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Original Research

Digital Panoramic radiography for implant planning: Quick and Simple method

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***ABSTRACT*:**
Aim & Objectives: To assess the accuracy of vertical height measurements on direct digital panoramic radiographs. **Material & methods**: 10 dry adult human hemi-mandibles were taken. Acrylic templates were prepared on mandibles with wax layer below it as a soft tissue simulator. Metal balls were embedded in acrylic templates as a reference object. Digital panoramic radiographs of mandibles with acrylic template were taken. Radiological length of metal ball and vertical alveolar bone height was measured on imaging software with mouse driven calliper. The magnification factor was calculated at the given site by dividing the actual diameter of the object by the diameter measured on the radiographic image. Actual bone height directly measured by sectioning of dry hemi-mandibles at marked site. Radiological (ABH1) and actual measurements (ABH2) were compared and data was statistically analysed. **Results**: There was no statistically significant difference between two groups (ABH1 & ABH2) found (p=0.86). **Conclusion**: In conclusion vertical measurements had acceptable accuracy and reproducibility when software based calibrated measurement tool used, Confirming that digital panoramic radiography can be reliably utilised to determine the pre-operative implant length in molar mandibular segment. Hence using this simple and quick method the real bone height can be arythmatically evaluated.
Key words: Panoramic radiography, implant imaging, Digital panoramic radiography, implant planning.

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INTRODUCTION:

Implant surgery in posterior mandible is a challenging operation, which can cause serious complication of inferior alveolar nerve injury, resulting in sensory disturbance in lower lip area.[1] Before dental implant surgery it is a prerequisite to assess the height of residual alveolar bone in the area where implants are to be placed, the location of the nasal floor and the maxillary sinus floor, the location of the mandibular canal, detection of lesions within the jaw bones, the interval to the adjacent dental roots and so on.[2] The diagnostic phase of dental implant therapy and, the proper choice of radiographic examination are important to the long-term success of a dental implant. The accuracy of image measurement is an essential requirement of any radiographic technique used for dental implant diagnosis.[3] This is best archived by CT and Cone beam CT (CBCT) but these modalities have their own limitations like high radiation dose, metallic artefacts and most importantly its high cost and its limited availability.[4] Panoramic radiography one of the widely used technique which provides imaging of both the jaws with comparatively lower radiation exposure at low cost and crucially its easy availability in remote areas too as compared to CT and CBCT.[5] Hence this study was conducted to assess the accuracy of vertical height measurements on direct digital panoramic radiographs using metal balls as radio-opaque reference object positioned on the dry mandible.

MATERIAL AND METHODS:

Ten dry human hemimandibles were used in this study. Layer of wax sheet was adapted over the ridge of mandible as a soft tissue simulator. An acrylic template was prepared over the wax sheet for each mandible using clear acrylic and markings were done in the region of first molar, [Figure 1]. Two small metal balls of known diameter (4.5 mm) were embedded in the acrylic template on each mandible at a first molar region on both sides as a radiographic reference objects, [Figure 2]. The mandibles were placed on a PVC plate and laid on digital panoramic machine (CS 8000C Panorex) at a standard position so the midline laser beam was approximated in the middle and y line crossing the canine region, [Figure 3]. Digital panoramic radiographs were obtained of each mandible with acrylic template using standardised parameters, [Figure 4]. After taking radiographs the radiological measurements were taken by using Kodak imaging software's measurement tool with mouse driven calliper. Radiological diameter of metal ball and vertical alveolar bone height from aleveolar crest till roof of mandibular canal in the same region, [Figure 5]. The magnification factor was calculated at the given site by dividing the actual diameter of the object by the diameter measured on the radiographic image. Using this method, the evaluation of the height of alveolar bone available for implantation can then be determined by the application of the following mathematical formula.

$$ADB / RDB = ABH_1 / RBH$$

$$\text{therefore, } ABH_1 = ADB \times RBH / RDB$$

Where,

- ADB = Actual diameter of metal ball (which is 4.5 mm)
- RDB = Diameter of metal ball on radiograph.
- RBH = Bone height available for implantation measured from the radiograph.
- ABH_1 = Actual bone height available.

Sectioning of hemimandibles at marked sites where metal balls were placed done by using die cutting machine for direct measurement of actual bone height (ABH_2) by digital vernier calliper with precision of 0.02mm, [Figure 6, 7]. Hence the Actual bone height measured by above mathematical formula (ABH_1) is compared with actual bone height obtained by direct sectioning of mandible (ABH_2).

We considered this real measurement as a gold standard and compared it with radiographic calculated measurements. The obtained data was statistically analyzed using SPSS 18 software.

RESULTS:

All Samples with the values of ABH_1 and ABH_2 were tabulated, [Table. 1].

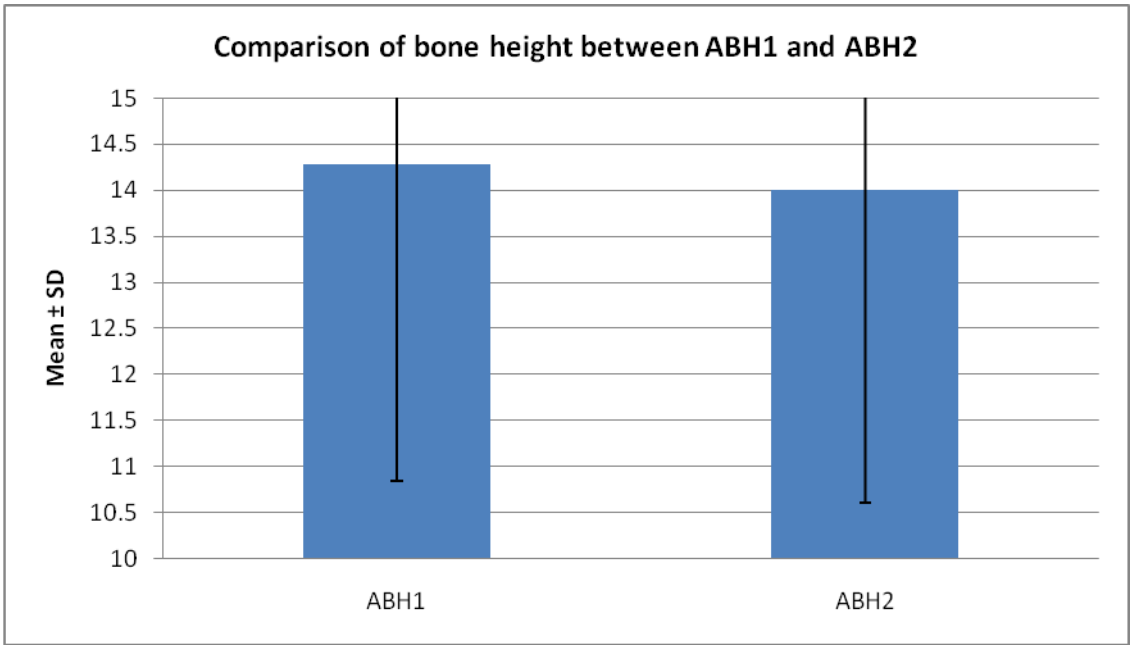
Table 1: Radiological (ABH_1) and actual (ABH_2) bone height measurements of all samples

Sr.	Sample	ABH1	ABH2
1	Sample 1.1	15.09 mm	15.00 mm
2	Sample 1.2	14.86 mm	14.00 mm
3	Sample 2.1	12.1 mm	13.00 mm
4	Sample 2.2	13.00 mm	12.5 mm
5	Sample 3.1	16.3 mm	15.5 mm
6	Sample 3.2	18.29 mm	19.00 mm
7	Sample 4.1	17.4 mm	15.00 mm
8	Sample 4.2	17.80 mm	18.00 mm
9	Sample 5.1	9.19 mm	9.09 mm
10	Sample 5.2	8.80 mm	9 mm

Mean values of ABH_1 (14.28 ± 3.43mm) & ABH_2 (14.0 ± 3.39mm) were compared with the mean difference of 0.27 and't' value was 0.18. Hence there was no statistically significant difference between two groups (ABH_1 & ABH_2) found (p=0.86), [Table 2, Graph 1].

Table 2: Comparison of mean values of ABH_1 and ABH_2

Parameter	ABH1	ABH2	Mean difference	95% of difference	t-value	p-value
Bone height (mm)	**14.28 ± 3.43**	**14.0 ± 3.39**	**0.27**	**-3.4 – 2.88**	**0.18**	**0.86**



Graph 1: Comparison of bone height between ABH_1 and ABH_2

DISCUSSION:

Panoramic radiography by far is a very popular and widely accepted technique. Apart from the routine uses, it is also used for dimensional and angular measurements which help to determine the inclinations of impacted teeth, relative position of the roots and for implant site assessment.[6] However, image distortion or magnification is one of the inherent short coming of panoramic radiography. Taking this into consideration we have conducted the present study to evaluate the precision of dimensional measurements on panoramic radiographs.

The prospective clinical study using the panoramic radiographs to evaluate the preoperative planning of posterior mandibular implants showed that panoramic radiographs appeared to be sufficient to evaluate available bone height before insertion of posterior mandibular implants when a safety margin of at least 2 mm above the mandibular canal is respected.[1] In our study we have also observed that there was no significant difference between radiographic and actual measurements. Digital panoramic radiographs have many advantages, such as minimal storage required in comparison with film radiographs, explanation can be given to the patient in front of the monitor, the radiograph appears on the monitor immediately after imaging, the data can be copied readily, it can be easily measured and magnified using various tools, contrast can be controlled readily and the effective radiation dose is smaller in comparison with film panoramic radiography.[7, 8, 9] Considering above points we used digital panoramic machine (Kodak 8000C Panorex) in our study which was proved to be very advantageous and accurate imaging tool. The method we have used in our study is been utilised routinely by many implantologists but there was no any confirmatory research data to prove the specificity and reliability of the method. Hence we have designed the study to confirm it by measuring the actual vertical dimension by direct sectioning of mandible at the given site. Hatcher et al. in 2003 concluded that the CBCT can assess the implant site adequately.[10] In another study Naitoh et al. in 2010 depicted that by using CBCT, the postoperative findings of incisor implants could be assessed.[11] However Bolin et al. in some another study suggest panoramic radiography could be useful for the evaluation of the bone height in mandibular region posterior to the mental foramen.[12] In our study we have also found significant results in the comparison of radiological vertical height and actual vertical height.

CONCLUSION:

Vertical measurements had acceptable accuracy and reproducibility when software based calibrated measurement tool used, confirming that digital panoramic radiography can be reliably utilised to determine the pre-operative implant length in molar mandibular segment. By using this simple and quick method the real bone height can be arythmatically evaluated. Hence in the light of our results we recommend to consider digital panoramic radiography as one of the imaging modality in implant planning where CBCT is not available.

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