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Original Research Article

To Evaluate the Vertical Magnification for Implant Planning in Complete Edentulous Patients using Digital Panoramic Machine Kodak 8000

Juhi Singh[1], Maneesh Rajan[2], Arunendra Singh[3], Santosh Mishra[4]

[1]Ex-SR, SSMC, Rewa
[2]Ex-Senior Lecturer, MMDC, Darbangah
[3]Senior Dental Officer, CHC Sarsaul, Kanpur
[4]Assistant Professor, SSMC, Rewa

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Corresponding Author: Dr. Juhi Singh
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Abstract:

To evaluate the variation in vertical magnification of digital panoramic machine Kodak 8000 Panoramic System in relation to different regions of maxillary and mandibular edentulous arches and to compare this variation in magnification. The study sample of 40 patients was divided into 2 different groups (20 each) depending upon the two different diameters of metallic spheres i.e., 3mm & 6mm used as radiographic reference. Each group was further subdivided into 2 subgroups depending upon the arch of placement of metallic sphere. The metallic spheres were placed in 4 different regions of maxilla and mandible. Digital panoramic radiograph was obtained and was subjected for measurement using Trophy Dicom Software. Data was analyzed statistical analysis by paired "t" test and student "t" test. The present study has established that there is variation in magnification both in vertical and horizontal direction for maxilla and mandible. In maxillary arch vertical magnification rate shows lowest values for 3mm spheres in right posterior, right and left anterior regions. In mandibular arch vertical magnification shows lowest values for 3mm spheres in right and left posterior, right anterior regions. The vertical magnifications in posterior regions were higher than anterior region. On comparing the magnification of maxilla and mandible, values were higher in maxilla. The study concludes that radiographic reference objects (use of metallic spheres) can be used as a steady method for radiographic assessment in edentulous patients, as there is variation in the magnification in both maxillary and mandibular arch area specifically.

Keywords: Panoramic, Radiography, Magnification, Digital Radiography, Edentulous.

Introduction

Field of diagnosis and medicine was revolutionized with the advent of radiation for imaging purpose. In the field of dental medicine, diagnosis and treatment planning panoramic radiographs are the most contributing ones. [1,2]Panoramic radiography provides a descriptive correlation of maxillofacial structures within the focal trough. It also specifies the location of important anatomical structures in relation to the alveolar crest. It also endow with estimation of bone height, vital structures, and any pathological conditions in the area. [3] Panoramic radiography with the introduction of digital panoramic radiography has the years trounce many confines of controlled magnification in the vertical dimensions, decreased overlapping of tooth contact areas and single point contact of the rotating beam onto the object to allow for a sharper, well defined images.[4]

Also digital image acquisition results in reduced processing time and aided with variety of image manipulation tools. [5] Foremost shortcoming of panoramic radiography is magnification, discrepancy in magnification occur according to the type of equipment used and the position of the desired landmarks during image acquisition. [6] Also, the amount of magnification is not the uniform throughout. Distortion results from varied magnification in the horizontal and vertical dimensions in different parts of an image. [3] Considering a standard magnification ratio for assessment during treatment planning is complex and should be avoided.[6]As panoramic radiograph is most commonly used diagnostic tool and aids in treatment planning, the present study was conducted to evaluate the variation in vertical magnification of digital panoramic machine in relation to eight regions of maxillary and mandibular edentulous arches.

Materials & Methods

This prospective study conducted on edentulous patients attending the OPD seeking for complete denture fabrication, and was approved by the Institutional human ethics committee & Institutional Research & Development committee. A total of 40

individuals, including both males and females, were randomly selected for the study after obtaining their written informed consent. The total sample was divided into 2 groups of 20 subjects each, according to the variation in diameter of metallic balls (3mm & 6mm) used in the study. These groups were further divided into 2 subgroups each of 10 patients according to the arch of placement of specified radiopaque reference object (metallic sphere) i.e., maxillary ormandibular arch (Flow chart: 1). In first subgroup metallic ball was placed at 4 sitesin maxillary arch and in second subgroup metallic ball were placed at 4 sites in mandibular arch. Metallic balls in each arch at a time were placed in anterior canine region and posterior 1st molar region bilaterally on the edentulous arch considering adjacent associate anatomical landmarks in mind to identify the position on edentulous arch.

Primary impression of the selected edentulous individual was made using impression compound and metallic non perforated impression tray and primary cast was prepared using dental plaster. On the prepared primary cast, temporary base plate was fabricated using cold cure acrylic both for maxillary and mandibular arch. Small circular slots were prepared in canine region and molar region bilaterally in order to seat the radiopaque reference object i.e., metallic sphere as close as possible to alveolar crest. Then a wax rim of desired vertical height was fabricated over the base plate in which the metallic spheres were thereby placed.(fig. 1a and 1b)

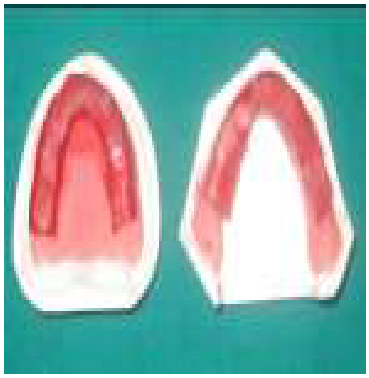

Figure: 1a

Figure 1b

The prepared base plate with wax rim was placed in patient's mouth and patient was positioned in digital panoramic machine KODAK 8000 PANORAMIC SYSTEM following proper protection and safety measures. (fig.2) The radiograph thus obtained had the radiographic markers in position which was later on subjected to metric analysis invertical dimensions for each sphere using Trophy Dicom Imaging Software. For measurement in vertical directions, most prominent points in the vertical planes we remarked and the diameters of the reference spheres were measured. (fig.3)

Figure 2: Patient positioned in panoramic machine

Figure: 3 Metric analysis of obtained radiograph done on DICOM imaging software

Statistical Analysis: The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD. T test was applied to compare the radiographic and real values and student "t" test was employed to test the significance of two means. Calculation of mean radiographic diameter was

done and percentage mean magnification was calculated using the formula as follows; Percentage (%) magnification= 1- (radiographic diameter/original diameter) X 100 Magnification factor= 1+ (% magnification/100)

Result & Discussion

Magnification of maxillary right posterior region, right anterior region, left anterior region, left posterior region vertically (Paired 't' test) (Table 1) The percentage vertical magnification inmaxillary posterior region ranges from3.33% to 5.67% in a group A1 with 3 mmmetallic sphere as reference object whereas its value in group B1 with 6 mm metallic sphere as reference object ranges from 4.83% to 7%. The percentage vertical magnification in maxillary anterior region ranges from 2.67% to 3% in a group with 3 mm metallic sphere as reference object whereas its value in group with 6 mm metallic sphere as reference object ranges from 2.67% to 3.83%.

Magnification of mandibular right posterior region, right anterior region, left anterior region, left posterior region vertically (Paired 't' test) (Table 2)

The percentage vertical magnification in mandibular posterior region ranges from3.67% to 4% in a group A2 with 3 mm metallic sphere as reference object whereas its value in group B2 with 6 mm metallic sphere as reference object ranges from 5%to 5.67%. The percentage vertical magnification in mandibular anterior region ranges from -0.33% to 2.67% in a group with 3 mm metallic sphere as reference object whereas its value in group with 6 mm metallic sphere as reference object ranges from 3% to 4.50%.

Comparison of vertical magnification of various metallic spheres among different groups (Table 3)

On comparing the vertical magnification for both the groups a significant difference was obtained with all the values obtained were higher for group B with 6 mm metallic ball except for the percentage magnification in left anterior region which was higher for group A with 3 mm metallic ball.

Comparison of Magnification of metallic sphere of both the dimensions in Maxillaand Mandible (Overall – irrespective of Groups) (Table 4)

On comparing for maxilla and mandible in anterior and posterior region it was observed that all obtained values were obtained statistically significant and were higher in maxilla than in mandible. Panoramic radiography is pioneer of modern dental radiology, as it produces a single projection image for the visualization of maxillomandibular structers. [7] The anatomic intricacy of this region makes the diagnostic imaging a complex task, which was resolved by the advent of rotational panoramic radiography unit in 1946 hence revolutionizing the field of medicine and diagnosis. [8] With the passage of time rotational panoramic radiography has overcome many hurdles of imaging and evolved to the present form of digital acquisition system. Panoramic radiography is often the first-choice method for the implants planning because it provides information of the anatomical and pathological conditions of maxillomandibular region8 and vertical bony dimensions [9] in a single film. However, magnification is the major disadvantages of this image modality for treatment planning and without knowing the magnification degree and the image distortion, errors in measurements may occur. [9] Distortion arises because the degree of magnification varies in the horizontal and vertical planes. [10] To determine the exact magnification in a particular area, it requires the use of reference objects with known dimensions. The true magnification is calculated from the ratio of the projected to true length of the reference object. [11] The magnification, which differs in the vertical and horizontal direction depending on the anatomic areas, is a basic setback in panoramic radiographs. [12] In spite of these drawbacks, panoramic radiography has been the most commonly employed radiographic technique used for implant treatment planning. [2] Present study was conducted on edentulous patient keeping the 3mm and6mm metallic sphere as reference object to determine the magnification of specified regions as sphere eliminates errors due to oblique projections, which is a major drawback with linear objects inclined in vertical plane to X- ray beam. [13]hence improves to be a more accurate method of evaluation of magnification which is been also been considered by various authors; Anil S [14], Heinisch et al [15], Vazquez L et

Al [16], Ladeira D.B. Set al [17], Yassaei Set al [18], Vazquez L et al1, Blum IR [19], Tal H et al [20], Devlin H et al [21], Schulze R et al [13]. Magnification of KODAK 8000 PANORAMIC SYSTEM used in the study has been specified as 1.27+10% by the manufacturer. Present study was conducted for determining the area specific magnification in edentulous patients with to determine the accuracy of radiographic measurements for implant placement. In the present study mean vertical magnification values for maxillary anterior region on right and left side for3mm metallic sphere was 0.090±0.074 (1.03) and 0.080±0.103 (1.0267)respectively & for 6 mm metallic sphere it was 0.230±0.106 (1.0383) and 0.160±0.084(1.0267) respectively. Mean vertical magnification values for maxillary anteriorregion was 0.198± 0.253 (1.0458) which was statistically significant. In a study done by Y K Kim et al8, on 24 implants placed in maxillary anterior region have specified the mean vertical magnification of 1.296±0.019. In another study by Gomez - Roman et al [12] mean vertical enlargement ratio at coronal end of placed implant was 1.25 and 1.27 in right and

left side of maxillary canine region. The mean vertical magnification of panoramic radiographs in anterior maxilla was proposed to be 1.22±0.0222 In the present study mean vertical magnification values for mandibular anterior region on right and left side for 3 mm metallic sphere was -0.010±0.088 (- 0.33) and 0.080±0.092 (1.0267) respectively & for 6mm metallic sphere was 0.270±0.095 (1.0450) and 0.180±0.114 (1.03) respectively. Mean vertical magnification in mandibular anterior region was 0.192± 0.248 (1.0443) which was statistically significant. In a study done by Y K Kim et al8, on 24 implants placed in mandibular anterior region have specified the mean vertical magnification of 1.2428±0.649. In another study done by Gomez - Roman et al [12] the mean vertical enlargement ratio at coronal end of placed implant was reported 1.26 and 1.27 in right and left side of mandibular canine region.

In the present study different diameters of metallic sphere were kept at the maxillary posterior region (1st molar) to determine the mean vertical magnification of specified panoramic machine. For the metallic sphere of 3 mm the magnification values for right and left side was 0.1±0.094 (1.0333) and 0.170± 0.048 (1.0567) whereas, for 6 mm sphere it was 0.420±0.114 (1.07) and 0.290±0.120 (1.0483) on right and left side respectively. The mean vertical magnification in maxillary posterior region (1st molar) was 0.3± 0.277 (1.0693). Near similar values of mean vertical enlargement has been reported by Gomez- Roman et al12 in maxillary 1st molar on left and right side as 1.28 &1.27 respectively. In a study done by Y K Kim et al [8] vertical magnification1.29± 0.259 was reported.

In the present study determined the mean vertical magnification of mandibular posterior region (1st molar). For the metallic sphere of 3 mm the magnification rate on right and left side was 0.110±0.088 (1.0367) and 0.120± 0.092 (1.04) whereas, for 6 mm sphere it was 0.3±0.133 (1.05) and 0.340±0.165 (1.0567) on left and right side respectively. The mean vertical magnification in mandibular posterior region (1st molar) was 0.273±0.267 (1.0631). Gomez- Roman et al [12] in a study reported that mean vertical enlargement in mandibular 1st molar on left and right side was 1.26 &1.25 respectively. Y K Kim et al8 reported that vertical magnification was 1.2517± 0.403 whereas, Park JB has concluded that mean magnification of implants in molar and premolar region was 1.27 & 1.31 respectively[23]. Study by Thanyakarnet al has proposed vertical magnification in 2nd premolar and molar region to be 17%- 28%. Present study has stated mean vertical magnification values of maxillary anterior and posterior region as 1.0458 and 1.069 whereas, for mandibular anterior and posterior region as 1.0443 and 1.0631 and all these values were statistically significant (0.001). Mean vertical Magnification values are slightly higher for maxilla than mandible and are higher for posterior region than anteriors. These results were in accordance with Tronje et al (1981), that vertical magnification within the image layer does not exceed 10%. Similar results were also reported by; Kim YK et al8 who has proposed that a significant difference between magnification rate of implant length between maxilla and mandible(0.005).

Also, Park JB23 has suggested that vertical magnification in maxillary and mandibular region was higher for molars as compared to anterior. In a study done by Kamble RH et al[25] have mentioned very slight variation in maxilla and mandible i.e., 19.7% and 20% respectively which was in support with the data of present study. Similarly, Sattayasansskull et al. have reported higher magnification values in vertical plane for molar region (39%) compared to incisors and premolars (36%) which favors the present study analysis. Also, Thanyakarn C et al. have supported the result and have concluded that vertical magnification was lower for mandibular premolars than for maxillary second premolars and first molar. Scarfe et al[27,17]have proposed lower magnification for maxilla and higher for mandible which was in contrast with the present study. In contrast in a study done by Lamia et al In the present study all the values of vertical mean magnification for all the specified regions of maxilla and mandible were lowest for 3 mm ball followed by 6mm metallic sphere respectively. Range of Mean Magnification rate for 3 mm sized sphere in different regions was from 2.00% to 12.67%. Range of Mean Magnification rate for 6mm sized sphere in different regions was from 3.50% to 11.38%. These numerical values have verified that larger will be the implant size, larger will be the magnification rate.

In favor of the present observation, Schulze R[13] had concluded that larger objects will probably produce larger variation in measurement. Similarly, Park JB[23] has suggested that higher magnification value from the group with implants having longest length. Also, the observation has been supported by Melveret al. In contrast to present study Devlin H21 has compared 2.5mm and 6mm metallic balls and thereby concluded that larger diameter of implant is more reliable.

Conclusion

Determination of bone quantity using orthopantomograms with radiologic markers has been used in various previous studies. However, three- dimensional assessment of anatomical structures cannot be done.[30] Present study has established that variation in magnification values differ with different panoramic systems and variation in magnification in vertical direction for bothmaxilla and mandible. This variation in

magnification is related to the path of effective rotation centre, source to image receptor distance, object to film distance and position & shape of image layer. So, resultant magnification is specific for each panoramic machine. The present studyhas established the reliability of radiographic markers as a dependable method for radiographic assessment in edentulous patients.

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