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Original Research Paper

Dental Science

TRANS-TOMOGRAPHIC EVALUATION OF IMPLANT SITE

Anand choudhary Professor Dept of Oral Medicine and Radiology Hazaribagh Dental College

Pallavi Kesarwani* Senior Lecturer Department of Oral Pathology Hazaribagh Dental College
*Corresponding Author

ABSTRACT

Aim: The aim of this study was to evaluate the reliability of panoramic and cross sectional radiography using panoramic machine, to accurately depict the anatomical structures in posterior region of the mandible which is of great help in implant planning.

Methods and Materials: The study was carried out using 21 dry edentulous human hemi mandibles. The area selected for analysis was 2 cm distal to anterior limit of mental foramen. A panoramic radiograph and a cross-sectional radiograph were made for the specimen using panoramic machine (Gendex Orthoralix 9200). The mandible was sectioned at selected site. The distance from the alveolar crest to superior border of mandibular canal and inferior border of mandible was measured in panoramic and cross sectional radiograph at the selected site and compared with the actual measurements in the cut- section of the mandible (Gold Standard)

Results: All the panoramic and cross sectional radiographs accurately depicted the cortical border of the mandible and the inferior alveolar canal. The measurements were more in panoramic radiographs by a mean of 0.29mm ± 0.25mm in cross sectional radiographs by a mean of 0.62mm ± 0.20mm compared to gold standard for bone height above superior border of mandibular canal. The difference between the measurements made in radiographs and cut section was statistically significant (Wilcoxon's signed ranked test).

Conclusions: It was concluded that both the imaging techniques were reliable for vertical linear measurements in the posterior region of the mandible. However a minimum of 2mm of safety margin is recommended. In cases where additional information about bucco-lingual position of mandibular canal is required, cross sectional radiograph should be used.

KEYWORDS : Transtomography, implant, posterior mandible.

Introduction: Few advances in dentistry have been as remarkable as dental implants.[1] They are the nearest equivalent reaplacement to natural teeth.[2] The treatment for complete or partially edentulous patients changed 30 years ago with the provision of first prosthesis supported by osseointegrated dental implant by P I Branemark.[3]

Dental implant placement involves meticulous pre, intra operative and post operative planning.[4] The assessment of bone support in endosseous implants is fundamental to the clinical utility of implants for restoration and function. Radiographs are critical tool for assessment of bony architecture, and are useful for each of the three phases of implant treatment [5,6] However common radiographs like intraoral peri apical radiograph, panoramic radiograph etc. donot provide accurate evaluation of quality and quantity of available bone, because the images they produce are of unpredictable magnification and represent only single (facial) aspect of maxilla and mandible.[7,8] Therefore tomographic methods; either conventional or computed tomography is preferred.[9] Although computer tomography is an ideal technique, it has several disadvantages which includes high cost, high radiation dose, metal artifacts, and less availability of accurate software .[10]

Conventional cross sectional tomography using an OPG machine provides acceptable image details in acquiring cross sectional images in the posterior region of the mandible. It has low cost, low exposure dose, and acceptable image details.[6,10]

Now the newer versions of the OPG machines has built in tomography function. Therefore a need was felt to evaluate the accuracy of the cross sectional tomography using a panoramic machine unit to measure the accurate depth of mandibular canal in the posterior region of mandible.

METHODOLOGY:

Pre radiographic phase:

Twenty one dry human hemi mandibles were used in the study. A site 2 cm distal to anterior limit of mental foramen was selected and an orthodontic wire of 16 gauge was adapted and fixed to lateral surface of alveolar ridge of the mandible at this site. This served as a reference line in radiographic examination, for localization of proposed area of interest in both panoramic and cross sectional radiograph.

RADIOGRAPHIC PHASE:

For each of the hemi mandible section

Two radiographs were made using the panoramic machine unit:

- Panoramic radiograph
- Cross sectional radiograph (transversal tomography or transcan)

The exposure parameters (electric factors) used for the both the procedures were the lowest one established for this equipment for the respective procedures (For panoramic radiograph it was set at 60 kVp 3 mA and 12 seconds and for Trans-tomography it was set at 60 kVp, 3mA and 5 seconds). An added aluminium filter of 2 cm was placed in front of the equipment collimator diaphragm for both the radiographic procedures, in order to impede film over exposure, due to absence of soft tissue and opposite side of the mandible.

The hemi mandibles were placed over the chin rest (used for positioning edentulous patients or patients whose anterior teeth are missing) and secured using plastic sticking tape; parallel to the ground. The cross sectional radiograph of the dry hemi mandibles were made utilizing transcan positioning device.

PROCESSING AND INTERPRETATION OF RADIOGRAPHS

All films were processed manually at ideal processing conditions. Each radiograph was traced. Three cross sectional images were formed. The image which sharply depicted the metallic wire and best depicted the anatomic structures of the proposed site was selected. The linear distance from the highest point on the crest of alveolar ridge to superior border of mandibular canal and inferior border of mandible was measured at the site of reference (region where the metallic wire was fixed) in both panoramic and cross sectional images with the help of Vernier calipers precisely. Mandibles were sectioned in the region of reference, at 90 degree in relation to their base with the help of a metal cutting saw. The above measurements were made on the mandibular specimen using Vernier calipers. All the measurements made in panoramic

radiograph were divided by 1.25 and cross sectional radiograph by 1.40 to deduct the inherent magnification of the machine for the respective procedure. The result were obtained and statistically analysed using Wilcoxon's signed ranked test. (Figure 1&2).

Results:

OBSERVATIONS:

Visibility of the anatomical structures in the radiographs:

The outer cortex of the mandible and mandibular canal was well demarcated, in all the panoramic and cross sectional radiographs.

MEASUREMENTS MADE IN PANORAMIC RADIGRAPH, CROSS-SECTIONAL RADIOGRAPH AND CUT SECTION OF THE MANDIBLE [Table 1, graph1]

The mean distance from crest of the edentulous mandible to upper border of mandibular canal in the panoramic radiographs was 11.85 mm ±1.32mm, in cross sectional radiographs it was found to be 12.19 mm ±1.39 mm and in the cut section of the specimens mean was found to be 11.57mm ± 1.39 mm. (table 1, graph 1)

The mean measurement of the distance from alveolar crest to lower border of the mandible measured in panoramic radiographs was 22.4mm ±3.01mm, in cross-section radiographs it was 22.1 mm ± 2.9mm and in cut section it was 22.10mm ± 3.01mm.

COMPARISON OF MEASUREMENTS MADE IN PANORAMIC, CROSS-SECTIONAL RADIOGRAPH AND CUT SECTION OF THE MANDIBLE [Table2, Graph2]

Distance from Alveolar Crest to Superior Border Of Mandibular Canal

a) The mean difference for the measurements made between panoramic radiograph and cut section of the mandible at the reference site was 0.29mm ± 0.25 mm.

b) The average difference for measurements made between cross sectional radiograph and cut section was 0.62 mm ± 0.20 mm.

This difference was found to be statistically significant p< 0.05.

Distance from Alveolar Crest to inferior Border Of mandible.

The mean difference for measurements made in panoramic radiographs and cut section of mandible was 0.29mm ±0.40 mm.

The average difference between the measurements made between cross sectional radiograph and cut section was 0.60 mm ± 0.39 mm.

This difference was found to be statistically significant p< 0.05.

A highly significant correlation was found between panoramic radiographs and cross sectional radiographs for both the measurements.[graph3]

[Table 1] Comparison of measurements made from alveolar crest to superior border of mandibular canal

	Panoramic radiograph (PAN)	Cross – sectional radiograph (Cr-Sec)	Cut – section	Comparison of measurements		
				PAN-Cut sec	Cr-Sec-Cut sec	PAN - Cr sec
Range (mm)	10.2-14.3	10.3-14.7	9.9-14.1	-0.4 - 0.7	0.2 - 1	-0.9 - 0.5
Mean ±SD (mm)	11.85 ±1.32	12.19 ±1.39	11.41 ±1.55	0.29 ±0.25	0.62 ±0.20	-0.34 ±0.30
Difference%				2.6%	5.94%	3.27%
z value				3.40	3.47	4.03
p value				<0.05	<0.05	<0.05

z value for Wilcoxon's signed ranked test

p value for significance (p<0.05 – significant)

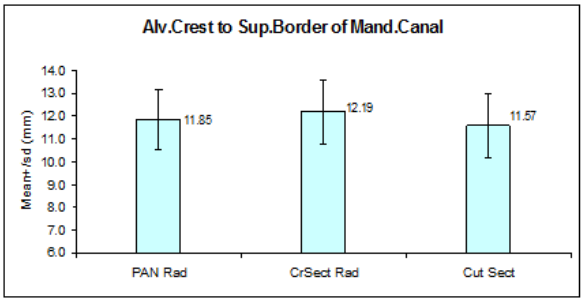
[Table 2] Comparisons of measurements made from alveolar crest to lower border of mandible.

	Panoramic radiograph (PAN)	Cross – sectional radiograph (Cr-Sec)	Cut – section	Comparison of measurements		
				PAN-Cut sec	Cr-Sec-Cut sec	PAN - Cr sec
Range (mm)	17.9–28.2	18.1–28.7	17.3–27.8	-0.4 - 0.7	-0.5–0.8	-1.4–1.5
Mean ±SD (mm)	22.40 ±3.01	22.70 ±2.90	22.10 ±3.01	0.29 ±0.40	0.60 ±0.39	-0.30 ±0.55
Difference%				1.3%	2.6%	-1.4%
z value				2.70	3.52	2.91
p value				<0.05	<0.05	<0.05

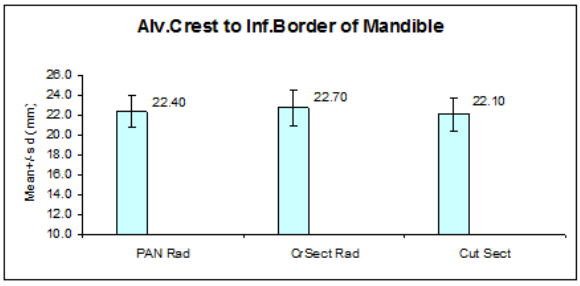
z value for Wilcoxon's signed ranked test

p value for significance (p<0.05 – significant)

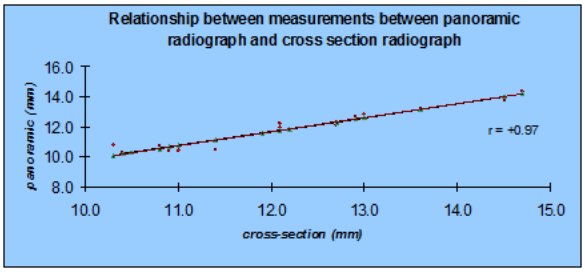
[GRAPH – 1]



[GRAPH – 2]



[GRAPH – 3]



Discussion

For implant surgery in posterior region of the mandible, the optimal technique used should determine the location of mandibular canal in relation to alveolar crest within 1-2mm, as well assess the alveolar width and inclination of the alveolar ridge.[11,12]

In spite of many disadvantages, panoramic radiography has been used as the single most common radiographic examination in implant treatment planning. [13,14]At present, some form of cross-sectional imaging is recommended by American Academy of Oral

and Maxillofacial Radiology for most patients receiving Oral Implants. [9,15]

The panoramic machine used in the present study, had facility to produce cross sectional images along with conventional panoramic radiographs. It produced cross sectional image based on the principle of Transtomography. The projection technique combines the theory of translational scanning with the movement principle of conventional linear tomography.

A site 2 cm behind the anterior limit of mental foramen was marked for radiographic examination. In its course through the mandible the mandibular canal is more clearly visible at and behind the molar region in panoramic radiographs.[16,17]

Reliability of panoramic and cross sectional radiographs in accurately delineating anatomical structures at the implant site:

In all the panoramic and cross sectional radiographs the cortical border of mandible as well as inferior alveolar canal was clearly visualized While comparing various radiographic methods in localization of inferior alveolar canal it was found that Computer tomography gave the most accurate localization of mandibular canal in edentulous mandible, followed by cross-sectional tomography and panoramic radiography. Peri-apical radiography were least accurate in assessment of inferior alveolar canal.[18,19]

Accuracy of the measurements made in panoramic and cross sectional radiographs:

While measuring distances from the crest on mandibular ridge to the inferior alveolar canal, it was found that panoramic radiograph overestimated the distance of alveolar crest to superior border of mandibular canal by an average of 0.29mm. While measuring the overall height of the mandible; the distance from alveolar crest to lower border of the mandible was overestimated by 0.29mm. Both the measurements were less than 1mm.

The panoramic radiograph of a correctly positioned patient/jaw is sufficient enough for the measurement of the vertical dimension.[20] In a study by Tal and Mosses, measurements made in panoramic radiographs were compared with computed tomograms and was found to be sufficiently accurate.[21] However in various studies, it were reported that panoramic radiograph was inaccurate in determining the vertical bone height for pre operative implant treatment panning especially in anterior jaw region.[22]

The cross sectional radiographs overvalued the distance of the alveolar crest to upper border of inferior alveolar canal by an average of 0.62 mm and to the lower border of mandible by 0.60mm.

The values were slightly overestimated but acceptable for implant placement[23,24]

However, the measurement accuracy of cross sectional radiography using panoramic machine depends upon various factors such as correct positioning, projection view and magnification. The machine used in the present study had aligning templates, to align particular section of jaw; using the impression of the jaw. This intraoral aligning template is better in accurate positioning of the patients for tomographic imaging because the exact site and orientation of tomographic site can accurately be determined. Image quality in cross sectional tomographic imaging also depends upon form of the dental arch and its compliance with the projection view. [25] Errors in tracing caused by slight blurring of the cortical borders of the mandible, may have contributed to slight amount of measurement discrepancy in the present study.

In a recent study it was found that computed tomography produced more accurate images, compared to linear tomography using panoramic machines. [6,22]

In routine cases it may not be useful to use CT because of greater cost, high radiation dose and accurate software. The dose absorbed by most organs is 3-10 times higher for CT than for conventional tomograms.[25]

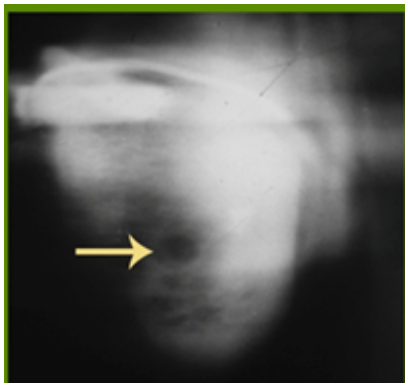
American Academy of Oral and Maxillofacial Radiology recommends cross sectional radiography for less than 7 implant sites and CT for multiple implants assessment. The much lower price of both equipment and examinations make the cross sectional conventional tomography more attractive than CT.[25]

Conclusions:

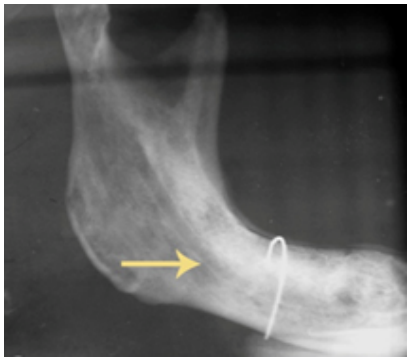
The present study was conducted to assess the efficacy of panoramic and cross sectional radiographs; using panoramic machine in evaluating implant site in posterior region of the mandible. Based on the observation of the present study it was concluded that:

- Both panoramic radiographs and cross sectional tomograms were effective in delineating the cortical border of the mandible and locating the mandibular canal. Panoramic radiograph delineated the mandibular canal in superior-inferior aspect; whereas cross sectional radiograph in addition provided the bucco-lingual location of the mandibular canal.
- However both the radiographic methods overestimated the bone height above the superior alveolar canal by an average which was less than 1 mm. The distance is very meager during clinical placement of implants, in view of the safe distance of ±2mm, considered by the implantologist during implant placement.
- The panoramic radiographs presented values closer to the true measurements of dry mandibles than cross sectional radiographs.

The results of this study indicate that both of these imaging systems could be useful for vertical measurements in posterior region of the mandible in assessing the implant sites. However, further studies using clinical settings of implant placements in patients are required to validate the accuracy of these imaging systems.



[Figure 1]: Radiographic image of cross section of mandible



[Figure 2]: Panoramic image of mandible

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