้อ semispinalis capitis (type B) และ 3% ไม่แทงกล้ามเนื้อ semispinalis capitis แต่อ้อมออกมาด้าน medial ระหว่างกล้ามเนื้อ semispinalis capitis กับ nuchal ligament (type C) และมีความสัมพันธ์กับกล้ามเนื้อ obliquus capitis inferior โดย 94% ลอดใต้กล้ามเนื้อ obliquus capitis inferior (type X) ขณะที่ 6% แทงทะลุกล้ามเนื้อ obliquus capitis inferior (type Y)

Keywords: Greater occipital nerve, Occipital neuralgia

คำสำคัญ: เส้นประสาท greater occipital อาการปวดไปตามแนวเส้นประสาทบริเวณซึ่งอยู่ใกล้กระดูกท้ายทอย

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Introduction

Occipital neuralgia is a common cause of headache and is characterized by paroxysmal stabbing pain in the sensory distribution of the greater, lesser, or third occipital nerves (Graff-Radford et al., 1986; Horowitz, Yonas, 1993; Sulfaro, Gobetti, 1995; Ashkenazi, Levin, 2004). The greater occipital nerve (GON) is the most common cause of occipital neuralgia (Natsis et al., 2006). The GON originates from the medial branch of the dorsal ramus of C2 spinal nerve. After coursing backwards between posterior arch of the first cervical vertebrae (atlas) and lamina of the second cervical vertebrae (axis), the GON as it courses inferior to the obliquus capitis inferior muscle and turns around the lower edge of this muscle. Then, the GON ascends anterior to suboccipital triangle (composed of the rectus capitis posterior major, obliquus capitis superior and obliquus capitis inferior muscles) (Vital et al., 1989; Tubbs et al., 2007; Tubbs et al., 2014). The GON pierces the semispinalis capitis muscle (Kemp et al., 2011; Richard et al., 2012) and trapezius or its aponeurosis to the subcutaneous tissue. The GON lies inferolateral to the external occipital protuberance (EOP) (Schaeffer, 1953). At this point, it travels with the occipital artery. The GON is medial to the occipital artery (Sindou, Mertens, 1994; El Sekily, Zedan, 2015). The GON divides into medial and lateral branches to supply the integument of the scalp as the vertex of the skull (Loukas et al., 2006). There are several treatments for occipital neuralgia including pharmacotherapy (e.g., antiepileptic drug, antidepressants, nonsteroidal analgesics etc.), physiotherapy (transcutaneous electrical nerve stimulation, external orthosis etc.) (Merskey, 1981; Anthony, 1992; Oh et al., 2004) surgery (neurectomy, rhizotomy, ganglionectomy, sectioning of the obliquus capitis inferior etc.) (Hunter, Mayfield, 1949; Stechison, Mullin, 1994; Gill et al., 2004) and nerve block. The treatment procedure might use the basic knowledge of gross anatomy to avoid surgical errors to occur in occiput dissection.

Objectives of the study

The aim of this study was to identify possible relations between the GON and the three muscles, the trapezius, the semispinalis capitis and the obliquus capitis inferior muscles. In addition, any morphological features of the GON that could play a role in the development of the occipital neuralgia were identified.

Materials and methods

In the prone position, 50 adult formalin fixed cadavers (100 sides) from the Department of Anatomy, faculty of medicine, Chulalongkorn University, were used to collect the data. The average age at death was 77 years (range 41–99 years). The cadavers were completely preserved and there were no damages on the occiput. A horizontal skin incision was made along the line joining the upper border of the auricles and a midline incision through the neck. The skin was removed from medial to lateral. The piercing point of the GON to the subcutaneous tissue was observed. Then the trapezius muscle was detached laterally to observe the type of the GON in relation to the semispinalis capitis muscle. Next, the semispinalis capitis muscle was detached laterally in order to follow the GON until the suboccipital triangle was identified. The type of the GON in relation to obliquus capitis inferior muscle was identified.

Results

The type of the GON pierced to the subcutaneous tissue. This study found that the GON pierced the trapezius muscle or type I, the aponeurosis of the trapezius muscle or type II and the aponeurosis between the trapezius and sternocleidomastoid muscle or type III in 2% , 67% and 31% respectively (figure 1-3). Details of number and genders of each type were shown in table 1. The data of the symmetry of GON piercing to the subcutaneous tissue was shown in table 2.

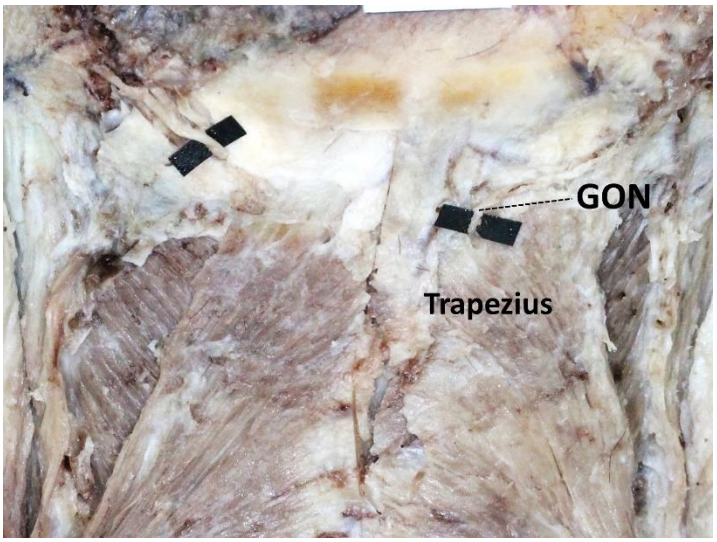

Figure 1 Gross image of the GON pierced the trapezius muscle or type I (right side).

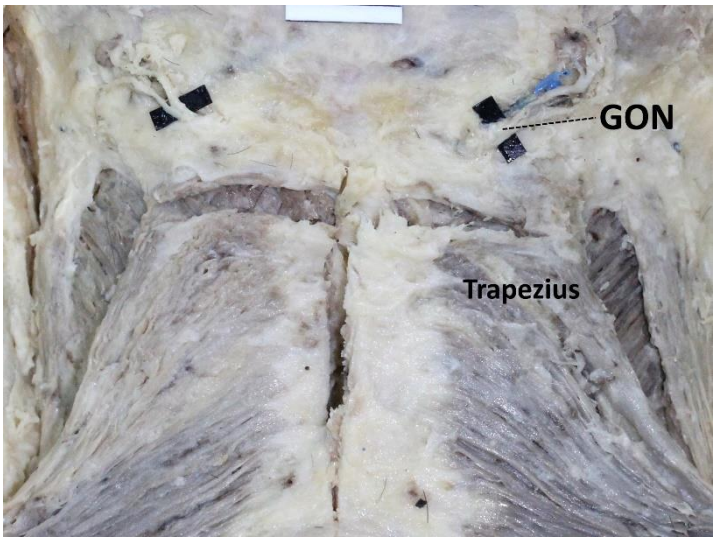

Figure 2 Gross image of the GON pierced aponeurosis of the trapezius muscle or type II (both sides).

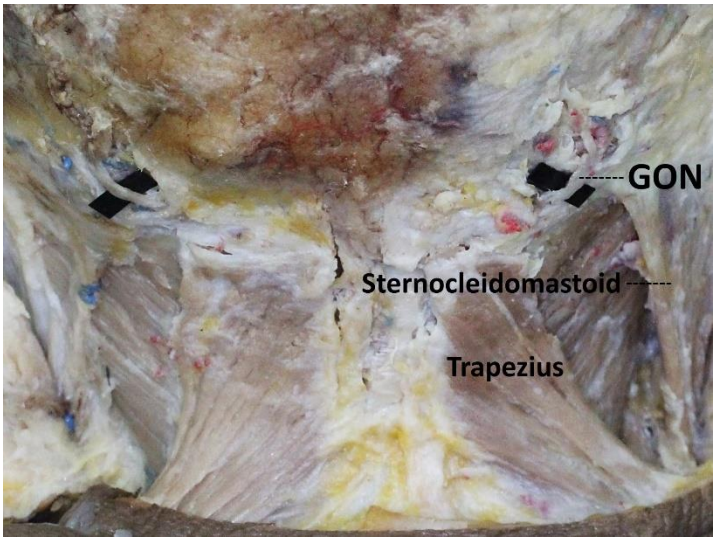

Figure 3 Gross image of the GON pierced aponeurosis between the trapezius and sternocleidomastoid muscle or type III (both sides).

Table 1 Types of the GON pierced to the subcutaneous tissue.

Gender / Type	Male		Female		Total (%) n=100
	Left (n=23)	Right (n=23)	Left (n=27)	Right (n=27)	
Type I	0	1 (1%)	1 (1%)	0	2 (2%)
Type II	13 (13%)	14 (14%)	18 (18%)	22 (22%)	67 (67%)
Type III	10 (10%)	8 (8%)	8 (8%)	5 (5%)	31 (31%)

Table 2 Types of the symmetry of GON pierced to the subcutaneous tissue.

Types	Frequency (cadaver)		Total	%
	Male	Female		
Symmetry				
Type II	11	16	27	54
Type III	6	3	9	18
Total	17	19	36	72
Asymmetry				
Type I & Type II	-	1	1	2
Type I & Type III	1	-	1	2
Type II & Type III	5	7	12	24
Total	6	8	14	28

Types of the GON were in relation to the semispinalis capitis muscle. The GON pierced the semispinalis capitis muscle or type A and the tendinous band of the semispinalis capitis muscle or type in 95% and 2% respectively (figure 4, 5). The rest of the specimens was found that the GON did not pierce the semispinalis capitis muscle but bypassed the semispinalis capitis muscle to travel between its most medial fibers and the nuchal ligament or type C (figure 5) in 3%. The most common was type A. The detail of number and genders were shown in table 3. The data of the symmetry of GON in relation to the semispinalis capitis muscle was shown in table 4.

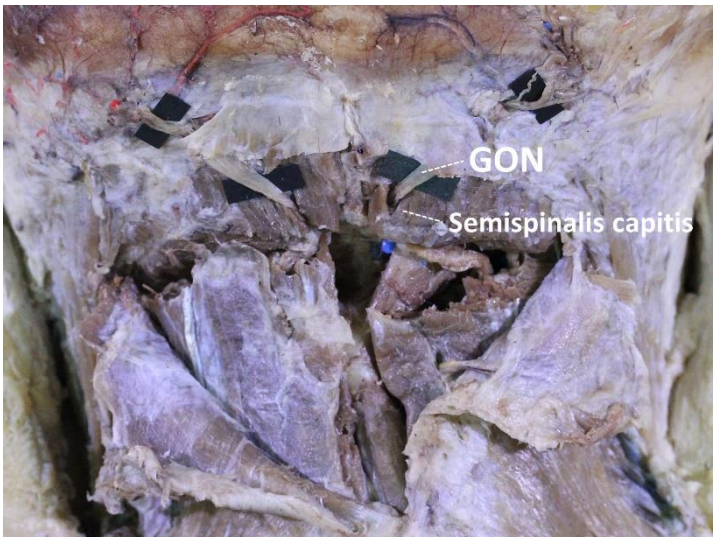

Figure 4 Gross image of the GON pierced the semispinalis capitis muscle or type A (both sides).

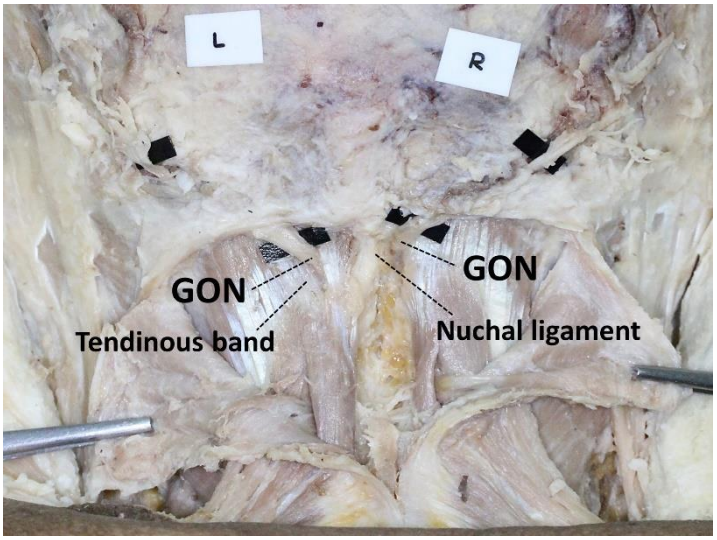

Figure 5 Gross image of the GON pierced a tendinous band of the semispinalis capitis muscle or type B (left side) and the GON did not pierce the semispinalis capitis muscle but bypassed the semispinalis capitis muscle to travel between its most medial fibers and the nuchal ligament or type C (right side).

Table 3 Types of the GON in relation to the semispinalis capitis muscle

Gender / Type	Male		Female		Total (%) n =100
	Left (n=23)	Right (n=23)	Left (n=27)	Right (n=27)	
Type A	21 (21%)	21 (21%)	27 (27%)	26 (26%)	95 (95%)
Type B	1 (1%)	1 (1%)	0	0	2 (2%)
Type C	1 (1%)	1 (1%)	0	1 (1%)	3 (3%)

Table 4 Types of the symmetry of GON in relation to the semispinalis capitis muscle

Types	Frequency (cadaver)		Total	%
	Male	Female		
Symmetry				
Type A	21	26	47	94
Total	21	26	47	94
Asymmetry				
Type A & Type C	-	1	1	2
Type B & Type C	2	-	2	4
Total	2	1	3	6

Types of the GON were in relation to the obliquus capitis inferior muscle. The GON turned around the lower edge of the obliquus capitis inferior muscle or type X (figure 6) in 94%, and pierced the muscle of the lower edge of obliquus capitis inferior or type Y (figure 7) in 6%. The most common type was type X. The detail of number and genders of each type were shown in table 5. The data of the symmetry of GON in relation to the obliquus capitis inferior muscle was shown in table 6.

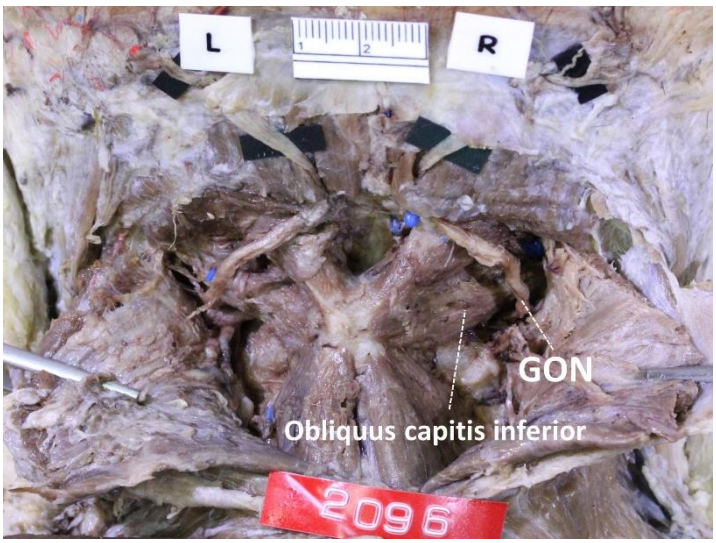

Figure 6 Gross image of the GON turned around the lower edge of the obliquus capitis inferior muscle or type X (both sides).

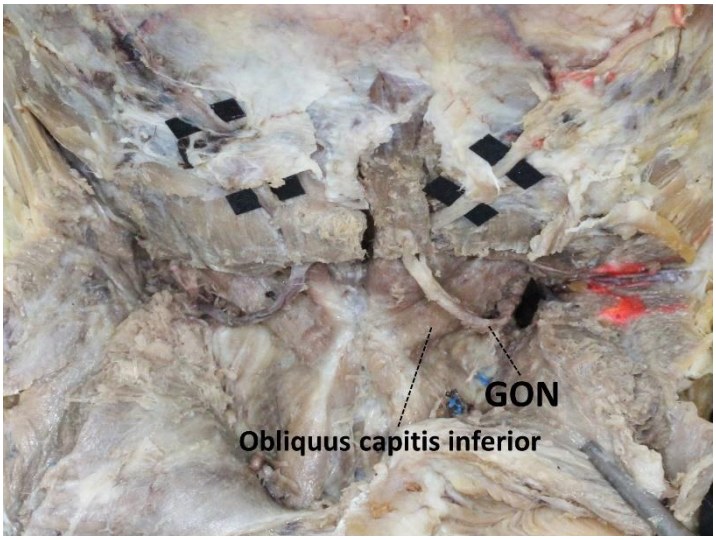

Figure 7 Gross image of the GON pierced the muscle of the lower edge of obliquus capitis inferior or type Y (both sides).

Table 5 Types of the GON in relation to the obliquus capitis inferior muscle

Gender / Type	Male		Female		Total (%) n=100
	Left (n=23)	Right (n=23)	Left (n=27)	Right (n=27)	
Type X	23 (23%)	23 (23%)	24 (24%)	24 (24%)	94 (94%)
Type Y	0	0	3 (3%)	3 (3%)	6 (6%)

Table 6 Types of the symmetry of GON in relation to the obliquus capitis inferior muscle

Types	Frequency (cadaver)		Total	%
	Male	Female		
Symmetry				
Type X	23	22	45	90
Type Y	-	1	1	2
Total	23	23	46	92
Asymmetry				
Type X & Type Y	-	4	4	8
Total	-	4	4	8

Discussion

Occipital neuralgia related to the entrapment of the GON has been previously reported (Hunter, Mayfield, 1949; Bogduk, 1980). Possible zone of the GON irritation and entrapment included the point at which the nerve emerges between the atlas and the axis (Stechison, Mullin, 1994), the point where the GON pierced the obliquus capitis inferior, semispinalis capitis and trapezius muscles (Bogduk, 1980; Vital et al., 1989) were also reported. Bovim et al. (1991) and Tubbs et al. (2014) reported that the GON pierced the trapezius muscle or type I in 45% and 23.3%, and pierced the aponeurosis of the trapezius muscle or type II in 55% and 76.7% respectively. In contrast, Bogduk (1982) presented that the GON did not pierce the trapezius muscle but pierced aponeurosis between the trapezius and sternocleidomastoid muscle. The result of this study confirmed previous reports that type II was the most common but the number of type I was the lowest and differed from previous studies (Bovim et al., 1991; Tubbs et al., 2014). However, the finding of type III was similar to the report of Bogduk.

Tubbs et al. (2014) and this study found that the GON pierced the semispinalis capitis muscle or type A in 73.3 and 95%, the GON pierced a tendinous band of the semispinalis capitis muscle or type B in 16.7% and 2%, the GON did not pierce the semispinalis capitis muscle but bypassed the semispinalis capitis muscle to travel between its most medial fibers and the nuchal ligament or type C in 10% and 3% respectively. While Bovim et al. (1991) found that the GON pierced the semispinalis capitis muscle in 90% and the GON did not pierce the semispinalis capitis muscle but bypassed the semispinalis capitis muscle to travel between its most medial fibers and the nuchal ligament in 10%. Moreover, Mosser et al. (2004) found that the GON pierced the semispinalis capitis muscle in 100%.

Bovim et al. (1991), Natsis et al. (2006), Tubbs et al. (2014) and this study found that the GON turned around the lower edge of the obliquus capitis inferior muscle or type in 92.5, 95, 93.3, 94%, the GON pierced the muscle of the lower edge of obliquus capitis inferior or type Y in 7.5, 3.8, 6.7, 6% respectively. However, the result of this study did not find any case of the GON that passed through suboccipital triangle as reported by Natsis et al. Moreover, There is the study of the relationship between the GON and the occipital artery to determine the better landmark for appropriate medication (El Sekily, Zedan, 2015).

Conclusion

This study has documented potentially useful piercing point to subcutaneous tissue and intramuscular course for identification of the GON. The most common type is piercing aponeurosis of the trapezius muscle (type II), pierced the semispinalis capitis muscle (type A) and turned around the lower edge of the obliquus capitis inferior muscle (type X). We hope that these data will aid surgeons and clinicians in nerve block and avoiding complications in this region.

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