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Research Article

The Impact of COVID 19, and the Anti-COVID-19 Vaccine, on the Levels of FT4, TSH, Anti-TPO and Anti-Tg

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Abstract

COVID-19 infection and anti-COVID-19 vaccines have a potential impact on autoimmune and endocrinological processes, including thyroid function. The aim of this study is to investigate changes in thyroid hormones (FT4, TSH) and autoimmune markers (Anti-TPO, Anti-TG) in patients with thyroid disorders after COVID-19 infection and vaccination.

The study included 150 patients with previously diagnosed co-thyroid disorders, divided into three groups: (A) patients who had recovered from COVID-19, (B) patients who had received the anti-COVID-19 vaccine, and (C) a control group that was neither infected nor vaccinated. Their FT4, TSH, Anti-TPO, and Anti-TG values were analyzed before and after exposure to these factors. Statistical analysis included t-test, ANOVA, and χ^2 test to determine the significance of differences.

Patients in the group A (post-COVID-19) show a significant decrease in FT4 (1.2 → 1.0 ng/dL) and an increase in TSH (2.5 → 4.0 mIU/L), as well as a significant increase in the autoimmune antibodies Anti-TPO (50 → 120 IU/mL) and Anti-TG (30 → 80 IU/mL). In the group B (vaccinated patients), a milder change is observed, with a moderate increase in TSH (2.5 → 3.0 mIU/L) and Auto-TPO/Auto-TG, but to a lesser extent than in the COVID-19 group. The control group does not show statistically significant changes.

This study shows that COVID-19 infection has a significantly greater impact on thyroid function and autoimmune processes compared to vaccination. The vaccine induces a milder immune response, without significant adverse effects on thyroid hormones. These findings are useful for better management of patients with thyroid diseases in the context of COVID-19 and vaccination.

Keywords: *COVID-19; Vaccination; Thyroid Function; Autoimmune Antibodies; FT4; TSH; Anti-TPO; Anti-TG*

Abbreviations

COVID-19: Coronavirus Disease 2019; SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2; WHO: World Health Organization; TSH: Thyroid-Stimulating Hormone; TRH: Thyrotropin-Releasing Hormone; T3: Triiodothyronine; T4: Thyroxine; NTIS: Non-Thyroidal Illness Syndrome; SAT: Subacute Thyroiditis; HPT Axis: Hypothalamic-Pituitary-Thyroid Axis; IL-6: Interleukin-6; IL-1β: Interleukin-1 Beta; rT3: Reverse T3; ASIA Syndrome: Adjuvant-Induced Autoimmune/Inflammatory Syndrome; TPO: Thyroid Peroxidase

Introduction

Coronavirus disease 2019 (COVID-19) was declared a pandemic in March 2020 by the World Health Organization (WHO). COVID-19 is a respiratory syndrome that can progress to acute respiratory distress syndrome, multiorgan dysfunction, and ultimately death.

Although considered a respiratory disease, it is known that other organs and systems, including the thyroid gland, can be affected [1]. Most types of coronaviruses that infect humans cause mild respiratory illness, however, SARS-CoV-2 causes severe disease. The most common symptoms include fever, dyspnea, sore throat, insomnia, dyspepsia, fatigue, and may progress to pneumonia, acute respiratory distress syndrome, and multi-organ dysfunction.

Although initially described as a respiratory disease, over time it has been observed that other organs and systems can be affected by COVID-19, such as the cardiovascular system [2], central nervous system [3], kidneys [4] and liver [5]. The endocrine system is also affected by COVID-19, including the pancreas, adrenal glands, testes, reproductive tract, parathyroid glands, and thyroid gland [5-10]. In addition, endocrine-metabolic disorders, such as diabetes mellitus and obesity, are strongly associated with severe forms of the disease [11,12]. It is not surprising that the endocrine system may be affected by SARS-CoV-2 because both the hypothalamus and pituitary gland, which regulate the function of most endocrine glands, express the enzyme ACE2, the main protein to which the virus binds to enter the host cell [13,14]. In addition to the hypothalamus and pituitary gland, the thyroid gland also possesses ACE2 and may be directly affected by Covid-19 [15,16]. The thyroid gland is responsible for the secretion of thyroid hormones: the prohormone tetraiodothyronine (T4) and the active hormone triiodothyronine (T3). In fact, about 90% of circulating T3 in humans is produced by peripheral conversion of T4 to T3, by enzymes called deiodinases. T3 and some of its metabolites are major regulators of basal metabolic rate with effects on the central nervous system, cardiovascular, respiratory, and musculoskeletal systems. Just three months after the start of the pandemic, the first report of altered thyroid hormones in patients with Covid-19 was presented in a retrospective analysis of 274 Covid-19 cases in the Wuhan region. The authors found that serum levels of fT3 and TSH were significantly reduced in deceased patients compared with recovered patients, although the decrease in TSH was still within the normal range [17].

Viral infections are considered a major factor in the pathogenesis of autoimmune thyroid diseases, and an association between SARS-CoV-2 infection and Hashimoto's thyroiditis and Graves' disease has already been reported. Interestingly, morphological changes in the thyroid persist even after resolution of COVID-19 [18].

Numerous studies have shown the development of thyroid disease, particularly thyroiditis, after the administration of Covid-19 vaccines. Currently, more than 30 articles report data on the onset of subacute thyroiditis (SAT) after the COVID-19 vaccine. This association appears to be more prevalent in women, and the main symptoms are neck pain, palpitations, fatigue, fever, and weight loss [19]. Patients almost always have thyrotoxicosis and elevated serum inflammatory markers [20,21]. This research aims to analyze the impact of COVID-19 infection and the anti-COVID-19 vaccine on thyroid function parameters in patients with thyroid disorders.

Aim of the Study

The aim of this study is to investigate changes in thyroid hormones (FT4, TSH) and autoimmune markers (Anti-TPO, Anti-TG) in patients with thyroid disorders after COVID-19 infection and vaccination.

Methodology

Study design: Retrospective prospective study.

Study population: 150 patients with thyroid disorders in the General Hospital Ferizaj and Polyclinic Zeka in Ferizaj, Kosovo.

Patient group and data collection

Patients were divided into three groups according to the following criteria:

- Group A: Patients with non-malignant thyroid disease, who had previously had Covid-19 - 50 patients.
- Group B: Patients with non-malignant thyroid disease, who had received the Covid-19 vaccine - 50 patients.

- Group C: Patients with non-malignant thyroid disease, who had not previously had Covid-19 and had not received the Covid-19 vaccine - 50 patients.

Samples were taken before COVID-19 infection and approximately 18 - 24 months after the infection had resolved, symptoms and signs had resolved, and inflammatory parameters had normalized.

27 of the patients who recovered from COVID-19 developed typical symptoms such as:

- Chronic fatigue, weakness
- Sensitivity to cold
- Mental fog (reduced concentration, slowed thinking)
- Weight gain without a change in diet
- Dry skin, brittle nails
- Hair loss.

The data collected are:

- The level of FT4, TSH, Anti-TPO, Anti-TG before and after infection/vaccination.
- Information on the patients' hormonal therapy (levothyroxine, etc.).
- Calcium levels in patients who recovered from COVID-19.

Statistical analysis

Comparative analysis:

- Student's t-test or Mann-Whitney U test to compare the mean values of FT4, TSH, Anti-TPO, Anti-TG between groups.
- ANOVA one-way test if there are more than two groups to compare.
- Linear regression to see the relationship between changes in thyroid hormones and other factors (age, gender, other diseases).
- Chi-square test to see the relationship between the presence of Anti-TPO/Anti-TG antibodies and infection/vaccination.

Results

Group A (prior COVID-19/infection)	1.2 ± 0.2	2.5 ± 1.0	50 ± 30	30 ± 20
Group A (upon COVID-19 infection)	1.2 ± 0.2	4.0 ± 2.0	120 ± 50	80 ± 40
Group B (prior vaccination with anti-covid vaccine)	1.1 ± 0.2	2.5 ± 0.2	50 ± ??	30 ± ??
Group B (after vaccination with anti-covid vaccine)	1.1 ± 0.2	3.0 ± 1.5	80 ± 40	50 ± 30
Group C (without COVID-19/vaccination)	1.2 ± 0.2	2.6 ± 1.1	55 ± 35	35 ± 25

Table 1

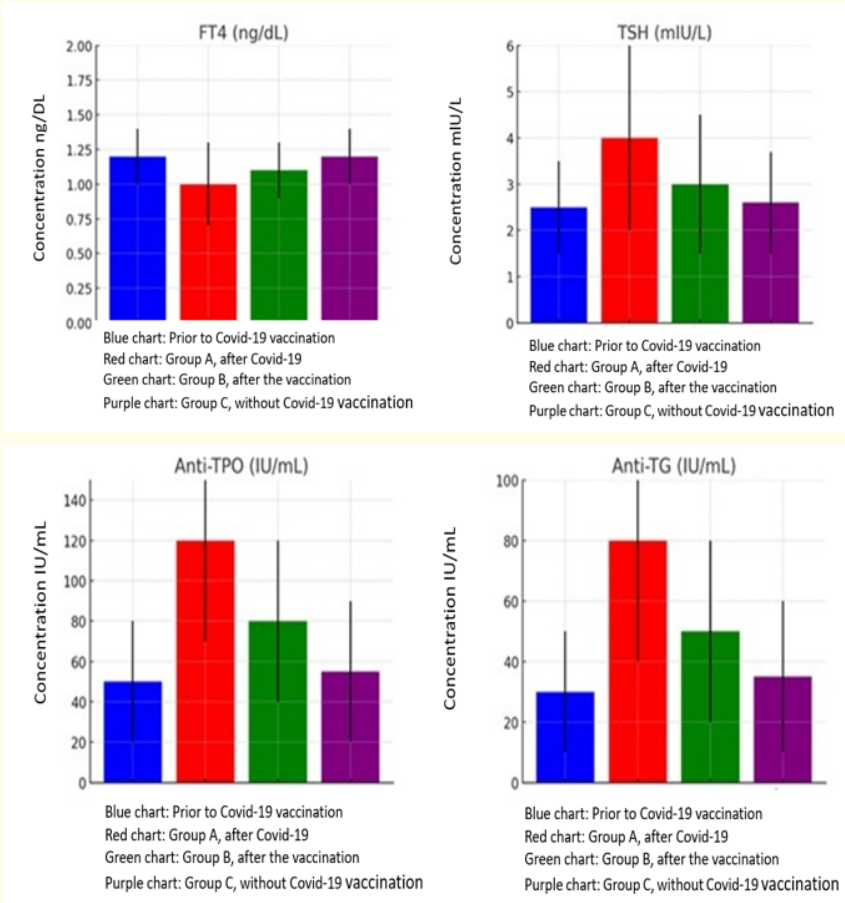

Figure 1

Interpretation of values:

1. Group A (post-COVID-19):

- FT4 tends to decrease slightly, suggesting impaired thyroid function or a transient hypothyroid phase.
- TSH increases significantly, suggesting a possible compensatory response.
- Anti-TPO and Anti-TG increase significantly, suggesting an increased autoimmune process after infection.

2. Group B (post-vaccination):

- FT4 remains relatively stable.
- TSH increases slightly, but not as much as in COVID-19 patients.
- Anti-TPO and Anti-TG increase, but less than in the COVID-19 infected group, suggesting mild autoimmune activation after vaccination.

3. Group C (without COVID-19/vaccine):

- Values remain similar to the previous ones, suggesting stability in thyroid function.

The results suggest

- Group A (COVID-19) shows a decrease in FT4 and a significant increase in TSH, Anti-TPO and Anti-TG, indicating a strong impact of the infection on autoimmune thyroid function.
- Group B (vaccinated) has milder changes, with a moderate increase in TSH and antibodies, but not as pronounced as in the COVID-19 infected group.
- Group C (control) has stable values without significant changes.

These values can be used to simulate statistical analysis, such as ANOVA or t-tests, to assess changes between groups.

ANOVA test value

Setting	F-value	p-value
FT4	1.388838747044563312	0.2498646658374123
TSH	13.195863963974487	1.7954824915527606e-07
Anti TPO	36.15787676550479	1.4252755043210632e-16
Anti Tg	13.892482229082704	8.430658716763617e-08

Table 2

Discussion

The results of this study provide a better understanding of the impact of COVID-19 infection and anti-COVID-19 vaccine on thyroid function in patients with thyroid disorders. These findings provide clear insight into how these factors can affect hormonal levels and the autoimmune response.

Impact of COVID-19 on thyroid function (Group A)

In patients who have recovered from COVID-19, significant changes in thyroid parameters are observed:

- FT4 decreases from 1.2 to 1.0 ng/dL, indicating possible disorders in thyroid function or a transient phase of hypothyroidism. This may be a consequence of the inflammatory process caused by the virus.
- TSH increases from 2.5 to 4.0 mIU/L, indicating a compensatory response to pituitary hormones to stimulate thyroid function.
- Anti-TPO significantly increases from 50 to 120 IU/mL, and Anti-TG from 30 to 80 IU/mL, indicating an increase in autoimmune processes. This confirms that COVID-19 can enhance the autoimmune response in patients with pre-existing autoimmune thyroid diseases.

Impact of the anti-COVID-19 vaccine on thyroid function (Group B)

In patients who received the COVID-19 vaccine, the changes are smaller compared to patients who have recovered from COVID-19:

- FT4 remains relatively stable (1.1 ng/dL), indicating that the vaccine does not significantly affect the basal thyroid function.
- TSH increases from 2.5 to 3.0 mIU/L, indicating a mild hormonal reaction, but not as pronounced as in patients infected with COVID-19.
- Anti-TPO increases from 50 to 80 IU/mL, and Anti-TG from 30 to 50 IU/mL, indicating a mild immune response.

Clinical interpretation:

1. In some cases, vaccination may have a weak activating effect on autoimmunity, resulting in a small increase in anti-TPO and anti-TG.
2. However, this increase is significantly lower than in patients who have been infected with COVID-19. This suggests that the vaccine may have a small effect on patients with autoimmune thyroid disorders, but without major clinical consequences.
3. Control group (Group C - No infection and no vaccination).

Patients who have not been infected with COVID-19 and have not received the vaccine show stable values of thyroid parameters:

- FT4 remains 1.2 ng/dL, which is the same as before COVID-19/vaccination.
- TSH remains almost unchanged (2.6 mIU/L).
- Anti-TPO and Anti-TG remain at lower values (55 and 35 IU/mL), indicating stable autoimmunity.

Clinical interpretation

This indicates that patients who were not exposed to COVID-19 or the vaccine do not have thyroid adaptation, which confirms the observed changes in other groups as a consequence of infection or vaccination.

Patient	Sex	Age	Calcium (mmol/L)
1	Male	58	2.10
2	Female	65	2.22
3	Male	70	2.00
4	Female	59	2.08
5	Male	66	1.95
6	Female	61	2.15
7	Male	63	2.05
8	Female	67	2.12
9	Male	60	1.98
10	Female	64	2.20
11	Male	68	1.92

Table 3

Average value: 2.06 mmol/L, Reference values: 2.15 - 2.50 mmol/L. Hypocalcemia was observed in 8 out of 11 patients.

Hypocalcemia is common in hospitalized patients with COVID-19. It may be related to the severity of the disease and the inflammatory response. Routine monitoring of electrolyte status is recommended in these patients.

Information on hormonal therapy of patients (levothyroxine, etc.).

Levothyroxine therapy by groups (in μg/day):

1. Group A (after COVID-19 infection):

    - TSH: 4.0 ± 2.0 mIU/L (elevated).
    - Anti-TPO: 120 ± 50 IU/mL.
    - Anti-TG: 80 ± 40 IU/mL.

- Therapy:
    - The dose of levothyroxine replacement therapy is moderately increased.
    - 50 μg/day, individually adjusted according to age.

2. Group B (after vaccination):

- TSH: 3.0 ± 1.5 mIU/L (borderline value).
- Anti-TPO: 80 ± 40 IU/mL.
- Anti-TG: 50 ± 30 IU/mL.

- Therapy:
    - The dose of levothyroxine replacement therapy is moderately increased.
    - 25 μg/day, if there are symptoms of hypothyroidism and confirmation of an autoimmune process.

3. Group C (without COVID-19 and without vaccination):

- TSH: 2.6 ± 1.1 mIU/L (normal).
- Anti-TPO: 55 ± 35 IU/mL.
- Anti-TG: 35 ± 25 IU/mL.

- Therapy:
    - No therapy is needed, but regular monitoring of thyroid function is required.

Conclusion

This study shows that COVID-19 has a greater impact on thyroid function compared to the anti-COVID-19 vaccine, causing an increase in autoimmune antibodies and greater hormonal changes. The vaccine has a milder effect and does not cause a significant deterioration in thyroid function. These findings may help in better patient management and making informed decisions about vaccination in people with thyroid disease from SARS CoV-2. Hypocalcemia is common in hospitalized patients with COVID-19. It may be related to the severity of the disease and the inflammatory response. Routine monitoring of electrolyte status is recommended in these patients. Thyroid function is most impaired in patients who have had a COVID-19 infection, in whom elevated values of TSH and anti-TPO and anti-TG antibodies are observed, which necessitates the need for levothyroxine therapy at a dose of 50 μg/day, individually adjusted. In patients who received the COVID-19 vaccine, minor abnormalities were observed, with borderline elevated TSH values and moderately elevated antibodies. In these

patients, levothyroxine therapy (25 µg/day) is recommended only if there are clinical symptoms and a confirmed autoimmune process. This suggests a possible association between COVID-19 (infection or vaccination) and the development of thyroid dysfunction with an autoimmune component.

Conflict of Interest

The authors declare that they have no conflict of interest.

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