RESEARCH PAPER

Evaluation Of Thyroid Function Alterations Across Different Stages Of Chronic Kidney Disease: A Cross-Sectional Study

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Abstract
Chronic kidney disease leads to endocrine disorders which include thyroid hormone changes that impact kidney blood flow and body functions and body fat levels. The researchers conducted a cross-sectional study to measure how thyroid function changed throughout the different stages of chronic kidney disease in 100 patients who received conservative treatment. The researchers used enzyme-linked immunosorbent assay to measure serum triiodothyronine and thyroxine and thyroid-stimulating hormone while they evaluated renal function through serum urea and serum creatinine and estimated glomerular filtration rate which they calculated using the CKD-EPI creatinine 2009 equation. The researchers also used estimated glomerular filtration rate to classify patients which allowed them to study how thyroid dysfunction progressed with worsening renal impairment. 55% of patients showed thyroid profile abnormalities. 41% of patients showed low T3 syndrome as their main metabolic change while 14% showed primary hypothyroidism. 55% of patients showed abnormal T3 results, 46% showed abnormal T4 results, and 14% showed abnormal TSH results. The association between thyroid profile alterations and CKD severity was demonstrated through the relationship between serum T3 changes and renal function decline. The thyroid function abnormalities which included low T3 syndrome developed as a common condition in chronic kidney disease patients while they proved useful as biochemical markers for clinical evaluation and treatment choices and extended drug treatment in CKD patients.

Keywords: Chronic kidney disease; thyroid function; low T3 syndrome; hypothyroidism; estimated glomerular filtration rate.

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1. Introduction

1.1 Background

Multiple endocrine and metabolic pathways establish a physiological connection between the thyroid gland and the kidney. The essential thyroid hormones known as triiodothyronine T3 and thyroxine T4 control multiple kidney functions which include kidney development and renal blood circulation and glomerular filtration and kidney tubule sodium absorption and body fluid regulation. A person's thyroid status may be a factor in kidney function. Hypothyroidism results in decreased heart output which leads to reduced kidney plasma flow and decreased glomerular filtration rate. The condition of hyperthyroidism causes an increase in kidney blood flow and glomerular filtration rate and it activates the renin–angiotensin–aldosterone system. The earlier experimental and clinical studies demonstrated that thyroid hormones produce two types of effects which include pre-renal effects that depend on cardiovascular control and direct renal impacts that affect renal hemodynamics and tubular function (Katz et al., 1975). The evaluation of thyroid function tests become essential for clinical purposes because chronic kidney disease patients develop progressive kidney function decline which creates endocrine balance disturbances in their bodies.

1.2 Thyroid Dysfunction in CKD

Chronic kidney disease (CKD) is a progressive disorder characterized by a persistent decline in renal function. The body experiences changes in thyroid hormone metabolism through all stages of kidney function decline. CKD can affect thyroid physiology through impaired iodine clearance which leads to inorganic iodide accumulation and chronic metabolic acidosis and protein-energy malnutrition and systemic inflammatory activity. CKD patients develop low T3 syndrome because these mechanisms prevent their bodies from converting T4 to T3. Lim (2001) declared that thyroid abnormalities which develop in chronic renal failure cases happen without primary thyroid gland disease because of changes in hormone metabolism and uremic conditions. Inflammation also has an important role, as cytokine-mediated inhibition of deiodinase activity may reduce conversion of T4 into biologically active T3. Advanced renal failure leads to impaired iodine

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excretion which affects how the body handles thyroid iodine resulting in changes that impact thyroid structure and function. The mechanisms that cause CKD patients to have reduced T3 levels and reduced T4 levels and increased TSH levels occur because of their thyroid axis disturbances which vary in severity and type.

1.3 Research Gap

Medical professionals need to identify the clinical patterns of chronic kidney disease which connects to thyroid dysfunction across various patient groups. Abnormalities related to thyroid function like low T3 syndrome, subclinical hypothyroidism, and overt primary hypothyroidism have been recognized in patients with chronic kidney disease. Both the symptoms of the chronic kidney disease, such as fatigue, dry skin, lethargy, edema and poor appetite, and those of hypothyroidism would be similar and would make it difficult for doctors to make a proper clinical diagnosis, as biochemical tests would be necessary. The study by Singh et al. (2006) found that the thyroid hormone levels changed among patients with chronic renal failure who did not undergo dialysis thus demonstrating the need to conduct thyroid assessments before patients start dialysis. The study by Rhee et al. (2015) established a link between thyroid function and estimated glomerular filtration rate which demonstrates the requirement to assess thyroid profile according to the intensity of renal disease. The research needs to investigate how common low T3 syndrome and primary hypothyroidism appear through different stages of chronic kidney disease because dedicated studies need to focus on patients who receive conservative treatment without undergoing hemodialysis. The pattern establishes a distinction between non-thyroidal illness which functions as an adaptive response and actual thyroid failure. Patients with chronic kidney disease who take long-term medications need thyroid function tests because their thyroid changes will affect their metabolic state and cardiovascular danger and treatment results and monitoring of their therapies.

1.4 Aim of the Study

The research investigated thyroid hormone levels T3 and T4 and TSH levels in patients who suffered from chronic kidney disease with multiple stages of kidney function impairment. The research studied the thyroid function alterations in patients with chronic kidney disease who received conservative treatment together with their prevalence of low T3 syndrome and primary hypothyroidism. The selected thyroid parameters and renal function measures were aligned with the clinical and biochemical framework used for CKD assessment in the study population.

1.5 Objective

The research targeted thyroid dysfunction assessment through its impact on renal disease severity. The researchers examined the relationship between the decline of estimated glomerular filtration rate (eGFR) and the increase of serum creatinine and chronic kidney disease (CKD) progression and serum T3 and T4 concentrations and TSH concentration. Thyroid profile variables were evaluated within each renal function category to determine if there was an increase in thyroid function abnormalities as renal function worsened.

2. Materials and Methods

2.1 Study Design

The research team carried out a cross-sectional observational study at one research center to assess how thyroid function changes during various stages of chronic kidney disease. The study assessed serum T3, T4, and TSH levels among patients with established CKD and examined their relationship with renal disease severity. The research team selected this study design to investigate how frequently thyroid disorders occurred in patients with chronic kidney disease who received conservative treatment at a specific clinical evaluation point.

2.2 Study Setting

The Department of General Medicine at a tertiary care centre served as the location for the research. The researchers conducted patient screening in the general medicine wards to identify individuals who showed clinical and biochemical signs of chronic kidney disease. The hospital environment allowed for the complete evaluation of patients through renal function tests, thyroid profile tests, clinical assessments, and ultrasonographic examinations to confirm with kidney function decline.

2.3 Study Period

The research study began in January 2025 and continued until September 2025. The researchers evaluated all patients who met the study criteria at the time of their hospital admission with chronic kidney disease and gathered data throughout the study period to ensure consistent procedures for recruiting patients and performing laboratory tests and diagnosing patients and monitoring thyroid function variations across different stages of renal disease.

2.4 Study Population

The study involved 100 patients who had chronic kidney disease and received treatment without undergoing dialysis or kidney transplantation. Inclusion/exclusion criteria were used to select patients. The study involved male and female participants who had ages between 35 and 80 years. The selected population represented different levels of renal impairment, thereby allowing evaluation of thyroid profile alterations in relation to varying stages of chronic kidney disease.

2.5 Inclusion Criteria

Patients were included in the study if they had CKD diagnosed and treated conservatively. The study

included persons who had chronic kidney disease confirmed by their clinical symptoms, elevated blood urea, elevated serum creatinine, and decreased creatinine clearance as well as ultrasonographic findings of chronic kidney disease. The researchers chose patients for the study after they confirmed that thyroid profile assessment could be done without any influence from existing thyroid medication.

2.6 Exclusion Criteria

The researchers excluded patients who required hemodialysis because dialysis treatments would interfere with their ability to produce thyroid hormones. The study excluded pregnant women and patients who had thyroid disorders and received treatment and patients who used medications that would affect thyroid function tests and patients who had undergone thyroid surgery. The researchers used these exclusions to minimize confounding factors and to demonstrate that their findings about thyroid profile changes directly resulted from chronic kidney disease and its degree of progression.

2.7 Diagnostic Criteria for Chronic Kidney Disease

The medical team diagnosed chronic kidney disease based on the presence of uremia symptoms for three months and blood urea and serum creatinine had risen for three months, with a decrease in creatinine clearance. The ultrasonographic examination revealed evidence of bilateral kidney contraction and loss of corticomedullary differentiation or type 2 or type 3 renal parenchymal disease. The team also used supportive biochemical and radiological findings to make their assessment when it was relevant.

2.8 Ethical Considerations

The study received Institutional Ethical Committee approval before its execution. The study team provided all eligible patients with information about the evaluation's objectives and needed laboratory tests. The researchers obtained written informed consent from participants before they provided samples and underwent thyroid function tests and protected patient confidentiality during all stages of collecting and analyzing data. The research adhered to ethical standards that govern clinical studies with human subjects and standard biochemical testing.

2.9 Sample Collection and Laboratory Assessment

The research team collected 5 mL of venous blood from each participant after they completed their enrollment process. The collected samples underwent testing for thyroid function and renal biochemical assessments. The laboratory took measurements of serum urea, serum creatinine levels, T3 levels, T4 levels, and TSH values. The laboratory tests established thyroid status, which researchers used to examine its impact on kidney function decline.

2.10 Thyroid Function Parameters

Thyroid function assessment was conducted through testing serum triiodothyronine and thyroxine and thyroid-stimulating hormone levels. The Enzyme-Linked Immunosorbent Assay method was used to measure T3 and T4 and TSH levels. The chosen parameters demonstrated their capability to measure thyroid hormone distribution in the body and thyroid hormone production and the pituitary gland's response to thyroid hormones. The combined analysis of results enabled detection of low T3 syndrome and primary hypothyroidism and reduced T4 levels.

2.11 Reference Ranges Used

The reference values used for thyroid profile interpretation were serum T3 of 70 to 204 ng/dL, serum T4 of 4.6 to 12.5 µg/dL, and TSH less than 5 µIU/mL. The assessed parameters defined abnormal results for any values that fell outside these established limits. The researchers used these cut-off values to determine normal thyroid function and low T3 syndrome and hypothyroid conditions for all study participants.

2.12 Assessment of Renal Function

The renal function assessment used blood urea and blood creatinine tests together with estimated glomerular filtration rate (eGFR) evaluation. eGFR was calculated using the 2009 CKD-EPI creatinine equation that requires age and sex and serum creatinine and race information. The method assessed renal impairment through disease severity classification for patient evaluation. The eGFR values obtained from calculations established a relationship with thyroid hormone measurements.

2.13 CKD Stage and eGFR Grouping

The researchers assessed thyroid function changes in patients who had various levels of renal impairment based on their estimated glomerular filtration rate results. The study divided participants into three groups based on their eGFR levels which included eGFR less than 15 mL/min/1.73 m² and eGFR 16–30 mL/min/1.73 m² and eGFR greater than 30 mL/min/1.73 m². The classification system allowed researchers to investigate thyroid profile changes at three different stages of renal dysfunction which included advanced renal dysfunction and moderate renal dysfunction and relatively less severe renal dysfunction.

2.14 Operational Definitions

Low T3 syndrome was characterized by a low level of serum T3 and a normal TSH. Patients with primary hypothyroidism had to have high TSH and low thyroid hormones and have typical hypothyroid symptoms. The presence of thyroid profile alteration was established when any thyroid parameter T3 T4 or TSH showed results outside their normal range. The research team used those definitions to conduct both patient classification and statistical analysis.

2.15 Statistical Analysis

The researchers conducted their analysis through two different statistical methods that included descriptive statistics and inferential statistics. Categorical variables were summarized using frequency and percentages and continuous variables were summarized using mean, median, standard deviation, minimum and maximum. To investigate the relationship between thyroid parameters and renal function parameters (eGFR and blood urea and creatinine), the researchers performed correlation analysis. The researchers used a p-value to establish whether their results reached statistical significance.

3. Results

3.1 Baseline Characteristics of Study Participants

A total of 100 patients with chronic kidney disease were evaluated. The study population included participants whose ages ranged between 35 years and 80 years. The study population included 58 male participants and 42 female participants. The study results showed that 41 patients belonged to the pre-geriatric category which includes those under 60 years while 59 patients belonged to the geriatric category which includes those above 60 years. The baseline demographic characteristics are summarized in Table 1.

Table 1. Baseline demographic characteristics of CKD patients

Variable	Category / Value	Frequency / Statistic
Total patients	—	100
Age	Mean ± SD	60.36 ± 7.692 years
Age	Median	60 years
Age	Range	35–80 years
Age group	<60 years	41 (41%)
Age group	>60 years	59 (59%)
Sex	Male	58 (58%)
Sex	Female	42 (42%)

3.2 Distribution According to Symptom Duration

The duration of symptoms among CKD patients showed considerable variation. Symptom duration reached up to one year for most patients which made up 63 percent of the study group. The study found that thirty-six patients experienced symptoms for one to five years while one patient had symptoms that lasted more than five years. The distribution showed that most patients received their first evaluation during their first year of visible disease while a significant number of patients had existing renal problems at their assessment time. The distribution of symptom duration is presented in Table 2.

Table 2. Distribution of patients according to symptom duration

SYMPTOM DURATION	Frequency
up to 1 Yr	63
1 to 5 yrs	36
>5 yrs	1

3.3 Renal Function Profile

The study results showed that kidney function tests demonstrated significant differences between each participant. The study showed that serum urea levels varied from 36 to 224 mg/dL and the average result measured 128.01 mg/dL. The range of serum creatinine levels extended from 1.3 to 13.3 mg/dL, while the average level reached 3.916 mg/dL. The estimated glomerular filtration rate ranged from 5 to 46 mL/min/1.73 m², with a mean value of 17.94 mL/min/1.73 m². The results supported the conclusion that most study participants had moderate to advanced renal impairment, which Table 3 displayed.

Table 3. Descriptive statistics of renal function and thyroid profile parameters

	AGE	SEX	SYMPTOM DURATION	UREA	CREATININE	EGFR	SERUM_T4	SERUM_T3	TSH	HYPO THYROID SYMPTOMS
N	100	100	100	100	100	100	100	100	100	100
Mean	60.36	1.42	16.22	128.01	3.916	17.94	5.2906	86.581	4.6773	1.32
Median	60	1	12	126.50	3.2	16	5.35	68	3.7	1
SD	7.692	0.496	15.952	46.56	1.82976	8.75113	2.65585	30.37564	3.05592	0.469
Minimum	35	1	1	36	1.3	5	0.92	54	0.2	1
Maximum	80	2	120	224	13.3	46	10	151.3	14.32	2

3.4 Distribution of Patients by eGFR Group

Patients were categorized according to estimated glomerular filtration rate to evaluate thyroid function changes across renal disease severity. Among the 100 CKD patients, 43 had eGFR below 15 mL/min/1.73 m², representing the most advanced renal impairment group. The study found that 48 patients had eGFR results between 16 and 30 mL/min/1.73 m² whereas only nine patients showed eGFR results exceeding 30 mL/min/1.73 m². The advanced CKD categories contained the largest number of patients. Table 4 and Figure 1 display the eGFR category distribution.

Table 4. Distribution of CKD patients according to eGFR category

eGFR category	Number of patients	Percentage
<15 mL/min/1.73 m²	43	43%
16–30 mL/min/1.73 m²	48	48%
>30 mL/min/1.73 m²	9	9%

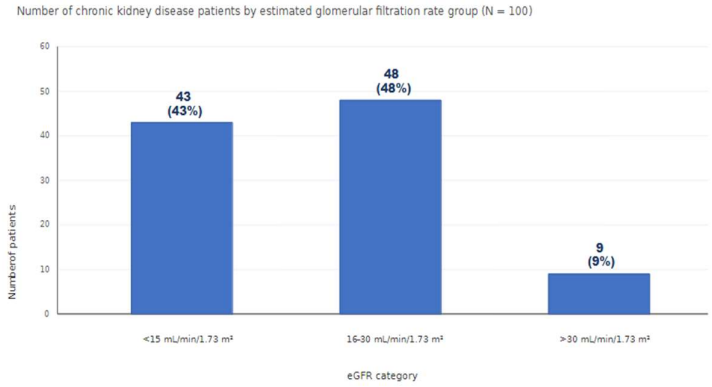

Figure 1. Distribution of CKD patients according to eGFR category

3.5 Thyroid Function Profile

Thyroid function parameters demonstrated significant differences among patients who had chronic kidney disease. Serum T3 levels ranged from 54.0 to 151.3 ng/dL, with a mean value of 86.581 ng/dL. Serum T4 levels ranged from 0.92 to 10.0 µg/dL, with a mean value of 5.2906 µg/dL. Serum TSH values ranged from 0.2 to 14.32 µIU/mL, with a mean value of 4.6773 µIU/mL. The results showed that patients with chronic kidney disease frequently experienced changes in their thyroid hormone levels.

3.6 Frequency of Thyroid Profile Abnormalities

Among the 100 CKD patients, serum T3 testing showed abnormal results in 55 patients while 45 patients showed normal results, which established low T3 as the most common thyroid profile change. Serum T4 testing showed abnormal results for 46 patients while 54 patients showed normal results. Serum TSH testing showed abnormal results for 14 patients while 86 patients showed normal results. The study showed that thyroid profiles had abnormal results throughout the sample, with T3 changes occurring more often than T4 and TSH abnormalities, which established low T3 syndrome as the main condition in CKD patients. Table 5 and Figure 2 display the thyroid function abnormalities that occur in the population.

Table 5. Frequency of thyroid function abnormalities among CKD patients

Thyroid parameter	Normal n (%)	Abnormal n (%)
T3	45 (45%)	55 (55%)
T4	54 (54%)	46 (46%)
TSH	86 (86%)	14 (14%)

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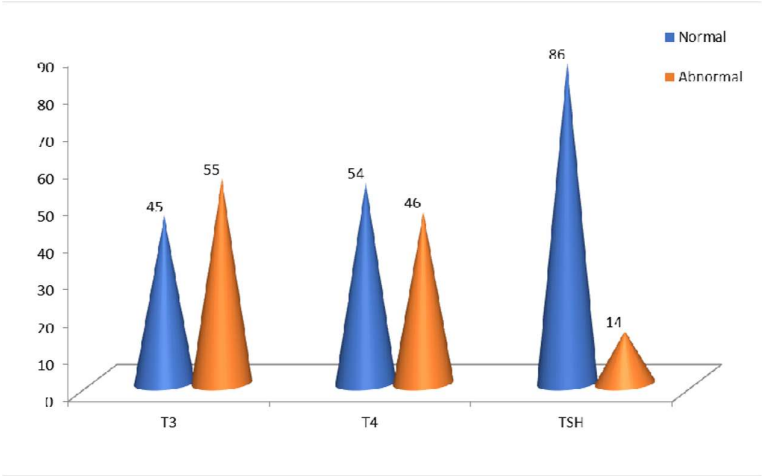

Figure 2. Frequency of normal and abnormal thyroid function parameters

3.7 Pattern of Thyroid Dysfunction

The study included 100 CKD patients who were found to have 55 patients with low serum T3 levels. Among their group, 14 patients showed both elevated TSH levels and low T4 levels together with hypothyroid symptoms, which led to their classification as primary hypothyroidism. The remaining 41 patients had low serum T3 with normal TSH levels and were classified as having low T3 syndrome. The study found that low T3 syndrome represented the main pattern of thyroid dysfunction while primary hypothyroidism was present in a smaller group of patients who showed clinically important symptoms.

Table 6. Pattern of thyroid dysfunction among CKD patients

Thyroid dysfunction pattern	Number of patients	Percentage
Low T3 syndrome	41	41%
Primary hypothyroidism	14	14%
No major thyroid dysfunction	45	45%

3.8 Hypothyroid Symptoms in CKD Patients

Of the patients studied 32 patients showed hypothyroid symptoms while 68 patients showed no symptoms. From the total number of patients with symptoms 14 patients showed elevated TSH together with hypothyroidism while 18 patients showed low T3 syndrome with normal TSH levels. Every patient with primary hypothyroidism showed symptoms while 18 out of 41 patients with low T3 syndrome exhibited symptoms. Sixteen patients experienced skin dryness while eighteen patients showed hoarseness of voice which demonstrated the shared clinical symptoms between CKD and hypothyroid conditions. The distribution of hypothroid symptoms according to thyroid dysfunction pattern is presented in Table 7 and Figure 3.

Table 7. Hypothyroid symptoms according to thyroid dysfunction pattern

Variant	Symptomatic patients	Patients without symptoms	Percentage symptomatic
Low T3 syndrome	18	23	43.90%
Primary hypothyroidism	14	0	100%

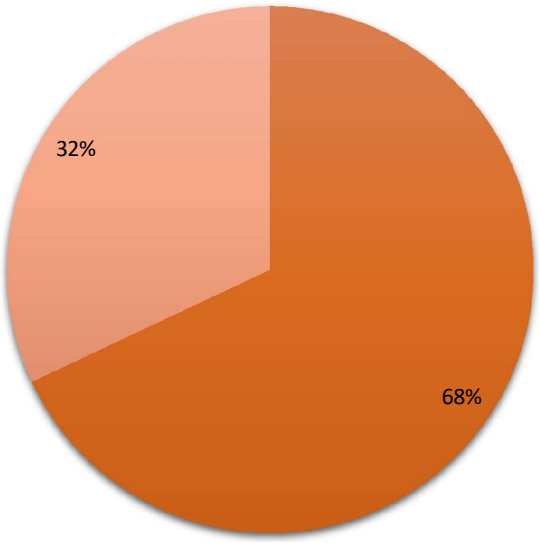

Figure 3. Distribution of hypothyroid symptoms among CKD patients

3.9 Age-wise Distribution of Low T3 Syndrome

Researchers evaluated low T3 syndrome across multiple age groups. Among patients below 50 years, 4 out of 11 had low T3 syndrome, accounting for 36.3%. The 50–60 years age group experienced low T3 syndrome in 19 out of 40 patients, which equals 47.5%. The 60 years and older population had low T3 syndrome present in 18 out of 49 patients, which equals 36.73%. The 50–60 years age group showed the highest rate of occurrence.

3.10 Sex-wise Distribution of Low T3 Syndrome

The study revealed that there was low T3 syndrome in both male and female CKD patients. 22 (37.93%) of the 58 male patients had low T3 syndrome. 45.23% (n = 19) out of 42 female patients were affected with low T3 syndrome. The study found that more males had the condition but females showed higher rates of occurrence. The study showed that female CKD patients had a higher rate of low T3 syndrome than other study participants.

3.11 Correlation of Thyroid Parameters with Renal Disease Severity

The correlation analysis showed that thyroid profile results established significant relationships with renal disease severity. The study found that serum T3 levels had a significant relationship with both serum creatinine and eGFR results which showed that changes in thyroid hormones led to deterioration of kidney function. The study found that TSH levels showed significant relationships with both urea and creatinine together with eGFR results and hypothyroid symptoms and T4 and T3 levels. The study found that individuals with hypothyroid symptoms experienced worsening of their kidney function tests. The study results confirmed that advanced CKD patients show increased thyroid function test abnormalities. Table 8 displays the correlation results.

Table 8. Correlation between renal function parameters and thyroid profile

Parameter pair	Correlation coefficient	p-value
T3 and creatinine	0.232	0.020
T3 and eGFR	-0.205	0.041
T4 and creatinine	0.492	0.0001
T4 and eGFR	-0.464	0.0001
TSH and urea	0.507	0.0001
TSH and creatinine	0.591	0.0001
TSH and eGFR	-0.550	0.0001

4. Discussion

The research examined how thyroid function changed through various stages of chronic kidney disease while discovering that conservatively treated CKD patients developed thyroid profile abnormalities. The study revealed that over half had thyroid function abnormalities; the most common of which was the presence of serum T3 abnormality. The study found that 55% of 100 CKD patients had T3 level abnormalities while 46% had T4 level abnormalities and 14% had elevated TSH levels. Low T3 syndrome, 41% of patients, was the main thyroid disorder seen in the study, while 14% of patients had primary hypothyroidism. The research results demonstrate that CKD patients show thyroid dysfunction beyond direct hypothyroidism,

which manifests as changed peripheral thyroid hormone metabolism that results in decreased T3 levels.

The metabolic and inflammatory changes which develop during chronic renal dysfunction explain why low T3 syndrome occurs more frequently in this research study. The combination of impaired renal clearance and chronic metabolic acidosis together with protein-energy malnutrition and systemic inflammation leads to reduced T4 to T3 conversion in people who have CKD. The study findings support the idea that renal failure disrupts thyroid hormone metabolism through various mechanisms which include hormone production and distribution and hormone breakdown and elimination. Kaptein (1986) explained that renal failure causes thyroid dysfunction through complex changes which affect both peripheral thyroid hormone metabolism and the hypothalamic-pituitary-thyroid axis. The research discovered that most patients with low T3 levels had normal TSH values which supports the concept that low T3 syndrome develops from non-thyroidal illness rather than primary thyroid gland failure.

The relation between thyroid dysfunction and renal disease progression showed clear evidence. The average eGFR measurement reached 17.94 mL/min/1.73 m^2, with most patients showing advanced stages of kidney disease. The eGFR results showed that 43 patients had values below 15 mL/min/1.73 m^2 while 48 patients had values between 16 and 30 mL/min/1.73 m^2. Serum T3 established a strong connection with renal function measurements which included eGFR and serum creatinine because T3 changes indicated increased renal damage. The observation by Song et al. (2009) showed that low triiodothyronine prevalence increased according to CKD stage among subjects with normal TSH according to the current study. The current results establish low T3 as a biochemical marker which shows increasing severity of chronic kidney disease.

The medical field finds primary hypothyroidism which occurs in 14% of patients to be medically important. Patients with primary hypothyroidism were all symptomatic and 43.90% of patients with low T3 syndrome had symptoms of hypothyroidism. The differentiation is important as the symptoms of CKD are fatigue, lethargy, dry skin, edema, and loss of appetite, all of which are symptoms of hypothyroidism. Lo et al. (2005) reported an increased prevalence of both subclinical and clinical hypothyroidism among individuals with CKD, supporting the need for careful biochemical assessment rather than reliance on symptoms alone. The study used T3, T4, and TSH testing methods to identify low T3 syndrome and primary hypothyroidism.

The relationship between low T3 levels and total body illness burden shows potential value as a predictive tool for future outcomes. Patients with CKD suffer from several health conditions, such as inflammation and malnutrition, and anemia and cardiovascular risk, which also impact on thyroid hormone metabolism. Zoccali et al. (2005) identified low triiodothyronine as a marker linked with inflammation in end-stage renal disease. The present research establishes a connection between malnutrition-inflammatory complex and thyroid hormone alterations, which show systemic deterioration instead of being related to endocrine disease confined to one area.

The study results match the findings of Carrero et al. (2007) who investigated the clinical and biochemical effects that low thyroid hormone levels had on euthyroid patients with chronic kidney disease. The present study demonstrates that low T3 syndrome occurs in high percentages because chronic illness leads to adaptive mechanisms which decrease T3 levels during advanced renal dysfunction. The physiological adaptation process shows weak bodily reserves when it occurs with either malnutrition or inflammation or cardiovascular health problems.

The changes in thyroid function which occur during chronic kidney disease progression show their practical value for both therapeutic and pharmaceutical fields. The multiple medications which CKD patients take for extended periods can lead to thyroid dysfunction, which affects their cardiovascular disease risk, metabolic response, medication metabolism, and clinical assessment procedures. The study by Basu and Mohapatra (2012) demonstrated how thyroid disorders interact with kidney disease because both conditions require healthcare professionals to perform combined endocrine and renal assessments. The study results demonstrate that monitoring endocrine function in chronic kidney disease patients who undergo extended drug treatment, especially those with advanced renal impairment, represents an essential procedure for the journal that publishes research on drug delivery technology and therapeutic sciences.

The research faced multiple restriction points. The research used a single-centre cross-sectional design to assess 100 patients which prevented the researchers from establishing causal connections. The research results do not apply to dialysis-dependent chronic kidney disease patients because the study excluded hemodialysis patients. The study did not complete its analysis of free T3 and free T4 levels and thyroid autoantibodies and inflammatory markers and nutritional markers and long-term outcomes. The study derived significant advantages from its limitations because it identified a specific population with chronic kidney disease while excluding participants with known thyroid disorders and dialysis-related problems and used the CKD-EPI equation to assess eGFR and measured T3 and T4 and TSH in every study participant.

The study found that kidney disease patients show frequent thyroid profile changes which result in low T3 syndrome as the most common thyroid disorder. The findings support routine consideration of thyroid profile assessment in CKD patients, particularly in advanced stages, to differentiate adaptive low T3 syndrome from primary hypothyroidism and to improve clinical monitoring.

5. Conclusion

Patients with chronic kidney disease exhibited frequent thyroid function changes and their most common thyroid disorder was low T3 syndrome. The evaluated CKD patients showed reduced serum T3 levels more frequently than they showed T4 or TSH abnormalities which demonstrated that their thyroid hormone metabolism problems developed before they reached complete thyroid axis dysfunction. Primary hypothyroidism affected a smaller but medically significant percentage of patients who required differentiation between actual thyroid gland dysfunction and the non-thyroidal illness patterns that accompany kidney impairment.

The relationship between serum T3 changes and kidney function decline demonstrates that thyroid profile alterations directly relate to the severity of chronic kidney disease. Biochemical thyroid testing becomes especially valuable for advanced renal dysfunction patients because their symptoms overlap with both hypothyroidism and chronic kidney disease. The measurement of T3 T4 and TSH levels enables doctors to identify endocrine disorders at an early stage while providing essential clinical data that helps them differentiate between low T3 syndrome and primary hypothyroidism. Thyroid profile monitoring provides CKD patients with a treatment assessment tool that helps doctors assess their clinical responses and metabolic conditions and cardiovascular dangers throughout their extended medical care.

Thyroid profile should be monitored for chronic kidney disease (CKD) patients being treated conservatively. Monitoring should be used in patients with declining eGFR and rising creatinine, exhibiting hypothyroidism symptoms. Long-term follow-up of patients is necessary for a better understanding of impacts on outcomes in chronic kidney diseases due to thyroid hormone changes.

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