

IDENTIFICATION OF POSTERIOR SUPERIOR ALVEOLAR ARTERY DURING DIRECT SINUS FLOOR ELEVATION: A CONE BEAM COMPUTED TOMOGRAPHY RADIOGRAPHIC STUDY

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Abstract

Background: The study aims to present the location and course of the posterior superior alveolar artery (PSAA) using cone beam computed tomography (C.B.C.T.) imaging, which is considered as a valuable part for treatment planning in sinus augmentation procedures for dental implant treatment.

Materials and Methods: Data was extracted from included C.B.C.T. images using implant planning software and entered on Microsoft Excel and SPSS for statistical analysis. For each radiograph measurements were taken on premolar and molar region to determine the location of PSAA as being extraosseous or intraosseous. The distance of the artery from the floor of the sinus was also measured.

Results: The study included 56 radiographic images. 44 view of right and left maxillary sinus satisfied the inclusion criteria. Each sinus had 2 points of measurements, giving total of 176 sites. The average distance of PSAA was 11.1 from the floor of the maxillary sinus and the median was 10.5mm. The PSAA was extraosseous in most instances with 57% of the total sample.

Conclusions: The location of the PSAA can be mostly in extraosseous site. The artery might also move from extraosseous to intraosseous location, or Vice versa, during its course as it travel from the molar to premolar area. Correct identification during planning of sinus lift procedures can help in avoiding accidental trauma during surgery.

Keywords: Posterior superior alveolar artery, Maxillary sinus augmentation, Sinus floor elevation, Cone beam computed tomography.

Introduction:

The maxillary sinus is an air-filled cavity, considered as a key structure of the midface and the largest of the paranasal sinuses and first to develop. It's located under the orbits bilaterally fills the body of the maxilla on both sides of the nose and is pyramidal in shape, lined with pseudostratified columnar epithelium.¹

The Maxillary sinus serves many functions, including air conditioning, pressure damping, vocal resonance, and the reduction of the weight of the skull and contribute to the growth of mid-face.²

Vascular supply to the maxillary sinus is derived primarily from branches of the maxillary artery including the posterior superior alveolar artery, the infraorbital artery, and the posterior lateral nasal artery.

The posterior superior alveolar artery (PSAA) can course along the medial wall of the sinus. The infraorbital artery passes along the infraorbital groove and canal, under the orbit, and finally through the infraorbital foramen on the facial surface of the maxilla and the infraorbital artery anastomoses along the anterolateral wall of the sinus, supplying the mucous membrane of the nasal chambers. An extra osseous anastomosis often exists between these two arteries. The posterior lateral nasal artery

branches from the sphenopalatine artery and passes through the sphenopalatine foramen to enter the nasal cavity and can be found within the medial wall of the sinus. As it continues anteriorly, the posterior lateral nasal artery begins to branch, supplying blood to the posterior and medial wall of the sinus.³

The cone beam computed tomography (CBCT) provide excellent radiographic visualization of the sinus cavity, sinus lining and part of blood and nerve supply. The last can only be seen as it passes within the bony walls of the sinus. The CBCT can also be used as a diagnostic aid for sinus pathology (Figure.1). The CBCT also considered valuable aid for planning of augmentation procedure for dental implant treatment.⁴

Augmentation of the maxillary sinus is well documented procedure that is needed in some cases during placement of dental implant in the posterior maxillary region. In general, there is two methods that can be used. The direct sinus lift and the indirect sinus lift.^{5&6}

Indirect sinus lift technique involves augmenting the sinus cavity through the crest of the residual ridge. It was first described by Tatum in 1986 and later modified by Summers which advocate the use tapered osteotomies with increasing

diameters. Indirect osteotomy maxillary sinus floor elevation is generally indicated where the sub-antral alveolar bone height is equal to or higher than 6 mm.^{7&8}

On the other hand, direct sinus lift involves elevating the sinus membrane by opening a direct access to the sinus cavity

Material and Methods:

In this study, three-dimensional cone-beam computed tomography (C.B.C.T.) for patients attending implant clinic from January 2021 to January 2022 were selected to be included this research. Total of 56 radiographic study were included. SimPlant Pro (Version 11.04), an implant planning software, was used to view and analyse the C.B.C.T. images. Figure 1

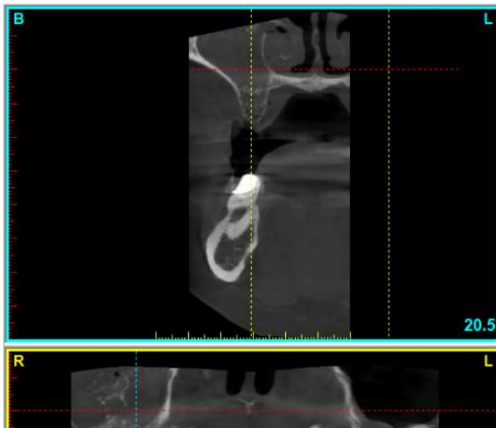


Figure 2 Cone-beam computed tomography showing normal left maxillary sinus (Right side of the figure) and complete obliteration of the right maxillary sinus (Left side of the figure) due to chronic suppurative sinusitis caused by failed augmentation procedure.

on lateral wall on the maxillary sinus was first introduced by Tatum in 1976 and later developed by Boyne and James in 1980.^{9&10} The posterior superior alveolar artery may pass through the area of window preparation causing troublesome bleeding during the sinus lifting procedure.¹¹

The first point in the measurement was at premolar region, while the second point was on the first molar region. Location of artery was categorized as either intraosseous if the artery runs within the lateral wall of the maxillary sinus or extraosseous if the artery was out of the bone or when leaving only depression on the sinus wall. The distance between the



Figure 1 Sinus floor elevation by indirect sinus lift at the left maxillary 1st molar region.

posterior superior alveolar artery and floor of the maxillary sinus was also calculated. Sinus floor elevation done either by indirect or direct sinus lift at the left maxillary 1st molar region. Figure 2 and Figure 3

All distance measurement were rounded to the nearest decimal.

The inclusion criteria for this selection includes C.B.C.T. images for upper arch including the maxillary sinus of each side, premolar and molar area of each side and the images must visible with high



Figure 3 Sinus floor elevation by direct sinus lift at the posterior right maxillary region.

resolution to allow correct identification of the posterior superior alveolar artery.

The exclusion criteria were views of the mandibular arch, when the posterior maxilla was outside field of view, low quality C.B.C.T. images or when missing information about patient gender. The study included 56 patients with bilateral maxillary sinus CBCT scans and total of 12 radiographic views were excluded for variety of reasons either due to posterior maxilla was outside the field of view (6) or poor radiographic quality (4) or Missing patient information (2)

All data were entered, and statistical analysis was made by using Microsoft Excel 365 and independent sample t-test was made by SPSS Ver.21.

Results:

The study included 56 patients with bilateral maxillary sinus CBCT scans and total of 12 radiographic views were excluded for variety. The remaining 44 radiographic views were included in the statistical analysis. A total of 88 right and left sinuses were examined at molar and premolar regions, giving 176 sites reading. Maxillary posterior superior alveolar artery (PSAA) was visualized in 44 patients, 19 female and 25 male patients. Giving a gender ratio of 1:1.3. The average distance from the inferior border of the PSAA canal to the sinus floor was 11.1mm in the total sample, 10.4 mm (std. deviation 4.1mm) in male and 12.5 mm (std. deviation 6.5mm) in female. Furthermore, the median was 12mm and 10.3 mm for females and males respectively. These results are shown in Table I

Table I: Maxillary posterior superior alveolar artery measurements

	Number (44)	Average distance (11.1)	Median (10.5)
Female	19	12.5±6.5	12
Male	25	10.4±4.1	10.3

The most common path of PSA artery was extraosseous (57%) followed by intraosseous (43%) according to the following details. On the right side, the most common course of PSAA identified was extraosseous in 54 sites, followed by intraosseous, which was found in 34 sites. On the left side, the most common course of PSAA identified was extraosseous in 47 sites, followed by intraosseous, which were present in 41 sites. The results of right and left sides can be summarized as shown in Table II.

Table II Summary of location of PSAA on the right and left sides.

	Intraosseous 75(43%)	Extraosseous 101(57%)	Total
Right	34 (39%)	54 (61%)	88
Left	41 (47%)	47 (53%)	88

In relation to Premolar region, the PSAA location was 48% intraosseous and 52% extraosseous. While for Molar region, the PSAA identified mostly in extraosseous location in 59 sites representing 67% of the sample (Table III).

Table III Summary of location of PSAA on the premolar and molar regions.

	Intraosseous 75(43%)	Extraosseous 101(57%)	Total
Premolar	46 (48%)	42 (52%)	88
Molar	29 (33%)	59 (67%)	88

The location of the PSAA being extraosseous was higher in both genders being for females and males 61% and 55% respectively (Table IV).

Table IV Summary of location of PSAA in relation to different genders.

	Intraosseous 75(43%)	Extraosseous 101(57%)	Total 178 (100%)
Female	30 (39%)	46 (61%)	76
Male	45 (55%)	55	100

The result of statistical analysis by independent sample t-test between the means of both groups was 2.469 (p value 0.015) when equal variances assumed and t value was 2.204 (p value 0.030) when equal variances not assumed. The t-test showed significant differences between the means of both groups at 95% confidence interval.

Discussion:

In this study, the ratio of females to males was 1:1.3 and the PSAA was visualized in 46 patients. Other study done by Pandharbale and colleagues, the ratio was 1:1.5 and the PSAA was visualized in 30 patients only. The sample size was larger in this study with slightly more balanced gender distribution.¹²

In the current study, the artery was mostly extraosseous (57%), while (43%) was intraosseous. Tehranchi and colleagues reported similar results regarding the location of PSAA being intraosseous in 47%.¹³ Other studies gave different percentage of the intraosseous course of the artery being 52%-55%.^{14&15}

According to Kim and colleagues, the prevalence of intraosseous course of the posterior superior alveolar artery was higher in males, having a percentage 57.1% and 42.85% for males and females respectively.¹⁵ This is also confirmed by the present study, the intraosseous course was found in 75 sites, 45 sites in males and 30

sites in female giving a percentage of 60% and 40% respectively.

In the present study, the mean distance from the artery to the sinus floor was 11.1 mm, 10.4 mm in male and 12.5 mm in female. This distance reported by Pandharbale and colleagues was 9.96mm and Fayek and colleagues reported the distance was 8.2±2.2 mm in males and 7.3±2.1 mm in females.¹⁶ Both studies use the same reference point which is the floor of maxillary sinus, even though there is a difference in the readings which might be addressed to the anatomical variations of the different ethnic groups. Other studies reported the distance between PSAA and crest of the ridge,¹³⁻¹⁵ this measurement is variable as the height of the ridge is effected by the periodontal condition of the dentition and significantly reduced following extraction of the associated dentition.¹⁷

Conclusion:

The location of the PSAA can be mostly in extraosseous site. The artery might also move from extraosseous to intraosseous

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location, or Vice versa, during its course as it travel from the molar to premolar area. Correct identification during planning of sinus lift procedures can help in avoiding accidental trauma during surgery. This

would minimize the likelihood of having unnecessary bleeding that limit the critical visualization of the sinus membrane during the delicate sinus floor elevation procedure.

Reference:

1. Whyte A, Boeddinghaus R. The maxillary sinus: physiology, development and imaging anatomy. *Dentomaxillofac Radiol*. 2019 Dec;48(8):20190205. <https://doi.org/10.1259/dmfr.20190205>
2. Cappello ZJ, Minutello K, Dublin AB. Anatomy, Head and Neck, Nose Paranasal Sinuses. 2023 Feb 11. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. PMID: 29763001.-
3. Flanagan D. Arterial supply of maxillary sinus and potential for bleeding complication during lateral approach sinus elevation. *Implant Dent*. 2005 Dec;14(4):336-8. <https://doi.org/10.1097/01.id.0000188437.66363.7c->
4. Oba Y, Tachikawa N, Munakata M, Okada T, Kasugai S. Evaluation of maxillary sinus floor augmentation with the crestal approach and beta-tricalcium phosphate: a cone-beam computed tomography 3- to 9-year follow-up. *Int J Implant Dent*. 2020 Jul 10;6(1):27. <https://doi.org/10.1186/s40729-020-00225-7->
5. Stern A, Green J. Sinus lift procedures: an overview of current techniques. *Dent Clin North Am*. 2012 Jan;56(1):219-33, x. <https://doi.org/10.1016/j.cden.2011.09.003->
6. Bhalla N, Dym H. Update on Maxillary Sinus Augmentation. *Dent Clin North Am*. 2021 Jan;65(1):197-210. <https://doi.org/10.1016/j.cden.2020.09.013->
7. Tatum H Jr. Maxillary and sinus implant reconstructions. *Dent Clin North Am*. 1986 Apr;30(2):207-29. [https://doi.org/10.1016/S0011-8532\(22\)02107-3-](https://doi.org/10.1016/S0011-8532(22)02107-3-)
8. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. *Compendium*. 1994 Feb;15(2):152, 154-6, 158 passim; quiz 162.-
9. Tatum H, Jr. Lecture presented to the Alabama Implant Congress. *Clinical Implant Dentistry and Related Research*. 1976.-
10. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg*. 1980 Aug;38(8):613-6.-
11. Molina A, Sanz-Sánchez I, Sanz-Martín I, Ortiz-Vigón A, Sanz M. Complications in sinus lifting procedures: Classification and management. *Periodontol 2000*. 2022 Feb;88(1):103-115. <https://doi.org/10.1111/prd.12414->

12. Pandharbale AA, Gadgil RM, Bhoosreddy AR, Kunte VR, Ahire BS, Shinde MR, Joshi SS. Evaluation of the Posterior Superior Alveolar Artery Using Cone Beam Computed Tomography. *Pol J Radiol*. 2016 Dec 19;81:606-610. <https://doi.org/10.12659/PJR.899221>-
13. Tehranchi M, Taleghani F, Shahab S, Nouri A. Prevalence and location of the posterior superior alveolar artery using cone-beam computed tomography. *Imaging Sci Dent*. 2017 Mar;47(1):39-44. <https://doi.org/10.5624/isd.2017.47.1.39>-
14. Mardinger O, Abba M, Hirshberg A, Schwartz-Arad D. Prevalence, diameter and course of the maxillary intraosseous vascular canal with relation to sinus augmentation procedure: a radiographic study. *Int J Oral Maxillofac Surg*. 2007 Aug;36(8):735-8. <https://doi.org/10.1016/j.ijom.2007.05.005>-
15. Kim JH, Ryu JS, Kim KD, Hwang SH, Moon HS. A radiographic study of the posterior superior alveolar artery. *Implant Dent*. 2011 Aug;20(4):306-10. <https://doi.org/10.1097/ID.0b013e31822634bd>-
16. Fayek MM, Amer ME, Bakry AM. Evaluation of the posterior superior alveolar artery canal by cone-beam computed tomography in a sample of the Egyptian population. *Imaging Sci Dent*. 2021 Mar;51(1):35-40. <https://doi.org/10.5624/isd.20200146>-
17. Van der Weijden F, Dell'Acqua F, Slot DE. Alveolar bone dimensional changes of post-extraction sockets in humans: a systematic review. *J Clin Periodontol*. 2009 Dec;36(12):1048-58. <https://doi.org/10.1111/j.1600-051X.2009.01482.x>-

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Availability of Data and Material:

The author is prompt to supply datasets generated during and/or analyzed during the current study on wise request.

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