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Original Research Article

Study of Distance Measurement of the Alveolar Crest to Maxillary Sinus Floor on Different Views of CBCT

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Abstract: Knowledge of the exact location of the floor of maxillary sinus is a very important factor in relation to safe regions for implant therapy and surgery. The aim of this study was to evaluate the distance between the alveolar crest and maxillary sinus floor on cross-sectional, 3D and panoramic views of CBCT. 94 CBCT images taken with Galileos machine were selected for the purpose of this cross-sectional study, using convenience sampling. The distance between the alveolar crest and the floor of maxillary sinus was determined on 3D, panoramic and cross-sectional views at the regions of teeth #4, #5, #6 and #7 by two radiologists. Data were analyzed with SPSS 20, using the repeated-measures ANOVA, paired t-test and kappa coefficient ($\alpha = 0.05$). There were significant differences in the distances between the alveolar crest and the floor of the sinus in the second premolar area on the three different views ($P = 0.011$). However, there were no significant differences in other areas between the three views (P, first premolar = 0.602; P, first molar = 0.079; P, second premolar = 0.498). T-test revealed significant differences between 3D and cross-sectional views ($P = 0.008$) and 3d with panoramic views ($P = 0.001$), but the difference between the panoramic and cross-sectional views was not significant ($P = 0.868$). In comparisons made in relation to the distance between the alveolar crest and the floor of the maxillary sinus, there were significant differences between 3D and cross-sectional, and 3D and panoramic views; however, the difference between cross-sectional and panoramic views was not significant.
Keywords: Cone-beam computed tomography, Maxillary sinus, Panoramic

INTRODUCTION

Maxillary sinus is the largest paranasal sinus [1]; it might be affected by odontogenic conditions or even get involved during dental procedures due to its close proximity to the oral cavity. Therefore, it is necessary for dentists to determine the distance between the alveolar crest and the maxillary sinus floor in maxillary molar surgeries and for the placement of implants in this area [2, 3]. After extraction of maxillary molars, the expansion of the maxillary sinus will continue until it occupies the alveolar space and in some cases, the maxillary sinus floor is located at the alveolar crest [4].

Several imaging techniques have been used for the evaluation of the position of maxillary sinus floor, including panoramic, conventional tomography, CT scan and more recently, cone-beam computed tomography (CBCT) techniques [5].

Panoramic radiographs are used as a routine radiographic technique for evaluations before placement of implants and for preparation of treatment protocols [6]. After introduction of the CBCT technique, 3D imaging became available for practical purposes in dentistry [7–9]. One of the principal advantages of CBCT is the easy access, ease of use, presentation of data in real values and 3D reconstruction by this technique [10–12]. The CBCT technique can reveal the location of impacted teeth and their relationship with and effect on the adjacent teeth [13]. Data acquired from this technique during the imaging can be used again to provide consecutive cross-sections at axial, coronal and sagittal planes. In addition, CBCT makes it possible to reconstruct 3D images of the area in question [14]. The CBCT machine is able to reconstruct images at any arch similar to a panoramic image, with no difference from the conventional panoramic images, except for the fact that it has less superimposition [15].

In a study by Terakado *et al* [16], the diagnostic efficacies of CBCT and panoramic techniques were compared in relation to the topographic

relationship between the maxillary sinus floor and the posterior teeth, their pathologic conditions and apical periodontitis. A total of 39 apical periodontitis lesions and changes resulting from them were detected on CBCT images; however, only six of these lesions were detected by the panoramic technique. Therefore, the CBCT technique proved more effective than the panoramic technique in the 3D evaluations of the maxillary sinus and its relation with posterior teeth.

Mehdizadeh *et al* [17] compared the cross-sectional, 3D and panoramic views for the evaluation of the relationship between the inferior alveolar canal and third molars. They concluded that the panoramic and 3D views exhibited lower accuracy compared to the cross-sectional views provided by the CBCT technique.

Kay and Killey [18] evaluated the distance between the maxillary sinus floor and the root apices of maxillary molars on CBCT images and reported no significant differences between the left and right sides and between males and females.

Hekmatian *et al* [19] compared the distances between the root apices of maxillary molars and the maxillary sinus floor between the two cross-sectional and panoramic views of CBCT technique and reported significant differences between the two views.

The CBCT technique is commonly used for evaluation of patients, especially before surgical procedures. New software programs have made it possible to reconstruct CBCT images in different ways and evaluate the images in different views. However, it appears there are a limited number of studies available on different views of CBCT images, especially in the maxilla. Therefore, the aim of the present study was to evaluate the distance between the alveolar crest and the floor of the maxillary sinus with the use of different views and processing of CBCT images.

MATERIALS AND METHODS

In the present descriptive-analytical study, 94 CBCT images [17] of patients referring to the Department of Oral and Maxillofacial Radiology, Isfahan Faculty of Dentistry, during 2014–2015, on which the alveolar crest and the maxillary sinus floor were visible, were selected using convenience sampling technique. All the images had been taken using Galieous CBCT scanner (GMBH, Sirona Dental Systems, Bensheim, Hessen, Germany). Images on which the alveolar crest and the sinus cavity floor were not visible and also the images of patients with a history of maxillofacial surgery or trauma were excluded from the study. The images were reconstructed on three views of 3D, panoramic and cross-sectional and evaluated simultaneously by two oral and maxillofacial radiologists in cooperation with each other under the same conditions in relations to the illumination of the room and the monitor, 32-bit LG L1755s Flatron LG, Seoul, South Korea) with a resolution of 1440×690 pixels, with the use of Galileous software program (SIDEXIS XG, Sirona Dental X-ray Imaging Systems, Version 3.7). The mean distances between the alveolar crest and the maxillary sinus floor were determined and recorded by the two specialists in three views of cross-sectional, panoramic and 3D. Since the two specialists cooperated with each other to measure the distances, there was no need to calculate the coefficient of agreement between their measurements.

The vertical distance between the alveolar crest and the floor of the maxillary sinus was measured in mm in 4 areas: teeth #4, #5, #6 and #7. To make the measurements reproducible, all the measurements were made from the alveolar crest in the central area of the teeth from the mesiodistal and buccolingual dimensions of the teeth to the floor of the maxillary sinus.

The vertical distance from the alveolar crest to the floor of the sinus in each view was recorded for each tooth area separately and also irrespective of the tooth area and analyzed with SPSS 20 (SPSS Inc., Chicago, IL, USA). Kappa coefficient was used to evaluate agreement between the different views. Repeated-measures ANOVA was used to evaluate the differences in the distances from the alveolar crest to the maxillary sinus floor between the three views. Paired t-test was used for two-by-two comparisons of the views. Kappa coefficient value was 0.1–0.9. Statistical significance was set at $\alpha = 0.05$.

RESULTS

First the kappa coefficients were calculated to evaluate agreement between the three views two-by-two and separately for each tooth area; the results are presented in Table 1.

Table 1: Kappa coefficients for agreement between the three views of 3D, panoramic and cross-sectional, two-by-two and separately for each tooth area

View / Tooth area	3D–cross-sectional		3D–panoramic		Panoramic–cross-sectional	
	Kappa coefficient	P-value	Kappa coefficient	P-value	Kappa coefficient	P-value
1st premolar	0.89	0.001	0.96	0.001	0.96	0.001
2nd premolar	0.77	0.001	0.83	0.001	0.92	0.001
1st molar	0.74	0.001	0.87	0.001	0.89	0.001
2nd molar	0.86	0.001	0.88	0.001	0.88	0.001

As shown in the Table, the agreement between each two technique in all the areas was >0.77. Figure 1 presents the mean distances in all the three view separately in each tooth area.

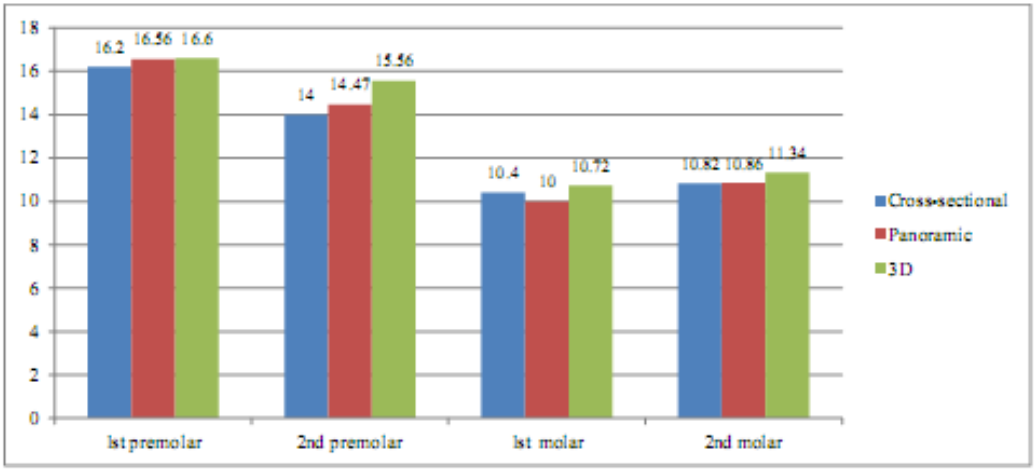

Fig-1: The mean distances in the three views of 3D, panoramic and cross-sectional separately in each tooth area in mm

Repeated-measures ANOVA was applied to all the three views separately in each tooth area. Based on the results of repeated-measures ANOVA, there were no significant differences between the three views in the first premolar, first molar and second molar area (P=0602, P=0.079 and P=0.498, respectively. The differences significant only in the second premolar areas (P=0.011). Paired-test showed a significant difference between the 3D and cross-sectional views (P=0.016); however, there were no significant differences between the cross-sectional and panoramic (P=0.056) and between the cross-sectional and panoramic views (P=0.188).

Then the means of all the numerical values from the three views were calculated irrespective of the tooth areas. Table 2 presents kappa coefficients of agreement two-by-two for the views evaluated.

Figure 2 presents the mean distances from the alveolar crest to the maxillary sinus floor in the three cross-sectional, panoramic and 3D views.

Table 2: The kappa coefficients of agreement between the 3D, panoramic and cross-sectional views two-by-two irrespective of the tooth area

Kappa coefficient / View	Kappa coefficient	P-value
3D–cross-sectional	0.84	0.001
3D–panoramic	0.91	0.001
Panoramic–cross-sectional	0.93	0.001

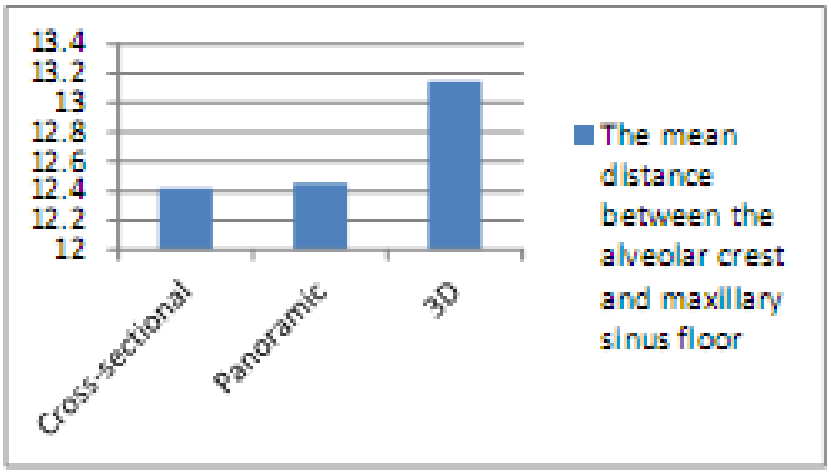

Fig-2: The mean distances from the alveolar crest to the maxillary sinus floor in the 3D, panoramic and cross-sectional views irrespective of the tooth area

Pair t-test was used to analyze the mean differences between the three views. The results of this test showed significant differences between the 3D and cross-sectional views (P=0.008) and between the 3D and panoramic views (P=0.001); however, the difference between the panoramic and cross-sectional views was not significant (P=0.868).

DISCUSSION

New radiographic techniques have made it possible to view anatomic structures in different dimensions without superimposition [20]. CBCT makes it possible to prepare 3D images; therefore, it is useful for determining the exact distance between the alveolar crest and the maxillary sinus floor [8]. Therefore, in the present study, three different views of CBCT images were compared for the measurement of the distance between the alveolar crest and the floor of the maxillary sinus.

The results of a study by Hansen *et al* [5] showed that use of images with more cross-sections in the CBCT technique is helpful in exactly determining the location of the mandibular canal and it is easier to visualize the alveolar crest relative to the mandibular canal [5]. In the present study, the distances between the alveolar crest and the floor of the maxillary sinus were compared in panoramic, cross-sectional and 3D views of CBCT images.

The results of the present study showed significant differences between the cross-sectional view and the 3D view and between the panoramic view and the 3D view; however, the difference between the cross-sectional and panoramic views were not significant. Therefore, the results of the present study showed that the panoramic and cross-sectional views were equally precise. In the present study, cross-sectional, 3D and panoramic views exhibited significant differences in relation to their accuracy in determining the distance between the alveolar crest and the floor of the maxillary sinus, with significant differences between the 3D and cross-sectional and between the panoramic and 3D views. In this context, the 3D view showed that the distance between the alveolar crest and the maxillary sinus floor in all the 4 tooth areas was greater than that measured on cross-sectional and panoramic views.

Hekmatian *et al* [19] used Ramex 3D CBCT unit to evaluate and compare the distances between the apices of posterior maxillary teeth and the floor of the maxillary sinus in two cross sectional and panoramic view of CBCT images and concluded that there were significant differences between the two views, and the panoramic view always showed a greater distance between the root apex and the maxillary sinus floor compared to the cross-sectional view.

The results of the present study did not reveal significant differences between the cross-sectional and panoramic views, which do not coincide with the results of the study by Hekmatian *et al* [19]. Two of the reasons for such a difference might be a difference in the sample sizes and the differences in the CBCT machine.

Vannier [21] showed that differences in CBCT scanners depend on the type of the detector and the algorithm used to process the image; in this context, the x-ray source, the x-ray dose applied, the monitor and the processing software have insignificant effects on the image resolution. In addition, the results of the present study showed that new techniques for the reconstruction of CBCT images have several advantages in craniofacial imaging and can decrease surgical problems.

Therefore, consistent with the study by Vannier [21], in the present study, the different views for processing of CBCT images yielded different results in relation to the distance between the alveolar crest and the floor of the maxillary sinus, indicating that it is the algorithm used for image processing that can result in differences in measurements. Therefore, use of one view is not sufficient and evaluations made in different views of CBCT technique can help more accurately determine the distance between the alveolar crest and the sinus cavity floor.

One of the limitations of the present study was the lack of evaluation of distances on the left and right sides separately and lack of evaluation of the effect of gender on the distance between the alveolar crest and the maxillary sinus floor. It is suggested that further studies be carried out with larger samples sizes and by considering factors such as age, gender and the left and right sides.

CONCLUSION

Under the limitations of the present study, different processed views of CBCT images of different areas of the dental arch yielded different results. Comparison of the distances between the alveolar crest and the maxillary sinus floor revealed significant differences between the 3D and cross-sectional and between 3D and panoramic views; however, there was no significant difference between the cross-sectional and panoramic views. Therefore, use of only one view is not sufficient and evaluations made in different views of CBT images can help determine the distance between the alveolar crest and the maxillary sinus floor more accurately.

REFERENCES

1. Kruger GO; Textbook of Oral and Maxillofacial Surgery. 6th ed. St Louis: Mosby, 1984; 281-96.
2. Chidiac JJ, Shofer FS, AI-Kutoub A, Laster LL, Ghafari J; Comparsion of CT scanograms and

cephalometric radiographs in craniofacial imaging. Orthod Craniofac Res., 2002; 5(2): 104-13.
3. Helgers ML, Scarfe WC, Scheetz JP, Farman AG; Accuracy of linear temporomandibular joint measurements with cone beam computed tomography and digital cephalometric radiography. Am J Orthod Dentofacial Orthop., 2005; 128(6): 803-11.
4. Tantanapornkul W, Okouchi K, Fujiwara Y, Yamashiro M, Maruoka Y, Ohbayashi N; A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod., 2007; 103(2): 253-9.
5. Lofthag Hansen S, Gröndahl K, Ekestubbe A; Cone beam CT for preoperative implant planning in the posterior mandible: visibility of anatomic landmarks. Clin Implant Dent Relat Res., 2009; 11(3): 246-55.
6. Libersa P, Savignat M, Tonnel A; Neurosensory disturbances of the inferior alveolar nerve: a retrospective study of complaints in a 10-year period. J Oral Maxillofac Surg., 2007; 65(8): 1486-9.
7. Yabroudi F, Sindet-Pedersen S; Cone Beam Tomography (CBCT) as a Diagnostic Tool to Assess the Relationship between the Inferior Alveolar Nerve and Roots of Mandibular Wisdom Teeth. Smile Dent J., 2012; 3(7): 12-16
8. Feldkamp LA, Davis LC, Kress JW; Practical cone-beam algorithm. J Opt Soc Am A Opt Image Sci Vis., 1984; 1(6): 612-9.
9. De Vos W, Casselman J, Swennen G; Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: a systematic review of the literature. Int J Oral Maxillofac Surg., 2009; 38(6): 609-25.
10. Kipp DP, Goldstein BH, Weiss WW Jr. Dysesthesia after mandibular third molar surgery: a retrospective study and analysis of 1,377 surgical procedures. J Am Dent Assoc., 1980; 100(2): 185-92.
11. Deepak C, Saravanan B, Kumar SK. CBCT-A Paradigm Shift in the Management of Dental Impactions. Indian J Multidiscip Dent., 2011; 1(2): 68-73.
12. Monaco G, Montevecchi M, Bonetti GA, Gatto MRA, Checchi L; Reliability of panoramic radiography in evaluating the topographic relationship between the mandibular canal and impacted third molars. J Am Dent Assoc., 2004; 135(3): 312-8.
13. Cevidanes LH, Styner MA, Proffit WR; Image analysis and superimposition of 3dimensional cone-beam computed tomography models. Am J Orthod Dentofacial Orthop., 2006; 129(5): 611-8.
14. Swennen GR, Schutyser F; Three-dimensional cephalometry: spiral multi-slice vs cone-beam computed tomography. Am J Orthod Dentofacial Orthop., 2006; 130(3): 410-6.
15. Chasioti E, Sayed M, Drew H; Novel techniques with the aid of a staged CBCT guided surgical protocol. Case Rep Dent., 2015; 2015: 439706.
16. Terakado M, Hashiomoto K, Arai Y, Honda M, Sekiwa T, Sato H; Diagnostic imaging with newly developed ortho cubic super-high resolution computed tomogeraphy (Ortho-CT). Oral Surg Oral Med Oral Pathol Oral Radiol Ended., 2000; 89(4): 509-18.
17. Mehdizadeh M, Ahmadi N, Jamshidi M; Evaluation of the relationship between mandibular third molar and mandibular canal by different algorithms of cone-beam computed tomography. J Isfahan Dent Sch., 2014; 10(3): 183- 90.
18. Killey HC, Kay LW; The maxillary Sinus and its dental implications. Bristol: John Wright, 1975.
19. Hekmatian E, Mehdizadeh M, Iranmanesh P, Mosayebi N; Comparative evaluation of the distance between the apices of posterior maxillary teeth and the maxillary sinus floor in cross-sectional and panoramic views in CBCT. J Isfahan Dent Sch., 2014; 10(2): 145-53.
20. Bianchi J, Goggins W, Rudolph M; *In vivo*, thyroid and lens surface exposure with spiral and conventional computed tomogeraphy in dental implant radiography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod., 2000; 90(2): 249-53.
21. Vannier M; Craniofacial computed tomography scanning: technology, applications and future trends. Orthod Cranio Res., 2003; 6(Suppl 1): 23-30.