ORIGINAL RESEARCH

The Impact of Hyperthyroidism on Dental Caries in relation to Salivary Constituents among Women: A Case Control Study

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Abstract

Aim: The aim of this study was to evaluate the impact of hyperthyroidism on dental caries among women regarding the salivary potential of hydrogen (pH), salivary flow rate (SFR), salivary chloride (Cl), and potassium (K).

Materials and methods: A case control comparative study design was used in the present study; the sample size was 90 females between the ages of 25 and 45. The study population was divided into two groups; the case group included 45 participants. Which has a history of hyperthyroidism, while the control group included 45 healthy females. The clinical examination was performed according to the instructions of the World Health Organization (WHO) 2013. The saliva was collected in order to determine the SFR, pH, and electrolyte concentrations. Salivary K and Cl were measured using the atomic absorption spectrophotometry method and the colorimetric method, respectively.

Results: The caries experience in the hyperthyroid group was higher compared to the healthy group but with no significant difference. Salivary pH and flow rate was lower among the hyperthyroid group compared to the healthy group, but there was no statistically significant difference. Electrolytes were higher in the study group than in the control group, with a significant difference. The correlation between salivary electrolytes and caries experience was nonsignificant.

Conclusion: The present study revealed that patients with hyperthyroidism had greater levels of caries experience when compared to the healthy group, and that was associated with a decrease in SFR and pH. As a consequence, patients with hyperthyroidism require special care for their dental health.

Clinical significance: The medical history evaluation is extremely important for oral health and has significantly influenced oral health. Therefore, it is important to recognize the possible consequences of hyperthyroidism on oral health. Dental healthcare practitioners must be aware of the oral and systemic manifestations of the hyperthyroidism. The risk of dental caries increased as the SFR decreased among these patients, in addition to changes in salivary pH and electrolytes, so patients with hyperthyroidism have a greater need for dental care.

Keywords: Chloride, Dental caries, Electrolytes, Hyperthyroidism, Salivary flow rate, Potassium, Potential of hydrogen.

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Introduction

Hyperthyroidism is a pathological condition defined by excessive thyroid hormone synthesis and secretion into the blood. Women are more likely than men to suffer from thyroid dysfunction, which has genetic and environmental causes.[1,2] Due to increased thyroid hormone release, hyperthyroidism occurs.[3,4] Most studies have discovered that patients with thyroid dysfunction have higher rates of dental caries and more severe periodontal disease.[5,6] The oral manifestation might be caused by the disease process, thyroidectomy, or the antithyroid medication, as some theories put forth.[3,7] There were conflicting studies regarding salivary changes in thyroid dysfunction patients, including a rise, reduction, or remained unchanged in the salivary potential of hydrogen (pH), flow rate, and various salivary organic and inorganic elements.[8,9] Numerous body functions depend on electrolytes, including fluid balance, nerve conduction, blood clotting, and muscle contraction. However, the influence of thyroid hormones on electrolytes and minerals has not been thoroughly investigated, and the underlying processes have not been completely defined. As a result, there is little information about the relationship between thyroid disorder and electrolyte imbalance.[10] A previous study demonstrated that electrolytes are essential in regulating thyroid hormone production as well as it's involved in the etiology and pathophysiology of thyroid disorders, It was hypothesized that changes in the levels of chemical electrolytes in affected thyroid tissue might serve as diagnostic indicators for this malfunction.[11] Investigations show that patients with hypothyroidism and hyperthyroidism have a considerable imbalance in the serum potassium (K) and chloride (Cl) levels.[12,13] The concentrations of these ions in saliva may be used in a wide variety of fields, as a diagnostic and therapeutic tool, demonstrating the efficacy of salivary constituent evaluation. As a diagnostic fluid, saliva has benefits over serum that are hard to ignore, such as the fact that it can be collected noninvasively by individuals and even patients. It does not need any special instruments for the gathering process. Saliva, in contrast to blood, does not coagulate, which is an advantage for those who have difficulty getting their blood, such as those who are overweight or who have hemophilia.[14] Previous research found that both the

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organic and inorganic parts of saliva have a lot of functions that should be taken into account when identifying how saliva affects dental caries.[15]

Dental caries is a complicated condition that may have a variety of causes and is a multifactorial disease that leads to localized damage to the tooth structure. It is caused by the interaction between many factors, including the tooth substrate, dietary carbohydrates, and cariogenic bacteria, which leads to the fermentation of carbohydrates and the production of acid. This changes the pH, which affects the balance between the oral environment and the tooth structure, causing minerals to be lost through demineralization.[16] Mineral loss can be reversed through remineralization if the conditions are ideal. Salivary ions help remineralize caries lesions naturally, but external factors or elements can speed up the process. Dental remineralization is the procedure in which minerals from the environment, like saliva or biofilm, are returned to tooth structures and can replace minerals in enamel and dentin that have lost some of their minerals during demineralization.[17,18] Salivary flow rate (SFR) is the amount of saliva naturally produced by the salivary glands. SFR and composition may be important in preserving the integrity of both soft and hard tissues in the mouth cavity.[19] The neurological system that affects salivary circulation controls the salivary gland's activity, and the amount of saliva that is released also relies on many other factors, such as thyroid hormone changes and some drugs that have side effects on long-term use.[9] The oral healthcare providers need to be knowledgeable about the oral and systemic manifestations of hyperthyroidism in order to detect any potential consequences of this disease and assess the degree to which the illness is under control. The aim of the present study was to investigate the impact of hyperthyroidism on dental caries among women and determine whether there have been any alterations in SFR, pH, or salivary electrolytes as compared to healthy women.

Materials and Methods

This case control study was conducted in December 2021. The ethical approval committee, College of Dentistry/University of Baghdad, Iraq, was granted permission to conduct the study. The study included 90 females aged 25–45 who attended an endocrine disorder center in Al-Sader Medical City in Al-Najaf Governorate/Iraq. The study population consisted of two groups; the case group consisted of 45 females with a history of hyperthyroidism who received antihyperthyroid medication, while the control group included 45 healthy females without any systemic disease. A prestudy was performed, and a total of 10 females were evaluated to fully explain any difficult circumstances that may occur throughout the study, so data from medical records were used to determine the type of thyroid malfunction, how long the patient had been ill, the drugs they were taking, and their medical history. A simple randomization method was used in the present study, and the samples were required to satisfy the following inclusion and exclusion criteria—they shouldn't had any other systemic illnesses, so the participants were free from any other systemic diseases aside from hyperthyroidism in order to avoid the influence of other diseases on oral health. They also shouldn't have been pregnant or smokers, nor should they have been taking any other medications besides the one described for the thyroid disorder. According to World Health Organization (WHO) 2013[20] guidelines, examinations were conducted on each patient under standardized circumstances. The general details and data, which included name, age, gender, and dental and medical histories, were entered on a particular form before the examination, so a personal file containing the information was registered. Each patient was inspected in an appropriate chair with a headrest and artificial headlight. The WHO recommended to use of a distinctive index, the Decayed, Missing, and Filled Teeth (DMFT) index/S, for recording the dental caries experiences. The DMFT index data was obtained directly from the coded numbers. The decay involved all teeth with codes 1 or 2. The missing involved teeth coded 4, while code 3 involved the filling teeth. All permanent teeth were included in the examination except teeth with coded 6, fissure sealant, or 7 were not involved in calculations of the DMFT index.

Salivary Sample

The unstimulated whole saliva was collected in screw-capped tubes according to the instructions of Tenovuo and Lagerlof.[21] Saliva was collected at 10–12 AM. It was conducted under standardized conditions. Initially, it had asked the female not to eat or drink anything other than water for 1 hour before the saliva collection. The saliva was collected at the same time of day. The method of saliva collection met the following requirements; in order to avoid any physical strain while collecting the saliva, the female was seated comfortably, and the saliva collection duration was specified; at 5 minutes, as recommended. The study participants drooled their saliva into screw-capped tubes. The SFR was calculated by dividing the volume of collected saliva measured in milliliters by the number of minutes consumed in the collection, fixed at 5 minutes, expressed in mL/minute.[22] Saliva pH was measured by a digital pH meter, the pH meter's sensor was inserted into the tube containing saliva, and the tube was tilted so that the saliva could cover the entire surface of the sensor. After measurement of flow rate and pH, the saliva was centrifuged at 3000 rpm for 10 minutes. The supernatant was put in Eppendorf tubes, labeled, and sealed; after that, it was frozen at −80°C for further examination.

Biochemical Analyses

Electrolyte analysis was performed for all control and patient groups. Firstly, the frozen samples of saliva were allowed to thaw before being subjected to biochemical analysis.

The salivary K concentrations were measured by the atomic absorption spectrophotometry method according to the instrumental manufacturer's specifications.[23] The normal range of the ions in saliva was 10–36 mmol/L K and 5–40 mmol/L Cl.[24] The K-concentration was determined using a special device, atomic absorption spectrophotometer. A Hallow cathode lamp specific for K was used at a wavelength of 766.5 nm.[23]

The salivary Cl concentration was measured by the colorimetric method, which used a spectrophotometer device and a ready-made kit (Agape, Germany). Several chemical reactions occurred to determine the Cl ion concentration. When Cl ions and mercury II thiocyanate interacted, they formed thiocyanate ions, which interacted with iron(III) and nitric acid, and produced a red color. The color's intensity reflected the concentration of Cl ions in the sample.

Statistical Analysis

Results were displayed as mean, standard error, and standard deviation to determine the level of significance at a *p*-value of 0.05. Data description and analysis were performed by using an independent sample *t*-test; a parametric test of the difference between two groups. The statistical software was Statistical Package for the Social Sciences version 22.

Results

Table 1 shows the descriptive and statistical test of age among groups; 90 females participated in this study, and the ages ranged from 25 to 45. The mean value was 35.56 in the study group compared to the control group, which was 35.82, with a nonsignificant difference *p*-value > 0.05.

A clinical examination revealed that all females had dental caries, as shown in Table 2. The results found that all caries experience in the study group was higher compared to the control group, with nonsignificant difference *p*-value > 0.05, except the mean value of filling surface was higher in the control group 4.267 compared to the study group 2.978 with a significant difference the *p*-value < 0.05.

The mean value of the salivary pH was lower in the study group 6.727 compared to the control group 6.869, with a nonsignificant difference *p*-value > 0.05. The mean value of the SFR was lower in the study group 0.284 compared to the control group 0.304, and these differences were nonsignificant with a *p*-value of >0.05. The mean value of K was higher in the study group 15.660 compared to the control group 12.627, and the Cl mean value was higher in the study group 0.327 compared to the control group 0.266; these differences were significant *p*-value < 0.05 as observed in Table 3.

Table 4 shows the correlation between SFR, pH, and caries experience among the study and control groups. The result found the SFR in the study group had a positive nonsignificant correlation except the filling surface was negative, while in the control group, the correlations were negative significant correlation except decay surface and missing surface were negative nonsignificant *p*-value > 0.05.

In the study group, the correlation between salivary pH and caries experience was positive, except the filling surface and Decayed, Missing, and Filled Surfaces (DMFS) were negative, the results found the correlations were nonsignificant *p*-value > 0.05 except missing surface and DMFS were significant *p*-value < 0.05, while in the control group the correlations were negative and nonsignificant correlation *p*-value > 0.05 except DMFT and DMFS were significant different *p*-value < 0.05.

Table 5 shows the correlation between the electrolytes and caries experience. A positive nonsignificant correlation was found between the Cl and caries experience in the study group, while in the control group, the correlations were also positive and nonsignificant except the missing surface was negative nonsignificant *p*-value > 0.05. The K had negative nonsignificant correlations with caries except decay surface was positive nonsignificant in the study group while the control group found the correlations were negative nonsignificant except for missing surface and DMFT, which were positive nonsignificant correlations with *p*-value > 0.05.

According to the results of the clinical examination, dental caries was present in all female participants. However, the study group exhibited a greater incidence of caries compared to the control group. The hyperthyroid group exhibited a lower salivary pH and

Table 1: Descriptive and statistical test of age among study and control groups

Groups	*Minimum*	*Maximum*	*Mean*	*± Standard deviation*	*t-test*	*p-value*
Study	25	45	35.56	6.887	0.154	0.878
Control	25	45	35.82	6.743		

*Significant at *p* < 0.05

Table 2: Mean values and statistical difference of caries experience among study and control groups

	Groups					
	Study		*Control*			
Variables	*Mean*	*± Standard error*	*Mean*	*± Standard error*	*t-test*	*p-value*
Decay surface	8.489	0.596	7.244	0.411	1.719	0.089
Missing surface	6.022	1.063	4.333	0.805	1.266	0.209
Filling surface	2.978	0.274	4.267	0.353	2.883	0.005
DMFS*	17.489	1.062	15.844	0.894	1.185	0.239
DMFT*	10.289	0.483	10.156	0.502	0.191	0.849

*Significant at *p* < 0.05; *DMFS, Decayed, Missing, and Filled Surfaces; *DMFT, Decayed, Missing, and Filled Teeth

Table 3: Mean values and statistical difference of variables among study and control groups

Variables	*Groups*	*Mean*	*± Standard error*	*t-test*	*p-value*
pH	Study	6.727	0.059	1.879	0.064
	Control	6.869	0.048		
Flow rate	Study	0.284	0.039	0.498	0.620
	Control	0.304	0.008		
Potassium	Study	15.660	0.182	12.111	0.000*
	Control	12.627	0.172		
Chlorine	Study	0.327	0.008	4.688	0.000*
	Control	0.266	0.011		

*Significant at *p* < 0.05

Table 4: Correlation between SFR, pH, and caries experience among study and control group

		SFR		*pH*	
	Groups	*r*	*p-value*	*r*	*p-value*
Study	Decay surface	0.005	0.973	0.244	0.106
	Missing surface	0.104	0.496	0.347	0.019*
	Filling surface	−0.174	0.253	−0.213	0.159
	DMFS*	0.062	0.685	−0.430	0.003*
	DMFT*	0.117	0.443	0.186	0.221
Control	Decay surface	−0.124	0.415	−0.083	0.590
	Missing surface	−0.305	0.042	−0.271	0.071
	Filling surface	−0.316	0.034*	−0.211	0.165
	DMFS*	−0.456	0.002*	−0.365	0.014*
	DMFT*	−0.567	0.000*	−0.301	0.044*

*DMFS, Decayed, Missing, and Filled Surface; *DMFT, Decayed, Missing, and Filled Teeth; *significant at $p < 0.05$

Table 5: Correlation coefficient between salivary ions and caries experience

		Chloride		*Potassium*	
	Groups	*r*	*p*	*r*	*p*
Study	Decay surface	0.090	0.556	0.159	0.297
	Missing surface	0.106	0.488	−0.347	0.019
	Filling surface	0.072	0.638	−0.070	0.647
	DMFS*	0.176	0.249	−0.277	0.066
	DMFT*	0.116	0.446	−0.103	0.500
Control	Decay surface	0.172	0.258	−0.059	0.702
	Missing surface	−0.004	0.977	0.084	0.582
	Filling surface	0.050	0.743	−0.142	0.351
	DMFS*	0.095	0.535	−0.007	0.962
	DMFT*	0.013	0.934	0.107	0.484

*DMFS, Decayed, Missing, and Filled Surface; *DMFT, Decayed, Missing, and Filled Teeth; *significant at $p < 0.05$

flow rate. The study found that both electrolytes were greater in the hyperthyroid group, with a significant difference.

Discussion

Whenever the thyroid gland produces a greater quantity of thyroid hormone than the body requires, a condition known as hyperthyroidism can develop.[25,26] Tetraiodothyronine (T4 or thyroxine) and triiodothyronine (T3) are the main thyroid hormones. Tetraiodothyronine has a long half-life of 7 days, while the half-life of triiodothyronine varies between 10 and 24 hours the rate of secretion thyroxine = 80–90 µg/day triiodothyronine = 4–5 µg/day reverse T3 = 1–2 µg/day.[27] Thyroid disorders can impair the body's ability to heal itself and cause an imbalance in the body's homeostasis.[28] Increased susceptibility to caries and periodontal disease are two oral symptoms of hyperthyroidism that are frequently seen in patients.[29]

Only a few previous research investigated these electrolytes in saliva among hyperthyroid patients; the majority of previous investigations measured these electrolytes in serum instead of saliva.[12,13] Previous studies on thyroid disorder patients found a low level of K while the Cl level was increased in these patients.[30,31] In the present investigation, salivary electrolytes were higher in the study group compared to a control group with significant differences. That agrees with a study carried out by Kumara et al., who found that hyperthyroid individuals' serum K levels were significantly increased but the levels of Cl were not significantly different among the patients and control group.[13]

Potassium (K) is an important component of the enzyme Na-K ATPase, which is positioned on the cell membrane and facilitates the flow of water and nutrients across the membrane. K is also an essential component of many other enzymes. Any disturbance in thyroid function will cause an alteration in renal function and a change in the metabolism of electrolytes. Thyroid hormones are responsible for regulating the activity of sodium–potassium pumps in the majority of the body's tissues. However, when thyroid hormones become dysregulated, K shifts within the cell, as well as causing a disturbance in the kidney's ability to excrete K.[12,32–34]

According to the results of the present investigation, which found all female participants experienced 100% caries, However, the incidence of caries was higher in the study group compared to the control group with no significant differences. The findings of this investigation agreed with a study conducted by Al-Rubbaey found the severity of the caries rate was elevated in thyroid dysfunction groups contrasted to the normal individual.[35] Al-Mashaykhi noticed that caries severity (DMFS and DMFT) was higher in the hypothyroid and hyperthyroid groups than in the symptomatic group with no statistically significant differences.[36]

The study found a nonsignificant decrease in SFR in the study group compared to the control group, Al-Rubbaey observed the same result, which found a decrease in the amount of flow and pH of saliva in thyroid dysfunction groups in contrast to the healthy

individual, these differences were determined to be extremely significant according to the statistical analysis.[35] Another study done by Al-Naif and Al-Aswad found a reduction in SFR among hyperthyroid patients.[37] There is a connection between the reduction in the amount of salivary flow and a drop in buffer capacity as well as the pH of the saliva. It also has a negative effect on oral sugar clearance, which may make dental caries severe in individuals with thyroid dysfunction.[38] It's possible that this provides some explanation regarding the cause of the high rate of caries in individuals who have hyperthyroidism. The dry mouth, along with major changes in the salivary ionic composition, are brought on by decreased salivary output, which increases the risk of oral diseases.[39] The present study correlated the caries experience with salivary K and Cl, the result found that salivary CL had positive nonsignificant correlations with DMFT/DMFS among the hyperthyroid group, negative nonsignificant correlations were observed between salivary K and DMFT/DMFS among the hyperthyroid group, as all correlations were nonsignificant. The SFR showed positive nonsignificant correlations with DMFT/DMFS in the study group, while salivary pH showed a positive nonsignificant correlation with DMFT and a negative statistically significant correlation with DMFS. The concentrations of the inorganic ions such as K and Cl were substantially different between dental plaque fluid and saliva. probably due to plaque bacteria's metabolic activities, hence, saliva served as the primary source of these ions in the body.[40] dental caries is a complex illness and several risk factors may contribute to its development, However, regardless of the patient's systemic condition, the presence of dental caries is evidence that the individual is unaware.[41] Dental education is essential for individuals to improve both their knowledge of and attitude toward oral health. Because of this, special preventative programs need to be developed for such patients. It is essential for oral healthcare professionals to possess knowledge regarding the oral and systemic evidence of hyperthyroidism in order to detect any potential complications and assess the degree to which the condition is controlled.

Limitation

The sample size was small for several reasons, which was affected by the withdrawal of many participants, and finding a participant who met all of the criteria was difficult in a limited time, the duration of the investigation and saliva sample collection was restricted to a specified time because the saliva samples will deteriorate if a long time passes. Another limitation of this study was that the visual and tactile investigations were only used during clinical dental examinations, whereas radiographs could have been used to confirm the diagnosis, but the patient was being treated in an endocrine center and dental radiography was unavailable. Further research is necessary to investigate more types of biomarkers with a larger sample size.

Conclusion

This study reported that a change in salivary electrolyte concentration, flow rate, and pH in hyperthyroid patients contributed to an increase in the percentage of dental caries in the hyperthyroid group compared to the control group. According to the findings of the study, the correlations between K and caries experience were negative, while the correlations between Cl and caries experience were positive, and most of the correlations were nonsignificant.

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