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Distribution of Posterior Superior Alveolar Artery in a North Indian Population - A Retrospective CBCT Study

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Abstract: ***Background and Aim: The purpose of the present retrospective study was to characterize the Prevalence, Shape, Diameter and Measurement of distance from the sinus and alveolar crest of Posterior Superior Alveolar Artery (PSAA) in north India population with Cone Beam Computed Tomography and to emphasize its importance for any surgical procedure. Materials and Methods: Fifty high quality maxillary CBCT scan of the patients undergoing sinus augmentation procedure or implant therapy were included in the study. The visibility of the PSAA on the CBCT examinations were made using Care stream software version 5.1 Dental LLC, Atlanta, GA, USA. The data of the CBCT images were sliced in coronal and cross section. CBCT images were evaluated to assess the shape, diameter of intrabony indentation and to measure the distance of PSAA from alveolar crest and sinus in relation to first maxillary molar. Result: Out of 50 patients scan , 32 were females (64%) and 18 males (36%) patient of age 14- 77 yrs which were further divided into two age groups first group between 14-46yrs (50%) and second between 47-77yrs (50%). Maximum 22 scans (44%) showed type I shape and out of 22 maximum scans were observed in second age group. When diameter of the arteries were classified, 68% of the artery was <1mm and 100% artery was visualized in of all scans and it was observed that most common position was below the Schneidenan membrane (60% i.e. equal in both age groups). The average distance from the floor of the sinus to the lower border of the artery for age group1 was 4.592 (SD±2.6964), age group2 was 7.264 (SD±5.2962) (p value is 0.029) which showed significant statistical difference. When we compared distance from sinus to lower border of artery than the mean distance for dentulous was 5.512 (SD±3.8520) and for edentulous 8.113 (SD±6.3591) i.e. increase in distance was observed in edentulous patient than dentulous patient (p value 0.124). Conclusion: The visibility of the PSAA on CBCT images was stated higher. The PSAA was more visible to the alveolar crest in the first molar area. CBCT scan is recommended as a routine examination prior to a sinus sinus floor evaluation, LeFort, modified Caldwell-Lucor excisting bone for maxillary bone grafts surgical procedures.***

Keywords: CBCT, Posterior Superior Alveolar Artery, Sinus, Surgical

1. Introduction

Posterior superior alveolar artery (PSAA) is the branch of maxillary artery that supplies lateral sinus wall and its overlying membrane[1]. The blood supply of the maxillary sinus and Schneiderian membrane comes from the maxillary artery. The maxillary artery is branched into 5 arteries: posterior superior alveolar artery (PSAA), infraorbital artery (IOA), artery of the pterygoid canal, descending palatine artery, and sphenopalatine artery[2]. These branches descends on the maxillary tuberosity which further branches out, that enter the alveolar process and supply posterior teeth and the maxillary gingiva. The infraorbital artery is a continuation of the internal maxillary artery; they both anastomose to a common vessel at the lateral antral bony wall. To avoid laceration during sinus floor elevation and surgical procedure, it is important to know clinically the location of PSAA. For implant placement, quality and quantity of the alveolar bone should be sufficient. In posterior maxilla, resorption of alveolar bone and pneumatization of maxillary sinus cavity compromises dental implant therapy, thus assessment of alveolar bone is essential. For the preservation of vitality of the maxillary region, for augmentation and for elevation of sinus floor adequate blood supply to maxilla is mandatory.

Knowledge of blood supply allows dental practitioner to prevent local bone necrosis and to optimize regional healing via proper vascularization of the graft materials, preserving the vitality of the affected maxillary region and to avoid unnecessary complications

CBCT is important imaging tool to assess the location of PSAA, to evaluate bone dimension, recognize specific anatomical landmarks, and to detect sinus pathologies. Because of size and cost effectiveness, high-speed scanning, sub millimeter resolution, low patient radiation dose and interactive analysis, it is preferred over computed tomography (CT) [3].

The aim of the present study was to assess diameter, prevalence, shape and position of the PSAA and its relationship to the alveolar crest and floor of maxillary sinus.

2. Material and Method

A retrospective study was planned after formal approval from the review board of our institution Fifty high quality maxillary CBCT scan (coronal and cross section) of the patients undergoing sinus augmentation procedure or implant therapy were included in the study and low quality images such as scattering, inferior level of window exposure and having any

pathology were excluded from the study. The data was collected from CBCT Diagnostic Research Center (Delhi-NCR). Intra-examiner variation was measured during this study The images were obtained at 74-80kvp, 10mA, 10.80 sec, voxel size of 76µm x 76µm x 76µm, resolution of 0.75 mm, range of exposure 236-280 mGy.cm^3± 20% and the small field of view (FOV) size of 5 cm× 3.75 cm and were created in DICOM format, evaluated by axial, cross-sectional and sagittal reconstruction with a thickness of 1mm and a cutting interval of 1mm.. The visibility of the PSAA on the CBCT examinations were made using Care stream software version 5.1 Dental LLC, Atlanta, GA, USA.The images were studied by three members of radiology team independently. All radiologist measured same variations in the present study. Out of 50 patients scan , 32 were females (64%) and 18 males (36%) patient of age 14- 77 yrs which were further divided into two age groups first group between 14-46yrs (50%) and second between 47-77yrs (50%).

The data of the CBCT images were sliced in coronal and cross section. CBCT images were evaluated to assess the shape of intrabony indentation and to measure the distance of PSAA from alveolar crest in relation to first maxillary molar as well as distance of PSAA from maxillary sinus. The shape of intrabony indentation was classified into 4 types: Type I (as an arc smaller than a half circle), Type II (as an arc larger than a half circle), Type III (as a circular intrabony canal), and Type IV (as a tunnel on the lateral wall of maxillary sinus). The diameter of the arteries was classified into 3 groups: group 1 (<1mm), group II (1mm-2mm) and group III (>2mm). For evaluating position of PSAA, it was divided into 4 positions: below the schneidenan membrane (POSITION I), outer cortex of the lateral sinus wall (POSITION II), between the sinus wall (POSITION III) and intraosseous (POSITION IV).In all cases measurements were taken to determine the distance from the alveolar crest of maxillary first molar (DFC) and floor of maxillary sinus (DFS). The mean values and standard deviations of the measuring results were calculated. All data was analyzed using the statistical software package SPSS 19.0 (IBM, NY, USA).

3. Result

Out of 50 patients scan , 32 were females (64%) and 18 males (36%) patient of age 14- 77 yrs which were further divided into two age groups first group between 14-46yrs (50%) and second between 47-77yrs (50%) **TABLE 1**.

The shape of PSAA in relation to first molar, intra-bony indentation and the prevalence, in different age groups and gender was as follows; Maximum 22 scans (44%) showed type I shape and out of 22 maximum scans were observed in age group2 (12 scans 48%) followed by type III (30%), type II (20%) than type IV (6%) (p value is 0.773). Gender-wise maximum scan was for type I having 22 scans (44%) in which 44.4% were observed in males patient and 43.8% in females patient. Least cases of type IV was observed i.e. 3 cases, in which all were females (p value is 0.460). **TABLE 2, FIG 1.**

When diameter of the arteries were classified, 68% of the artery was <1mm, 32% was 1-2mm and 0% was >2mm. In age group1, maximum 18 cases showed the diameter <1mm (p value 0.544) and gender wise maximum 24 cases showed the diameter <1mm in female patients (p value 0.157). No significant correlation between diameter of the artery and age and gender was observed. **TABLE 3, FIG 2.**

Artery was visualized in 100% of all scans and it was observed that most common position was below the Schneidenan membrane (60% i.e. equal in both age groups) Fig 3 (c) followed by 30% at outer cortex of the lateral sinus wall, 6% showed intraosseous and 4% between the sinus wall (p value 0.402) and gender wise maximum 19 cases i.e. 59.4% showed the position below the Schneidenan membrane in females patient (p value 0.313) which showed no significant result. **TABLE 4**

The average distance from the floor of the sinus to the lower border of the artery for age group1 was 4.592 (SD±2.6964), age group2 was 7.264 (SD±5.2962) (p value is 0.029) which showed significant statistical difference and the distance from alveolar crest to the lower border of the artery for age group1 was 4.620 (SD±3.0024), age group2 was 4.128 (SD±2.6586) (p value is 0.542) which showed no significant result. Gender wise, distance from floor of the sinus to the lower border of the artery for female was 5.263 (SD±2.5820), male was 7.111 (SD±6.3748) having p value 0.153 and the distance from alveolar crest to the lower border of the artery for female was 4.131 (SD±2.6294), male was 4.806 (SD±3.1570) (p value is 0.42) which showed no significant result. **TABLE 5, FIG 3 (b)** Out of 50 scans, 42 scans (84%) was dentulous and 8 scans (16%) was edentulous. When we compared distance from sinus to lower border of artery than the mean distance for dentulous was 5.512 (SD±3.8520) and for edentulous 8.113 (SD±6.3591) i.e. increase in distance was observed in edentulous patient than dentulous patient (p value 0.124). When we compared distance from bone cortex to lower border of artery than the mean distance for dentulous was 4.267 (SD±2.7976) and for edentulous 4.937 (SD±3.0491) (p value 0.543) which was found to be statistically non significant. **TABLE 6**

4. Discussion

In the present study, Maximum cases were of type I shape (44%) in age group2 (48%) and least cases of type IV (6%). Gender-wise type I (44%), were observed in males44.4% patient and 43.8% in females patient. Lee J et al[4] reported maximum cases (24.7%) with an arc smaller than a half circle shape of PSAA and minimum cases (12.3%) with of tunnel on lateral wall of maxillary sinus, which is in accordance with the present study. Elian et al[5] reported 24.7% cases with arc smaller than half circle shape of PSAA. There was no correlation found between age, gender and shape of artery in literature.

In the present study, diameter of the arteries <1mm was seen in 68% of cases, and 0% cases was reported with diameter

>2mm.Guncu G et al (2011) [1] and Ella et al (2005) [6], in their sudies found mean diameter 1.3 and 1.2mm respectively. Our study is in accordance with IIguy D et al (2013) [7] who found diameter<1mm (68.9%).No significant correlation between diameter of the artery, age and gender was observed in our present study which was in accordance with Guncu G et al (2011) [1]. IIguy D et al (2013) (39%) [7]and Kim et al (2006) [8] found average diameter of artery higher in males. Mardinger et al (2007) [9]put forth that older patients have wider diameter but could not find significant correlation between gender and diameter of canal.

Findings from the present study reported that 100% of all our scans identified the presence of artery were below the Schneidenan membrane whereas, Kurt et al (2014) [10], Guncu G et al (2011) [1], Elian et al (2005) [5] and Mardinger et al (2007) [9] reported prevalence of artery in 71.4%64.5%, 52.9% and 55% respectively. In the present study we examined position of artery below the Schneidenan membrane (60%), at outer cortex of the lateral sinus wall (30%), intraosseous (6%) and between the sinus wall (4%), this explains the higher incidence in present study and also the location of PSAA has been said to be in closer proximity with the maxillary first molar. Elian et al[5] examined intraosseous branch on outer or inner wall and Guncu G et al (2011) [1] examined intraosseous, below Schneiderian membrane and outer cortex of lateral sinus wall. Maximum cases reported were below the Schneidenan membrane (60%) in the present study which was in accordance with, Guncu et al (2011) [1]who reported maximum cases intraosseous (68.2%).

In the present study, distance from floor of the sinus to the lower border of the artery in female was 5.263 (SD±2.5820), male was 7.111 (SD±6.3748) and the distance from alveolar crest to the lower border of the artery for female was 4.131 (SD±2.6294), male was 4.806 (SD±3.1570).IIguy et al (2013) found the mean distance from the artery to the alveolar crest in females 7.50±3.03 mm and 8.34±3.43 mm in males and from the artery to the antral floor was 9.29 mm in females and 8.66 mm in males whereas, Güncü et al (2011) [1].7.8±0.3 mm and by Mardinger et al ((2007[9]), was 7–8 mm. These differences can be explained by the variation in the positions of arteries anatomically in different group of population.

In the present study, distance from sinus to lower border of artery for dentulous was 5.512mm and for edentulous 8mm and the distance from bone cortex to lower border of artery for dentulous was 4.267mmand for edentulous 4.937mm.No such study defining the relation of distance of dentulous and edentulous with position of PSAA have been reported in literature till date.

5. Conclusion

The result from this study suggested that CBCT scan is a valuable tool in evaluating PSAA shape, position, diameter and distance before sinus and implant surgery. Although variations exist in every patient. Keeping all these facts in mind and since no such study has been conducted in North India population that is why the current study has been designed. The knowledge of the present study may assist surgeons and forensic odontologist.

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Legends

Table 1: Age group wise and gender wise distribution of posterior superior alveolar artery.

			GENDER		Total
			F	M	
Age group	14-46yrs	Count	16	9	25
		% within age group	64.0%	36.0%	100.0%
	47-77yrs	Count	16	9	25
		% within age group	64.0%	36.0%	100.0%
Total		Count	32	18	50
		% within age group	64.0%	36.0%	100.0%

Table 2: Age group wise and gender wise, Shape of posterior superior alveolar artery.

			SHAPE				Total	P value
			I	II	III	IV		
Age group	14-46 yrs	Count	10	5	9	1	25	
		% within age group	40.0%	20.0%	36.0%	4.0%	100.0%	
	47-77yrs	Count	12	5	6	2	25	
		% within age group	48.0%	20.0%	24.0%	8.0%	100.0%	
Total		Count	22	10	15	3	50	0.773
		% within age group	44.0%	20.0%	30.0%	6.0%	100.0%	
			GENDER					
GENDER F		Count %	14 43.8%	7 21.9%	8 25.0%	3 9.4%	32 100.0%	0.460
M		Count %	8 44.4%	3 16.7%	7 38.9%	0 0%	18 100.0%	
TOTAL		Count	22	10	15	3	50	
		%	44.0%	20.0%	30.0%	6.0%	100.0%	

Table 3: Age group wise and gender wise, diameter of posterior superior alveolar artery.

POSITION							
			Diameter group		>2mm	Total	P value
			<1mm	1-2mm			
Age group	14-46yrs	Count	25	7	0	25 100.0%	0.544
		% within age group	100.0%	28.0%	0		
	47-77yrs	Count	25	9	0	25 100.0%	
		% within age group	100.0%	36.0%			
Total		Count	34	50	0	50 100.0%	
		% within age group	68.0%	100.0%			
		Diameter group	Total				
F		Count	24	8	O	32	0.157
		% within GENDER	75.0%	25.0%	O	100.0%	
M		Count	10	8	O	18	
		% within GENDER	55.6%	44.4%	O	100.0%	
Total		Count	34	16	O	50	
		% within GENDER	68.0%	32.0%	O	100.0%	

Table 4: Age group wise and gender wise, position of posterior superior alveolar artery.

			POSITION				Total	P value
			1	2	3	4		
Age group	14-46 yrs	Count	15	9	0	1	25	0.402
		% within age group	60.0%	36.0%	.0%	4.0%	100.0%	
	47-77 yrs	Count	15	6	2	2	25	
		% within age group	60.0%	24.0%	8.0%	8.0%	100.0%	
Total		Count	30	15	2	3	50	
		% within age group	60.0%	30.0%	4.0%	6.0%	100.0%	
F		Count	19	8	2	3	32	0.313
		% within GENDER	59.4%	25.0%	6.3%	9.4%	100.0%	
M		Count	11	7	0	0	18	
		% within GENDER	61.1%	38.9%	.0%	.0%	100.0%	
TOTAL		Count	30	15	2	3	50	
		% within GENDER	60.0%	30.0%	4.0%	6.0%	100.0%	

Table 5: Age group wise and gender wise, distance from artery to alveolar crest and distance from artery to floor of sinus.

	Age group	N	Mean	Std. Deviation	T value	P value
DFS	14-46yrs	25	4.592	2.6964	.5393	0.029
	47-77yrs	25	7.264	5.2960	1.0592	
DFC	14-46yrs	25	4.620	3.0024	.6005	0.542
	47-77yrs	25	4.128	2.6586	.5317	
	GENDER	N	Mean	Std. Deviation		
DFS	F	32	5.263	2.5820	1.451	0.153
	M	18	7.111	6.3748		
DFC	F	32	4.131	2.6294	1.771	0.422
	M	18	4.806	3.1570		

Table 6: Comparison of distance from artery to alveolar crest and distance from artery to floor of sinus in dentulous and edentulous group.

	Group	N	Mean	Std. Deviation	T value	P value
DFS	Dentulous	42	5.512	3.8520	-1.564	0.124
	Edentulous	8	8.113	6.3591	-1.118	
DFC	Dentulous	42	4.267	2.7976	-0.613	0.543
	Edentulous	8	4.937	3.0491	-0.578	

Figures

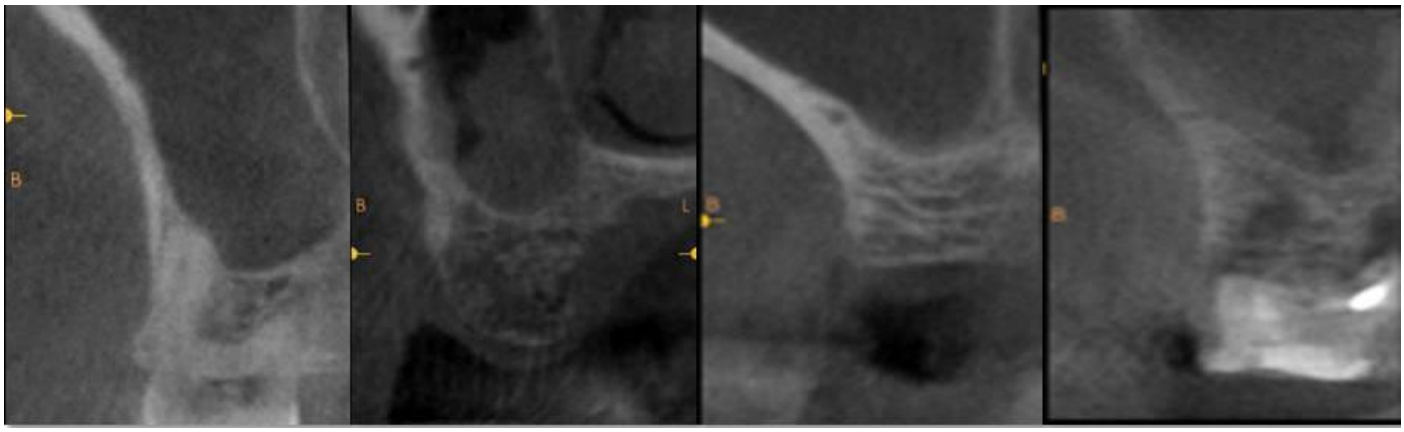

Figure 1: (a) : an arc smaller than a half circle; (b) an arc larger than a half circle; (c) a circular intrabony canal; (d) as a tunnel on the lateral wall of maxillary sinus.

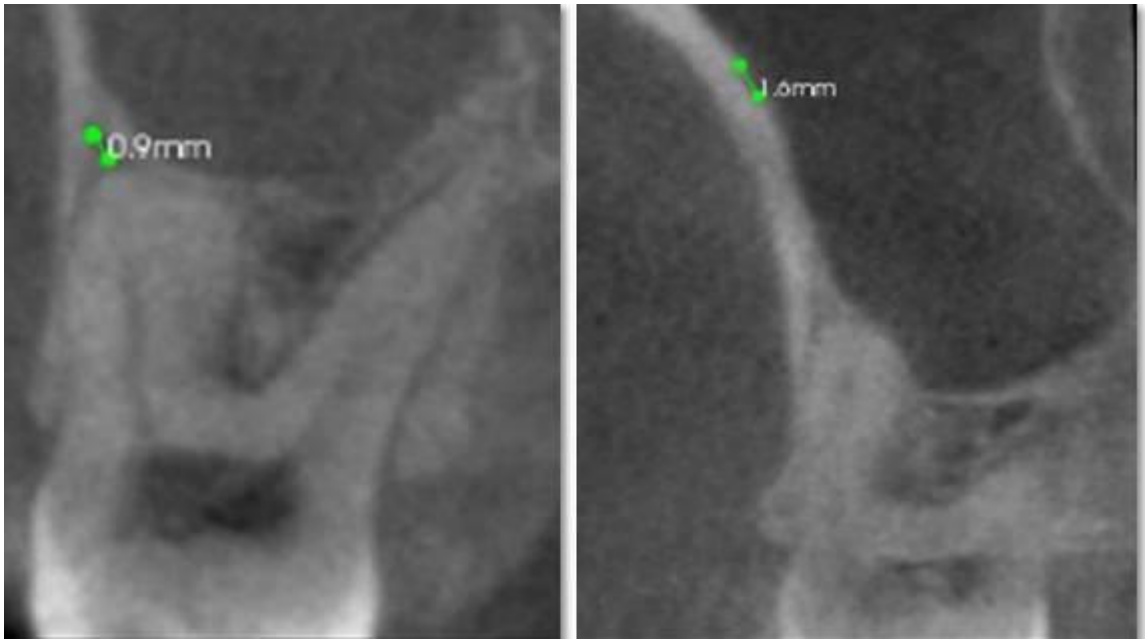

Figure 2: The diameter of the arteries (a) <1mm; (b) 1mm-2mm.

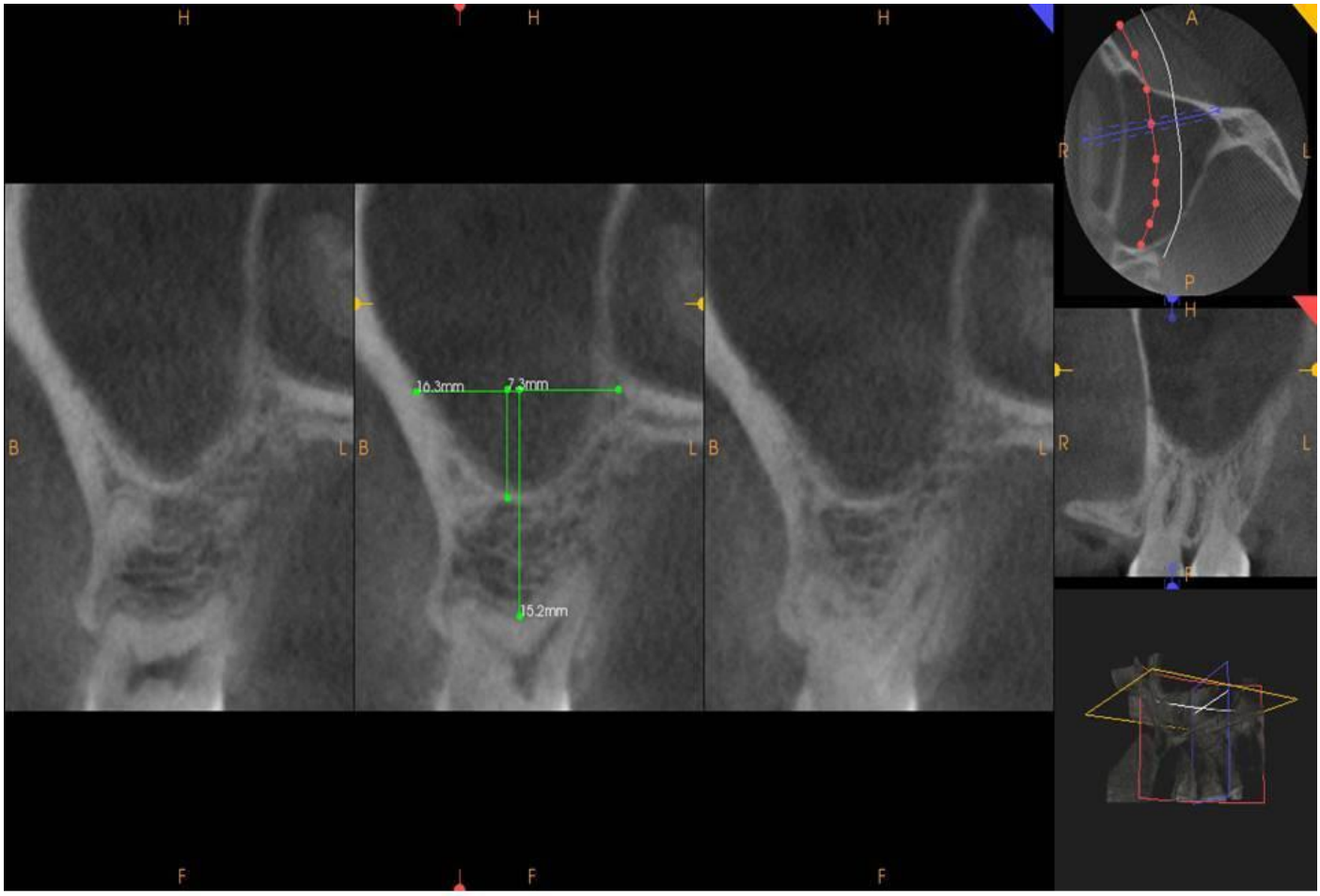

Figure 3: (a) Shape of PSAA; (b) the distance from the alveolar crest of maxillary first molar (DFC) and floor of maxillary sinus (DFS) ; (c) Position of PSAA below the schneidenan membrane (POSITION I).