Localization of the position of vital anatomical structures in the lateral wall of maxillary sinus during different surgical intervention using cone beam computed tomography

Ali Hakiem Tawfieq (MSc)¹, Haider Ali Hasan (PhD)², Manar Abd Alrazaq Hassan (MSc)³, Mohamed Salah Khifi (PhD)⁴

¹,³ College of Medicine, University of Diyala, Diyala, Iraq
² College of Dentistry, University of Babylon, Iraq
⁴ Faculty of Dental Medicine of Monastir, Tunisia

Abstract

Background: Proper information about the anatomy of the maxillary sinus is required to avoid any unexpected complications that may arise due to the close relation between the maxillary sinus and posterior superior alveolar artery.

Objective: To the current study used cone beam computed tomography CBCT imaging to assess the position of the posterior superior alveolar artery (PSAA) in relationship to the alveolar ridge and the flour of maxillary sinus.

Patients and Methods: A number of 95 Iraqi patients participated in this prospective study (53 females, 42 males; age range 20-49 years). From January 2021 to February 2022, attended a 2nd specialised dentistry institution in Baquba city for CBCT scanning for numerous diagnostic and management purposes.

Results: According to our study, we detected the presences of artery in (83.68%) of the sample. females showed higher PSAA prevalence than men on both sides, and the difference was significant overall, Also, the existence of artery for each side and total in the intramembranous locating in females is greater than that in males, which may demonstrate that the probability of Bleeding and other side effects is higher in males, since the existence of artery in the intramembranous area in females will reduce the likelihood of traumatic injury throughout any surgical treatment.

Conclusion: This research used CBCT to determine the precise location of PSAA in the Iraqi population. This data could assist in decreasing the likelihood of hemorrhage as well as other complications which may happen throughout any surgical treatment, such as dental implant placement, ridge expansion. As well as other surgical interventions in this region.

Keywords: Maxillary sinus walls, posterior superior alveolar artery, cone beam computed tomography
Introduction

In order to supply blood to the lateral sinus walls and sinus floor membrane, via a branch known as the posterior superior alveolar artery (PSAA) [1]. Pre-surgical radiographic assessment to detect and identify the precise position of the artery during any surgical intervention to prevent injuring these arteries and consequent perioperative bleeding [2]. For craniofacial imaging, cone beam computed tomography (CBCT) is suitable. It produces accurate views of highly contrast structures; it is also appropriate imaging of bone [3,4]. Furthermore, the practical use of the CBCT approach offers various potential benefits for "maxillofacial imaging," including X-ray beam limitation, imaging accuracy, dosage reduction, and short scan time [5].

Sinus floor elevation can be considered as a surgical operation method for increasing the volume of bone in the vertical dimension for dental implant insertion [6]. Nonetheless, the complication should be avoided during surgery and afterwards during sinus floor elevation. A blood vessel disruption caused by these complications may result in serious hemorrhage [7].

The posterior superior alveolar artery, shenopalatine artery, larger palatine artery, and infraorbital artery supply the maxillary sinuses. The infraorbital artery and PSAA are maxillary artery branches that nourish the schneiderian membrane and the lateral wall of the sinus. Extraosseous and intraosseous branches of the PSAA and infraorbital artery may anastomose. The PSA artery travels laterally, outside of the maxillary bone, to the convexity of the maxillary tuberosity, and is in direct contact to the bone and the periosteum [8,9].

Knowledge of the anatomy of the maxillary sinus is required to avoid any unexpected complications that may arise due to the tight interaction between the maxillary sinus and PSAA [10,11]. Scanning techniques that exposed the patient to radiation exposure must provide as much necessary details as feasible, and the clinician must acquire as much valuable information as possible. When compared to traditional medical computed tomography (MDCT) scans in maxillofacial imaging, cone beam computed tomography (CBCT) is more helpful with the option of low dosage [12]. The actual dosage from a conventional dental protocol scan with MDCT is 1.5 to 12.3 times higher than that from equivalent medium-field of view dental CBCT scans (International Committee on Radiological Protection - ICRP 2007) [13,14]. Hence, CBCT is used before any treatments in the alveolar ridge and maxillary sinus in patients who require dental implants. CBCT is well appropriate for craniofacial area imaging. It shows precise images of well-contrasted structures; it is also suitable for bone imaging [15].

The current study used CBCT imaging to assess the connection and position of the posterior superior alveolar artery in relationship to the alveolar ridge and the floor of maxillary sinus.

Patients and Methods

A number of 95 Iraqi patients participated in this prospective trial (53 females, 42 males; age range 20-49 years). From January 2021 to February 2022, attended a 2nd specialised dentistry institution in Baquba.
city for CBCT scanning for numerous diagnostic purposes. For all views, the same radiographic apparatus was used: "Tomographic pictures were taken with a CBCT scanner (NewTom VGi)TM."

Some of the scanning settings were as follows:
"Voltage =110 kilovolts, exposure period =24 seconds, electrical charge =5.7 mA, voxel size =0.5 mm, viewable field of view =16 cm ×14 cm"

Oral and maxillofacial radiologists performed the measurements and analysis.

Excluded criteria:
- Participants suffering from systemic disorders that impair growth and development
- The existence of any deciduous teeth in the region of interest.
- Radiography revealed the existence of pathological alteration in the region of interest.
- A preexisting incidence of surgery and/or trauma to the target location.

Included criteria:
Each teeth in the designated target should have been available and permanent.

The test was carried out on 10 selected randomly Iraqi individuals in order to determine the reliability and repeatability of the link between PSAA and maxillary sinus wall using cone beam computed tomography."

Figures (1): (A,B and C) depict coronal view of CBCT used to determine the location of the PSAA
A intramembranous (inside the Schneiderian membrane of maxillary sinus), B intraosseous (inside the bone of lateral wall of maxillary sinus) and C (outside the extraosseous bone of lateral wall of maxillary sinus)

Inter examiner calibration
This calibration was executed by contrasting the study's observation of a randomised chosen ten sample to the observation of another well-trained oral and maxillofacial radiologist. There wasn't a significant
difference (p>0.05) when the paired t-test was employed to compare the two measures.

**Intra examiner calibration**

The calibration was accomplished by the investigator repeating the evaluation of a randomized chosen ten CBCT images 2 weeks after the initial measurement. When the two readings were compared using a paired t-test, the difference was not significant (p>0.05).

**Statistical Analysis**

With the Statistical Package for Social Science (SPSS version -22, Chicago, Illinois, USA), minimum, maximum, mean, standard deviation (SD), and standard error (SE), cluster chart bars, frequency, and percent Shapiro Wilk test, Levene test, Two independent Sample T test, One Way Analysis Of Variance (ANOVA) with Games-Howell posthoc test, and Pearson Chi square are examples of inferential statistics. The acceptable threshold of relevance is 0.05.

**Results**

Table (1): Association between artery and tooth presence

<table>
<thead>
<tr>
<th>Side</th>
<th>Tooth</th>
<th>Total</th>
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<td></td>
<td>dentulous</td>
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</table>

Results in Table (1) show 95 subjects that 190 sides (95 right and 95 left) participated in this study, 159 (83.68%) artery is present in this study with 31 (16.32%) artery not present and the left side has more artery present than the right one, although the presence of teeth has more artery than that absent of teeth to presence the artery in each side and in the total sample but the result is not significant association.
Results in Table (2) show that distance from artery to alveolar crest in the right side is higher in the extraosseous from other locations while in the left side this distance is higher in the intraosseous membrane but with no significant difference.

Findings in Table (3) show that distance from artery to sinus floor is higher in extraosseous from other two locations in each side with significant difference between location.

Findings in Table (4) show that in the right side each result is significant from each location to other while in the left side only when compare extraosseous to Intramemranous, this result is only significant while other results are not significant.
Results in Table (5) show that distance of artery to alveolar crest and distance of artery to sinus floor in each side is higher in males than that in females with significant difference in distance of artery to alveolar crest in right side and significant difference in distance of artery to sinus floor in left side while other results are not significant.

Results in Table (6) show that females represent with more artery presence than males in each side and in the total with significant result in the left side and in the total while not significant in the right side.
Table (7): Association between location and gender

<table>
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<th>P value</th>
<th>N.</th>
<th>%</th>
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<tr>
<td>Intra.Mem.</td>
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<tr>
<td>Location</td>
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<td>28</td>
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<td>47.50</td>
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<tr>
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Findings in Table (7) show that presence of artery in each side and in the total in the intramembranous find in females more than that in males while in the extra osseous, artery find to be higher in males than that in females, in the intra osseous, artery find to be higher in males more than that of females in the right side and in the total while in the left side, this result is higher in females more than that in males, but all these results are not significant.

**Discussion**

Cone Beam Computed Tomography is an ideal choice for maxillofacial scanning. It produces crisp pictures of highly contrast features; it is also appropriate for skeletal scanning [16, 17]. Furthermore, the practical use of the CBCT approach offers various potential benefits for "maxillofacial imaging," including X-ray beam limitation, picture accuracy, dosage minimization, and short scan time [5].

The objective of this investigation was to determine the connection and position of the PSAA in relation to the alveolar bone ridge and floor of maxillary sinus. The accurate identification of PSAA position is crucial. Nevertheless, because no study has been conducted within the Iraqi population, only analogous studies in other groups can be used to examine how the variable PSAA location varies by ethnic background.

According to a study done on the Turkish population, the artery was found in 89.3 percentage points of the sinuses and was predominantly intraosseous (71.1% percentage), [18]. In this study, we detected the artery in 83.68% percentage. The artery detecting performance was greater than that reported by Güncü et al.[13] (64.5%), Elian et al.[19] (52.9%), Mardinger et al. [20] (55%), and Kim et al.[21] (52%). Whereas a research conducted by Sun W et al on a Chinese population revealed the
presence (87.6%)[22], a comparable study conducted by Cruz ILA et al on a Mexican population revealed the presence (90%) [23] the difference in percentage of PSAA detection may be due to techniques and ethnic variances, because these studies were conducted in different regions of the world.

Females showed higher PSAA prevalence than men on both sides, and the difference was significant overall, which agrees with Kim et al, but disagrees with Lee et al.[24], and Rahpeyma et al [25]. This disparity may be attributable to a difference in the male to female ratio of responders.

Also, the existence of artery for each side and total in the intramembranous locating in females is greater than that in males, which may demonstrate that the probability of Bleeding and other side effects is higher in males, which must be taken into account when expelling bone for surgical treatment in this region, since the existence of artery in the intramembranous area in females will reduce the likelihood of traumatic injury throughout any surgical treatment.

Males show a greater distance from the artery to the alveolar crest and a greater distance from the artery to the sinus floor than females, which is consistent with the findings of Fayek et al [26] Güncü et al.[13] and Mardinger et al. [27], however they disagree with Ilgüy et al [18] This disparity might be attributed to differences in number of respondents or technique . The limitation of present study was we use the CBCT to detect both the hard tissue (lateral wall of maxillary sinus) and soft tissue (PSAA and schneiderian membrane ) which may be better to detected by magnetic resonance imaging devices because it show better quality for imaging of soft tissue.

**Conclusions**

This research used CBCT to determine the precise location of PSAA in the Iraqi population. This data could assist in decreasing the likelihood of hemorrhage as well as other complications which may happen throughout any surgical treatment, such as dental implant placement, ridge expansion, as well as other surgical interventions in this region.

**Recommendations**

Evaluating the same variable with sample size larger than used in this study also doing comparison of the variable used in this study in varied races.

**Source of funding:** The current study was funded by our charges with no any other funding sources elsewhere.

**Ethical clearance:** Ethical approval was obtained from the College of Medicine / University of Diyala ethical committee for this study.

**Conflict of interest:** Nil

**References**


[3] Venkatesh E, Elluru SV. Cone beam computed tomography: basics and
تحديد موضع الهياكل التشريحية الحيوية في الجدار الجانبي للجيب الفكي العلوي أثناء التدخلات الجراحية المختلفة باستخدام التصوير المقطعي المحوسب بالشعاع المخروطي

علي حكيم توفيق 1, حيدر علي حسن 2, منار عبد الرزاق حسن 3, محمد صالح خلفي 4

الملخص
خلفية الدراسة: المعلومات الدقيقة عن تشريح الجيب الفكي مطلوبة لتجنب أي مضاعفات غير متوقعة قد تنشأ بسبب العلاقة الوثيقة بين الجيب الفكي والشريان السنخي الخلفي.

أهداف الدراسة: استخدمت الدراسة الحالية التصوير المقطعي المحوسب بالشعاع المخروطي لتقييم موقع الشريان السنخي العلوي الخلفي في الجيب الفكي العلوي.

المرضى والطريقة: شارك في هذه الدراسة 95 مريضاً عراقياً (53 أنثى، 42 ذكرًا، الفئة العمرية 20-49 سنة). واستغرقت من يناير 2021 إلى فبراير 2022، وشملت المرضى الذين راجعوا في المركز التخصصي الثاني لطب الأسنان في مدينة بعقوبة لإجراء اشعة للعديد من الأغراض التشخيصية والعلاجية.

النتائج: وفقاً لدراستنا تم الكشف عن وجود الشريان في (83.68%) من العينة. أظهرت الإحصاءات انتشار الشريان السنخي العلوي الخلالي أعلى من الرجال في كلا الجانبين (68%) من العينة. أظهرت الإحصاءات نقص الشريان في (16.32%) من العينة. وظلت الشريان في الجانبين (16.32%) من العينة. وظلت الشريان في الجانبين (16.32%) من العينة.

الاستنتاجات: استخدم هذا البحث التصوير المقطعي المحوسب بالشعاع المخروطي لتحديد الموقع الدقيق لـ الشريان السنخي العلوي الخلفي في السكان العراقيين. يمكن أن تساعد البيانات المستندة من هذا البحث في تقليل احتمالية النزف بالإضافة إلى المضاعفات الأخرى التي قد تحدث خلال أي علاج جراحي، مثل زرع الأسنان وتوسيع عظم الفك، بالإضافة إلى التدخلات الجراحية الأخرى في هذه المنطقة.

الكلمات المفتاحية: جدان الجيب الفكي العلوي، الشريان السنخي العلوي الخلفي، التصوير المقطعي المحوسب بالشعاع المخروطي.

hakim@uodiayla.edu.iq

البريد الإلكتروني: hakim@uodiayla.edu.iq
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