Mean alveolar bone crest height decrement in subjects with an osteoporosis risk

H P S Effrianto, M Priminiarti* and B N Makes

Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia

*E-mail: menikneidy@yahoo.com

Abstract. People 40–75 years of age have an osteoporosis risk that may be signaled by a decrease in alveolar bone crest height. Thus, this measure can be used as an indicator of osteoporosis risk. This study was conducted to provide a database of decreased alveolar bone crest heights in ages at risk of osteoporosis by using intraoral radiographs. Forty periapical radiographs of the posterior region of tooth 36 (or 46) were measured twice at different times by two different observers. The interproximal decrease in alveolar bone crest height was measured from the alveolar bone crest to the cementoenamel junction (CEJ) for each tooth on the mesial and distal sides using a ruler (mm). The mean decrease in alveolar bone crest height in at-risk ages for osteoporosis was 3.50±1.085 mm, with a mean of 3.15±0.864 mm for those 45–59 years of age, and 3.90±1.156 mm for those aged 60–75 years. The mean decrease in alveolar bone crest height in people 60–75 years of age was larger than in people 45–59 years of age. There was a medium correlation between age and decreased alveolar bone crest height.

1. Introduction

An improvement in public awareness toward healthy lifestyles is reflected in the significantly increasing number of elderly people worldwide, including Indonesia. Since the osteoporosis prevalence is directly proportional to life expectancy, the increasing number of elderly need to be balanced with specific treatments regarding the possibility of an osteoporosis epidemic. In 2005, an osteoporosis risk analysis was conducted by Puslitbang Gizi of the Republic of Indonesia's Health Ministry and a nutrition company in 16 areas throughout Indonesia with bone mass density (BMT) examinations using a clinical bone sonometer. They sampled 65,727 people consisting of 22,799 males and 42,928 females and reported an osteopenia prevalence of 41.7% and an osteoporosis prevalence of 10.3%. However, in 2012, based on data by the Health Ministry, the prevalence was 19.72%, which indicates a drastic increase of 9.42%. Osteoporosis is a condition characterized by bone density decrements and microarchitectural deterioration of bone tissue; thus, making bones more prone to fracture [1]. Osteoporosis is preceded by osteopenia, a condition in which bone mass starts to deteriorate. Although osteoporosis happens more to women, men also are at risk of osteoporosis. As estrogen decrements in women are associated with osteoporosis, men are also affected by a hormone, specifically, testosterone decrements aggravate bone porosity [2]. However, women undergo menopause; therefore, osteoporosis occurs earlier than in men. Estrogen in women starts to decrease at the age of 30, while in men, testosterone starts to decrease at the age of 65 [3]. Nevertheless, after passing 30 years of age, which marks the peak in bone mass, then entering the age of 40, both men and women undergo physiological bone mass decrements [4,5].

Osteoporosis is also known as the silent disease, which implies that a patient usually does not have any symptoms, such as pain, and the patient can still do normal activities until a point comes when the patient gets a fracture for the first time [2]. Postmenopausal osteoporosis usually occurs for 15–20 years after menopause, in women this relates to approximately 51–75 years of age. However, osteoporosis can also occur due to a calcium deficiency, related to age, and a bone remodeling imbalance that occurs in the elderly, usually in those above 70 years of age [4].

With regard to osteoporosis, on examination, bone strength is determined by two factors including bone quality and bone quantity. Bone quality relates to the trabeculae pattern and bone density, while bone quantity refers to bone width and height. Several studies have been conducted using panoramic radiographs to evaluate density and cortical bone width of the mandible to find a correlation with osteoporosis. However, in other studies, periapical dental radiographs have been used to evaluate trabeculae patterns and alveolar bone densities [2,6]. Osteoporosis in other body parts is related to symptoms in the oral cavity, such as alveolar bone resorption, reduction of the cortex mandibular width, and tooth loss, findings concluded from previous study [7]. Regarding this context in Indonesia, there has not been any research concerning quantitative data that includes the mean level of cortex width, alveolar bone crest height, and tooth loss in elderly people with a risk of osteoporosis. Therefore, the objective of this research was to obtain quantitative data on mean alveolar bone crest heights in age groups with a risk of osteoporosis. This research was conducted as a preliminary study in which the data obtained can be used for later research regarding osteoporosis.

2. Materials and Methods

This research was conducted in Dental Teaching Hospital of the Faculty of Dentistry, Universitas Indonesia. This research was conducted to determine the mean alveolar bone crest decrement levels in patients aged 40–75 years, which is the age group with an osteoporosis risk, without differentiating men and women. The sampling was done at the initial stage of the research. The samples were periapical intraoral radiographs from 40–75-year-old patients in the Dental Teaching Hospital of the Faculty of Dentistry, Universitas Indonesia.

The minimum total samples needed was determined using an equation base on previous research. Measurements and calculations of the distance from the alveolar bone crest to the cementoenamel junction (CEJ) were done twice by two observers at the same time on two different days. After the measurements were performed, compatibility tests between the two observers using a technical error of measurement (TEM) test was done. After the most accurate numbers with the lowest TEM values were obtained, statistical analyses were done using SPSS software with the frequency stated in numbers and percentages. Correlation tests were performed using analysis software with the Pearson test methods.

3. Results and Discussion

3.1 Results

Eighty samples of alveolar bone height obtained from 40 bisections and parallel periapical radiographs that fulfilled the inclusion criteria were the objects of this research. The total sample distribution according to age groups can be seen below in Table 1.

Table 1. Frequencies of sample distributions

Age Group	Men *n* (%)	Women *n* (%)
Pre-elderly (40–59 years old)	8 (40)	12 (60)
Elderly (60–75 years old)	8 (40)	12 (60)
Total (40–75 years old)	16 (40)	24 (60)

Based on Table 1, 80 samples from both mesial and distal alveolar bone were chosen according to the inclusion criteria from 40 radiographs. Samples were divided into two groups that included a pre-elderly group and an elderly group, both with the same number of samples (n = 40). The pre-elderly group had ages ranging from 40–59 years, while the elderly group had ages ranging from 60–75 years. Both groups were defined as having a risk of osteoporosis. In the pre-elderly group, the youngest patient was 50 years old and the oldest was 59 years old; however, in the elderly group, the youngest patient was 60 years old and the oldest was 75years old.

There was an imbalance in the numbers of men and women samples in this study. The percentage of samples was 60% for women and 40% for men. According to the rule of radiographic research, radiographs used as samples in this research had to be observed by two observers at different times, and reliability tests for the results were conducted. Intraobserver reliability was measured to define the assessment reliability between the two observers. The Dahlberg formula was used to measure the intra- and interobserver reliability on all data from the periapical radiograph measurements. The Dahlberg formula utilizes measurements on the subject group to determine the TEM with the following equation:

$$\text{TEM} = \sqrt{\sum \boldsymbol{di^2/2n}}$$

di = difference between the two measurements
n = total number of samples

The Dahlberg values obtained from the intra- and interobserver reliability tests can be seen in Table 2.

Table 2. Dahlberg values for the intra- and interobserver reliability

Test	Interpretation	TEM Value (mm)
Intraobserver Reliability	AI vs. AII	0.14252
	BI vs. BII	0.15309
Interobserver Reliability	AI vs. BI	0.41833
	AI vs. BII	0.15309
	AII vs. BI	0.41833
	AII vs. BII	0.40311

A = First observer
B = Second observer
I = First observing time
II = Second observing time

Based on the TEM data above, for both the intraobserver and interobserver reliability tests, the lowest score for alveolar bone crest height decrement was 0.14252 for AI versus AII, and the highest score was 0.41833 for AI versus BI and AII versus BI. According to the Dahlberg formula, the accepted level of measurement tolerance (MT) for bone and tooth measurements is 1 mm. Based on the intraobserver and interobserver tests with the Dahlberg formula, a TEM of ≤ 1 mm was obtained from all data.

The variable used for data processing was data with the lowest TEM, which means it had the best score in measuring alveolar bone crest height decrements. Data used in this research was the mean value of the measurement performed by the first observer at the first observation time and the measurement performed by the first observer at the second observation time.

Table 3: Frequency and percentage of alveolar bone crest height decrements in age groups with an osteoporosis risk

Alveolar Bone Crest Height Decrement (mm)	Frequency Mesial (n)	Frequency Distal (n)	Total (n)	Percentage (%)
1.5	2	0	2	2.5

2	3	5	9	11.25
2.5	2	3	5	6.25
3	12	8	20	25
3.5	5	5	10	12.5
4	10	10	20	25
4.5	3	0	3	3.75
5	2	4	6	7.5
5.5	1	1	2	2.5
6	0	2	2	2.5
6.5	0	0	0	0
7	0	1	1	1.25
Total	41	39	80	100

The highest frequency and percentage from an age group with an osteoporosis risk were at 3 mm and 4 mm alveolar bone crest height decrements with a frequency of 25% for each decrement, as shown in Table 3. The results of alveolar bone crest height decrement data processed descriptively are shown below in Table 4.

Table 4: Statistical results of the mean and standard deviation of alveolar bone crest height decrement

Alveolar Bone Crest Height Decrement (mm)	Mean ± SD	Mode	Minimal	Maximal
Pre-elderly	3.15±0.864	3.0	1.5	5
Elderly	3.90±1.156	4.0	2.0	7
Total	3.50±1.085	3.5	1.5	7

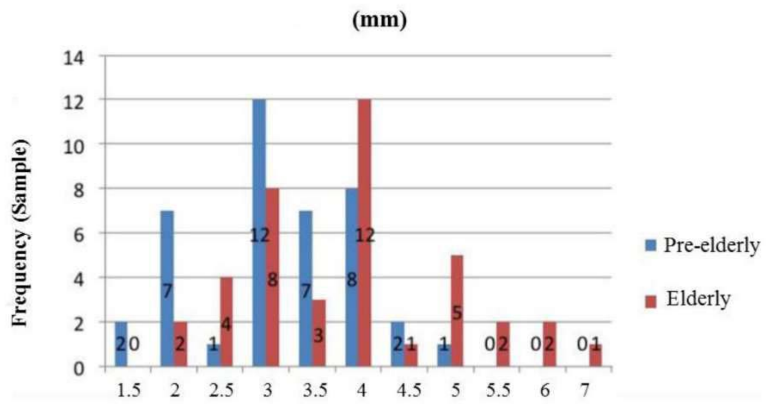

Figure 1. Bar diagram of the frequency of alveolar bone crest height decrements in pre-elderly and elderly groups

As can be seen in Figure 1, the highest frequency for alveolar bone crest height decrement in the pre-elderly group was a 3-mm decrease in 12 subjects, which was 30% of the total sample. The highest frequency for alveolar bone crest height decrement in the elderly group was a 4-mm decrease (mesial side) in 12 subjects, 30% of the total sample.

Pearson tests were performed to identify any correlations between age and alveolar bone crest height decrements. A scatter-plot diagram was made before the Pearson test was performed to determine if both variables were linear. The first variable was age and the second variable was the alveolar bone crest height decrement. The independent variable (age) is on the x-axis, while the dependent variable (alveolar bone crest height decrement) is on the y-axis. The scatter-plot diagram between age and alveolar bone crest height decrement can be seen below in Figure 2. According to the result of Pearson correlation test, the *r* value is 0.372, which implies a medium correlation between age and the mean alveolar bone crest height decrement.

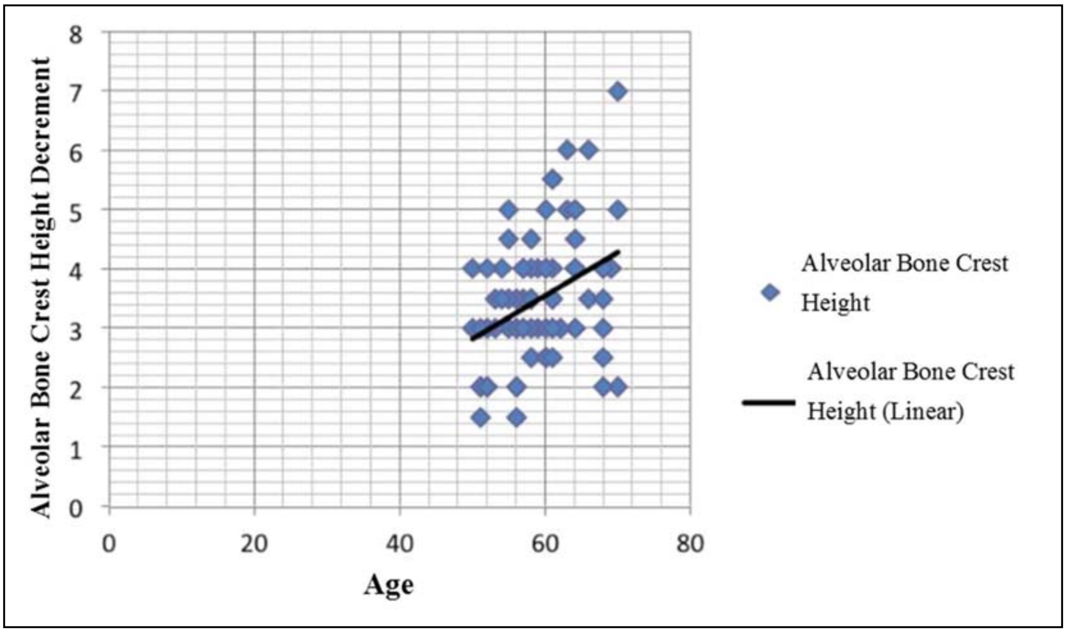

Figure 2: Scatter-plot diagram between age and alveolar bone crest height decrements

3.2 Discussion

The objective of this research was to determine the mean alveolar bone crest height decrement in patients 40 to 75 years of age with an osteoporosis risk from RSGM-P (Dental Hospital). We did this by conducting a linear measurement on periapical radiographs. Data obtained from this research was the distance from the alveolar bone crest to the CEJ.

As can be seen from Table 4, the mean alveolar bone crest height decrement of the pre-elderly group (40–59 years old) was 3.15±0.864 mm, while the mean of the elderly group (60–75 years old) was 3.90±1.156 mm, and the mean for both groups was 3.50±1.085 mm. Previous research aiming to determine the distribution of alveolar bone crest height in adult patients showed different results. In that research, the mean distance from the alveolar bone crest to the CEJ was 1.4±0.7 mm for ages 15–24 years, 3.0±1.5 mm for ages 45–54 years, and 3.02±1.4 mm for ages 75–94 years [8]. It was concluded from that research that the distance from the alveolar bone crest height to the CEJ increased until 45 years of age and afterward remained stable until 94 years of age [9].

The difference in the mean alveolar bone crest height decrement of the pre-elderly and elderly was expected to be caused by nutritional factors that affect bone quality and quantity, such as calcium intake, which affects bone density. Calcium can be obtained from one’s daily diet and this has been shown to prevent osteoporosis. Moreover, there are other nutrient factors that affect calcium resorption and bone density [10]. This research agrees with previous research on the elderly who were above 70 years of age, which showed that, in the elderly, the vitamin D3 production amounts are 25–30% of that produced by young adults. The aging process also affects the efficiency of calcium resorption in the small intestine. Afterward, this condition could correlate with vitamin D insufficiency and deficiency, which might lead to decreases in calcium resorption efficiency; thus, taking calcium from the bone[10]. The elderly have a risk of vitamin D deficiencies due to the decrease of vitamin D resorption from their diet. Furthermore, it could be assumed that the elderly are exposed to less sunlight than young adults; therefore, the primary source of vitamin D3, which is synthesized in the skin and requires ultraviolet beta rays from sunlight, is reduced [10].

As can be seen from Table 5, the *r* value from the Pearson correlation is 0.372 and implies a medium correlation between age and the mean alveolar bone crest height decrement. Therefore, it can be concluded from this research that age is one of the predisposing factors in the decrement of alveolar bone crest height. The factors stated above may affect the difference in the mean alveolar bone crest height decrement in the pre-elderly and elderly groups. In this study, the elderly group had a tendency for a higher mean alveolar bone crest height decrement than the pre-elderly group. The region of interest (ROI) in this research is the alveolar bone crest on the proximal region of tooth 36 (or 46) from intraoral periapical radiographs. These teeth were selected for study because they usually have a normal position and can be seen clearly on radiographs with the lowest distortion of all regions [8,11]. The mesial and distal parts in this research were measured as one unit as Hausman *et al.* did in their research [12]. The age selection for this research was based on the physiological aging processes that occur in both men and women. An age of 30 years is the peak age for bone mass, and entering the age of 40, both men and women undergo physiological decrements in bone mass [4,5]. Therefore, the minimum age limit for the participants in this research was 40 years to fulfill other inclusion criteria, while the maximum age limit was 75 years because patients above 75 years are assumed to have already undergone osteoporosis [4].

For analysis, the age variable was divided into two groups, the pre-elderly group (40–59 years) and the elderly group (60–75 years), in accordance with UU No. 13 Tahun 1998 (Law Number 13 Year 1998) regarding elderly welfare, which states that being elderly includes those above 60 years of age. The advantage of this research is that the periapical radiograph was taken using parallel techniques based on a study conducted by Akerson *et al*. Their study showed that periapical radiographs have a higher accuracy than panoramic radiographs for bone measurements, while for the previous research, radiographs used were panoramic radiographs [13].

The limitation of this research included determining the observer agreement on radiograph measurements, which was caused by a lack of quality radiographs, even though they could still be interpreted. There were also some vertical distortions in which there was a lengthening or shortening of tooth 36 (or 46) on several samples of this research. The lack of accuracy in measurement could be affected by the observing process without the aid of standardized tools. The TEM of the measurement of the first observer on the first observation and the measurement of the first observer on second observation had the lowest values, which could indicate that these were the most accurate measurements. These variations may be due to the differences in reference points for both observers, and the first observer was more stable than the second observer. An observer’s stability could be influenced by fatigue factors, which could have affected both observers. Another limitation of this research included the fact that there was no gender differentiation; thus, a comparison with previous research that showed a significant difference between gender and osteoporosis could not be done. Beside gender, several other predisposing factors of osteoporosis, such as low body mass index (BMI), early menopause, family history of osteoporosis, consumption of thyroid medication, and steroid and anticonvulsant use. These factors were not considered in this study, thus become the limitation of this present study. Bone density and several other local factors that influence bone quantity could not be evaluated; thus, this lack of data affected the research results.

Ideally, the total amount of 80 samples with a balance of men and women is a necessity for this type of research, but this could not be fulfilled due to the limitation of subjects that fulfilled the inclusion criteria. The lack of a sample quantity with subjects ranging from 40–49 years old and 71–75 years old was an obstacle in this research. The difficulty in data acquisition was also due to the documentation that had not been well stored; thus, this led to a limitation of data. Nevertheless, the objective of this research was to determine the association between mean alveolar bone crest height decrements and patients with an osteoporosis risk. Thus, all samples represented their respective group without gender consideration. The results of this research are expected to aid further research regarding osteoporosis detection using radiographs; thus, collaboration between medical and dental teams could help in reducing osteoporosis rates. Dentists are expected to be able to contribute in preventing osteoporosis by early detection of the changes that happen to alveolar bone, then refer the patient to a medical team for further treatment and an accurate diagnosis.

4. Conclusion

The mean alveolar bone crest height decrement in the age group with an osteoporosis risk was 3.50±1.085 mm. The value of the pre-elderly group was 3.15±0.864 mm and the elderly group was 3.90±1.156 mm. Furthermore, we conclude that there was a tendency for a higher mean alveolar bone crest height decrement in the age group from 60–75 years than for the age group from 40–59 years. A positive correlation between age and the mean alveolar bone crest height decrement in the 40–75-year-old participants was obtained from the analysis of this research.

References

[1] Gulsahi A 2015 Osteoporosis and jawbones in women *J Int Soc Prevent Communit Dent* **5** 263-7.
[2] Fox-spencer R 2007 *Simple Guide Osteoporosis* (Jakarta: Penerbit Erlangga).
[3] Yasar F and Akgunlu F 2006 The differences in panoramic mandibular indices and fractal dimension between patients with and without spinal osteoporosis. *Dentomaxillofac. Radiol*. **35** 1-9.
[4] Ide P 2012 *Agar Tulang Sehat* (Jakarta: PT Elex Media Komputindo).
[5] Juluri R, Prashanth E, Gopalakrishnan D, Kathariya R, Devanoorkar A, Viswanathan V, Romanos GE. 2015 Association of postmenopausal osteoporosis and periodontal disease: A double-blind case-control study *J Int Oral Health* **7** 119-123.
[6] Camargo AJ 2016 Diagnostic performance of fractal dimension and radiomorphometric indices from digital panoramic radiographs for screening low bone mineral density *Braz J Oral Sci* **15** 131-136
[7] Reddy S 2008 Signs and Salivary Parameters as Indicators of Possible Osteoporosis and Osteopenia in Postmenopausal Women - A Study of 45 Subjects *Braz J Oral Sci* **7** 502-1506
[8] Adriani, Masulili D, Iskandar S L C and Hannah B 2008 Evaluasi radiografis intraoral konvensional kehilangan tulang alveolar pada periodontitis kronis perokok dan bukan perokok. Jakarta. *Maj. Kedokt. Gigi*. **15** 105-10.
[9] Grynpas M D 2002 The Concept of Bone Quality in Osteoporosis. *Aging Osteoporosis and Dental Impants.* Eds. Zarb G and Lekholm U. (Chicago: Quintessence Publishing Co.) p. 25-34.
[10] Lindawati S K 2003 Penentuan indeks densitas tulang mandibula perempuan pascamenopause dengan memperhatikan beberapa faktor risiko terjadinya osteoporosis [Dissertation] (Jakarta: Fakultas Kedokteran Gigi Universitas Indonesia).
[11] Supriyadi 2012 Distorsi radiograf periapikal pada berbagai regio gigi. *Dentika Dental J.* **13** 33-6.
[12] Suresh S, Kumar T S S, Saraswathy P K and Pani-Shankar K H 2012 Periodontitis and bone mineral density among pre and post menopausal women: a comparative study. *J. Indian Soc. Periodontol.* **14** 30-4.
[13] Alkan BA, Aral CA, Aral K, Acer N, Şişman, Y 2016 Quantification of circumferential bone level and extraction socket dimensions using different imaging and estimation methods: a comparative study *Oral Radiology* **32** 145-153.