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Differences in Panoramic Mandibular Index value between male and female hypertension patients using panoramic radiography

(A review in hypertensive patients consuming Amlodipine at Ulin General Hospital Banjarmasin)

Novi Tiara Lestari^{1*}, Norlaila Sarifah² , Didit Aspriyanto³,
Bayu Indra Sukmana⁴ , Iyana Erlita⁵

ABSTRACT

Objectives: This study is aimed to analyze the panoramic mandibular index value in male and female hypertensive patients using panoramic radiography.

Materials and Methods: This research is a comparative analytic research with a purposive sampling technique. The study sample was hypertensive patients at Ulin Hospital, Banjarmasin from March to May 2023.

Results: The results showed that there was no statistically significant difference through statistical data on the panoramic mandibular index value between men (0.27 ± 0.07) and women (0.26 ± 0.09). The age group that experienced a decrease in mandibular cortical thickness was most in the age group ≥ 65 years (0.22 ± 0.06).

Conclusion: It is known that there is no significant difference in the panoramic mandibular index value between women and men.

Keywords: Hypertension, mandibular cortical thickness, panoramic radiography, panoramic mandibular index

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INTRODUCTION

Hypertension is a systemic condition characterized by an increase in blood pressure beyond the normal limit of 120/80 mmHg. JNC VIII states that hypertension can be defined as a condition in which an individual has blood pressure ≥ 140 mmHg (systolic) and/or ≥ 90 mmHg (diastolic).^{1,2,3,4} The prevalence of hypertension in the Indonesian population aged ≥ 18 years is known to be relatively high, ranging from 26.5% to 31.7%, with hypertensive individuals who are aware of their condition comprising 7.7% to 9.5%, and those who take hypertension medication being only 2.3%. The data from Riskesdas 2018 showed that the highest incidence of hypertension was found in individuals aged ≥ 18 years, and it was predominantly observed in South Kalimantan Province, with a prevalence of 44.1%. This condition is supported by a study conducted by Unja *et al.* in 2018, which stated that the incidence of hypertension in South Kalimantan Province in the year 2018 was recorded at 20,020 cases.^{5,6}

Hypertension experienced by an individual is known to affect bone mineral density (BMD) through the regulation of blood pressure and calcium metabolism. Hypertension can lead to an imbalance in calcium metabolism, subsequently causing calcium leakage from bones. This alteration then results in secondary hyperparathyroidism, characterized by an increase in *parathyroid*

hormone (PTH). This increase will subsequently lead to a decrease in BMD and bone quality.⁷ The increased bone resorption is known to be triggered by the stimulation of osteoclast formation. This effect is related to the activity of $\beta 2$ -adrenergic receptors present in osteoblastic and osteoclastic cells. The leakage of calcium from bones will ultimately be excreted by the kidneys in the form of urine.⁸

Patients with hypertension will certainly not be exempted from the use of antihypertensive drugs. The class of antihypertensive drugs is known to include the following groups: *beta blocker*, *angiotensin II receptor blocker*, *angiotensin converting enzyme inhibitor*, *diuretic*, and *calcium channel blocker*. Calcium channel blockers are the main class of antihypertensive drugs, and one of the frequently used medications is amlodipine. Amlodipine is a dihydropyridine calcium channel blocker, functioning as a calcium ion antagonist.⁹ Hypertensive patients who consume antihypertensive medication such as amlodipine will affect their calcium levels, which subsequently impacts their bone condition and becomes a risk factor for bone fractures.¹⁰ Amlodipine can also decrease bone quality by reducing the production of steroid hormones, thus reducing bone formation and decreasing the volume of trabecular and cortical bone in the mandible.¹¹

¹Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin, Indonesia, 70236

²Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin, Indonesia, 70236

³Department of Dental Materials, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin, Indonesia, 70236

⁴Department of Orthodontics, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin, Indonesia, 70236

⁵Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin, Indonesia, 70236

*Correspondence to:
Novi Tiara Lestari
novitiara278@gmail.com

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Panoramic radiography is one of the dental medicine techniques that can provide an image encompassing the teeth, maxilla, and mandible, allowing visualization of the inferior mandibular cortex. Panoramic radiography is also used to assess bone quality based on changes in density known to be influenced by certain systemic conditions, including hypertension. The examination of panoramic radiography is conducted using several qualitative and quantitative indices, namely *mandibular cortical index (MCI)*, *mental index (MI)*, *panoramic mandibular index (PMI)*, and *gonion antegonial index*.^{10,12}

PMI is an index that provides results in the form of a comparison between the thickness of the mandibular cortex and the distance from the inferior mental foramen to the inferior border of the mandibular cortex. Therefore, this measurement method allows calculations to be performed despite variations in magnification by different researchers.^{12,13,14} Based on the statement above, the researchers are interested in determining the differences in *panoramic mandibular index* values between male and female hypertensive patients using panoramic radiography.

MATERIALS AND METHODS

This research is a non-paired comparative analytic quantitative study with a cross-sectional design that has obtained approval from the Ethics Committee of Health Research, Faculty of Dentistry, ULM Banjarmasin, with reference number 061/KEPKG-FKGULM/EC/IV/2023. The study population comprises patients diagnosed with hypertension by doctors in the Internal Medicine Clinic at Ulin Banjarmasin Regional Public Hospital. Based on the calculation using the formula for a large comparative analytic sample, a total of 18 individuals were obtained in each group. The sampling technique employed in this study is *purposive sampling*.

The inclusion criteria for this research include male and female hypertensive patients who are

willing to participate as research subjects, patients diagnosed with pure hypertension without any other systemic diseases and undergoing therapy with calcium channel blocker (amlodipine), patients receiving amlodipine therapy between the ages of 40 to 75 years, clear mandibular cortex visible in panoramic radiographs, non-pregnant female patients, and panoramic radiographs showing complete object visualization. As for the exclusion criteria in this study, they are as follows: patients diagnosed with hypertension accompanied by other systemic diseases such as diabetes mellitus and kidney failure, panoramic radiographs showing mandibular fractures, panoramic radiographs that are not interpretable, and panoramic radiographs with overlapping images.

Next, respondents who have met the criteria undergo panoramic radiography at Ulin Banjarmasin Regional Public Hospital. The results of the panoramic radiography are collected in digital format and measured using the Panoramic Mandibular Index method. Panoramic Mandibular Index is an index that provides results in the form of a comparison between the thickness of the mandibular cortex and the distance from the inferior mental foramen to the inferior border of the mandibular cortex. The analyzed results are recorded in millimeters (mm) as the unit of measurement. The measurement of the *panoramic mandibular index* values from both groups was performed on the right and left sides of the mandible, and then the mean value was taken as the final result. The obtained data are grouped into nominal scale (male and female) and ratio scale for the measurement of *panoramic mandibular index* (PMI) values. Next, the data is tested for normality, used SPSS. The data of Kolmogorov-Smirnov assumption test was used to tested the normality of data distribution, a non-paired parametric T-test is conducted. The test is used to determine the comparison of *panoramic mandibular index* values in the research sample of hypertensive patients consuming amlodipine between males and females.

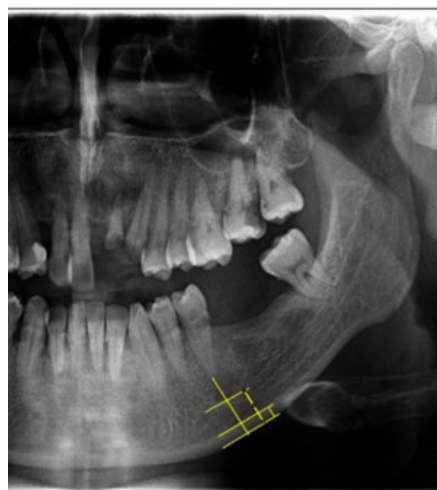


Figure 1. Panoramic Mandibular Index is a comparison between the thickness of the mandibular cortex and the distance from the inferior mental foramen to the inferior border of the mandibular cortex

RESULTS

This research was conducted on 36 hypertensive patients aged approximately between 40-75 years who were undergoing treatment at Ulin Banjarmasin Regional Public Hospital. The study was carried out from April 2023 to May 2023. The obtained data were then subjected to comparative analysis. The sample characteristics are presented in Table 1. This table shows that the majority of the research sample falls into the age group of 46-55 years.

The results of mandibular cortex width measurements based on gender using PMI can be seen in Table 2. This table shows that female patients obtained an average mandibular cortex

width of 0.26 ± 0.09 , with a mean width of 0.26 ± 0.1 on the right side and 0.26 ± 0.09 on the left side. Male patients obtained an average mandibular cortex width of 0.27 ± 0.07 , with a mean width of 0.27 ± 0.07 on the right side and 0.28 ± 0.07 on the left side.

The results of mandibular cortex width measurements based on age using PMI can be seen in Table 3. This table shows that the largest mandibular cortex width was found in the age groups of 36-45 years and 46-55 years.

The results of bone density measurements in hypertensive patients based on the Panoramic Mandibular Index according to age can be seen in Figure 2, indicating that 26 patients experienced a decrease in mandibular cortical density, while 10

Table 1. Characteristics of Research Samples Based on Age and Gender

Variable	Number of Patients	Percentage
Age		
36-45 years	2	5%
46-55 years	15	42%
56-65 years	13	36%
≥ 65 years	6	17%
Gender		
Woman	18	50%
Man	18	50%
Total	36	100%

Table 2. Mean Mandibular Cortex Width Based on Gender

Gender	n	Mandibular Cortex Width (Mean + SD)	
Woman	18	Right (0.26 ± 0.1)	Left (0.26 ± 0.09)
		Man	18

Table 3. Results of Measurement of the Average Value of Mandibular Cortex Width Based on Age

Age	n	Mandibular Cortex Width (Mean ± SD)
36-45 Years	2	(0.28 ± 0.1)
46-55 Years	15	(0.28 ± 0.09)
56-65 Years	13	(0.26 ± 0.08)
≥ 65 Years	6	(0.22 ± 0.06)

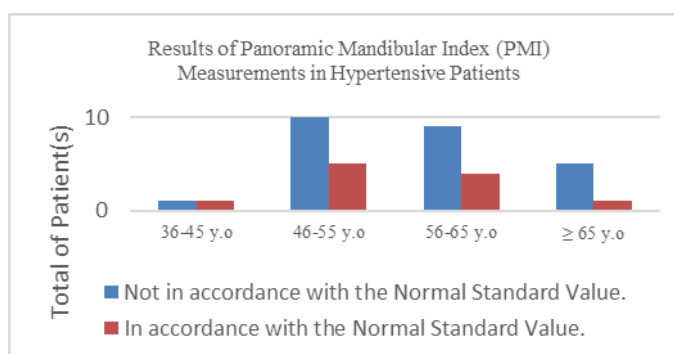


Figure 2. Results of Mandibular Cortical Thickness Measurements in Hypertension Patients based on Panoramic Mandibular Index by Age

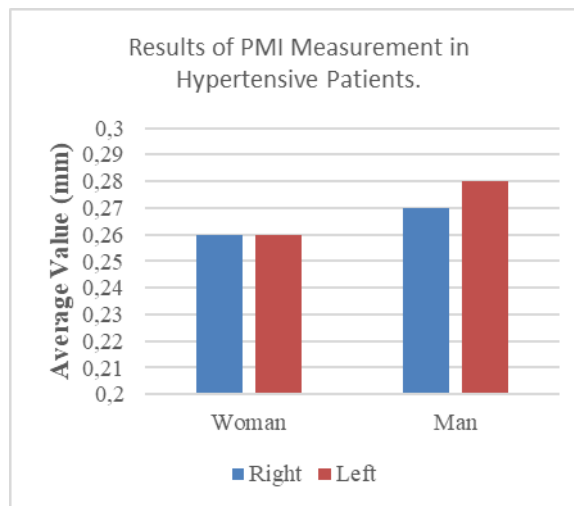


Figure 3. Results of Mandibular Cortical Thickness Measurements in Hypertension Patients based on Panoramic Mandibular Index Based on Gender

patients did not show a decrease in mandibular cortical density. The results of bone density measurements in hypertensive patients based on the Panoramic Mandibular Index for the right and left mandibular cortical density in males and females can be seen in Figure 3, showing that the decrease in mandibular cortical density was more pronounced on the left side in males, whereas females exhibited similar results on both the right and left sides.

DISCUSSION

The research results showed that the average mandibular cortex width in female patients was 0.26 ± 0.09 , while in male patients, it was 0.27 ± 0.07 . The statistical data analysis in both groups yielded results ($p > 0.05$), indicating that there is no significant difference. These findings are consistent with the study by Azhari *et al.*, which also demonstrated no significant difference in mandibular cortex width values between males and females.¹⁵ The findings of this study are consistent with the research conducted by Satria *et al.*, which also demonstrated a decrease in mandibular cortical thickness in hypertensive patients consuming amlodipine.

This can be attributed to the mechanism of amlodipine, which reduces the influx of calcium ions into myocardial cells and blood vessels, subsequently leading to an increase in cytokines and VEGF (Vascular Endothelial Growth Factor). This increase further results in the elevation of osteoclasts, leading to a reduction in mandibular cortical thickness. Amlodipine also modifies L-type channels and reduces the amount of calcium ions inside the cells, leading to an impact on contractility in muscle cells and the release of enzymes and hormones. L-type calcium channels are found in osteoblasts as calcium channel blockers (CCBs) are known to influence the process of cell remodeling.^{2,16}

Amlodipine is known as a dihydropyridine

calcium channel blocker with antihypertensive effects that work by inhibiting the entry or absorption of calcium when calcium enters the L-type calcium channel membranes. This activity subsequently reduces intracellular calcium concentration and stimulates smooth muscle in peripheral and coronary arteries, while inhibiting calcium absorption, which further affects bone quality and density.¹¹

The research results in Table 2 indicate that there are differences in PMI measurements between male and female patients. These findings are consistent with the study conducted by Gunawan *et al.*, which states that the reduction in mandibular cortical thickness in female hypertensive patients is higher than in male patients. This condition may be attributed to the loss of estrogen hormone, which can contribute to the rate of decrease in mandibular cortical thickness.^{17,18} The development and bone density in women are also known to be greatly influenced by estrogen hormone, and during menopause, when the ovaries stop producing estrogen, it leads to an increase in bone loss.^{10,19,20} Women usually have a higher level of compliance in taking amlodipine medication compared to men. This is what leads to a decrease in bone density.²¹

The difference in the rate of mandibular cortical thickness reduction is also known to be influenced by the growth process. The peak bone growth and development in males are known to be higher than in females, characterized by a larger peak growth in males compared to females, which leads to a slower decrease in mandibular cortical thickness in male patients.^{10,19,20}

The research results in Table 3 indicate that the group with age ≥ 65 years has the lowest average mandibular cortex value compared to other groups, with a value of 0.22 ± 0.06 . These findings are consistent with the study by Naik A *et al.*, which states that mandibular cortical thickness values tend to increase with age.^{19,21} This research is also supported by the study conducted by Arsalan *et al.*, which states that mandibular cortical thickness is

strongly correlated with age.²³ This condition can occur because a decrease in bone density is known to begin around the age of 35. The reduction in mandibular cortical density typically increases further during menopause due to a decrease in estrogen hormone levels. The first phase of mandibular cortical density reduction occurs at the age of 30-35 years when the number of osteoblasts and osteoclasts is balanced and decreases further at the age of 35-45 years, known as the second phase. The third phase occurs at the age of 45-55 years, characterized by increased bone fragility and a higher risk of fractures, leading to the fourth phase above the age of 55 years, where there is a decrease in osteoblast activity while osteoclasts remain active.²⁴ This research is also supported by the study conducted by Sari *et al.*, which states that there are differences in the average mandibular cortical thickness values in postmenopausal women using PMI in panoramic radiographs.²⁵

The results of the conducted research indicate that 26 individuals were detected to experience a decrease in mandibular cortical density. The findings of the study demonstrate that mandibular cortical measurements using the *panoramic mandibular index* are capable of identifying the mandibular bone mineral density in patients.²⁶ The results of this research are consistent with the study conducted by Satria *et al.*, which showed a significant relationship between patients with hypertension and a decrease in mandibular cortical density. Hypertension is known to be associated with high levels of sodium chloride (NaCl) in the body. This condition is caused by hypertension disrupting calcium absorption and increasing calcium excretion in the urine (hypercalciuria). In conditions of high NaCl levels, calcium in the blood cannot be filtered in the kidneys to be reabsorbed back into the bloodstream in the proximal distal tubules and Henle's loop, so it has to be excreted. Both ions have the same binding site, which is the claudin-2 protein in the proximal tubules of the kidney, causing them to compete for binding.⁷ The results of this research are also supported by the study conducted by Hussein *et al.*, which states that there is a relationship between hypertension and the use of medication with a decrease in mandibular cortical density, which can also be influenced by other factors such as age and physical activity.⁸

The results of the study on the mandibular cortex width of the right and left sides in male and female patients showed differences, although not statistically significant. Due to the small number of research samples, there is no significant difference in the value of the difference between male and female. This study has been done intra-observer agreement. These differences are attributed to different bone remodeling activities, influenced by genetic conditions, muscle mass, and variations in sex hormones secreted in males and females. Genetic factors, in the form of differences in gene expression, play a role in influencing the functions of bone cells, such as osteoclasts and osteoblasts, which contribute to the variation in bone density

between males and females.²⁰ The results of this study are supported by the research conducted by Azhari *et al.* in 2019, which stated that there were relatively small differences in the average length of the right and left mandibles between males and females.¹⁵

CONCLUSION

The research results indicate that the measurements using PMI in females have higher average of mandibular cortical density with an average mandibular cortex value of 0.26 ± 0.09 , while the measurements based on age showed the lowest mandibular cortical thickness value in the age group ≥ 65 years with an average value of 0.22 ± 0.06 . The results of cortical mandibular thickness measurements in male and female hypertensive patients consuming amlodipine showed no significant difference.

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None.

FOOTNOTES

All authors have no potential conflict of interest to declare for this article. The study had approval from the Ethics Committee of Health Research, Faculty of Dentistry, ULM Banjarmasin, with reference number 061/KEPKG-FKGULM/EC/IV/2023. All procedures conducted were in accordance with the ethical standards.

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