ANATOMY OF THE GREATER OCCIPITAL NERVE BLOCK IN INFANTS

Research report

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Abstract

Background: Pain relief for posterior fossa craniotomies as well as occipital neuralgia, are indications for the use of the greater occipital nerve block in children. The greater occipital nerve originates from the C2 spinal nerve and is accompanied by the occipital artery as it supplies the posterior scalp.

Aim: The aim of this study was to develop a unique, yet simple technique for blocking the greater occipital nerve in children through the evaluation of the anatomy of this nerve and the accompanying occipital artery in the occipital region.

Methods: The greater occipital nerve and occipital artery were dissected and exposed in six formalin-fixed cadavers (five infants [average age of 51.4 days] and one two-year old) from the Department of Anatomy, University of Pretoria. Measurements between the nerve and selected bony landmarks were obtained. The relationship between the greater occipital nerve and the occipital artery at the trapezius muscle hiatus was also evaluated.

Results: The greater occipital nerve is on average 22.6 ± 5.6mm from the external occipital protuberance in infants. The average width of the medial three fingers measured at the proximal interphalangeal joint, for each respective cadaver is 20.4 ± 4.0mm, with a strong correlation coefficient of 0.97 between the aforementioned distances. In 83.3% of the specimens, the occipital artery lies lateral to the greater occipital nerve at the trapezius muscle hiatus.

Conclusion: In infants, the greater occipital nerve can be blocked approximately 23mm from the external occipital protuberance, medial to the occipital artery. This distance is equal to the width of the medial three fingers at the proximal interphalangeal joint of the patient.

KEYWORDS: regional, anaesthesia, child pain, occipital artery, anatomical

What is already known:

In children, the greater occipital nerve could be blocked midway between the external occipital protuberance and mastoid process.

What new information this article adds:

In infants, the greater occipital nerve could be blocked at a distance equal to the width of the medial three fingers of the patient's hand along the line drawn from the external occipital protuberance to the mastoid process.

1. Introduction

Regional techniques are considered a useful alternative to systemic analgesics in an attempt to avoid the negative side effects of opiate analgesia, such as nausea, vomiting, itch and respiratory depression.[1] Through the use of regional nerve blocks, all the protective reflexes of the patient remain intact, with the patient being fully conscious, but without discomfort or pain.[2] This could be particularly important to doctors working with limited resources in developing countries, or to volunteers of charity medical organisations such as Doctors Without Borders and Operation Smile.

One of the quandaries of clinical anatomy with regard to paediatric practice is that anatomy, for the most part, is based on studies performed in adults. This is then extrapolated to infants and children, which in many cases could be erroneous. Clinical anatomy of the head and neck, for example, changes as the bones of the skull develop and the child grows. Safe nerve blockade requires precise knowledge of the course, position and depth of the target nerve in order to ensure that the needle tip is placed close enough to anaesthetise, but not damage the nerve.[3,4] With seventy percent (70%) of the world's poorest countries being in sub-Saharan Africa, simple techniques need to be developed in order to assist medical practitioners who do not have access to imaging modalities such as ultrasound.

The greater occipital nerve block is most commonly indicated to alleviate pain associated with headache disorders such as occipital neuralgia, cervicogenic headaches, migraines, as well as cluster headaches, in adults.[5-7] In children, a greater occipital nerve block can be used for postoperative pain management following occipital craniotomies, cranioplasties, as well as posterior ventriculoperitoneal shunts.[8] A greater occipital nerve block can also be used to alleviate pain from occipital neuralgia in children.[9]

The greater occipital nerve is the medial branch of the 2nd cervical dorsal ramus. It travels deep to the semispinalis capitis muscle, after which it pierces this muscle and emerges onto the scalp by passing above an aponeurotic sling that is located between the trapezius and sternocleidomastoid muscles. It is closely accompanied by the occipital artery, which lies lateral to the nerve as it emerges onto the posterior scalp.[10]

In adults, one of the most common landmarks used for blocking the greater occipital nerve is a point at the medial one-third of the line drawn between the external occipital protuberance and the mastoid process or by palpating the occipital artery, which lies lateral to the nerve.[11]

Suresh and Voronov suggested that in children, the midpoint of a line drawn between the mastoid process and the midline, is a good guide to the location of the greater occipital nerve.[12] However, no information from anatomical dissections of the greater occipital nerve in children could be found to confirm this. Therefore, the aim of this study was to formulate a unique, yet simple method to facilitate a greater occipital nerve block based on anatomical dissections and distinctive measurements of the greater occipital nerve and its associated occipital artery in infant cadavers.

2. Materials and methods

Ethical approval to conduct dissections on a sample of paediatric cadavers within the Department of Anatomy, University of Pretoria, was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (77/2014). All dissections were conducted in the Department of Anatomy under the rules and regulations stipulated in the South African National Health Act, Act 61 of 2003.

The greater occipital nerve and occipital artery were dissected and exposed bilaterally in 6 paediatric formalin-fixed cadavers. The sample included five infants and one cadaver of a two-year old. The average age of the infants at the time of death was 51.4 days.

The distances between the external occipital protuberance and the rudimentary mastoid process, as well as between the external occipital protuberance and the greater occipital nerve, were measured with a Vernier digital calliper (accuracy of 0.01mm). The relationship between the occipital artery and the greater occipital nerve was also noted as they exit the trapezius muscle aponeurosis, as seen in Figure 1.

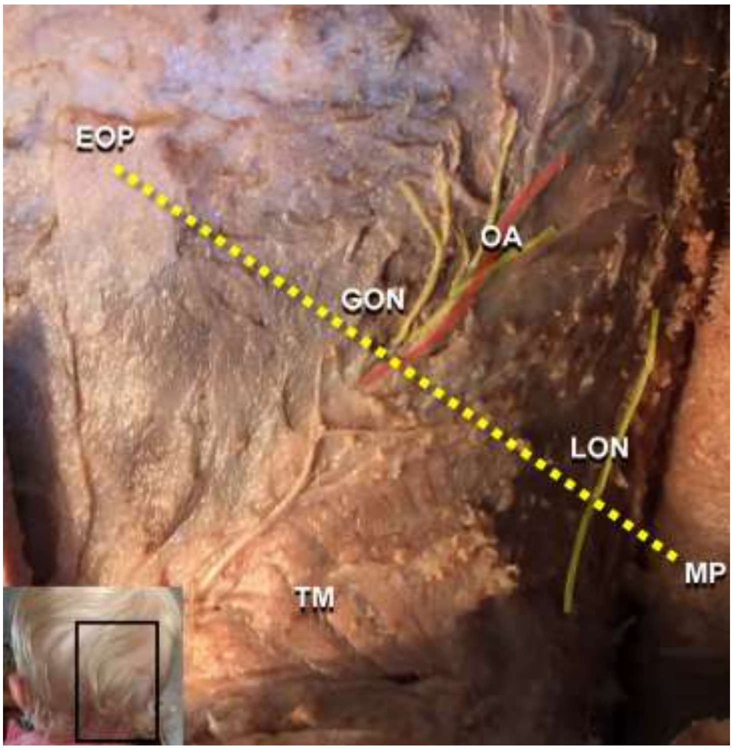

Figure 1: Dissection of the occipital region of a paediatric cadaver, with the greater occipital nerve (GON) and occipital artery (OA) highlighted in yellow and red respectively [EOP: External occipital protuberance; LON: Lesser occipital nerve; MP: Mastoid process; TM: Trapezius muscle]

Descriptive statistics using SAS® version 9.3, for Windows, which included the mean of each measurement, the standard deviation in order to establish the range of the sample as well as the 95% confidence interval to establish the true population value for the statistic value, including upper and lower ranges, was completed. A Wilcoxon signed rank test was performed in order to determine the statistical significance between the values obtained from the left and the right sides.

To ascertain the probability of using the patient's fingers as a measuring instrument, the width of the fingers on the right hand of each cadaver was measured at the proximal interphalangeal joint for the medial four, medial three, and medial two fingers, as well as the small finger and thumb. These results were correlated with the occipital nerve measurements obtained from the same cadaver, using a Pearson population correlation coefficient.

3. Results

Since no statistically significant differences ($p>0.05$; Wilcoxon signed rank test) were observed between the left and right sides of the cadavers, the samples for left and right sides were combined, as seen in Table 1. However, since only one two-year old cadaver was studied, the data obtained from this cadaver is presented but not included in the final calculations.

Table 1: Measurements on the infant group, two-year old and total population of cadavers (left and right sides combined).

	Infants only		2-year old only		Total sample	
	Distance EOP-MP	**Distance GON-EOP**	**Distance EOP-MP**	**Distance GON-EOP**	**Distance EOP-MP**	**Distance GON-EOP**
n	10	10	2	2	12	12
Average	51.3	22.6	83.9	30.4	56.7	23.9
SD	13.2	5.6	0.8	4.1	17.4	6.0
CI 95%	8.2	3.5	1.1	5.7	9.9	3.4
Lower	43.1	19.1	82.8	24.7	46.9	20.5
Upper	59.5	26.1	85.0	36.1	66.6	27.3

Key:
EOP: External occipital protuberance
MP: Mastoid process
GON: Greater occipital nerve
CI 95%: Confidence interval of 95%
Lower: Lower range of values with a 95% confidence interval
Upper: Upper range of values with a 95% confidence interval

The following results were obtained for this infant sample: The external occipital protuberance was on average 56.7 ± 17.4mm from the rudimentary mastoid process with a range of 8mm, while the average distance of the greater occipital nerve from the external occipital protuberance was on average 23.9 ± 6.0mm (CI 0.05; 3.5mm) .

Table 2: Relationship between the occipital artery and the greater occipital nerve, bilaterally.

	Paediatric cadavers
n	12
Artery lies lateral to nerve	10 (1.4mm)
Artery lies medial to nerve	0
Artery lies between branches of the nerve	2

The greater occipital nerve was located medial to the occipital artery in 10 cases, with an average distance of 1.4mm between the nerve and the artery as they emerge at the trapezius muscle hiatus onto the posterior scalp, as seen in table 2. In two cases the greater occipital nerve branched prior to leaving the hiatus in the aponeurosis, resulting in the nerve branches being located around the occipital artery.

In order to facilitate a greater occipital nerve block in infants, a single and easy to use measurement could be useful. The width of the fingers at the proximal interphalangeal joints was proposed as a possible measuring tool. The measurements obtained for the fingers' width on the right hand of each infant cadaver are shown in Table 3.

Table 3: Width of the fingers on the right hand of each infant cadaver as well as the Pearson correlation coefficient.

	4 fingers	**3 fingers**	**2 fingers**	**1 finger**	**Thumb**
n	4	4	4	4	4
Average	27.4	20.4	12.7	6.1	7.6
SD	4.6	4.0	2.7	1.0	1.5
CI 95%	4.5	3.9	2.6	1.0	1.5
Lower	23.0	16.5	10.1	5.1	6.2
Upper	31.9	24.4	15.3	7.1	9.1
Pearson Correlation Coefficient					
GON – EOP (R-value)	0.971	**0.972**	0.970	0.971	0.96
p-value	0.004	**0.006**	0.006	0.002	0.011

Key:
EOP: External occipital protuberance
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GON: Greater occipital nerve
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Lower: Lower range of values with a 95% confidence interval
Upper: Upper range of values with a 95% confidence interval

The width on the right hand could only be measured in four infant cadavers, since one cadaver's arms had been disarticulated, prior to the commencement of this study. The width at the proximal interphalangeal joint of the medial three fingers of each infant cadaver was the most similar and statistically significant (Pearson correlation coefficient r = 0.972; p = 0.006) to the distance between the external occipital protuberance and the greater occipital nerve, as indicated in Figure 2.

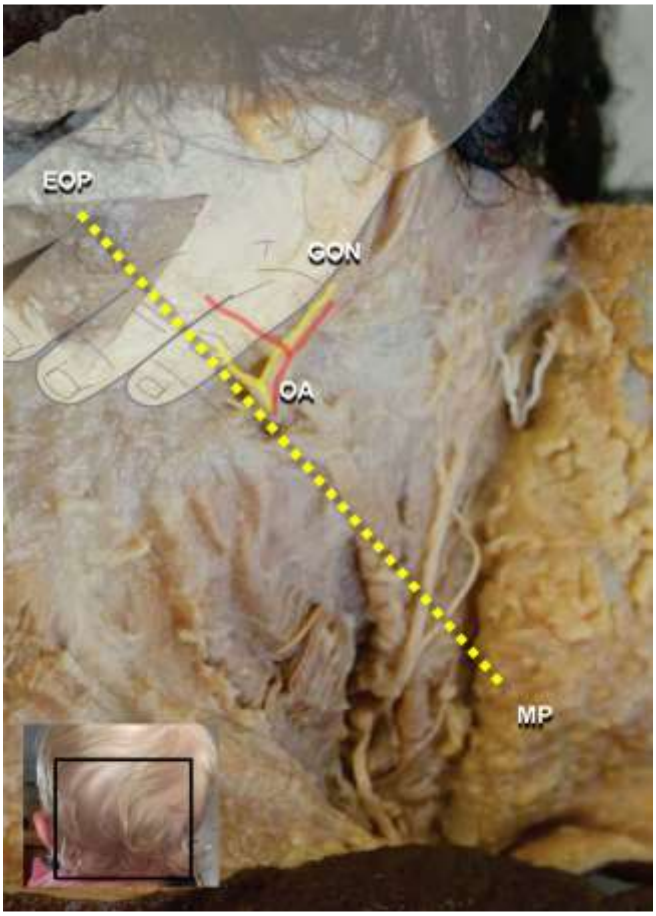

Figure 2: Representation of the exact location for the greater occipital nerve block in infants, with the greater occipital nerve (GON) and occipital artery (OA) highlighted in yellow and red respectively. An image of the infant's hand is superimposed for clarity

4. Discussion

The greater occipital nerve block could be used for post-operative pain control following craniotomies, cranioplasties or ventriculoperitoneal shunts[8] and, to a lesser extent, in occipital neuralgia in children.

In adults, one of the most common methods of blocking the greater occipital nerve is using a point on the medial one-third of the distance on the line between the external occipital protuberance and the mastoid process.[6,11,13] Various locations of the greater occipital nerve have been reported, yet, no information on dissections of the greater occipital nerve in the children could be obtained. Suresh and Voronov state: "The midpoint of a line drawn between the mastoid process and the midline will be a good guide to the location of the greater occipital nerve." [12] However, this statement seems a bit vague, as the exact point on the midline is not described.

In this anatomical study, for the infant sample, the distance between the external occipital protuberance and the greater occipital nerve was on average 23mm apart, which can be described as 44% of the distance between the external occipital protuberance and the mastoid process (measured at 51mm). Although the results of our study and that of Suresh and Voronov [12] appear similar, the difference could possibly be attributed to the difference in the age of the sample population. In this study, only five infant cadavers (with a mean age of 51.4 days) were used, due to the infant cadavers being a scarce resource. In a recent (not yet published) study on neonatal cadavers, the greater occipital nerve was found at the midpoint on the line between the external occipital protuberance and the mastoid process. It is interesting to note, that for the one two-year old cadaver the distance between the external occipital protuberance and greater occipital nerve is 36.27% of the distance between the external occipital protuberance and the mastoid process. It could therefore be argued that the distance between the greater occipital nerve and the external occipital protuberance becomes smaller due to the expanding skull and the distance between the external occipital protuberance and the mastoid process increasing (as seen in adults).

To facilitate a greater occipital nerve block in infants, we report that the collective width of the three medial fingers on the right hand (20mm) at the proximal interphalangeal joint, is closely correlated to the distance between the greater occipital nerve and the external occipital protuberance. The correlation coefficient between these two measured variables is 0.972, which indicates that a very strong positive correlation exists for each individual cadaver, albeit a small sample size was used in this study. This landmark could also serve as a starting point for those providers who have access to the use of ultrasound.

The occipital artery lies lateral to the greater occipital nerve in 83% of the cases, with an average distance of 1.4mm between the greater occipital nerve and the occipital artery at the hiatus in the aponeurosis of the trapezius muscle. Several authors indicate that the greater occipital nerve is blocked in children by palpating the laterally located artery.[8,12,14,15,16] Complications could occur in the event of an intravascular injection.[8] In the majority of cases in this study, the greater occipital nerve was found medial to the occipital artery, as described in the literature.[9,17] However, in view of anatomic variation and the proximity of the occipital artery to the greater occipital nerve, [1,9,18] careful aspiration is advised prior to injection of local anaesthetic.

The distortion and potential disfigurement caused by formalin preservation of the infant cadaveric samples could be considered a limitation of this study. However, little if any distortion of the bony skull occurs. The mastoid process, the occipital protuberance and nerve foramina are not likely to be altered. Thus, these measurements could be considered representative of the clinical situation. The small infant sample can be also be regarded as a limitation of this study. This can be attributed to the scarcity of available donated specimens. However, the obtained data are still invaluable and will greatly assist clinicians performing this nerve block in the children.

5. Conclusion

In conclusion, in infant patients, the greater occipital nerve can be located and blocked medial to the occipital artery at a distance equal to the width of the medial three fingers of the patient from the external occipital protuberance.

Disclosures

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