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CBCT: Tracing Dominant Region of Periodontitis on Psychological Stress

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ABSTRACT

The prevalence of periodontal abnormalities is 20-50% of the global population. Periodontitis is inflammatory in 10% -15% of the adult population. Hormones that were affected by microbial infections will reduce the immune system and increase cortisol secretion. Stress triggers the immune response including changes in the oral cavity. Stress-related periodontitis results in increased levels of interleukin-1 beta (IL-1β), interleukin-6 (IL-6), interleukin-10 (IL-10), and the hormone cortisol in the blood, as well as increased plaque formation and gingival inflammation that damages periodontal tissue. In this study, experimental animals were tested with Cone-beam computed tomography (CBCT) for the dominant tracing of the periodontitis region due to psychological stress. Aim: This study aimed to find periodontitis-dominant regions in psychologic stress with CBCT. This study used 6 white Wistar rats with psychological stress (running and moderate exercise fear) and control models. Treatment with 1 day and 5 days and termination with decapitation followed by CBCT test. Psychological stress changes the different mechanisms in the periodontium to activate inflammatory factors that can lead to periodontitis. In this study, to find the dominant periodontitis due to psychological stress by looking at the volume of interest of periodontal tissue widening, the CBCT test showed the area where the distribution width gap and trabecular thickness were measured. This VOI is an area that will determine the distribution width gap and trabeculae thickness. This tracing is to focus on which areas should be of concern in periodontitis therapy. Tracing with CBCT to find the dominant periodontitis region, so that more focus on periodontitis therapy on psychological stress.

Keywords: Periodontitis, Regio, Tracing, Physiological Stress, CBCT

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INTRODUCTION

A Periodontal is a supporting tissue around the teeth that supports the normal function of the teeth with a periodontal tissue structure consisting of the gingiva, alveolar bone, periodontal ligament, cementum[1,2,3]. Most of the treatments for oral diseases (gingivitis and periodontitis, dental caries, and oral cancer) can be prevented but there are many obstacles due to the high incidence of these oral diseases[4]. The prevalence of periodontal abnormalities in both developing and developed countries is estimated to affect 20-50% of the global population[5]. Periodontitis is an inflammatory disease due to infection of the tooth supporting tissue that affects 10% -15% of the adult population[6,7]. The prevalence of periodontitis development has increased by 50% of the population worldwide and continues to increase in prevalence by 10% [3].Based on the 2018 Riskesdas data, the percentage of periodontitis cases in Indonesia was 74.1%, with the second highest prevalence after caries (88.8%), seen from the type of work the prevalence of cases was 68.1% of cases. Based on the data above, it can be seen that periodontitis is a growing problem that cannot be underestimated. Its prevalence increases with age and can occur in anyone[8]. Genetic and environmental and behavioral factors influence the progression of periodontitis severity[3].

Several theories explain how hormones can influence microbial infections involving the immune system. Stress can affect the central nervous system and hypothalamus to release corticotropin-releasing hormone and arginine vasopressin which stimulates the release of adrenocorticotropin from the pituitary which produces cortisol in the adrenal cortex which directly changes the gene expression profile of the oral microbiome which will increase periodontitis[9,10,11,12].

Stress is related to emotional and physiological as an individual's ability to adapt physically and psychologically, stress can also be associated with increased susceptibility to diseases that trigger immune responses including changes in the oral cavity such as periodontitis[12]. Stress-related periodontitis results in increased levels of interleukin-1 beta (IL-1β), interleukin-6 (IL-6), interleukin-10 (IL-10), and the hormone cortisol in the blood, as well as increased plaque formation and gingival inflammation that damages periodontal tissue[13,14]. Polymorphonuclear neutrophils (PMN), which are components in leukocytes that affect periodontal health[6]. Increased macrophage infiltration generally precedes the incidence of periodontitis, macrophages phagocytosis of bacteria that infiltrate the gingival tissue[15]. Immunoglobulin is a protein that plays a role in the immune system, there are 5 types of protein, namely Ig A, Ig G, Ig M, Ig E, and Ig D among these proteins IgG and IgA

have an important role in periodontitis because IgG is the main antibody that circulates in the blood. and can move through the bloodstream to the tissue, whereas IgA has an important role in protecting the surface of the gingival mucosa[16,17]. In this study, experimental animals were tested with Cone beam computed tomography (CBCT) which evaluated the condition of the alveolar bone qualitatively and quantitatively by visualizing the precise 3D anatomical structures for diagnosis and analysis, accurate measurement of alveolar bone height and thickness is clinically very important in periodontal treatment, orthodontics, and implants[18,19]. This study aimed to find periodontitis-dominant regions in psychologic stress with CBCT.

MATERIALS AND METHODS

Experimental design

This study used three groups (control and two treatments), six Wistar rats with five months of age, 300 grams of weight, and a male type. / min is equivalent to 65-70% VO_2max 49, with a treadmill for 15 minutes with a rest for 45 minutes followed by the animal try to run 15 minutes continuously and continue for one day and five days: and the fear treatment group by bringing the experimental animal closer to the cat as a rat predator for one day and five days.

CBCT analysis

Rats were sacrificed on day 1 and day 5 followed by decapitation, previously anesthetized with ketamine 95 mg/kg BW intramuscularly and xylazine 5 mg/kg BW intraperitoneally then put into 10% buffered formaldehyde solution for fixation before the sample was tested CBCT. The sample was placed in a container that was given wax as the fixation of the sample when the 360 °CBCT rotation was scanned (CS 9000 3D, NY USA).

Ethical approval

This study has been evaluated and approved by the animal ethics committee of IPB University with Ethical Clearance Number: 019/KEH/SKE/XI/2020.

RESULTS AND DISCUSSION

There are three approaches to the theory of stress (Stress stimulus model, Stress response model, and Transactional Stress model)[20]. Various variables assessing periodontal disease and response to periodontal therapy due to psychological disturbances and stress[21]. Periodontitis is caused by direct and indirect causes, periodontitis can be directly caused by pathogenic bacteria, and indirectly it can be caused by systemic reactions in the patient's body due to immune reactions[22]. Periodontitis is what causes loss of supporting tissue and results in tooth loss due to infection[7]. Stress can be made of quantitative data called the perceived stress scale (PSS) which can affect psychological balance by increasing cortisol levels which can increase the incidence of periodontitis[23,24,25]. the hormone cortisol directly induces changes in the oral microbiome that can affect periodontitis and its progress[10,4.11], inflammatory factors in biological pathways can result in host responses to periodontal disease[26,9,3]. Stress can be a risk indicator for oral health[27]. Psychological stress changes the different mechanisms in the periodontium to activate inflammatory factors that can lead to periodontitis[28]. Stress contributes to the pathogenesis of periodontal disease[29]. Biological changes due to stress are a risk factor for oral disease. Stress can result in changes in saliva which can increase the susceptibility to periodontal disease dental caries appears[30].

In this study, to find the dominant periodontitis due to psychological stress was by looking at the volume of interest of CBCT periodontal tissue widening. After tracing with CBCT, the dominant region was located in the upper left jaw, especially the molar region.

Stress samples due to running and fear treatment showed periodontitis in the same region predominantly in the upper left jaw in the molar region. Tracing was carried out to make it easier to identify and analyse which region was more prevalent and dominant for periodontitis in treatment with a psychological stress model in experimental animals.

The left maxillary molar region of all samples showed a gap in all treatment samples due to the susceptibility of the maxilla to consist of thin and incompatible bones. The effect of stress that causes an increase in the hormone cortisol can cause periodontitis in vulnerable regions with an average distribution width gap of 205,649 mm and an average trabeculae thickness of 0.53812475 mm (Table. 1).

Measurement of the mean distribution width gap and trabeculae thickness indicates that this region has the most severe and dominant periodontitis among the other regions in the treatment sample. Distribution width gap and trabeculae thicknesses are indicators and parameters of the occurrence of periodontal tissue widening which indicates the occurrence of periodontitis. This measurement is carried out from the cement enamel junction to the periapical apex to be able to analyse the presence of periodontal tissue widening around the periapical as a whole.

Table 1. Distribution of Width Gap and Trabeculae Thickness

Sample	Distribution of Width Gap								Average
S1	5.996	168.924	212.805	179.409	144.128	99.305	135.469	0	135.148
S2	56.836	363.539	444.861	134.763	0	0	0	0	250.000
L1	84.372	314.797	600.831	0	0	0	0	0	333.333
L2	46.277	137.823	139.739	142.159	121.893	116.247	111.811	18.405	104.294
	Total Average								205.694
	Trabeculae Thickness								
Sample	S1	S2	L1	L2					Average
	0.615031	0.406727	0.745608	0.385133					0.53812475

In CBCT imaging, it shows the area where the distribution width gap and trabeculae thickness are measured. The area marked in red is Volume of Interest (VOI) after tracing to all regions of the maxilla and mandible. This VOI

is an area that will determine the distribution width gap and trabeculae thickness. Distribution width gap is the width of the gap that is distributed around the periapical in units of mm. Trabeculae thickness is the thickness of the gap (heterogeneity, calculated from the distribution of the thickness of the gap) in units of mm (Fig. 1-6).

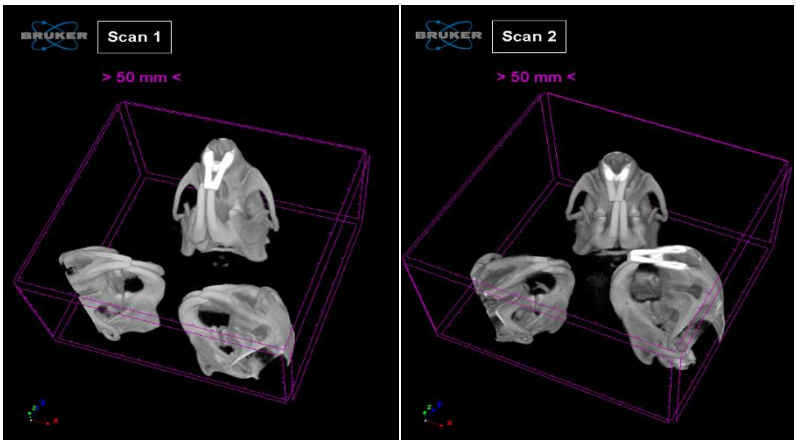

Figure 1. Treated sample and control in experimental animal models with psychological stress.

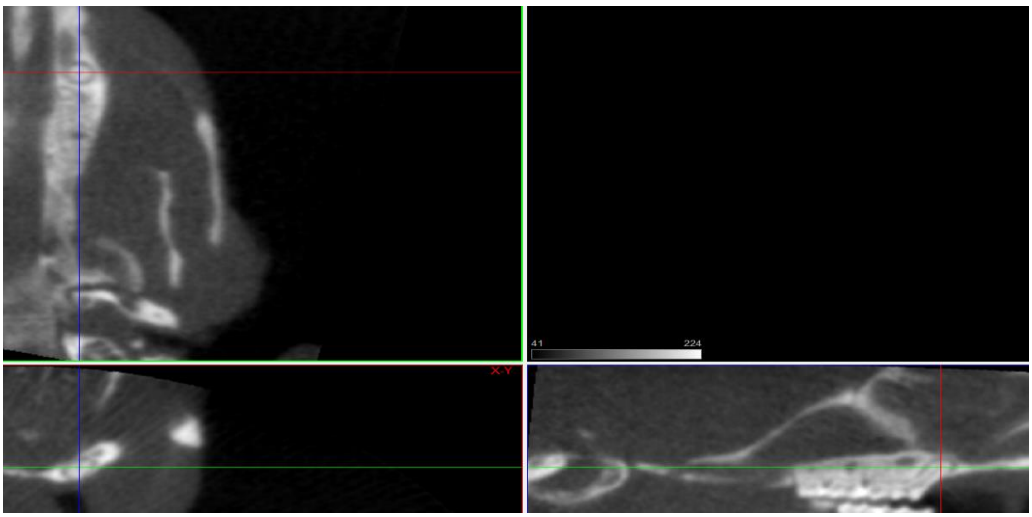

Figure 2. Tracing regions in treated samples and controls in experimental animal models with psychological stress.

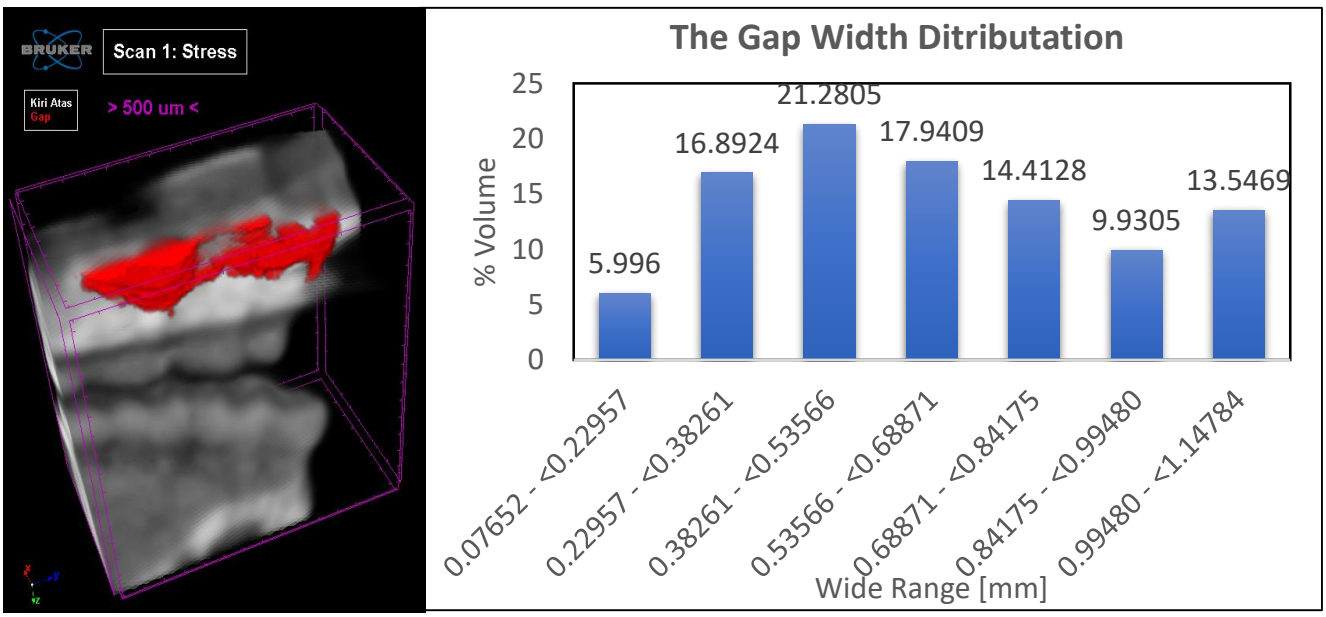

Figure 3. Tracing dominant psychological stress regions in the S1 sample with a graph of the gap width distribution.

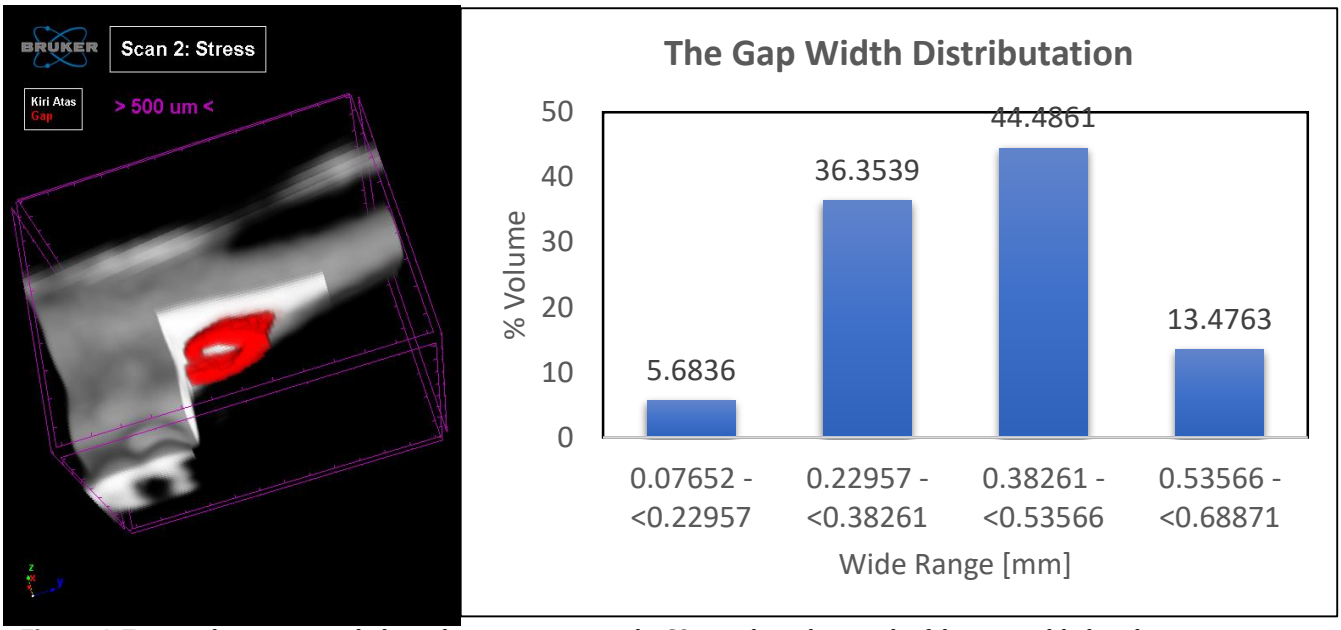

Figure 4. Tracing dominant psychological stress regions in the S2 sample with a graph of the gap width distribution.

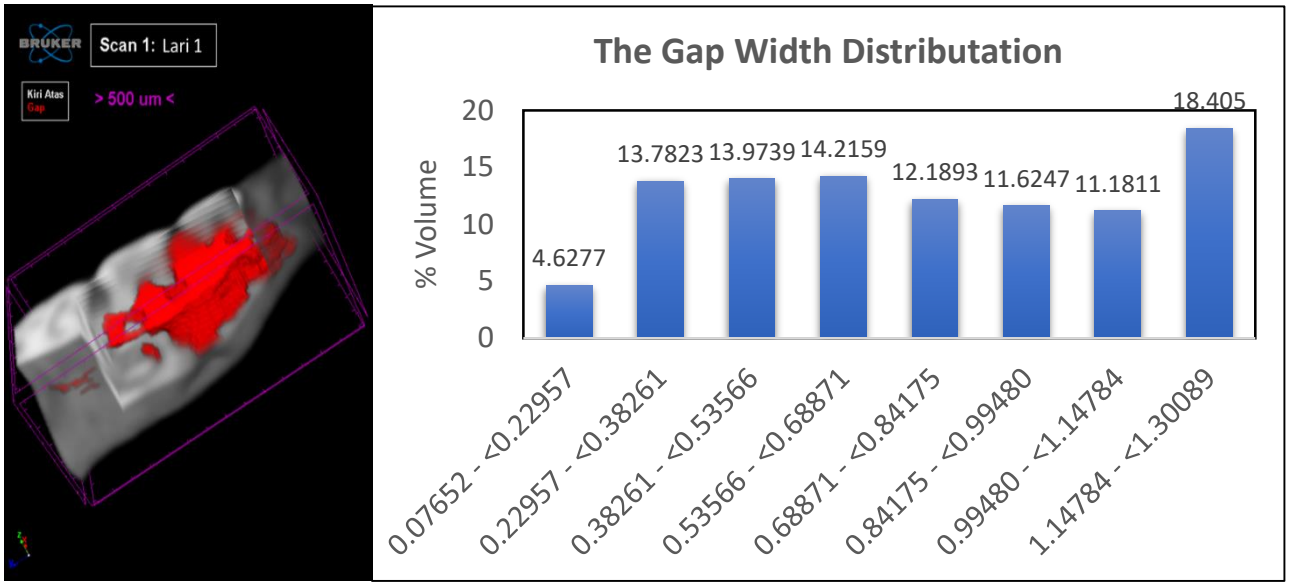

Figure 5. Tracing dominant psychological stress regions in the L1 sample with a graph of the gap width distribution.

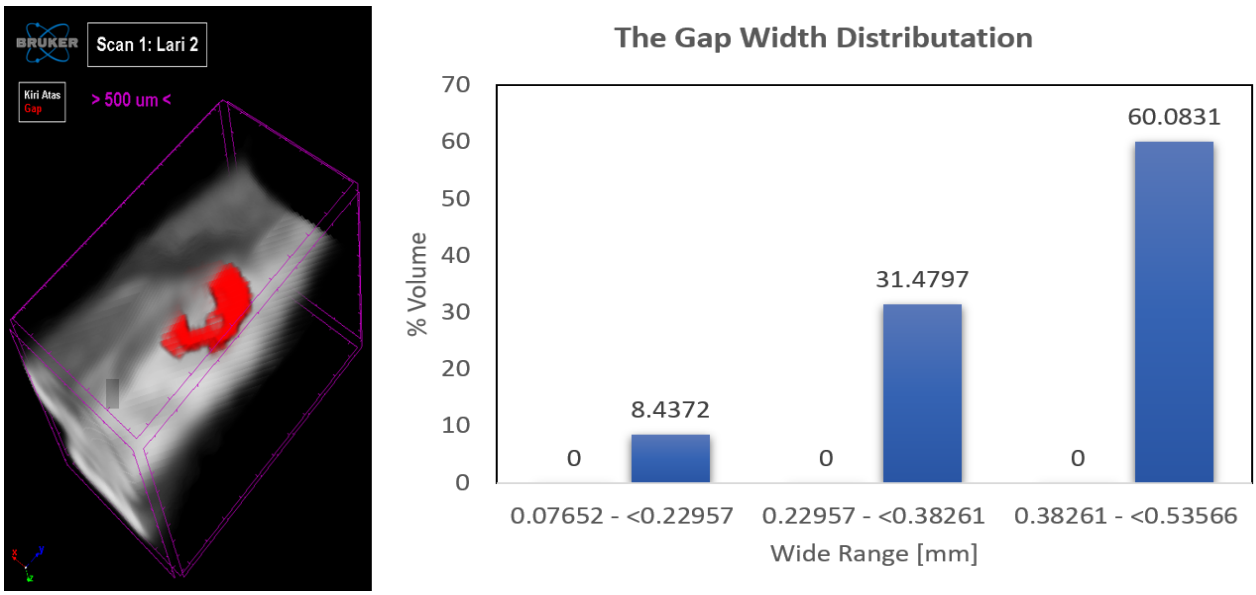

Figure 6. Tracing dominant psychological stress regions in the L2 sample with a graph of the gap width distribution.

Tracing region dominant in periodontitis can be used to identify and analyse as well as diagnose and treat periodontitis cases due to psychological stress treatment. Tracing can also be used to prevent periodontitis due to psychological stress treatment. Prevention is needed to eliminate the occurrence of periodontitis from the start or will become severe periodontitis. This tracing is to focus on which areas should be of concern in periodontitis therapy.

CONCLUSION

In conclusion, tracing with CBCT to find the dominant periodontitis region, so that more focus on periodontitis therapy on psychological stress.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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REFERENCES

1. Seo BM, Song IS, Um S, *et al*. Periodontal Ligament Stem Cells. Stem Cell Biol Tissue Eng Dent Sci. 2015; 291-296.
2. IU Madukwe. Anatomy of the periodontium: A biological basis for radiographic evaluation of periradicular pathology. J Dent Oral Hyg. 2014; 6(7): 70-76.
3. Könönen E, Gursoy M, Gursoy U. Periodontitis: A Multifaceted Disease of Tooth-Supporting Tissues. J Clin Med. 2019;8(8):1135.
4. Scannapieco FA, Gershovich E. The prevention of periodontal disease—An overview. Periodontol 2000. 2020; 84(1): 9-13.
5. Séverin T. Periodontal Health and Disease A practical guide to reduce the global burden of. Glob Periodontal Heal Proj. 2018; 1-28.
6. Sczepanik FSC, Grossi ML, Casati M, *et al*. Periodontitis is an inflammatory disease of oxidative stress: We should treat it that way. Periodontol 2000. 2020; 84(1): 45-68.
7. Liu J, Ruan J, Weir MD, *et al*. Periodontal bone-ligament-cementum regeneration via scaffolds and stem cells. Cells. 2019; 8(6): 537.
8. Kemenkes RI. Laporan_Nasional_RKD2018_FINAL.pdf [Internet]. Badan Penelitian dan Pengembangan Kesehatan. 2018.
9. Loos BG, Dyke TE Van. The role of inflammation and genetics in periodontal disease. Periodontol 2000. 2020; 26-39.
10. Duran-Pinedo AE, Solbiati J, Frias-Lopez J. The effect of the stress hormone cortisol on the metatranscriptome of the oral microbiome. NPJ Biofilms Microbiomes. 2018; 4(1): 1-4.
11. Curtis MA, Diaz PI, van Dyke TE. The role of the microbiota in periodontal disease. Periodontol 2000. 2020; 83(1): 14-25.
12. Coelho JMF, Miranda SS, da Cruz SS, *et al*. Is there association between stress and periodontitis? Clin Oral Investig. 2020; 24(7): 2285-2294.
13. Kuswandani SO, Masulili SL, Soedarsono N, *et al*. Academic Stress Influences Periodontal Health Condition and Interleukin-1 beta Level. J Dent Indones. 2014; 21(1): 16-20.
14. Johannsen A, Bjurshammar N, Gustafsson A. The influence of academic stress on gingival inflammation. Int J Dent Hyg. 2010; 8(1): 22-27.
15. Puspitaningrum MS, Rahmadhani D, Rizqianti Y, *et al*. The combination of epigallocatechin-3-gallate and platelet rich plasma in periodontal ligament stem cells for jaw osteomyelitis therapy: A review. Biochem Cell Arch. 2020; 20: 3015-3021.
16. Kulshrestha R, Srinivasa TS, Biswas J. Role of immunoglobulin G and a in periodontitis: A review. J Pure Appl Microbiol. 2013; 7(1): 673-676.
17. Damgaard C, Reinholdt J, Enevold C, *et al*. Immunoglobulin G antibodies against Porphyromonas gingivalis or Aggregatibacter actinomycetemcomitans in cardiovascular disease and periodontitis. J Oral Microbiol. 2017; 9(1).
18. Li Y, Deng S, Mei L, *et al*. Accuracy of alveolar bone height and thickness measurements in cone beam computed tomography: A systematic review and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019; 128(6): 667-679.
19. Kapila SD, Nervina JM. CBCT in orthodontics: Assessment of treatment outcomes and indications for its use. Dentomaxillofacial Radiol. 2015; 44(1).
20. Golbidi S, Frisbee JC, Laher IX. Chronic stress impacts the cardiovascular system: Animal models and clinical outcomes. Am J Physiol - Hear Circ Physiol. 2015; 308(12): H1476-H1498.
21. Halawany HS, Abraham NB, Jacob V, *et al*. Is psychological stress a possible risk factor for periodontal disease? A systematic review. African J Psychiatry. 2015; 18(1): 1-7.
22. Puspitaningrum MS, Rahmadhani D, Rizqianti Y, *et al*. Freeze-dried epigallocatechin-3-gallate and stem-cells from human exfoliated deciduous-teeth scaffold as the biocompatible anti-relapse material post-orthodontic treatment: A review. Biochem Cell Arch. 2020; 20: 2935-2942.
23. Rezkita F, Sarasati A, Wijaya FN, *et al*. Chitosan scaffold, concentrated growth factor and gingival mesenchymal stem cells as the osteoporotic jawbone therapy: A review. Biochem Cell Arch. 2020; 20: 2913-2919.
24. Jaiswal R, Shenoy N, Thomas B. Evaluation of association between psychological stress and serum cortisol levels in patients with chronic periodontitis - Estimation of relationship between psychological stress and periodontal status. J Indian Soc Periodontol. 2016; 20(4): 381-385.
25. Park HJ, Lee HJ, Cho SH. Influences of oral health Behaviors, depression and stress on periodontal disease in pregnant women. J Korean Acad Nurs. 2016; 46(5): 653-662.
26. Marchesan JT, Girnary MS, Moss K, *et al*. Role of inflammasomes in the pathogenesis of periodontal disease and therapeutics. Periodontol 2000. 2020; 82(1): 93-114.

27. Arman K, Petruninaitė A, Grigalauskienė R, *et al*. Stress experience and effect on self-perceived oral health status among high school students. Stomatologija. 2016; 18(3): 75-79.
28. Haririan H, Andrukhov O, Böttcher M, *et al*. Salivary Neuropeptides, Stress and Periodontitis. J Periodontol. 2017; 1-15.
29. Sudhanshu A, Sharma U, Hosakote V, *et al*. Impact of Yoga on Periodontal Disease and Stress Management. Int J Yoga. 2017; 10: 121.
30. Sabbah W, Gomaa N, Gireesh A. Stress, allostatic load, and periodontal diseases. Periodontol. 2018; 154-161.