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Anatomical and Radiological Study of the Greater Palatine Foramen in Adult Human Skulls

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Abstract

Thirty adult human skulls with full eruption of the third molar teeth were examined to determine the anatomy of the greater palatine foramen and canal. Forty computerized tomography scans of the patients were collected to study the location of the greater palatine foramen, direction and length of the greater palatine canal. Dry skulls were differentiated into 14 males and 16 females. Bony results demonstrated that the most common location for the greater palatine foramen was opposite the upper third molar tooth. The most common direction for the greater palatine canal into the oral cavity was anteroinferiorly. In radiological results (CT scan): the mean length of the greater palatine canal was 21.7 mm in males; and 18.1 mm females. The most common location of the greater palatine foramen (GPF) was (1) Opposite the third molar in 45% of the males; and 45% of the females. (2) The next common location was between the second and third molar teeth in 25% of the males; and 30% of the females. (3) Then opposed to the second molar in 20% of the males; and in 25% of the females, (4) Distal to the to the third molar in 10% of the males; and non in females. The direction of the greater palatine canal was anteroinferiorly in 55% of the males; and in 65% of the females. It is concluded that the dentist has to take these anatomical notes with consideration to obtain a successful injection for greater palatine nerve block.

Keywords: greater palatine foramen, canal, greater palatine nerve block.

الملخص:-.

أجريت الدراسة التشريحية على ثلاثين جمجمة آدمية بالغة (14 ذكر و16 أنثى) كانت تتميز بظهور الضرس الطاحن الثالث العلوى وذلك لتحديد مكان الثقب الحنكي الكبير وكذلك اتجاه القناة الحنكية الكبيرة. كما تم تجميع أربعين صورة أشعة مقطعية لمرضى غير مصابين بأي مرض في منطقة الحنك وذلك لتحديد اتجاه وطول القناة الحنكية الكبيرة. وأوضحت النتائج إن الوضع الأكثر شيوعا للثقب الحنكي الكبير كان بجانب الضرس الطاحن الثالث العلوى. أما عن اتجاه القناة الحنكية الكبيرة ناحية تجويف الفم فقد كان الاتجاه الأمامي السفلى هو الأكثر شيوعا. بالنسبة لنتائج صور الأشعة المقطعية وجد أن متوسط طول القناة الحنكية الكبيرة 21.7 مم في الذكور و 18.1 مم في الإناث و إن الوضع الأكثر شيوعا للثقب الحنكي الكبير بجانب الضرس الطاحن الثالث بنسبه 45% في كل من الذكور والإناث , والوضع التالي كان بين الضرس الطاحن الثاني والثالث بنسبة 25% من الذكور و30% من الإناث, أما مقابل الضرس الطاحن الثاني كان بنسبة 20% من الذكور و25% من الإناث وقد وجد في بعض الحالات موقع الثقب الحنكي الكبير بعد الضرس الطاحن الثالث في 10% من الذكور فقط. بالنسبة لاتجاه القناة الحنكية الكبيرة كان الاتجاه الأمامي السفلى هو الأكثر شيوعا بنسبة 55% من الذكور و 65% من الإناث . هذه الدراسة توضح لطبيب الأسنان بوضع هذه الملاحظات التشريحية في عين الاعتبار لكى يحصل على أفضل نتيجة عند تخديره للعصب الحنكي الكبير.

الكلمات المفتاحية: الثقب الحنكي الكبير – القناة الحنكية الكبيرة – الضرس الطاحن الثالث العلوى

1. Introduction

Most of the textbooks locate the foramen in a general way, near the lateral palatal border (Drake et al., 2005), or in the Poster lateral border of the hard palate (Gardner et al., 1975). The position of the greater palatine foramen in relation to the maxillary molars is stated to be of different positions e.g. opposite the second molar (Selden, 1948), opposite the third molar or anywhere between the second and third molars (Shane, 1975), medial to the last molar (Moore and Dalley , 1999). The greater palatine foramen which is the lower orifice of the canal of the same name, opens close to the lateral border of the hard palate behind the palatomaxillary suture.(Snell 2008; McMinn 1994; Joseph1982). The greater palatine

foramen lies between the second and third maxillary molar and approximately 1 cm onto the hard palate. (Reichman and Simon,2004). The greater palatine foramen lies between the palatine bone and maxilla and levels with the last molar tooth. The lesser palatine foramina, is just behind it, perforate the palatine bone itself (McMinn, 2003). The greater palatine foramen is situated 0.5 cm from the posterior border of the hard palate and when the third molar was absent, the foramen is not medial to the second molar but at its distal margin (at the level of the un erupted wisdom tooth). (Lang,1995). The greater palatine foramen is located posteromedially to the third maxillary molar and anteromedially to the maxillary tuberosity and pterygoid hamulus (Stilianos et al.,2007). The lesser palatine foramina are located on the palatine bone just behind the greater palatine foramen and they transmit the middle and posterior palatine nerves. (Scheid,2007). Richard et al. (1997) state that possible to locate the greater palatine foramen in the hard palate and inject liquid material directly into the canal. The canal varies between 22 and 33 mm in length and since the foramen rotundum lies 30 to 40 mm from the greater palatine foramen, the needle should be inserted no more than 25 mm to the greater palatine foramen to avoid the intracranial or intraorbital injection. The most common error occurring during the administration of the maxillary nerve block through the greater palatine canal is stepping the needle off from the posterior aspect of the hard palate.

2. Methodology

A- Anatomical study:

The study was conducted on thirty adult human dry skulls having full eruption of the upper third molar teeth, obtained from Anatomy department, Benghazi University and Anatomy Department, Faculty of Medicine, Alexandria University**.** Dry skulls were differentiated into 14 males and 16 females. All the skulls studied were normal and free of any pathological changes**.** Each skull was examined by using a scale and (1) Location of GPF in relation to maxillary molar teeth**.** (2) Direction of the greater palatine canal into the oral cavity**.** (3) Presence of the palatal spine projected from the posterior margin of GPF**.** (4) The presence of the lesser palatine foramina**.**

B-Radiological study (CT scan):

The study was included 40 computerized tomography scans of patients ranging in age from 25 to 59 years (20 males and 20 females). They are obtained from "Benghazi D and T center, Benghazi, Libya**."** The following points were studied in both axial and coronal

images**:** (1) Length of the greater palatine canal in mm**.** (2) Location of GPF in relation to the maxillary molar teeth**.** (3) Direction of the greater palatine canal (GPC) (4) CT scan study was done by Philips16 slices spiral machine which examine the random 40 patients who underwent high resolution examination for GPC & GPF during examination of the facio-maxiallary bone (Para nasal sinus) with slice thickness 1.0 mm & 0.5 mm interval**.** Modifying the examination by increasing the field of examination to cover the anatomical region of the GPF at the hard palate& the origin of the maxillary molar teeth**.** Axial sections covering the area of the GPC starting from the lower most part of the hard palate visualizing the opening of the lower part of the GPC i.e. the greater palatine foramina at the lateral aspect of the hard palate, to localize the position of the GPF regarding to the maxillary molar teeth**.** The examination done by helical ct with slice thickness 1.0mm, from that we can assess the length of the GPC in mm by summation the number of the cuts visualizing the GPC.

3. Data and Results

I- Anatomical results:

The location of the greater palatine foramen in relation to the maxillary molar teeth (Table I): The present study showed that the most common location of the GPF is opposite the third maxillary molar tooth This was observed in 64.28% male and 62.5% female skulls**.** The next common location was between the second and third molar teeth, it was observed in 28.57% male and 18.75% female**.** The least common position was observed distal to the third molar it was found in 7.15% male and 18.75% females**.** It has been found that the location of the foramen was symmetrical on the right and left sides**.** The direction of the greater palatine canal into the oral cavity (Table II) The present study showed that the most common direction was anteroinferiorly; being observed in 50% male and 56.25% female skulls**.** The next common direction was inferiorly ,where it was observed in 35.71% male and 31.25% female skulls**.** The least direction was anteriorly ,where it was observed in 14.29% in male and 12.5% in female skulls. The direction of the canal was symmetrical on both sides**.** The presence of a bony projection (spine) at the posterior border of the greater palatine foramen This projection was observed in 64.28% male and 50% female skulls **.**The presence of the palatal spine in front of the greater palatine foramen (Table III): A palatal spine was present in the poster lateral part of the hard palate, on each side, in front of the greater palatine foramen. This spine was ill defined in 7.14% male and 12.5% female skulls. A single unilateral spine on each side was observed in 50% male and 31.25% female skulls Two spines were present on each side in

21.43% male and 25% female skulls**.** Two spines were present with a bridge in between, on each side in 14.29% male and 25% female skulls.

Table I: The location of the GPF in relation to the maxillary molar teeth:

Location	Males		Females	
	No.	%	No.	%
Opposite third molar tooth	9	64.28	10	62.5
Between the second and third molar teeth	4	28.57	3	18.75
Distal to the third molar tooth	1	7.15	3	18.75
Total	14	100	16	100

Table II: The direction of the greater palatine canal (GPC) into the oral cavity:

Direction	Males		Females	
	No.	%	No.	%
Anteroinferiorly	7	50.00	9	56.25
Inferiorly	5	35.71	5	31.25
Anteriorly	2	14.29	2	12.50
Total	14	100	16	100

Table III: The incidence of palatal spine(s) in the hard palate in front of the greater palatine foramen

	Males		Females	
	No.	%	No.	%
ILL defined spine	1	7.14	2	12.50
Single spine on each side	7	50.00	5	31.25
Two spines on each side	3	21.43	4	25.00
Two spines with a bridge in between on each side	2	14.29	4	25.00
Bony canal	1	7.14	1	6.25
Total	14	100	16	100

II- Radiological results (CT results):

The length of the greater palatine canal (Table IV), The mean length of the GPC was 21.7 mm in males in range from 26.8 to 16.6 mm SD = ±2.66. While in the female cases the mean length was 18.1 mm in range from 25.4 to 16.0 mm SD = ±2.19).The mean length of the greater palatine canal was 19.9mm, and these results showed statistically significant difference between males and females ($p< 0.05$) The location of the greater palatine foramen (Table V) The most common location of the GPF was opposite to third molar tooth 45% males and 45% females, the next common position was between the second and third molars 25% males and 30% females, opposite to second molar in 20% males and 25% females. The least common location was distal to third molar (retromolar) in 10% of males and 0% of females. Direction of the greater palatine canal (Table VI). The most common direction was anteroinferiorly in 55% males; and 65% females. The next common direction was vertical in 35% males; and 30% females. The anterior direction was 10% males and 5% females.Figure1.

Table IV: The mean length of the greater palatine canal in mm:

	No.	Mean length	Range
Males	20	21.7	16.6–26.8
Female	20	18.1	16.00–25.4

Table V: The location of the greater palatine foramen:

Location	Males		Females	
	No.	%	No.	%
Opposite third molar tooth	9	45	9	45
Distal to the third molar tooth (retromolar)	2	10	–	–
Between the second and third molar teeth	5	25	6	30
Opposite second molar tooth	4	20	5	25
Total	20	100	20	100

Table VI: The direction of the greater palatine canal:

Direction	Males		Female	
	No.	%	No.	%
Anterior	2	10	1	5
vertical	7	35	6	30
Anteroinferiorly (posterior)	11	55	13	65
Total	20	100	20	100

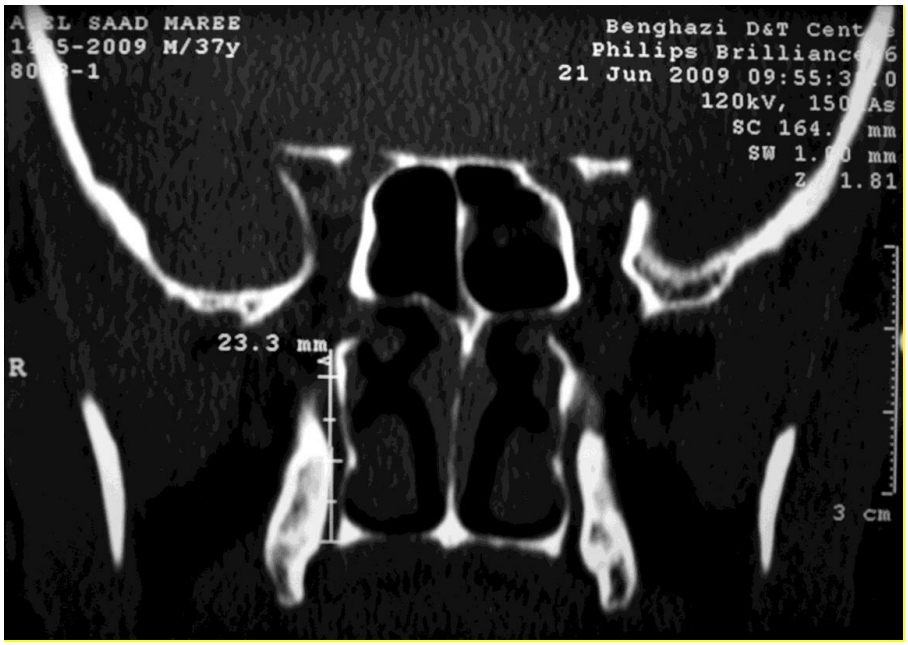


Figure 1. Photograph of a coronal CT image showing the direction and the measurement of the length of the greater palatine canal.

4- Discussion

The localization of the GPF is important to the clinical procedure like anesthesia of the greater palatine nerve, periodontal surgery, palatine tumor, abscess drainage and other clinical interventions. To know the location of the GPF and their variations offer safety to carry out conservative procedures during the clinical activity In the present study, the GPF was located most frequently opposite the maxillary third molar (64.28% of male and 62.5% of female skulls). (Ajmani.,1994) found that the most frequent location for the GPF was medial to the third molar tooth in 48.5% and 64.7% in Nigerian and Indian skulls respectively. In Kenyan African skulls, (Hassanali and Mwaniki.,1984) found that the most frequent location of the GPF was opposite to the third molar being found in 76%. However, in Chinese skulls, (Wang et al, .1988) found that the most common location for the GPF was opposite a line between the second and third molar teeth being observed in 48% of their studied skulls. In the present study, the molar-foramen positional relationship was the same bilaterally. In infants and children the relative location of the GPF moves posteriorly as the next posterior tooth erupts (Hassanali and Mwaniki.,1984). Based on the mean measurements, the present study showed that the mean distance from the center of the GPF to the mid sagittal plane was 15.64±1.875 mm on the right side and 15.5±1.506 mm on the left side in male; and 15.00±1.40 mm on the

right side and 14.71±1.40 mm on the left side in female skulls. The mean distance between the center of the GPF and the posterior border of the hard palate was 5.42±1.9 mm on the right side and 5.7±1.54 mm on the left side in male; and 5.187± 1.7 mm on the right side and 5±1.3 mm on the left side in female skulls. The mean distance from the center of the GPF to incisive fossa was 38.9±5.298 mm on the right side and 38.9±5.298 mm on the left side in male; and 53.25±16.9 mm on the right side and 53.23±16.9 mm on the left side in female skulls. Such measurements may afford an alternative consideration in the technique of anesthetic injection about this area. Regarding the direction of the greater palatine foramen into the oral cavity, the most common direction in the present study was anteroinferiorly (50% in males and 56.25% in females). The canal was directed vertically (inferior) in 35.71% of male and 31.25% of female skulls. Anteriorly directed canal was observed in 14.29% of male and 12.5% of female skulls. It is to be noted that the anteroinferior and anterior directions explain the difficulty encountered when attempting to enter the greater palatine canal if the injected needle is directed vertically; in such cases anterior angulation of the needle is required for easy introduction of the anesthetic drug. In the present study, a bony projection (spine) along the posterior border of the foramen was in the present study, examination of the hard palate in front of the greater palatine foramen revealed the presence of a single spine, on each side, in 50% of male and 31.25% of female skulls. Two spines were present, on each side, in 21.43% of male and 25% of female skulls. Two spines with bridge in between were present in 14.28% of male and 25% of female skull. A unilateral bony canal was present in 7.14% of male and 6.25% of female skulls. In comparison, previous investigators (Jeyaseelan and Gupta.,1988) reported a single unilateral spine in 21.1% of skulls, single bilateral spine in 36.5% of skulls, unilateral bony canal in 11.5% and bilateral bony canal in 5.7% of skulls. (Khatric et al.,1988) revealed the presence of two spines on both sides in 17.1% of dry skulls. The presence of bony canal probably explains the occasional difficulty in infiltrating the greater palatine nerve for local anaesthesia during the surgery on the hard palate. (Khatric et al.,1988) The bony canal may act as anatomical barrier to diffusion of anesthesia during the infiltration of the greater palatine nerve for local anesthesia. (Jeyaseelan and Gupta.,1988) The majority of the skulls in the present study 78.57% of males and 75% of females showed arched palatal vaults, 21.42% of males and 18.75% of females were flat palates and 6.25% of female skulls showed very highly arched palatal vaults. The palatal growth takes place in the length in the sagittal plane anterior to the greater palatine foramen (Shane, 1975). In the present study, 50% of the skulls have multiple lesser palatine

foramina. The frequency of multiplicity of foramina is comparable to that observed in Kenyan skulls 49% (McMinn, 2003).

The greater palatine canal is formed by the opposition of an obliquely descending groove at the poster inferior aspect of the medial wall of the maxillary bone and the greater palatine groove deep to the lateral surface of the perpendicular plate of the palatine bone. This canal opens inferiorly at the greater palatine foramen located at the lateral margin of the horizontal plate (Daniels et al., 1998).

5-Conclusion

The greater palatine canal constitutes a significant communication between the oral cavity and the pterygopalatine fossa so the anatomical and radiological study of the greater palatine canal and foramen can allow better understanding and accomplishment of surgical and anesthetic treatment concerned with the posterior maxillary region.

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