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

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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

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Introduction

In order to The maxillary artery, supplies 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 flour 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

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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"

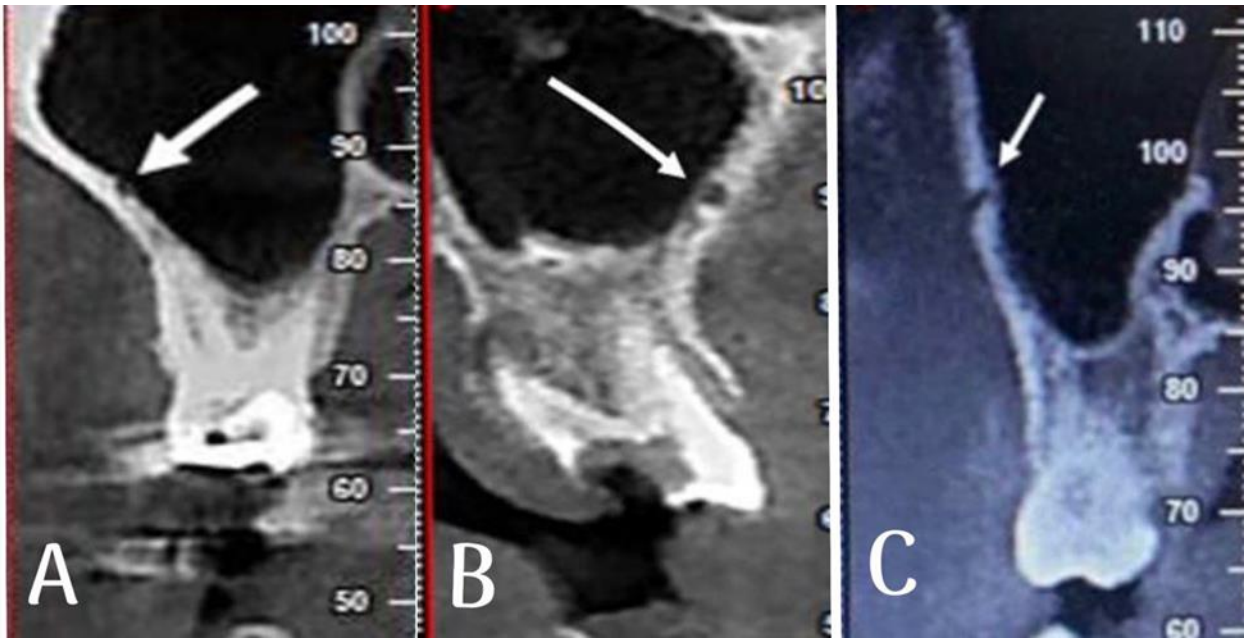
Oral and maxillofacial radiologists performed the measurements and analysis.

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.



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)

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."

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

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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

Side			Tooth						Total	
			dentuolous		edentulous					
			N.	%	N.	%	Chi square	P value	N.	%
R	Presence	with	51	80.95	27	84.38	0.169	0.681 NS	78	82.11
		free	12	19.05	5	15.63			17	17.89
	Total		63	100.00	32	100.00			95	100.00
L	Presence	with	58	82.86	23	92.00	1.225	0.268 NS	81	85.26
		free	12	17.14	2	8.00			14	14.74
	Total		70	100.00	25	100.00			95	100.00
Total	Presence	with	109	81.95	50	87.72	0.971	0.324 NS	159	83.68
		free	24	18.05	7	12.28			31	16.32
	Total		133	100.00	57	100.00			190	100.00

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.

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Table (2): Descriptive and statistical test of Alveolar crest among locations

Sides	Location	N	%	Mean	SD	SE	Min.	Max.	F	P value
R	Intra.Oss	28	35.90	9.461	4.455	0.842	3.900	16.500	0.367	0.69389
	Extra.Oss	15	19.23	10.773	1.350	0.347	8.700	13.100		
	Intra.mem	35	44.87	9.637	6.215	1.051	4.200	19.900		
L	Intra.Oss	21	25.93	7.936	3.833	0.837	3.290	14.100	0.982	0.37907
	Extra.Oss	18	22.22	9.667	2.543	0.600	8.100	18.000		
	Intra.mem	42	51.85	9.673	5.957	0.919	4.800	21.600		

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.

Table(3): Descriptive and statistical test of Sinus floor among location

Sides	Location	Mean	SD	SE	Min.	Max.	F	P value
R	Intra.Oss	18.986	4.338	.820	13.600	25.500	16.541	**0.00000***
	Extra.Oss	20.510	2.372	.612	16.000	22.500		
	Intra.mem	15.543	2.139	.362	12.900	19.000		
L	Intra.Oss	17.414	4.864	1.061	10.750	23.700	3.552	**0.03338 ***
	Extra.Oss	17.928	2.811	.663	14.700	25.200		
	Intra.mem	15.860	1.803	.278	13.000	19.800		

*=significant at p<0.05

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.

Table(4): Multiple Comparisons of sinus floor distance among locations using Games-Howell

Side	(I) Location	(J) Location	Mean difference	p value
R	Intra.Oss	Extra.OSS	-1.52429	**0.30639***
		Intra.mem	3.44286	**0.00130***
	Extra.OSS	Intra.mem	4.96714	**0.00000***
L	Intra.Oss	Extra.OSS	-0.51349	0.91161
		Intra.mem	1.55476	0.34915
	Extra.OSS	Intra.mem	2.06825	**0.02216***

*=significant at p<0.05

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 Intramembranous, this result is only significant while other results are not significant.

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Table (5): Descriptive and statistical test of Alveolar crest and sinus floor among gender

Side		Gender									
		M				F					
		N	Mean	SD	SE	N	Mean	SD	SE	T test	P value
R	Alveolar crest	38	19.358	3.901	.633	40	16.191	2.826	.447	4.088	**0.00012**
	Sinus floor	38	9.316	4.201	.682	40	10.245	5.600	.885	0.832	0.40837
L	Alveolar crest	40	17.315	2.703	.427	41	16.144	3.520	.550	1.682	0.09676
	Sinus floor	40	8.066	2.843	.450	41	10.348	6.092	.951	2.168	**0.03435**

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.

Table (6): Association between artery and gender

Side			Presence						Total	
			With		Without					
			N.	%	N.	%	Chi square	P value	N.	%
R	Gender	M	38	48.72	4	23.53	3.590	0.058 NS	42	44.21
		F	40	51.28	13	76.47			53	55.79
	Total		78	100.00	17	100.00			95	100.00
L	Gender	M	40	49.38	2	14.29	5.961	**0.015 ***	42	44.21
		F	41	50.62	12	85.71			53	55.79
	Total		81	100.00	14	100.00			95	100.00
Total	Gender	M	78	49.06	6	19.35	9.279	**0.002 ***	84	44.21
		F	81	50.94	25	80.65			106	55.79
	Total		159	100.00	31	100.00			190	100.00

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.

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Table (7): Association between location and gender

Side			Gender						Total	
			M		F					
			N.	%	N.	%	Chi square	P value	N.	%
R	Location	Intra.OSS.	18	47.37	10	25.00	5.672	0.056 NS	28	35.90
		Extra.OSS.	8	21.05	7	17.50			15	19.23
		Intra.Mem.	12	31.58	23	57.50			35	44.87
	Total		38	100.00	40	100.00			78	100.00
L	Location	Intra.OSS.	10	25.00	11	26.83	1.305	0.521 NS	21	25.93
		Extra.OSS.	11	27.50	7	17.07			18	22.22
		Intra.Mem.	19	47.50	23	56.10			42	51.85
	Total		40	100.00	41	100.00			81	100.00
Total	Location	Intra.OSS.	28	35.90	21	25.93	4.625	0.099 NS	49	30.82
		Extra.OSS.	19	24.36	14	17.28			33	20.75
		Intra.Mem.	31	39.74	46	56.79			77	48.43
	Total		78	100.00	81	100.00			159	100.00

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

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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

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تحديد موضع الهياكل التشريحية الحيوية في الجدار الجانبي للجيب الفكي العلوي أثناء التدخلات الجراحية المختلفة باستخدام التصوير المقطعي المحوسب بالشعاع المخروطي

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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 العلوي الخلفي.

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

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

النتائج: وفقا لدراستنا تم الكشف عن وجود الشريان في (83.68%) من العينة. أظهرت الإناث انتشار الشريان السنخي العلوي الخلفي أعلى من الرجال في كلا الجانبين الايمن والايسر، وكان الفرق معنوياً بشكل عام، كما أن وجود الشريان لكل جانب والإجمالي في الموقع الغشائي في الإناث أكبر منه في الذكور، مما قد يدل على أن احتمالية النزيف والآثار الجانبية الأخرى تكون أعلى عند الذكور، حيث أن وجود الشريان في المنطقة الغشائية اقل عند الإناث سيقلل من احتمالية الإصابة أثناء أي علاج جراحي.

الاستنتاجات: استخدم هذا البحث التصوير المقطعي المحوسب بالشعاع المخروطي لتحديد الموقع الدقيق لـ الشريان السنخي العلوي الخلفي في السكان العراقيين. يمكن أن تساعد البيانات المستنتجة 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: جدران الجيب الفكي العلوي, الشريان السنخي العلوي الخلفي, التصوير المقطعي المحوسب بالشعاع المخروطي.

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تاريخ استلام البحث: 5 تشرين الثاني 2023

تاريخ قبول البحث: 19 تشرين الثاني 2023

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