

PATTERN OF SERUM CORTISOL LEVELS IN DIFFERENT THYROID DISORDERS

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**ABSTRACT****Introduction:** Thyroid disorders are now common endocrinological issues with an ample number of cases with the most abundant cases of hypothyroidism. Serum cortisol levels have been found to be deranged in cases of thyroid disorders. The thyroid disorders have impact on adrenals glands that produces cortisol. In hypothyroidism, high cortisol results in increase cortisol half-life and also decrease of metabolic clearance. However, control mechanisms often allow normal cortisol values. This study was carried out with an aim to evaluate the serum cortisol in different thyroid disorders and to correlate the relation of serum cortisol with thyroid hormones.**Materials and methods:** This hospital based cross sectional descriptive study was carried out in a tertiary care center of Madesh province, National Medical College Teaching Hospital in a time frame for six month from September 2022 to February 2023. A total of 300 samples were enrolled in the study (100 hyperthyroid, 100 hypothyroid and 100 euthyroid as control) after taking a well informed written consent and prior ethical clearance. The thyroid function test and serum cortisol was estimated and data were put in Microsoft excel 2010 and analyzed using SPSS version 22.**Results:** This study showed that there was highly significant difference in the highest level of sensory block achieved between the two groups ($p < 0.001$) and motor blockade. Most of patients receiving bupivacaine alone (Group B) had achieved T6 dermatomal sensory level block and Bromage score of 4, while patients receiving fentanyl with bupivacaine (Group F) achieved T8 and also Bromage score of 3 respectively. The mean duration for highest sensory level in group F and group B was 7.76 and 9.66 minutes, respectively. The mean duration for 2 segment regression in group F and group B was 95.28 and 67.24 minutes respectively. Hypotension was significantly high in Group B.**Conclusion:** The study concluded that serum cortisol level is elevated in cases of hypothyroidism, particularly in frank primary hypothyroidism. However, the mean cortisol levels were found to be normal in other thyroid disorders.**Keywords:** Euthyroid, Hyperthyroidism, Hypothyroidism, Serum Cortisol**INTRODUCTION**

The thyroid hormones that are thyroxine (T₄) and triiodothyronine (T₃), together have an important role in basal metabolism and the functioning of almost all tissues and systems in the body.¹ There is a highly sensitive and strict negative feedback loop that maintains the thyroid stimulating hormone (TSH) secreted from pituitary gland within a relatively narrow limit. TSH stimulates the synthesis and release of thyroid hormones from the thyroid gland, that in turn negatively feedback the hypothalamus and anterior pituitary gland to limit further TSH release. The reduced thyroid hormone levels existing together with elevated TSH are an indication

that the response of the thyroid gland to TSH is impaired, i.e. primary hypothyroidism. Similarly, increased level of thyroid hormones with reduced TSH is an indication that the response of thyroid gland to TSH is impaired, i.e. primary hyperthyroidism.

However, at present context attention has been given to subclinical hypothyroidism and hyperthyroidism. TSH elevation with normal T₃ and T₄ levels has been categorized as subclinical hypothyroidism. And reduced TSH with normal T₃ and T₄ has been termed as subclinical hyperthyroidism. Among all the thyroid disorders,

subclinical hypothyroidism is most common; two large population-based studies revealed that 4% to 8.5% of individuals without known thyroid disease actually have subclinical hypothyroidism as evidenced by a mildly elevated TSH (i.e., 4.5-10 uIU/L).^{2,3}

Complicating matters is the current controversy about the proper lower limit of TSH that defines patients in the subclinical hypothyroidism range (in other words, the upper limit of the normal reference range for TSH).⁴⁻⁸

Serum cortisol levels have been found to be deranged in cases of thyroid disorders. The thyroid disorders have impact on adrenals glands that produces cortisol. In hyperthyroidism, thyroid hormone stimulates production of 11 ceto-metabolites biologically inactive, unable to slow pituitary activity, inducing an increased production of endogenous cortisol. Excessive catabolism may lead to the exhausting of over stimulated adrenal glands, and therefore to a decreased cortisol. In hypothyroidism, high cortisol results in increase cortisol half-life and also decrease of metabolic clearance. However, control mechanisms often allow normal cortisol values. These alterations in functional and secretory activity of adrenal glands, seen in nearly 10% of these subjects, sometimes command a specific attitude in diagnosis and therapy. Analysis of thyroid hormones and cortisol were performed in 108 subjects, with thyroid diseases.

The aim of the study is to evaluate the level of serum cortisol in different thyroid disorders and correlate the pattern of cortisol with different thyroid disorders. Limited research has been done in the relationship between thyroid hormone and cortisol level so far, at least in our set up in Nepal. Finding out the fact that cortisol levels is highly affected by thyroid disorder can imply an understanding of adrenal hormones and its management.

MATERIALS AND METHODS

This hospital based cross sectional descriptive study was carried out in a tertiary care center of Madesh province, National Medical College Teaching Hospital in a time frame for six month from September 2022 to February 2023. A total of 300 samples were enrolled in the study (100 hyperthyroid, 100 hypothyroid and 100 euthyroid as control) after taking a well informed written consent and prior ethical clearance from Institutional Review Committee (IRC), National Medical College Teaching Hospital, Birgunj, Nepal (Ref).

Inclusion Criteria:

1. Patients attending Endocrinology OPD and wards
2. Age group between 20 to 60 years old

3. Those participants who are willing to participate in our study
4. Nepalese citizen

Exclusion Criteria

1. The patients of renal failure
2. Patient having any diagnosed cases of benign and malignant tumors
3. Age group below 20 and above 60 years
4. The patients who will not be willing to participate in the study.

The blood sample for the serum cortisol estimation was taking properly using the aseptic method and test was analyzed in Beckman Coulter Access 2 automated immunoassay analyzer following a standard operation guideline from IFCC. The normal reference range for the serum cortisol level at 8 AM was taken as 8.7 – 22.4 µg/dL. Similarly, for TSH 0.34 – 5.6 µIU/mL, fT3 2.5- 3.9 pg/mL and fT4 0.61 – 1.12 ng/dL (as mentioned in the analyzers standard operating test brochure).

Statistical Analyses

All the data were entered in the Microsoft Excel 2010, converted to SPSS version 22 accordingly. Frequency and percentage were calculated for descriptive statistics. Chi square test was applied to compare the categorical variables. The numerical data were expressed in the mean and standard deviation or median and interquartile ranges depending on their distribution. P value <0.05 will be considered as statistical significant.

RESULTS

Among the total of 300 participants in this study, majority of them were female (n=236, 78.7%). The distribution of the participants as per the gender is shown in figure 1. The mean age of the euthyroid participants was 28.63 ± 10 years. The mean age were 53.16 ± 17.18 years, 28.37 ± 8.8 years, 52.10 ± 15.94 years and 32.98 ± 14.18 years for primary hyperthyroidism, primary hypothyroidism, subclinical hyperthyroidism and subclinical hypothyroidism, respectively.

Figure 1: Distribution of population based on gender (n=300)

Of the total participants having the thyroid disorders, majority were of subclinical hypothyroidism 27% (n=81), followed by subclinical hyperthyroidism (n=63, 21%).

The details of the distribution of participants based on thyroid function test are as shown in table 1.

Table 1: Distribution of population based on the thyroid function status (n=300)

Thyroid function status	Frequency	Percent
Euthyroid	100	33.3
Primary hyperthyroidism	37	12.3
Primary hypothyroidism	19	6.3
Subclinical hyperthyroidism	63	21.0
Subclinical hypothyroidism	81	27.0
Total	300	100.0

The mean level for the TSH, fT3 and fT4 for thyroid function status for different thyroid status is as shown in the table 2. The serum cortisol level in different thyroid disorders showed a different picture, particularly in the cases of primary hypothyroidism. The mean serum cortisol levels in the euthyroid, primary hyperthyroidism, subclinical hyperthyroidism and subclinical hypothyroidism were found to be within normal reference range. However, the mean serum cortisol level in cases of frank primary hypothyroidism was $38.54 \pm 15.54 \mu\text{g/dL}$, that is a high cortisol level.

Table 2: Comparison of variables between different study groups (n=300)

Variables	Categories	N	Mean	SD	P value*
fT3 (pg/mL)	Euthyroid	100	3.15	0.34	0.00
	Primary hyperthyroidism	37	5.19	0.88	
	Primary hypothyroidism	19	1.99	0.35	
	Subclinical hyperthyroidism	63	3.54	0.20	
	Subclinical hypothyroidism	81	3.07	0.36	
fT4(ng/dL)	Euthyroid	100	0.90	0.30	0.00
	Primary hyperthyroidism	37	2.01	0.41	
	Primary hypothyroidism	19	0.44	0.11	
	Subclinical hyperthyroidism	63	0.95	0.09	
	Subclinical hypothyroidism	81	0.79	0.11	
TSH ($\mu\text{IU/mL}$)	Euthyroid	100	3.45	1.19	0.00
	Primary hyperthyroidism	37	0.13	0.10	
	Primary hypothyroidism	19	41.85	26.00	
	Subclinical hyperthyroidism	63	0.13	0.10	
	Subclinical hypothyroidism	81	12.11	3.50	
Cortisol ($\mu\text{g/dL}$)	Euthyroid	100	12.86	2.34	0.00
	Primary hyperthyroidism	37	13.32	5.38	
	Primary hypothyroidism	19	38.54	15.54	
	Subclinical hyperthyroidism	63	13.80	5.83	
	Subclinical hypothyroidism	81	14.09	2.71	

The correlation between the serum cortisol level with the different thyroid related hormones is as shown in the table 3.

Table 3: Correlation of serum cortisol level with TFT Parameters (n=300)

S.No.	Variables	Correlation coefficient (r)	P value
1	Age	-0.10	0.07
2	fT3	-0.34	0.00*
3	fT4	-0.24	0.00*
4	TSH	0.78	0.00*

The results demonstrated a statistically significant correlation between serum cortisol levels and markers of thyroid dysfunction, particularly TSH and T4 levels. Notably, a positive correlation between serum cortisol and TSH was observed.

DISCUSSION

This hospital based cross sectional descriptive study carried out for a period of 6 months in National Medical College Teaching Hospital Birgunj, enrolled 300 participants (100 euthyroid, 100 hypothyroid and 100 hyperthyroid subjects). The thyroid function status was evaluated with the serum cortisol levels in different thyroid disorders. Majority of the participants were female (n=236, 78.7%). The mean age of the euthyroid participants was 28.63 ± 10 years. The mean age were 53.16 ± 17.18 years, 28.37 ± 8.8 years, 52.10 ± 15.94 years and 32.98 ± 14.18 years for primary hyperthyroidism, primary hypothyroidism, subclinical hyperthyroidism and subclinical hypothyroidism, respectively. The mean serum cortisol levels in the euthyroid, primary hyperthyroidism, subclinical hyperthyroidism and subclinical hypothyroidism were found to be within normal reference range. However, the mean serum cortisol level in cases of frank primary hypothyroidism was $38.54 \pm 15.54 \mu\text{g/dL}$, a high cortisol level.

Analysis of thyroid hormones and cortisol were performed in 108 subjects in a study in 2000, with thyroid diseases. The results showed low cortisol values (80.35 nmol/L) in 4.77% of hyperthyroid, high values in 3.57% of hyperthyroid (1348.18 nmol/L) and 12.5% of hypothyroid (969.05 nmol/L).⁹ The total result do not tally with the findings of this study, however the high cortisol levels in a majority of the hypothyroid cases can be justified with the above results.

A study done in 2023 in India that included 65 hypothyroid cases (56 females, 9 males) and 65 euthyroid controls have a similar finding. Serum cortisol showed a significant correlation with thyroid related hormones. Linear regression represented a negative correlation between serum T4 and T3 levels and serum cortisol in hypothyroidism. However, TSH and cortisol showed a positive correlation.¹⁰ These findings align with the results of our study, suggesting potential regulatory mechanisms and compensatory responses in hypothyroid patients.

Cortisol levels were elevated in hypothyroid individuals in the certain other studies, and there was a positive association between TSH and cortisol, which is consistent with the findings of a previous similar study by Ali and Dhelal.^{10,11}

The study's results focuses in the fact that there is a complex interaction between cortisol and thyroid function, suggesting a direct relationship between serum cortisol and TSH levels in hypothyroidism. Patients with frank primary hypothyroidism exhibited elevated cortisol concentrations, indicating a potential compensatory mechanism initiated by the HPA axis. Integrating serum cortisol assessment with the results of thyroid function tests could offer comprehensive insights into hypothyroidism severity and progression, providing a more holistic approach to patient care.

CONCLUSION

The study concluded that serum cortisol level is elevated in cases of hypothyroidism, particularly in frank primary hypothyroidism. However, the mean cortisol levels were found to be normal in other thyroid disorders. The result of the study emphasizes the fact that thyroid hormones have a role in the secretion and functioning of the cortisol levels in the human body. The further more elaborative study needs to be carried out to outline and establish the frank relation of the thyroid hormones and cortisol levels in the body.

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REFERENCES

- Boelaert K, Franklyn JA: Thyroid hormone in health and disease. *J Endocrinol* 2005, 187:1–15.
- Canaris GJ, Manowitz NR, Mayor G, Ridgway EC: The Colorado thyroid disease prevalence study. *Arch Intern Med* 2000, 160:526–534.
- Hollowell JG, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA, Braverman LE: Serum TSH, T-4, and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). *J Clin Endocrinol Metabol* 2002, 87:489–499.
- Demers LM, Spencer CA (Eds): *Laboratory Medicine Practice Guidelines: Laboratory Support for the Diagnosis and Monitoring of Thyroid Disease*. Washington, DC: National Academy of Clinical Biochemistry; 2002. www.nacb.org.
- Fatourechi V: Subclinical Hypothyroidism: An Update for Primary Care Physicians. *Mayo Clin Proc* 2009, 84:65–71.
- Spencer CA, Hollowell JG, Kazarosyan M, Braverman LE: National health and nutrition examination survey III thyroid-stimulating hormone (TSH)-thyroperoxidase antibody relationships demonstrate that TSH upper reference limits may be skewed by occult thyroid dysfunction. *J Clin Endocrinol Metabol* 2007, 92:4236–4240.
- Surks MI, Goswami G, Daniels GH: The thyrotropin reference range should remain unchanged. *J Clin Endocrinol Metabol* 2005, 90:5489–5496.
- Wartofsky L, Dickey RA: The evidence for a narrower thyrotropin reference range is compelling. *J Clin Endocrinol Metabol* 2005, 90:5483–5488.
- Seck-Gassama, Ndoeye O, Mbodj M, Akala A, Cisse F, Niang M, Ndoeye R. Variations de la cortisolémie au cours des dysthyroïdies [Serum cortisol level variations in thyroid diseases]. *Dakar Med*. 2000;45(1):30-3. French. PMID: 14666786.
- Sinha SR, Prakash P, Keshari JR, Kumari R, Prakash V. Assessment of Serum Cortisol Levels in Hypothyroidism Patients: A Cross-Sectional Study. *Cureus*. 2023 Dec 8;15(12):e50199. doi: 10.7759/cureus.50199. PMID: 38192949; PMCID: PMC10772313.
- The levels of cortisol, insulin, glucose and HBA1C in overt hypothyroid Iraqi patients. Ali SS, Dhelal AKJ. https://wjpr.net/abstract_file/2891 *World J Pharm Res*. 2015;4:493–502. [[Google Scholar](#)]
- Evaluation of serum cortisol levels in patients with hypothyroidism at a tertiary care hospital, Telangana, India: a case-control study. Yaamarthy V, Rani CJ, Hemamalini R, Ahmed MI. <https://doi.org/10.7860/JCDR/2023/59976.17588> *J Clin of Diagn Res*. 2023;17:3. [[Google Scholar](#)]