

**Analysis of Horizontal and Vertical Dimension Distortion of Mandible on Panoramic
Radiograph
(Research Report)**

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ABSTRACT

Background(s):

Panoramic radiography has been frequently used by dentists in determining disease diagnosis, treatment plans, and evaluating the results of treatment. The advantages of panoramic radiography are overview of maxilla, mandible, teeth and associated anatomic structures on one single image, relatively low radiation dose, and greater comfort for patient. However, this technique has disadvantage related to distortion which result in difference between dimension of radiographic image of the objects with their actual dimension.

Objective(s):

The purpose of this study is to analyze difference of vertical and horizontal dimension measurement between dry mandible and the panoramic radiographic image of it.

Methods:

This study is an analytical observational study with a cross-sectional approach. Panoramic radiography was performed on 9 dry human mandibles using digital panoramic machine Veraviewpocs Morita 2D. The measurement was conducted on 9 lines which is divided into 4 horizontal lines and 5 vertical lines including anterior to posterior region. This study used wires on anterior and posterior region of mandible as landmarks. Digital caliper and software i-Dixel are tools used to measure lines on samples.

Result(s):

Obtained data were analyzed using Interclass Correlation Coefficient (ICC) as a reliability test and independent t-test as a comparative test. ICC values between 0,81 - 0,89 which indicate good reliability. Independent t-test results show there is a significant difference ($p < 0,05$) between horizontal line measurement on actual mandible compared to panoramic radiograph in the anterior region, whereas insignificant difference is found in the posterior horizontal line and the vertical line measurement ($p > 0,05$).

Conclusion(s):

The measurement of vertical dimension on panoramic radiograph is more reliable than the measurement of horizontal dimension.

Keywords:

Panoramic radiography, distortion, vertical dimension, horizontal dimension, mandible

BACKGROUND

Radiography examinations has been one of the most needed supporting examinations to establish the diagnosis of a disease in dentistry. Dentist usually gathered information about the main patient's concern obtained from anamnesis, clinical picture of patient's oral cavity, and additional information derived from radiography examination to get the proper diagnosis so as to develop a good and adequate treatment plan for the patient's disease.¹ The use of radiography examination could be useful when evaluating the result of a treatment that has been done.²

Since the first invention in 1959, radiography panoramic examination has been through a lot of development and has been the diagnostic tool that can be used daily in dental practice.³ Radiography panoramic examination are the most common used by the dentist as supporting examination for establish the diagnose disease.⁴ With the advantage that has a wide area coverage of maxilla, mandibular, and the surrounding structures, panoramic radiography is often used for dental treatment that require the results of a broad overview from the anatomical structure of the jaw, such as determination of the third molar position, problem in the temporomandibular joint area, evaluation of dental development (especially in mixed dentition phase), case with an extensive lesion, and evaluation of tooth impaction. This type of radiography could be used for patient that intolerant with intraoral radiography procedure.¹

Although panoramic radiography has a lot of advantage that could support the success of a dental treatment, this examination still has several disadvantages that could potentially interfere the success of dental treatment. Magnification in the results of panoramic radiographic images is one of the shortcomings of panoramic radiography and is the main problem that will be faced when using panoramic radiography.⁵ Magnification in panoramic radiography persists even though dentist has carried out radiography panoramic examination with precise and correct, but the precise in carrying out panoramic radiography techniques will minimize magnification on the result so that the picture quality can be improved and assist dentist in determining the diagnoses, developing treatment plan, and evaluating treatment results appropriately.^{4,6}

Each panoramic machine has varieties of design that makes the position of focal trough vary so that the magnification from each panoramic machine is also different. Based

on previous research, magnification occurs in results of panoramic images of actual anatomical structures amounts to approximately 15-25%.⁴

METHODS

The type of the research are observational analytics with cross-sectional approach. This research carried out at RSGM-P FKG Dental Radiology Installation of Trisakti University and the Anatomical Laboratory of FK-FKG Trisakti University from September to November 2020. The study sample used a dry mandible at the practicum of the Faculty of Dentistry, Trisakti University.

The tools that been used in this research are, digital panoramic machines (Veraviewpocs Morita 2D), digital funnel, iDixel 2.0 (Morita) software, tape, crop pliers, Styrofoam, tripod camera, 3D Phantom. The materials that are used are dry mandibles and 0.9 mm wire ligatures.

The way it works begins with the determination of 18 points of measurement which become 4 horizontal lines and 5 vertical lines marked with markers in the form of wire attached to dry mandibles. Horizontal lines in panoramic radiography can be seen in figure 1. Vertical lines in panoramic radiography can be seen in figure 2. Measurements in the mandible are made using a digital caliper. Mandible position on the chin rest on the panoramic machine. Making panoramic radiography of the mandible by fixing the mandible with a fixator in the form of tape. At the inferior limit of the mandible in the posterior region, styrofoam cushioning is given to get the appropriate occlusal tilt when the patient is exposed where the position of the mandible angulus is slightly higher than the menthon. Vertical planes are aligned using a laser beam placed on the midline line. 3D Phantom placed behind the anterior mandible to reduce scattering radiation for imaging results panoramic radiography is not opaque because in the object of study there is no spine. Exposure for one sample was carried out for 7.9 seconds with 60kVp and 1mA, a large reduction in kVp and mA aimed at keeping the radiographic image from becoming radiolucent because the object was only a dry mandible. Measurements on panoramic radiography were made using idixel software.

The data obtained was conducted interobserver reliability tests using Interclass Correlation Coefficient (ICC). Next the data is carried out a normality test. If the data is

normally distributed, then the data will be analyzed using independent T-test analysis to determine the difference in vertical and horizontal dimensional sizes between dry mandibles and mandibular panoramic radiography. If the distributed data is not normal it will use the Mann-Whitney test.

RESULTS

The study was conducted on five dry mandibles and five dry mandibular digital panoramic radiographs to determine the difference between direct stabilization and panoramic measurements on measurements of four horizontal lines and five vertical lines. The condition of some of the mandibles sampled in this study was an asymmetry on the left and right sides of the jaw and there were some jaws that still had teeth and also did not have teeth. Before data analysis, an interobserver reliability test was conducted to test Accuracy of measurement results using Interclass Correlation Coefficient (ICC).

The ICC value obtained in the nine-line measurement is the range of 0.812 – 0.899 which according to the ICC assessment category, the coefficient of realization 0.80 – 1.00 is a very high consistency. So that the measurement data obtained in panoramic radiography and measurements in dry mandibles have a very high consistency. So that the data is continued with a normality test. Normality test results data can be seen in table 1.

From the normality test table above shows that dry mandible measurement variants and panoramic measurements for H1a lines, H1b lines, H2a lines, H2b lines, V1 lines, V2a lines, V2b lines, V3a lines, and V3b lines are distributed normal ($p > 0.05$), so a valid independent T test was used in this study. Next independent T test to determine the difference in vertical and horizontal dimensional sizes between dry mandibles with mandibular panoramic radiography can be seen in table 2.

Based on the T-independent test table above, $p\text{-value} < 0.05$ on the H1a line and H1b line are obtained which shows that there are significant differences in these variants. While in the H2a line, H2b line, line V1, line V2a, V2b line, V3a line, and Line V3b get a $p\text{-value}$ of > 0.05 which means there is no significant difference in the variant.

DISCUSSION

Panoramic radiography examination has become a supporting examination that very commonly used by dentists to support the success of the plan dentist care to be done.⁴ Distortion that occurs in radiography Panoramic can interfere with success the treatment and can occur in horizontal dimensions and vertical dimensions with large distinctions of each side of the jaw. Measurements in vertical dimensions are more reliable than horizontal dimensions.⁹ Based on inter-observer reliability tests using Interclass Correlation Coefficient (ICC) to see the consistency of the data obtained, ICC values for AI VS BI were obtained at panoramic measurements of 0.881 and dry mandibular measurements of 0.812. For AII VS BII in panoramic measurements of 0.894 and in dry mandible measurements of 0.842. AIII VS BIII at panoramic measurements of 0.896 and in dry mandibular measurements of 0.820. AIV VS BIV at panoramic measurements of 0.869 and in dry mandible measurements of 0.889 and in dry mandibular measurements of 0.841. AVII VS BVII in panoramic measurements of 0.899 and in dry mandibular measurements of 0.813. AVIII VS BVIII in panoramic measurements of 0.898 and in dry mandible measurements by 0.828. AIX VS BIX at panoramic measurements of 0.882 and in dry mandibular measurements of 0.846. According to the ICC assessment category, the coefficient of reliability (> 0.800) indicates that the results of the data obtained have excellent consistency.¹⁰

Next, a normality test is carried out to find out whether normally distributed data or not. Based on the normality test conducted in this study, results were obtained that showed that the data were normally distributed for all lines. Normalized distributed data if the normality test shows a value ($p > 0.05$).¹¹

Distortions that occur in panoramic radiography occur because there are differences in the angles of the center of rotation of panoramic radiographic aircraft components.⁵ In this study T-independent tests were conducted to find out whether there are significant differences and previous normality tests showed results that the data were normally distributed so that the data is valid for T-independent tests to examine whether the data experienced significant differences or not. There is a significant difference if the p-value is < 0.05 .

Based on the T-independent test conducted in this study, the p value on the H1a line was 0.029 with a distortion percentage of -23.54. In the line H1b, a value of p is 0.036 with a

distortion percentage of -21.50. The p value on the H2a line is 0.402 with a distortion percentage of -2.44. For the H2b line, a p value of 0.356 is obtained with a distortion percentage of -2.62. In the H1a, H1b, H2a, and H2b lines, the results obtained are in line with previous research conducted by Mehrdad et al which showed that the results of measurements in panoramic radiography are smaller than the measurement results in dry mandibles.⁵ However, the magnitude of the distortions obtained in this study on these lines is different from the results of research conducted by Mehrdad et al because in research conducted by Devlin and Yuan stated that in each panoramic radiography machine there are different distortions caused by the components of panoramic machines different from each other.^{4,5}

Line V1, the p value is 0.390 with a distorted percentage of 4.22. In the V2a line, the p value is 0.399 with distortion percentage of 2.44. The p value on the V2b line is 0.205 with a distortion percentage of 4.30. Line V3a, the value at is 0.397 with a distortion percentage of 2.71 and on the V3b line, the value of p is 0.391 with a distortion percentage of 3.69.

As the results of the T-independent test on the nine lines, it shows that a significant difference occurs in the horizontal line in the anterior region ($p < 0.05$). This is in line with research conducted by Cruz et al, Munakhir et al, and Abdinian et al, this may be due to changes in the angle of the center of rotation of X-ray sources, anatomical structures, and films that change in different regions during the rotation of panoramic radiographic machines. Distortions in horizontal dimensions are influenced by the horizontal movement of receptors and opposite X-ray sources and curved mandibular structures.^{3,5,12} In the horizontal line of the posterior region, this study showed that there was no significant difference. The results are in line with research conducted by Munakhir et al conducted in Jogjakarta where in the study, horizontal lines in the posterior region there is no significant difference between measurements on panoramic radiography and measurements in dry mandibles.³

Vertical lines in this study show results that are not in line with research conducted by Vaishali et al, where this study shows that there is no significant difference in vertical lines between panoramic measurements and dry mandibular measurements while in studies conducted by Vaishali et al show that there are significant changes in vertical dimensions between panoramic measurements and dry mandibular measurements. This can be due to differences in the methods used.¹³ The results of the data in this study are in line with previous research conducted by Mehrdad et al which stated that measurements in vertical

dimensions are more reliable than horizontal dimensions.⁵ And also in line with research conducted by Abdinian et al which stated that vertical dimensional measurements in panoramic radiography are more accurate than horizontal dimensions. By 15-25%. This is due to several factors, namely the shape of the anatomical structure of the mandible, the placement of the position of the object to be exposed, and variations in the components that make up the panoramic machine.⁴

From the results of the study obtained, horizontal dimensional measurements in the anterior region should not be used to emphasize diagnoses. In the measurement of horizontal dimensions of the posterior region and vertical dimensions, it is reliable but still considers the surrounding anatomical structure because the measurement still has insignificant differences. One example is that at the time of implant installation, panoramic radiography is still reliable but cannot be used as gold standard.

CONCLUSION(s)

Based on the results of the study, it can be concluded that in horizontal dimensional measurements anterior region, there is a significant difference between the results of direct measurements and panoramic radiography while in the posterior region there is no significant difference between the results of direct measurements and panoramic radiography. However, in the vertical dimension there is no significant difference in both the anterior and posterior region between the results of direct measurements and panoramic radiography.

ACKNOWLEDGMENT

The author would like to thank the Faculty of Dentistry at Trisakti University for supporting this study.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest.

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TABLES

Table 1. Normality Test

Measuring Line	Measuring Method	Sig.
H1a	Measurement of Dried Mandible	0,880
	Measurement of Panoramic	0,837
H1b	Measurement of Dried Mandible	0,352
	Measurement of Panoramic	0,863
H2a	Measurement of Dried Mandible	0,215
	Measurement of Panoramic	0,202
H2b	Measurement of Dried Mandible	0,901
	Measurement of Panoramic	0,970
V1	Measurement of Dried Mandible	0,655
	Measurement of Panoramic	0,614
V2a	Measurement of Dried Mandible	0,954
	Measurement of Panoramic	0,966
V2b	Measurement of Dried Mandible	0,875
	Measurement of Panoramic	0,748
V3a	Measurement of Dried Mandible	0,398
	Measurement of Panoramic	0,462
V3b	Measurement of Dried Mandible	0,524
	Measurement of Panoramic	0,367

Table 2. Independent T-test

Measuring Line	Mandible		Panoramic		Sig	Mean of Distortion	Percentage of Distortion
	Mean	SD	Mean	SD			
H1a	9,334	1,707	7,116	1,479	0,029	0,762	-23,54
H1b	9,126	1,704	7,068	1,428	0,036	0,774	-21,50
H2a	37,902	3,509	30,292	4,595	0,402	0,799	-2,44
H2b	39,956	5,640	34,072	3,802	0,356	0,852	-2,62
V1	15,886	3,493	16,514	3,408	0,390	1,039	4,22
V2a	20,922	3,056	21,444	3,189	0,399	1,024	2,44
V2b	22,144	1,747	23,088	1,694	0,205	1,042	4,30
V3a	19,814	3,075	20,336	3,024	0,397	1,026	2,71
V3b	20,734	3,217	21,480	3,205	0,391	1,035	3,69

FIGURES

**Figure 1.** Exposure of Mandible



Figure 2. Measurement of Mandible



Figure 3. Results of Mandible Panoramic Radiograph Measurement