IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

CBCT Assessment Of Posterior Superior Alveolar Artery Position Across Dentition Types

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ABSTRACT

Background:

The posterior superior alveolar artery (PSAA), a vital branch of the maxillary artery, supplies the lateral maxillary sinus wall and posterior maxilla. Anatomical variations in the PSAA are clinically significant, particularly during sinus lift procedures, implant placement, and maxillofacial surgeries, where inadvertent arterial injury may lead to hemorrhage and compromised surgical outcomes. Cone-beam computed tomography (CBCT) provides accurate three-dimensional visualization of maxillary sinus anatomy and is the preferred modality for pre-surgical planning. Understanding the PSAA's position relative to the sinus floor and alveolar crest in different dentition states is essential for improving surgical safety.

Aim:

To assess the anatomical location and distances of the intraosseous PSAA from the floor of the maxillary sinus and the alveolar crest in dentulous and partially edentulous patients, and to evaluate variations based on gender using CBCT.

Materials and Methods:

A cross-sectional retrospective analysis of 188 CBCT scans of patients aged 18–75 years was conducted. Scans were divided into two groups: dentulous (n = 94) and partially edentulous (n = 94). The PSAA was identified on coronal and sagittal CBCT sections, and linear measurements were made from its inferior border to (1) the maxillary sinus floor and (2) the alveolar crest in the first or second molar region. Scans with artifacts, pathology, impacted teeth, or prior surgical changes were excluded. Data were analyzed using SPSS version 22.0, with a significance level of $p \leq 0.05$.

Results:

The mean distance of the PSAA to the sinus floor was 9.98 mm in dentulous patients and 9.67 mm in partially edentulous patients, showing no statistically significant difference ($p = 0.450$).

The mean distance of the PSAA to the alveolar crest was 17.53 mm in dentulous patients and 15.51 mm in partially edentulous patients, indicating a statistically significant reduction in partially edentulous individuals ($p = 0.001$).

Gender analysis revealed:

- Dentulous group: No significant gender differences for PSAA distance to the sinus floor or alveolar crest ($p > 0.05$).
- Partially edentulous group: A significant gender difference was found in PSAA distance to the sinus floor (greater in males; $p = 0.022$), while the distance to the alveolar crest showed no significant difference ($p = 0.143$).

Conclusion:

The PSAA's position relative to the sinus floor remains comparable between dentulous and partially edentulous patients; however, its distance to the alveolar crest is significantly reduced in partially edentulous individuals due to post-extraction alveolar bone resorption. Gender differences are minimal but become significant in partially edentulous patients regarding sinus floor measurements. CBCT provides high accuracy for PSAA localization and plays an essential role in pre-operative planning for implant placement and sinus augmentation procedures. This study offers valuable baseline data to enhance surgical safety and minimize vascular complications in the posterior maxilla.

KEYWORD : PSAA, sinus floor, alveolar crest, dentition status, CBCT

Introduction

The maxillary sinus is a paired, air-filled cavity within the maxilla. Age-related bone resorption and sinus pneumatization reduce posterior maxillary bone height and quality, creating challenges for implant placement. Anatomically, the adult maxillary sinus is pyramid-shaped, extending from the lateral nasal wall to the maxillary process.

Its vascular supply arises mainly from the maxillary artery, specifically the posterior superior alveolar artery (PSAA) and the infraorbital artery (IOA), which supply the lateral sinus wall and Schneiderian membrane. The PSAA travels through foramina in the lateral/posterior sinus wall and is accompanied by the posterior superior alveolar nerve (PSAN), which innervates posterior maxillary teeth and gingiva. The PSAA shows variations in its course—straight type (78%) and U-shaped type (22%)—with diameters ranging 2–2.7 mm. Anatomical variability is influenced by age, sex, dentition status, and degree of sinus pneumatization.

In sinus elevation procedures, intraoperative complications—particularly hemorrhage (11–56%) and membrane perforation—are often linked to injury of the PSAA. Identifying intraosseous anastomoses is crucial when placing implants, especially in severely atrophic ridges where the residual bone height is limited. The two common sinus augmentation techniques are:

- Crestal approach
- Lateral window approach (Tatum; Boyne & James), preferred in cases of minimal alveolar height but with risk of PSAA-related bleeding.

The PSAA is also at risk during Caldwell-Luc surgery, Le Fort I osteotomy, open sinus lift, and maxillary fracture management. Larger arterial diameters increase bleeding potential and may compromise graft stability due to poor postoperative vascular support.

Radiographic assessment is essential before surgery. AAOMR recommends panoramic radiography as an initial tool, but it lacks detail due to superimposition. Studies assessing PSAA location use:

1. CBCT (most accurate, 60–87% detection rate),
2. Conventional CT,
3. Cadaveric dissection.

CBCT is considered the gold standard for maxillary sinus pre-surgical planning because it provides 3D visualization of the sinus anatomy, PSAA canal, bone quality, and associated pathoses. Software-based 3D planning enhances accuracy and surgical safety.

Purpose of the Study

To evaluate the anatomical position, course, and dimensions of the posterior superior alveolar artery (PSAA) in relation to surrounding structures in dentulous and partially edentulous patients. Understanding PSAA anatomy is essential to prevent surgical bleeding complications during procedures such as sinus lifting and implant placement in the posterior maxilla, where the artery is vulnerable to injury. Limited existing research highlights the need for precise assessment of PSAA location to enhance surgical safety and outcomes.

Material and methods

The present cross-sectional study with selected CBCT scans meeting the inclusion and exclusion criteria were analysed. The study was conducted in the Department of Oral Medicine and Radiology in our dental institution after obtaining the approval from institutional ethical committee.

The study was conducted on CBCT scans of patients to evaluate posterior superior alveolar artery and relation of level of alveolar crest and maxillary sinus for selected teeth region in the posterior maxilla and their association with gender. The CBCT scans of patients between the age group of 18-75 years of either gender; both dentulous and edentulous, fulfilling the inclusion and exclusion criteria were included in the study. The study was performed by using simple randomized sampling technique.

I) Sample size

The study included 188 CBCT scans of both gender patient ranging from 18-75 years and was divided into two main groups:

Group 1: CBCT Scan of Dentulous patients (n=94)

Group 2: CBCT Scan of Partially Edentulous patients (n=94)

II) Sample selection

Inclusion criteria-

- CBCT scan of patients in the age group of 18-75 years
- CBCT scans showing adequate part of posterior maxilla with presence of maxillary posterior teeth
- CBCT scans showing adequate part of maxilla with missing 1st and/or 2nd molars

Exclusion criteria-

- CBCT scans with low image quality, radiographic artifact, partial image.
- CBCT scans with impacted teeth in the area of interest.
- CBCT scans with bony pathology in the region of interest and cysts, tumour, mucosal thickening, malignancy, developmental defects, inflammatory, infectious diseases, periodontal pathology etc.
- CBCT scans showing radiographic evidence of trauma and surgery in area of interest.

METHODOLOGY

- The present study retrospectively analysed 188 CBCT scans of patients who were referred for various other purposes for viewing the maxillary arch and were selected from the Department of Oral Medicine and Radiology
- The images were evaluated in a darkened, quiet room and image contrast and brightness was adjusted to ensure optimal visualization.

- The location of intraosseous PSSA on the lateral wall of the maxillary sinus was evaluated on coronal section where it first appeared from mesiobuccal root or crown of the maxillary first molar (anterior margin) to distal surface of the maxillary second molar (posterior margin) **Fig a.**
- The location of a tooth in the edentulous area was confirmed by using the adjacent teeth or contralateral tooth as a guideline.
- The position of PSAA marked on the coronal section of CBCT was confirmed on the sagittal sections **fig b.**
- A horizontal line was then drawn at the greatest depth of the Maxillary Sinus floor.
- Another horizontal line was then drawn to the most prominent and inferior point on the alveolar crest in first molar or second molar region.
- Both the horizontal line was parallel to each other
- The location of the PSAA was assessed in molar region by using the following measurements: (**fig c)**
    - Distance between the inferior border of the PSSA to the greatest depth of the Maxillary Sinus floor.
    - Distance between the lower border of posterior superior alveolar artery and alveolar crest.

Statistical analysis:

Data will be collected, tabulated, formulated, and was analysed using SPSS statistical software version 22.0. The level of significance (α) was taken as 5% and hence P value ≤ 0.05 was considered significant for interpretation of results.

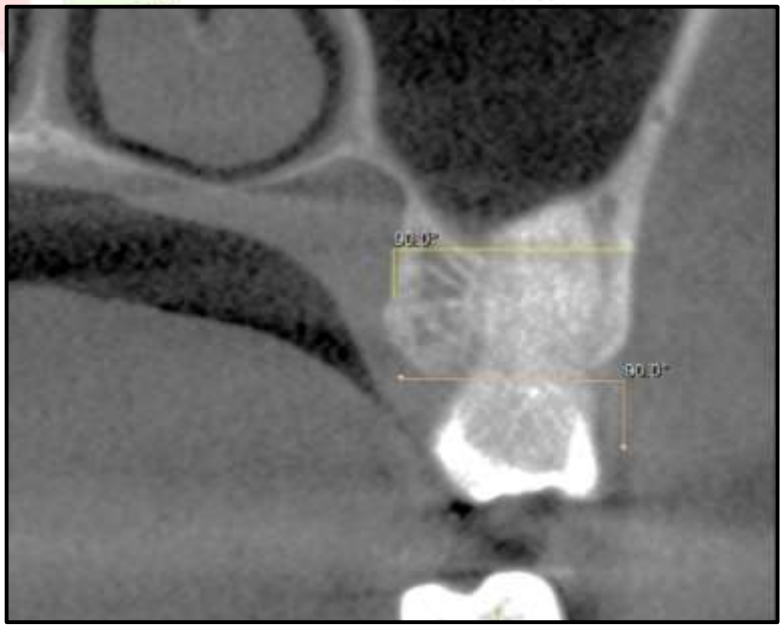

Fig. a: Radiographic representation to determine Intraosseous PSSA with Maxillary Sinus floor and alveolar crest in coronal plane.

Fig. b: Radiographic representation to determine Intraosseous PSSA with Maxillary Sinus floor in sagittal plan

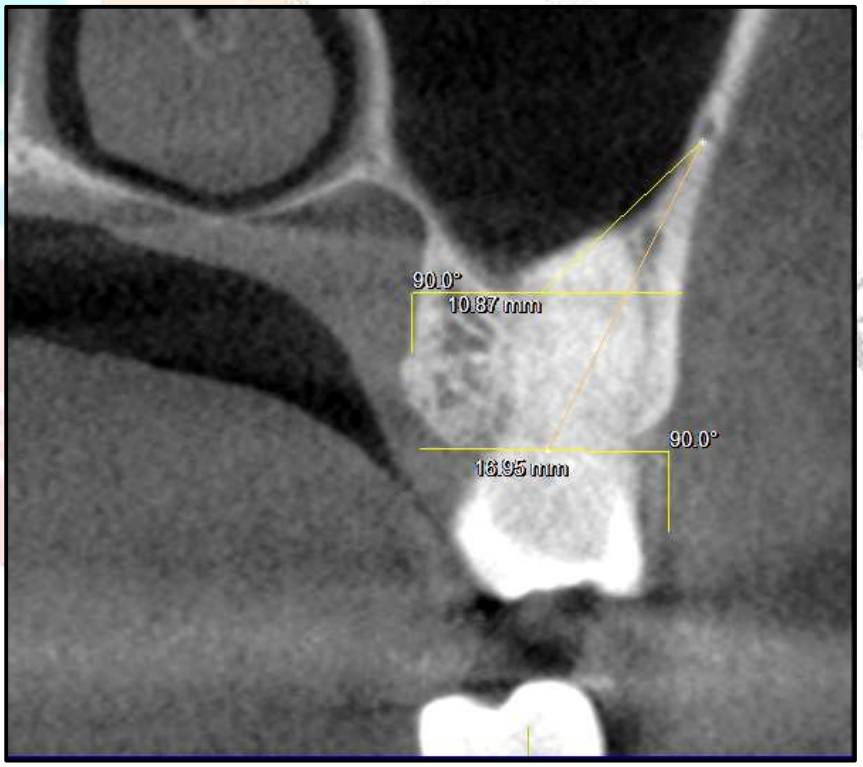

Fig. c: Measurement of the Inferior border of the PSSA to maxillary Sinus floor and alveolar crest.

Observations & results

Present study was undertaken to evaluate intraosseous posterior superior alveolar artery to the floor of maxillary sinus and alveolar crest in Dentulous and partially edentulous patients and their association with gender using Cone beam computed tomography

Table No. 1: Descriptive statistics of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous patients using CBCT

Dentulous Patients: posterior superior alveolar artery to the floor of maxillary sinus in dentulous patients	
Mean	9.98
Std. Deviation	3.02
Std. Error	0.31
Variance	9.17
Range	15.33
Minimum	4.41
Maximum	19.74

- Above table shows the mean, median, standard deviation (SD), range, minimum and maximum values for intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous patient.

Table No. 2: Descriptive statistics of intraosseous posterior superior alveolar artery to the alveolar crest in dentulous patients using CBCT

Dentulous Patients: posterior superior alveolar artery to the alveolar crest in dentulous patients	
Mean	17.52
Std. Deviation	3.34
Std. Error	0.34
Variance	11.22
Range	15.71
Minimum	12.16
Maximum	27.87

- Above table shows the mean, median, standard deviation (SD), range, minimum and maximum values for intraosseous posterior superior alveolar artery to the alveolar crest in dentulous patients

Table No. 3: Descriptive statistics of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in partially edentulous patients using CBCT

Dentulous Patients: posterior superior alveolar artery to the floor of maxillary sinus in partially edentulous patients	
Mean	9.67
Std. Deviation	2.58
Std. Error	0.26
Variance	6.67
Range	12.70
Minimum	4.23
Maximum	16.93

- Above table shows the mean, median, standard deviation (SD), range, minimum and maximum values for intraosseous posterior superior alveolar artery to the floor of maxillary sinus in partially edentulous patients

Table No. 4: Descriptive statistics of intraosseous posterior superior alveolar artery to the alveolar crest in partially edentulous patients using CBCT

Dentulous Patients: posterior superior alveolar artery to the alveolar crest in partially edentulous patients	
Mean	15.50
Std. Deviation	3.62
Std. Error	0.37
Variance	13.14
Range	16.60
Minimum	8.78
Maximum	25.38

- Above table shows the mean, median, standard deviation (SD), range, minimum and maximum values for intraosseous posterior superior alveolar artery to the alveolar crest in partially edentulous patients

Table No. 5: Comparison of mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous and partially edentulous patients using CBCT

Independent Samples T Test

posterior superior alveolar artery to the floor of maxillary sinus	**Mean**	**S.D.**	**Std. Error**	**Range**	**Mean Diff.**	**t Statistic**	**P Value**
Dentulous patients	9.98	3.02	0.31	4.41 - 19.74	0.31	0.758	0.450 Non-Significant
partially Edentulous patients	9.67	2.58	0.26	4.23 - 16.93			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus were more in dentulous as compared to partially edentulous patients and these differences found were not significant statistically.
- So, mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus were comparable among both groups.

Table No. 6: Comparison of mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in dentulous and partially edentulous patients using CBCT

Independent Samples T Test

intraosseous posterior superior alveolar artery to the alveolar crest	**Mean**	**S.D.**	**Std. Error**	**Range**	**Mean Diff.**	**t Statistic**	**P Value**
Dentulous patients	17.53	3.34	0.34	12.16 - 27.87	2.02	3.972	0.001* Significant
partially Edentulous patients	15.51	3.62	0.37	8.78 - 25.38			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the alveolar crest were more in dentulous as compared to partially edentulous patients and these differences found were significant statistically.
- So, mean distance of intraosseous posterior superior alveolar artery to the alveolar crest were significantly more in dentulous as compared to partially edentulous patients.

Table No. 7: Comparison of mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in male and females in dentulous patients using CBCT

Independent Samples T Test

Dentulous Patients	Mean	S.D.	Std. Error	Range	Mean Diff.	t Statistic	P Value
Male	10.21	3.30	0.44	4.41 - 19.74	0.53	0.834	0.407 Non Significant
Female	9.68	2.63	0.41	5.18 - 16.53			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus were more in male as compared to female patients in dentulous patients and these differences found were not significant statistically.
- So, mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous patients were comparable among with respect to gender.

Table No. 8: Comparison of mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in males and females in dentulous patients using CBCT

Independent Samples T Test

Dentulous Patients	Mean	S.D.	Std. Error	Range	Mean Diff.	t Statistic	P Value
Male	17.60	3.20	0.43	12.16 - 27.87	0.17	0.233	0.816 Non Significant
Female	17.43	3.57	0.56	12.67 - 27.85			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the alveolar crest were more in male as compared to female patients in dentulous patients and these differences found were not significant statistically.

- So, mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in dentulous patients were comparable among with respect to gender.

Table No. 9: Comparison of mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in males and females in partially edentulous patients using CBCT

Independent Samples T Test

Partially Edentulous Patients	Mean	S.D.	Std. Error	Range	Mean Diff.	t Statistic	P Value
Male	10.23	2.71	0.38	4.54 - 16.93	1.21	2.323	0.022* Significant
Female	9.02	2.27	0.34	4.23 - 13.16			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus were more in male as compared to female patients in partially edentulous patients and these differences found were significant statistically.
- So, mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus were significantly more in male as compared to female patients in partially edentulous patients

Table No. 10: Comparison of mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in males and females in partially edentulous patients using CBCT

Independent Samples T Test

Partially Edentulous Patients	Mean	S.D.	Std. Error	Range	Mean Diff.	t Statistic	P Value
Male	16.01	3.85	0.54	8.78 - 24.27	1.10	1.477	0.143 Non-Significant
Female	14.91	3.27	0.49	8.84 - 25.38			

- From the above table it was found that mean distance of intraosseous posterior superior alveolar artery to the alveolar crest were more in male as compared to female patients in partially edentulous patients and these differences found not significant statistically.
- So, mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in partially edentulous patients were comparable among with respect to gender.

Discussion

The PSAA a branch of the maxillary artery, is closely associated with the maxillary bone and sinus. Its prevalence is documented to vary widely in the literature. In recent years, the placement of dental implants combined with sinus lifting surgeries in the atrophic posterior maxilla has become increasingly common. During these procedures, it is crucial for practitioners to be mindful of anatomical structures, particularly the PSAA, to prevent excessive bleeding.

Furthermore, many surgeons emphasize the importance of conducting a CBCT scan prior to any posterior maxillary surgery. This imaging technique aids in accurately locating the PSAA, thereby helping to prevent intraoperative haemorrhage that could result from damaging this vital artery.

In this study, the participants have been classified depending on all the two parameters namely dentition status and gender which makes it simpler and more descriptive to compare it with the anatomy, location and distances between PSAA and the structures of interest.

Present study was carried out to assess the anatomy, location and distances between PSAA and the maxillary sinus and alveolar crest on dentulous and partially edentulous patients using CBCT.

In this study, a total of 188 CBCT scans were included with age ranging from 18-75 years.

Table 1 shows the mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous patients. Mean distance of PSAA to Maxillary Sinus Floor were 9.98 mm (SD: 3.02 mm) whereas higher mean distance were observed in studies by **Ang et al**[27] was 11.44 mm (SD: 3.36 mm) from the floor of the maxillary sinus.

Table 2 shows the mean distance of intraosseous posterior superior alveolar artery to the alveolar crest is 17.52 mm (SD: 3.34 mm), these results were in accordance with the study conducted by **Godil et al**[8] which shows PSAA located 17.37 mm (SD: 3.94 mm) from the alveolar crest. On contrary slight shorter value were found by **Chitsazi et al**[17] which shows PSAA located 16.17 mm (SD: 1.63 mm) from the alveolar crest.

Table 3 shows the mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in partially edentulous patients. Mean distance of PSAA to Maxillary Sinus Floor were 9.67 mm (SD:

2.58 mm) these results were in accordance with the study conducted by **Ismail et al[37]** which shows PSAA located 9.24 mm (SD: 4.75 mm) from maxillary sinus in partially edentulous patients.

Table 4 shows the mean distance of intraosseous posterior superior alveolar artery to the alveolar crest is 15.50 mm (SD: 3.62 mm) whereas higher mean distances was observed in studies by **Ismail et al[37]** which shows 19.07 (SD: 5.41mm) from the alveolar crest .

Table 5 shows the comparison of Mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous and partially edentulous patients. The mean distance for dentulous patients is 9.98 mm (SD: 3.02 mm), while for partially edentulous patients, it is 9.67 mm (SD: 2.58 mm). The mean difference of 0.31 mm is statistically non-significant ($p = 0.450$). This was in accordance with **Danesh-Sani et al[10] and Ilgüy et al[9]** where no significant difference in the PSAA's position relative to the sinus floor between dentulous and partially edentulous patients.

Table 6 shows the comparison of Mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in dentulous and partially edentulous patients. The mean distance for dentulous patients is 17.53 mm (SD: 3.34 mm), while for partially edentulous patients, it is 15.51 mm (SD: 3.62 mm). The mean difference of 2.02 mm is statistically significant ($p = 0.001$). This was in agreement with **Chitsazi et al[17]** where significant difference in the PSAA's position relative to the alveolar crest among dentulous and partially edentulous patients. On contrary the study by **Rathod et al[1]** shows no significant difference between dentulous and partially edentulous participants regarding the PSAA's position.

Table 7 shows Mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in male and females in dentulous patients. The mean distance for male patients is 10.21 mm (SD: 3.30 mm), while for female patients, it is 9.68 mm (SD: 2.63 mm). The mean difference of 0.53 mm is statistically non- significant ($p = 0.407$). This was in agreement with **Khojastehpour et al[2], Danesh-Sani et al[10]** demonstrates no substantial gender based difference in the distance from the PSAA to the floor of the maxillary sinus. On contrary **Ilgüy et al[9]** shows statistically significant difference between the gender ($p < 0.05$).

Table 8 shows Mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in males and females in dentulous patients. The mean distance for male patients is 17.60 mm (SD: 3.20 mm), while for female patients, it is 17.43 mm (SD: 3.57 mm). The mean difference of 0.17 mm is statistically non-significant ($p = 0.816$). This was in agreement with **Fayek et al[13], Tehranchi et al[23]** illustrates no significant gender-based variance in the distance from the PSAA to the alveolar crest**.** On contrary **Waingade et al[30]** shows distance was significantly greater in males than in females as this variation could be due to the use of different imaging modality, sample size, and racial variances amongst study populations.

Table 9 shows Mean distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in males and females in partially edentulous patients. The mean distance for male patients is 10.23 mm (SD: 2.71 mm), while for female patients, it is 9.02 mm (SD: 2.27 mm). The mean difference of 1.21

mm is statistically significant (p = 0.022). This was in agreement with **Mankar et al[38]** demonstrates distance from the PSAA to the maxillary sinus floor was suggestively larger in males than females.

Table 10 shows Mean distance of intraosseous posterior superior alveolar artery to the alveolar crest in males and females in partially edentulous patients. The mean distance for male patients is 16.01 mm (SD: 3.851 mm), while for female patients, it is 14.91 mm (SD: 3.27 mm). The mean difference of 1.10 mm is statistically non- significant (p = 0.143). This was in accordance with **Tehranchi et al[23] , Chitsazi et al[17]** shows PSAA is typically located between 10–20 mm from the alveolar crest, with no significant differences between males and females**.**

Limitations and future scope of study

The present study evaluated the anatomy, location and distances between the PSAA and the maxillary sinus and the alveolar crest on dentulous and partially edentulous patients using cone beam computed tomography. However, the limitation of the study consists of a smaller sample size.

Thus, for further evaluation and future scope, more studies with a larger sample size are needed to correlate the anatomy, location and distances between PSAA and the maxillary sinus and alveolar crest with all the three parameters namely various age groups, gender and dentition status of members.

Conclusion

From the present study the following can be concluded

1. Distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus and alveolar crest were comparable among both groups
2. Distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in dentulous was slightly more than partially edentulous patient but this difference found was not significant statistically.
3. Distance of intraosseous posterior superior alveolar artery to the alveolar crest in dentulous were more than partially edentulous patient and this difference found was significant statistically.
4. Distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus and to the alveolar crest in males was more than females in dentulous patients but this difference found was not significant statistically.
5. Distance of intraosseous posterior superior alveolar artery to the floor of maxillary sinus in males were more than females in partially edentulous patients this difference found was significant statistically
6. Distance of intraosseous posterior superior alveolar artery to the alveolar crest in males were more than females in partially edentulous patients but this difference found was not significant statistically.

CBCT enables the accurate measurement of intraosseous PSAA and also aids in measuring the distance from anatomic structures, due to its three-dimensional nature. CBCT proves to be a valuable diagnostic aid in pre implant radiological assessment. There is association of alveolar crest with dentition status and gender with partially edentulous patients. The results of this study may provide an insight on the usefulness of CBCT in providing a base line data for selecting the appropriate site for implant placement and other surgical procedures in terms of presence and location of posterior superior alveolar artery.

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