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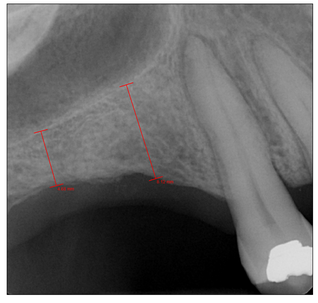
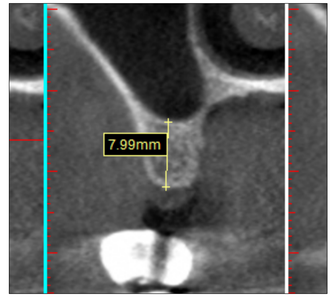
Accuracy of Cone Beam Computed Tomography Versus Periapical Radiography Measurements When Planning Placement of Implants in the Posterior Maxilla | A Retrospective Study



Barsoum, Adam, DMD; Kakumoto, Takahito, DDS; Froum, Stuart, DDS



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Introduction

Intraoral periapical radiography (PA) is the primary diagnostic and most commonly used method for measuring the remaining crestal bone height when implant treatment is planned in the posterior maxillary area (1). A major drawback of conventional periapical radiographs is that 3-dimensional (3D) objects (tooth or ridge) are compressed and superimposed into 2-dimensional (2D) images that are often distorted. The use of cone beam computed tomography (CBCT) avoids this problem. However, not every patient in need of dental implants requires CBCT scan imaging. The purpose of this retrospective study was to compare periapical radiography to CBCT scans for the measurement of alveolar ridge height in edentulous posterior maxillary areas.

Materials and Methods

Twenty patients with 35 sites in total from the NYU de-identified implant database that had combined periapical and CBCT images of the posterior maxilla were selected for analysis of the distance of the alveolar crest to the sinus floor. The cross-sectional images were independently evaluated by two examiners. The distance from the crest of the ridge to the floor of the maxillary sinus was measured at the same distance from the mesial or distal of the natural tooth or implant adjacent to the selected edentulous ridge. Using the same distance from an adjacent tooth or implant allowed precise site orientation with both imaging systems.

A straight line perpendicular to a tangent at the crest of the ridge was extended to the floor of the maxillary sinus. The length of the line was measured and used as the CBCT ridge height. (Fig.1a-b) Periapical measurements of the same area were recorded by extending a straight line parallel to the long axis of the adjacent natural tooth or implant from the alveolar crest to the floor of the maxillary sinus. The length of the line was measured and recorded as the PA ridge height. (Fig.2)

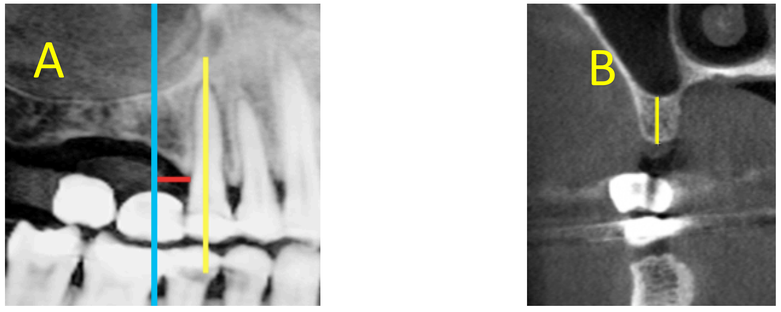

Fig 1A. Measurement on CBCT: Blue line represents the area measured being parallel to the long axis of the adjacent tooth.
Fig 1B. Measurement in cross-sectional plane.

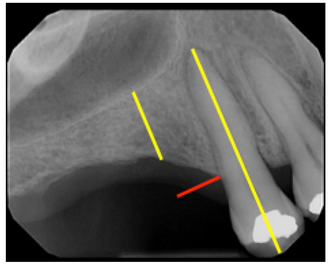

Fig 2. Measurement on PA: Area of interest is parallel to the long axis of the adjacent natural tooth, extending from the crest of the ridge to the floor of the maxillary sinus.

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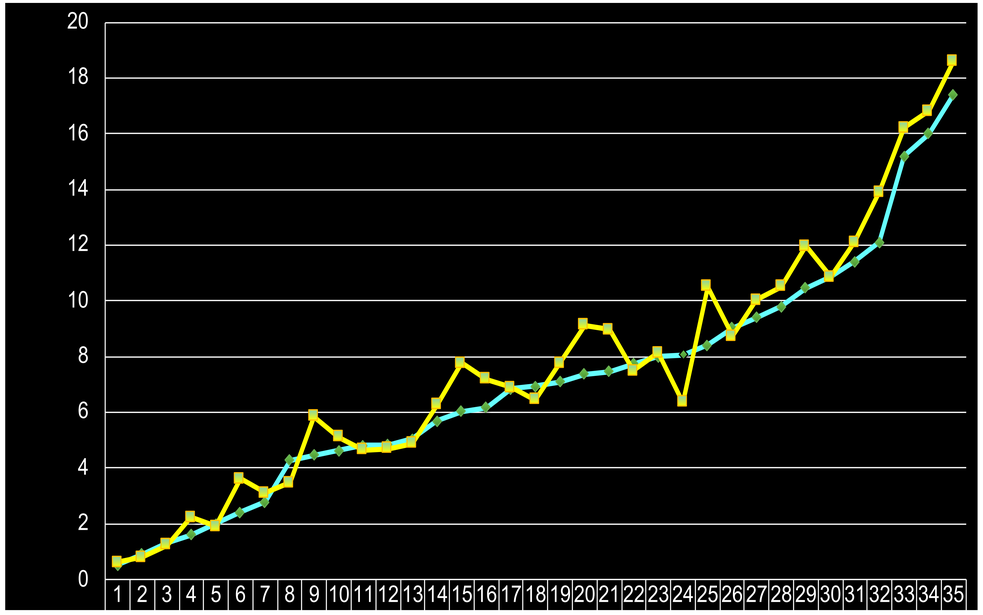
RESULTS

Difference in measurements were consistently seen when the remaining crestal height was measured on periapical radiographs and CBCT images. Results from the sites are listed in Table 1. When the threshold was set to 1mm, the discrepancy observed was 34% in 12 sites. Periapical radiographs overestimated the measurements 66% of the time in 23 sites. The average discrepancy was 0.75mm and ranged from -1.69 to +2.1mm when PA minus CBCT distance measurements were calculated.



PA vs CBCT Discrepancy

≥ 0.5mm: 21/35 (60%)

≥ 1.0mm: 12/35 (34%)

Sites	CBCT	PA	PA minus CBCT
1	0.51	0.61	0.1
2	0.9	0.8	-0.1
3	1.3	1.24	-0.06
4	1.6	2.22	0.62
5	2	1.91	-0.09
6	2.4	3.6	1.2
7	2.77	3.1	0.33
8	4.27	3.47	-0.8
9	4.45	5.85	1.4
10	4.63	5.11	0.48
11	4.81	4.65	-0.16
12	4.83	4.68	-0.15
13	5.03	4.88	-0.15
14	5.68	6.26	0.58
15	6.02	7.76	1.74
16	6.17	7.19	1.02
17	6.84	6.88	0.04
18	6.93	6.44	-0.49
19	7.08	7.77	0.69
20	7.37	9.12	1.75
21	7.45	8.97	1.52
22	7.74	7.49	-0.25
23	7.99	8.12	0.13
24	8.05	6.36	-1.69
25	8.4	10.5	2.1
26	9.04	8.72	-0.32
27	9.41	10.02	0.61
28	9.8	10.5	0.7
29	10.47	11.96	1.49
30	10.88	10.86	-0.02
31	11.4	12.1	0.7
32	12.1	13.9	1.8
33	15.2	16.2	1
34	16	16.8	0.8
35	17.4	18.6	1.2

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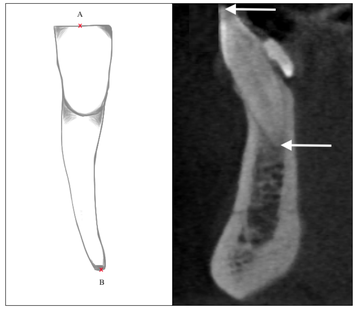
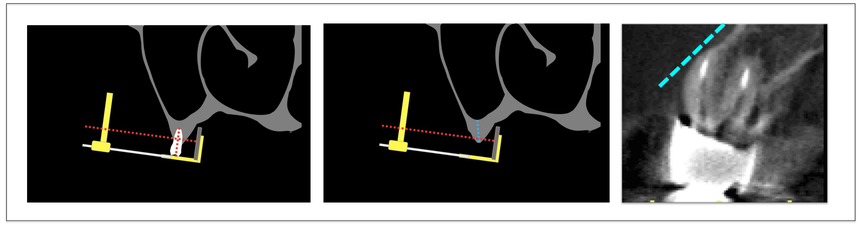
Discussion

Inaccuracy of PA

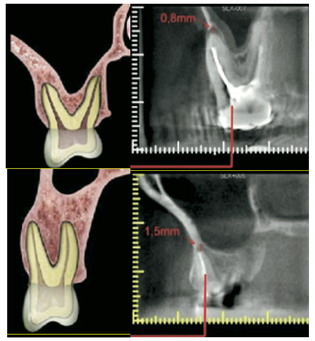


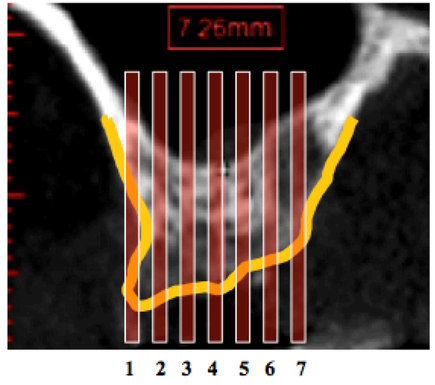
In tooth measurements the incisal edge and root apex allow for repeatability and act as landmarks for measurement. Additionally often times the tooth and ridge have dissimilar long axis and as the tooth is extracted it is difficult to use the paralleling cone technique correctly.



Anatomy of Posterior maxilla

If the sinus extends in between the roots in a triangular shape it is often insufficient radiolucency to be detected on the periapical, similar to incipient decay on buccal/lingual surfaces and therefore causes an overestimation.

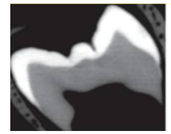




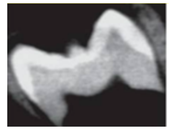
The shape of the alveolar ridge height as seen in these cross-sectional images may appear longer on a periapical radiograph than in cross-sectional image, as superimposition will show the height to be as high as the highest point of the ridge #1, but in reality the area of interest for implant placement #4 has inadequate ridge height.

Accuracy of CBCT

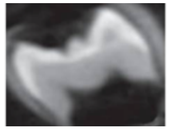
Voxel size of the CBCT should be considered to optimize the accuracy of the linear measurements. Even though CBCT scans employing a larger voxel size offer lower radiation exposure, they are associated with decreased spatial resolution compared to scans with a smaller voxel size. This factor makes repeatability and reproducibility of measuring points more challenging.



40 µm



70 µm



200 µm

500 µm

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CONCLUSION

CBCT imaging is a valuable adjunct in radio-anatomical and radio-diagnostic observations in the posterior maxilla region. Furthermore, CBCT measurements were shown in the current study to be more accurate in assessing the remaining crestal ridge height apical to the sinus membrane when compared to PA radiographs. More research is necessary to verify the findings in the current study.