International Journal of Dental Sciences
www.dentaljournal.in
ISSN: 2663-4708
Received: 11-10-2026, Accepted: 10-11-2026, Published: 25-11-2026
Volume 8, Issue 4, 2026, Page No. 76-84

Evaluation of the alveoloantral artery using CT and its implications in planning maxillary sinus lifts in posterior edentulous patients

Luis Brayan Armijo Yanza
Department of Oral Surgery, Hemisferios University. Quito, Ecuador
DOI: https://doi.org/10.66856/ijds.2026.8.4.8158

Abstract
Introduction: The alveoloantral artery (AAA) is a vascular structure relevant to maxillary sinus lift procedures, where there is a risk of injury and hemorrhage during osteotomy. Identification of the AAA using cone-beam computed tomography (CBCT) helps identify anatomical changes relevant to the surgical procedure.
Objective: To analyze the anatomical and morphometric characteristics of the AAA with the anatomical parameters of the maxillary sinus and the residual alveolar ridge in adult patients with posterior edentulism.
Methodology: A quantitative, observational, analytical, cross-sectional, and retrospective study was conducted using 230 CT scans obtained at the SCANBIO radiology center in Cuenca, Ecuador. The identification, location, arterial diameter, distances to the residual ridge, sinus plane, and lateral wall thickness were recorded. Data were analyzed using descriptive statistics and Spearman's correlation.
Findings: The results showed a high frequency of AAA, predominantly located within the bone, and variations in morphometric characteristics. Significant associations were found between arterial measurements and anatomical parameters, as well as with different levels of surgical involvement.
Conclusion: TCHC allows for individualized assessment with anatomical data that serves as a guide in the design of the osteotomy and identification of circumstances that may increase surgical complexity.

Keywords: Alveoloantral artery, cone beam computed tomography, maxillary sinus, posterior edentulism, maxillary sinus lift, surgical planning

Introduction

Oral rehabilitation using dental implants has become one of the most common treatment options for edentulism , restoring function and aesthetics in the long term (Ayran *et al*. 2026; Kupka *et al*. 2024) [1,2]. One of the main limitations is the quantity and quality of bone found in the posterior sector of the maxilla, which is frequently related to the progressive resorption of the posterior alveolar ridge and to the pneumatization of the maxillary sinus (Mahurstawi *et al*. 2025; Kim *et al*. 2021; Ayran *et al*. 2026) [2–4].

Alveolar ridge resorption leads to a reduction in available bone height, making it difficult for implants to achieve primary stability and necessitating complementary bone grafting treatments, such as maxillary sinus lifts (Yang & Lee, 2021) [5]. Lateral sinus lifts are one of the most commonly used surgical options to increase bone volume, both vertically and transversely, in patients with posterior maxillary edentulism (Urechescu *et al*. 2026; Yang & Lee, 2021) [5,6].

This type of surgical procedure suffers intraoperative and postoperative complications (Çevik -Sönmez *et al*. 2024) [7]. Complications include perforations of the Schneiderian membrane, intraoperative hemorrhage, maxillary sinusitis (Alqhtani *et al*. 2025; Çevik - Sönmez *et al*. 2024; Gładysz *et al*. 2024) [7–9].

A vascular injury during lateral window osteotomy causes hemorrhage, which worsens surgical visibility, increases surgical time including the sinus lift procedure, and projects a greater likelihood of perforating the sinus membrane (Alqhtani *et al*. 2025; Danesh- Sani *et al*. 2017) [8,10].

From an anatomical perspective, the infraorbital artery and the posterior superior alveolar artery are the main vascular structures located within the maxillary sinus. Their pathways form a vascular anastomosis known as the alveoloantral artery (Gładysz *et al*. 2024; Wang *et al*. 2025; Zhou *et al*. 2023) [9,11,12]. This vascular structure arises from the lateral wall of the maxillary sinus and is important for bone vascularization, graft integration, and tissue healing after surgery (Turkoglu & Ayyildiz. 2025; Yeung *et al*. 2022) [13,14].

alveoloantral artery has anatomical variability in its course, location, and diameter; it is defined by its position as intraosseous, superficial, and submembranous, and is influenced by age, sex, degree of edentulism , bone resorption pattern, thickness of the lateral wall of the maxillary sinus, and the presence of sinus septa, increasing the complexity of the surgical procedure, requiring a very careful three-dimensional analysis to avoid hemorrhagic complications during lateral osteotomy (Altayar *et al.* 2023; Godil *et al*. 2021) [15,16].

The lateral osteotomy is performed approximately 3 mm above the floor of the maxillary sinus, and the height of the surgical window is classified as small (<5 mm), medium (5-8 mm) or large (>8 mm) (Urechescu *et al*. 2026) [6]. Cone beam computed tomography (CBCT) has proven to be the imaging procedure of choice for preoperative assessment of the maxillary sinus and vascular structures due to its three-dimensional reconstruction capability (Ayran *et al.* 2026; Yeung *et al*. 2022) [2,14].

CT angiography accurately identifies the location, course, diameter, and anatomical relationship of the alveoloantral artery to adjacent structures, which contributes to surgical planning (Gulec *et al*. 2025; Ayran *et al*. 2026) [2,17]. Furthermore, this considerably reduces the incidence of

surgical complications, improves the predictability of maxillary sinus lift procedures by designating anatomical safety parameters (Godil *et al*. 2021; Hosseinzadeh *et al*. 2025; Misăiloaie *et al*. 2024; Tassoker. 2022) [15,18–20].
Alveoloantral artery using CTHC and analyze the implications in the planning of maxillary sinus lift in edentulous patients, generating evidence that contributes to the improvement of the safety, accuracy and predictability of the records used in the methodological process.

Methodology

The study design was quantitative, observational, analytical, cross-sectional and retrospective, consisting of the analysis of cone beam computed tomography (CBCT) scans obtained and deposited in the digital database of the SCANBIO radiological center in Cuenca, corresponding to the period between January 2024 and May 2026.

The unit of analysis consisted of each maxillary sinus corresponding to an edentulous posterior sector that met the selection criteria. In said maxillary sinus, the presence or absence of tomographic identification of the alveoloantral artery was determined using the Blue-Sky Plan 5 program. This artery was identifiable by means of its anatomical location, diameter, distance to the residual alveolar ridge, and distance to the floor of the maxillary sinus.

The study consisted of 1,000 cones beam computed tomography (CBCT) scans of patients treated at the SCANBIO radiology center during the period between January 2024 and May 2026. From the tomographic records, the maxillary sinuses were identified in the edentulous posterior sectors.

In each CT scan, the presence or absence of the abdominal aortic aneurysm (AAA) was assessed, along with its anatomical location, diameter, and linear relationships to the maxillary sinus floor and the residual alveolar ridge. The thickness of the lateral wall and the distance between the sinus floor and the residual alveolar ridge were also determined.

The sample consisted of 230 CT scans of edentulous posterior teeth, selected from the CT scans included in the SCANBIO radiology center database. The right and left maxillary sinuses were included according to the selection criteria, the diagnostic quality for performing the morphometric and anatomical evaluation of the alveoloantral artery, and the anatomical parameters for planning maxillary sinus lift surgery in patients using a lateral window approach.

The unit of analysis consisted of each maxillary sinus corresponding to an edentulous posterior sector of the 230 selected CT scans. In patients with bilateral edentulism, both maxillary sinuses were analyzed individually, maintaining their identification.

Non-probability convenience sampling was used to select maxillary sinuses from edentulous posterior sectors using CT scans from the SCANBIO database. Selection was based on availability, quality, and adherence to inclusion and exclusion criteria, resulting in a sample of 230 computed tomography scans. This procedure allowed for the study of the anatomical characteristics of the alveoloantral artery and its relationship to the maxillary sinus structures in the selected sample.

The inclusion criteria include the following

1. TCHC corresponding to edentulous patients of the posterior maxilla aged 26 years or older.
2. TCHC collected in SCANBIO in the period from January 2024 to May 2026.
3. Existence of unilateral or bilateral posterior edentulism in the maxilla.
4. Complete observation of the posterior sector of the maxilla, the residual alveolar ridge, the floor of the maxillary sinuses and the lateral wall of the maxillary sinus.
5. Sufficient diagnostic quality to perform the observations and measurements established in the protocol itself.

The exclusion criteria are listed below

1. The TCHC that were found prior to maxillary sinus surgery or sinus lift where it was evaluated.
2. The maxillary sinuses that were found with previous bone grafts in the region of interest.
3. Presence of dental implants in the posterior sector of the maxilla.
4. Presence of fractures, resections or surgical history that have satisfactorily modified the anatomy of the region.
5. The existence of pathology related to the maxillary sinuses that prevents the visualization of anatomical references for measurements
6. TCHC with an incomplete visual field of the posterior maxillary sector

For the collection of the database, a training, standardization and calibration process was carried out for a study examiner in order to corroborate the accuracy, reproducibility and reliability of the observations and measurements made from the TCHC.

The tomographic evaluation was performed by a single examiner throughout the study, who was previously trained in volume orientation; handling multiplanar reconstructions; identifying anatomical landmarks; recognizing abdominal aortic aneurysms (AAAs); and finally, in the use of digital measurement tools. Standardization included determining the AAA, categorizing it as intrasinusal, intraosseous, or superficial; measuring the diameter and the distances between the AAA and the sinus floor, the AAA and the residual rim, the sinus floor and the residual rim, and the lateral wall thickness at 5 mm.

intra-observer reproducibility, 10% of the maxillary sinuses in the sample were randomly selected, and measurements were taken by the same examiner after a four-week interval without knowledge of the initial results.

For quantitative variables, the intraclass correlation coefficient (ICC) was calculated. For categorical variables, specifically the presence/absence and anatomical location of the AAA, Cohen's Kappa coefficient allowed for comparison between measurements taken by different observers. An expert examiner participated in the calibration, comparison, and assessment of interobserver agreement.

The calibration was done using the software, the orientation of the reconstructions, the tomographic planes, the anatomical reference points, and the criteria followed to perform the measurements.

Data was obtained from CT scans in the SCANBIO digital database. Each patient was identified by an alphanumeric code, and each maxillary sinus by its corresponding side, excluding names, identification numbers, and other direct personal data. The data were analyzed, first in a matrix designed for data collection for the research, and subsequently incorporated into an electronic database developed in Microsoft Excel.

Categorical variables were collected using Likert-type scales, and quantitative variables were recorded in millimeters. When AAA could not be collected, the variables dependent on visualization were recorded as not applicable.

Once cleaned, the database was included in the IBM SPSS Statistics version 31 program for statistical processing and analysis.

The 230 data points were evaluated using a cone-beam computed tomography (CBCT) system, selected from the SCANBIO radiology center, and organized and coded in a data matrix created in Microsoft Excel. The information was processed using IBM SPSS Statistics, version 31, to perform a descriptive and inferential analysis of the anatomical and morphometric characteristics of the alveoloantral artery (AAA), the anatomical parameters of the maxillary sinus, and their implications for planning sinus lift surgery via a lateral window approach.

First, a descriptive analysis of qualitative variables was performed, including the presence or absence of the abdominal aortic aneurysm (AAA) on CT scan, its anatomical location, patient sex, and the level of surgical involvement, using absolute frequencies and percentages. Quantitative variables such as age, AAA diameter, distance between the artery and the residual alveolar ridge, distance between the AAA and the maxillary sinus floor, distance between the maxillary sinus floor and the residual alveolar ridge, and thickness of the lateral maxillary sinus wall were also analyzed.

Kolmogorov-Smirnov normality test was applied. The results indicated that the variables did not have a distribution different from normal ($p < 0.05$); non-parametric tests were used for inferential analysis.

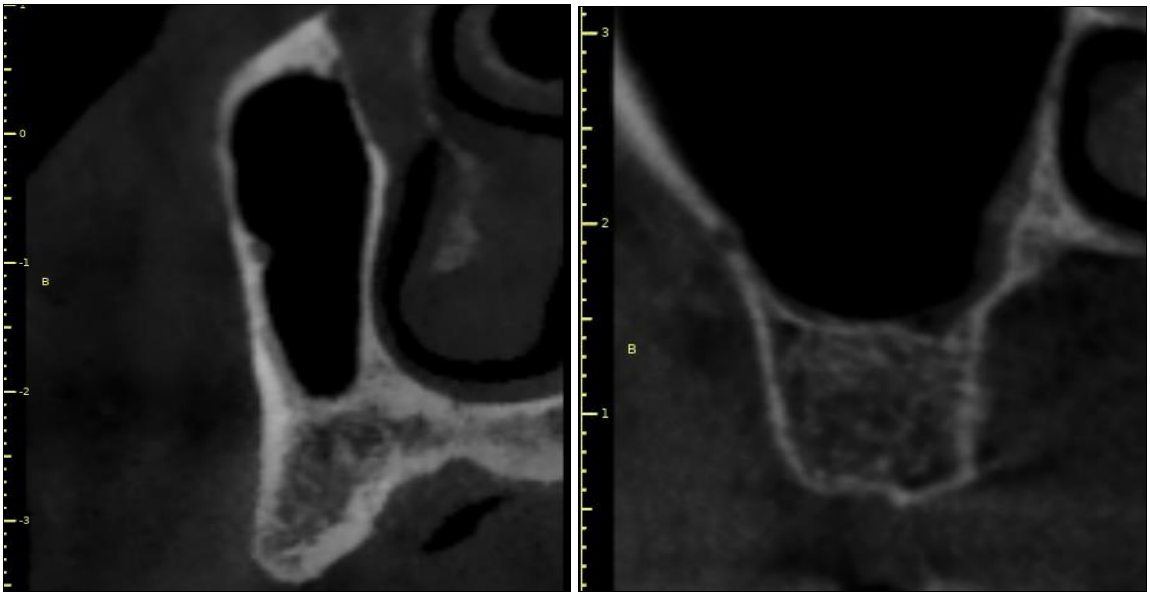
The relationship between the morphometric characteristics of the AAA and the anatomical parameters of the maxillary sinus and the residual alveolar rim was analyzed using Spearman's rank correlation coefficient. Specifically, the associations between arterial diameter, the distances from the AAA to the residual rim and to the sinus floor, the distance from the maxillary sinus floor to the residual rim, and the thickness of the lateral wall of the maxillary sinus were assessed.

The surgical implications of lateral window maxillary sinus lifts were considered an ordinal qualitative variable, classified into three levels: high, moderate, and low. For classification, a joint clinical evaluation of the anatomical and morphometric characteristics observed in the CT scans was performed, with the aim of describing the importance of these characteristics for planning the lateral osteotomy prior to surgery; the results are presented as absolute frequencies and percentages for each category.

A statistical significance level of $\alpha = 0.05$ was established for all inferential tests, considering results obtained with $p < 0.05$ values to be statistically significant.

Findings

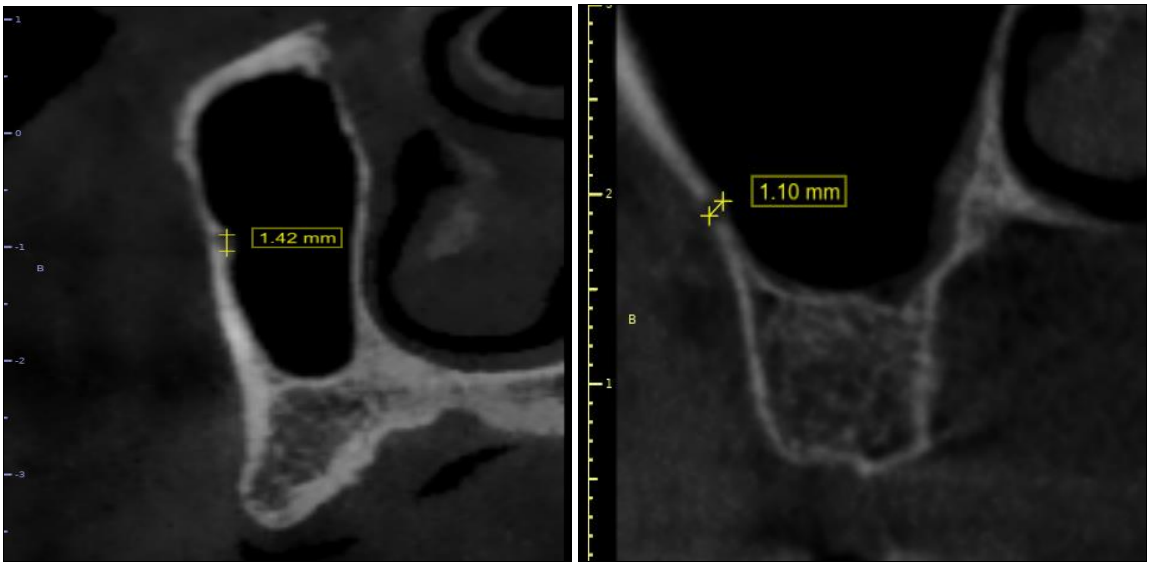
A study of 230 cone-beam computed tomography scans was performed, and the classification, diameter, distance between the AAA and the sinus floor, the distance between the AAA and the residual rim, the distance between the sinus floor and the residual rim, the thickness of the lateral wall, and the surgical implication determined by a joint tomographic assessment of the anatomical characteristics were identified. (Figures 1, 2, 3, and 4)



a. Intrasinusal **b. Intraosseous**

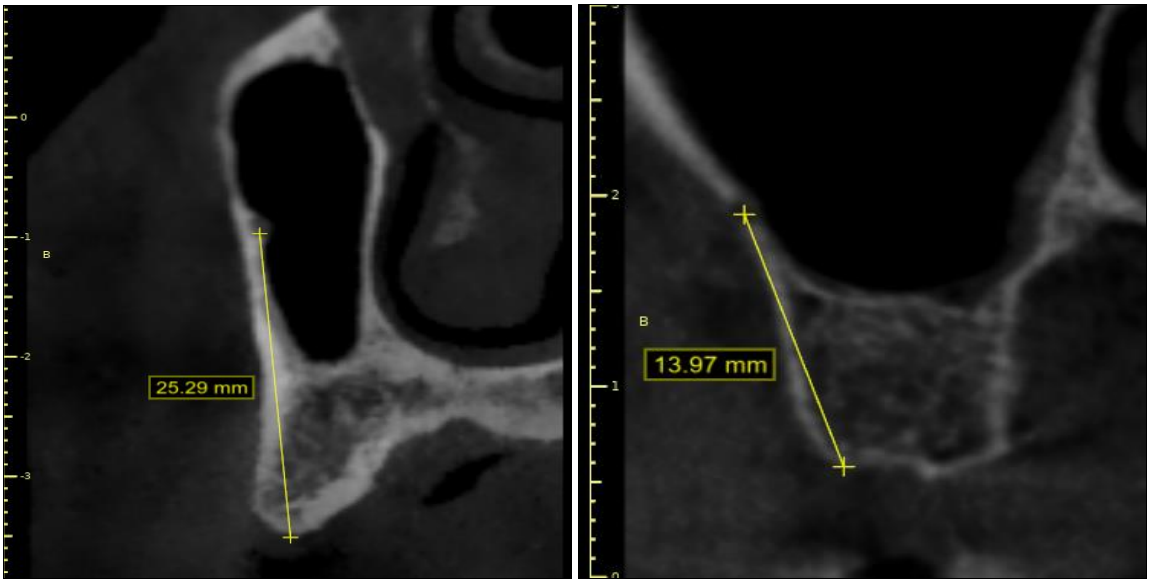
Source: Original work. [2026]

Fig 1: AAA Location Identification



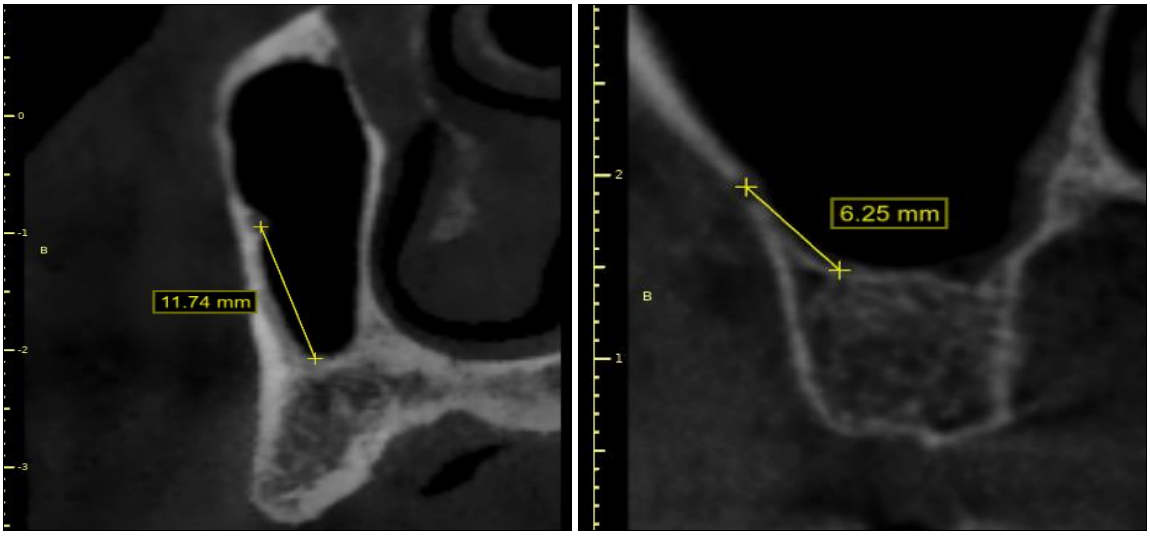
Source: Original work. [2026]

Fig 2: AAA Diameter



Source: Original work. [2026]

Fig 31: Distance from the AAA to the residual alveolar ridge



Source: Original work. [2026]

Fig 4: Distance from the AAA to the floor of the maxillary sinus

Table 1 shows the presence and absence of AAA in the maxillary sinuses of the edentulous posterior sectors. In 84.3% of the evaluated tomographies, the existence of the artery could be visualized, but in 15.7% it was not possible to visualize it, which is interpreted as a high frequency of visualization of the AAA. The location of the alveoloantral artery was evaluated using computed tomography (CT). It was found that 67.5% (n=131) of the arteries were located intraosseously, 30.9% (n=60) intrasinusally, and 1.5% (n=3) superficially. According to these results, the intraosseous course was the anatomical location with the highest prevalence in the CT scans analyzed. (Table 1)

Table 1: Percentage distribution of the presence/absence of the alveoloantral artery (AAA) , the anatomical location of the alveoloantral artery

Alveolar-antral artery	n	%	% cumulative
Presence	194	84.3	84.3
Absence	36	15.7	100
Total	230	100	
Location			
Intraosseous	131	67.5	67.5
Superficial	3	1.5	69.1
Intrasinusal	60	30.9	100
Total	194	100	

Source: n: participants, %: percentage

The anatomical characteristics of the alveoloantral artery (AAA) were determined by data showing a diameter ranging from 0.47 to 3.2 mm, with an average size of 1.45 mm. The average morphometric measurements for the distance from the alveoloantral artery to the floor of the maxillary sinus were 16.82 mm and 9.73 mm, respectively. (See Table 2).

The morphological parameters of the maxillary sinus and the residual alveolar ridge showed, on average, a distance from the floor to the residual ridge of 9.38 mm, with values ranging from 0.86 to 28.21 mm. The thickness of the lateral wall of the maxillary sinus averaged 1.69 mm, with a minimum value of 0.60 mm and a maximum value of 10.33 mm (See Table 2). The results showed variability in residual bone height and lateral wall thickness of the maxillary sinus among the analyzed CT scans.

Table 2: Descriptive statistics of the diameter of the alveoloantral artery and its position with respect to the residual ridge and the floor of the maxillary sinus (mm). Distance from the floor to the residual ridge and the thickness of the lateral wall of the sinus (mm*)*

	n	Minimum	Maximum	Average	OF
AAA Diameter	194	0.47	3.2	1.45	0.48
Distance from the AAA to the residual ridge	194	6.37	32.48	16.82	5.64
Distance from the AAA to the floor of the maxillary sinus	194	2.58	23.81	9.73	3.87
Distance from floor to residual edge	230	0.86	28.21	9.38	3.97
Thickness of the lateral wall of the sinus	230	0.6	10.33	1.69	0.95

Source: n: participants, SD: Standard deviation

The correlation between the anatomical-morphometric characteristics of the alveoloantral artery and the anatomical parameters of the maxillary sinus and the residual alveolar ridge was performed using Spearman's correlation. The data indicate that the diameter of the alveoloantral artery and the distance from the floor of the maxsillary sinus to the residual ridge; the distance from the alveoloantral artery to the residual ridge and the thickness of the lateral wall of the maxillary sinus; and the distance from the artery to the floor of the maxillary sinus with the thickness of the lateral wall of the sinus did not show a statistically significant correlation ($p \leq 0.05$).Meanwhile, the distance from the AAA to the residual rim and the distance from the sinus floor to the residual rim revealed a positive and statistically significant correlation ($\rho = 0.372$; $p = 0.001$), when the distance from the AAA increases, so does the distance from the sinus floor to the residual rim, although it is considered to be of low to moderate intensity.

The distance between the AAA and the maxillary sinus floor and the distance from the sinus floor to the residual ridge showed a statistically significant negative correlation ($\rho = -0.224$; $p = 0.002$). An increase in the distance from the artery to the maxillary sinus floor resulted in a decrease in the distance from the sinus floor to the residual ridge.

The diameter of the alveoloantral artery and the thickness of the lateral wall of the sinus were positively and statistically significantly correlated ($\rho = 0.291$; $p = 0.001$). As the diameter of the AAA increased, the thickness of the lateral wall of the maxillary sinus also increased, although the relationship was weak to moderate. Table 3

Table 3: Spearman correlation between the anatomical and morphometric characteristics of the alveoloantral artery with the anatomical parameters of the maxillary sinus and residual alveolar ridge

Alveoloantral artery vs. maxillary sinus and alveolar ridge	n	Rho Spearman	p
AAA diameter and the distance from the sinus floor to the residual rim	194	0.091	0.207
Distance from the AAA to the residual ridge and distance from the sinus floor to the residual ridge	194	0.372	0.001*
Distance from the AAA to the floor of the maxillary sinus and the distance from the sinus floor to the residual ridge	194	-0.224	0.002*
AAA diameter and sinus sidewall thickness	194	0.291	≤0.001*
Distance from the AAA to the residual rim and the thickness of the sinus lateral wall	194	0.102	0.157
Distance from the AAA to the floor of the maxillary sinus and the thickness of the lateral wall of the sinus	194	-0.098	0.174

Source: p* = significance value ≤ 0.05

According to Table 4, the distribution of the level of surgical involvement in relation to maxillary sinus lift, as measured by CT scans, is as follows: 40.9% low, 30.4% high, and 28.7% moderate. The low surgical involvement category was predominant, but the moderate and high categories comprised 59.1% of the sample.

Table 4: Percentage distribution of surgical implications for maxillary sinus lift

	n	%	% cumulative
High	70	30.4	30.4
Half	66	28.7	59.1
Low	94	40.9	100
Total	230	100	

Source: n: participants, %: percentage

The characterization of the presence, location, and morphometric characteristics of the alveoloantral artery (AAA) and its relationship with the anatomical parameters of the maxillary sinus and the residual alveolar ridge was studied. Anatomical variations were observed, along with the relationship of certain morphometric variables and with different degrees of surgical involvement for maxillary sinus lift via lateral window surgery.

Discussion

The tomographic evaluation of the alveoloantral artery (AAA) was related to the anatomy of the edentulous posterior maxilla, as well as to the planning of the maxillary sinus lift technique with a lateral window. In this study, 230 tomographic scans were analyzed, focusing on the identification of the artery, its location, morphometric characteristics, and anatomical relationships with the maxillary sinus and the residual alveolar ridge. These results allow for a discussion of the variability of vascular anatomy and its potential influence on pre-surgical planning, referencing studies that have used cone-beam computed tomography (CBCT) to study these structures.

Tomographic identification of the abdominal aortic aneurysm (AAA) is one of the first aspects to consider during the pre-surgical evaluation of the maxillary sinus. In this study, the artery was identified in 84.3% of cases (n = 194), and in 15.7% (n = 36) no AAA was identified, as per the study by Danesh- Sani *et al.* (2017) [10], which shows it in 60.58% of the estimated maxillary sinuses, and also by Zhou *et al.* (2023) [12], which was 62.18%.

However, Alqhtani *et al*. (2025) [8] confirmed an identification rate of 98.3% in a Saudi population, which is higher than in this study. The difference is likely linked to the characteristics of the populations studied, the tomographic protocols used, and the criteria for duct identification. Therefore, the variations in detection rates support the interpretation of AAA visualization based on the circumstances of each patient and study performed.

The lack of tomographic identification of the AAA is considered within the context of a specific evaluation, considering the limitations of CT in visualizing small-caliber vascular structures. In this study, 15.7% of cases did not present an arterial pathway capable of being identified, information that is not interpreted as an anatomical absence of this artery; in fact, Danesh- Sani *et al*. (2017) [10] argued that the absence of visualization of the vascular conduit by CTHC does not imply non-existence, since the detection capacity depends as much on the characteristics of the conduit as on the quality of the image.

Lateral osteotomy was considered a possibility due to the presence of vascular structures that were not visible, even with a CT scan that did not identify a specific pathway. The anatomical location of the AAA is another important parameter for determining its relationship to the lateral wall of the maxillary sinus.

Of the 194 cases with tomographic identification of the artery, the intraosseous course predominated at 67.5% (n=131), followed by the intrasinusal course at 30.9% (n = 60) and the superficial course at 1.5% (n = 3). These results are similar to those described by Danesh- Sani *et al*. (2017) [10] found a predominance of intraosseous vascular canals in 69.6% of cases, followed by intrasinusal canals in 24.3% and superficial canals in 6.1%. Zhou *et al*. (2023) [12] found frequencies of 60.71%, 38.50%, and 0.79%, respectively. The concordance regarding the predominance of intraosseous vascular canals highlights that the vascular canal may be directly related to the thickness of the wall where the osteotomy is performed, making its identification a relevant consideration for lateral window preparation.

The variability of the arterial course should be considered an influence on surgical access. In the present study, one-third of the identified arteries were located within the sinus, while a superficial course was infrequent. Alqhtani *et al*. (2025) [8] corroborated differences in the distribution of arterial locations between the premolar and molar regions. This indicates that the vessel's location is not necessarily fixed along the entire length of the sinus wall. The identification of an intraosseous or intrasinusal course reveals different relationships between the artery, the lateral bone, and the Schneiderian membrane. Therefore, planned surgery must consider not only the presence of the vessel but also its precise location within the area where the osteotomy will be performed.

The diameter of the AAA is a morphometric property of interest due to the possible relationship between diameter and volume of the artery. In this study, the average diameter was 1.45 mm, with a range of 0.47 to 3.20 mm. This average diameter is larger than that determined by Zhou *et al*. (2023) [12], which was 0.99 mm, and also higher than that of Danesh- Sani *et al*. (2017) [10], which was 1.17 mm. These differences determine that the arterial caliber has variations according to the population and the anatomical region of study.

Obtaining the diameter individually using CTHC provided additional information for identifying vascular structures that would be involved in lateral window preparation. The distance between the AAA and the residual alveolar ridge allows for establishing the vertical position of the vascular pathway relative to the surgical field. In this study, an average distance of 16.82 mm was observed, with extreme values of 6.37 and 32.48 mm.

Alqhtani *et al*. (2025) [8] determined the distance of the arterial course from the alveolar crest and found anatomical variations between premolars and molars, highlighting the relevance of the specific location. Therefore, the variability found in the present study cannot determine the distance between the artery and the residual ridge.

The relationship between the AAA and the maxillary sinus floor provides additional information for understanding the vertical arrangement of the anatomical structures involved in sinus elevation. In this study, the average distance

measured between the artery and the sinus floor was 9.73 mm, greater than the 8.16 mm reported by Danesh- Sani *et al*. (2017) [10] and the 8.00 mm described by Zhou *et al*. (2023) [12].

Although the differences are due to the characteristics of the samples and the anatomical locations evaluated, the results were obtained from all three studies: the artery is located at different elevations relative to the sinus floor. The pre-surgical evaluation aims to identify the relationship between the course of the blood vessel and the projected area of the osteotomy for its subsequent application in maxillary access procedures.

Residual bone height is one of the key variables for recognizing the anatomical characteristics of the edentulous posterior maxilla. In this study, the average residual bone height between the maxillary sinus floor and the residual alveolar ridge was 9.39 ± 3.98 mm, with a range from 0.86 to 28.21 mm.

The authors Kim *et al*. (2021) [3] and Mahardawi *et al*. (2025) [4] were referenced in the theoretical framework and related the modification of the posterior ridge of the jaws to the processes of alveolar ridge resorption and sinus pneumatization, with tooth loss. Consequently, the variability in bone height observed justifies the need to measure the residual ridge of each patient before proposing the characteristics of the approach.

The thickness of the lateral wall of the maxillary sinus represents another anatomical factor that can influence the preparation of the access window. In this study, the mean thickness was 1.69 mm, with a range of 0.60 to 10.33 mm. Danesh- Sani *et al*. (2017) [10] observed that the thickness of this wall varied depending on the anatomical region. The mean thickness was 1.21 mm for the second molar, 1.98 mm for the first molar, 2.02 mm for the second premolar, and 2.16 mm for the first premolar.

The analysis of morphometric associations allows us to understand the anatomical structures of the maxillary sinus and the residual ridge, and how these relationships occur. In the present study, a positive correlation was reported between the distance of the anterior alveolar canal (AAC) to the residual ridge and the distance of the sinus floor to the residual ridge ($\rho = 0.372$; $p = 0.001$). This result means that the measurement corresponding to the first relationship tends to increase along with that of the second relationship, although the strength of the association is low to moderate. This finding is anatomically relevant because both types of measurements can be referenced to the alveolar ridge, so part of the association is explained by the geometry of the structures evaluated.

The location of the artery relative to the sinus floor was associated with the height of the residual alveolar ridge. In the present study, a negative correlation was reported between the distance of the AAA to the sinus floor and the distance from the sinus floor to the residual ridge ($\rho = -0.224$; $p = 0.002$). Zhou *et al*. (2023) [12] reported negative associations between anatomical distances of the artery and the maxillary sinus, although for certain parameters and regions they were not entirely comparable to our study. Therefore, measurements of the spatial relationship of the AAA to the sinus floor and the residual ridge, and the individual interpretation of each distance, are isolated parameters.

The relationship between arterial diameter and lateral bone thickness of the maxilla is relevant to the assessment of surgical access anatomy. The present study found a positive correlation between the variables ($p = 0.291$; $p \leq 0.001$), although the correlation coefficient is weak. Zhou *et al*. (2023) [12] AAA diameter and lateral wall thickness, considering both parameters important in tomographic evaluation. However, the established correlation does not allow us to conclude that a thicker wall determines a larger arterial diameter, nor that there is a causal relationship between these characteristics. The results support the assessment of vascular caliber and lateral bone thickness, along with the other parameters, in lateral window planning.

The absence of statistically significant associations between variables provides information for assessing the anatomy of the posterior maxillary region. In this study, we found no significant correlations between the AAA diameter and the distance from the sinus floor to the residual crest ($p = 0.091$; $p = 0.207$), the distance from the AAA to the residual crest and the lateral wall thickness ($p = 0.102$; $p = 0.157$), and the distance from the AAA to the sinus floor and the lateral wall thickness ($p = -0.098$; $p = 0.174$).

These data indicate that there was insufficient statistical evidence of monotonic correlations for any of the variables in the analyzed sample. The morphometric characteristics studied should be assessed individually and in a complementary manner, without assuming that one measurement will allow for changes in the calculation of the others.

The assessment of anatomical and surgical implications allows for the correlation of tomographic findings with the planning needs for sinus lift surgery via lateral window. In this study, 40.9% of cases were classified as having low surgical involvement, 30.4% as having high surgical involvement, and 28.7% as having moderate surgical involvement, with 59.1% of cases falling simultaneously into the moderate and high categories.

Alshamrani *et al*. (2023) [21] emphasize that, within the preoperative evaluation of sinus lift surgery, it is important to consider the anatomy and possible complications of the procedure, while Danesh- Sani *et al*. (2017) [10] propose variations in the lateral window design when there are adjustments that complicate the procedure. The distribution in this study highlights the ability to integrate tomographic measurements to recognize different levels of anatomical complexity in a single study before surgery.

Similarly, the classification of high, moderate, or low surgical involvement corresponds to a preoperative anatomical assessment, not a clinical outcome. The results should be understood as relevant for surgical planning, without attributing to them the proven ability to predict complications. Furthermore, the results of this study determine how AAA presents variations in tomographic identification, location, diameter, and spatial relationship with the maxillary sinus and the residual alveolar ridge. The similarities and discrepancies found with Danesh- Sani *et al*. (2017) [10], Zhou *et al*. (2023) [12] and Alqhtani *et al*. (2025) [8] are anatomical implications with different populations and surgical sites.

With reference to the objectives set throughout the study, the evaluation by TCHC allowed the characterization of the main morphometric parameters and the evaluation of the associations that were established between the measurements, and provided useful anatomical information for the individualized planning of the maxillary sinus lift by means of a lateral window.

Conclusions

The alveoloantral artery presented variations in its anatomical location, intraosseous course, diameter, and distance with respect to the residual alveolar ridge and the base of the maxillary sinus.

The thickness of the lateral wall of the maxillary sinus and the separation between the sinus base and the residual alveolar ridge showed anatomical variability between posterior and edentulous sectors.

The results determined that bone conditions are not homogeneous and a tomographic study is necessary. Furthermore, relationships were found between the morphometric characteristics of the alveoloantral artery and the anatomical parameters of the maxillary sinus and the residual alveolar ridge. However, these correlations were of low to moderate strength.

The evaluation of anatomical and morphometric characteristics identified different rates of surgical involvement in maxillary sinus lift through the lateral window; the ability of cone beam computed tomography guides the design of the osteotomy and recognizes anatomical conditions in the surgical intervention and the risk of potential vascular injuries.

References

1. Kupka JR, König J, Al-Nawas B, Sagheb K, Schiegnitz E. How far can we go? A 20-year meta-analysis of dental implant survival rates. Clinical Oral Investigations,2024:28(10):541. https://doi.org/10.1007/s00784-024-05929-3
2. Ayran Ş, Özyiğit HA, Karabıyıkoğlu SE, Öztürk HP, Oral N. Morphological assessment of the posterior superior alveolar artery using cone-beam computed tomography. Folia Morphologica,2026:85(0):e01726069. https://doi.org/10.5603/fm.111262
3. Kim S, Lim HC, Kim DH, Herr Y, Chung JH, Shin SI. Factors affecting maxillary sinus pneumatization following posterior maxillary tooth extraction. Journal of Periodontal and Implant Science,2021:51(4):285–295. https://doi.org/10.5051/jpis.2007220361
4. Mahardawi B, Jiaranuchart S, Arunjaroensuk S, Dhanesuan K, Mattheos N, Pimkhaokham A. The clinical benefit of alveolar ridge preservation in the posterior maxilla: A systematic review and meta-analysis. Scientific Reports,2025:15(1):23019. https://doi.org/10.1038/s41598-025-06261-w
5. Yang DH, Lee NV. A simple method of managing the alveolar antral artery during sinus lift surgery. International Journal of Otolaryngology and Head & Neck Surgery,2021:10(3):131–146. https://doi.org/10.4236/ijohns.2021.103014
6. Urechescu H, Pricop M, Cuzic C, Oncescu NG, Pricop A, Streian F. Assessment and localization of the posterior superior alveolar artery in lateral window approach for maxillary sinus floor elevation. BMC Oral Health,2026:26(1):749. https://doi.org/10.1186/s12903-026-08146-4
7. Çevik Sönmez T, Topçuoğlu EC, Akbulut Ö. Cone beam computed tomography assessment of anatomical risk factors in maxillary sinus floor elevation: A cross-sectional study. Türkiye Klinikleri Journal of Dental Sciences,2024:30(3):370–378. https://doi.org/10.5336/dentalsci.2024-102207
8. Alqhtani A, Alhaidan AY, Aloufi AJ, Alharbi FS, Alkahtani LM, Alamri RH, *et al*. CBCT-based retrospective analysis of posterior superior alveolar artery anatomy in a Saudi population. Diagnostics,2025:15(23):2999. https://doi.org/10.3390/diagnostics15232999
9. Gładysz T, Kruczała Z, Bąk F, Ochwat K. The role of the antral alveolar artery in oral and maxillofacial surgery: A comprehensive review. Translational Research in Anatomy,2024:36:100309. https://doi.org/10.1016/j.tria.2024.100309
10. Danesh-Sani SA, Movahed A, ElChaar ES, Chong Chan K, Amintavakoli N. Radiographic evaluation of maxillary sinus lateral wall and posterior superior alveolar artery anatomy: A cone-beam computed tomographic study. Clinical Implant Dentistry and Related Research,2017:19(1):151–160. https://doi.org/10.1111/cid.12426
11. Wang Z, Hou X, Liu Q, Shangguan Y, Zhou H. Construction of the risk prediction model of the alveolar antral artery as the intrasinusoidal type at the point of UL6. Scientific Reports,2025:15:17529. https://doi.org/10.1038/s41598-025-01475-4
12. Zhou Q, Qiao F, Zhu D. The radiological evaluation of the anatomy of the antral alveolar artery and the lateral wall thickness using cone-beam computed tomography: A retrospective study. Current Medical Imaging,2023:20:e060323214356. https://doi.org/10.2174/1573405619666230306093633
13. Turkoglu A, Ayyildiz H. Relationship between the diameters of sphenopalatine foramen and alveolar antral artery and maxillary sinus volume: A retrospective cone beam computed tomography study. BMC Oral Health,2025:25:1356. https://doi.org/10.1186/s12903-025-06730-8
14. Yeung AWK, Hung KF, Li DTS, Leung YY. The use of CBCT in evaluating the health and pathology of the maxillary sinus. Diagnostics,2022:12(11):2819. https://doi.org/10.3390/diagnostics12112819
15. Godil AZ, Devadiga TJ, Supnekar SC, Kazi AI, Wadwan SA, Dugal R. Position of posterior superior alveolar artery in relation to the maxillary sinus using cone beam computed tomography in India sub-population. Journal of Oral Medicine and Oral Surgery,2021:27(3):34. https://doi.org/10.1051/mbcb/2021007
16. Altayar BA, Al-Tayar B, Lin W, Al-Wesabi SN, Al-Shujaa EA, Sakran K, *et al*. Cone beam computed tomographic analysis of maxillary sinus septa among Yemeni population: A cross-sectional study. BMC Oral Health,2023:23(1):466. https://doi.org/10.1186/s12903-023-03124-6
17. Gulec M, Icen V, Ozmen EE. Evaluation of maxillary sinus pathologies and the posterior superior alveolar artery canal using cone-beam computed tomography. BMC Oral Health,2025:25(1):70. https://doi.org/10.1186/s12903-025-05452-1
18. Hosseinzadeh M, Alehossein S, Norouzi H, Safi Y. Extremely rare bilateral variation of the posterior superior alveolar artery on the maxillary sinus floor observed using CBCT: A case report. Radiology Case Reports,2025:20(6):2891–2894. https://doi.org/10.1016/j.radcr.2025.02.076
19. Tassoker M. Cone beam CT evaluation of maxillary sinus and posterior superior alveolar artery. Selcuk Dental Journal,2022:9(1):191–199. https://doi.org/10.15311/selcukdentj.846996
20. Misăiloaie A, Tărăboanță I, Budacu CC, Sava A. Preoperative cone beam computed tomography assessment of maxillary sinus variations in dental

implant patients. Diagnostics,2024:14(17):1929. https://doi.org/10.3390/diagnostics14171929
21. Alshamrani AM, Mubarki M, Alsager AS, Alsharif HK, AlHumaidan SA, Al-Omar A. Maxillary sinus lift procedures: An overview of current techniques, presurgical evaluation, and complications. Cureus,2023:15(11):e49553. https://doi.org/10.7759/cureus.49553