

Evaluation of the Presence and Positioning of the Posterior Upper Alveolar Artery in the Lateral Wall of the Maxillary Sinus by Cone-Beam Computed Tomography

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Received: January 23, 2023

Published: February 10, 2023

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DOI: 10.31080/ASDS.2023.07.1583

Abstract

Objective: To evaluate the presence, positioning and diameter of the posterior superior alveolar artery in relation to the alveolar ridge using cone beam computed tomography.

Materials and Methods: 100 computed tomography scans (200 maxillary sinuses) of patients (50 males and 50 females) undergoing maxillary sinus lift treatment were included in this study. The presence of the artery, its diameter and position in relation to the maxillary sinus, and the distance between the alveolar ridge and the inferior base of the artery were evaluated.

Results: The artery was detected in 45% of cases, and 46.67% were located in the external cortical in the maxillary sinus. The mean distance between the alveolar crest and the inferior base of the posterior superior alveolar artery was 15.5 ± 4.7 mm. The mean diameter of the posterior superior alveolar artery was 0.9 ± 0.3 mm. No correlation was found between artery diameter and patient age (Pearson correlation test $r = 0.12$, $p = 0.26$). No correlation was also found between the distance to the artery and age (Pearson correlation test $r = 0.04$, $p = 0.69$).

Conclusions: Within the limits of this study it can be concluded that posterior superior alveolar artery was found with relatively large frequency in the maxillary sinus, mainly in the external cortical, presenting a considerable diameter. From this perspective, careful preoperative analysis is recommended to avoid bleeding in the maxillary sinus lift procedure.

Keywords: Computed Tomography; Implant Dentistry; Oral Rehabilitation; Oral Surgery; Anatomical Structures.

Introduction

Sinus membrane elevation (sinus lift) through the lateral wall of the maxillary sinus is a widely used technique to provide bone height gain in the posterior maxilla. In this perspective, the specific anatomical knowledge of the region is essential to avoid accidents and complications during surgery [1-3].

The accidents and complications associated with the procedure that can usually occur are infection, perforation of the sinus mem-

brane, suture dehiscence, chronic sinusitis, bucco-sinus communication, and hemorrhage [4-6].

Perforation of the membrane and transoperative hemorrhage are complications most frequently reported during sinus lift through the lateral wall [7,8]. Therefore, the anatomy of the region should be carefully examined prior to the surgical intervention, precisely to minimize the risks and improve the effectiveness of the technique [9].

The blood supply of the maxillary sinus and sinus membrane is provided by the posterior superior alveolar artery and the infraorbital artery, which are branches of the maxillary artery. These two vessels form anastomosis throughout the maxillary sinus wall, joining in a common vessel in the lateral wall of the maxillary sinus [10].

Elian, *et al.* (2005) [11] found arteries in the lateral wall of the maxillary sinus in 53% of the cases among the 50 computed tomography images evaluated, located approximately 16.4mm from the alveolar ridge.

Studies in 18 anatomical specimens identified intraosseous anastomosis in all cases studied, with a mean distance to the alveolar ridge of 19mm [10]. Another study identified the artery in 47% of the cases using computed tomography images, but when the anatomical specimens were dissected, the artery was found in 100% of the cases. This demonstrates that the non-visualization of the artery in computed tomography scans does not imply its absence in patients [12].

There are differences in the literature regarding the positioning of the artery. Elian, *et al.* (2005) [11] reported that it is positioned 16.4mm from the alveolar ridge. Other studies showed that this distance varies from 18.9 to 19.6mm from the alveolar margin [10,13,14]. A recent study cited 18±4.9mm as the distance between the inferior border of the artery and the alveolar ridge [9].

Thus, considering that computed tomography evaluation prior to maxillary sinus elevation procedure is essential to minimize risks arising from rupture of the posterior superior alveolar artery and there is a lack of consensus in the literature about its presence and positioning, the purpose of this study was to evaluate the presence and positioning of the posterior superior alveolar artery in the lateral wall of the maxillary sinus using cone beam computed tomography.

Material and Methods

This study considered patients who sought treatment at the Implant Dentistry Specialization Clinic at Paulista University (São Paulo, Brazil) from January 2009 to September 2011.

Fifty male and 50 female patients ranging in age from 18 to 70 years were selected for bilateral maxillary sinus analysis, totaling 200 maxillary sinuses.

The computed tomography images came from the same radiology institute using the I-cat Cone Beam Imaging System™ (Hatfield, PA, US).

A single observer with experience in computed tomography scan analysis was calibrated to examine the scans. Fifteen randomly chosen scans were presented to the observer without the observer knowing their identification. The analyses were done twice, one week apart, to compare the calibration. A reproducibility of 86.6% of the samples was observed.

The cases were analyzed according to the following exclusion and inclusion criteria

- **Exclusion:** Presence of pathologies in the maxillary sinus.
- **Inclusion:** Need for rehabilitation with osseointegrated implants in the posterior region of the maxilla.
- Were evaluated:
- Distance between the inferior border of the artery and the inferior border of the alveolar ridge [11].
- Diameter of the artery [15].
- **Artery position:** intraosseous, below the sinus membrane, external cortical [16].

Results

A total of 200 computed tomography images were analyzed. The posterior superior alveolar artery was observed in 45% of the cases. In most cases (46.67%) it was located in the external cortical of the lateral wall of the maxillary sinus; 27.78% intraosseous and; 25.56% below the sinus membrane (Table 1).

Position					
Both Sides	General	%	Male	Female	P
Intraosseous	25	27.78	9	16	
Intrasinusal	23	25.56	11	12	
External Cortical	42	46.67	25	17	0.17
Right Side	General	Male	Female	P	
Intraosseous	10	2	8		
Intrasinusal	14	5	9		
External Cortical	21	13	8	0.06	
Left Side	General	Male	Female	P	
Intraosseous	15	7	8		
Intrasinusal	9	6	3		
External Cortical	21	12	9	0.78	

Table 1: Overall mean of the position of posterior superior alveolar artery and comparison between right and left side in relation to male and female gender.

The mean diameter found was 0.9 ± 0.3 mm (Table 2).

Diameter				
Both Sides	General Average/SD*	Male Average/SD*	Female Average/SD*	P
	0.90/0.3	0.88/0.25	0.92/0.3	0.53
Right Side	General Average /SD*	Male Average/SD*	Female Average/SD*	P
	0.88/0.30	0.89/0.34	0.86/0.29	0.8
Left Side	General Average /SD*	Male Average/SD*	Female Average/SD*	P
	0.89/0.30	0.84/0.25	0.95/0.34	0.2

Table 2: Mean diameter of the posterior superior alveolar artery relating right and left side with male and female genders.

*SD = Standard Deviation.

In most cases (71), the diameter was less than 1mm; in 18 cases the diameter was between 1 and 2mm and in one case greater than 2mm.

The mean distance between the inferior border of the artery and the alveolar ridge was 15.5 ± 4.7 mm, being 15.4 ± 5 mm on the right side and 15.8 ± 4.4 mm on the left side. On the right side there was a statistically significant difference between the values found in males and females ($p = 0.04$) (Table 3).

Distance				
Both Sides (n = 90)	General Average/SD*	Male Average/SD*	Female Average/SD*	P
	15,5/4,7	16,2/4,9	14,9/4,5	0,18
Right Side (n = 45)	General Average/SD*	Male Average/SD*	Female Average/SD*	P
	15,4/5,0	17,0/5,4	13,9/4,7	0,04
Left Side (n = 45)	General Average/SD*	Male Average/SD*	Female Average/SD*	P
	15,8/4,4	15,6/4,5	16,1/4,3	0,68

Table 3: Distance between the base of the posterior superior alveolar artery and the alveolar ridge, relating right and left side with male and female genders.

*SD = Standard Deviation.

No relationship was found between the distance between the base of the artery and the alveolar ridge and the age of the patients ($r = 0.04$, $p = 0.69$). No correlation was also found between the diameter and the age of the patients (Pearson correlation test $r = 0.12$, $p = 0.26$) (Table 4).

	Side	Pearson Correlation	
	Age vs. Distance	Right Side	$r = -0.04$
Left Side		$r = 0.14$	$p = 0,37$
Both Sides		$r = 0.04$	$p = 0,69$
Age vs. Diameter	Side	Pearson Correlation	
	Right Side	$r = 0,12$	$p = 0,42$
	Left Side	$r = 0,12$	$p = 0,44$
	Both Sides	$r = 0,12$	$p = 0,26$

Table 4: Relationship between age and distance between the base of the posterior superior alveolar artery and the alveolar ridge and relationship between age and diameter of the posterior superior alveolar artery, right and left sides.

Discussion

In the present study, it was possible to identify the presence of the posterior superior alveolar artery in 45% of the cases (90 of the 200 maxillary sinuses studied). This result is in agreement with other studies found in the literature, such as Elian., *et al.* (2005) [11] and Mardinger., *et al.* (2007) [15], who reported 52.9% and 55%, respectively.

In the article of Güncü., *et al.* (2011) [9], the presence of the artery was reported in 64.5% of 242 maxillary sinuses. Anastomosis between the posterior superior alveolar artery and infraorbital artery were found in 100% of cases in a study in cadavers [10,12,13], suggesting that the non-identification of the artery in computed tomography does not imply its absence, but perhaps cannot be identified due to the small diameter [12]. This fact may justify the difference between the percentage of arteries found in this study compared to the study of Güncü., *et al.* [9].

The artery was detected at a mean distance of 15.5 ± 4.7 mm from the alveolar ridge, which corresponds to the result found by Güncü., *et al.* (2011) [9] who found a mean of 18 ± 4.9 mm in their study that evaluated 242 computed tomography.

The mean diameter found was 0.9 ± 0.3 mm. It is in agreement with Ella, *et al.* (2008) [16], who found a mean diameter of 1.2mm. Solar, *et al.* (1999) [10] found a mean diameter of 1.6mm, but their study involved the analysis of 18 anatomical specimens, which facilitated more accurate measurement of the diameter of the arteries, since there is a distortion in the computed tomography scan image.

No relationship was found between the diameter of the artery and the age of the patient (Pearson Correlation Test, $r = 0.12$, $p = 0.26$). Also, no relationship was found between the distance from the alveolar ridge to the base of the artery and the age of the patient (Pearson Correlation Test, $r = 0.04$, $p = 0.69$).

The middle third of the lateral maxillary sinus wall is a location often used to open the access window to the membrane in maxillary sinus lift procedures. For this reason, according to Ella, *et al.* (2008) [16], some anatomical aspects should be considered to avoid complications during the surgical procedure, such as

- **The position of the artery:** Superficial, intraosseous or intrasinus. The intraosseous and intrasinus positions can mask the artery due to the thickness of the external cortex, and the surgeon may be surprised by bleeding and hemorrhage during the procedure.
- **The termination:** Whether or not it has anastomosis with the infraorbital artery.
- **The course of the artery:** Long or short.
- **The diameter of the artery:** If the diameter found is greater than 2.5mm, the risk of bleeding is high and the surgical procedure can be risky if only local anesthesia is used.

Therefore, the preoperative study of computed tomography images is highly recommended for evaluating the presence and location of the posterior superior alveolar artery, avoiding risks during surgery and ensuring the success of the proposed treatment.

Conclusions

The posterior superior alveolar artery was found in a relatively high frequency in the maxillary sinuses, especially in the external cortical of the sinus, presenting a significant diameter. Careful preoperative analysis of the anatomical structure by computed tomography scan is necessary to prevent bleeding during the maxillary sinus lift procedure.

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