DOI: https://doi.org/ 10.32828/mdj.v19i1.995

MDJ

Evaluation of salivary Tumor Necrosis Factor-Alpha in patients with hypothyroidism and periodontitis:

A Case- Control Study

Ghada Ghalib Hussien*

Omar Husham Ali**

*Master student at Collage of dentistry, University of Baghdad, Periodontics department, Iraq, B.D.S in dental surgery, phone: 009647725478147, E-mail: ghada.ghaleb1205a@codental.uobaghdad.edu.iq.

**Assist. Prof. at Collage of Dentistry, University of Baghdad, Periodontics department, Iraq, B.D.S., MSc. In Periodontics.

Abstract

Introduction: The immune system has served as a bridge among periodontitis and the endocrine system, particularly in the case of thyroid disorders. After non-surgical periodontal therapy for hypothyroid patients, serum thyroid stimulating hormone levels fall within the normal limits, which reduces the inflammatory markers linked to both periodontal and hypothyroid diseases**.** The pro-inflammatory cytokine tumor necrosis factor-alpha (TNF-α), released by macrophages, plays a significant role in bone loss caused by periodontitis. TNF-α will increase the production of collagenases, prostaglandin E2, chemokines and cytokines, cell adhesion molecules, and factors that are related to bone resorption. The aim of our study is to evaluate the salivary level of TNF-α in hypothyroidism patients with periodontitis in comparison to healthy controls.

Material and subject: Saliva were collected from 90 subjects with age ranged between (22-65) years, 50 of them hypothyroid patients (25 patients with hypothyroidism and healthy periodontium, 25 patients with hypothyroidism and periodontitis) and 25 patients with periodontitis and systemically healthy compare with 15 subject as control (systemically healthy with healthy periodontium). Detection of TNF-α in saliva was done by using Enzyme Linked Immunosorbent Assay.

Result: The current results revealed that salivary TNF-α levels are significantly high (p<0.001) in diseases group (periodontitis group (132.8 ng/L), hypothyroid patients groups without periodontitis (128.4 ng/L) and with periodontitis (117.0 ng/L) as compared to control group (73.4 ng/L), while there are no significant difference between diseases group.

Conclusion: Salivary TNF-α level increased significantly in all diseased groups (periodontitis group, hypothyroidism groups with and without periodontitis) in comparison to healthy subject.

Key Words: Periodontal disease, Tumor Necrosis Factor-α, Hypothyroidism, Saliva.

1. Introduction

A connection between periodontitis and hypothyroidism was found [(1)]. To confirm this link, measure the strength of any correlation with sickness severity, show causality, and determine the contribution of each disease to the pathogenesis of the other, additional controlled, prospective clinical and immunologic studies would be required [(2)]. The cytokines generated because of thyroid dysfunction may have served as the catalyst for an increased inflammatory cascade. This could result in higher local concentrations of inflammatory mediators like cytokines and prostaglandins, increased concentration of matrix metalloproteinase [(3)], and other proteinases with damaging consequences on bone and connective tissue, ultimately resulting in osteoporosis and periodontal breakdown [(1)].

Periodontal diseases are multifactorial, multi-microbial conditions that gradually destroy the teeth supporting structure, dental biofilm is thought to be a substantial contributor to these disorders, but host immunological responses do the majority of the damage [(4, 5)]. The host response is thought to be predominantly mediated by neutrophils, monocytes/macrophages, B and T lymphocytes, when these are activated, inflammatory mediators are created, including chemokine's, cytokines, arachidonic acid metabolites, and proteolytic enzymes. Overall, these contribute to tissue degeneration and resorption of bone by activating a variety of different host degradative enzymes [(6)]. If periodontitis-related tissue damage is not identified and treated effectively, it can result in the breakdown of both hard and soft tissues and eventually tooth loss [(7)].

Thyroxine and triiodothyronine, often known as T4 and T3, respectively, are two important related hormones produced by the thyroid gland. These hormones are important for the growth, development, and metabolism of the majority of vertebrate tissue [(8)]. As a result, a lack of or abnormally low level of these hormones can cause hypothyroidism, a common endocrine condition with a variety of adverse effects on the body [(9)]. Hypothyroidism characterized by inability of the thyroid gland to produce enough thyroid hormone to meet the body's metabolic needs; untreated hypothyroidism can cause hypertension, dyslipidemia, infertility,

cognitive deficits, and neuromuscular impairment [10]. A clinical case of primary hypothyroidism is diagnosed When the concentrations of TSH are higher than the standard range (>4.5 mlU/L) and a free thyroxine concentration is under the reference range (< 12 pmol/L) [11].

Biomarkers are the characteristics/product of the body at can be used to understand the prognosis, etiology, diagnosis, progression, remission, or outcome of medical treatment [12]. Cytokines defined as soluble proteins that bind to specific receptors on target cells and start intracellular signaling cascades, which modify how genes expressed and result in phenotypic changes in the cell [13].

Tumor necrosis factor (TNF-α) is a pro-inflammatory cytokine that regulates cell proliferation, death, and division in addition to inducing the production of other cytokines [14]. TNF- α is one of the TNF superfamily's members [15]. Although natural killer (NK) cells, T cells, mast cells, and endothelial cells can also create TNF-α, macrophages are primarily the source of TNF-α [16]. TNF-α is released in substantial amounts when macrophages come into contact with interlukin-1 (IL-1) or lipopolysaccharide (LPS) [17].

Both endogenous and exogenous thyroid hormones and TSH affect the homeostasis and metabolism of bones [18]. It is common knowledge that different hormones cause different reactions in the bones of the skeleton. TNF-α, is one of the key cytokines that promote inflammation, is produced locally in a number of tissues under a number of different clinical circumstances, including thyroid dysfunction [18]. This cytokine has the ability to stimulate the production of metalloproteinase by the periodontium's resident cells, which degrades connective tissue, as well as the growth and activation of osteoclasts, which degrades alveolar bone [18]. bacteria produce The endotoxins in tooth plaque elaborate with this TNF-α to worsen the inflammatory cascade by inducing the production of other cytokines that activate matrix metalloproteinase and cause periodontal destruction [18].

Saliva is an aqueous solution contains both inorganic and organic components, it is a complex, diluted and colorless solution [19]. Saliva offers a novel, non-invasive, and straightforward method to aid in disease diagnosis, saliva collection is comparatively risk-free and reduces the possibility of virus dissemination [20]. The structure of the microbiota as well as changes in biochemicals, deoxyribonucleic acid [21], ribonucleic acid (RNA), and proteins can detected in saliva, which is now thought to be a possible source of biological markers [20]. So it is anticipated that saliva may eventually replace serum or urine tests in the diagnosis of diseases [20].

In this study, we examined the relationship between periodontitis individuals and hypothyroidism with the salivary level of TNF-α. The aim of this study was to show the TNF-α salivary level in people with periodontitis and hypothyroidism in comparison to healthy controls.

Hypotheses

Null hypotheses H_0: there is no significant variation of salivary levels of TNF-α in hypothyroidism patients with periodontitis in comparison to healthy control.

Alternative hypotheses H_1: there is a significant variation of salivary levels of TNF-α in hypothyroidism patients with periodontitis in comparison to healthy control.

2. Material and Methods

2.1 Study design and ethics

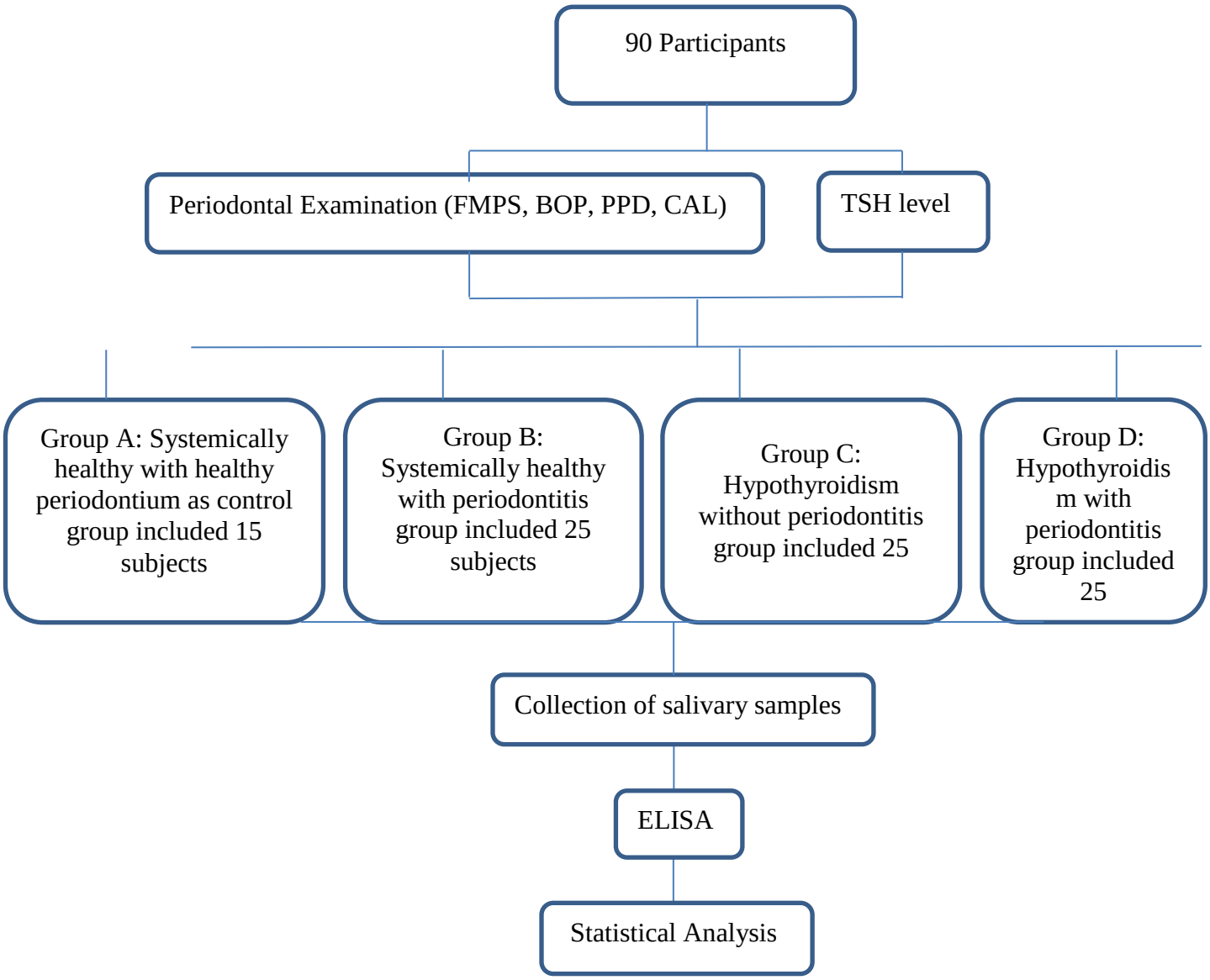

Figure A: Consort flowchart of design of the study.

Our study was a case-controlled research that took place from January 2022 to June 2022 at the Teaching Clinics of the Periodontics Department, College of Dentistry, University of Baghdad and the Educational Laboratories, Medical City. The College of Dentistry Ethics Committee at the University of Baghdad reviewed the study and granted it ethical approval (Reference number: 543, Project number: 543522, Date 17\4\2022). In this study, the percentage of male and female as follow male 32%, female 68% with mean age of (39.5).

Healthy periodontium defined as: intact periodontal tissue (no probing attachment loss), probing pocket depth PPD ≤ 3 mm, and bleeding on probing BOP <10% [22]. All cases of periodontitis Were defined in reference to [23]: Interdentally detectable clinical attachment level CAL at ≥2 non-adjacent teeth or CAL present at ≥3mm on the buccal or lingual/palatal surfaces in conjunction with pocketing >3mm at ≥2 teeth and also PPD ≥5mm or PPD at ≥4mm with BOP. While patients with hypothyroidism defined as: TSH: >4.5 mlU/L, T4: <12 pmol/L, T3: <3 pmol/L [11].

The salivary samples used to compare the salivary levels of TNF-α in-patient with hypothyroidism and periodontitis to healthy controls. Furthermore, in this study we will correlate Clinical parameters assessments to their corresponding biomarker concentration.

2.2 Inclusion and exclusion criteria

Included participants must have a new diagnosis of hypothyroidism, have at least 20 teeth and do not take treatment in the last 3 months. While the exclusion criteria for participant in this study include Subjects who consume alcohol or smoke, have a systemic disease other than hypothyroidism, any patients received extensive periodontal therapy, taking antibiotics, anti-inflammatory drugs, or any medication related to hypothyroidism. Patients that have any inflammatory oral disease that may affect the biomarkers under investigation, women take contraceptive pill, pregnant or nursing women.

2.3 Sample size

To calculate sample size, we use TNF-α as a primary outcome of the study. The concentration of this biomarker during health is estimated to be equal to (2.15pg/ml) and during periodontitis, its concentration is (12.92pg/ml) [17] which gives an odd ratio of (6) between periodontal health and periodontitis. Epitools software used to calculate sample size at 95% confidence interval and 5% error margin. The total sample size is 90 subjects divided into four groups, each case group will consist of 25 subjects and control group will consist of 15 subjects.

2.4 Enrollment of participants

The study's participants will include those seeking periodontal therapy at the Teaching Clinics of Department of Periodontics at the University of Baghdad's, College of Dentistry as well as those attending the Educational Laboratories in the Medical City. After receiving a thorough description of the study's goals and procedures, every subject will freely sign an informed consent form and Become enrolled in the study.

2.5 Calibrations

Before the start of the study, calibration sessions will perform between the gold-standard periodontics specialist and a main investigator. Kappa-coefficient assay was used to evaluate inter- and intra-examiner calibration for categorical variables (PI and BOP), a kappa value of 75% was the desired level. The level of agreement for continuous variables (PPD and CAL) should be >0.9 as assessed by the Interclass coefficient assay. These sessions will carry out on five patients.

2.6 Periodontal parameters and clinical examination

All teeth, excluding the third molar, will be included in periodontal examination. This includes determining of full mouth plaque score (FMPS) [(24)], gingival bleeding on probing (BOP) [(25)], probing pocket depth (PPD) [(26)], and clinical attachment level (CAL) [(27)], using a periodontal probe (Michigan O probe). Thyroid investigation will be done on patients with hypothyroidism (TSH and T4). [(11)]

2.7 Collection of salivary samples

Unstimulate Saliva from each patient was taken before any oral examination was performed and placed in sterile test tubes [(28)]. The expected amount of saliva to be collected per person was 3 ml on average. The obtained samples will immediately put on ice and centrifuged at 1000 rpm for 15 minutes. Then, the clear salivary supernatants will aspirate using a micropipette into a plastic Eppendorf tube. The samples then frozen to -20 c prior to ELISA analysis.

2.8 Enzyme-linked immunosorbent assays Laboratory procedure

After the collection of salivary samples, we allow them to melt at room temperature before beginning the experimental procedures. Then saliva samples will analyze for protein levels of TNF-α using commercially available ELISA kits that will ordered from MyBioSource in California, USA.

2.9 Statistical analysis

Descriptive statistics including mean, SD, median, and IQR utilized for the continuous data, while frequency and percentage used for the categorical variables. The distribution of parametric data examined using the Shapiro-Wilk test. The Kruskal-Wallis test served as a substitute for non-parametric data. If clinical and biochemical parametric variables were correlated, it was determined using the Spearman's or Pearson's correlation test (depending on the distribution of the data).

3. Result

The age of participants ranged (22-65) years with data (38.97±13.574, 39.50), in this study there were a significant female's predominance among study groups (n=61). Descriptive statistics of clinical parameters (full mouth plaque score FMPS, bleeding on probing BOP, probing pocket depth PPD and clinical attachment level CAL) showed that all clinical parameters had their highest data in patients of group B (FMPS (77.471±23.292, 80.600), BOP(56.262±17.399,57.000), PDD(3.990±1.873,4.560),

CAL(3.640±0.803,3.540). We illustrated the distribution of participants according to sex, age of the patients and clinical periodontal parameters in each group in Table 1.

When compere the age among groups by using Kruskal-Wallis test (multiple pairwise comparisons) test showed a statistical significant (P<0.05) among study groups (Group A with Group B, Group A with Group D, Group B with Group C, Group C with Group D) as shown in Table 2. Comparison of clinical periodontal parameters (FMPS, BOP) by using Kruskal Wallis test (multiple pairwise comparisons test) the result showed a statistical significant (P<0.05) among study groups (Group A with Group D, Group A with Group B, Group C with Group D, Group B with Group C). While for PPD we use Mann-Whitney comparison, the result showed a statistical significant between (Group B and Group D), for CAL T test used, the result showed a statistical significant between (Group B and Group D) as shown in Table 3.

Biochemical tests indicate that the concentration of salivary TNF-α in cases group (Group B (132.8 ng/L), Group C (128.4 ng/L) and Group D (117.0 ng/L)) was higher significantly in comparison to control group (73.4 ng/L). While TNF-α level had a non-significant difference between cases group (Figure A). When we compare the level of TNF-α among study groups statistically by using Kruskal Wallis test **(**multiple pairwise comparisons), the result indicate that there is a statistical significant (P<0.05) among study groups (Group A with Group B, Group A with Group C, and Group A with Group D) as shown in table 5.

When levels of TNF-α were correlated with the clinical periodontal parameters by using spearman correlation coefficient because the data was not normally distributed, the results showed a positive significant correlation of TNF-α with BOP (r=0.545**, p=0.005) and PPD (r=0.430*, p=0.023) in-group D. While TNF-α had a non-significant negative correlation with FMPS (r=-0.567, p= 0.027) and BOP (r=-0.215, p=0.441) in-group A and in-group C, FMPS (r=-0.105, p=0.619), BOP (r=-0.043, p=0.837).

In addition, there were a non-significant positive correlation among TNF-α and all clinical periodontal parameters in-group B {PI (r=0.133, p=0.527), BOP (r=0.334, p=0.103), PPD (r=0.059, p=0.780), CAL (r=0.385, p=0.057) and with FMPS (r=0.184, p=0.379) and CAL (r=0.302, p=0.143) in-group D (Table 4).

4.Discussion

Salivary TNF-α showed high level in all diseased groups as inflammatory biomarker in comparison to healthy control. However salivary TNF-α did not show a significant level in hypothyroidism when comper to periodontitis and healthy individuals. This study was conducted to evalute the level of TNF-α in hypothyroidism and periodontitis patients in comparison to healthy control.

Clinical definition of periodontitis is not enough for detection of this disease, the
definitions of periodontitis based on marginal radiographic bone loss are limited because they are not specific enough and fail to detect mild to moderate periodontitis [(29)]. In addition,

the definitions of periodontitis based on radiographic bone loss should be restricted to the stages of mixed dentition and tooth eruption [30]. For most patients, clinical parameters are effective instruments for evaluating their health and disease states. However, other individuals due to multiple factors more likely to develop and maintain a dysbiotic microbiota in conjunction with chronic periodontal inflammation and it is unclear whether the clinical parameters used today are adequate to monitor the progression of the disease so biomarkers are currently available [23]. Biomarkers are predicted to make significant contributions to a better assessment of the grade of periodontitis and to increased diagnostic accuracy in the early diagnosis of the disease, these might help to assist the periodontitis grading and staging [23].

We choice saliva in this study because salivary sample analysis is a cost-effective strategy since it is completely noninvasive and requires little effort from the patient, it is simple to collect, store, and transmit the samples [31]. Saliva is a rich source of readily available proteins and peptides that can be used to evaluate biomarkers generated during the onset and course of disease [32]. The focus of current research has been on saliva-based diagnostics because there are linkages between many systemic diseases and the salivary molecules have good correlations with blood levels [33].

In this study, the result showed that the severity of periodontal disease increase with age progression in periodontitis group and hypothyroidism with periodontitis group. This may related to the fact that aging negatively affects innate and adaptive immune response cells and molecules, including in the oral cavity [34]. Also for hypothyroidism, almost all bodily tissues, at all stages of development, depend on thyroid hormones to function properly [35]. Other study related this to an increase in the synthesis of anti-thyroglobulin antibodies, anti-peroxidase antibodies, and TSH hormone [36].

Salivary level of TNF-α increase from health to disease, in which the lowest concentration founded in control group while the highest concentration founded in cases group, for periodontitis patients the TNF-α, is a one of the first signaling cytokines, which are also common in periodontal lesion. TNF- α can be recognized as an essential immune response mediator in periodontitis as it is directly produced by a variety of cells and typically activates the immune system by secondary mediator molecules, inducing chemokine's, adhesion molecules, and prostaglandin E2 [37, 38].

The release of matrix metalloproteinase, stimulation of osteoclast differentiation, elevation of phagocytic and neutrophil activity, and induction of apoptosis in fibroblasts are all effects of TNF-α. The amount of TNF-α is elevated in plaque-induced inflammation, such as that linked to chronic periodontitis [37, 38].

Also in hypothyroidism groups both with and without periodontitis the TNF-α level was high in this study, this agreed with the result of other study that showed high level of TNF-α in hypothyroid patient in comparison to healthy subject [1]. TNF-α is produced locally in several tissues in a variety of clinical conditions, including thyroid dysfunction [18].

For correlation of salivary TNF-α with clinical periodontal parameters the result showed that there were a

significant positive correlations of TNF-α with BOP and FMPS in-group of hypothyroidism with periodontitis. The positive significant correlation of TNF-α with BOP and FMPS may be due to the fact that the TNF-α is known as a pro-inflammatory cytokine that affects the activation of inflammatory leukocytes and change of vascular permeability [(39)]. Also the positive correlation among the level of the TNF-α and the disease severity was mightily confirm the hypothesis that this cytokine are likely to be involved in the periodontitis pathogenesis [(40)].

The limitation of this study was small sample size. Use saliva instead of serum for detection of cytokines level because the serum has the bulk of cytokines concentrations spatially in systemic disease. We did not include a group of gingivitis to examine the level of cytokines in mild inflammation; also, we did not classify the periodontitis according to extent and severity as stage and grade. We examine the level of TSH and T4 as a diagnostic tool for hypothyroidism, but we did not compere the level of them with the level of biomarkers. Monitoring the level of the selected salivary TNF-α following periodontal therapy will provide a clear picture.

Suggestions include need larger sample size. Examine the level of RANKL with OPG to obtain the OPG/RANKL ratio. Use serum instead of saliva for estimation the level of biomarkers especially in systemic diseases. Compare the levels of TSH and T4 with the salivary levels of OPG and TNF-α in hypothyroidism patients. Examine the level of TNF-α after periodontal therapy. Gingivitis group Included in the study. Classify periodontitis according to severity and extent as stage and grade.

5. Conclusion

Salivary TNF-α level increased significantly in all diseased group (periodontitis group, hypothyroidism groups with and without periodontitis) in comparison to healthy subject, but there are no difference in level of salivary TNF-α between diseased group.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Tables:

Table 1: Statistical description for sex, age and clinical periodontal parameters among study groups.

Sex	Frequency(n) Percent (%)	Group A	Group B	Group C	Group D	Total
Male	N	3	10	1	15	29
	%	20%	40%	4%	60%	32%
Female	N	12	15	24	10	61
	%	80%	60%	96%	40%	68%
Total	N	15	25	25	25	90
Age	Mean±SD	23.53±3.091	45.48±9.319	29.12±5.769	51.56±9.917	38.97±13.574
	Median	22.00	42.00	30.00	46.00	39.50
Clinical periodontal parameters						
FMPS	Mean±SD	5.860±1.725	77.471±23.292	7.740±1.779	64.280±23.390	42.502±36.573
	Median	6.140	80.600	8.000	60.000	38.500
BOP	Mean±SD	4.586±1.481	56.262±17.399	7.272±1.752	49.840±14.226	32.257±26.277
	Median	4.970	57.000	7.500	50.000	32.000
PPD	Mean±SD	0.000±0.000	3.990±1.873±	0.000±0.000	2.984±2.109	1.937±2.307
	Median	0.000	4.560	0.000	4.000	0.000
CAL	Mean±SD	0.000±0.000	3.640±0.803	0.000±0.000	2.135±0.594±	1.604±1.633
	Median	0.000	3.540	0.000	2.300	1.500

Table 2**:** Multiple pairwise comparison of age among study groups.

Group paires	Group A-Group C	Group A-Group B	Group A-Group D	Group B-Group C	Group C-Group D	Group B-Group D
P value	1.000	0.000	0.000	0.000	0.000	0.920

* The significance level is 0.05

Table 3: Multiple pairwise comparison of (PI, BOP) among study groups, Mann-Whitney comparison of PPD between group B and group D, T test comparison of CAL between group B and group D.

Clinica Parameters	Group paires	GroupA-GroupC	GroupA-GroupD	GroupA-GroupB	GroupC-GroupD	GroupB-GroupC	GroupB-GroupD
FMPS	P value	0.791	0.000	0.000	0.000	0.000	1.000
BOP	P value	0.499	0.000	0.000	0.000	0.000	1.000
PPD	P value	0	0	0	0	0	0.018
CAL	P value	0	0	0	0	0	0.000

*The significance level is 0.05

Table 4: Correlation between TNF-α and clinical periodontal parameters among study groups.

Groups	Marker	FMPS		BOP		PPD		CAL	
		R	P value	r	P value	R	P value	R	P value
Group A	TNF-α	-0.567	0.027	-0.215	0.441	0	0	0	0
Group B	TNF-α	0.133	0.527	0.334	0.103	0.059	0.780	0.385	0.057
Group C	TNF-α	-0.105	0.619	-0.043	0.837	0	0	0	0
Group D	TNF-α	0.184	0.379	0.545**	0.005	0.430*	0.032	0.302	0.143

* spearman correlation coefficient

Table 5: Multiple pairwise comparison of TNF-α among study groups

Group pairs	Group A-group B	Group A-group C	Group A-group D	Group C-group D	Group D-group B	Group C-group B
P value	0.000	0.000	0.000	1.000	0.706	1.000

The significance level is 0.05

Figures:

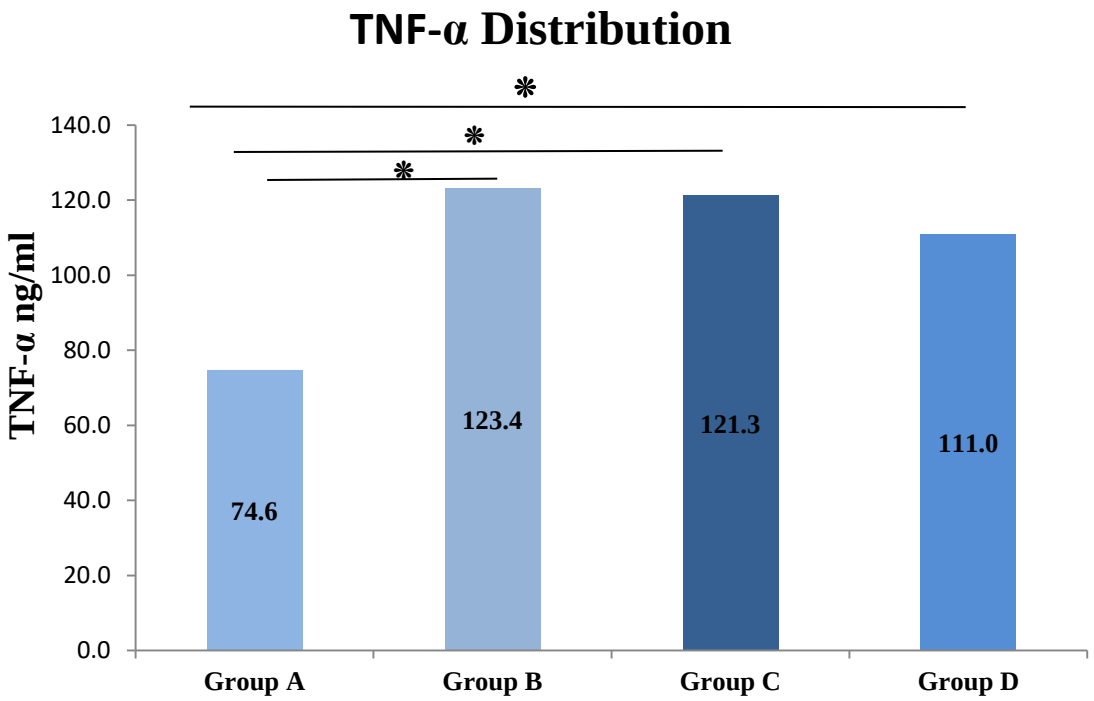

Figure A: Salivery concentration of TNF-α among study groups. The TNF-α level was significantly ❋ higher in patients of cases group than control group, while there were non-significant differences among disease groups.

Refrence

1. Monea A, Elod N, Sitaru A, Stoica A, Monea MJESJ. 2014. Can thyroid dysfunction induce periodontal disease? European Scientific Journal; 10(15). https://eujournal.org/index.php/esj/article/view/3440
2. Aldulaijan HA, Cohen RE, Stellrecht EM, Levine MJ, Yerke LM. 2020. Relationship between hypothyroidism and periodontitis: A scoping review. Clinical and experimental dental research; 6(1):147-57. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7025985/
3. Miller CS, King CP, Langub MC, Kryscio RJ, Thomas MV. 2006. Salivary biomarkers of existing periodontal disease: A cross-sectional study. The Journal of the American DentalAssociation;137(3):322-9. https://www.sciencedirect.com/science/article/pii/S0002817714609120
4. Kinane DF, Stathopoulou PG, Papapanou PN. 2017.Periodontal diseases. Nature reviews Disease primers;3:17038. https://pubmed.ncbi.nlm.nih.gov/28805207/
5. Abdulkareem AA, Imran NK, Abdulraheam RH, Gul SS. 2021. Prevalence and factors influencing reporting of true periodontal chief complaints: A retrospective analysis. Clinical and experimental dental research;7(4):443-9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8404502/
6. Hernández M, Dutzan N, García-Sesnich J, Abusleme L, Dezerega A, Silva N, et al. 2011. Host-pathogen interactions in progressive chronic periodontitis. Journal Dental Research; 90(10):1164-70. https://pubmed.ncbi.nlm.nih.gov/21471325/
7. Saliem SS, Bede SY, Cooper PR, Abdulkareem AA, Milward MR, Abdullah BH. Pathogenesis of periodontitis - A potential role for epithelial-mesenchymal transition. The Japanese dental science review. 2022;58:268-78. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9489739/
8. Ali LKJIJoPS. 2010. The Effect of Chronic Renal Failure on Thyroid Hormones. Iraqi Journal of Pharmaceutical Sciences (IJPS); 19(1):65-8. https://bijps.uobaghdad.edu.iq/index.php/bijps/article/view/521
9. Fadhil MF, Ibraheem SR, Al-Kazaz AA-KA. 2019. Study the association between IL-17 level and autoimmune antibodies in hypo and hyper thyroidisms patients. Iraqi Journal of Science; 60(9):1967-76. https://ijs.uobaghdad.edu.iq/index.php/eijs/article/view/1167
10. Hollowell JG, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA, et al. 2002. Serum TSH, T(4), and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). The Journal of clinical endocrinology and metabolism; 87(41):489-99. https://pubmed.ncbi.nlm.nih.gov/11836274/
11. Mirjanic-Azaric B, Avram S, Stojakovic-Jelisavac T, Stojanovic D, Petkovic M, Bogavac-Stanojevic N, et al. 2017. Direct Estimation of Reference Intervals for Thyroid Parameters in the Republic of Srpska. Journal of medical biochemistry; 36(41):137-44. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5471646/
12. Mayeux R. 2004. Biomarkers: Potential uses and limitations. The Journal of the American Society for Experimental NeuroTherapeutics; 1(41):182-8. https://doi.org/10.1602/neurorx.1.2.182
13. Preshaw PM, Taylor JJ. 2011. How has research into cytokine interactions and their role in driving immune

responses impacted our understanding of periodontitis? Journal of clinical periodontology; 38 Suppl 11:60-84. https://pubmed.ncbi.nlm.nih.gov/21323705/

14. Li H, Lin X. 2008. Positive and negative signaling components involved in TNFalpha-induced NF-kappaB activation. Cytokine; 41(1):1-8. https://pubmed.ncbi.nlm.nih.gov/18068998/

15. Locksley RM, Killeen N, Lenardo MJ. 2001. The TNF and TNF receptor superfamilies: integrating mammalian biology. Cell Journal; 104(4):487-501. https://pubmed.ncbi.nlm.nih.gov/11239407/

16. Clark IA. 2007. How TNF was recognized as a key mechanism of disease. Cytokine & growth factor reviews; 18(3-4):335-43. https://pubmed.ncbi.nlm.nih.gov/17493863/

17. Varghese SS, Thomas H, Jayakumar ND, Sankari M, Lakshmanan R. 2015. Estimation of salivary tumor necrosis factor-alpha in chronic and aggressive periodontitis patients. Contemporary clinical dentistry; 6(Suppl 1):S152-S6. https://pubmed.ncbi.nlm.nih.gov/26604566

18. Rahangdale SI, Galgali SR. 2018. Periodontal status of hypothyroid patients on thyroxine replacement therapy: A comparative cross-sectional study. Journal of Indian Society of Periodontoogyl; 22(6):535-40. https://pubmed.ncbi.nlm.nih.gov/30631233/

19. Kareem MA, Abbas HA. 2022. Thyme Extract as Corrosion Inhibitor for Teeth Filler Alloy in Saliva Media. Iraqi Journal of Science; 57(4C):2800-10. https://ijs.uobaghdad.edu.iq/index.php/eijs/article/view/6249

20. Zhang C-Z, Cheng X-Q, Li J-Y, Zhang P, Yi P, Xu X, et al. 2016. Saliva in the diagnosis of diseases. International Journal of Oral Science; 8(3):133-7. https://doi.org/10.1038/ijos.2016.38

21. Chandna S, Bathla M. 2011. Oral manifestations of thyroid disorders and its management. Indian J Endocrinol Metab; 15(Suppl 2):S113-S6. https://pubmed.ncbi.nlm.nih.gov/21966646

22. Chapple IL, Mealey BL, Van Dyke TE, Bartold PM, Dommisch H, Eickholz P, et al. 2018. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. Journal of periodontology;89:S74-S84. https://pubmed.ncbi.nlm.nih.gov/29926944/

23. Tonetti MS, Greenwell H, Kornman KS. 2018. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. Journal of periodontology; 89 Suppl 1:S159-s72. https://pubmed.ncbi.nlm.nih.gov/29926952/

24. O'Leary TJ, Drake RB, Naylor JE. 1972. The plaque control record. Jounal of Periodontology; 43(1):38. https://pubmed.ncbi.nlm.nih.gov/4500182/

25. Ainamo J, Bay IJIdj. 1975. Problems and proposals for recording gingivitis and plaque. International Dental Journal;25(4):229-35. https://pubmed.ncbi.nlm.nih.gov/1058834/

26. Listgarten MJJocp. 1980. Periodontal probing: what does it mean? Journal of clinical periodontology; 7(3):165-76. https://pubmed.ncbi.nlm.nih.gov/7000852/

27. Dye BA, Selwitz RHJJocp. 2005. The relationship between selected measures of periodontal status and demographic and behavioural risk

factors. Journal of clinical periodontology; 32(41):798-808. https://pubmed.ncbi.nlm.nih.gov/15966889/

28. Navazesh M. 1993. Methods for collecting saliva. Annals of the New York Acadedmy of Sciences; 694:72-7. https://pubmed.ncbi.nlm.nih.gov/8215087/
29. Lang NP, Hill RWJJocp. 1977. Radiographs in periodonties. Journal of clinical periodontology; 4(1):16-28. https://pubmed.ncbi.nlm.nih.gov/321483/
30. Tonetti MS, Mombelli AJAoP. 1999. Early-onset periodontitis. Annals of periodontology; 4(1):39-52. https://pubmed.ncbi.nlm.nih.gov/10863374/
31. Malathi N, Mythili S, Vasanthi HRJISRN. 2014. Salivary diagnostics: a brief review. International Scholarly Research Network of Dentistry. https://pubmed.ncbi.nlm.nih.gov/24616813/
32. Nanakaly HT. 2016. Interleukine-6 Level in Saliva of Patients with Chronic Periodontitis: A Case-Control Study. Journal of Baghdad College of Dentistry;28(1):103-8. https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/1091
33. Roi A, Roi CI, Negruțiu ML, Riviș M, Sinescu C, Rusu L-CJJoCM. 2020. The challenges of OSCC diagnosis: Salivary Cytokines as potential biomarkers. Journal of Medical Medicine; 9(9):2866. https://pubmed.ncbi.nlm.nih.gov/32899735/
34. Ebersole JL, Dawson DA, Emecen Huja P, Pandruvada S, Basu A, Nguyen L, et al. 2018. Age and Periodontal Health—Immunological View. Current Oral Health Reports; 5(4):229-41. https://pubmed.ncbi.nlm.nih.gov/30555774/
35. Leng O, Razvi S. 2019. Hypothyroidism in the older population. Thyroid Research; 12(1):2. https://doi.org/10.1186/s13044-019-0063-3
36. Jabbar ZS, Al-Shamma KJ, Taher MAJIJoPS. 2013. Some Hormonal Changes in Women with Primary Hypothyroidism under the Effect of Thyroid Hormone Replacement Therapy. Iraqi Journal of Pharmaceutical Sciences (IJPS); 22(1):56-64. https://bijps.uobaghdad.edu.iq/index.php/bijps/article/view/424
37. Taylor JJJP. 2010. Cytokine regulation of immune responses to Porphyromonas gingivalis. Periodontology 2000; 54(1):160-94. https://pubmed.ncbi.nlm.nih.gov/20712639/
38. Liu Y-CG, Lerner UH, Teng Y-TAJP. 2010. Cytokine responses against periodontal infection: protective and destructive roles. Periodotology 2000; 52:163-206. https://pubmed.ncbi.nlm.nih.gov/20017801/
39. Varghese S, Thomas H, Jayakumar N, Sankari M, Lakshmanan R. 2015. Estimation of salivary tumor necrosis factor-alpha in chronic and aggressive periodontitis patients. Contemp Clin Dent; 6(6):152-6.https://www.contempclindent.org/article.asp?issn=0976-237X;year=2015;volume=6;issue=6;spage=152;epage=156;aulast=Varghese
40. Mahmood HK, Al-Ghurabi BH. 2020. Association between anti-CMV IgG and salivary levels of ILâ€ • 6 and TNF-Î± in chronic periodontitis. Journal of Baghdad College of Dentistry; 32(41):5-11. https://jbcd.uobaghdad.edu.iq/index.php/jbcd/article/view/2887