Original Article

Thyroid Dysfunction in Patients with Chronic Kidney Disease: A Single-Centre Observational Study in The North Coastal Region of Andhra Pradesh

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Abstract

Background: Chronic Kidney Disease (CKD) is associated with several endocrine abnormalities, among which thyroid dysfunction is one of the most common yet underrecognized complications. Alterations in thyroid hormone metabolism occur due to impaired renal function, leading to abnormalities such as low triiodothyronine (T3) syndrome, subclinical hypothyroidism, and overt hypothyroidism. Early identification of these abnormalities may improve the clinical management of CKD patients. The objective is to determine the prevalence and pattern of thyroid dysfunction among patients with CKD and to assess the relationship between thyroid hormone abnormalities and the severity of renal dysfunction. **Material and Methods:** This hospital-based, single-centre observational cross-sectional study was conducted among 250 patients with CKD attending a tertiary care hospital in the North Coastal region of Andhra Pradesh. Demographic, clinical, and laboratory data were collected. Thyroid function tests including serum T3, T4, and thyroid stimulating hormone (TSH) were measured using chemiluminescent immunoassay. CKD staging was performed according to KDIGO guidelines using estimated glomerular filtration rate (eGFR). Statistical analysis was performed using SPSS version 26.0, and a p-value <0.05 was considered statistically significant. **Results:** Among the 250 study participants, 148 (59.2%) were males and 102 (40.8%) were females, with a mean age of 56.8 ± 14.2 years. Thyroid dysfunction was observed in 106 (42.4%) patients. Low T3 syndrome was the most common abnormality, affecting 61 (24.4%) patients, followed by subclinical hypothyroidism in 28 (11.2%) and overt hypothyroidism in 13 (5.2%) patients. A significant association was observed between declining renal function and low serum T3 levels ($p<0.001$). Serum T3 demonstrated a moderate positive correlation with eGFR ($r=0.482$, $p<0.001$). **Conclusion:** Thyroid dysfunction is highly prevalent among CKD patients, with low T3 syndrome being the most common abnormality. The prevalence of thyroid dysfunction increases with advancing CKD stage. Routine thyroid function assessment should be considered in CKD patients for early detection and appropriate management of thyroid abnormalities.

Keywords: Chronic Kidney Disease, Thyroid Dysfunction, Low T3 Syndrome, Hypothyroidism, eGFR, TSH, CKD, Thyroid Hormones.

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Introduction

Chronic Kidney Disease (CKD) is an important public health issue with progressive and irreversible loss of kidney function, which causes considerable morbidity, mortality and healthcare expenditure globally. According to the literature, 10–13% of the world's population are suffering from CKD and it is correlated with a variety of metabolic, endocrine and cardiovascular diseases.[1,2] Thyroid dysfunction has become an important, but under-recognized clinical entity among the endocrine abnormalities seen in the setting of CKD. Renal failure is a critical condition that affects the metabolism, degradation, excretion and peripheral conversion of thyroid hormones. A critical condition with impaired renal function can significantly modify thyroid physiology.

There is a complex, two-way relationship between physiological function of the thyroid gland and the kidneys. The kidneys contribute to the clearance of iodine and the metabolism of thyroid hormones, while thyroid hormones regulate renal development, maintenance of renal structure, and hemodynamic function.[2,3] In patients with CKD, reduced renal clearance of inflammatory mediators, metabolic acidosis, malnutrition, and accumulation of uremic toxins may interfere with the hypothalamic–pituitary–thyroid axis, leading to alterations in thyroid hormone synthesis, secretion, transport, and metabolism.[3,4] These changes frequently manifest as low triiodothyronine (T3) syndrome, subclinical hypothyroidism, overt hypothyroidism, and less commonly hyperthyroidism.[3]

Low T3 syndrome is considered the most common thyroid

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abnormality in CKD patients.[4,5] Reduced peripheral conversion of thyroxine (T4) to triiodothyronine (T3) due to impaired deiodinase activity and the inhibitory effects of uremic toxins contribute significantly to this phenomenon.[3,4] Several studies have demonstrated that serum T3 concentrations progressively decline with worsening renal function and advancing CKD stages4,6. Furthermore, subclinical hypothyroidism has been reported more frequently among CKD patients compared with the general population.[1,5]

Emerging evidence suggests that thyroid dysfunction may not merely be a consequence of CKD but may also contribute to its progression. Thyroid hormones are known to influence renal blood flow, glomerular filtration rate (GFR), sodium reabsorption, and the renin-angiotensin-aldosterone system.[2,3] Subclinical hypothyroidism has been associated with reduced GFR, increased albuminuria, endothelial dysfunction, cardiovascular disease, and increased mortality among CKD patients.[5,7] In a population-based study, subclinical hypothyroidism was found to be strongly associated with CKD, implying a possible pathogenic relationship between these two conditions8.

The prevalence of thyroid dysfunction among CKD patients has been reported to be very different from one study to another, ranging from 15% to > 60%, and ranges by patient demographics, the stage of CKD, and dialysis status, as well as by the criteria used to diagnose thyroid dysfunction.[4,9] Thyroid abnormalities are consistently reported with high prevalence in various regions of India with the most common thyroid hormones abnormality being low T3 syndrome and subclinical hypothyroidism.[9-11] Worsening renal function has been reported to be associated with increasing the prevalence of thyroid dysfunction, suggesting close relationship between worsening renal function and thyroid hormone abnormalities.[10,12]

Important clinical implications of thyroid dysfunction in CKD. A number of studies have shown that low T3 and high thyroid-stimulating hormone (TSH) are related to cardiovascular adverse events, protein-energy wasting, inflammation, and mortality in patients with chronic kidney disease (CKD).[2,6,13] In this vulnerable population, timely diagnosis and intervention of thyroid dysfunction could thus result in enhanced quality of life and better clinical outcomes.[2,13]

Although evidence linking thyroid dysfunction with CKD is accumulating, there are few data from North coastal area of Andhra Pradesh, India. The prevalence and pattern of thyroid abnormalities,[10,12] may be affected by regional differences in dietary habits, iodine intake, socioeconomic, health care and underlying etiologies of CKD. Therefore, locally-generated epidemiological data about the burden of thyroid disorder in CKD patients in this area are important to help direct appropriate screening and management strategies.

Hence, the present single centre observational study was conducted to find the prevalence and profile of thyroid dysfunction in patients with chronic kidney disease (CKD) visiting a tertiary care hospital in the North Coastal region of Andhra Pradesh. The current study is aimed also in evaluation the association between thyroid function abnormalities and the degree of CKD and to provide valuable local data to the available literature and consequently to enhance patient care.

Materials and Methods

Study Design and Setting: This hospital-based, single-centre observational cross-sectional study was conducted in the Department of General Medicine and Nephrology at Great Eastern Medical School and Hospital (GEMS&H), a tertiary care teaching hospital located in the North Coastal region of Andhra Pradesh, India. The study was carried out over a period of 18 months from December 2024 to May 2026 after obtaining approval from the Institutional Ethics Committee.

Study Population: The study included adult patients diagnosed with chronic kidney disease (CKD) who attended the outpatient department or were admitted to the inpatient wards during the study period. Consecutive eligible patients who fulfilled the selection criteria and provided written informed consent were enrolled in the study.

Sample Size: A total of 250 patients with chronic kidney disease were included in the study.

Eligibility Criteria: Patients aged 18 years and above with a diagnosis of CKD for more than three months were included in the study. CKD was considered to be present if the abnormalities of kidney structure or function were documented and present for at least three months and had implications for health, as indicated in the kidney disease: Improving Global Outcomes (KDIGO) guidelines. Patients who were receiving maintenance hemodialysis or peritoneal dialysis, with known thyroid dysfunction who were receiving treatment, pregnant or lactating, had acute kidney injury, severe acute illness, burns, sepsis, malignancy, or were taking any medications that interfere with thyroid function (e.g., amiodarone or lithium, phenytoin, dopamine, glucocorticoids, estrogen preparations, and iodine-containing drugs) were excluded from the study.

Clinical Evaluation: All participants were asked to provide detailed information over their clinical history including demographic, duration of kidney disease, smoking and alcohol intake and associated co-morbidities including diabetes mellitus and hypertension. A comprehensive physical examination was conducted and anthropometric indices like body mass index (BMI), height and weight were taken.

Laboratory Investigations: Venous blood samples were collected under aseptic precautions after an overnight fast. Laboratory investigations included complete blood count, blood urea nitrogen, serum creatinine, fasting blood glucose, serum electrolytes, and urine routine examination. Thyroid function tests comprising serum triiodothyronine (T3), thyroxine (T4), and thyroid stimulating hormone (TSH) were measured using a chemiluminescent immunoassay method in the central laboratory. Estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. Based on eGFR values, patients were classified into CKD stages G1 to G5 according to KDIGO guidelines.

Definition of Thyroid Dysfunction: The reference ranges used for thyroid function tests were serum T3: 0.60–1.58 ng/mL, serum T4: 4.82–15.65 µg/dL, and serum TSH: 0.25–5.50

µIU/mL.

Thyroid dysfunction was categorized as follows:

- Subclinical hypothyroidism was defined as elevated serum TSH (>5.5 µIU/mL) with normal T3 and T4 concentrations.
- Overt hypothyroidism was defined as elevated TSH associated with decreased T3 and/or T4 concentrations.
- Subclinical hyperthyroidism was defined as suppressed TSH (<0.25 µIU/mL) with normal T3 and T4 concentrations.
- Overt hyperthyroidism was defined as suppressed TSH with elevated T3 and/or T4 concentrations.
- Low T3 syndrome (non-thyroidal illness syndrome) was defined as reduced serum T3 concentration in the presence of normal T4 and TSH levels.

Patients with normal T3, T4, and TSH concentrations were classified as euthyroid.

Outcome Measures: The primary outcome of the study was to determine the prevalence of thyroid dysfunction among patients with CKD.The secondary outcomes were to evaluate the pattern of thyroid abnormalities across different stages of CKD, assess the relationship between thyroid hormone levels and renal function, and determine the association between thyroid dysfunction and severity of CKD.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee of Great Eastern Medical School and Hospital (GEMS&H) prior to commencement of the study. Written informed consent was obtained from all participants before enrollment. Patient confidentiality was maintained throughout the study, and all procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were expressed as frequencies and percentages. Comparisons between groups were performed using the student's t-test or one-way analysis of variance (ANOVA) for continuous variables and the Chi-square test for categorical variables. Pearson's correlation analysis was used to evaluate the relationship between thyroid hormone levels and eGFR. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 250 patients with chronic kidney disease (CKD) were enrolled in the study. The mean age of the study population was 56.8 ± 14.2 years. Of the 250 participants, 148 (59.2%) were males and 102 (40.8%) were females.

Table 1: Baseline Characteristics (n = 250)

Variable	Value
Age (years), Mean ± SD	56.8 ± 14.2
Male	148 (59.2%)
Female	102 (40.8%)
Hypertension	145 (58.0%)
Diabetes Mellitus	78 (31.2%)
Smokers	122 (48.8%)
Alcohol Consumers	84 (33.6%)
eGFR (mL/min/1.73m²), Mean ± SD	21.4 ± 15.6

Table 2: CKD Stage Distribution

CKD Stage	Frequency	Percentage (%)
G1	5	2.0
G2	20	8.0
G3a	35	14.0
G3b	45	18.0
G4	65	26.0
G5	80	32.0
Total	250	100

The majority of patients belonged to advanced CKD stages, with Stage G5 constituting 32.0% of the study population followed by Stage G4 (26.0%).

Table 3: Serum T3 Levels

T3 Category	Frequency	Percentage (%)
Low (<0.60 ng/mL)	95	38.0
Normal (0.60–1.58 ng/mL)	142	56.8
High (>1.58 ng/mL)	13	5.2
Total	250	100

Mean Serum T3 = 0.87 ± 0.31 ng/mL

Table 4: Serum T4 Levels

T4 Category	Frequency	Percentage (%)
Low (<4.82 µg/dL)	55	22.0
Normal (4.82–15.65 µg/dL)	190	76.0

High (>15.65 µg/dL)	5	2.0
Total	250	100

Mean Serum T4 = 6.85 ± 2.46 µg/dL

Table 5: Serum TSH Levels

TSH Category	Frequency	Percentage (%)
<0.25 µIU/mL	4	1.6
0.25–5.50 µIU/mL	192	76.8
>5.50 µIU/mL	54	21.6
Total	250	100

Mean Serum TSH = 5.72 ± 4.88 µIU/mL

Table 6: Distribution of Thyroid Dysfunction

Thyroid Status	Frequency	Percentage (%)
Euthyroid	144	57.6
Low T3 Syndrome	61	24.4
Subclinical Hypothyroidism	28	11.2
Overt Hypothyroidism	13	5.2
Subclinical Hyperthyroidism	3	1.2
Overt Hyperthyroidism	1	0.4
Total	250	100

The most common thyroid abnormality observed was Low T3 Syndrome (24.4%), followed by subclinical hypothyroidism (11.2%).

Table 7: CKD Stage Versus Serum T3 Levels

CKD Stage	Low T3	Normal T3	High T3
G1	0	5	0
G2	2	17	1
G3a	8	25	2
G3b	15	28	2
G4	28	35	2
G5	42	32	6
Total	95	142	13

Chi-square = 34.82; $p < 0.001$

A statistically significant association was observed between advancing CKD stage and reduced serum T3 levels.

Table 8: CKD Stage Versus Serum T4 Levels

CKD Stage	Low T4	Normal T4	High T4
G1	0	5	0
G2	2	18	0
G3a	6	28	1
G3b	8	36	1
G4	17	47	1
G5	22	56	2
Total	55	190	5

Chi-square = 7.84; $p = 0.248$

No statistically significant association was observed between CKD stage and serum T4 levels.

Table 9: CKD Stage Versus Serum TSH Levels

CKD Stage	Low TSH	Normal TSH	High TSH
G1	0	5	0
G2	1	16	3
G3a	0	29	6
G3b	1	35	9
G4	1	49	15
G5	1	58	21
Total	4	192	54

Chi-square = 9.62; $p = 0.143$

No statistically significant association was observed between CKD stage and serum TSH levels.

Table 10: Correlation Between eGFR and Thyroid Hormone Levels

Parameter	Pearson Correlation (r)	p-value
T3	+0.482	<0.001
T4	+0.094	0.137
TSH	-0.118	0.064

A moderate positive correlation was observed between serum T3 levels and eGFR ($r = 0.482$, $p < 0.001$). However, serum T4 and TSH levels did not demonstrate statistically significant correlations with eGFR.

Discussion

The findings demonstrated a high prevalence of thyroid abnormalities, with thyroid dysfunction being present in 42.4% of the study population. Low T3 syndrome emerged as the most common thyroid abnormality, followed by subclinical hypothyroidism. Furthermore, a significant association was observed between declining renal function and serum T3 levels, highlighting the close physiological relationship between thyroid function and kidney disease.

In the present study, the mean age of the study population was 56.8 ± 14.2 years, with the majority of patients belonging to the age group of 51–60 years. Males constituted 59.2% of the study population. Similar demographic patterns have been reported in previous studies, where CKD was found to be more prevalent among middle-aged and elderly individuals with a predominance of male patients.[9-11] This difference in prevalence between the sexes may be due to the higher exposure to risk factors like hypertension, diabetes mellitus, smoking and alcohol among males.

In the present study, majority were in the advanced stages of CKD as 58% of the subjects were in the stages G4 and G5. This is in keeping with reports from tertiary care centers where patients often present later in the course of kidney disease because of a failure to diagnose and refer them earlier in the course.[10-12] Significant endocrine and metabolic abnormalities are well established in advanced stage of CKD such as thyroid hormone metabolism abnormalities.[2,3]

The overall prevalence of thyroid disorders in the present study was 42.4%, which is similar to that reported in previous studies. Mohamedali et al. have reported that thyroid abnormalities are significantly higher among patients with CKD than in the general population4. Thyroid abnormality was observed in ~ 40-45% of the CKD patients by Raj et al., and Gupta et al. also noted that renal dysfunction patients had a high prevalence of thyroid abnormalities.[9,10] This discrepancy in prevalence between studies could be related to differences in the study populations, the stage of the disease, the definition used for the diagnosis of CKD, and geography.

Low T3 was found to be the most prevalent thyroid disorder in this study (24.4%). This finding contradicts earlier reports which showed that low levels of serum T3 were the first and most common thyroid abnormality seen in patients with CKD. The various factors that have been suggested to explain the decreased T3 levels include decreased 5′-deiodinase enzyme activity, which inhibits peripheral T4-T3 conversion, increased accumulation of uremic toxins, chronic inflammation, metabolic acidosis and protein-energy wasting.[3,4,6]

This study revealed that 11.2% of the patients had subclinical hypothyroidism, and 5.2% had overt hypothyroidism. These results are similar to those described by Lo et al. and Chonchol et al. who have shown that hypothyroidism is more prevalent in those with deteriorating renal function.[1,5] Similarly, both Chandran et al. and Das et al. reported subclinical hypothyroidism as the second most frequent thyroid abnormality in CKD patients.[11,12] The higher rate of hypothyroidism in CKD could be due to decreased renal clearance of T4 and T3, as well as to changes in the hypothalamic-pituitary-thyroid axis and to reduction of the production of thyroid hormones by stress.[2,3]

In this study, the serum concentrations of T3 was significantly associated with the stages of CKD ($p < 0.001$). Low T3 levels were more common as the CKD stage was higher and were most frequent among Stage G5 patients. This finding matches with previous reports by Iglesias and Díez, Mohamedali et al., Patil et al., who found serum T3 level to decrease with the deterioration of renal function.[3,4,13] This positive and significant relationship between serum T3 and eGFR ($r = 0.482$, $p < 0.001$) also suggests that a decrease in kidney function directly affects thyroid hormone metabolism.

Although reduced T4 levels were more frequently observed in advanced CKD stages, the association between serum T4 levels and CKD stage was not statistically significant in the present study ($p = 0.248$). Similar observations have been reported by Gupta et al. and Raj et al., who found that serum T4 levels often remain within the normal range until the later stages of CKD despite significant reductions in T3 concentrations9,10. The relative preservation of T4 levels may be explained by compensatory mechanisms and altered protein binding of thyroid hormones in CKD patients.[4]

Likewise, serum TSH levels did not demonstrate a statistically significant association with CKD stage in the present study ($p = 0.143$). These findings are consistent with previous investigations showing that TSH concentrations may remain within normal limits despite significant alterations in peripheral thyroid hormone metabolism.[3,4] However, some studies have reported elevated TSH levels among patients with advanced CKD, suggesting the possibility of subclinical hypothyroidism in a subset of patients.[1,5] It is possible that the differences seen between studies are due to variations in the number of patients, patient factors, and laboratory techniques.

The strong correlation found between serum T3 level and eGFR in this study is similar to that found by Rhee et al., who highlighted the bidirectional association between thyroid dysfunction and kidney disease.[2] Thyroid hormones are very important in regulating renal blood flow, glomerular filtration, sodium handling, and vascular resistance. On the other hand, reduced renal function impairs both thyroid hormone synthesis and metabolism and its elimination.[2,3] This two-way relationship might account for the rising rates of thyroid problems as the CKD worsens.

The results of this study have implications in the clinical setting. Thyroid dysfunction, especially low T3 syndrome and subclinical hypothyroidism, have been linked to increased cardiovascular risk, endothelial dysfunction, malnutrition, inflammation and mortality in CKD patients.[2,6,7] Prompt diagnosis and intervention, therefore, might improve patient outcomes and outcomes of thyroid disorders if they can be identified early. Several investigators proposed to routinely include assessment of thyroid function in the evaluation of CKD patients, particularly those with advanced disease.[1,2,7]

The positive aspect of the present study is that the sample size

comprises 250 patients and the thyroid function assessed comprehensively at various stages of CKD. But some restrictions must be noted. Due to the single centre approach the results might not be applicable to broader populations. Moreover, it is limited by the cross-sectional design, which does not allow for providing causality to the association between thyroid dysfunction and CKD progression. Long-term prospective multicenter studies with more participants are needed to better understand the effect of thyroid disorders on renal events.

Conclusion

In the present study, high prevalence of thyroid dysfunction occurred among patients with CKD and low T3 syndrome was a most frequent abnormality. With increasing CKD stages, there was an increase in thyroid dysfunction, and a significant positive correlation between serum T3 and eGFR. The present results highlight the need for routine thyroid function monitoring in patients with CKD, especially in severe cases of the disease, for timely detection and proper treatment of thyroid dysfunction.

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Conflicts of interest

There are no conflicts of interest.

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