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Posterior superior alveolar artery thickness and intraoperative bleeding in maxillary sinus floor augmentation procedures

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Abstract

Aim: This study aimed to investigate the relationship between the thickness of the posterior superior alveolar artery (PSAA) and the intraoperative bleeding volume during maxillary sinus floor augmentation (MSFA) procedures.

Materials and Methods: This was a prospective observational study involving 24 consecutive participants who underwent MSFA at a university hospital in Turkey. The thickness of the PSAA was assessed using cone beam computed tomography (CBCT). Intraoperative data were collected to measure bleeding volume. The statistical analysis included Spearman correlation analysis to determine the relationship between PSAA thickness and bleeding volume.

Results: The present study revealed no significant correlation between the thickness of the PSAA and the volume of intraoperative bleeding. The mean PSAA thickness was 1.36 mm (SD: 0.40 mm), and the widest canal diameter was 2.40 mm. Univariate analysis revealed no significant associations between PSAA diameter and the assessed factors, with β values ranging from -10.510 to 6.814 and p values all above 0.2.

Conclusion: These findings suggest that the thickness of the PSAA, as determined by CBCT, may not be a predictive factor for intraoperative bleeding during MSFA procedures. This study contributes to the understanding of surgical risk management in MSFA patients and supports the continued use of CBCT for preoperative assessment.

Introduction

The maxillary sinus floor augmentation (MSFA) operation is a widely used technique for the rehabilitation of partially and totally edentulous maxilla [1]. Initially, reported in 1980 by Boyne and James [2] as the lateral window technique and later published by Tatum [3] in 1986 as a sinus surgery technique, it has become a commonly practiced and reliable oral surgical procedure today [4]. However, like any surgical intervention, this procedure is associated with various complications that can jeopardize the outcome of the surgery and the success of the treatment applied [5]. Complications associated with MSFA can occur intraoperatively during sinus floor elevation or postoperatively. Membrane perforation is the most common complication during MSFA, occurring in more than 19.5% of patients, followed by intraoperative bleeding during antrostomy [6]. In their latest systematic review, Stacchi et al. [7] reported that sinus membrane perforation and intraoperative bleeding are intraoperative complications that were reported by 21 randomized and 11 prospective clinical studies and occurred at rates of 15.7% and 0.4%, respectively.

The arterial blood supply of the maxillary sinus is provided by branches of the maxillary artery, namely, the greater palatine, infraorbital, and PSAA. Typically, the PSAA and inferior alveolar artery form anastomoses both inside and outside the bone in the lateral antral wall, nourishing the Schneiderian membrane and epiperiosteal vestibular tissues. According to the literature, while intraosseous anastomosis is common, extraosseous anastomosis occurs in approximately 44% of cases [8, 9]. Intraosseous anastomosis, also known as the alveolar antral artery, is particularly important. Damage to any of the arteries supplying the maxillary sinus during window osteotomy can potentially cause bleeding during sinus lifting procedures [10]. Although bleeding during MSFA is not life-threatening, it can obstruct clear visibility of the surgical field and potentially distract the surgeon, especially depending on their experience [11]. The rarity of significant bleeding during oral surgery can make this situation challenging or even necessitate postponing the operation [12]. Intraoperative bleeding not only reduces visibility and hampers surgi-

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cal procedures but also increases the risk of postoperative hematoma, subsequent infection, and complete loss of the graft [13]. It is believed that the larger the diameter of the artery is, the greater the risk of intraoperative bleeding [7, 14]. A diameter of the intraosseous canal larger than 2 mm is considered to indicate a greater likelihood of bleeding [15].

Numerous radiological studies have evaluated the anatomy of the canal surrounding the artery across different populations using various imaging techniques [9, 16, 17]. However, the number of studies addressing the clinical significance of arterial thickness remains limited [18]. The primary objective of this study was to investigate the relationship between the diameter of the canal and intraoperative bleeding in participants who underwent MSFA at a research university hospital in Turkey. The null hypothesis of this study is that there is no significant relationship between canal diameter and intraoperative bleeding in these surgical cases.

Materials and Methods

This prospective observational study was conducted after receiving approval from the Marmara University School of Medicine Clinical Research Ethics Committee (IRB Approval No: 06.01.2023.168). The study protocol was registered on clinicaltrials.gov (ID: NCT05710497) before the first patient was enrolled. Written and verbal informed consent was obtained from all patients who agreed to participate. All phases of this study were conducted in accordance with the Declaration of Helsinki of the World Medical Association. The STROBE guidelines were used for reporting the results.

Sample size calculation

The sample size needed for this study was calculated using G*Power software (version 3.1; Dusseldorf, Germany). Based on an anticipated effect size ($|\rho| = 0.54$), which corresponds to a coefficient of determination (r2) of approximately 0.30, an alpha level of 0.05, and a power of 0.80, a total sample size of 21 was initially determined to be necessary to achieve sufficient statistical power. The r^2 value of 0.30 was chosen based on theoretical considerations, reflecting an anticipated moderate to strong relationship between the PSAA diameter and intraoperative bleeding, despite the absence of prior studies to support this estimate. Considering a potential drop-out, the final sample size was increased to approximately 24 to ensure adequate power. The initial calculation indicated that a total sample size of 21 subjects would be necessary. To account for potential drop-outs and ensure adequate statistical power, the final sample size was increased to 24.

Participants and study design

Between March 2023 and November 2023, consecutive patients who presented with posterior maxillary tooth loss and underwent MSFA using the lateral window technique at a research university hospital in Turkey were invited to participate in the study. The inclusion criteria were individuals aged 18-65 years with unilateral or bilateral posterior edentulous maxilla, no history of sinus surgery or bone grafting in the posterior maxilla, and high-quality, artifact-free CBCT scans. Candidates also had to have sufficient bone width for standard dental implants despite insufficient bone height. The exclusion criteria included smoking more than 10 cigarettes per day, inability to identify PSAA on images, presence of pathology or foreign bodies in the maxillary sinuses, and complete edentulism. Medically, patients with American Society of Anesthesiology status III or higher, cognitive decline, conditions or medications affecting bleeding, poorly controlled diabetes (glycated hemoglobin $\geq$6.5%), or the use of antiresorptive or antiangiogenic medication were excluded.

Predictor variables

Predictor variables, including age (continuous variable), sex (male, female), smoking status (nonsmoker, light smoker), comorbidity (absent, present), absence of local anesthesia (one or two), sinus perforation (absent, present), simultaneous implant placement (absent, present), and the side of the patient (right or left), were recorded as covariates.

PSAA diameter

Training on the use of software and the interpretation of cone beam computed tomography (CBCT) scans was provided in several sessions (led by FB). All the images were reviewed, and the measurements were carried out by a single examiner (SNY). To measure the artery diameter, an estimated window was first planned for tomography. The maximum thickness of the artery within this window area was recorded as the arterial thickness. The artery diameter was assessed using a digital caliper tool, with evaluations made using coronal section scans. All the images were analyzed for the presence or absence of the PSAA canal along the lateral wall of the maxillary sinus, as well as for its diameter. The diameter of the PSAA canal (measured as the largest diameter of the PSAA) and its distance from the lower boundary were measured. The diameter of the canal was recorded as the greatest distance between the inner cortical boundaries. Since the artery could be observed in multiple regions, the largest value between the most posterior and anterior positions of the canal was recorded as the canal's diameter.

In acquiring patient images, the Planmeca Promax 3D Mid device (Planmeca Oy, Helsinki, Finland) was utilized, employing CBCT in the Planmeca Romexis software (Planmeca Oy). This mode encompassed both the maxilla and mandible (90 kV, 12 mA, 36 seconds of exposure). Imaging was conducted with a single 360-degree rotation around the patient's head while the patient was standing. During the process of obtaining X-ray images, the sagittal and vertical planes were aligned perpendicular to the ground, while the orbitomeatal plane was positioned parallel to the ground. Images of the maxilla and mandible were generated through two consecutive radiations in a field of view (FOV) area of 16x9 cm^2 and were compiled using the Romexis 3.83 software program (Planmeca Oy, Helsinki, Finland). The voxel size of the obtained images was set at 0.40 mm^3, with a slice thickness of 0.40 mm.

In this study, 20 randomly selected samples, determined through numbers generated in Excel, were used to assess the intrarater and interrater reliability of radiologically measured arterial thicknesses using the intraclass correlation coefficient (ICC). The intrarater reliability was analyzed based on measurements made by the same observer at two-week intervals utilizing a two-way mixed effects model. Similarly, interrater reliability was evaluated based on measurements taken by different observers via the same two-way mixed effects model. For the ICC calculations, IBM SPSS Statistics for Mac, Version 29.0.1.0 (IBM Corp., Armonk, NY, USA) software was used.

All surgeries in this study were performed by the same surgeon with more than three years of experience in implantology under local anesthesia (Maxicaine Fort, Vem Drug, Ankara, Turkey). Access to the surgical site was achieved through a combination of one mesial and one distal vertical incision, along with a crestal incision. Subsequently, a trapdoor osteotomy (window) measuring 10-15 mm in length (mesiodistally) and 8-10 mm in height (apicocoronally) was created on the lateral wall using piezosurgery or a bur to access the Schneiderian membrane and sinus cavity [19].

The membrane was carefully dissected with hand tools and elevated apically, with special attention given to maintaining its integrity. In patients with sufficient basal alveolar bone for stable implant placement, the implants were placed into the sinus cavity following a standard protocol, with the apical end protected by the intact sinus membrane. When adequate basal bone for primary stability of the implant was lacking, a two-stage technique was employed, with dental implants placed after complete bone regeneration. The space created by elevating the membrane inside the sinus was filled with bone replacement graft material, and the flaps were closed using 3.0 or 4.0 vicryl polyglactin resorbable sutures (Ethicon, Inc., Somerville, NJ, USA).

Postoperative instructions

Patients were instructed to use NSAIDs (Apranax, Abdi İbrahim, Istanbul, Turkey) as pain relievers as needed and a combination of 1000 mg amoxicillin with 250 mg clavulanate (Augmentin, GlaxoSmithKline, Brentford, UK) as an antibiotic to manage discomfort and prevent infection post surgery. Dietary advice included a cold liquid diet for the first four days, transitioning to soft foods until the sutures were removed. The use of 0.2% chlorhexidine mouthwash (Kloroben, Drogsan Drugs, Ankara, Turkiye) was also recommended twice daily for ten days.

Follow-up period

Suture removal was scheduled between 14 and 21 days after surgery, and patients were instructed to refrain from using any removable prosthesis in the operated area for six weeks to prevent trauma and promote effective healing. Postoperative complications, such as major hematoma or edema, were monitored through self-reported data from the participants.

Bleeding volume

The primary outcome measure of the study was intraoperative bleeding. To measure the volume of bleeding during the procedure, measurements were taken from two routinely used aspirators. The initial measurement of the bleeding volume included blood loss from the mucosal incision until closure of the wound, which was conducted immediately after completion of the surgery. The bleeding volume was calculated by subtracting the volume of saline used during the operation from the total fluid accumulated in the aspirator. A second aspirator was utilized to aspirate saliva accumulating in the surgical area. In patients who underwent simultaneous implant placement, bleeding occurring after the initiation of implant surgery was separately recorded and subtracted from the total bleeding volume. This volume was calculated as the total bleeding volume (V1) minus the bleeding volume during implant surgery (V2).

Statistical analysis

Each sinus lifting operation was considered a separate statistical unit in the study. All statistical analyses, except those involving the intraclass correlation coefficient (ICC), were conducted using Prism software (version 10.0, Graphpad, CA, USA). ICC analyses were performed using SPSS software (version 29.0, IBM Corp., NY, USA). Descriptive statistics are presented as 'n' and percentages for categorical variables and as the mean or median $\pm$ SD and min–max for continuous variables. The normality of the data was assessed using the Shapiro-Wilk test. The Spearman correlation test was used to evaluate the correlation between the PSAA diameter and intraoperative bleeding volume. Univariate and multivariate linear regression analyses were performed to identify factors influencing intraoperative bleeding volume. A p-value of <0.05 was considered to indicate statistical significance.

Results

Twenty-seven patients were screened for the study, but 4 patients (14.29%) were excluded because PSAA could not be detected. In the study of 24 participants, the mean age was 48.83 ± 10.56 years (95% CI: 44.38 to 53.29). Overall, 15 participants (62.5%) were male, and 9 (37.5%) were female. Regarding smoking status, 19 participants (79.17%) were nonsmokers, and 5 (20.83%) were light smokers. Comorbidities were present in 7 participants (29.17%). For intraoperative local anesthesia (L.A.) usage, 15 participants (62.5%) received one L.A., and 9 (37.5%) received two. Sinus perforation was observed in only 1 participant (4.17%). Simultaneous implant placement occurred in 10 patients (41.67%), and the majority of the procedures, 13 (54.17%), were performed on the left side. The PSAA diameter was less than 2 mm in 23 participants (95.83%) (Table 1).

The intrarater reliability analysis revealed that the ICC for a single measurement was 0.596 (95% confidence interval: 0.217-0.818, $F(19, 19) = 3.85$, $p = .003$), indicating a moderate level of reliability. For average measurements, the ICC increased to 0.747 (95% confidence interval: 0.357-0.9, $F(19, 19) = 3.85$, $p = .003$), suggesting a higher reliability level. According to the interrater reliability analysis, the ICC for a single measurement was 0.739 (95% confidence interval: 0.452-0.888, $F(19, 19) = 6.500$, $p < .001$), indicating a high level of reliability. The ICC for average

Table 1. Sociodemographic and clinical characteristics of the participants (n=24).

Variables	N (%)	Mean (SD)	95% CI
Age		48.83±10.56	44.38 – 53.29
Sex			
Male	15 (62.5)		
Female	9 (37.5)		
Smoking status			
Non-smoker	19 (79.17)		
Light-smoker	5 (20.83)		
Comorbidity			
Absent	17 (70.83)		
Present	7 (29.17)		
No of L.A.			
One	15 (62.5)		
Two	9 (37.5)		
Sinus perforation			
Absent	23 (95.83)		
Present	1 (4.17)		
Simultaneous implant			
Absent	14 (58.33)		
Present	10 (41.67)		
Side			
Right	11 (45.83)		
Left	13 (54.17)		
PSAA diameter			
< 2 mm	23 (95.83)		
>2 mm	1 (4.17)		

Min: Minimum; Max: Maximum; L.A.: Local Anesthetic; PSAA: Posterior Superior Alveolar Artery.

measurements was even greater at 0.850 (95% confidence interval: 0.622-0.94, $F(19, 19) = 6.5$, $p < .001$), reflecting an even greater level of reliability.

Based on our findings, the mean diameter of the PSAA was 1.36 mm, with a standard deviation (SD) of 0.4 mm, ranging from a minimum of 0.82 mm to a maximum of 2.4 mm. Additionally, the mean volume of bleeding measured during the procedures was 24.88 mm^3, with a standard deviation of 19.75 mm^3.

The correlation coefficient (r) was found to be -0.27, suggesting a weak inverse relationship between the PSAA diameter and bleeding volume. However, this correlation was not statistically significant, as indicated by a p value of 0.22 (Table 2).

Bleeding

In our study, one patient experienced significant bleeding, which was successfully managed using a tampon soaked in tranexamic acid. Notably, no membrane perforation was observed in this patient, and the operation was completed without any complications. Additionally, based on self-reported data collected from participants, no significant complications were reported in any of the patients.

Table 2. Correlations between the PSAA diameter and bleeding volume.

Variables		PSAA diameter
Bleeding volume (continuous)	r*	-0.270
	p	0.220

PSAA: Posterior Superior Alveolar Artery; *:Spearman test.

Table 3. Univariate analysis of factors influencing intraoperative bleeding.

Values	Univariate		Multivariate	
	β (%95 CI)	p	β (%95 CI)	p
Sex (female)	-2.111 (-19.75 – 15.53)	0.806*	-	-
Age (continuous)	-0.051 (-0.777 – 0.878)	0.900*	-	-
Smoking Status (light smoker)	-5.400 (-26.320 – 15.520)	0.598*	-	-
Comorbidity (present)	-6.076 (-24.690 – 12.540)	0.506*	-	-
No of L.A. (one)	-10.510 (-27.550 – 6.528)	0.214*	-	-
Sinus perforation (present)	-7.174 (-49.840 – 35.500)	0.731*	-	-
Simultaneous implant (present)	6.814 (-10.260 – 23.890)	0.417*	-	-
Side (left)	3.294 (-13.800 – 20.390)	0.693*	-	-
PSAA diameter (continuous)	-8.614 (-30.030 – 12.800)	0.413*	-	-

CI: Confidence Interval; * Multiple linear regression analysis.

Univariate analysis of the PSAA diameter did not reveal any statistically significant differences according to various factors, including sex, age, smoking status, comorbidity, the number of local anesthetics used, sinus perforation, simultaneous implant placement, or surgical site (Table 3). Due to the lack of significant findings in the univariate analysis, a multivariate analysis was not conducted.

Discussion

Clinicians often encounter bleeding as a frequent and potentially outcome-compromising complication during open sinus lifting operations, second only to membrane perforation [20]. Bleeding complications during MSFA procedures are commonly mentioned but appear to be of lesser significance in real-world scenarios and in the current literature, as noted in this systematic review [21]. This study, conducted at a research university hospital in Turkey, is the first to evaluate the relationship between PSAA measurements via CBCT and intraoperative bleeding. These findings emphasize the importance of careful preoperative radiographic and surgical planning. Although our results do not reject our null hypothesis and reveal no correlation between PSAA anatomy and intraoperative bleeding, this does not diminish the importance of meticulous planning or a careful surgical approach.

There have been varying reports on the clinical identification of canals containing the PSAA compared to its use in imaging studies. While cadaver studies have reported a 100% prevalence of PSAA, the frequency of visualization of the PSAA canal in imaging studies varies widely, ranging from 35.0% to 99.4% [9, 22-24]. The reasons for this variation could be attributed to factors such as the technical characteristics of the methods, differences in canal anatomy across ethnic origins, the expertise levels of radiologists, and the advanced imaging capabilities of digital technologies [9, 22-24]. In the Turkish population, where this clinical study was conducted, the canal was identified in 89.3% of patients [16]. Our results also indicate that the canal was affected in 85.71% of patients screened for the MSFA procedure in our study.

Anatomical details are more distinctly visualized with CBCT than with traditional computed tomography (CT). CBCT is highly recommended for the diagnosis and analysis of hard tissues in the maxillofacial region [25]. In patients requiring sinus augmentation before dental implant placement, CBCT should be considered [26, 27]. Compared to standard CT, CBCT allows more accurate and reliable measurements in dental and maxillofacial imaging with a lower radiation dose [28]. PSAA is more easily detected via CBCT than via CT [11]. Utilizing CBCT to evaluate the PSAA prior to MSFA surgeries assists clinicians in taking precautions against bleeding while preparing the bone window and elevating the sinus membrane [29, 30].

The diameter of the PSAA has been widely discussed in the literature on CBCT. According to recent systematic review results by Alves et al. [11], the average diameter of the anastomosis varies between 1.0 and 1.52 mm. Their meta-analysis revealed that the majority of arteries have a diameter between 1.0 and 1.9 mm, followed by those with a diameter less than 0.9 mm and that only approximately 4.0% of the arteries have a diameter greater than 2 mm. Our CBCT measurements yielded the following results: mean diameter of the PSAA: 1.36 mm (SD: 0.40 mm; min: 0.82 mm; max: 2.40 mm). The variations in diameter measurements could be attributed to racial differences. Compared with studies conducted in the Turkish population, our results align with those from larger radiological studies. Güncü et al. [17] reported an average artery diameter of 1.30 mm (SD=0.50), while İlgüy et al. [16] reported an average artery diameter of 0.94 mm (SD=0.26).

Cases with a canal diameter greater than 2 mm are limited. Canal diameters were less than 1 mm in 55.8% of the patients, between 1 and 2 mm in 40.2%, and more than 2 mm in 4.0%, with diameters ranging from 0.3 to 2.6 mm and an average diameter of 1.0±0.5 mm [31]. Shams et al. [32] reported an average canal cross-sectional diameter of 0.83 ± 0.33 mm (95% CI 0.81-0.85, min 0.2 mm, max 2.5 mm). Studies by Duruel et al. [33] did not observe any patients with a PSAA of 2 mm or larger. In our sample, one participant (4.17%) exhibited an artery thickness greater than 2 mm.

In the context of PSAA localization, a significant pattern has been observed in various studies. According to Tofangchiha et al. [20], the PSAA was found to be intraosseous in 63.6% of patients, intrasinusoidal in 28.9%, and extraosseous in 7.5%. These findings are in line with the observations of other researchers, including Danesh-Sani et al. [34], Ilgüy et al. [16], Güncü et al. [17], and Chitsazi et al. [22], all of whom noted similar trends in arterial localization.

During preparation of the bone window in sinus lifting procedures, bleeding is the second most common complication following disruption of sinus membrane integrity [35]. The probability of intraoperative bleeding during MSFA has been reported to be 0.4% [7]. Bleeding can lead to several complications, such as perforation of the sinus membrane, reduced blood flow, bone necrosis, displacement of the graft, decreased visibility in the surgical field, prolonged surgery duration, or even postponement of the operation [12, 35]. Postoperative bleeding can adversely affect the stability of the grafted material, potentially leading to inadequate nourishment of the grafted area [36]. Some authors speculate that the risk of bleeding increases to 57% when the sinus artery diameter is greater than 0.5 mm; however, this has not been confirmed by clinical studies, to the best of the authors' knowledge [36]. Our study measured an average artery diameter of 1.36 mm (SD=0.4), and no significant correlation was found between increased artery diameter and bleeding volume. It is important to note that artery diameter alone is not the sole factor influencing bleeding; various individual factors may also impact it. The rationale behind this thought is that the artery diameter might increase beyond a certain point. We hypothesize that variations between 1 and 2 mm in diameter may not have a substantial impact on bleeding.

A comprehensive approach based on the surgical protocol is recommended for managing intraoperative bleeding during MSFA [37]. This includes identifying the location of the PSAA using general markers and observing both the presence and specificity of the PSAA (canal) on CBCT images, such as its position and diameter. Being prepared for potential bleeding from the PSAA is crucial.

The use of CBCT preoperatively is advised to prevent surgical complications and ensure optimal treatment planning by determining significant anatomical landmarks and their characteristics [22, 34, 38]. The necessary precautions depend on the PSAA location. If it is superficially present under buccal soft tissues, careful separation from the bone and reflection without damaging the buccal flap is possible. Conversely, when located intraosseously, modifying the size and location of the buccal wall osteotomy is recommended to avoid artery perforation. For a completely intraosseous PSAA, a double window technique, which involves isolation using traditional rotary burs after detection, is suggested [35]. Another approach for entirely intraosseous cases involves selectively cutting the bone around the artery using piezosurgery, leaving the artery intact for bone window isolation. Finally, if the patient is attached to the Schneiderian membrane inside the sinus, the clinician can either separate and reflect the artery with the sinus membrane carefully or adapt the buccal window to an area without the artery [10].

For dental practitioners handling cases involving the PSAA, one reassuring aspect is that identifying the point of bleeding is generally easier than identifying the point of bleeding with soft tissue bleeding, such as that originating from the floor of the oral cavity [37]. Several techniques for managing severe intraoperative bleeding, such as clamping the vessel if accessible with an instrument, occluding the canal opening using a fine particulate bone graft, utilizing an electrocautery device or endoscopic ligation, or obstructing the canal opening with a tampon soaked in tranexamic acid or bone wax, have been described [39]. A case report described massive bleeding following a dental implant in the sinus, which was thought to be linked to the PSAA, where bleeding was controlled through maxillary sinus osteoplasty and bipolar coagulation [40]. However, using an electrocautery device poses a risk of perforating the sinus membrane in bleeding situations. A robust foundation in basic surgical sciences and the ability to manage various complications are the best preventive measures to avoid potentially serious complications. Profound knowledge of regional anatomy is also imperative [12]. In our study, the single significant bleeding event encountered was managed with a tampon soaked in tranexamic acid. However, other options should always be readily available to the surgeon and included in the patient's preoperative briefing and consent process.

Limitations

In our study, we focused not on the artery itself but on the thickness of the canal observed in radiographic images. The widest canal diameter measured in our sample was 2.40 mm. Therefore, our results do not provide insights into cases in which the arterial thickness is greater than this thickness. Importantly, our study was not an evaluation of long-term healing; rather, it concentrated on the short-term relationship between arterial anatomy and the volume of intraoperative bleeding. However, since our findings did not assess wound healing, we recommend continuing to preserve the artery in every possible scenario. This approach underscores the importance of caution and precision in surgical practices, especially when dealing with complex anatomical structures.

One of the strengths of this study is its focus on evaluating the CBCT images of patients who underwent sinus lifting operations, allowing direct comparisons with clinical scenarios. The prospective study design involved the collection of detailed data to assess intraoperative bleeding and helped in mitigating information bias. This approach enhances the reliability of the findings by ensuring that the data collected are closely aligned with the actual clinical experiences, thereby providing valuable insights into the real-world implications of arterial anatomy in sinus lifting procedures.

Conclusion

In this observational study conducted in a cohort of 24 consecutive participants at a university hospital in Turkey, we observed no correlation between the thickness of the PSAA and the volume of intraoperative bleeding. According to the results of this study, MSFA is a safe procedure when conducted with careful planning and surgical procedures, as guided by CBCT. The advent of CBCT scanning technology, which is now routinely available for surgical use, represents a significant advancement. This cutting-edge technique aids surgeons in preoperatively assessing critical anatomical structures in three dimensions, contributing to the prediction and prevention of serious complications. In cases where unexpected intraoperative vascular complications are encountered, a solid foundation in basic surgical sciences and the ability to manage various complications are the best preventive measures to avoid potentially serious complications. These findings underscore the importance of integrating advanced imaging techniques into surgical planning and emphasize the need for surgical expertise in managing complex procedures.

Ethical approval

This prospective observational study was conducted after receiving approval from the Marmara University School of Medicine Clinical Research Ethics Committee (IRB Approval No: 06.01.2023.168).

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