Comparison distortion in the mandible skull using panoramic digital radiograpy and cone beam computed tomography

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ABSTRACT

Panoramic radiography is widely used as a tool supporting the diagnosis in dental practice. Currently the technology has evolved with the presence of radiographic imaging such as Cone Beam Computed Tomography (CBCT) that displays a three-dimensional picture. The purpose of this study was to determine large distortions that occur several regio in the mandible using digital panoramic radiographs and CBCT. Method experimental The research on one of the skull laboratories fitted staples vertically and horizontally in alveolar regions 31, 33, 35, 37, 41, 43, 45, 47, and then measured the length of the staples using the term digital. Furthermore, digital panoramic radiography performed with position 0º, +5º, +10º, -5º, -10º and CBCT radiography with 0º positions. Measurement description of radiopaque vertical and horizontal lines on digital panoramic radiographs and CBCT are computerized using the EZ software measurement menu. Calculating percentage distortion radiopaque overview of vertical and horizontal lines on digital panoramic radiographs and CBCT of the mandible by doing a comparison of the actual size of the skull. The results obtained on the percentage of minimal distortion of digital panoramic radiographs vertically was in the 31 region positioned +5º at 0,23%, in the 33 region positioned 00 at 5,99%, in the 35 region positioned -100 at -6,33%, in the 37 region positioned +100 at -1,46%, in the 41 region positioned -5º at 0,46%, in the 43 region positioned 00 at 0,52%, in the 45 region positioned +10º at -0,45%, in the 47 region positioned +10º at -4,76%. The percentage of minimal distortion of digital panoramic radiographs horizontally all of region was positioned 0º. The percentage of minimal distortion of CBCT all of region was positioned 0º and different on each mandible alveolar region. The conclusion of this study is average distortion that occurs in the mandible using CBCT is more less than digital panoramic radiographs. That is mean CBCT more accurate than digital panoramic radiographs.

Key words: digital panoramic, CBCT, mandible

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ABSTRAK

Radiografi panoramik banyak digunakan sebagai alat bantu penunjang diagnosis dalam praktek kedokteran gigi. Saat ini teknologi telah berkembang dengan hadirnya radiografi pencitraan seperti Cone Beam Computed Tomography (CBCT) yang menampilkan gambaran secara tiga dimensi. Tujuan penelitian ini adalah untuk mengetahui besar distorsi yang terjadi pada mandibula menggunakan radiograf panoramik digital dan CBCT. Metode penelitian menggunakan eksperimental laboratoris. Penelitian dilakukan dengan menggunakan satu buah tengkorak kering yang dipasang staples secara vertikal dan horizontal pada alveolar daerah 31, 33, 35, 37, 41, 43, 45, 47, kemudian diukur panjang staples tersebut menggunakan jangka digital. Selanjutnya dilakukan radiografi panoramik digital dengan posisi 0°, +5°, +10°, -5°, -10° dan radiografi CBCT dengan posisi 0°. Kemudian dilakukan pengukuran gambaran garis radiopak vertikal dan horizontal pada radiograf panoramik digital dan CBCT tersebut secara computerized menggunakan perangkat lunak EZ menu measurement. Dilakukan penghitungan persentase distorsi gambaran garis radiopak vertikal dan horizontal pada radiograf panoramik digital dan CBCT dari mandibula dengan melakukan perbandingan terhadap ukuran sebenarnya pada tengkorak. Hasil penelitian menunjukkan persentase distorsi minimal pada radiograf panoramik digital secara vertikal, regio 31 pada posisi +5° sebesar 0,23%, regio 33 pada posisi 0° sebesar 5,99%, regio 35 pada posisi -10° sebesar -6,33%, regio 37 pada posisi +10° sebesar -1,46%, regio 41 pada posisi -5° sebesar 0,46%, regio 43 pada posisi 0°sebesar 0,52%, regio 45 pada posisi +10° sebesar -0,45%, regio 47 pada posisi +10° sebesar 4,76%. Persentase distorsi minimal pada radiograf panoramik digital secara horizontal pada seluruh regio berada pada posisi 0°. Persentase distorsi minimal pada radiograf CBCT pada seluruh regio berada pada posisi 0° dan berbeda pada setiap regio di mandibula. Kesimpulan penelitian ini adalah rata-rata distorsi pada mandibula, dengan menggunakan radiografi CBCT lebih kecil daripada radiografi panoramik digital. CBCT memberikan hasil lebih akurat daripada panoramik digital.

***Kata kunci**: panoramik digital, CBCT, mandibula*

INTRODUCTION

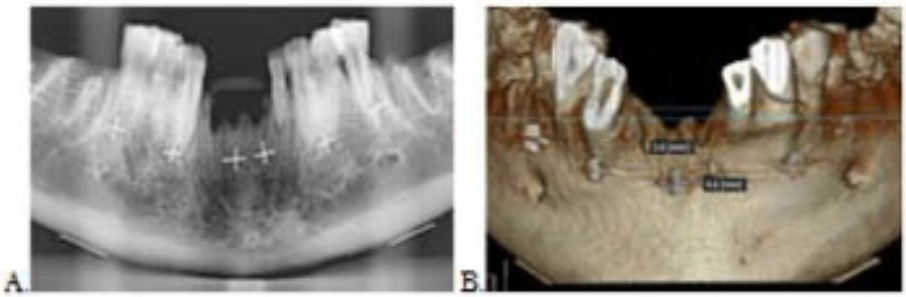
The accuracy of teeth length measurement by panoramic radiograph depends on the placement of patient's head position technique.[1] Varies of jaw anatomy of individual bone architect shows as variation of degree between FHP (Frankfort Horizontal Plane) and occlusal plane. For certain indication of specific diagnose, the standard position of head can be changed on the panoramic radiograph unit.[2]

Panoramic radiograph is a radiograph technique which sensitive to the position changes where research on head's position is needed to observe the toleration of distortion happened and on which position. The accuracy of teeth length measurement by panoramic radiography effected by distortion. This distortion caused by asimetric expended in different subject dimension.[3] Magnification of the panoramic radiography is not the same, it could be over 25%, vertically 10% and horizontally 16%.[4]

CBCT is a radiography technology of three dimension (3D) which can overcome the limitation of radiography appliance such superimposed image, less detailed and imperfect hard tissue image, less radiation dosage compared to CT and an aspect of anatomy structure in an image.[5] CBCT has high accuracy value until it is used as standard value in measurement.[6] Accuracy of an image iss produced by a group of volumetric data consist of a small 3D cubes bullock, known as voxel, each represents the level of x-rays absorbent. Voxel measurement determine images resolution.[5] This study is done to determine distortion happened on mandibular using digital panoramic radiography and CBCT.

MATERIAL AND METHODS

This study was done in Radiology Installation of Dental Clinic of Faculty of Dental University Padjajaran Bandung. A skull being stapled vertically and horizontally on alveolar site of 31, 33, 35, 37, 41, 43, 45, 47, then the length of the staples are measured by digital callipers. Digital panoramic radiograph with position of 0°, +5°, +10°, -5°, -10° being done after that and also CBCT radiograph with 0° position using Picasso Trio appliance. There are five digital panoramic radiographs in vertical radiopac line image and horizontal on mandible being produced. Measurement of vertical and horizontal radiopac line images being done next by computerized (mm), using EZ menu software both on digital panoramic radiograph and CBCT. Then the measurements collected being compared from digital panoramic radiograph and CBCT done on the skull.



Gambar 1. Vertical and horizontal radiopac line image on mandible and measurement by computerized. A. Panoramic Digital B. CBCT.

RESULT

The research on one of the skull laboratories fitted staples vertically and horizontally. Table 1 shows the percentage distortion of minimal radiopaque vertical and horizontal line on alveolar of mandible by digital panoramic radiograph and CBCT. Positions which caused minimal distortion are different on each alveolar site of the mandible. On the digital panoramic radiograph, the frequent position which caused minimal vertical distortion was +10° and horizontally 0°. On CBCT, vertically and horizontally with the position of 0°, the whole region produced small distortion with variation of percentage.

Table 2 shows the average percentage of mandible distortion on digital panoramic radiograph and CBCT vertically and horizontally. On the digital panoramic radiograph, shorter measurement with average percentage vertically minimal mandible distortion on the position of +10° occurred as big as -7.9%, and horizontally on 0° was -2.05%.

Table 1. Minimal percentage distortion.

Mandibula Alveolar Area	Digital Panoramic				CBCT			
	Vertical Position	Distortion (%)	Horizontal Position	Distortion (%)	Vertical Position	Distortion (%)	Horizontal Position	Distortion (%)
31	+5°	0,23	0°	-0,26	0°	-2,05	0°	7,61
33	0°	5,99	0°	-14,22	0°	-3,23	0°	0,49
35	-10°	-6,33	0°	0,25	0°	1,27	0°	7,77
37	+10°	-1,46	0°	5,44	0°	1,90	0°	-1,22
41	-5°	0,46	0°	1,74	0°	-1,83	0°	-0,74
43	0°	0,52	0°	-6,57	0°	-2,06	0°	-1,52
45	+10°	-0,45	0°	-15,66	0°	-0,10	0°	-1,20
47	+10°	-4,76	0°	0,79	0°	3,17	0°	0,79

Note: Radiograf in vertical and horizontal position: sign (+) dan (-) shows *frankfort horizontal plane* which makes an angle towards floor plane. In distortion: sign (-) shows shortage in measurement.

Table 2. Total measurement and average percentage of distortion of mandible vertical and horizontally using digital radiograf panoramic and CBCT.

Size of	Mandibula			
	Vertical		Horizontal	
	Total measurement (mm)	average distortion (%)	Total measurement (mm)	average distortion (%)
Skull	43,11	0	41,86	0
Digital Panoramic				
0^0	48,3	12,04	41,0	-2,05
$+5^0$	37,1	-13,94	33,5	-19,97
$+10^0$	39,7	-7,91	33,5	-19,97
-5^0	38,0	-11,85	35,2	-15,91
-10^0	38,7	-10,23	36,4	-13,04
CBCT	42,7	-0,95	42,3	1,05

According to the results, there are differences percentages of distortion of alveolar site of mandible vertically and horizontally on digital panoramic radiograph and CBCT. On digital panoramic radiograph, it is found that the radiograph of 0 was the most to produce minimum percentage. It might be because at the 0^0 radiograph, object is at the focal trough. This suits Pasler, F.A (2007) study which recommended Frankfort horizontal plane is 0^0 or parallel to the floor.[2] Percentage happened on the digital panoramic radiograph are way bigger compared to CBCT. In this study, digital panoramic radiograph uses direct type of sensor which has high quality of light sensitivity, the image is low-noise, with higher pixel and high resolution compared to indirect type of sensor until image of the line is produced.[2,7]

Digital panoramic on $+10^0$ radiograph, posterior alveolar of mandible shows different percentage, shortening vertically as big as -0.45 - -4.76%, shortening and lengthening horizontally on 0^0 radiograph which is -15.66 - 5.44%. Measurement of alveolar of left second premolar site of mandible mainly horizontally shows the closest measurement. This suits R. Schultze, et al (2000) who used digital panoramic radiograph and conclude that the most accurate measurement are from the horizontally measured.[8]

DISCUSSION

Digital panoramic radiograph produce varies of distortion percentage. This might be because of the rotation between range of focus-object and range of object-film are not the same for each location until varies of enlargement produced. This suits Langland, et al (2007) statement which says factors effecting enlargement vertically and horizontally including constant distance of film from radiation source in every panoramic radiograph and distance of film from variation of subject depending on position of patient's head.[3] Radiograph which often used on panoramic radiography is 0^0. The result of this study proved that digital panoramic radiograph 0^0 shows mean percentage of distortion horizontally were smaller compared to other digital panoramic radiograph, lengthen of estimation 12.04% from vertically real measurement.

CBCT shows small difference of percentage in this study. This might be because of the panel detector sensor used has a very small measurement and it comes with three dimension image. This suits H. Lund, et al (2009) study which says measurement on 3DX Accuitomo FPD tomography shows greatly matched with the real distant.[9] CBCT radiograph has voxel that determine images resolution and produced by a group of volumetric data which consist of a #D small cubes bullock until the accuracy of the structure and detail can be seen compared to 2D . This suits Ilkay Peker, et al (2009) says which says measurement found from CBCT radiograph is more consistent with direct measurement compared to measurement from panoramic radiograph.[10]

CBCT radiograph 0^0 produced small difference of percentages, maybe the 3D radiograph is less effected by angle of the position due to the focal

trough which caused the whole angle position lie on the focal trough. This suits Lascala, et al (2004) statement which says CBCT radiograph is less affected by patient's and effected-free by superimposed pattern of anatomy of the structure that might have effect on significant measurement.[11]

Radiograph 0° on CBCT, alveolar posterior part of mandible experienced difference of percentage vertically which was -0.10 - 3.17% and horizontally -1.22 - 7.77%, it shows that CBCT radiograph can be used to measure more accurate vertically and horizontally. This suits Suomalainen Anni (2010) study that state the CBCT has better accuracy and used as standard value in measurement.[6]

Digital panoramic radiograph and CBCT produced variations of distortion percentage. This is due to the ration between distance of focus-object with distance of object-film are not the same for each location until varies of enlargement produced. This suits Langland et al (2007) statement which says factors effecting enlargement vertically and horizontally included distance of film from a consistent source of radiation in every panoramic radiography and variation film distance from subject depending on patient's position.[3]

Radiograph 0° is often used on panoramic radiography and CBCT. This study found that the digital panoramic radiograph 0° shows smaller mean of percentage compared to other digital panoramic radiograph. CBCT radiography shows smallest mean of percentage compared to digital panoramic radiograph.

CONCLUSION

The conclusion of this study is average distortion that occurs in the mandible using CBCT is more less than digital panoramic radiographs. That is mean CBCT more accurated than digital panoramic radiographs.

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REFERENCES

1. Stramotas, S, et al. Accuracy Of Linear And Angular Measurements On Panoramic Radiographs Taken At Various Positions In Vitro. Eur J Orthod 2002; 24: 43-52.
2. Pasler, FA. Pocket Atlas Of Dental Radiology. New York: Thieme Medical Publisher Inc; 2007, 2-39.
3. Langland, OE, Langlais, RP. Principles Of Dental Imaging. Baltimore: The William and Wilkins Company; 2007, 54-6.
4. Adam Shui-Cheong Siu. Imaging Modalities For Preoperative Assessment In Dental Implant Therapy: An Overview. Hong Kong Dent J 2010; 7: 23-30.
5. Whaites, E. Current Product Picasso Trio. 2008. www.vatech.com (15/8/11).
6. Suomalainen, Anni. Cone Beam Computed Tomography In Oral Radiologi. J of University of Helsinky 2010; 48.
7. White, SC, Pharoah, MJ. Oral Radiology Principles And Interpretation. 5thed. Mosby, St.Louis, Elsevier Science; 2004, 166-90, 225-41
8. Schulze, R, et al. Precision And Accuracy Of Measurements In Digital Panoramic Radiography. J Dentomaxillofacial Radiology 2000; 29: 52-6.
9. H Lund, K Grondahl, HG Grondahl. Accuracy and precision of linear measurements in cone beam computed tomography accuitomo tomograms obtained with different reconstruction techniques. British Institute of Radiology doi: 10.1259/dmfr/15022357. J Dentomaxillofacial Radiology 2009 ; 38: 379-86
10. Peker, I, et al. The Comparison Of Subjective Image Quality In Conventional And Digital Panoramic Radiography. Indian J of Dental Research 2009; 20; 1: 21-5.
11. CA Lascala, J Panella, MM Marques. Analysis of the accuracy of linear measurements obtained by cone beam computed tomography (CBCT NewTom). British Institute of Radiology doi: 10.1259/dmfr/25500850. J Dentomaxillofacial Radiology 2004; 33: 291-4