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Radioanatomic image of alveolar bone crest, cementoenamel junction and dental apex in Orthopantomograph 100 panoramic radiography

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ABSTRACT

Panoramic radiography can be used in most dentomaxillofacial procedures, that can give a wide coverage of teeth and supporting tissue for assisting diagnosis. The aim of this research was to obtain data about the validity of panoramic radiography for measuring radioanatomy alveolar bone crest, cementoenamel junction (CEJ), and dental apex which is useful in measuring the level of alveolar bone resorption. This descriptive research and measurement was done to 25 sample which fulfilled sample criteria from panoramic radiography result by orthopantomograph 100. This research was done with Ramfjord criteria radioanatomy point. The result of this research showed that the average value measured of alveolar bone crest from the entire region was about 41.67%, most value at the mandibular molar was about 92%, the least value at the maxillary premolar was about 0%. The average value measured of CEJ from entire region was about 11%, most value at the maxillary molar and mandibular molar about 26%, at least value at the maxillary incisor, mandibular incisor, and maxillary premolar were about 0%. The average value measured of dental apex from the entire region was about 56.33%, most value at the mandibular molar was about 96%, the least value at the maxillary premolar was about 8%. The conclusion of this research was a part of radioanatomy alveolar bone crest and a part of dental apex could be measured, while CEJ at least measured. Measurement from the three of radioanatomy point showed the mandibular molar region which was at most measured.

Key words: Panoramic radiography, Orthopantomograph 100, alveolar bone crest, cementoenamel junction, dental apex, radioanatomy

INTRODUCTION

Panoramic radiography is frequently used as an initial survey radiograph that can give information on teeth and supporting tissue for diagnosis making.[1] Panoramic radiography has several advantages including wide anatomic exposure, low patient radiation dose, comfortable in examination and it can be used in patients who cannot open their mouth.[1] In panoramic radiograph, the dose received by patients is 10 times lower than those in the full mouth image which significantly reduces the dose received by patients.[2]

The examination of alveolar bone damage using panoramic radiography results in a more realistic image.[3] There are similarities between the results of the clinical examination results with

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the bone height in panoramic radiograph.[4]

However, panoramic radiographic also has disadvantages, i.e. magnification, geometric distortion, dental overlapping, especially in premolar region.[1] Study performed by Scarfe et al.[6] in 1998 on the characteristic of orthopantomograph 100 shows that the vertical magnification factor found in focal through represents increase in area around the light source, i.e. 24-37%.[5] However, the vertical dimension error can still be tolerated up to 10%.

The radioanatomy of alveolar bone crest, CEJ and dental apex are often used to measure the height of alveolar bone. Pierro et al.[7] used alveolar bone resorption measurement method by measuring CEJ to the alveolar bone crest[7], while Salonen et al.[8] studied it by using a method that compared bone height and root length.

The examination of alveolar bone resorption level requires that the three radioanatomic points should be seen clearly. Therefore, a study on the radioanatomy of alveolar bone crest, CEJ and dental apex is really necessary as a preliminary study to discover the appropriacy of panoramic radiograph in measuring alveolar bone resorption level.

Based on those reasons, the author was interested in studying the radioanatomic image of alveolar bone crest, CEJ and dental apex in panoramic radiograph using Orthopantomograph 100 device.

MATERIALS AND METHODS

The study was aimed at describing the radioanatomy of cementoenamel junction (CEJ), alveolar bone crest and dental apex by using panoramic radiograph. Panoramic radiograph made with Orthopantomograph 100 at the Radiology Department, Oral and Dental Hospital, Faculty of Dentistry, Universitas Padjadjaran in June 2006.

The study population consisted of panoramic radiographs from patients who did panoramic radiograph taken at the Radiology Department of the Oral and Dental Hospital, Faculty of Dentistry, Universitas Padjadjaran during the month of June 2006, i.e. 69 panoramic radiographs. The sampling method used is the purposive sampling technique and the sample criteria applied in this study were radiographs taken from male and female adult patients (not in the mix dentition period), no fixed orthodontic appliance worn, no prothesis worn, and 1.6, 2.1, 2.5, 3.6, 4.1, and 4.5 teeth are still intact.

The instruments and materials used in this research include orthopantomograph 100 device, manufactured in 1999; panoramic radiogram; Nikon Cool pix L4 digital camera; viewer with photo frame made of black rigid paper; Yashida photo reproduction device; and computer using Microsoft XP[R] operating system and Corel[R] photo paint 12 software.

The radioanatomic image of CEJ, alveolar bone crest and dental apex is considered measurable if they can be seen clearly and the borders are apparent. On the contrary, the radioanatomic image of CEJ, alveolar bone crest and dental apex is considered unmeasurable if it is hazy or can not be seen.

The stages in the study include: (1) Panoramic radiograph reproduced using a digital camera; (2) The reproduction results were then transfered to a computer; (3) Editing process was performed to the photo using Corel[R] photo paint 12 software to get clearer image; (4) Ramfyord teeth were then examined, i.e. 2.1 and 4.1 teeth that represented incisive regions, 2.5 and 4.5 teeth that represented premolar region and 1.6 and 3.6 teeth that represented molar region. The measurement included radioanatomic of CEJ, alveolar bone crest and dental apex to reveal the measurable or unmeasurable radioanatomic image. To make the categorize of measurable and unmeasurable points, the measurable radioanatomic parts were marked by a dot. The measurement of each incisive (I) and premolar (P) consisted of 5 points including 2 points of cementoenamel junction, 2 points of alveolar bone crest, and 1 point of dental apex, meanwhile in lower molar (M) there were 6 points consisting of 2 CEJ points, 2 alveolar bone crest points and 2 dental apex. In upper molar teeth there were 7 points consisting of 2 CEJ points, 2 alveolar bone crest points, and 3 apex points, i.e. mesial, distal and palatal points. To make radioanatomic measurement easier, an examination was performed by zooming out the photo using Corel[R] photo paint 12 software until the maximum limit was reached; (5) Then,

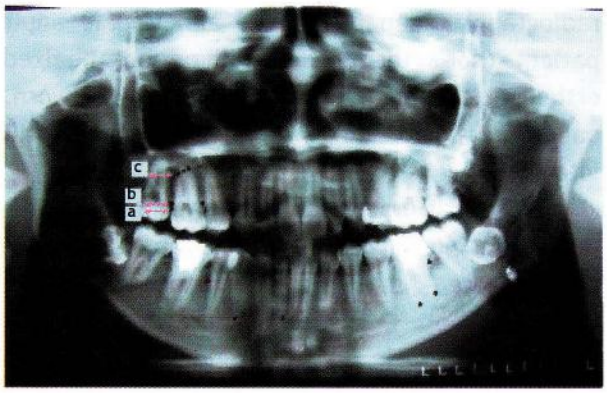

Figure 1. Radioanatomic points in panoramic radiograph. a. CEJ; b. Alveolar bone crest; c. Dental apex.

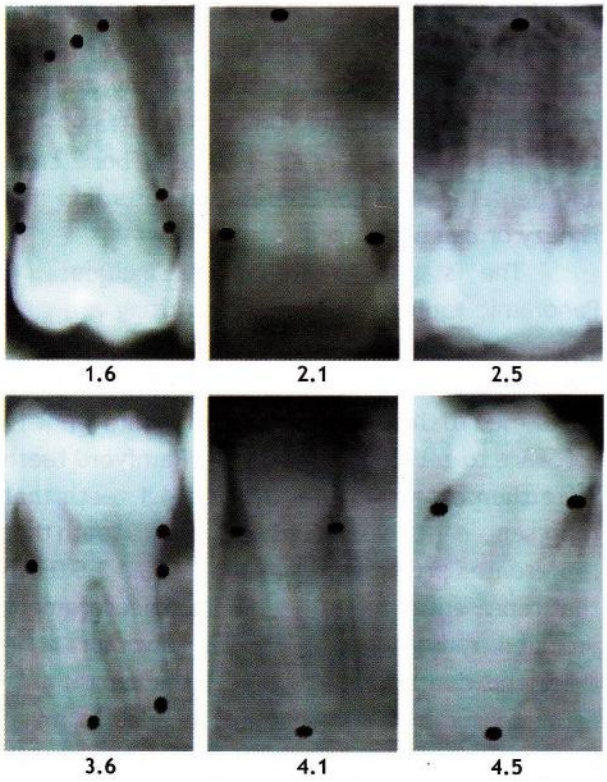

Figure 2. Radioanatomic points of CEJ, alveolar bone crest, and dental apex on measured teeth.

data processing and analysis in radioanatomic examination results were performed.

RESULTS

Panoramic radiograph taken from patients at the Department of Radiology, Oral and Dental Hospital, Faculty of Dentistry Universitas Padjadjaran during June 2006, i.e. 69, were included as sample population. From the population 25 panoramic radiographs met the criteria.

To the 25 panoramic radiographs, examination on 825 radioanatomic points that include 300 points at the CEJ junction, 300 points at the alveolar bone crest and 225 points at the dental apex were performed. The examination on palatal root was not calculated in data calculation because in all alveolar bone crest resorption measurement, only mesial and distal roots were used. The complete study results are presented in Table 1.

Measurement of each I, P, and M teeth shows that the lowest value is in the average measured point is the average measured from the CEJ radioanatomic image of 2.1 and 4.1 teeth. While the highest value is in the average measured dental apex radioanatomic image is the average measured from the radioanatomic image of dental apex of 3.6 tooth.

In radioanatomic point examination in I, P, and M regions, the average value of measured CEJ radioanatomic points for incisive region is 0%, for premolar region 7%, and for molar region 26%. The average value of alveolar bone crest radioanatomic image for I region is 35%, P region 18%, and M region 72%. Meanwhile, for the average value of the dental apex radioanatomic points, the results show 60% for region I, 40% for region P, and 69% for region M.

Table 2 shows the highest measured average value of the three radioanatomic points that is shown in the molar region, while the lowest value is found in the average measured points of CEJ in incisive region. Table 3 shows a comparison of measured average value of the three radioanatomic points in maxillary and mandible. In the average measured value of the radioanatomic points, the CEJ has the lowest percentage compared to the

Table 1. The average measured value of CEJ, alveolar bone crest, and dental apex radioanatomic images.

Tooth	CEJ (%)	Alveolar bone crest (%)	Dental apex (%)
2.1	0	46	40
4.1	0	24	80
2.5	0	0	8
4.5	14	36	72
1.6	26	52	42
3.6	26	92	96
x	11	41.67	56.33

Table 2. Comparison of average measured value of the three radioanatomic points in incisive, premolar and molar.

Radioanatomic	Insisivus			Premolar			Molar		
	2.1	4.1		2.5	4.5		1.6	3.6	
CEJ (%)	0	0	0	0	14	7	26	26	26
Alveolar bone crest (%)	46	24	35	0	36	18	52	92	72
Dental apex (%)	40	80	60	8	72	40	42	96	69

Table 3. Comparison of measured average value from the three radioanatomic points in maxilla and mandible.

Radioanatomic	Maxilla				Mandible			
	2.1	2.5	1.6		4.1	4.5	3.6	
CEJ (%)	0	0	26	8.67	0	14	26	13.33
Alveolar bone crest (%)	46	0	52	34	24	36	92	50.67
Dental apex (%)	40	8	42	30	80	72	96	82.67

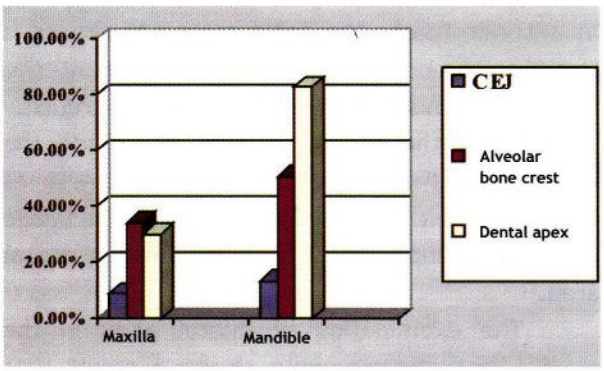

Figure 3. Average measured value of the three radioanatomic points in maxilla and mandible.

alveolar bone crest and dental apex, i.e. 8.67% in the maxillary and 13.33% in the mandible.

Figure 3 shows that the average measured value of the three radioanatomic points in the mandible is higher that in the maxilla. The highest average measured value is the average measured value of the dental apex radioanatomic points in the mandible.

DISCUSSION

Panoramic radiography with flat and upward projection based on tomography principles will produce a more realistic image. A panoramic radiography using Orthopantomograph 100 x-ray device with high technology will be able to produce excellent images with high resolution. Panoramic radiography with all its advantages and low dose is expected to have the capacity to be used in radiographic examination that will significantly reduce the dose received by the patients.

Therefore, a study on the ability to detect CEJ, alveolar bone crest and dental apex of the panoramic radiography as an examination tool will become a facility in radiographic examination.

Table 1 shows the results of the three radioanatomic parts. The average measured value for CEJ radioanatomic point is 11%, for alveolar bone crest 41.67% and for dental apex is 56.33%. This study shows that the percentage of measured CEJ radioanatomic point is small while the measured anatomic point for alveolar bone crest and dental apex is quite high. However, the radiographic examination needs a clearly visible image so that a measurement of the radioanatomic point can be performed.

The radioanatomic examination data in the incisive, premolar and molar regions shown in Table 2 is developed from the study results that the percentage of incisive and premolar regions, CEJ radioanatomic point and alveolar bone crest are smaller that in the molar region. This is caused by an overlap in the premolar region, superimposition in anterior region and thin focal through in anterior region.

According to Langland et al.[6] in Ortho-pantomograph X-ray device, patient's position in the anterior region is more critical because the focal trough is very thin so that the mistake in anterior teeth position outside the focal through, either forward or backward, will reduce the sharpness of the image.[6] Figure 3 shows that the average measured value of the three radioanatomic

points in the mandible are bigger than in the maxilla. This study shows that the teeth in the mandible is more measurable than those in the maxilla. In the mandible, the bone condition is more compact compared to the maxilla and the bone anatomical structure of the maxillary is less compact since the presence of hard palate and maxilla sinus produces superimposition that will blur the radiographic image of teeth in the maxilla. This is in line with the suggestion from Bondemark et al.[9] showing that the anatomical structure superimpose in the mandible is smaller than the one found in the maxilla.[9]

Meanwhile, in the examination of 3.6 tooth, it is shown that the average measured value of the CEJ radioanatomic point is 26%, alveolar bone crest 92%, and dental apex is 96%. The average measured value of 3.6 tooth has the highest percentage compared to other teeth. Mandibular bone condition that is more compact compared to the maxilla and a small degree of superimposition and overlap in the molar region cause the image of the alveolar bone crest, CEJ and dental apex images of 3.6 tooth clearer, making it more measurable.

The average measurable value of CEJ radioanatomic point in Table 1 consists of average measured values that are much smaller than those of the alveolar bone crest and dental apex. This is due to the poor quality of the image, dental overlap and CEJ overlap that leads to difficulty in measuring CEJ point in the image.[10] The superimpose of the anterior teeth and a huge overlap in the premolar region in panoramic radiography makes the CEJ image more unmeasurable.

The difficulty in identifying the CEJ may lead to decreased tendency of using panoramic radiography for CEJ measurement. Tabel 2 shows that in incisive and premolar regions, CEJ radioanatomy has a very small measured average value (0% in 2.1, 4.1, 2.5 teeth, while in 4.5 tooth the percentage is 14%). This is due to the fact that the panoramic radiography of the incisive and premolar regions is not very clear compared to the molar region. The condition is caused by superimposed incisive region and overlapped premolar area making it difficult to measure CEJ image.

According to Frommer[11] superimpose of the columna spinalis is seen in the anterior part of panoramic radiograph. In panoramic x-ray device there is a tendency to produce overlapped images especially in the premolar area. Table 2 shows that in the incisive and premolar regions, CEJ radioanatomy has the smallest average measurable value (0% in 2.1, 4.1, 2.5 teeth, while in 4.5 tooth the percentage is 14%).

Therefore, the average value of CEJ radioanatomy is very small in incisive and premolar regions so that the measurement of alveolar bone crest resorption using CEJ reference point is difficult in the incisive and the premolar region.

Measurement of dental apex radioanatomic point shows that the average radioanatomic value measured in incisive region is 60% and in premolar 40% which is smaller than the molar region (69%). In anterior teeth, the focal trough thickness is less than the posterior teeth so that the anterior region is often situated outside the focal trough.

When the diagnosed area is outside the focal trough, the image is not clear and sometimes cannot be seen. The presence of spine bone image often causes superimposition in the anterior dental area.[12]

The examination of dental apex in the maxilla and the mandible shows a result that the average measured value of the dental apex radioanatomy in 2.1 tooth is 40%, which is smaller than the value for 4.1 tooth, i.e. 80%. This is due to the fact that superimposed maxillary incisive apical image with the palate is seen.

Table 3 shows that the average value of dental apex radioanatomic point measured in the maxilla is much smaller than that in the mandible. This is due to the presence of empty space in the mouth that leads to a more radiolucent image. Therefore, according to Pasler[3], it is better that when the patient is positioned to the X-ray device, the patient is instructed to swallow and pull the tongue back at the oral base. The tip of the tongue should be raised until it touches the palate. This position will optimize the visualization of the apical image of the upper dentition.[3]

In upper premolar, the average measured value of the alveolar bone crest radioanatomy point is 0% (completely unmeasurable) while the average value of the dental apex radioanatomic point measured is only 8%. This is due to the superimposed of the upper jaw which is more than

those found in mandible as well as the possibility that the upper premolars experience more overlapping compared to the lower premolars.

Panoramic radiography is one of the choices for measuring mandibular alveolar height.[13] Table 3 shows that the average measurable value of the alvolar bone crest radioanatomic point in the maxilla is 34%, while the value for the mandible is 50.67%. This is because the superimpose in mandible is less than the superimpose in the maxilla.

The results of this study shows that the average value for measured alveolar bone crest radioanatomic point leads to a quite high percentage for molar region making the panoramic radiography usable in measuring alveolar bone damage, especially in the molar region.

This is strengthen by the suggestion from Rose et al.[4] stating that there is a similarity of the clinical examination results when it is compared to the bone height in the panoramic radiography. In addition, Rohlin et al.[14] stated that when compared to the actual alveolar bone crest damage, the size of alveolar bone crest damage in panoramic radiograph is more accurate compared to the periapical radiograph.

CONCLUSION

From the results of a study on 25 panoramic radiographs that are measurable, it can be concluded that a part of alveolar bone crest radioanatomy and a part of dental apex radioanatomy points can be measured (41.67% for alveolar bone crest and 56.33% for dental apex) while the CEJ radioanatomic point is the least measurable point (11%). The measurement of the three radioanatomic points show that the radioanatomy of alveolar bone crest, CEJ and dental apex is the most measurable in the mandibular molar region.

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