Original Article

Comparative study of measurement accuracy of two digital spiral and digital linear tomography with CBCT in implant treatment plan

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ABSTRACT

Statement of the problem: In order to replace lost tooth of patients, we use dental implants which are common. Therefore, accurate measuring of bone height and width before placing implants is necessary.

The aim of this study is evaluating the accuracy of linear and spiral tomography in careful determination of implant site sizes in comparison with gold standard (CBCT).

Materials and Methods: This study is survey of methods and in it, the height and width of regions in maxilla and 8 regions of mandible were measured in two dimensions of bone height and width in a dry skull using linear and spiral tomography. Then, this skull was scanned using CBCT and real sizes of required distances specified on bone cross-section and compared with spiral and linear tomographic sections.

Results: Regarding differences in recorded amounts in measurement of every region (by each of imaging systems), one-way ANOVA statistical test showed no significant differences in accuracy of imaging systems in comparison with each other ($p<0.05$). There were no significant differences in system accuracy by height and width. Spiral tomography, in comparison with gold standard (CBCT) resulted in overestimations for measurements of upper and lower jaws .However; linear tomography underestimated (in comparison with CBCT data) the measurements of the lower jaw.

Conclusion: Although accuracy of linear and spiral tomography is not same with CBCT in determining size of jaw bone, dental tomography could be used in the study of cross-section of short edentulous regions.

Keywords: CBCT, Linear Tomography, Tomography, Spiral Computed

INTRODUCTION

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Use of dental implants is commonly increasing in the treatment of edentulous patients which needs widespread radiographic studies. In order to evaluate height, width and structure of bone in place of implant, there is a need to some various

imaging techniques.[1, 2] Tomography is considered as a suitable method in the study of jaw bone before placing implant. Although there are some ideal methods like CT scan which shows jaw bone shape and place of vital structures with high accuracy, tomography is cheaper and more accessible with less patient radiation dose. [2, 3]

Tomography is one of radiographic methods which is used for cross-sectional images and now is popular. Its popularity reason is using dental implants in recent decade and its lower cost with lower imaging time in comparison with CT imaging. [4]

Common tomography is suggested to evaluate accessible bone quantity and to represent anatomic structures for implant treatment in edentulous people. Various studies recommended using this technique for evaluation before implant surgery. [5]

Spiral tomography is one type of tomography the benefits of which are uniform density, consistent magnification, dimensional stability, lack of parasite lines and ghost images. In digital tomography, there is image calibration capability and transforming it to real size picture. [3]

In recent years, a method called cone Beam computed tomography (CBCT) has been introduced which has high efficiency in oral diagnosis than tomography or common CT. CBCT is more cost-effective [2, 6] and could be used in large continuum of oral and dental surgeries and CT substitution. [7]

Regarding these points and the importance of selecting suitable radiographic methods to evaluate anatomic points and characteristics of jaw bones in implant treatments, we comparatively studied diagnostic accuracy of digital linear and spiral tomography with CBCT in implant treatment planning.

MATERIALS AND METHODS

In this empirical in vitro study, we used a dry skull of edentulous human. The number of required samples in this study, based on calculation of sample size, was 21 but in order to increase accuracy 32 regions were considered.

In this skull, 16 edentulous regions were considered as potential sites for implant placement. These regions were 2 points in maxillary central incisors region(left and right), 2 points in maxillary canine region, 2 points in maxillary molar region, 2 points in maxillary pre-molar region , 2 points in mandibular central incisors region , 2 points in mandibular pre-molar region , 2 points in mandibular first molar region and 2 points in mandibular third molar region .

In each of these 16 points, we were trying to conduct a vertical measurement (bone height) and a horizontal measurement (bone width) in cross-section slice (buccolingual). So, we placed 16 titanium screws in alveolar crest in these regions and 16 screws in the buccal surface of the alveolar ridge in these regions, 0.5 cm below alveolar crest and fixed them so that 32 regions were prepared for imaging and

evaluating. In order to balance soft tissue, skull was covered with eight layers of base plate wax.

After these steps, imaging was done. First, we placed the skull in spiral tomography device, Cranex model (Soredex Company, Helsinki, Finland) and did tomography of 16 regions (each in 3 cross-sections) implement with 4mm slice thickness.

Then, without changing fixed markers on skull, we did linear tomography imaging with Planmeca device, Promax model (Planmeca company,Helsinki,Finland) . Here, 16 tomographies (each region 3 sections) were done by 3mm slice thickness.

Finally CBCT imaging was done by Newton 3G model (NewTom Company, Italy) with a 12- inch field of view. An important point in imaging with 3 systems was attention to same position of skull in them. Therefore, two metal markers, one below orbit of one side and the other in the opposite side far upper than the external auditory meatus of that site to determine Frankfort plan.

This plan during imaging with two tomography systems was placed parallel with horizon (floor) and in CBCT imaging, on floor of the room.

After imaging, we did our measurements. This was done by Oral and Maxillofacial Radiologist 2 times with the 2 week intervals. In the case of difference between first and second measurements in every region, we considered mean of 2 sizes.

Images of Sordex tomography with PSP digital system were prepared and observed in Digora software. Images of Planmeca tomography device which is a digital CCD device were observed with Romexis software. CBCT images were observed by NewTom software (NNT software). All images were evaluated in digital tomography images after enhancement and manipulation of visual condition in computer in order to obtain ideal view and after calibration (eliminating magnification and reaching real size). In order to measure bone height in cross-section of regions, marker's distance to anatomic landmarks on base was measured.

So, in the maxillary central and canine regions, distance of alveolar crest to floor of nose was measured. In maxillary pre-molar and molar region, distance of alveolar crest to floor of maxillary sinus (most laterally of inferior aspect) was measured. Also in mandibular central incisors region , distance from crest to inferior border of mandible , in mandibular pre-molar region , distance to upper edge of mental foramen and in mandibular first and third molars regions , distance from crest to upper wall of infra- Alveolar canal upper wall were measured. In order to measure the width of bone in cross-sections we measured the distance from center of markers that were placed on the buccal surface of the alveolar ridge to the most posterior part of the palatal or lingual cortex (direct horizontal line) and besides bone

height, buccolingual width of bone was measured in 16 regions and in any technique 32 numbers were obtained. It is necessary to say that measurements in every system were done by digital ruler of software. Cross-section in CBCT with 3.5 mm slice thickness was determined.

Finally, obtained results in both digital tomography systems were compared with CBCT which have real sizes as gold standard .In order to ensure dimensional accuracy of CBCT in measuring real dimension, we determined widths of all regions and heights of mandibular central incisors determined by Collis.

Comparison of CBCT results with Collis results indicates high measurement accuracy. After analyzing results with SPSS software, we could find the accuracy of linear and spiral digital tomography systems.

RESULTS

Table 1 shows mean and standard deviation of height measurements of regions in each imaging system. Measurements indicate overestimation of linear and spiral tomography imaging in comparison with gold standard. With differences in recorded amounts of height measurements , one-way ANOVA indicates no significant difference in accuracy of imaging systems in comparison with each other(P-Value=0.376).

Table 2 shows mean and standard deviation of width measurements in both techniques. Measurements indicate overestimation of these systems. With differences in recorded amounts of width measurements, one-way ANOVA indicates no significant difference in accuracy of imaging systems in comparison with each other (P =0.883).

Table1: Mean and standard deviation of" height" measurements in three imaging systems

Imaging technique	Mean	Std Deviation
CBCT	19.3750	5.17475
linear tomography	21.1937	4.81975
spiral tomography	22.2231	5.47977

Table2: Mean and standard deviation of "width" measurements in three imaging systems

Technique imaging	Mean	StdDeviation
CBCT	11.2688	2.92705
Linear tomography	11.2938	2.66420
spiral tomography	11.6950	2.53753

DISCUSSION

In this study, in order to examine accuracy of both spiral and linear digital tomography, we used CBCT as gold standard and compared results. As we pointed out, major application of cross-section (tomography, CT or CBCT) is in implant treatment and finding quantity of patient's alveolar bone (height and width) and morphology. The more the width and height of bone , the larger size we can use implant (fixture) with and by increasing amount of anchorage and better distribution of functional loading forces, we can improve prognosis of implant treatment .

In spite of high resolution of images and accuracy of new CBCT method, reason of emphasis on tomography in this study, is less patient radiation dose, less cost and cheaper devices in comparison with CBCT, so dose in tomography techniques equals to 1/5 to 1/2 panoramic, while dose in CBCT is equals to 3 to 40 Panoramic depending on system and image receptor.

Results of measurement in digital spiral and linear tomography showed no significant statistical difference in obtained means in comparison with gold standard (CBCT). So we can say that accuracy of tomography is acceptable. Shahab [3, 8] reported high validity of spiral tomography in mandible and maxilla measurements. Tallaye poor [9] in his research, accepted accuracy of linear tomography in determining Maxillary Sinus and floor of nose. Bashirzade et al. [1] reported same results. This result is consistent with those of Ballriek [11], Shahab [8], Lascala [12], Oroudahi [13] and Tavakoli.

Minor differences in system accuracy are attributed to Calibration method.

Regarding study results, accuracy of tomography measurements in comparison with CBCT in alveolar bone width is higher than that in alveolar bone height.

Based on results, 56% of measured regions in spiral tomography and 50% in linear tomography show bone width with 1mm accuracy which in height is 50% and 44%

for linear and spiral tomography, respectively.

In Tallayepoor et al. study [9] in Maxilla, measured regions of alveolar crest to floor of nose (bone height) has high accuracy but in width, maxillary posterior regions show more accurate measurements.

CONCLUSION

Results of measurement in digital spiral and linear tomography showed no significant statistical difference in obtained means in comparison with gold standard (CBCT). So we can say that accuracy of tomography is acceptable.

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