

Computed tomography based measurement of the dimensions of foramen ovale and rotundum in trigeminal neuralgia

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ABSTRACT

الأهداف: مقارنة أحجام الثقوب البيضاوية والمستديرة للمرضى المصابين بألم العصب الثلاثي (TN) و الأفراد الأصحاء عن طريق الأشعة المقطعية CT.

الطريقة: اشتملت هذه الدراسة على عدد 21 مريض مصاب بألم العصب الثلاثي و 24 شخص سليم متطوع و أجريت الدراسة في قسم التشريح - مدرسة الطب - جامعة غازي عنتاب - غازي عنتاب - تركيا خلال الفترة من مايو 2004 حتى أغسطس 2009م حيث تم الحصول على التصوير المقطعي لهم و فحص بعد الثقب البيضاوي على مستوى القحف الإكليلي من خلال الأشعة المقطعية.

النتائج: بلغ متوسط أحجام الثقوب المستديرة على الجانب الأيمن و الأيسر 3.04x3.2 mm و 2.8x2.9 mm في المرضى المصابين بألم العصب الثلاثي (TN) و 2.4x3.2 mm و 2.5x3.1 mm في مجموعة التحكم. بلغ متوسط أحجام الثقوب البيضاوية على الجانب الأيمن و الجانب الأيسر 4.8x6.04 mm و 4.9x5.5 mm لدى المرضى المصابين بألم العصب الثلاثي TN و 3.7x8.2 mm و 4.1x7.6 mm في مجموعة التحكم. لم تكن أبعاد الثقوب على الجانب الأيمن و الأيسر مختلفة بشكل ملحوظ في كلتا المجموعتين $p>0.05$. إضافة إلى ذلك، لم يكن هنالك فرق إحصائي ملحوظ بين أبعاد الثقوب لمجموعة المرضى TN و مجموعة التحكم $p>0.05$.

خاتمة: كشفت هذه الدراسة أن أحجام الثقوب المستديرة و البيضاوية متماثلة بشكل عالي في كلتا المجموعتين، مما يشير أن أحجام الثقوب لا تصاحب ظهور ألم العصب الثلاثي TN.

Objectives: To compare sizes of the foramen ovale and rotundum in trigeminal neuralgia (TN) patients and healthy individuals on CT images.

Methods: Twenty-one TN patients and 24 healthy volunteers were included in this retrospectively designed study, carried out at the Department of Anatomy, Medical School, Gaziantep University, Gaziantep, Turkey, between May 2004 and August 2009. The dimension of the foramen ovale on the cross-sectional images, and the foramen rotundum on coronal sections on CT images were examined.

Results: The mean sizes of the foramen rotundum on the right and left sides were 3.04x3.2 mm and 2.8x2.9 mm in TN patients, and 2.4x3.2 mm and 2.5x3.1 mm in controls. The mean sizes of the foramen ovale on the right and left sides were 4.8x6.04 mm and 4.9x5.5 mm in TN patients, and 3.7x8.2 mm and 4.1x7.6 mm in controls. The dimensions of left and right foramens were not significantly different in both TN patients and controls ($p>0.05$). Furthermore, a statistically significant difference was not found between the foraminal dimensions of the TN patients and controls ($p>0.05$).

Conclusion: This study revealed that the sizes of foramen ovale and rotundum are highly symmetrical in both groups, suggesting that sizes of the foramina are not associated with the occurrence of TN.

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The trigeminal nerve is the largest of the cranial nerves. The dorsal trigeminal nerve root originates from the ventrolateral pons to form the trigeminal ganglion from which emerge 3 main divisions; ophthalmic, maxillary, and mandibular nerves, which traverses through the superior orbital fissure, foramen rotundum, and foramen ovale. They carry a motor supply to the muscles of mastication, and transmit sensory information from the face, oral and nasal cavities, and most of the scalp.^{1,2} Disease within or local to the nerve can cause trigeminal neuralgia (TN) or loss of sensory or motor function in the distribution of the nerve. Trigeminal neuralgia is considered to be one of the most painful conditions to affect patients, and is the most common facial neuralgia with a reported annual incidence of 4.5/100.000 patients. It can be seen in any age group, but is more

frequent in middle aged and older patients.^{3,4} Vascular cross compression is considered to be an important cause of TN.^{2,3} However, that compression alone cannot account for the clinical syndrome of TN as the right side of the face is affected twice as often as the left side. This condition is not consistent with the theory of vascular compression, since there is no anatomical reason for blood vessels to be tortuous more frequently on the right side.⁵ Anatomical and radiological studies have shown that the rotundum and ovale foramina on the right side of the human cranium are significantly narrower than on the left side. The rotundum and ovale foramina are crossed by the maxillary and mandibular nerves, and these are the nerves mostly affected in TN.⁶⁻⁸ The purpose of this study was to compare sizes of the foramen ovale and rotundum in TN patients and healthy individuals on CT images.

Methods. Twenty-one patients (11 female, 10 male) who were diagnosed as having TN, and 24 (13 female, 11 male) healthy volunteers were included in the study. The mean age of the patients was 34.2 (21-48), and of the controls was 35.1 (29-41) years. This study was planned and performed at the Department of Anatomy, Medical School, Gaziantep University, Gaziantep, Turkey between May 2004 and August 2009. All patients had TN on the right side, and their clinical diagnosis was confirmed by the Department of Neurology, after a thorough history, physical examination, and radiological investigation. None of the patients with TN had any other disorder such as multiple sclerosis, plaques, tumors, and abnormalities of the skull base. The patients fulfilled the criteria of the International Headache Society for TN.⁹

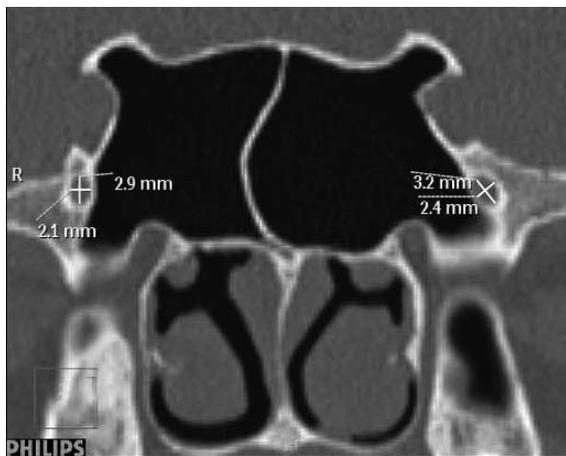


Figure 1 - Dimensional measurements of bilateral foramen rotundum on a reformatted cross-sectional image of CT scan data. Right foramen rotundum 2.1 x 2.9 mm, left foramen rotundum 3.2 x 2.4 mm.

CT examination. All patients had a standard thin-section skull base 6-slice CT exam (Philips Brilliance CT, Philips, Best, Netherlands). All CT scans were taken without contrast using a standard exposure and patient positioning protocol. This included axial CT scans slice with a slice thickness of 0.8 mm and exposure setting of 120 kV; 250 mAs; 0.75 s rotation times; 0.417 pitch values, 6x0.75 mm collimation; and 512x512 matrixes. The images were transferred to the workstation, and then a Philips CT Viewer was used to measure the dimensions of the foramen ovale on the cross-sectional images, and foramen rotundum on coronal sections (reformatted from axial images) at the smallest level viewed on CT images (Figures 1 & 2).

The Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA) version 8.0 for Windows was used for the statistical analyses of the data, and the Mann-Whitney U test was used to compare the foramina dimensions of the patients and controls. A *p*-value of <0.05 was considered significant.

Results. The mean sizes of the foramen rotundum on the right and left sides were 3.04x3.2 mm and 2.8x2.9 mm in TN patients, and 2.4x3.2 mm and 2.5x3.1 mm in controls. The mean sizes of the foramen ovale on the right and left sides were 4.8x6.04 mm and 4.9x5.5 mm in TN patients, and 3.7x8.2 mm and 4.1x7.6 mm in controls. The dimensions of the foramen ovale and rotundum are shown in Tables 1 & 2. The dimensions of the foramina on the left and right side were not significantly different in both TN patients and controls (*p*>0.05). The dimensions of the foramina were not significantly different between TN patients and controls (*p*>0.05). There was no difference between the sizes of foramina of both genders (*p*>0.05).

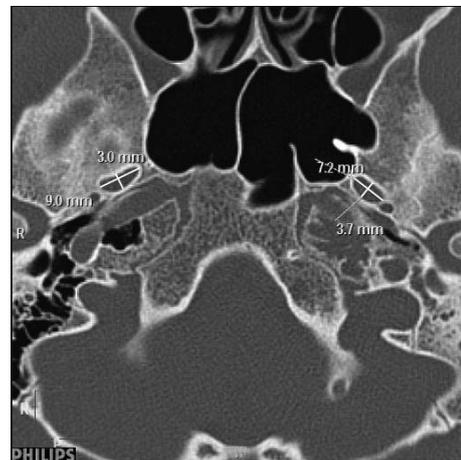


Figure 2 - A CT scan axial image of a 42-year-old female. Dimensional measurements of bilateral foramen ovale at smallest level viewed on the axial CT image. Right foramen ovale 9 x 3 mm, left foramen ovale 7.2 x 3.7 mm.

Table 1 - The dimensions (mm) of the foramen ovale and rotundum in trigeminal neuralgia patients.

Dimensions	Right rotundum	Left rotundum	Right ovale	Left ovale
Smallest size	2.0x2.3	1.6x2.0	3.4x2.0	3.0x2.0
Largest size	4.9x6.0	4.0x5.0	8.0x9.2	7.3x8.0
Average size	3.04x3.2	2.8x2.9	4.8x6.04	4.9x5.5

Table 2 - The dimensions (mm) of the foramen ovale and rotundum in controls.

Dimensions	Right rotundum	Left rotundum	Right ovale	Left ovale
Smallest size	1.6x2.4	1.9x2.5	2.4x6.5	3.0x4.9
Largest size	3.6x4.8	3.9x4.0	5.5x10.1	5.6x11.2
Average size	2.4x3.2	2.5x3.1	3.7x8.2	4.1x7.6

Discussion. Trigeminal neuralgia is a common cause of facial pain. It can be a devastating disease interfering with the patient's professional and social life, depending on the frequency and intensity of the painful paroxysms and degree of pain control.^{3,10} Despite a history dating back over 300 years, its exact cause remains unknown. Perhaps, for this reason, medical treatment failures are common. The most common cause of TN is a focal compression of the trigeminal nerve root entry zone by an aberrant loop of an artery or vein.¹¹ However, TN can occur in the absence of vascular compression or a neurovascular contact can be found in an asymptomatic patient.^{5,6,12}

Neto et al⁶ hypothesized that in cases of TN caused by vascular compression, the narrower foramina lead to a secondary entrapment of the maxillary and mandibular nerves, and this phenomenon plays a central role in the higher incidence of right sided TN. Although compression at the level of the foramen rotundum and ovale have not been described as a pathogenesis until now, our study investigates the dimensions of the foramen ovale and rotundum radiologically in TN and control subjects with respect to Neto's hypothesis. However, in our study, the sizes of the foramina were not significantly different between both sides of the skull as well as between the patients and controls. Therefore, a narrow foramen does not seem to be associated with the occurrence of TN. In addition, TN affects men more often than women, although there is no difference between the sizes of foramina of both genders. This condition is consistent with our findings.

The evaluation of the foramen ovale has been important in glycerol rhizotomy and electrocoagulation in TN.^{13,14} Complications may occur after glycerol rhizotomy and electrocoagulation via foramen ovale while treating TN. Each surgical technique for treatment of TN has merits and limitations. However, microvascular decompression provides the highest rate of long-term patient satisfaction with the lowest rate of pain recurrence.^{15,16}

Kaplan et al¹⁴ studied dimensions of the foramen ovale and its relation with arteries, veins, and other nerves to evaluate the mechanisms responsible for

complications during trigeminal rhizotomy via foramen ovale puncture. They found that the maximum diameter of the foramen ovale ranged between 6.9-7.2 mm. In our study, the maximum diameter of the foramen ovale on the right and left side ranged from 5.5x10.1 mm and from 5.6x11.2 mm in the healthy group. This difference in the measurements may be due to methodological differences. Measurements were made on live subjects in our study, whereas in the former study the measurements were made in dry skulls.

It was suggested that the rotundum and ovale foramina on the left side are invariably larger than the foramina on the right side in healthy subjects.^{7,8} In contrast, we found the foramina to be consistently symmetrical. This difference may be due to some methodological limitations, and racial, and geographic differences. Berge et al⁷ found that there was no difference between the sizes of the foramina on the right and left sides. Berge's measurements of the foramina correlated well with our results.

In conclusion, sizes of the foramina ovale and rotundum do not differ on both sides of the skull as well as between the patients with TN and healthy controls, suggesting that sizes of the foramina are not associated with the occurrence of TN.

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