ORIGINAL ARTICLE

The Difference of Gingival Inflammation, Oral Hygiene, and Periodontal Treatment Needs Between Metabolic Syndrome and Nonmetabolic Syndrome in Periodontitis Patients

Pitu Wulandari , Irma Ervina, Martina Amalia, Irna Caroline Sembiring, Steven, Gebby Gabrina, Angelina Betty Siburian, Ardia Wianda Ivanka, Ade Liana Dwi Ananda

ABSTRACT

Introduction: This research aimed to determine the difference of gingival index, papillary bleeding index, oral hygiene, and periodontal treatment needs between periodontitis patients with and without MetS.

Study Design: Analytic observational study using cross-sectional research design

Place and Duration of Study: Dental and Oral Hospital Universitas Sumatera Utara, Medan, Indonesia from November 2023 to January 2024.

Materials and Methods: This study involved ninety participants who were diagnosed with periodontitis. The determination of MetS patients and nonmetabolic syndrome (NMetS) patients was performed by examining blood pressure, blood glucose levels, body weight, height, and abdominal circumference. Oral examination was performed by measuring gingival index (GI), papillary bleeding index (PBI), oral hygiene index (OHI), and community periodontal index of treatment needs (CPITN). The data was analyzed using descriptive and parametric statistical tests with $p<0.050$ was considered significant.

Results: There was no significant difference in gingival inflammation as evaluated by GI ($p=0.592$) and PBI ($p=0.216$) between MetS patients and NmetS patients. There was a significant difference in oral hygiene examination as evaluated by OHI ($p= 0.005$) between MetS patients and NmetS patients. There was a significant difference in the examination of treatment needs as measured by the CPITN ($p=0.023$) between MetS patients and NmetS patients.

Conclusions: The gingival inflammation in periodontitis patients with MetS is more severe than the NMetS patients. The oral hygiene in periodontitis patients with MetS is worse than the NMetS patients. The patients with MetS have higher periodontal treatment needs than NMetS patients.

Key Words: *Gingival Inflammation, Metabolic Syndrome, Oral Hygiene, Periodontal Treatment, Periodontitis.*

Introduction

A complex inflammatory condition known as periodontitis develops when the human immune system interacts intricately with bacterial plaque. It can be identified by the degeneration of periodontal tissues, such as the periodontal ligament, gingiva, and alveolar bone, which results in the formation of periodontal pockets around the teeth that harbor numerous pathogenic bacteria that exacerbate the inflammatory process and contribute to further tissue destruction.[1] The worldwide prevalence of periodontal disease as stated by The World Health Organization (WHO) ranges from 20 to 50 percent.[2]

The factors that are interconnected to periodontitis other than bacteria are the presence of systemic diseases. One of the non-infectious conditions linked to periodontitis is metabolic syndrome.[3] Metabolic syndrome (MetS) is defined by elevated blood pressure, blood glucose, and abdominal circumference, as per the Adult Treatment Panel III (ATP III) criteria of the National Cholesterol Education Programme (NCEP).[4] In 2020, the anticipated global prevalence of MetS is 4.8% for adolescents and 2.8% for children, which translates to about 35.5 million adolescents and 25.8 million children.[5] Numerous studies on MetS have been carried out. In Indonesia, 21.66% of the population has MetS according to a study by Herningtyas et al.[6]

The condition that links MetS and periodontitis is oxidative stress. Metabolic syndrome stimulates

Department of Periodontics,
Universitas Sumatera Utara

Correspondence:
Dr. Pitu Wulandari
Department of Periodontics,
Universitas Sumatera Utara
E-mail: pitu.wulandari@usu.ac.id

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adipose tissue in the body to produce proinflammatory cytokines that cause oxidative stress.[7] Oxidative stress disrupts the equilibrium between the synthesis of reactive oxidative stress (ROS) and antioxidants in the cell, so that the antioxidant defense system cannot neutralize the increased ROS production. Decreased levels of antioxidants impair the body's ability to defend itself against pathogenic bacteria in oral cavity, which can cause periodontitis.[8]

There are several parameters of periodontal disease. Gingival index measurement is done by visually assessing the condition of the gingiva. A commonly used scale is the Löe and Silness Gingival Index.[9] Papillary bleeding index (PBI) measurement is used to evaluate bleeding between the papillae in patients with periodontitis. It gives an idea of the health of the gingival papillae and the presence of inflammation.[10] Another parameter of periodontal disease is oral hygiene. An individual's level of oral hygiene can be calculated using the Oral Hygiene Index (OHI), which measures the amount of plaque and calculus that has accumulated on the teeth surface.[11] The Community Periodontal Index of Treatment Needs (CPITN) is often used to describe changes in periodontal tissues. In this index, gum bleeding, the presence of calculus, and periodontal pocket depth are taken as references for the diagnosis of periodontitis.[12]

There is a pressing need for new research to provide deeper insights into how MetS may influence periodontal health. The updated knowledge on this field is crucial for enhancing both clinical practice and public health guidelines, ensuring that healthcare providers are equipped with the most current information regarding these interconnected health concerns. This research aimed to determine the difference of gingival index, papillary bleeding index, oral hygiene, and periodontal treatment needs between periodontitis patients with and without MetS.

Materials and Methods

This was an analytical observational study, utilizing a cross-sectional approach carried out on 90 patients who visited the dental and oral hospital of Universitas Sumatera Utara, Medan, Indonesia from November 2023 to January 2024. The patients were selected by purposive sampling method. A total of 50 patients were grouped as MetS patients and 40 patients were grouped as NMetS patients. The inclusion criteria were: periodontitis patients suffering from MetS, periodontitis patients without MetS, aged ≥17 years, has ≥ 20 teeth, had not received periodontal treatment for a minimum of 6 months, and were prepared to take part in this investigation. This study excluded the patients who were using anticoagulant medications and patients with systemic illnesses other than MetS. Informed consent is signed by patients prior to participating in the study. Demographic data was obtained through a questionnaire. Data obtained from patients included: age, gender, education, and employment status. This research project has been approved on December 15, 2023 by the Health Research Ethics Committee, Universitas Sumatera Utara (No: 1203/KEPK/USU/2023).

The presence of MetS was confirmed by assessing blood glucose levels, blood pressure, weight, height, and abdominal circumference. Blood glucose level assessments were performed using a glucometer to determine the presence of hyperglicemia in the patients. Hypertension in the patients was evaluated through blood pressure tests using a digital sphygmomanometer. The patient's Body Mass Index (BMI) was measured by dividing the patient's body weight (kilograms) by the square of their height (meters). A tape measure positioned parallel to the floor and encircling the midpoint of the body was used to measure the abdomen's circumference. The number at the point where the measuring tape intersects is the measurement of the abdominal circumference. Patients who have been examined were divided into two groups: MetS patients and NmetS patients.

Every participant had a comprehensive oral and periodontal assessment at the Dental and Oral Hospital, Universitas Sumatera Utara. The periodontal examination comprised several assessments. The evaluation of gingival inflammation was conducted using the gingival index (GI) and the papillary bleeding index (PBI). Gingival index was evaluated by gingival palpation. Papillary bleeding index was assessed by applying slight pressure with a periodontal probe to the oral and buccal gingival sulcus. The GI and PBI score was calculated based on the extent of bleeding in the

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gingiva. The oral hygiene index (OHI) was used to assess patient's oral hygiene. Oral hygiene index was determined by adding the debris score and calculus score, which were evaluated according to the extent of the tooth surface covered by debris and calculus. The assessment of treatment needs was conducted using the community periodontal index of treatment needs (CPITN). The CPITN score was determined based on the gum bleeding, the presence of calculus, and the depth of the pockets.

Version 22 of the Statistical Package for Social Sciences (SPSS) software was utilised for data analysis. The data was calculated using mean ± SD descriptive test. Statistical tests using Saphiro-Wilk test showed that the data was not normally distributed, so the data was considered non-parametric, thus the Mann-Whitney test was performed. Mann-Whitney statistical test was used to compare the GI, PBI, OHI, and CPITN between periodontitis patients with MetS and without MetS. A p-value of less than 0.05 was considered statistically significant.

Results

The data in Table 1 shows the demographic data of the research patients. The majority of patients suffering from MetS come from the age range of 46-55 years, while the majority of patients without MetS come from the age range of 17-25 years. Based on gender, 27 out of 50 (54%) patients with MetS were male, while 23 out of 40 (57,5%) patients without MetS were female. Both groups of study participants had high school degrees as their primary educational attainment level. Thirty (60%) patients suffering from MetS is employed, while 23 (42,5%) patients without MetS is unemployed, as determined by their employment status.

The data in Table 2 shows that the mean of blood glucose levels (MetS: 180.86 mg/dL; NMetS: 89.38 mg/dL), blood pressure (MetS: 153.40/91.96 mmHg; NMetS: 119.13/78.60 mmHg), height (MetS: 1,61 m; NMetS: 1,60 m), weight (MetS: 77,91 kg; NMetS: 58.83 kg), BMI (MetS: 29.85 kg/m^2; NMetS: 22.92 kg/m^2), and abdominal circumference (MetS: 100,79 cm; NMetS: 81.55 cm) in MetS patients were higher than NmetS patients.

The comparison of periodontal assessment results in periodontitis MetS patients and NMetS patients is shown in table 3. The patients with and without MetS differ significantly in terms of OHI (p=0.005) and CPITN (p=0.023), while the GI (p=0.592) and PBI (p=0.216) showed no significant difference between MetS and NMetS patients.

Table I: Demographic Characteristic of The Research Patients

Demographic characteristic	Mets (n=50)		No MetS (n=40)	
	n	%	n	%
Age (years)				
17-25	4	8	13	32.5
26-35	6	12	3	7.5
36-45	9	18	11	27.5
46-55	19	38	9	22.5
56-65	10	20	1	2.5
>65	2	4	3	7.5
Gender				
Female	23	46	23	57.5
Male	27	54	17	42.5
Education				
Elementary school	1	2	2	5
Middle school	1	2	3	7.5
High school	27	54	25	62.5
Bachelor	21	42	10	25
Employment Status				
Employed	30	60	17	42.5
Unemployed	20	40	23	57.5

Table II: Blood Glucose, Blood Preasure, Body Mass Index and Abdominal Circumference in Patients with MetS and No MetS

Variables	MetS	No. MetS
	Mean±SD	Mean±SD
Blood glucose level (mg/dL)	180.86±76.54	89.38±11.37
Systolic blood pressure (mmHg)	153.40±13.38	119.13±12.19
Diastolic blood pressure (mmHg)	91.96±5.35	78.60±10.43
Height (m)	1.61±0.09	1.60±0.06
Weight (kg)	77.91±11.56	58.83±8.88
BMI (kg/m^2)	29.85±3.99	22.92±2.72
Abdominal circumference (cm)	100.79±7.94	81.55±9.92

Table III: Periodontal Assessment Results of The Research Patients

Variables	Mets	No MetS	p
	Mean±SD	Mean±SD	
Gingival Index	1.19±0.37	1.15±0.39	0.592
Papillary Bleeding Index	1.47±0.57	1.31±0.44	0.216
Oral Hygiene Index	3.01±1.36	2.22±0.81	0.005*
Community Periodontal Index of Treatment Needs	3.54 ± 0.50	3.30 ± 0.46	0.023*

Mann-Whitney test; * Significant p<0.050

Discussion

This research was an analytical observational study, utilizing a cross-sectional approach to examine people ranging from late adolescents (17-25 years old) to eldery (>65 years old). The World Health Organization classifies age as young (25-44), middle age (44-60), elderly (60-75), senile (75-90), and long-livers (>90).[13] In this study, we classify age according to the Indonesian Ministry of Health. The selection of patients with this age range considers the time of third molar tooth eruption, which is between 17-25 years of age. The majority of the patients with MetS in this study came from the age range of 46-55 years. The study conducted by Campos et al. similarly demonstrated comparable findings, indicating that the majority of MetS patients were in the age range of 45-55 years.[14] As individuals grow older, the body's metabolism naturally declines, causing a reduction in the body's capacity to efficiently metabolize sugar and fat, which leads to a steady accumulation of body fat and a reduction in muscle mass. This shift in body composition can potentially contribute to insulin resistance and dyslipidemia development, which are the primary components of MetS.[15]

This study found that the patients suffering from MetS were more common in males than females. This difference may occur because of varying metabolic regulation in male and female patients due to differences in muscle mass, adiposity, and hormones. Male patients tend to have more visceral fat in their abdominal regions or upper bodies, whereas female patients typically exhibit a greater quantity of adipose tissue in their lower extremities.[16] Visceral fat tissue actively produces adipokines and inflammatory mediators associated with insulin resistance. The socioeconomic status of the patients in this study is seen in terms of education level and employment status. Patients with MetS had the majority of education for 10-12 years and are currently employed. Patients with an employment and a high level of education are at risk of obesity and MetS which is much higher compared to those who have a lower level of education and are unemployed. This is due to lifestyle changes that often involve the consumption of high-calorie foods and decreased physical activity.[17]

The data in table 2 shows that the results of the MetS component examination in each patients show differences, where patients with MetS have higher scores than patients without MetS. According to the criteria of NCEP ATP III,[4] which describes the normal threshold scores of MetS components, most MetS patients examined in this study exceeded normal scores, while patients without MetS were in the normal range of values.

The data in table 3 shows an insignificant difference in GI scores between individuals who have MetS and those who have not (p=0.592). However, patients with MetS still have higher scores than patients without MetS. Metabolic syndrome is characterized by chronic low-grade inflammation, which can extend to the periodontium and exacerbate gingival inflammation. Inflammatory mediators associated with MetS, such as Tumour necrosis factor-alpha (TNF-α), C-reactive protein, and interleukin-6 (IL-6), can enhance the inflammatory response in periodontitis, leading to increased gingival and papillary bleeding.[18] The findings in this study also showed that the PBI score of patients with MetS (PBI=1.47±0.57) was slightly higher than the PBI score of patients without MetS (PBI=1.31±0.44). This discovery aligns with the findings of the study conducted by Pietropaoli et al., which states that the number of patients with MetS who experience generalized gingival bleeding is more than patients who do not suffer from MetS. They also found that the serum CRP levels rose as the number of MetS constituents grew.[19]

Some studies show that hyperglycemia, which is one of the MetS components, was connected to elevated levels of serum CRP. C-reactive protein can induce the expression and activity of matrix metalloproteinases (MMPs) in the periodontium. Matrix metalloproteinases degrade extracellular matrix components, including collagen and elastin, leading to tissue breakdown and destruction. Increased MMP activity in the gingival tissues can weaken the structural integrity of the periodontium, making the gingiva more susceptible to bleeding upon mechanical stimulation.[20]

The data presented in table 3 indicates that patients with MetS have a high OHI score, with a mean of 3.01 ± 1.36, while patients without MetS have a moderate OHI score, with a mean of 2.22 ± 0.81. These scores are determined by the presence of debris and calculus. According to a study conducted by Jaramillo

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et al., the development of glucose intolerance in individuals with MetS strongly correlates with the presence of microorganisms that contribute to the formation of debris and calculus.[21] Insulin resistance leads to decreased cell sensitivity to insulin, which causes an increase in insulin levels, resulting in hyperglycemia. Hyperglycemia creates an advantageous environment for oral bacteria to flourish due to their utilization of glucose as the primary energy source, leading to increased oral bacterial proliferation. Increased bacterial proliferation leads to the formation of dental plaque, which is a biofilm consisting of bacteria, saliva proteins, and food debris.[22] Progressive bacterial colonization will eventually result in mineralization, resulting in the formation of calculus, which causes the increase in OHI score.

The large difference in OHI examination could be attributed to factors related to long-term habits because the accumulation of debris in the oral cavity takes some time to develop into dental calculus. Over the course of a person's life, dental calculus can accumulate on the supragingival and/or subgingival tooth surfaces. Its creation may be influenced by variables like age, food, systemic health, dental treatment frequency, and oral hygiene practices.[23] Gingival inflammation, which consists of papillary bleeding and gingival enlargement can occur spontaneously, resulting in a minimal difference in GI and PBI scores between the MetS and NmetS patients.

This study revealed that individuals with MetS had a higher CPITN score (CPITN=3.54 ± 0.50) compared to individuals without MetS (CPITN = 3.30 ± 0.46). Increased ROS in patients with MetS syndrome are susceptible to the emergence of chronic inflammatory mediators that will cause alveolar bone destruction, deep pocket formation, and higher attachment loss. Damage to the periodontium and worsening of periodontal disease can result from oxidative stress, which can be caused by an imbalance of ROS formation and antioxidants in saliva and gingival sulcus fluid. The imbalance of ROS formation and antioxidants will lead to collagen degradation and loss of attachment to periodontal tissues, resulting in higher CPITN scores.[24,25] The limitation of this study is the absence of laboratory tests, such as hemoglobin A1c (HbA1c), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels as parameters determining MetS. Future studies are expected to conduct laboratory tests to determine whether patients can be categorized as MetS or NMetS ptients.

Conclusions

The gingival inflammation in periodontitis patients with MetS is more severe than the NMetS patients. The oral hygiene in periodontitis patients with MetS is worse than the NMetS patients. The patients with MetS have higher periodontal treatment needs than NMetS patients.

Acknowledgments

1. Oral and Dental Hospital Universitas Sumatera Utara
2. Faculty of Dentistry, Universitas Sumatera Utara

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication. of this article.

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CONFLICT OF INTEREST

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.