The Role of Cone Beam Computed Tomography in Determination of the Greater Palatine Foramen Position Among Iraqi Population

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ABSTRUCT

Background: The use of the cone beam computed tomography for analysing the position of the greater palatine foramen in relation to various anatomical landmarks is crucial in dentistry. The aims of the current study, firstly is to determine the greater palatine foramen position in relation to various anatomical landmarks by using cone beam computed tomography and secondly is to make a comparison of the measurements according to side, gender, and age.

Materials and methods: This prospective study included 60 Iraqi patients (28males and 32 females) who selected according to availability of Inclusion criteria, which include age range (21 - 60 years), with no dentofacial deformities or pathological lesion at the maxilla. All patients had informed consent of this study. Measurements were taken for the distance from the greater palatine foramen to the pterygoid hamulas of sphenoid bone in sagittal view and from greater palatine foramen to alveolar ridge in the axial view by using cone beam computed tomography.

Results: The average distances of the greater palatine foramen to the pterygoid hamulus and alveolar ridge were 9.16 ±1.14 mm and 5.16 ± 0.84 mm respectively, there was no significant difference of distance according to side, gender although the distances higher in male more than female, but there was significant difference according to age.

Conclution: The use of cone beam computed tomography could prevent the complications of procedures carried out in the region of greater palatine foramen. The average distances from the greater palatine foramen to the alveolar ridge and pterygoid hamulus were statistically not significantly differ according to side, gender, but there was significant difference according to age.

Keywords: Greater palatine foramen, cone beam computed tomography, pterygoid hamulas, alveolarridge. **(J Bagh Coll Dentistry 2018; 30(1): 53-57)**

INTRODUCTION

Greater palatine foramen (GPF) is the inferior opening of the greater palatine canal (GPC), positioned at backside of the hard palate. The majority of research have situated GPF, on the palatal side between the maxillary 2nd and 3rd molars or medial to the maxillary 3rd molar [(1)]. Precise GPF positioning is needed in the maxillary nerve block which considered an effective method of attaining profound anesthesia of the hemi maxilla. Also, in recognizing the emergence of the greater palatine artery within the oral cavity, which signify important information in palatal free vascular flaps surgery, maxillary sinus, cleft palate, or during graft of palatal mucosa for periodontal surgery [(2,3,4)]. Determination of the precise position of the GPF in relation to anatomical landmarks is essential in order to keep away from possible complications associated with this area.

Predominantly, the previous studies analysing the position of GPF on dry skulls, thus giving an adequate information on the gender, age, and ethnicity of the subjects [(5)], 3D cone beam computed tomography (CBCT) are becoming commonly presented for use in maxillofacial applications due to its diagnostic capability and minimizing radiation dose to the tolerant, equivalent to (3% - 20%) of a conventional CT radiation dose, and comparable to 2D X-ray radiation dose [(6,7)]. So, the purpose of this study was to investigate the GPF position through measurement of distances from the greater palatine foramen to alveolar ridge and GPF to pterygoid hamulas of sphenoid bone by using (CBCT) data and providing essential information about the anatomical variation GPF position in Iraqi patients by comparison the measurements according to sides (right and left), gender (male and female), and age.

MATERIALS AND METHODS

A prospective study of CBCT scan for (60) Iraqi adult patients (32 females and 28 males) with age between 21-60 years attending Oral and Maxillofacial Radiology department of Al Sader Specialized Health Center for dental treatment in Baghdad city who underwent CBCT scans for different purposes since November 2016 to March 2017.

The patients who visited a diagnostic centre were selected after considering the inclusion criteria which are: age range 21-60 years, no dentofacial deformities or pathological lesion at the maxilla, maxillary lateral incisor teeth and at least

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one of maxillary molars for both right and left sides must be present.

All patients had their CBCT scans taken for other purposes and they had informed consent for participation in this study. The sample subject was divided into four age groups with 15 subject in each group:

1. **Group 1**: consists of 8 females and 7 males with age ranged between 21-30 years.
2. **Group 2**: consists of 9 females and 6 males with age ranged between 31- 40 years.
3. **Group 3**: consists of 8 females and 7 males with age ranged between 41-50 years.
4. **Group4**: consists of 7 females and 8 males with age ranged between 51- 60 years

The CBCT examinations were carried out for every patient with Kodak 9500 (Care stream, France), full rotation scan was performed with the size of field of view will be 18× 20.6cm diameter and the exposure parameters of radiographic machine include: voxel size 300, KV 90, MA 10.The analysis was conducted using the distance measuring tool of care stream (CS 3D) software.

Intra- and inter-examiner agreement was performed (Coefficient of variance and paired T test were used). All data were evaluated using SPSS software version 19 package. All images were obtained with volume 1 (high-resolution) and high-contrast options. The statistical analysis was made by using SPSS 20.0.0, Minitab 17.1.0, MedClac 14.8.1 software package was used to make the statistical analysis. A paired T test and ANOVA test used in statistics of study. For each GPF, the position determined by measuring the distance from the foramen into two different anatomical land marks which are discussed consequently:

1. The GPF position to pterygoid hamulas of sphenoid bone: To locate GPF in relation to pterygoid hamulas (PH) of sphenoid bone, the distance from the middle of GPF to the tip of hamulas of medial pterygoid plate of sphenoid bone was measured in millimetres in sagittal view as shown in figure 1.

2. The GPF position to alveolar ridge: For measuring the distance from GPF to the alveolar ridge (AR) in the axial view, firstly entering in the depth of the view until reaching the neck of teeth (cement -enamel junction area), a tangential line to the palatal side of upper posterior teeth was drawn, this line starting from distal margin of maxillary lateral incisors in both right and left side to the end of AR. Then with software reconstruction the position of GPF within the depth of palatine bone was determined which is ended by GPF, then perpendicular line from the tangential line to the medial wall of GPF passing through the center of the foramen represent distance from the GPF to the AR was done as shown in figure 2, that's help as for determination the position of GPF according to AR.

Figure 1: Sagittal view showing the distance from the GPF to the PH.

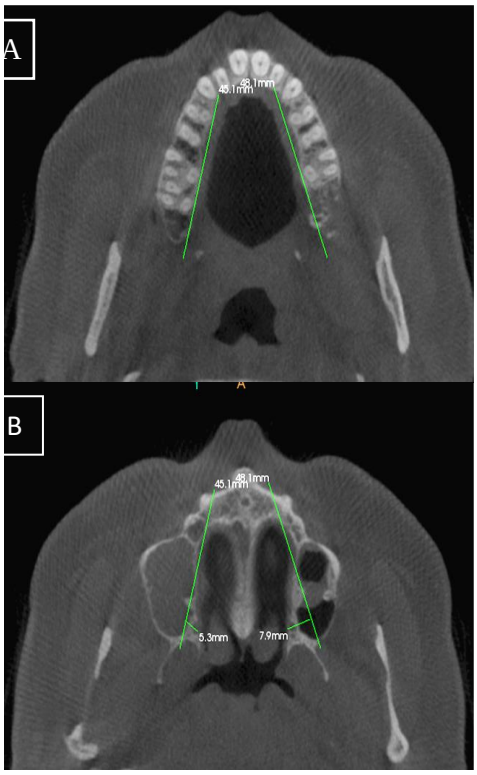

Figure 2: Axial view A and B showing method of measuring distance from GPF to AR.

RESULTS

Sixty patients (32 females and 28 males) with mean age of the 41.1 ± 12.2 year were examined. The average distance of the GPF to the PH of sphenoid bone was 9.16 ±1.14mm (9.10 ± 1.27 mm on the right side and 9.22 ± 1.50 mm on the left side). However, there is good agreement in the intra-class correlation for left and right sides of the distance GPF- PH, the average distance from GPF to PH of sphenoid bone in sagittal view in female was 8.96 ± 1.25mm, while in male was 9.39 ± 1.24mm, although distance higher in male more

than female, but there was no statistically significant difference for the distances from the GPF to the PH during comparison according to side and gender, as shown in table 1 and 2.

The change in distance from GPF to PH according to age groups, the average distance in group 1 and group 4 was significantly higher than group 2 and group 3, as illustrated in table 3.

The average distance from the GPF to the AR was 5.16 ± 0.84 mm (5.12 ± 1.81mm on the right side and 5.21 ± 1.43 mm on the left side). Also, the average distance in female was 5.08 ± 1.21mm, while in male was 5.26 ± 1.63mm, although there was fair agreement in the intra-class correlation for left and right sides of the distance GPF- AR, there was no statistically significant difference for the distances from the GPF to the AR during the comparison according to side, as shown in table 4.

The average distance from the GPF to the AR was 5.16 ± 0.84 mm (5.12 ± 1.81mm on the right side and 5.21 ± 1.43 mm on the left side). Also, the average distance in female was 5.08 ± 1.21mm, while in male was 5.26 ± 1.63mm, although there was fair agreement in the intra-class correlation for left and right sides of the distance GPF- AR, there was no statistically significant difference for the distances from the GPF to the AR during the comparison according to side, as shown in table 4.

There was no statistically significant difference for the distances from the GPF to the AR during the comparison according to gender, however the distance in male more than in female as illustrated in table 5.

There was considerable change in the distances from the GPF to the AR according to age. The average distance from the GPF to the AR axial view in group 1 was significantly higher than the rest of the groups 2,3 and 4, illustrated in table 6.

Table 1: Comparison of the GPF- PH distance according to side in sagittal view

Side	Right	Left	Average	P-value	ICC	Agreement
Number	60	60	60	-		
GPF-PH distance (mm)	9.10 ± 1.27	9.22±1.50	9.16±1.14	0.424	0.634	Good
ICC: intra-class correlation coefficient						

Table 2: Comparison between GPF-PH distances according to gender

Gender	Female	Male	P value
Number	32	28	-
GPF –PH distance sagittal view	8.96 ± 1.25	9.39 ± 1.24	0.191

Table 3: The comparison of the distance from the GPF to the PH of sphenoid bone in sagittal view according to age groups

Age groups	Group 1	Group2	Group 3	Group 4	P value
Number	15	15	15	15	-
Average distance GPF-PH	10.00±0.52	8.59± 1.52	8.97±1.40	9.11± 0.91	0.012

Table 4: comparison of the GPF- AR distance according to side in axial view

Side	Right	Left	P value	ICC	Agreement
Number	60	60	-		
Average distance (GPF-AR) in axial view (mm)	5.12 ± 1.81	5.21± 1.43	0.686	0.505	Fair
ICC: intra-class correlation coefficient					

Table 5: Comparison between the average distances from the GPF to AR according to gender

Gender	Female	Male	P value
Number	32	28	-
Average distance from GPF to AR in axial view (mm)	5.08±1.21	5.26±1.63	0.631

Table 6: The comparison of the GPF distance to AR to age groups

Age groups	Group 1	Group 2	Group 3	Group 4	P value
Number	15	15	15	15	-
Average distance from GPF to AR axial view(mm)	6.06± 1.61	4.83± 1.66	4.88±1.07	4.89± 0.78	0.041

DISCUSSION

The importance of GPF location applicability in dentistry e.g. maxillary nerve block, the palatal free vascular flaps surgery, maxillary sinus surgery in addition to the cleft palate closure and in Lefort I osteotomy necessitates more investigations to set up an precise reference point for GPF position since variability in the study results and most studies concerning GPF position have been carried out on dry adult skull, thus providing restricted information about age and gender of the samples[3,4,5].

The CBCT provides precise measurements with a less radiation dose and shorter exposure time in comparison to CT [7,8]. In the current study using CBCT, data image of Iraqi subjects to assess the GPF position in relation to pterygoid hamulas in sagittal view and alveolar ridge in axial view with compare distances measurements according side, gender, and age.

The distance from GPF to PH in current study (9.16 ± 1.14mm), which is higher than distance reported by Tomaszewska et al. and Sharma et al. which were 11.78 ± 2.23mm and 11.9 ±1.1 mm respectively [4,11]. The comparison in distance from GPF to PH was not significantly different between right and left sides, male and female, in comparison with previous studies. Sharma et al. showed distance from GPF to PH was significantly different between right and left sides but Tomaszewska et al. [4] shown no significant different between them, while comparison the distance from GPF to PH according to gender was not viable, because most of previous study measured GPF - PH distance on dried, unsexed skulls, except for Tomaszewska et al. which reported significant difference between male and female[4]. The distance from GPF to PH show significant difference according to age, within the limit of our knowledge GPF to PH distance was not evaluated by previous studies according to age as we did in current study, so there are limitation in comparing the result with other studies.

The distance from GPF to AR in current study (5.16 ± 0.84 mm), this result was lower than distance stated by Ikuta et al. (7.9 ±2.04) [5] but higher than distance obtained by Tomaszewska et al., (3±1.2 mm with no significant difference between two sides)[4]. In a study performed by Ikuta et al. results showed no significant difference according to side and gender[5],which is compatible with the current study, the variance in distance between current study and the above study may be attributed to the small sample or the difference in the ethnicity, sex, and age of subject.

It's clearly seen from the results of table 6, there was significant difference of GPF to AR distance according to age, group 1 was significantly higher than the rest of the groups, Baxter-Jones et al. stated that the gain of bone mass was during puberty and reaching a maximum at the second decade of life then decreasing subsequently [10,11]. On other hand, within the limit of our knowledge GPF to AR distance previously not investigated according to age so there are limitation in the comparison with other studies. A limiting factor in the current study was the small sample size. Thus, we suggest evaluating the GPF position on larger sample with greater difference in the range of age group. In addition, comparing GPF position in children and adults, as well as in subjects sample with definite craniofacial illnesses.

CONCLUSION

Positioning of GPF may represent an anatomical difficulty in oral and maxillofacial surgery in the posterior region of the palate, but using CBCT could prevent the complications of procedures carried out in region of GPF. The average distances from the GPF to the AR and PH was statistically not significantly differ according to side, gender but significantly differ according to age.

REFERENCES

1. Arx TV, Lozanoff S. Clinical oral anatomy: a comprehensive review for dental practitioners and researchers, textbook, 1st ed. AG Switzerland, Springer nature 2016. p 204-218
2. Chrcanovic BR, Custódio AL. Anatomical variation in the position of the greater palatine foramen. J Oral Science 2010; 52(1):109-13.
3. Nimigean V, Nimigean VR, Buţincu LA, Sălăvăstru I, Podoleanu L. Anatomical and clinical considerations regarding the greater palatine foramen. Rom J Morphol Embryol 2013; 54(3 Suppl):779-83.
4. Tomaszewska IM, Tomaszewski KA, Kmiotek EK, Pena IZ, Urbanik A, Nowakowski M, Walocha JA. Anatomical landmarks for the localization of the greater palatine foramen–a study of 1200 head CTs, 150 dry skulls, systematic review of literature and meta-analysis. J Anat 2014; 225(4):419-35.
5. Ikuta CR, Cardoso CL, Ferreira-Júnior O, Lauris JR, Souza PH, Rubira-Bullen IR. Position of the greater palatine foramen: an anatomical study through cone beam computed tomography images. Surgic Radiol Anat 2013; 35(9):837-42.
6. Asha ML, Arun Kumar G, SattigeriAnupama V, Raja Jigna V, Diksha M. Cone beam computed tomographic analysis of anatomical variations of greater palatine canal and foramen

in relation to gender in South Indian population. Oral Health Dent Manag 2015;14:384-90
7. Rahman VF, Fatah AA. Localization of maxillary impacted canine using cone beam computed tomography for assessment of angulation, distance from occlusal plane, alveolar width and proximity to adjacent teeth. J Bagh Coll Dentistry 2017;29(1):70-5.
8. Horner K, Jacobs R, Schulze R. Dental CBCT equipment and performance issues. Radiat Protect Dosimet 2012;153(2):212-8.
9. Sharma NA, Garud RS. Greater palatine foramen - key to successful hemimaxillary anaesthesia: a morphometric study and report of a rare aberration. Singap Med J 2013; 54(3): 152-9.
10. Baxter-Jones AD, Faulkner RA, Forwood MR, Mirwald RL, Bailey DA. Bone mineral accrual from 8 to 30 years of age: An estimation of peak bone mass. J Bone Miner Res 2011; 26: 1729–39.
11. Fatah AA, Ameer NA. Sex variations by linear measurements of palatal bones and skull base using 3D reconstructed computed tomographic scan among Iraqi sample. J Bagh Coll Dentistry 2016;28(4):82-8.

الخلاصة

الخلفية:استخدام جهاز الاشعه المقطعيه ذات الشعاع المخروطي لتحديد موقع الثقب الحنكي الكبير بالنسبة للمعالم التشريحية المختلفة أمر بالغ الأهمية في طب الأسنان. والهدف من الدراسة الحالية اولا هو تحديد موقع الثقب الحنكي الكبير بالنسبة للمعالم التشريحية المختلفة باستخدام جهاز الاشعة المقطعية ذات الشعاع المخروطي ومقارنة القياسات وفقا للجانب التشريحي والجنس والعمرللمواطنين العراقيين وثانيا هوإجراء مقارنة بين القياسات حسب الجانب والجنس والعمرللمواطنين العراقيين.

المواد وطريقة البحث: عينة البحث شملت ٦٠ مريضا عراقيا (٢٨ من الذكورو ٣٢من الاناث) من الذين حصلت موافقتهم للمشاركة في الدراسة. تتراوح اعمارهم بين (٢١ - ٦٠ سنة)،مع مراعاة عدم وجود تشوهات الأسنان أو كسور في الفك العلوي. أخذت القياسات للمسافة من الثقب الحنكي الكبير إلى النتوء الجناحي للعظم الوتدي باستخدام المقطع الشعاعي السهمي.وللمسافة من الثقب الحنكي الكبير إلى الحافه السنخية باستخدام المقطع الشعاعي المحوري.

النتائج: كان متوسط المسافة من الثقب الحنكي الكبيرالى النتوء الجناحي للعظم الوتدي ٩,١٦ ± ١,١٤ ملم (٩,١٠ ± ١,٢٧ ملم على الجانب الأيمن و ٩,٢٢ ± ١,٥٠ ملم على الجانب الأيسر)، ولم يكن هناك فرق كبير في المسافة وفقا للجانب التشريحي والجنس ولكن يوجد فرق حسب المرحلة العمرية. كان متوسط المسافة من الثقب الحنكي الكبير في الحافة السنخية ٥,١٦ ± ٠,٨٤ ملم (٥,١٢ ± ١,٤٣ مم على الجانب الأيمن و ٥,٢١ ± ١,٤٣ ملم على الجانب الايسر) ولم يكن هناك فرق كبير في المسافة حسب الجانب التشريحي والجنس ولكن يوجد فرق حسب المرحلة العمرية.

خاتمة:اظهرت الدراسة استخدام جهاز الاشعه المقطعية ذات الشعاع المخروطي يساعد في تجنب المخاطر الجراحية الممكن حدوثها في منطقة الثقب الحنكي الكبير. كما اظهرت الدراسة ان متوسط المسافات من موقع الثقب الحنكي الكبير بالنسبة إلى الحافة السنخية والنتوء الجناحي للعظم الوتدي إحصائيا لا تختلف اختلافا كبيرا حسب الجانب والجنس ولكن تختلف حسب المرحلة العمرية, بحيث لا يمكن استخدامها لتحديد الجنس ولكن يمكن استخدامها لتحديد الفئة العمرية.

الكلمات الرئيسية: الثقب الحنكي الكبير، جهاز الاشعة المقطعية ذات الشعاع المخروطي ، النتوء الجناحي للعظم الوتدي ، الحافة السنخية .