Differences in Antegonial Index values in type II diabetes mellitus patients using panoramic radiography

(A review based on the duration of suffering at Ulin General Hospital Banjarmasin)

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ABSTRACT

Objectives: This research is aimed to analyze the value of the antegonial index in patients with type II diabetes mellitus using panoramic radiography.

Materials and Methods: This research is using stratified random sampling study with unpaired numerical comparative formula. The research sample was patients who were visiting and diagnosed with type II diabetes mellitus for ≤ 5 years and > 5 years by doctors at the Internal Diseases Polyclinic at Ulin General Hospital, Banjarmasin. Mandibular cortical thickness can be seen in the results of panoramic radiographs using radiomorphometric measurements with mandibular cortical index measurements, which is called as antegonial index. Antegonial index measurement as

a screening tool can detect either the patient is positive or negative for having bone resoption.

Results: The result showed average value of mandibular cortical thickness in patients with diabetes mellitus type II with a period of disease ≤ 5 years does not match the normal limit of > 3.2 mm, which is 2.57 ± 1.41 and the average value of mandibular cortical thickness in the group of patients with long period of disease > 5 years is 2.19 ± 0.76.

Conclusion: Mandibular cortical thickness in patients with type II diabetes mellitus for ≤ 5 years and > 5 years is not within normal limits.

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INTRODUCTION

Diabetes mellitus (DM) is a common medical condition that affects a significant number of people worldwide.[1] According to the International Diabetes Federation (IDF) in 2019, it was projected that the prevalence of diabetes mellitus worldwide would increase from 463 million people in 2019 to approximately 578 million people in 2030. Indonesia ranks seventh globally in terms of the number of people affected by diabetes mellitus, with a total of 10.7 million individuals.[2] According to the Basic Health Research (RISKESDAS) conducted in 2018, the prevalence rate of diabetes mellitus in Indonesia was found to be 1.5%. Furthermore, the study revealed that in the South Kalimantan region, the percentage of individuals diagnosed with diabetes by healthcare professionals was 1.3%.[3] According to the data from the South Kalimantan Provincial Health Office in 2020, the number of diabetes mellitus patients was 77,997.[4]

Type II diabetes mellitus is a condition characterized by hyperglycemia or an elevated blood glucose (sugar) level.[5] The condition of hyperglycemia leads to a decrease in the body's calcium levels, resulting in a decline in the quality of

bone tissue.[1] Poor glucose control in patients with type II diabetes mellitus can lead to the occurrence of hyperglycemia.[6] Poor glycemic control is more commonly observed in patients with type II diabetes mellitus who have been suffering for less than 5 years compared to those who have been suffering for more than 5 years.[7] The condition of hyperglycemia can increase the formation of advanced glycation end-products (AGEs), leading to various chronic complications, both macrovascular and microvascular, and resulting in decreased bone thickness.[8] This statement is supported by a study conducted by Putri *et al.* (2020), which stated that patients with type II diabetes mellitus experience a decrease in bone thickness.[1]

Type II diabetes mellitus is one of the disorders that can affect bone mineral density (BMD).[9] Epsilawati *et al.* (2018) stated that low insulin levels in the blood can disrupt the physiological process of bone remodeling.[10] Remodeling is an activity of bone in the process of renewing mineral reserves due to the influence of local factors. Local factors can include bone resorption activity by osteoclasts, which stimulate osteoblasts to differentiate.[11,12] Several additional factors have been identified as

inhibitors of the remodeling process. These include calcitonin, estrogen, glucocorticoids, thyroid hormones, vitamin C, bone mineralization inhibitors such as pyrophosphate and blood pH, as well as low insulin levels. These factors inhibit the secretion of RANKL, which leads to calcium absorption. The development of an accelerated resorption process can be associated with the dysfunction of resorption inhibitors, resulting in decreased bone density among individuals diagnosed with diabetes mellitus.[10] This statement is supported by a study conducted by Jang et al. (2018), which compared the BMD values in patients based on the duration of type II diabetes mellitus. The study found that lower BMD values were observed in the group of patients who had been suffering from diabetes mellitus for a longer duration compared to the group of patients who were newly diagnosed with type II diabetes mellitus.[13]

The decrease in BMD in the mandible can be assessed through panoramic radiography using radiomorphometric measurements. Radiomorphometric measurements can be utilized to evaluate radiographic changes in the mandibular bone.[1,14,15] Mandibular cortical measurements, including mandibular cortical index (MCI), panoramic mandibular index (PMI), mental index (MI), gonial index (GI), and antegonial index (AI).[10,14-16]

One of the measurements using panoramic radiography that has been widely used and has been proven to have a strong correlation in assessing mandibular cortical thickness and observing signs of bone resorption is by using the measurement of the antegonial index angle.[1,17,18] Noerjanto et al. (2014) and Bajoria et al. (2015) stated that the use of the antegonial index (AI) on panoramic radiographs as a screening tool to assess mandibular cortical thickness has higher sensitivity and specificity and is reasonably accurate.[17,19] According to the study, the assessment of the antegonial index angle on panoramic radiographs has the potential to identify individuals who show bone resorption or the absence of bone resorption. The antegonial angle is a valuable parameter in orthodontic dentistry for assessing mandibular growth and detecting bone resorption.[17] Based on the research by Putri et al. (2020) and David et al.

(2017), the values of cortical mandibular thickness using the antegonial index (AI) method in patients with type II diabetes mellitus do not conform to the normal limits when compared to non-diabetic individuals.[1,14] Based on the description above, the researcher is interested in conducting a research study focused on evaluating the effectiveness of using panoramic radiography to assess the antegonial index in individuals diagnosed with type II diabetes mellitus.

MATERIALS AND METHODS

This study utilized a non-paired numerical comparative analytic method with a cross-sectional design. The aim was to compare the values of the antegonial index between two groups: patients diagnosed with type II diabetes mellitus for ≤ 5 years and > 5 years. This study has obtained ethical clearance approval from the Research Ethics Committee of the Faculty of Dentistry, ULM Banjarmasin with reference number 062/KEPKG-FKGULM/EC/IV/2023. The population in this study consists of patients who are visiting and diagnosed with type II diabetes mellitus for ≤ 5 years and > 5 years by doctors at the Internal Medicine Clinic of RSUD Ulin Banjarmasin from January 2023 – May 2023. Based on the calculation of the non-paired numerical comparative formula using a cross-sectional approach, the minimum number of samples in the study was 34 samples with each group amounting to 17 samples. The sampling technique used in this study was performed using the stratified random sampling method. The inclusion criteria in this study were as follows: patients diagnosed with type II diabetes mellitus with a minimum duration of suffering of ≤ 5 years and > 5 years by a doctor, conscious and communicative type II diabetes mellitus patients, non-pregnant female patients, willing to participate as research respondents, and clear panoramic radiographic images showing mandibular cortical features. The exclusion criteria in this study were as follows: patients diagnosed with type II diabetes mellitus with concomitant other systemic diseases, patients with diabetes mellitus whose condition worsened during the course of the study,
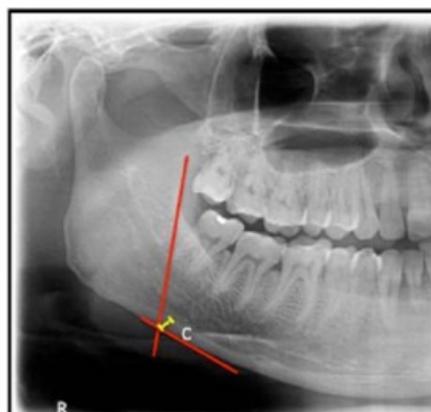

Figure 1. Antegonial Index Measurement[19]

panoramic radiographic images with mandibular fractures, radiographic images with inadequate quality, panoramic radiographic images that could not be interpreted, and panoramic radiographic images with overlapping.

Individuals who met the predetermined criteria then underwent panoramic radiography at Ulin Banjarmasin Hospital. The results of the panoramic radiography were obtained and recorded in digital format, and then analyzed using the antegonial index method. The antegonial index values from both groups were measured on the right and left sides of the mandible, and then the average values were calculated as the final result. The data was then processed and analyzed. The methodology used for data analysis involved the use of non-paired numerical comparative analysis. The statistical tests used in this study include tests for normality and homogeneity. Not-paired t-test is used when the data set shows normal distribution and homogeneity. The Mann-Whitney test, a non-parametric test, is appropriate for datasets that do not follow a normal distribution.

RESULTS

This study was conducted on 34 patients who were visiting and diagnosed with type II diabetes mellitus for ≤ 5 years and > 5 years by doctors at the Internal Medicine Clinic of RSUD Ulin Banjarmasin. The study was conducted from March 2023 to June 2023 at RSUD Ulin Banjarmasin. The data obtained in this study were then analyzed using comparative analysis. The sample characteristics can be seen in Table 1. This table indicates that based on the duration of suffering, the sample in this study, consisting of both ≤ 5 years and > 5 years, has an equal frequency of 17 individuals, accounting for 50%. The majority of the samples in this study are female, with a frequency of 19 individuals, representing 56%, while the male samples have a frequency of 15 individuals, accounting for 44%.

The results of the average cortical mandibular thickness based on the duration of suffering can be seen in Table 2. This table shows that the antegonial index values in both groups, based on a duration of ≤ 5 years and > 5 years, exceed the

Table 1. Frequency Distribution of Sample Characteristics

VARIABLE DURATION OF SUFFERING	FREQUENCY	PERCENTAGE
≤ 5 year	17	50%
> 5 year	17	50%
Total	34	100%
GENDER		
Male	15	44%
Female	19	56%
Total	34	100%

Table 2. Average Value of Cortical Mandibular Thickness in Type II Diabetes Mellitus Based on Duration of Suffering ≤ 5 years and > 5 years with Anetgonial Index

DURATION OF SUFFERING	n	ANTEGONIAL INDEX VALUE		
		MEAN	RIGHT JAW (MEAN ± SD)	LEFT JAW (MEAN ± SD)
≤ 5 year	17	2.57±1.41	2.67±1.66	2.42±1.21
> 5 year	17	2.19±0.76	2.27±0.77	2.11±1.99

Table 3. Status of Cortical Mandibular Thickness Based on Duration of Suffering ≤ 5 years and > 5 years

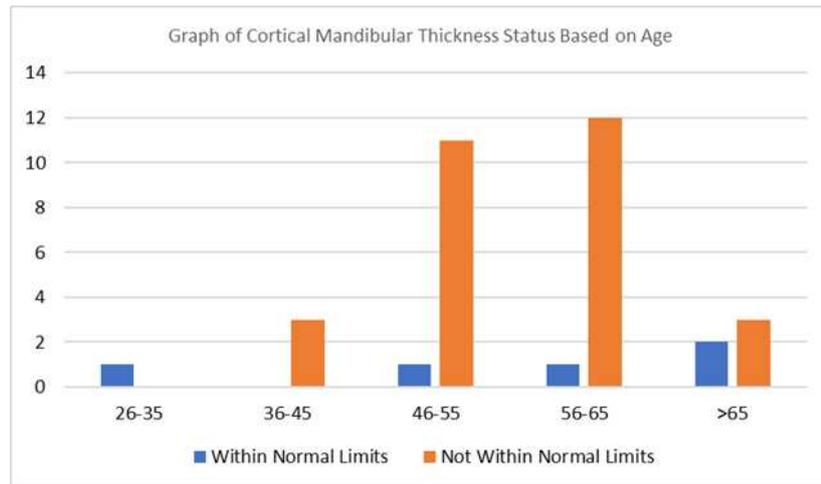| DURATION OF SUFFERING	n	STATUS OF CORTICAL MANDIBULAR THICKNESS	
		WITHIN NORMAL LIMITS	NOT WITHIN NORMAL LIMITS
≤ 5 year	17	3	14
> 5 year	17	2	15
Total	34	5	29

Figure 2. Cortical Mandibular Thickness Status Based on Age

normal limit of > 3.2 mm. The average measurement value of the antegonial index in the group with a duration of ≤ 5 years was 2.57±1.41, with the average cortical thickness of the right jaw being 2.67±1.66 and the average cortical thickness of the left jaw being 2.42±1.21. In the group with a duration of > 5 years, the average value obtained was 2.19±0.76, with the average cortical thickness of the right jaw being 2.27±0.77 and the average cortical thickness of the left jaw being 2.11±1.99.

The results of cortical mandibular thickness status based on the duration of suffering can be seen in Table 3. This table shows that out of a total of 17 radiographic images, 14 respondents with a duration of suffering ≤ 5 years were detected to have cortical thickness exceeding the normal limit and 15 respondents with a duration of suffering > 5 years were detected to have cortical thickness exceeding the normal limit of > 3.2 mm.

The results of the assessment of cortical mandibular thickness status based on age can be seen in Figure 2. Figure 2 shows that based on age, out of a total of 13 respondents, 12 respondents aged 56-65 had cortical mandibular thickness values exceeding the normal limit of > 3.2 mm.

The normality test results of the mean values based on a duration of ≤ 5 years for the right and left jaws showed that the data is not normally distributed, with a significance value of p<0.05 for both the right and left jaws, which is 0.000. The data was further analyzed using the Mann-Whitney test, which indicated a significance value of 0.535 (p>0.05), indicating no difference between the right and left jaws in the group suffering from type II diabetes mellitus with a duration of ≤ 5 years. Based on the normality test of the mean values of the duration of more than 5 years for the right and left jaws, the data shows non-normal distribution with a significance value of p<0.05 for the right jaw (0.549) and the left jaw (0.040). The data was further analyzed using the Mann-Whitney test, which indicated a significance value of 0.558 (p>0.05), meaning that there is no difference between the right and left jaws in the group

suffering from type II diabetes mellitus with a duration of more than 5 years.

DISCUSSION

Based on the data analysis in Table 2, the results indicate that the average cortical thickness of the mandible in the group of patients with type II diabetes mellitus is lower than the normal limit. This indicates that the cortical thickness of the mandible in patients with type II diabetes mellitus does not conform to the normal limit. When comparing between the two patient groups, namely the group with a duration of suffering ≤ 5 years and the group with a duration of suffering > 5 years, it was found that the group with a duration of suffering > 5 years had lower cortical thickness of the mandible compared to the group with a duration of suffering ≤ 5 years. The average cortical thickness of the mandible in the group with a duration of suffering > 5 years was 2.19±0.76, while in the group with a duration of suffering ≤ 5 years, it was 2.57±1.41. However, despite this difference, the research results state that the difference is not statistically significant. In other words, the cortical thickness of the mandible in both groups of patients with type II diabetes mellitus did not exhibit a significant difference that could be considered scientifically meaningful. This study also found that risk factors such as age, gender, and hormonal factors can influence the cortical thickness of the mandible in patients with type II diabetes mellitus. Increasing age can lead to an imbalance between bone resorption and bone formation, ultimately resulting in decreased bone thickness in the mandible.

The findings of this study are consistent with the research conducted by Arrozaq (2021), which also found insignificant results. Therefore, the conclusion of this research is that mandibular cortical thickness in patients with type II diabetes mellitus is not significantly influenced by the duration of the disease but can be affected by other risk factors such as age, gender, and hormonal

factors.[8] Another factor that plays a role in causing this is age and gender. This statement is supported by the theory that states that bone resorption is higher after the third decade of life.[8,20]

The research findings revealed that the status of mandibular cortical thickness based on the antegonial index in the age group of 56-65 had a higher average value, with 12 out of a total of 13 respondents having mandibular cortical thickness that did not meet the normal limit. These results are consistent with the study conducted by Sghaireen *et al.* (2020), which stated that mandibular cortical thickness values are higher in younger age groups.[21] With increasing age, the production and sensitivity of glucocorticoids increase, which in turn reduces bone mineral thickness. Elderly women experience menopause, where estrogen levels decrease significantly. This condition induces macrophages to produce osteoclastogenic cytokines and activate the nuclear factor-kappa B (NF-kB) receptor. RANK will stimulate osteoclasts to resorb bone and reduce bone mass. In men, estrogen and testosterone deficiencies occur due to decreased androgen levels and decreased aromatase enzyme. As a result, bone mineral thickness decreases.[8,22]

The results of this study also showed a difference in cortical thickness between the right and left mandible. This is supported by the research conducted by Azhari (2017) and Vivian (2019), which stated that the difference in cortical thickness between the right and left mandible can be caused by the habit of chewing predominantly on one side of the jaw.[23,24] The habit of chewing on one side can cause the masticatory muscles to become thick and strong, resulting in excessive pressure on the other side and affecting mandibular growth.[25,26] The occurrence of imbalanced chewing can be associated with tooth loss in individuals diagnosed with type II diabetes mellitus. Patients diagnosed with type II diabetes mellitus experience a decrease in mandibular cortical thickness due to bone resorption. This process leads to changes in cellular tissue components, ultimately resulting in tooth mobility and the potential for tooth loss. Tooth mobility arises as a consequence of reduced resistance between the tooth and the supporting tissues. The cortical thickness of the right and left lower jaw shows asymmetry, even though their anatomical structures are identical, indicating varying thickness values. This suggests a correlation between them in terms of bone thickness detection.[24-27]

This study also indicated that the antegonial index values in the group of patients with a duration of suffering of more than 5 years had a higher occurrence of mandibular cortical thickness values that did not meet the normal limit. This is supported by the study conducted by Jang *et al.* (2018), which stated that patients diagnosed with type II diabetes mellitus for more than 5 years have lower values of mandibular cortical thickness.[13] The low value of mandibular cortical thickness can be attributed to the patients' quality of life.[28] The longer patients endure the symptoms of type II diabetes mellitus, the worse their quality of life becomes. This is a common consequence of living with the disease for an extended period. This makes patients feel desperate and resigned to their current health condition, as well as tired of the never-ending cycle of treatment and therapy. In individuals with type II diabetes mellitus, the duration of suffering from this disease is a risk factor that affects their self-care practices. Patients with type II diabetes mellitus who have been suffering for a long time are 2.91 times more likely to engage in non-compliant behavior during diabetes mellitus management compared to patients with a shorter duration of suffering (< 5 years).[28,29]

In their study, Purwaningtyas *et al.* (2015) stated that a disease duration of > 5 years in patients with type II diabetes mellitus is a risk factor that leads to poor blood glucose control.[7,30] Hyperglycemia is caused by uncontrolled blood sugar levels, leading to oxidative stress, which in turn weakens the bones. Advanced glycation end-products (AGEs) are associated with hyperglycemia, which in turn has been linked to microvascular and macrovascular issues, as well as decreased bone thickness.[7,8] According to the research by Makhyan (2013), the accumulation of advanced glycation end products (AGEs) in cortical and trabecular bone has been proven to result in decreased bone thickness. The accumulation of AGEs within the collagen framework of bone can lead to mechanical impairment and increased stiffness, making the bone more susceptible to fractures.[8,31]

CONCLUSION

The results of the conducted research indicate that the values of mandibular cortical thickness, based on antegonial index measurements, in patients diagnosed with type II diabetes mellitus for ≤ 5 years, the average cortical thickness of the mandible was 2.57±1.41, with the average cortical thickness of the right mandible being 2.67±1.66 and the average cortical thickness of the left mandible being 2.42±1.21. The mandibular cortical thickness in these patients not conform to the normal limits. Additionally, for patients diagnosed with type II diabetes mellitus for > 5 years, the average cortical thickness of the mandible was 2.19±0.76, with the average cortical thickness of the right mandible being 2.27±0.77 and the average cortical thickness of the left mandible being 2.11±1.99. The mandibular cortical thickness in these patients also does not conform to the normal limits. Among the respondents, who were in the late elderly age group (56-65 years), 12 out of 13 participants had a higher number of deviations from the normal limits compared to other age categories, The measurement results of mandibular cortical thickness in patients diagnosed with type II diabetes mellitus for ≤ 5 years and > 5 years, based on the antegonial index values, did not meet the normal limit of > 3.2 mm.

ACKNOWLEDGMENTS

FOOTNOTES

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