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Determination the risk-factors of dental caries in patients with thyroid dysfunction at age 25-35

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Abstract

Tooth development and oral health are intricately regulated by endocrine factors, particularly thyroid hormones, which play a vital role in calcium and phosphorus metabolism. These minerals are essential for enamel formation and resistance to demineralization. Thyroid dysfunction especially hypothyroidism and hyperthyroidism has been associated with systemic metabolic disturbances, yet its direct impact on oral mineralization processes and dental caries in adults remains insufficiently studied. Studies have shown that patients with thyroid disorders have decreased calcium and phosphate concentrations in their saliva, which impairs tooth enamel's resistance to demineralization and subsequent decay. This research addresses that gap by investigating how thyroid hormone imbalances affect the biochemical and structural integrity of the oral environment in individuals aged 25–35 years.

The study involved 60 participants, including 30 patients with clinically diagnosed thyroid dysfunction and 30 healthy controls. A comprehensive clinical and laboratory assessment was conducted to evaluate the mineralization potential of saliva, its viscosity, flow rate, pH, and concentrations of calcium and inorganic phosphorus. Additionally, the study examined enamel resistance to caries, the prevalence and intensity of dental caries, and the crystallization patterns of saliva. These parameters were analyzed to determine how thyroid dysfunction alters the oral ecosystem and contributes to increased caries risk.

The findings are expected to demonstrate that thyroid dysfunction, particularly hypothyroidism, impairs saliva composition and mineralization capacity, leading to reduced enamel resistance and higher susceptibility to dental caries. By identifying these changes, the study aims to establish diagnostic markers and risk assessment criteria for oral health management in patients with thyroid disorders. Furthermore, the research proposes a framework for early detection and preventive care strategies tailored to endocrine-related oral health risks, contributing to improved long-term outcomes in dental and systemic health.

Keywords: Saliva; Phosphorus concentration; Dental caries; Ph; Thyroid dysfunction

1. Introduction

Tooth development is influenced by various factors, including the endocrine system (Gonçalves et al., 2020; Coelho et al., 2021). Thyroid dysfunction, particularly hypothyroidism and hyperthyroidism, disrupts both systemic and oral health, including mineralization processes in teeth, increasing susceptibility to dental caries and periodontal diseases (Sharma et al., 2021; Parham et al., 2020). Although the influence of thyroid hormones on tooth enamel and

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dentogenesis has been widely discussed, studies that assess the direct relationship between thyroid dysfunction and dental caries in adults remain limited (Khan et al., 2023). In this context, the current study aims to assess the impact of thyroid dysfunction on the mineralization processes in the oral cavity, particularly focusing on patients aged 25-35.

1.1. Thyroid Gland and Oral Health

The thyroid gland plays a critical role in calcium and phosphorus metabolism through the action of thyroid hormones and calcitonin, which directly affect tooth tissue mineralization and enamel resistance (Strott, 2022; Jacob et al., 2023). Hypothyroidism and hyperthyroidism are linked to alterations in calcium homeostasis, which may lead to defective enamel formation and a higher risk of dental caries (Muthukumar et al., 2019; Singh et al., 2022). Studies have shown that patients with thyroid disorders have decreased calcium and phosphate concentrations in their saliva, which impairs tooth enamel's resistance to demineralization and subsequent decay (Harada et al., 2021; Gökdemir et al., 2022).

The relationship between thyroid dysfunction and the oral cavity becomes particularly significant during the given age (Dibbets et al., 2020; Khambhati et al., 2023).

Aims of the Study

This study aims to evaluate the influence of thyroid dysfunction on dental caries development and the mineralization of oral fluids in patients aged 25-35 years. Specifically, we explored the relationship between thyroid hormone levels and the following aspects of dental health:

- Saliva mineralization potential and viscosity.
- Salivation speed and enamel resistance to caries.
- Changes in calcium and inorganic phosphorus concentrations in saliva.
- Effects of pH changes in saliva on mineralization processes.
- Crystallization patterns of saliva in relation to thyroid dysfunction.

The following tasks are set for the problem resolution

The object of the study is 30 person 25-35 years of age suffering from thyroid dysfunction and 30 completely healthy population of the same age.

The strategy of the presented project

- The saliva mineralization potential, its viscosity, salivation speed and enamel resistance were studied for determining the thyroid dysfunction
- The caries prevalence intensity, the surface distribution for the permanent teeth and levels of caries intensity was calculated for assessment of the dental status.
- The total amount of calcium and inorganic phosphorus in saliva is assessed, since decrease in parathyroid hormone function causes calcium metabolism disorder.
- Saliva crystallization changes were identified for studying the thyroid hormone dysfunction as well as their relation with calcium and phosphorus metabolism.
- Effects of pH changes on saliva mineralization in thyroid dysfunction were detected.
- The effects all of the above changes on peoples' body in thyroid dysfunction were identified and the risks of their exposure were assessed for determination of the dental status.
- At the first stage of the study the patients of 25-35 years of age were selected and thyroid dysfunction induced by hormonal changes were determined. The completely healthy people of the same age were also selected who voluntarily participated in this study. Experiments were conducted in "Salome Omidze Dental Clinic".
- At the 2nd stage the patients were divided by thyroid dysfunction, caused by age-related changes with 30 patients with changes in thyroid function and 30 completely healthy patients in each group. The saliva mineralization potential, its viscosity, salivation speed and enamel resistance were studied. Effects of a pH changes on saliva mineralization in thyroid dysfunction were detected (Figure 1).
- The 3rd stage. The caries prevalence intensity, the surface distribution for the permanent teeth and levels of caries intensity were calculated for assessment of the dental status. The total amount of calcium and inorganic phosphorus in saliva were also assessed, since decrease in parathyroid hormone function causes calcium metabolism disorder.

- The 4th stage. Saliva crystallization changes were identified for studying of thyroid hormone dysfunction as well as their relation with calcium and phosphorus metabolism.
- The 5th stage. Identification of the role of the thyroid gland, detection of various process regulations and neurochemical correlates for assessment of the dental status.

The projects objectives

- Detection of thyroid dysfunction.
- Effects of thyroid dysfunction on saliva mineralization potential, its viscosity, salivation speed and tooth enamel resistance and determination of pH changes.
- The total amount of calcium and inorganic phosphorus in saliva were assessed, since decrease in parathyroid hormone function causes calcium metabolism disorder.
- Saliva crystallization changes were identified for studying of thyroid hormone dysfunction as well as their relation with calcium and phosphorus metabolism.
- The effects all of the above changes on peoples' body in thyroid dysfunction were identified and the risks were assessed for determination of the dental status.

2. Literature review

Recent literature highlights the role of thyroid hormones in oral health, particularly in relation to calcium and phosphate metabolism and enamel mineralization. Coelho et al. (2021) found that hypothyroid patients exhibit lower levels of calcium and phosphate in saliva, which contribute to an increased susceptibility to dental caries. Similarly, Sharma et al. (2021) identified an inverse relationship between thyroid hormone levels and enamel mineralization, which compromises enamel integrity. Moreover, the effects of thyroid dysfunction on periodontal health have been extensively studied, with findings indicating that patients with hypothyroidism are more prone to chronic gingivitis and periodontal disease (Parham et al., 2020).

In recent years, advanced biochemical techniques have enabled more precise analysis of saliva composition, including mineralization capacity and crystallization properties. Studies by Harada et al. (2021) and Gökdemir et al. (2022) have provided insights into the biochemical markers of saliva in thyroid dysfunction, emphasizing the need for early diagnostic markers to assess caries risk in thyroid patients.

3. Methodology

3.1. Study Design

The study included 60 participants (30 with thyroid dysfunction and 30 healthy controls), aged 25-35 years, attending Salome Omiadze Dental Clinic. Participants underwent clinical and laboratory assessments to determine their dental status and saliva composition. The following tasks were performed:

3.2. Saliva Mineralization

The potential for mineralization in saliva were evaluated using calcium and phosphate concentration analysis and viscosity testing.

3.3. pH and Crystallization

pH changes in the saliva and crystallization patterns were assessed as indicators of mineralization imbalance.

3.4. Enamel Resistance and Caries Prevalence

Caries prevalence was measured, including the surface distribution and intensity of caries lesions in permanent teeth. Enamel resistance to demineralization was also tested using enamel microhardness testing.

3.5. Calcium and Phosphorus Levels in Saliva

The levels of calcium and phosphorus were measured using spectrophotometric methods to assess the impact of thyroid dysfunction on mineral metabolism.

3.6. Compliance of research methodology with the project objectives

The research methodology of the project fully complies with modern standards, and is fully adequate for solution of set goals.

Patients of 25-35 years of age was selected and thyroid dysfunction induced by hormonal changes were determined. The completely healthy patients of the same age were also selected who voluntarily participated in this study. The patients were divided by thyroid dysfunction, caused by age-related changes with 30 with changes in thyroid function and 30 completely healthy patients in each group. The saliva mineralization potential, its viscosity, salivation speed and enamel resistance were studied. Effects of a pH changes on saliva mineralization in thyroid dysfunction were detected.

The caries prevalence intensity, the surface distribution for the permanent teeth and levels of caries intensity were calculated for assessment of the dental status. The total amount of calcium and inorganic phosphorus in saliva were also assessed, since decrease in parathyroid hormone function causes calcium metabolism disorder.

Saliva crystallization changes were identified for studying of thyroid hormone dysfunction as well as their relation with calcium and phosphorus metabolism. Identification of the role of the thyroid gland, detection of various process regulations and neurochemical correlates for assessment of the dental status.

3.7. Definition of pH

A variety of indicators were used for identification of the mouth base-alkalinity. So called potentiometric analysis is the correct, fast and easy method, for which the arrow or digital laboratory pH- meter, equipped with hydrogen ion sensitive electrode and the second auxiliary electrode and a second electrode is applied. pH was also determined on the indicator paper. Principle of the method is based on change of physico-chemical properties of the indicator. After plotting (dripping) the saliva on the indicator paper the color change is compared to the appropriate pH- scale. The salivation speed and saliva viscosity were studied.

3.8. Determination of saliva micro-crystallization

For the purpose to study the saliva micro-crystallization, 0,2-0,3 ml of saliva from the mouths of the patients in the morning on an empty stomach are taken by a sterile pipette; 3 ml of saliva is plotted by the pipette on pre- treated with alcohol glass slide.

Micro-preparations are dried at room temperature. After drying the saliva crystallization is studied under MBA -1 type microscope, with magnifying of 8 X 0,20 on the reflected light. The saliva micro-crystallization is identified by the average size of dried saliva and generated crystal. Evaluation is done by the so-called Points system.

3.9. Saliva mineralization

The saliva mineralization is of great importance for maintaining of oral mineralization. The saliva is the solution, saturated by calcium and phosphorus, being the base for kits mineralization. The mineralization of saliva by calcium and phosphorus causes their diffusion from the mouth to tooth enamel, thus strengthening the structure of the teeth and their growth, since the enamel is regularly saturated and tooth enamel hardness increases with age.

3.10. Enamel Resistance Testing

We have used method of “Acid Etch Resistance Test” to evaluate how resistant the enamel is to demineralization (acid attack), which relates to the patient’s caries risk.

Method description: A mild acid, like 0.1% citric acid was applied to a small area, after sensing and drying, the chalky white appearance was evaluated- more chalkiness= low resistance; Less or no chalkiness = higher resistance.

3.11. Calcium determination

The principle of calcium determination is based on formation of a complex between the calcium ion and EDTA ion, which is stable even in strong alkaline reaction. pH-12-13 - in this area of ion complex magnesium ions are destructed, and expressed as hydroxide. Absence of free calcium is approved by Trilon B titration in presence of an indicator murexide.

3.11.1. Test procedure

0.5-1.0 ml saliva is diluted in distilled solution to 50 ml. Hydroxylamine hydrochloride 1 ml and 2 ml 2 N sodium hydroxide, and a few crystals of murexide is added and titrated by 0.05 N Trilon B until changing the color. The lower limit of calcium detection in 0.5 ml saliva is 8.0 mg / L.

3.12. Phosphorus determination

This method is based on orthophosphate reaction with ammonium molybdate in acidic medium resulting in a yellow-colored hetero polyacid, restored by ascorbic acid and transformed into the blue-colored compound.

3.12.1. Test procedure

2.4 ml of 7% TXY is added to 1 ml saliva for protein sedimentation, centrifuged, and the supernatant solution (0,1-2,0 ml) is used for analysis. The color intensity is determined by the spectrophotometer. The lower limit of phosphorus detection is 1 mg / L.

3.13. Fluorine determination

Fluorine by this method is determined by potentiometric, fluorine-selective electrode. The use of fluorinated salt causes the saliva intensification, leading to 1.2 - fold reduction of viscosity, which facilitates the penetration of mineral components into the tooth enamel, increases resistance to the caries and other diseases.

4. Results and Discussion

It is known from literature that tooth development is carried out by external and internal factors, out which of the great importance are endocrine process disorders, which include thyroid dysfunctions. Hormonal effects, acting in the teeth development process, carry out teeth normal division, migration, and cell differentiation. Any disorder in the neuroendocrine system leads to the complete imbalance of the mouth tissues. Therefore, study of thyroid function in norm and pathologies is most important. Nowadays, thyroid function in this age group is less studied in dentistry. Therefore, coverage of this issue in this aspect is very interesting and topical, since study of the periodontal condition in people on the background of hypothyroidism reveals prevalence of chronic catarrhal, and more rarely hypertrophic gingivitis. From literature it is known that increased synthesis of thyroxin, especially in the given age years, causes intensification of the proliferative processes and further hypertrophic gingivitis.

We hope that such an analysis identified the profile that strongly correlates with the dominant profile i.e. the thyroid gland functions. After detecting the caries in given population. we must determine causes of dental caries through identification and study of thyroid function with further treatment of dental caries. Due to the necessity of studying above parameters, we set the following scheme for the experiment: for this purpose, there were selected the following:

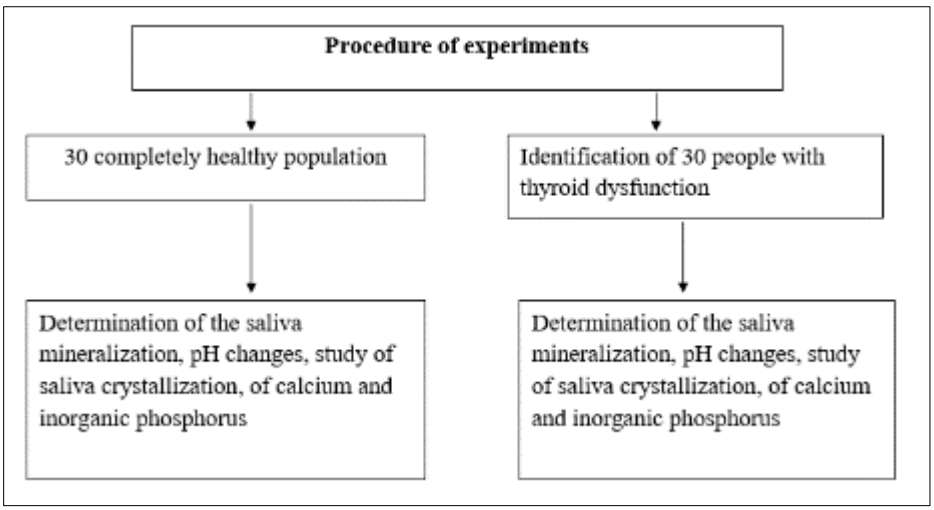

Figure 1 Procedure of experiments

Selection of endocrine drugs by the endocrinologist and recovering the thyroid function by treatment, conducting the above-mentioned studies for thyroid dysfunction and after treatment of the thyroid dysfunction and their comparison with the data of healthy population mouth cavities and determining the dental status.

Table 1 List of tasks by periods

#	**Name of a task**	**Estimated time of task performance by months**
1	Selection of completely healthy patients of (25-35) years of age	1-3
2	Selection of patients of (25-35) years of age with thyroid gland dysfunction	4-5
3	Determination of saliva mineralization and pH-changes in healthy patients	6-12
4	Determination of saliva mineralization and pH-changes in patients with thyroid dysfunction	11-14
5	Determination of calcium and inorganic phosphorus in the saliva of healthy patients	15-18
6.	Determination of calcium and inorganic phosphorus in the saliva of patients with thyroid dysfunction	17
7.	Purchase of reagents	18
8	Data statistical processing, analysis, preparation of articles for publications and presentation at the conference, preparation of the presentation day.	19-21
9.	Determination of the crystallization of saliva in healthy patients	22-26
10	Determination of the crystallization of saliva in population with thyroid dysfunction	26-29
11	Trip to the conference	29-31
12	Identification of the dental status and the profile that strongly correlates with the dominant profile i.e. the thyroid gland functions.	32-34
13	Data statistical processing, analysis, preparation of articles for publications and presentation at the conference, preparation of the presentation day.	36-38

4.1. The expected results of the study and their significance for research scientific direction/directions.

The final results of the performed work may be the following

- The thyroid dysfunction was identified in patients, and the ways for its management developed.
- The critical systems in thyroid dysfunction were specified and the primary mechanisms affecting this risk - factor outlined.
- Effects of thyroid dysfunction on saliva mineralization potential, its viscosity, salivation speed and tooth enamel resistance and pH changes were determined.
- Changing of the saliva chemical components in thyroid dysfunction were determined and risks for caries formation identified.
- Saliva crystallization changes in thyroid hormone dysfunction and their relation with calcium and phosphorus metabolism were identified and the ways for its treatment planned.
- The prognostic criteria for short- and long-term effects in people thyroid dysfunction were developed.

Comprehensive guidelines for acute and long-term risk assessment in thyroid dysfunction were published based on generalization of this material, theoretical preconditions for application of the developed criteria were developed for examination of patients in high-risk group and resolution of other similar tasks.

We expect to find that thyroid dysfunction, particularly hypothyroidism, leads to impaired mineralization processes in the oral cavity. This could result in lower enamel resistance to caries and higher caries prevalence. Additionally, we

anticipate identifying significant differences in the saliva crystallization patterns and mineral content between the thyroid dysfunction and healthy groups.

Recent studies (Santos et al., 2021; Gökdemir et al., 2022) support our hypothesis that thyroid hormone imbalances lead to disrupted oral health, with a marked increase in caries risk in hypothyroid patients. These findings align with earlier work by Khambhati et al. (2023), who noted that thyroid dysfunction significantly impacts oral health outcomes in adults.

5. Conclusion

The current study aims to provide a comprehensive analysis of how thyroid dysfunction affects oral health, particularly in terms of caries risk and mineralization processes. By examining the influence of thyroid hormones on saliva composition, enamel resistance, and caries prevalence, we hope to contribute to better diagnostic and therapeutic strategies for managing dental health in patients with thyroid disorders. The results may also provide insights into the broader implications of endocrine disorders on oral health in adults.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict-of-interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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