

The Average Mandibular Cortical Bone Width of Patients at Risk of Osteoporosis

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Abstract

Despite the increasing elderly population worldwide, including in Indonesia, various conditions such as osteoporosis prevent the elderly from experiencing an enhanced quality of life. The risk of osteoporosis increases with age and can be detected by taking panoramic radiographs to measure the width of the mandibular cortical bone. This study aims to obtain the average width of the mandibular cortical bone in individuals at risk of osteoporosis. Regions of interest were chosen in the mental foramen regions. The average width of the mandibular cortical bone in individuals at risk of osteoporosis aged 40-80 years was 4.80618 mm. The mandibular cortical bone in women aged 40-59 years tends to be wider than in those aged 60-80 years. The average width of the mandibular cortical bone in the 40-80 year age group in Indonesia could be classified as normal.

Clinical article (J Int Dent Med Res 2017; 10(Special Issue): pp. 652-656)

Keywords: mandibular cortical bone width, osteoporosis, elderly, Indonesia

Received date: 16 August 2017

Accept date: 18 September 2017

Introduction

According to the 2010 Indonesia Population Census, the elderly population in Indonesia amounted to 18.04 million, which is approximately 7.6% of the total population (237.6 million).¹ The elderly population is estimated to reach 25% by 2050, meaning that Indonesia will experience an elderly population boom. However, the increasing elderly population and life expectancy is not accompanied by their enhanced quality of life.² Despite their longevity, the elderly have limited capabilities because they suffer from various conditions and diseases.

As one of the clinical conditions affecting the elderly, osteoporosis is known as a silent killer because it is often only detected after reaching a severe stage, for example, when a hip bone breaks.^{3,4}

However, because osteoporosis occurs evenly across all of the bones in the body, including the bone in the oral area,^{4,5} the width of the mandibular cortical bone and alveolar bone level can be examined to determine the quality

and quantity of bone tissue. The quality of the bone is determined by the bone density and trabecula pattern, while the quantity of bone is judged by the thickness and height of the bone. Both quality and quantity of the bone can be examined through radiograph imaging.⁵

As a dentist, it is important to realize the roles of the quality and quantities of bone are significant in determining the case prognosis. In Indonesia, osteoporosis is often not considered in treatment planning; whereas, the role bone quality and bone quantity are important in determining the success of oral care, especially in elderly patients.

Panoramic and dental radiography is frequently used as a diagnostic procedure during routine dental checkups or before various dental procedures, which could be of significant clinical value if the dentist can use it to identify patients at high risk of osteoporosis.^{6,7} Several studies have been conducted to support the use of panoramic and dental radiograph to detect osteoporosis. For example, Priminiarti et al., evaluated bone density as parameters of mandibular bone quality in panoramic and dental radiographs, and Sulistyani et al. showed that changes in the mandibular alveolar bone density in periapical radiographs correlated with the mandibular cortex index in panoramic

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radiographs.^{8,9}

However, to our knowledge, a database of the bone quantity collected has not yet been created. Therefore, the purpose of this research study is to find the average width of the mandibular cortical bone in individuals who are at risk of suffering from osteoporosis within the age range of 40–80 years, without discriminating between women and men.

Methods

This descriptive cross-sectional study was approved by the Ethical Committee of the Faculty of Dentistry Indonesia and was conducted at the Dental Hospital Faculty of Dentistry Universitas Indonesia. Samples of this study were good quality panoramic radiographs of patients aged 40–80 years between October and November 2012. Panoramic radiographs were made using the X-ray apparatus of Digora Cranex tome CEPH (Finland). Although 96 panoramic radiographs were collected, only 89 panoramic radiographs met the quality standard to be measured.

The independent variable was age, and the dependent variable was the mandibular cortical bone width, which was measured in the left and right mental foramen regions as the region of interest (ROI). The measurement was performed using three different spots around the left mental foramen region and three different spots around the right mental foramen region, and the average was calculated. Two observers took the measurements twice each. This method is a modified version of the mental index (Horner and Devlin 1998) and the panoramic mandibular index (Benson et al. 1991).

Data were analyzed using the Dahlberg formula, which calculates the technical error of measurement (TEM) to measure intra observer and inter observer reliability. The data from the lowest TEM score in the inter observer measurement were analyzed using the Shapiro-Wilk normality test and independent t-tests. The statistical tests were performed using SPSS 17 (Statistical Package for the Social Sciences).

Results

The Dahlberg formula analysis showed that all intra observer and inter observer reliability measurements had a TEM ≤ 1 mm; the highest

TEM were 0.106 from All and BII, and the lowest TEM were 0.046 from AI and BI (Table 1). The data from the lowest TEM were used for further statistical analysis. The average age of the patients was 59.74 years of age, and the average width of the mandibular cortical bone was 4.8 mm (Table 2).

Table 1. Dahlberg score in reliability measurement of intraobserver and interobserver

	Observer	TEM (mm)
Intraobserver	AI VS All	0,074
	BI VS BII	0.051
Interobserver	AI VS BI	0.046
	AI VS BII	0.065
	All VS BI	0.102
	All VS BII	0.106

MT (Measurement tolerance ≤ 1 mm). A = first observer; B = second observer; I: first measurement; II: second measurement

Table 2. Overview of the research data characteristic

Variable	Mean	Standard Deviation	Minimum	Maximum
Age (years)	59.7416	6,72939	45	77
Width of Mandibular Cortical Bone (mm)	4.80618	0,971238	2,5	8

For analytical purposes, the independent variable was transformed into categorical data. The first group included patients aged 40–59 years, and the second group was patients aged 60–80 years. The first group comprised more patients (53.93%) than did the second group (Figure 1 and 2).

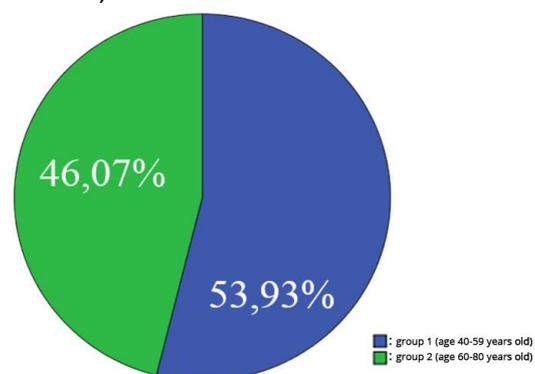


Figure 1. Age grouping graph

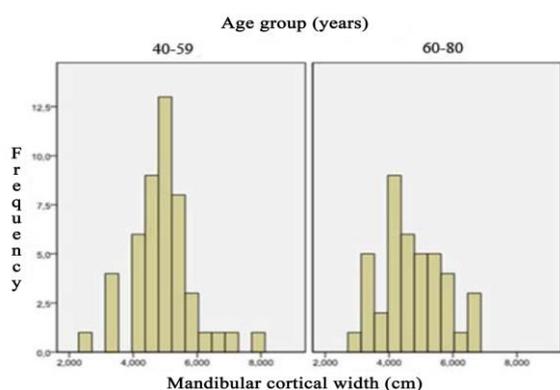


Figure 2. Distribution and frequency of mandibular cortical bone width in the first group and second group

The mandibular cortical bone widths of the first group were mostly in the range of 4.8–5.2 mm, and the mandibular cortical bone widths of the second group were mostly in the range of 4–4.4 mm. Therefore, the average mandibular cortical bone width in the first group was greater than that in the second group (Table 3).

Table 3. Average of mandibular cortical bone width based on age groups

	Mean	Standard Deviation	Average of Error Standard
Age 40-59	4,88542	0,970094	0,140021
Age 60-80	4,71341	0,976290	0,152471

The data were tested using independent t-tests to determine whether statistical differences exist between the two groups. The Shapiro-Wilk normality test showed that the data from both groups were normal in distribution ($p > .05$) (Table 4). The bivariate independent t-test showed that no statistical differences exist between the two groups ($p \geq .05$) (Table 5).

Table 4. Normality test

	df	Sig.
Age 40-59	48	0,063
Age 60-80	41	0,411

Table 5. Result of bivariate independent t-test of mandibular cortical bone thickness between the two groups

Variable	Mean	Standard Deviation	P	Mean Difference	95% Confidence Interval
Mandibular Cortical Width on group 1 (age 40-59 years old)	4,88542	0,970094	0,408	0,172002	-0,239245 - 0,583249
Mandibular Cortical Width on group 2 (age 60-80 years old)	4,71341	0,976290			

Discussion

Nowadays, a definitive diagnosis of osteoporosis can be made by measuring the bone mineral density (BMD) using Dual Energy X-ray Absorptiometry (DXA). However, in Indonesia, the total number of DXA is limited, and people seldom visit medical clinics seeking DXA because those with osteoporosis often experience few symptoms until it reaches a severe stage. Accordingly, there is an urgent need to find alternative methods for public screening to identify the risk of osteoporosis. While the panoramic radiograph is often used in dental offices as a supportive method of examination, using the panoramic radiograph to assess the mandible is useful to identify patients at risk of osteoporosis.^{10,11}

The amount of bone tissue in the body, known as bone mass, continues to grow until around age 30 when it reaches its peak bone mass, which is the maximum strength and density.¹² In this study, patients are grouped into two groups: (1) 40–59 years and (2) 60–80 years. The first group represents the condition of the person who has passed the peak bone mass but has not yet reached the category of elderly and the second group represents the elderly.^{12,13}

Meta-analysis research performed by Calciolari et al. found that the mandibular cortical width is useful to predict the BMD, revealing that 90% of patients with a cortical width wider than 4 mm have a normal BMD.⁶ However, several studies were conducted using the mandibular cortical bone width measurement of <3 mm as a

cut-off point to detect the risk of osteoporosis.^{6,14} As the average mandibular cortical bone width of all patients in this study is 4.80618 mm, it could be concluded that the population aged 40–80 years in Indonesia mostly has normal mandibular cortical bones. When comparing the two age groups, the average mandibular cortical bone width in group 1 (4.88542 mm) is larger than that in group 2 (4.71341 mm). This result showed that the younger age group has wider mandibular cortical bones, though both are still included in the normal category.

Hideto Ohtsuki reported that older female patients have a significantly increased risk of osteoporosis compared to elderly male patients.¹⁰ This difference is because the bone metabolism is affected by the sex hormone; thus, osteoporosis is more prevalent in women than in men because women's sex hormone changes during menopause.^{7,10,15}

The result of the independent t-test showed that no significant differences exist between the mean values of the mandibular cortical bone width of both groups. However, this result was influenced by several limitations in this study. Since gender is not considered a determinant, the comparison found in this study might be an underestimation of the actual outcome. Another limitation is the lack of information about other risk factors such as history of smoking, menstruation, hormone therapy, diet, and exercise.^{16,17}

Cigarette smoking increases the risk of osteoporosis because smoking accelerates bone loss,^{18,19} and coffee consumption is also a possible risk factor for osteoporosis; however, regular consumption of dairy products reduces the risk of osteoporosis.¹⁸ Although the optimal dose of exercise for maintaining bone health and preventing fracture is yet to be fully determined, exercise is an effective daily routine to diminish the risk of osteoporosis.²⁰

The primary purpose of this study is to gain an overview of the mandibular cortical bone width, regardless of other factors. Nevertheless, as a risk factor for osteoporosis, the age factor showed a positive relationship with the need for dental and oral maxillofacial treatment. Caries and periodontal diseases are among the most prevalent diseases, and if left untreated or treated inadequately, they will progress to dental gangrene and severe periodontitis, which need to be extracted. Osteoporosis plays a role in

delaying healing and increasing the risk of jaw fractures in dental extraction, and the success of pre-prosthetic and prosthetic treatment is determined by bone condition, especially dental implants, which depend on osseointegration and a bone remodeling process.^{21,22} In addition, the age-related incidence of a melioblastoma was found to stretch from the second to eighth decades of life,^{23,24} and the prognosis of jaw resection to treat a melioblastoma depends on the patient's healing ability, which is influenced by bone quality and bone quantity. It could be concluded that, as individuals get older, the risk of osteoporosis increases and the need for dental and oral maxillofacial treatment also increases.

The advantage of this study is the use of standardized panoramic radiographs and well-trained operators, which ensure good quality imaging to execute the measurements.

Conclusion

In this study, we obtained the average mandibular cortical width of patients at risk of osteoporosis, which is 4.80618 mm. This study also showed that the mandibular cortical bone in those aged 40–59 years old is wider than people aged 60–80 years. Further research about osteoporosis, jaw bone, and risk factors of osteoporosis should be conducted.

Acknowledgment

The publication of this manuscript is supported by Universitas Indonesia.

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