Research Article
J Nepal Soc Perio Oral Implantol. 2023 Jul-Dec;7(14):66-70.
DOI: 10.3126/jnspoi.v7i2.60887

Submitted: Nov 15, 2023
Accepted: Jan 19, 2024
Published: Feb 25, 2024

Prevalence of Alveolar Antral Artery in Patients Visiting Tertiary Care Centre: A Cone-beam Computed Tomography Study

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ABSTRACT

Introduction: Intrasseous anastomosis between the posterior superior alveolar artery (PSA) and infraorbital artery is termed as Alveolar Antral Artery (AAA). It is considered a common anatomical point of interest during lateral sinus floor elevation because of the risk of intraoperative haemorrhage.

Objective: To determine the prevalence of AAA along with its diameter and distance from the floor of the maxillary sinus.

Methods: A total of 250 Cone-beam Computed Tomography (CBCT) images scanned with a Dentium Rainbow CBCT machine were included in the study. The study design was an analytical cross-sectional study, done from June 2023 to October 2023. Using the multiplanar capabilities of the software, the prevalence, exact location, and diameter of the artery were determined in relation to the floor of the maxillary sinus. Data were collected and entered into Microsoft Excel and analysis was done in SPSS version 20.0.

Results: The artery could be identified in 197 (78.8%) of the cases on the right maxillary sinus and 185 (74%) of the cases on the left maxillary sinus. The mean diameter of the artery on the right sinus was found to be 1.24 mm and 1.10 mm on the left. The mean distance from the floor of the sinus was 10.22 mm on the right and 8.52 mm on the left side.

Conclusions: One significant anatomical feature in the wall of the lateral maxillary sinus is the alveolar antral artery. Preoperative CBCT scans are useful diagnostic tools for conditions that may affect this artery and for reducing surgical complications in suspected cases.

Keywords: Artery; cone-beam computed tomography; diameter; distance; maxillary sinus.

INTRODUCTION

Alveolar crest resorption and maxillary sinus pneumatisation are common sequelae after tooth loss in the posterior maxilla.[1] This leads to inadequate residual bone height for proper placement of dental implants. To overcome this, Sinus lift procedure was proposed by Tatum in 1970s and later performed by Boyne and James in 1980.[2,3] It is considered safe procedure with high predictability.[4]

However, several complications may arise due to extensive nature of maxillary vascular network that may compromise surgical procedure.[5,6] Thus, sound knowledge of vascularity of antero-lateral wall of the maxillary sinus is mandatory before performing a direct sinus lift.

Intrasseous anastomosis between PSA and infrarbital artery is termed as Alveolar Antral Artery (AAA).[7] It is seen in relation with the anterior wall of the maxillary sinus.[5] It supplies Schneiderian membrane, maxillary periosteum and antero-lateral wall of sinus.[8,9] It is considered as anatomical point of interest during sinus floor elevation via lateral window technique because of potential risk of haemorrhage. Also, it is important to maintain such anastomosis to support bone graft neoangiogenesis.[10]

Hence, this study aimed to determine the prevalence of AAA along with its diameter and distance from the sinus floor using cone-beam computed tomography (CBCT) images of patients visiting tertiary care hospital.

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Citation
Subedi G, Lamichhane S, Rijal AH, Humagain M, Bhusal S, Timilsina S. Prevalence of Alveolar Antral Artery in Patients Visiting Tertiary Care Centre: A Cone-beam Computed Tomography Study. J Nepal Soc Perio Oral Implantol. 2023 Jul-Dec;7(14):66-70.

METHODS

An analytical cross-sectional study was performed on the CBCT images of patients from the archives of the Department of Oral Medicine and Radiology, Dhulikhel Hospital. The study period was from June 2023 to October 2023. Ethical clearance was obtained from the Institutional Review Committee (IRC) of Dhulikhel Hospital (Ref. 70/23).

The calculated sample size was 250, according to the data derived from a similar study done by Gabriele et al.[5] The formula used was:

$$n = \frac{\text{Deff x Npq}}{(d^2/Z^2_{1-\alpha/2} \text{ x (N-1) +pq}}$$

Where,

n = sample size,
deff = design effect (1),
N = population size (700),
p = prevalence taken as 50% for maximum sample size calculation,
q = 1-p,
d = desired absolute precision or absolute level of precision (5%)

Completely or partially dentate patients above the age of 18 years with CBCT images present in the archives of dental radiology were included in the study. The exclusion criteria were any partial or incomplete images, the presence of maxillary fractures, and any pathologic lesions/artifacts present in the maxillary sinus region. CBCT images with adequate diagnostic quality were only recruited in the study.

The CBCT images were taken by the Dentium Rainbow CBCT machine, having parameters such as scan time: 20 seconds, peak voltage: 100 kV, tube current: 12 mA, Field of View: 1618 $cm^{2,}$ and voxel size: 300 . Axial and coronal views of the maxillary sinus were obtained and the obtained images were viewed and analysed using Rainbow TM Image Viewer Version 1.0.0.0. which has been used in several previous studies.[11,12]

Using the multiplanar capabilities of the software, the artery was identified with respect to the Schneiderian membrane and to the bony wall. The diameter as well as the distance of the artery from its lowest point to the floor of the maxillary sinus was also assessed (Figure 1). The diameter was recorded as the greatest distance between the inner sides of the cortical borders and the greater values between the most posterior and most anterior positions (Figure 2).[13] If no artery was detected, it was recorded as absent and the measurements were discontinued. If more than one artery was detected in a coronal section, then the artery with a larger diameter was measured (Figure 3). All the measurements were done both on the right as well as on the left sides.

Figure 1: Measurement of the distance of alveolar antral artery from the lowest point on the floor of maxillary sinus.

Figure 2: Measurement of the diameter of alveolar antral artery as the greatest distance between the inner sides of the cortical borders and the greater values between the most posterior and most anterior position.

Figure 3: Detection of two arteries on the lateral wall of the maxillary sinus.

All the data were entered in Microsoft Excel version 2016 and analysed using IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics were measured as mean and standard deviation and an unpaired t-test was used to compare the mean differences between the right and the left side. P value < 0.05 was considered statistically significant.

RESULTS

A total of 250 CBCT scans with 500 maxillary sinuses (on both sides) were included in the study. The average age of the study subjects was 34.24±13.8 years, with 19 being the lowest and 77 being the highest, wherein, 132 (52.8%) were males and 118 (47.2%) were females. Out of 250 sinuses, AAA was identified in 197 (78.8%) sinuses on the right side, whereas the artery was identified in 185 (74%) sinuses on the left side.

Bilateral AAA was visualised in 176 (70.4%) patients and unilateral AAA was visualised in 23 (9.2%) of the patients, while in 51 (20.4%) AAA was not visualised on both sides. This includes the identification of the artery in relation to the maxillary second premolars and first molars.

The mean diameter of the artery was 1.24 mm on the right side and 1.10 mm on the left side (95% confidence interval, Table 1). The maximum diameter was measured to be 5.14 mm on the right side and 5.16 mm on the left side and the minimum diameter of the artery was 0.75 mm on both sides. When diameters of the artery between the right and the left sides were compared, it was found to be statistically significant (P value = 0.04, Table 1).

The mean distance of AAA as measured from the lowest point on the floor of the maxillary sinus was 10.22 mm on the right side and 8.52 mm on the left side (Table 2). The maximum distance of the artery from the sinus floor was measured as 26.56 mm while 2.53 mm being the minimum on the right side.

Table 1: Comparison of mean scores of diameters of the alveolar antral artery between right and left maxillary sinuses.

	Mean±Standard Deviation	P value
Right side	1.24±0.78	0.04
Left side	1.10±0.77	

P value < 0.05 was considered statistically significant

Table 2: Comparison of mean scores of distances of alveolar antral artery from the floor of maxillary sinus between right and left sides.

	Mean±Standard Deviation	P value
Right side	10.22±7.005	0.005*
Left side	8.52±6.52	

P value < 0.05 was considered statistically significant

Similarly, on the left side, the maximum distance was 24.37 mm and the minimum distance was 2.6 mm. Table 2 depicts the comparison of the distance of AAA from the floor of the maxillary sinus between the right and left sides, which was found to be statistically significant (P value = 0.005)

DISCUSSION

Alveolar antral artery is considered as an important anatomical landmark present on the anterolateral wall of the maxillary sinus. During various surgical procedures such as sinus lift surgeries with lateral window approach, Caldwell Luc surgeries, and horizontal osteotomy of the maxilla, there may be a potential risk of haemorrhage due to the severing of the artery.[14] Therefore, a detailed knowledge of the vascular anatomy of the maxillary sinus is a must before performing such procedures.

The present study was done to determine the prevalence, diameter, and distance of AAA in relation to the floor of the maxillary sinus, along with its clinical implications during direct sinus lift surgeries. The presence of this artery was first mentioned by Strong in 1934, where, the innervation and vascular supply of the maxillary sinus was discussed.[15]

The arterial supply of the maxillary sinus is mainly by the three branches of the maxillary artery: the greater palatine artery, the posterior superior alveolar (PSA) artery, and the infraorbital artery.[9] The PSA and infraorbital artery form the anastomosis extraosseously as well as intraosseously, along the bony lateral antral wall which supplies the Schneiderian membrane, maxillary periosteum as well as the antero-lateral wall of the maxillary sinus. AAA is the intra-osseous anastomosis between the PSA and infra-orbital artery and is of particular importance during direct sinus lift procedures. According to the study done by Traxler et. al., the extraosseous anastomosis was found to be present in 44% of cases.[16]

However, according to the literature search, cadaveric studies and studies done using CBCT images to measure the prevalence of this artery have produced inconsistent findings. This anastomosis has a 100% prevalence rate in cadaver investigations[17], however, CBCT studies only reveal a 47–67% prevalence.[17] This discrepancy may be explained by the fact that some alveolar antral arteries are subperiosteal to the Schneiderian membrane and not localised in the bone and that CBCT is unable to detect arteries with a diameter of less than 0.5 mm.[17] Also, the lower resolution of the CBCT machine might hinder the detection of the artery.

In the current investigation, we used CBCT to analyse the diameter, location, and existence of the AAA in the Nepalese population. Out of the 250 scans, the artery was radiographically detected in 78.8 % of the right sinuses and 74 % of the left sinuses. These findings were inconsistent with the study done by Elian et. al., where the artery was radiographically identified in 51.4% of right sinuses and 54.3% of left sinuses.[18]

Kim et al (2011) measured the mean diameter of this artery at 1.52 ± 0.47 mm[19], which is more or less similar to the findings of the present study. Also, these findings are largely consistent with the research conducted by Mardinger et al. (2007), which discovered that this artery was situated 16.9 mm on the lateral sinus wall from the floor of the sinus.[20]

Knowing this artery's diameter before surgery increases the surgeon's awareness of the potential for bleeding during the procedure and allows them to modify the ostectomy window's location or bone cuts. The likelihood of haemorrhage increases with the increase in the diameter of the artery.

Taking this into consideration, maintaining this anastomosis is crucial for both preventing bleeding complications and promoting bone graft neoangiogenesis.[10] For these reasons, it is important to take into account the anastomosis's concurrent reflection with the Schneiderian membrane during sinus augmentation procedures, especially if it is possible and especially if its diameter is consistent.

CONCLUSION

Within the limitations of the study, it is possible to state that, in order to prevent the occurrence of fatal complications during and after surgery, preoperative evaluation using CBCT is extremely crucial for the appropriate assessment of prevalence, diameter, and distance of AAA from the floor of maxillary sinus and treatment planning for severely atrophic ridges in the posterior maxilla. A preoperative CBCT scan will help the surgeon make decisions, lower risks, and boost success rates. If in case, severe bleeding results from the AAA's severing, the clinician should be ready to handle this complication by putting all the containment and resolution measures into place such as the use of tranexamic acid, bone wax, electro-coagulation or ligature.

According to the literature search, the authours did not find any investigations in the Nepali population regarding the prevalence, exact location, and diameter of AAA in relation to the floor of the maxillary sinus, further research with a larger sample size is necessary to be conducted in the future.

Conflict of interest: None.

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