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Research Paper: Evaluation of posterior superior alveolar artery position and its relationship with maxillary sinus in cone beam computed tomography images

Masoumeh Johari[1], Neda Alizad[1], Samira Asghari Moghaddam[1], Anahita Davoodnezhad[2]

[1]Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran

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ABSTRACT

Introduction: The posterior superior alveolar artery (PSAA) and the infraorbital artery (IOA) are the branches of the maxillary artery that provide blood flow to the maxillary sinus. The arterial site is essential for implant placement in the maxillary sinus area to prevent surgical injury. This study examined the location of PSAA and its relationship to the maxillary sinus.

Materials and Methods: In this study, 145 CBCT images of patients referred to the Radiology department of the dental faculty, Tabriz University of Medical Sciences, were included.

Results: The mean distance between the lower border of the artery and the right alveolar crest 16.63 mm in the whole. On the left side, it was equal to 15.72 for men, 15.9 for women, and 15.83 overall, with a significant difference in ratio to gender ($P> 0.05$) and a significant difference in proportion to the maxilla ($P<0.05$). The mean diameter of the right PSAA in men was 0.76, in women 0.71, and general 0.73 ($P> 0.05$). On the left side, in men, it was 0.77, in women 0.71, and general 0.73. A significant difference was reported between genders ($P <0.05$).

Conclusion: The results showed that the distance between the artery's inferior border and the alveolar crest on the right side of the maxilla is greater than on the left. In addition, the diameter of PSAA is greater in men than in women. In other cases, the values are not significantly different. Men are more likely to bruise than women.

*** Corresponding Author:**
Neda Alizad
Address: Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
Tel: +98-1333486418
E-mail: Nedaalizad@gmail.com

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Introduction

The vascular system of the maxillary sinus is diverse in structure and anatomy, including the infraorbital artery, the superior anterior alveolar artery (ASAA), and the superior posterior alveolar artery (PSAA), which are maxillary arterial branches (1,2). Blood supply to the maxillary sinus and the Schneiderain membrane is via the maxillary artery. Mr. Starang first noted the presence of this artery in 1934(3,4). The infraorbital artery and nerve originate in the Pterygopalatine cavity. This artery protrudes through the inferior orbital fissure. The pterygopalatine arteries separate from it, and the upper anterior alveolar artery separates as it passes through the infraorbital canal (5,6). Bleeding during surgery should be checked before any surgical procedure. It is usually located between the middle third and the bottom of the sinus anterior wall. For this reason, it is usually located above the bony window, where implants and implants are placed (5,7).

Cone beam CT imaging has revolutionized craniofacial imaging. This imaging technique has reduced x-ray dose, increased image accuracy and resolution, reduced image error, and reduced artifacts (8). CBCT plays an important role in pre-surgical evaluations by accurately three-dimensional assessment of anatomical structures (9).

The superior posterior alveolar nerve and artery pass through a canal in the maxillary sinus bony wall. The location of this canal has been identified in previous studies by various methods, including CBCT and examination of anatomical specimens (10,11). According to a study by Kawai et al., this canal is divided into three categories: canal-like, fragmented, and groove-shaped (with an outward and inward bony pathway) (12). Different distances from the end edge of the PSAA to the bony crest (in the premolar and molar region) have been published by different authors (13-15). Also, the distance from the bony canal to the bony crest is influenced by bone loss, its location in the maxillary bone, and the presence or absence of teeth, considering surgeries performed near the maxillary sinus are essential (14-17).

Since a comprehensive study of the Iranian population has not been performed, the anatomy of the superior posterior alveolar artery in the Iranian population has not been fully understood. Hence, this study locates the posterior alveolar artery and its relation to the alveolar ridge and maxillary sinus. It also compares CBCT of patients referred to Tabriz Dental Faculty in 2016-2017. The results of this study can be used in evaluations before maxillofacial surgery.

Materials and methods

CBCT images of patients referred to the radiology department of Tabriz Dental Faculty were included in the study from 2016 to 2017. CBCT examinations were performed for various reasons. Images of acceptable quality were included in the study. The scans were carried out by a NewTom VG x-ray machine in the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences. This x-ray machine uses a cone x-ray beam with a 1920x1536 pixel flat panel detector, a rotation of 360º, a pixel size of 0.127 µm, and 120 kVp. The scans were carried out at kVp110 kVp, exposure time of 3.6 seconds and 4.71 mA. The initial and final reconstruction was done by NNT Viewer software version 8.0.0 (Quantitative Radiology, Verona, Italy). Images with intraosseous/intra-sinus pathoses and images with severe metal/motion artifacts were excluded from the study. In most patients, most teeth were present. However, edentulous patients were included in this study. In the images obtained from the patients, the location of the posterior alveolar artery and the distances were assessed by a maxillofacial radiologist with ten years of clinical experience using the NNT viewer software.

The distance between the lower border of the artery and the alveolar ridge (A), bone height from the sinus floor to the ridge crest (B), distance from the artery to the medial wall of the sinus (C), and artery diameter (D) and arte-

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rial position in coronary scans were measured (Figure 1).

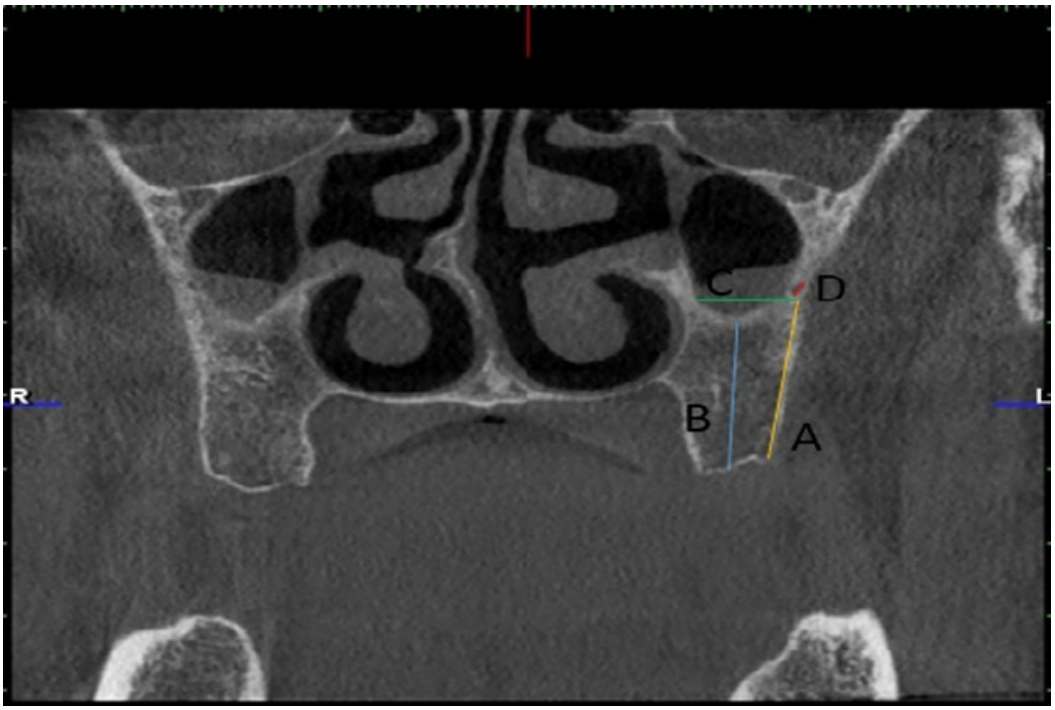

Figure 1) Distance between the lower border of the artery and the alveolar ridge (A), Bone height from sinus floor to ridge crest (B), Distance from artery to the medial wall of the sinus (C), Diameter of the artery (D)

The course of PSAA is classified as:

a. intraosseous (Figure 2a)

b. Under the membrane (Figure 2b)

c. Located in the outer cortex of the lateral wall of the sinus (Figure 2c)

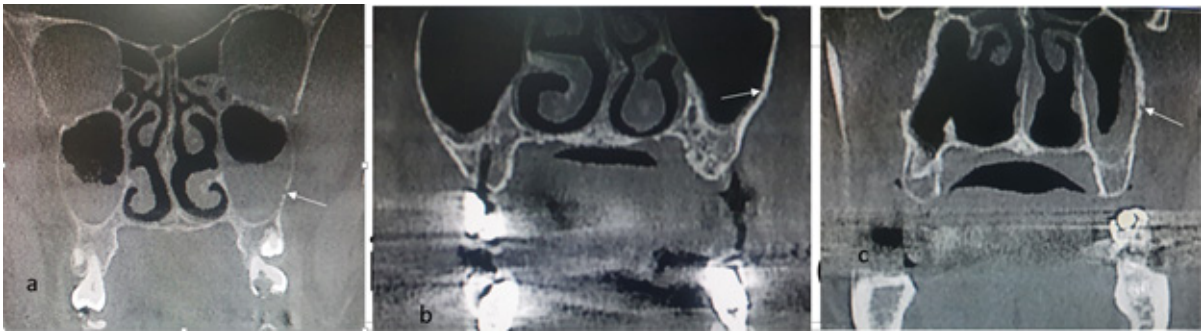

Figure 2) a) Coronal view of the maxillary sinus and intraosseous artery b) Coronal view of the maxillary sinus and under the membrane artery c) Coronal view of the maxillary sinus and the artery is located in the outer cortex of the lateral wall of the sinus

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Results

In this study, 145 CBCT images were evaluated. Samples were 39.3 percent male and 60.7 percent female. On the patient's right side, 52.4% had an intraosseous canal, 39.3% under the membrane canal, and 8.3% in the lateral sinus wall in the external cortex. On the left side, 51% of the canal was inside the bone, 42.8% was under the membrane, and 6.2% was in the lateral sinus wall in the external cortex. According to descriptive statistics, the mean distance between the inferior border of the canal and the right alveolar crest was 16.21 in males, 16.62 in females, and 16.63 in total. On the left side, it was equal to 15.71 for men, 15.9 for women, and 15.83 in total.

The bone's mean height from the floor of the maxillary sinus to the apex of the right alveolar ridge was 9.64 in males, 9.93 in females, and 9.82 in total. On the left side, it was equal to 9.6 for men, 10.02 for women, and 9.86 in total.

The distance from the posterior alveolar artery to the medial wall of the right sinus was 16.21 in males, 16.63 in females, and 16.62 in general. On the left side, it was equal to 15.72 for men, 15.9 for women, and 15.83 for the whole.

The mean diameter of the right posterior upper alveolar artery was 0.76 in males, 0.71 in females, and 0.73 in total. On the left side, it was equal to 0.77 for men, 0.71 for women, and 0.73 for the whole.(Table 1)

Table 1)

Variable		Mean±SD		P-value	
		Right side	Left side	By gender	By the jaw Bside
Distance between PSAA inferior border and alveolar crest	Male	16.21 ± 4.48	15.72 ± 3.9	0.125	0.004
	Female	16.62 ± 3.13	15.9 ± 2.98		
	Total	16.46 ± 3.72	15.83 ± 3.38		
Height of bone from the maxillary sinus floor to the alveolar ridge	Male	9.64 ± 3.21	9.6 ± 4.16	0.573	0.852
	Female	9.63 ± 2.67	10.02 ± 2.82		
	Total	9.82 ± 2.88	9.86 ± 3.4		
Distance from the PSAA to the sinus medial wall	Male	14.09 ± 3.05	13.74 ± 2.69	0.707	0.751
	Female	13.96 ± 2.47	14.05 ± 2.38		
	Total	13.98 ± 2.71	13.93 ± 2.5		
Diameter of PSAA	Male	0.76 ± 0.15	0.77 ± 0.2	0.002	0.641
	Female	0.71 ± 0.1	0.71 ± 0.08		
	Total	0.73 ± 0.12	0.73 ± 0.14		

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According to the descriptive statistics, the study's data show that the distance between the inferior border of the PSAA canal and the right alveolar crest is more than the left side, and also, in women, it is more than in men. In terms of bone height from the maxillary sinus floor to the maxillary alveolar crest, which was also larger in females. The distance from the posterior alveolar artery to the medial sinus wall was generally larger on the right side. The posterior alveolar artery diameter was larger in males than in females.

The distance between the inferior border of PSAA and the alveolar crest based on gender and jaw position was compared by T-test. In comparison with gender, the test statistic is more than the significant value of the test (0.05). Hence, it can be said that the distance between the inferior border of the canal and the alveolar ridges is not significantly different based on gender. However, based on the jaw position, the statistical value is less than the significant value of the test (0.05), so the distance between the inferior arterial and alveolar ridges on the right side is significantly greater than on the left side.

Discussion

A sinus augmentation is a highly predictive method for placing successful dental implants into the atrophic posterior maxilla (18-21). Knowing the anatomical structure of this area is vital for this method. The posterior alveolar artery (PSAA) and the infraorbital artery (IOA) are branches of the maxillary artery that provide blood flow to the lateral wall of the sinus and upper membrane (11,22).

Knowledge of the maxillary sinus vessel anatomy is essential to prevent bleeding and membrane perforation. Large-diameter blood vessels may increase bleeding risk during surgery (23)

Studies identified the three branches of the maxillary artery that provide blood flow to the Schneiderian membrane, the lateral wall of the maxillary sinus, and the superior membrane with the PSAA, the infraorbital artery, and the maxillary artery (11,24,25).

The PSAA divides into an intraosseous branch, which passes through the lateral wall, and an outer bony branch, which passes through the outer surface of the bone (22). The maximum diameter of these vessels may reach 0.3 mm. The risk of bleeding during the surgery depends directly on the size of these arteries. The larger the artery, the greater the risk of bleeding during surgery (11,26,27).

CBCT is a new imaging technique in dentistry, which means the technique of CT with a cone-shaped X-ray beam (28). Dental implants, pathologies of the mouth and jaw, and orthodontics are common indications for CBCT (29).

In the present study, 145 samples of CBCT images of patients referred to the radiology department of the Tabriz Dentistry School were studied during 2016-2017, and the position of the artery in the maxillary sinus wall, its position relative to the alveolar ridge, and the medial wall of the sinus. Sagittal and axial images were determined based on the checklist attached, and the obtained data were analyzed. Most subjects had intraosseous canals, and a small percentage had under-the-membrane canals and canals located in the external cortex of the lateral sinus wall, similar to the Yalcin (30) study. Respectively, 39.3% of the participants were male, and 60.7% were female.

A radiographic study by Kim et al. in 2011, which examined the posterior superior alveolar artery, showed that PSAAs were more common on CT images and larger in men. In the molar areas, the PSAA was closer to the alveolar crest. Evaluation of PSAA in the maxillary sinus on preoperative CT images can reduce the likelihood of excessive bleeding during surgery, especially in the molar area (31).

Here, the results illustrate that the distance between the inferior border of PSAA and the alveolar crest on the right side is greater than on the left. This is in all males and all females. In the general case, the amount was significantly higher on the right side, but no difference was observed based on gender. The reason for the inconsistency with Kim et al. Investigation is

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the study's statistical population because all the gender ratios of the samples were different, and not all races were the same. According to Kim et al., the prevalence of PSAA varies between men 64% and women 40% (31).

In a study by Watanabe et al. 2014, the results showed that the mean distance between the PSAA and the alveolar crest was 1.24 mm. Also, it showed that the distance between the PSAA and the alveolar crest in the premolar region was shorter (32). The ridge height was 9.82 on the right and 9.86 on the left. This was not significantly different from each other, nor was it based on gender.

In the Pandharbale et al. (2016) study, the mean distance between the PSAA and the maxillary sinus floor was 9.96 mm. This is close to the present study results (34). This distance was reported in the Güncü study (32) as 7.8 mm and in the Mardinger study as 7 to 8 mm. This value difference may be due to anatomical differences at the arterial site (27).

Damage to the bone capillaries and their bleeding can darken the physician's vision and perforate the Schneiderian membrane. This, in turn, increases the surgical procedure duration. The present study showed that the mean arterial diameter was 0.73.

In the Pandharbale study, the mean arterial diameter was 0.63 mm. The mean distance between PSAA and the alveolar crest was in the second molar region (34), and the results of the present study were higher than the Pandharbale study. However, relative to the study of Güncü (1.3), Ella (1.2), and Kim (1.52) was lower (1,31,33), which means a lower risk of bleeding during surgery in the present study samples than in these three studies.

The results also showed that the posterior superior alveolar artery diameter was the same on both sides of the jaw. However, it was higher in men than in women, which may indicate a higher bleeding risk in men. However, clinical significance was not investigated. Ilgüy (3), Kim (31), Güncü (33), and Fayek (35) also achieved similar results, but Mardinger's study did not report a significant difference in posterior alveolar artery diameter between men and women (27).

Conclusion

Our results and previous studies suggest that the distance between the inferior arterial and alveolar ridges on the right side was greater than on the left. Still, there was no statistically significant difference between men and women. There was no statistically significant difference in bone height from the maxillary sinus floor to the apex on both sides of the jaw in men and women. The distance from the posterior alveolar artery to the upper wall to the inner wall of the sinus on both sides of the jaw in men and women was not statistically significant. The diameter of the posterior alveolar artery on both sides of the jaw was not statistically significant but was greater in men. Future studies should be conducted by comparing dentulous and edentulous persons because the ridge morphology may bias the measurements.

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None

Authors' contributions

Masoumeh Johari: Conceptualization, Methodology, Writing - Review & Editing **Neda Alizad:** Resources, Investigation, Visualization **Samira Asghari Moghaddam:** Data curation, Writing - Original Draft **Anahita Davoodnezhad:** Project administration, Supervision, Funding acquisition

Conflict of Interests

The authors declare no conflict of interest.

Ethical declarations

Not applicable

Financial support

None

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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