ORIGINAL RESEARCH ARTICLE

Jurnal Radiologi Dentomaksilofasial Indonesia December 2023, Vol. 7, No. 3: 95-100
P-ISSN.2685-0249 | E-ISSN.2686-1321

http://jurnal.pdgi.or.id/index.php/jrdi/index

Differences of bone quality in patients type II diabetes mellitus with mandibular cortical index analysis on panoramic radiograph

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ABSTRACT

Objectives: This study aims to determine the quality of the mandibular cortex in Type II diabetes mellitus patients by analyzing the Mandibular Cortical Index on panoramic radiography.

Materials and Methods: This type of research is unpaired comparative analytical design research using a cross-sectional stratified random sampling method and the Mann-Whitney statistical test. The subjects in this study were patients who visited and were diagnosed with type 2 DM for ≤ 5 years and > 5 years by doctors at the Endocrine Metabolic Internal Medicine Sub-Specialist Polyclinic, Ulin Hospital, Banjarmasin.

Results: Respondents who had suffered ≤ 5 years had the highest mandibular cortical C2 index value of 10 (58.8%). Respondents who suffered > 5 years had the highest mandibular cortical C3 index value of 10 (58.8%). Diabetes mellitus patients with mandibular cortical C3 index value were ranked highest out of a total of 34 samples and were found in patients suffering from diabetes mellitus > 5 years.

Conclusion: Patients with diabetes mellitus had poor bone quality, especially patients suffering from diabetes mellitus > 5 years.

Keywords: *Bone quality, diabetes mellitus type 2, mandibular cortical index, panoramic radiography*
Cite this article: Sarifah N, Nurrahman T. *Differences of bone quality in patients type II diabetes mellitus with mandibular cortical index analysis on panoramic radiograph*. Jurnal Radiologi Dentomaksilofasial Indonesia 2023;7(3)95-100. https://doi.org/10.32793/jrdi.v7i3.1113

INTRODUCTION

According to the American Diabetes Society, diabetes mellitus is a metabolic disorder that results in hyperglycemia due to abnormalities in insulin secretion or insulin action. The number of diabetes mellitus sufferers is predicted by the World Health Organization (WHO) to increase from 171 million in 2000 to 366 million people in 2030, with greater incidence occurring in Asia and Africa.[1] The prevalence of diabetes mellitus sufferers in Indonesia is estimated at 6.2%, with the number is around 10 million people.[2] Based on 2018 Riskesdas data, the prevalence of diabetes mellitus sufferers in South Kalimantan reached 1.30%, especially in Banjarmasin City, which reached 2.12%.[3]

Diabetes mellitus is a systemic disease that is included in the category of metabolic disease, characterized by increased blood glucose levels. 4 This disease can be caused by insulin deficiency due to damage to pancreatic beta cells (type 1 DM) or insulin resistance (type 2 DM).[4,5] Research results generally show that type 1 DM is associated with decreased bone mineral density (BMD). However, in type 2 DM, this is still controversial.[6–9] Various studies report different results, namely that there can be an increase, decrease, or no change in BMD in type 2 DM.[8] Based on research by Reema et al. in 2020, there was a decrease in BMD in type 2 DM patients in India. Which is lower than trabecular bone mineral density.[11] Jang et al. in 2018 compared BMD values in type 2 DM patients based on length of suffering. They stated that lower BMD values occurred in groups with a more extended period of type 2 DM compared to groups with a shorter period.[12]

The main characteristic of type 1 DM and type 2 DM is the presence of hyperglycemia or high blood glucose levels. [13] Hyperglycemia is considered to reduce bone quality significantly in diabetes mellitus sufferers. Hyperglycemia is associated with the accumulation of Advanced Glycation End Products (AGEs) in the bone matrix.14 AGEs are a group of compounds produced by the nonenzymatic glycation of various proteins.[14,15] AGEs have been shown to have an inhibitory effect on bone formation by increasing RANKL production. This protein plays a role in inhibiting osteoblast activity and increasing osteoclast activity. AGEs affect osteoblasts by suppressing cell growth and downregulating cell differentiation. It can inhibit bone formation and encourage the bone resorption process so that bone mineral absorption is disrupted. This situation will affect the density between bone matrices, so it can be said that hyperglycemia has a detrimental effect on bone

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Received on: October 2023
Revised on: November 2023
Accepted on: December 2023

quality through AGEs. [5,8,13–19]

The quality of bone can be seen from panoramic radiographic images through radiomorphometric measurements.[8,20] This measurement helps assess changes in the mandibular bone radiographically.[20] Several radiomorphometric indices, such as the Mandibular Cortical Index (MCI), Panoramic Mandibular Index (PMI), Mental Index (MI), Antegonial Index (AI), and Gonial Index (GI), have been applied. [8,20] The Panoramic Radiomorphometry Index can be used to measure bone mineral density and assess the shape and width of the mandibular cortex. The mandibular cortical bone is located at the mandible's lower border, visible as a radiopaque shadow stretching along the mandible's border. Cortical bone is more easily visible than trabecular bone on radiographs. [8.20–24]

Radiomorphometric analysis is one of the analyses that is often chosen and applied by many researchers in assessing bone quality, both qualitatively and quantitatively. One qualitative assessment uses the Klementti method, better known as the MCI index (Mandibular Cortical Index), where the evaluation is carried out visually by classifying the mandibular cortex into several categories according to its morphology.[22,25–27]

Based on research by David et al. in 2017, there was a decrease in the Mental Index value in type 2 DM patients compared to non-diabetic individuals. In a similar study by Epsilawati et al. in 2018, there was a decrease in the quality of mandibular cortical bone in type 2 DM sufferers regarding the Mental Index value. This index is one of the cortical indices contributing significantly to the diagnosis of decreased bone mineral density. The results of Epsilawati et al.'s research in 2018 had insignificant values due to the number of samples used needing to be more significant. Dual Energy X-ray absorptiometry (DEXA) is the gold standard for measuring bone mineral density, especially in the lumbar vertebrae, femoral neck, and antebrachium. DEXA measurement of mandibular BMD is rarely used because of superimposition and high cost. Panoramic radiography is another more economical alternative for assessing bone density. Panoramic radiography has been performed routinely in dental practice.[8,22]

Panoramic radiography has been used to predict low bone mineral density. Dentists have an essential role in detecting the risk of bone fractures with systemic involvement, one of which is in people living with diabetes. It makes researchers interested in measuring Mandibular Cortical Index values in type 2 DM patients using panoramic radiography.

MATERIALS AND METHODS

This research has received ethical approval from the Research Ethics Commission of the Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin No. 062/KEPKG-FKGULM/EC/VII/2023. This type of research is unpaired comparative analytical design research using a cross-sectional stratified random sampling method and the Mann-Whitney statistical test, obtained from patients who are visiting and diagnosed as having type 2 DM for ≤ 5 years and > 5 years by doctors at the Endocrine Metabolic Internal Medicine Sub-Specialist Polyclinic at Ulin Hospital, Banjarmasin in May 2023 – November 2023. The sampling technique in this research used the stratified random sampling method.

The inclusion criteria were: 1) Patients diagnosed with type 2 DM based on a history of suffering for ≤ 5 years and > 5 years without comorbidities by a doctor and a history of clinical symptoms experienced. 2) Type 2 DM patients are conscious and able to communicate. 3) Willing to be a research respondent. The exclusion criteria were: 1) The results of the panoramic radiograph are incomplete. 2) The results of the panoramic radiograph have overlapping. 3) The details of the object are lacking, so the differences in the anatomy of each part are less clear. 4) The results of the panoramic radiograph are distorted so that the size and shape are not the same as the original object.

The radiograph photo was analyzed with ImageJ software version 1.53K using the Mandibular Cortical Index (MI). Mandibular cortical index (MCI) refers to the cortical thickness of the inferior mandible as seen on panoramic radiographs on both sides of the mandible, slightly distal to the mental foramen. The MCI index is used to assess the appearance of the mandibular inferior cortex.[28,29] Mandibular cortical index (MCI) is classified into three groups according to the criteria described by Klemetti, namely [28,30]: a. C1 – Normal Cortex: the endosteal edges of the cortex are flat and sharp; b. C2 – Mild to moderate abrasion of cortex: endosteal margin shows semilunar defects

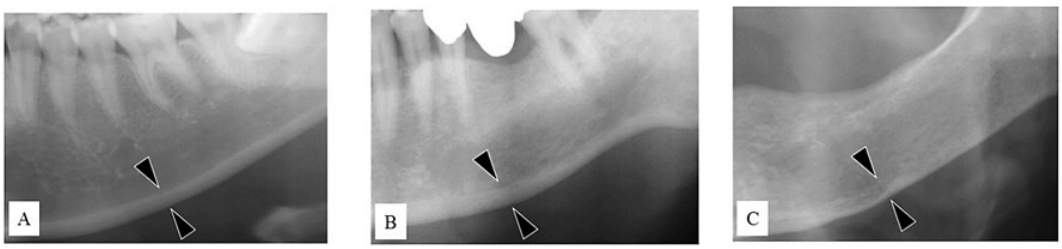

Figure 1. Mandibular cortical index, (A) C1 normal cortex, (B) C2 mild to moderate eroded cortex, and (C) severly eroded cortex[31]

(lacunar resorption) or appears to form endosteal cortical residue; c. C3 – Severely Eroded Cortex: the cortical layer forms heavy and markedly porous endosteal cortical residue (Figure 1).

RESULTS

The gender of most respondents was female (55.9%) with the age of respondents is 55.50 years old (Table 1 and 2). The result showed the highest value of the mandibular cortex was C3 (44.1%) as shown in Table 3. Table 4 showed that respondents who had suffered a long time ≤ 5 years were 17 people (50%), while respondents who had suffered for a long time > 5 years were 17 people (50%).

Table 5 showed that men had the highest mandibular cortical C2 index value of 7 (46.7%). The female gender has the highest mandibular cortical C3 index value, 9 (47.4%). The results of the Mann-Whitney test show a significance value of 0.791; this indicates no significant difference in the value of the mandibular cortical index between men and women.

Table 1. Gender characteristic of respondents

Gender	Frequency	Percent (%)
Male	15	44,1
Female	19	55,9
Total	34	100

Table 2. Age characteristic of respondents

Age	Mean	SD
	55,50	9,55

Table 3. Mandibular cortical index

Mandibular Cortical Index Value	Frequency	Percent (%)
C1	5	14,7
C2	14	41,2
C3	15	44,1
Total	**34**	**100**

Table 4. The Length of Suffering Diabetes Mellitus in Respondents

Long Suffering for Respondents	Frequency	Percent (%)
≤ 5 tahun	17	50
> 5 tahun	17	50
Total	34	100

Table 5. Mann Whitney bivariate analysis test results based on Mandibular Cortical Index by Gender

Gender	Mandibular Cortical Index Value				P value
	C1	C2	C3	Total	
Male	2 (13,3%)	7 (46,7%)	6 (40%)	15 (100%)	0,791
Female	3 (15,8%)	7 (36,8%)	9 (47,4%)	19 (100%)	

Jurnal Radiologi Dentomaksilofasial Indonesia 2023; 7(3); 95-100 | DOI: 10.32793/jrdi.v7i3.1113

Table 6. Mann Whitney Test Results Based on Mandibular Cortical Index with Length of Suffering

Long Suffering for Respondents	Mandibular Cortical Index Value				Mandibular Cortical Index Value
	C1	C2	C3	Total	
≤ 5 tahun	2 (11,8%)	10 (58,8%)	5 (29,4%)	17 (100%)	0,237
> 5 tahun	3 (17,6%)	4 (23,5%)	10 (58,8%)	17 (100%)	

Table 6 showed that respondents who had suffered ≤ 5 years had the highest mandibular cortical C2 index value of 10 (58.8%). Respondents who suffered > 5 years had the highest mandibular cortical C3 index value of 10 (58.8%). The results of the Mann-Whitney test show a significance value of 0.237; this shows no significant difference in the value of the mandibular cortical index between respondents who suffered ≤ 5 years and those who suffered > 5 years.

DISCUSSION

Azhari (2017), in his research, stated that the difference in the width of the mandibular cortex of the right and left jaws could be caused by a one-sided chewing pattern.[32] Physiologically, the right and left mandibular cortex widths have different balances. Still, both have a slight difference in density values, so both are related to the detection of osteoporosis.[32,33] Low mandibular cortex width is also followed by tooth loss, even though tooth loss has multifactorial causes. Still, several studies suggest that lost teeth have decreased in people with bone resorption or osteoporosis. It is due to reduced bone density or bone thickness impacting the supporting tissues of the teeth, which can cause tooth loss.[34] According to the International Osteoporosis Foundation (2020), several things affect the condition of a person's bone density, namely gender, age, race, long-term glucocorticoid therapy, lifestyle, and calcium intake.[35]

The results showed that respondents who had suffered ≤ 5 years had the highest mandibular cortical C2 index value of 10 (58.8%). Respondents who suffered > 5 years had the highest mandibular cortical C3 index value of 10 (58.8%). The results of the Mann-Whitney test show a significance value of 0.237; this shows no significant difference in the value of the mandibular cortical index between respondents who suffered ≤ 5 years and those who suffered > 5 years. Arrozaq (2021) stated that the insignificant difference in results could be caused by, apart from the long-suffering condition of the patient, age, gender, and hormonal risk factors also influenced mandibular cortical thickness.

Increasing age can cause an imbalance between bone resorption and remodelling, decreasing bone thickness. The age of the respondents was predominantly 51-60 years; this was due to higher bone resorption occurring after the third decade of age.

This study also showed that the value of mandibular cortical thickness in the group of patients with a duration of suffering > 5 years, which was not within the normal limits, was more significant. This is supported by research by Jang et al. (2018), which states that patients diagnosed with type II diabetes mellitus with a duration of > 5 years have lower mandibular cortical thickness values. The patient's quality of life can cause a low value of mandibular cortical thickness. The quality of life in question is that the longer the duration of suffering experienced by patients with type II diabetes mellitus, the worse their quality of life will be. This happens because the patient has had the disease for an extended period, causing the patient to feel bored with the series of treatments and therapies.

Long-suffering is a risk factor that influences the control behaviour of type II diabetes mellitus sufferers. Type II diabetes mellitus patients with a duration of suffering ≥ 5 years are at risk of having non-compliant behaviour in controlling diabetes mellitus compared to type II diabetes mellitus patients with a short period of suffering (< 5 years).

Panoramic radiography is one of the tools to help establish the diagnosis. Panoramic radiographs are often used to view the overall condition of the teeth. The images produced on panoramic radiographs can be anatomical structures of the oral cavity, maxillary sinuses, temporomandibular joints, and hyoid bone. Panoramic radiographs are commonly used for diagnosis in oral surgery, periodontal disease, correcting tooth position, and planning treatment for patients visiting the dentist for the first time. Abnormalities that can be seen on panoramic radiographs are osteoporosis, alveolar bone resorption, and reduced mandibular cortical thickness.[30,36]

The quality and quantity of bone can be viewed from panoramic radiographic images through radiomorphometric measurements. This measurement is helpful in radiographically assessing mandibular bone changes. Several radiomorphometric indices such as the Mandibular Cortical Index (MCI), Panoramic Mandibular Index

(PMI), Mental Index (MI), Antegonial Index (AI), and Gonial Index (GI) have been applied. The Panoramic Radiomorphometry Index can measure bone mineral density and assess the mandible's shape and cortical width. Mandibular cortical bone is the bone at the lower border of the mandible, visible as a radiopaque shadow that extends along the mandibular edge. Cortical bone is more easily seen than trabecular bone on radiographs, so the Mandibular Cortical Index (MCI) is a measurement that can describe bone quality visually well.[24]

CONCLUSION

The conclusions were obtained from various panoramic radiographs of the mandibular cortical bone quality. In this study, the quality of cortical bone with type C3 was ranked highest in 34 samples and was found in patients who had suffered from diabetes mellitus for more than > 5 years.

ACKNOWLEDGMENTS

None.

FOOTNOTES

All authors have no potential conflict of interest to declare for this article. All procedures conducted were in accordance with the ethical standards.

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