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Original Research Article

A CLINICAL STUDY OF THYROID FUNCTION TEST IN DECOMPENSATED LIVER DISEASE AND IMPLICATION OF SERUM FREE T3 AS A PROGNOSTIC INDICATOR

Vaishali Rajarikam[1], G Bhanu Prakash[2], Fatima Rasheed[3], Juhi Aggarwal[4], M Lakshmi Surya Prabha[5], Babulal S[6], Swarna Deepak Kuragayala[7], Mahaboob Vali Shaik[8]

[1]*Assistant Professor, Department of Pathology, S.V.S. Medical College, Yenugonda, Mahabubnagar, Telangana, India.*
[2]*Associate Professor, Department of Physiology, Anna Gowri Medical College and Hospital, Puttur, Andhra Pradesh, India.*
[3]*Professor, Department of Pathology, S.V.S. Medical College, Yenugonda, Mahabubnagar, Telangana, India.*
[4]*Professor & HOD, Department of Biochemistry, Santosh Medical College and Hospital, Santosh Deemed to be University, Ghaziabad, U.P., India.*
[5]*Addl DME, Director (Research & Development), Dr NTR University of Health Sciences, Vijayawada, Andhra Pradesh, India.*
[6]*Professor and HOD & Director (A&R), Department of Pulmonology, Nimra Institute of Medical Sciences, Vijayawada, India.*
[7]*Professor, Department of Critical Care Medicine, Apollo Health City, Jubilee Hills, Hyderabad, Telangana. India.*
[8]*Research Coordinator, Department of Research & Development, Nimra Institute of Medical Sciences (Affiliated Dr NTR University of Health Sciences), Vijayawada, AP, India.*

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Corresponding Author:
Dr. G Bhanu Prakash,
Associate Professor, Department of Physiology, Anna Gowri Medical College and Hospital, Puttur, Andhra Pradesh, India.
Email: drgbprakash@gmail.com

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ABSTRACT

Background: Thyroid hormone alterations are frequently observed in patients with liver cirrhosis. This study aimed to evaluate the association between thyroid profile parameters and severity of liver disease, and to assess the prognostic value of serum free T3 (fT3) in cirrhosis.

Materials and Methods: This observational study included 50 patients with liver cirrhosis aged 28–61 years (mean 46.36 ± 9.39 years). Clinical evaluation, biochemical investigations, thyroid profile (TT3, TT4, fT3, fT4, TSH), Child–Turcotte–Pugh (CTP) classification, and MELD scoring were performed. Correlation analysis, ROC curve analysis, and logistic regression were applied to determine prognostic significance.

Results: Among 50 patients, 34 (68%) were males and 16 (32%) were females. Alcohol was the most common etiology (44%), followed by hepatitis B (24%), hepatitis C (14%), and cryptogenic causes (18%). Ascites was present in 60%, hepatic encephalopathy (HE) in 46%, upper gastrointestinal bleeding in 36%, and jaundice in 76%. According to CTP classification, 44% were CTP-A, 40% CTP-B, and 16% CTP-C. Mean serum TT3, TT4, and fT3 levels decreased significantly with increasing CTP severity ($p < 0.05$), whereas fT4 and TSH showed no consistent significant association. Free T3 demonstrated a significant negative correlation with CTP score ($r = –0.470$, $p = 0.008$). Similar significant negative correlations were observed for TT3 and TT4. In MELD stratification, increasing MELD scores were associated with significant reductions in TT3, TT4, and fT3 ($p < 0.05$). Free T3 showed significant inverse correlation with MELD score. Low fT3 levels were significantly associated with ascites, hepatic encephalopathy, elevated INR, hyperbilirubinemia, and hyponatremia. Patients with severe ascites and advanced HE showed markedly reduced mean fT3 levels ($p < 0.01$). ROC analysis demonstrated good predictive accuracy of fT3 for complications and mortality. A serum fT3 cutoff <1.09 predicted mortality (AUROC 0.605), while levels <1.7183 predicted bleeding manifestations (AUROC 0.785). Logistic regression confirmed low fT3 as an independent predictor of cirrhosis severity (OR 95% CI: 1.1–4.4).

Conclusion: Serum free T3 levels decline significantly with increasing severity of liver dysfunction as assessed by CTP and MELD scores. Low fT3 is independently associated with ascites, hepatic encephalopathy, and disease progression. Free T3 may serve as a simple, cost-effective, and reliable

prognostic biomarker in patients with liver cirrhosis. Routine thyroid function testing, particularly serum fT3 estimation, should be considered for severity assessment and prognostic stratification in chronic liver disease.
Keywords: Liver cirrhosis; Free T3; Thyroid profile; Child–Turcotte–Pugh score; MELD score; Ascites; Hepatic encephalopathy; Prognostic biomarker; Chronic liver disease; Thyroid dysfunction.

INTRODUCTION

The liver is one of the most vital organs in the human body and the second largest organ after the skin. It plays a crucial role in maintaining metabolic homeostasis by regulating carbohydrate, protein, lipid, and vitamin metabolism; detoxifying endogenous and exogenous substances; and removing microbes and toxins from portal circulation before they enter systemic circulation. In addition, the liver is responsible for bile formation and excretion.[1-4]

Chronic liver disease (CLD) and cirrhosis constitute a major global health burden. India contributes significantly to global cirrhosis-related mortality, accounting for nearly 18.3% of worldwide liver cirrhosis deaths in 2010.[5] This highlights the urgent need for improved risk factor control, early detection, and reliable prognostic indicators in advanced liver disease.

The thyroid gland and liver share a complex and interdependent physiological relationship. The liver synthesizes thyroid hormone–binding proteins such as thyroxine-binding globulin (TBG), transthyretin, and albumin. It stores a substantial proportion of extrathyroidal thyroxine (T4) and triiodothyronine (T3), and serves as the principal site for peripheral conversion of T4 to the biologically active T3 through selenium-dependent 5′-deiodinase (Type 1 deiodinase). Additionally, deiodinase Type 3 catalyzes the conversion of T4 to reverse T3 (rT3), an inactive metabolite. The liver is also responsible for thyroid hormone degradation, conjugation, and biliary excretion, and functions as a major target organ for thyroid hormone action.[6,7]

Alterations in thyroid hormone levels are frequently observed in patients with chronic liver disease. The most common abnormality is low T3 syndrome, characterized by decreased total and free T3 levels, elevated rT3 levels, and a reduced T3:T4 ratio.[8] This is largely attributed to diminished hepatic Type 1 deiodinase activity, resulting in impaired peripheral conversion of T4 to T3, along with relatively increased Type 3 deiodinase activity leading to enhanced rT3 production. Some investigators suggest that reduced T3 levels may represent an adaptive mechanism aimed at lowering basal metabolic rate and preserving hepatocellular function.[8]

The plasma T3/rT3 ratio has been shown to correlate negatively with the severity of cirrhosis. Because T3 and rT3 bind to the same plasma proteins, this ratio provides a measure of liver function independent of variations in protein binding.[8] Furthermore, plasma free T3 (fT3) levels have demonstrated correlation with the severity of liver dysfunction and may possess prognostic significance, although they are not routinely utilized in clinical practice.

Despite most patients with liver disease being clinically euthyroid, biochemical thyroid function abnormalities are common. The most frequently encountered pattern is euthyroid sick syndrome (ESS), characterized predominantly by reduced free T3 levels, with variable reductions in free T4 and thyroid-stimulating hormone (TSH).[9,10] These hormonal changes may be influenced by the severity of underlying disease, nutritional status, systemic inflammation, and medications.

Long-standing evidence supports an association between chronic liver disease and thyroid hormone alterations; however, findings across studies remain inconsistent. Most research has focused on alcohol-related cirrhosis or primary biliary cirrhosis, and limited data exist regarding thyroid function abnormalities in decompensated liver disease irrespective of etiology.[11,12]

Given the intricate relationship between the liver and thyroid hormones, and the potential prognostic implications of altered thyroid function—particularly serum free T3—further evaluation in patients with decompensated liver disease is warranted.

Aim

To analyze thyroid function tests in patients with decompensated liver disease and to evaluate the prognostic significance of serum free T3 levels.

MATERIALS AND METHODS

Study Design: This was a hospital-based descriptive cross-sectional study.

Study Setting: Laboratory investigations were carried out in the central clinical laboratory and the study was conducted at S.V.S.Medical College and Hospital, Mahbubnagar.

Study Duration: The study was conducted over a period of 12 months from March 2025 to February 2026.

Sample Size Calculation: The sample size was calculated using the formula:

$$n = \frac{(Z_{1-\alpha/2})^2 \times P(1-P)}{d^2}$$

Where:

n= required sample size

Z_(1-α/2)= 1.96 at 5% level of significance

P= anticipated population proportion

d= absolute precision

Based on previous studies reporting thyroid dysfunction in approximately 16–20% of patients with liver disease, the anticipated proportion (P) was taken as 0.20.

$$n = \frac{(1.96)^2 \times 0.20 \times (1 - 0.20)}{(0.05)^2}$$

Sampling Method: Simple random sampling method was used.

Inclusion Criteria

Patients diagnosed with decompensated chronic liver disease based on:

- Clinical evidence of decompensation (ascites, variceal bleeding, hepatic encephalopathy),
- Radiological evidence of liver nodularity or portal collaterals,
- Biochemical and ultrasonographic findings suggestive of chronic liver disease.

Exclusion Criteria

- Patients with cardiac failure
- Patients with chronic kidney disease
- Patients with known pre-existing thyroid dysfunction (hypothyroidism or hyperthyroidism)
- Terminally ill patients

Study Procedure: A detailed history including presenting complaints, past medical history, and personal history was obtained. Complete physical and systemic examinations were performed.

The severity of liver disease was assessed using:

- Presence and grading of hepatic encephalopathy
- Ascites grading
- Total bilirubin
- Serum albumin
- Prothrombin time/INR
- Child–Turcotte–Pugh (CTP) score
- Model for End-Stage Liver Disease (MELD) score

Child–Turcotte–Pugh (CTP) Scoring System

Clinical Variable	1 Point	2 Points	3 Points
Encephalopathy	None	Grade 1–2	Grade 3–4
Ascites	Absent	Mild	Moderate–Severe
Bilirubin (mg/dL)	<2	2–3	>3
Albumin (g/dL)	>3.5	2.8–3.5	<2.8
PT prolongation / INR	<4 sec / <1.7	4–6 sec / 1.7–2.3	>6 sec / >2.3

Grading of Hepatic Encephalopathy

The West Haven Criteria were used:

Grade 0: No detectable changes

Grade 1: Mild lack of awareness, anxiety, shortened attention span

Grade 2: Lethargy, disorientation for time, subtle personality change

Grade 3: Somnolence, confusion, gross disorientation

Grade 4: Coma

MELD Score Calculation

The MELD score was calculated using:

"MELD"=10 x [0.957 x ln (Serum Creatinine) +0.378 x ln (Total Bilirubin) +1.12 ln (INR)+0.643]

Minimum acceptable value for each variable = 1

Maximum serum creatinine considered = 4 mg/dL

Maximum MELD score = 40

Laboratory investigations included complete blood count, liver function tests, renal function tests, prothrombin time, INR, activated partial thromboplastin time, viral markers, complete urine examination, and thyroid function tests including serum free T3 (fT3), free T4 (fT4), and thyroid-stimulating hormone (TSH). Imaging studies such as ultrasound abdomen were performed in all patients, while portal venous Doppler, CT/contrast-enhanced CT abdomen, and ECG were performed when indicated. Serum free T3 levels were correlated with the severity of liver disease using CTP and MELD scores to assess its prognostic significance.

Data analysis: Statistical analysis was performed using SPSS version 23.0 (IBM Corp., Chicago, Illinois). Continuous variables were expressed as mean ± standard deviation. Student's t-test was used to compare means between two groups, and one-way analysis of variance (ANOVA) was used for comparison among three or more groups. Pearson's correlation coefficient was used to determine the relationship between thyroid hormone levels and liver disease severity scores. Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the ability of serum free T3 to discriminate disease severity, and the area under the curve (AUC) was calculated. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Clinical, Laboratory, and Thyroid Characteristics of Patients with Decompensated Liver Disease (n = 50)

Variable	Category	n (%)
Etiology	Alcoholic	22 (44)
	Hepatitis B	12 (24)
	Hepatitis C	7 (14)
	Cryptogenic	9 (18)
Total Bilirubin (mg/dL)	< 2	11 (22)
	2–3	9 (18)
	> 3	30 (60)

INR	< 1.3	17 (34)
	≥ 1.3	33 (66)
Child–Pugh Class	A	22 (44)
	B	20 (40)
	C	8 (16)
Ascites (EASL 2010)	Absent	20 (40)
	Grade 1 (Mild)	16 (32)
	Grade 2 (Moderate)	10 (20)
	Grade 3 (Gross)	4 (8)
Hepatic Encephalopathy (West Haven)	Grade 0	27 (54)
	Grade I	10 (20)
	Grade II	7 (14)
	Grade III	4 (8)
	Grade IV	2 (4)
Thyroid Status	Subclinical Hypothyroidism	29 (58)
	Overt Hypothyroidism	2 (4)
	Subclinical Hyperthyroidism	2 (4)
	Euthyroid	17 (34)

Table 2: Thyroid Hormone Profile of the Study Population (n = 50)

Parameter	Mean ± SD	Observed Range	Reference Range (Adults)
Total T3 (ng/mL)	1.13 ± 0.32	0.75–1.99	0.87–1.80
Total T4 (µg/dL)	8.01 ± 1.95	5.8–12.5	6.09–12.23
Free T3 (pg/mL)	2.46 ± 1.10	1.08–4.46	2.1–4.4
Free T4 (ng/dL)	1.24 ± 0.49	0.72–2.8	0.8–2.7
TSH (µIU/mL)	4.10 ± 1.09	0.3–5.5	0.34–5.6

Mean FT3 and TT3 values were toward the lower limit of normal, while TSH values were toward the upper normal range.

Table 3: Association of Serum T3 and Free T3 with Child–Pugh Class

Parameter	Level	A n (%)	B n (%)	C n (%)	χ^2	P-value
Total T3	≤0.85	5 (22.7)	3 (15.0)	7 (87.5)	15.29	<0.001
	>0.85	17 (77.3)	17 (85.0)	1 (12.5)		
Free T3	≤2.1	6 (27.3)	11 (55.0)	6 (75.0)	10.75	0.05
	>2.1	16 (72.7)	9 (45.0)	2 (25.0)		

Low TT3 and FT3 were significantly associated with higher Child–Pugh class.

The mean value of the free T3 of the severe group is significantly lower (1.5225±0.5116) than the Moderate group (2.1525± 0.83374) and the mild group (3.08± 1.12) with a P-value 0.007, a significant difference. Mean value of the fT4 of severe group is higher (0.97 ± 0.29) than Moderate group (1.14 ± 0.327) and the mild group (1.42 ± 0.59) [P = 0.308].Mean value of the total T3 of the severe group is significantly lower (0.89±0.32) than the Moderate group (1.07±0.19) and the mild group (1.261±0.36) with a P-value of 0.01 significant difference for the CTPS group.

Table 4: Comparison of Thyroid Hormones Across CTPS Groups (ANOVA)

Parameter	Mild (n=22)	Moderate (n=20)	Severe (n=8)	P-value
TT3	1.26 ± 0.36	1.07 ± 0.19	0.89 ± 0.32	0.001
TT4	8.76 ± 2.15	7.70 ± 1.66	6.68 ± 1.10	0.02
FT3	3.08 ± 1.12	2.15 ± 0.83	1.52 ± 0.51	0.007
FT4	1.42 ± 0.59	1.14 ± 0.33	0.97 ± 0.29	0.308

FT3 and TT3 declined significantly with increasing CTPS severity.

Table 5: Thyroid Hormone Levels According to MELD Score

Parameter	≤9	10–19	20–29	30–39	P-value
T3	1.26±0.36	1.09	0.93±0.32	0.76±0.01	—
T4	8.76±2.15	7.91±1.62	6.65±1.13	5.95±0.21	—
FT3	3.08±1.12	2.22±0.85	1.62±0.46	1.14±0.08	0.0225
FT4	1.42±0.59	1.12±0.34	1.11±0.29	0.75±0.04	0.27
TSH	4.29±1.28	4.02±0.49	4.11±0.78	2.45±3.04	0.0003

FT3 and TSH showed significant association with higher MELD scores.

Table 6: Association Between Ascites and Low T3

Ascites	Low T3	Normal T3	χ^2	P-value
None	3	17		
Mild	2	14		
Moderate	6	4		
Severe	4	0	14.875	0.0019

Low T3 was significantly associated with increasing ascites severity.

Table 7: Association Between Hepatic Encephalopathy and Low T3

HE Grade	Low T3	Normal T3	χ^2	P-value
None	5	22		
I	2	8		
II	2	5		
III	2	2		
IV	2	0	13.31	0.001

Low T3 significantly correlated with worsening encephalopathy.

Table 8: Analysis of thyroid profile in patients with hepatic encephalopathy

Hepatic encephalopathy		N	Mean	Std. Deviation	F Value	P-Value
fT3	Absent	27	2.83	1.23931	6.77	0.001
	Grade 1	10	2.63	0.5355		
	Grade 2	7	1.564	0.20557		
	Grade 3	4	1.8	0.58878		
	Grade 4	2	1.09	0.014142		
fT4	Absent	27	1.424	0.56460	1.12	0.23
	Grade 1	10	0.993	0.227647		
	Grade 2	7	1.227	0.21638		
	Grade 3	4	0.832	0.047631		
	Grade 4	2	0.79	0.09899		
TSH	Absent	27	4.244	1.165990	0.81	0.52
	Grade 1	10	4.07	0.612916		
	Grade 2	7	3.971	0.715807		
	Grade 3	4	4.475	0.408503		
	Grade 4	2	1.9	2.2627		
TT3	Absent	27	1.248	0.33918		0.001
	Grade 1	10	1.058	0.20009		
	Grade 2	7	1.065	0.31685		
	Grade 3	4	0.795	0.038405		
	Grade 4	2	0.77	0.028284		
TT4	Absent	27	8.903	1.976882		0.20
	Grade 1	10	7.57	1.544919		
	Grade 2	7	6.542	1.180193		
	Grade 3	4	6.625	0.52618		
	Grade 4	2	6.0	0.28284		

Table 9: Comparison of the Area Under ROC curves (AUC) values of TT3, TT4, TSH, fT3 and fT4 of severe CTPS group for predicting the risk of mortality

Test Result Variable(s)	Area	Std. Error	P- Value	Asymptotic 95% CI	
				Lower Bound	Upper Bound
TSH	0.445	0.125	0.627	0.5	5.5
fT3	0.195	0.085	0.007	1.08	4.46
fT4	0.676	0.102	0.118	0.72	2.8
TT3	0.181	0.045	0.0075	0.75	1.99
TT4	0.243	0.100	0.022	5.8	12.5

Table 10: Comparison of the Area Under ROC curves (AUC) values of TT3, TT4, TSH, fT3 and fT4 of mild CTPS group for predicting the risk of mortality

Test Result Variable(s)	Area	Std. Error	P-Value	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TSH	0.466	0.088	0.749	0.5	5.4
fT3	0.756	0.103	0.042	1.2	4.35
fT4	0.376	0.102	0.246	0.82	2.6
TT3	0.746	0.055	0.085	0.85	1.62
TT4	0.777	0.125	0.028	6.2	11.8

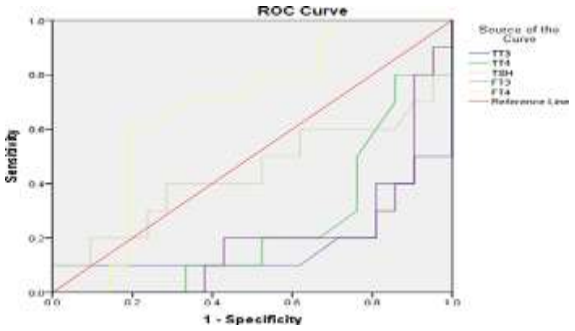

Figure 1: Comparison of the Area Under ROC curves (AUC) of TT3, TT4, TSH, fT3 and fT4 of severe CTPS group for predicting the risk of mortality

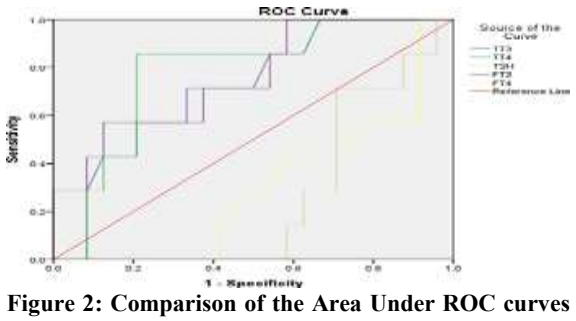

Figure 2: Comparison of the Area Under ROC curves (AUC) values of TT3, TT4, TSH, fT3 and fT4 of mild CTPS group for predicting the risk of mortality

Assessing the risk of mortality in severe CTPS group, TT4 (AUC = 0.243, P = 0.022.), fT3 (AUC = 0.195, P = 0.007) and TT3 (AUC = 0.181, P = 0.005) is significantly more accurate except for fT4 (AUC = 0.676, P = 0.118) and TSH (AUC = 0.445, P= 0.627). Assessing the risk of mortality in mild CTPS group, TT4 (AUC = 0.777, P = 0.028) is significantly more accurate than the fT3 (AUC = 0.756, P = 0.042). However, TT3 (AUC = 0.746, P = 0.085) is also having higher AUC value and for TSH (AUC = 0.466, P = 0.749) and FT4 (AUC = 0.376, P = 0.246.)

Table 11: Comparison of thyroid functions in patients with HE and without HE

	Cirrhosis without HE	Cirrhosis with HE	t-test (P)
FT3 (mean±SD)	2.8318±1.2393	2.027391304±0.7061	<0.0001
FT4 (mean±SD)	1.4240±0.5646	1.0186±0.2449	0.09
TSH (mean±SD)	4.2448±1.1659	3.92173913±0.9972	0.04
TT3	1.248±0.3391	0.989±0.2435	0.05
TT4	8.9037±1.9768	6.95659±1.3186	<0.001

Table 12: Comparison of thyroid functions in non-survivor and survivor group

MELD Score	Non-survivors	survivors	t-test (P)
FT3 (mean±SD)	1.09±0.014146	2.518±1.0819786	0.0707
FT4 (mean±SD)	0.79±0.0989	1.256±0.4886	0.1882
TSH (mean±SD)	1.9±2.2627	4.187±0.960	0.0028
TT3	0.77±0.02828	1.1443±0.3215	0.1096
TT4	6.0±0.28284	8.09167±1.94868	0.1393

Table 13: The area under the curve (AUC), cutoff values, Sensitivity, Specificity, positive predictive value (PPV), and negative predictive value (NPV) for statistically significant parameters for Bacterial Infection

Variable	AUC	Best cutoff	Sensitivity*	Specificity*	PPV	NPV	P-value
MELD	0.629	13.8	78.5%	56.7%	0.500	0.738	0.005
SGOT	0.606	145.76	78.5%	40.5%	0.561	0.787	0.033
Total bilirubin	0.612	3.176	65.0%	65.0%	0.472	0.759	<0.001
Albumin	0.598	3.8	78.4%	54.2%	0.485	0.658	<0.001
INR	0.782	1.114	70.4%	54.2%	0.517	0.835	0.010

*ROC analysis was performed to derive sensitivity and specificity based on a logistic regression model with the continuous variable of interest (MELD) as the only covariate.

Table 14: Correlation between Thyroid Function and Liver Function

	Bilirubin	ALB	SGOT	SGPT	ALP	INR	CPS
TSH	0.083	0.073	-0.076	0.006	0.076	-0.043	0.017
	0.313	0.375	0.353	0.939	0.354	0.598	0.841
T3	-0.440**	0.581**	0.001	0.034	0.027	-0.348**	-0.556**
	0.001	0.001	0.986	0.681	0.739	0.001	0.001
T4	-0.151	0.123	-0.063	-0.137	- 0.051	-0.085	-0.104
	0.066	0.132	0.443	0.095	0.538	0.302	0.205
FT3	-0.537**	0.596**	0.153	0.159	- 0.039	-0.433**	-0.658**
	0.001	0.001	0.062	0.052	0.631	0.001	0.001
FT4	-0.162*	0.076	-0.023	-0.044	- 0.027	0.130	-0.077
	0.048	0.356	0.778	0.591	0.741	0.114	0.347

DISCUSSION

In our present study, we analyzed the correlation between thyroid profile in cirrhosis patients with CTP class, Ascites grades, encephalopathy grades, and different laboratory parameters. Investigations such as complete blood hemogram, renal function tests, PT, INR, Liver function test, USG abdomen, portal venous Doppler, thyroid profile with free T3, free T4, and TSH. The information was evaluated to see if blood T3 levels may be used as a prognostic indicator in patients with decompensated liver disease.

Demographics: In the present study, Age group ranges from 28 to 61 years with the mean ± SD age of 31 patients being 46.36±9.3 years. The mean age of females (46.18±11.118 years) was like the mean age of males (46.44±8.61 years).

In a Kaur et al. (2002), 70 studies of 306 patients with acute hepatitis age group range from 1-68 years with a mean age of 26 ± 2.5 years.[13]

In a study by El-Feki et al. (2016),14 60 patients with Chronic Hepatitis C virus infection patients (45 patients are with cirrhosis group and 15 patients are without cirrhosis patients). In the cirrhosis group, the mean ± SD age (Years) was 51.8 ± 8.2 with the range of 33 to 65 years.

Punekar et al. studied 100 cases of liver cirrhosis cases, the mean ± SD age was 43 ± 14 years.[15]

In the present study, out of 50 patients, 34 (68%) were male patients and 16 (32%) were female patients. Sex ratio is Male: Female: 2.12:1.

Bahramedi et al,[16] a study of clinical, virologic, and phylogenetic features of chronic hepatitis in Iranian patients had a male: female ratio of 4:1.

All studies show a male preponderance of disease comparable with the present study probably because of high-risk behavior in males.

No statistically significant correlation was found between the gender of the population and thyroid profile. It was observed that the thyroid hormone profile in women did not differ from men in patients with liver cirrhosis.

Etiology and Complications: In etiologies, most cirrhotic cases are due to alcohol in 22 cases, followed by Hepatitis B in 12 cases. Hepatitis C was found in 7 instances, while cryptogenic etiology was found in 9 cases.

In this study, 18 (36%) patients had upper gastrointestinal bleeding, 30 (60%) patients had ascites, 23 (46%) patients had hepatic encephalopathy, and 38 patients had jaundice, respectively. There were no ascites in 40% of the patients, mild ascites in 32%, moderate ascites in 20%, and severe ascites in 8% of the patients. There was no encephalopathy in 54% of patients, 20% of whom had grade 1 hepatic encephalopathy, 14% had grade 2 encephalopathies, 8% had grade 3 encephalopathies, and 4% had degree 4 encephalopathies.

In a Punekar et al. (2018) study, Anemia (87%), thrombocytopenia (53%), coagulation abnormalities (65%), HE (38%), jaundice (32%), upper gastrointestinal hemorrhage (34%), azotemia (17%), pleural effusion (16%), sepsis (22%), and shock were the most prevalent consequences (14%). Constipation was seen in 49% of the patients. The most prevalent cause was determined to be alcohol (46%) followed by hepatitis B (19%), hepatitis C (3%), Wilson disease (1%), and others.

CTPS GROUP: In the present study, 22(44%) patients are Mild class (A), 20 (40%) patients are moderate class (B) and 8 (16%) patients are severe class (C) in the CTPS group. This indicates that most of the patients in our study were in various stages of decompensated liver cirrhosis.

Patira et al. (2017) found that 13 (26% of patients) had a score of 5-6 (grade A), 26 (52% of patients) had a score of 7-9 (grade B), and 11 (22% of patients) had a score of more than 10. (grade C).[17]

In a study of El-Feki et al. (2016), among 45 patients of cirrhosis group, the mean age of Child C (severe) group for CTPS Group (56.2 ± 5.0) is higher when compared with the mean age of Child A (mild) group (49.9 ± 8.5) and Child B (Moderate) group (49.3 ± 8.9).

Patira et al. (2017) were studied a total of 50 patients with cirrhosis of the liver with the age group of fewer than forty years and above sixty years for the CTPS group.

fT3 levels: In the present study, 22 (44%) patients are Mild, 20 (40%) patients are moderate and 8 (16%) patients are severe in the CTPS group. The mean value of the free T3 of the severe group is significantly lower (1.522±0.51) than the Moderate group (2.1525± 0.83) and the mild group (3.08± 1.12) [P = 0.007] for the CTPS group. It is observed that the level of severity of the CTPS group is increasing then the mean value of free T3 is decreased. We found that free T3 levels were inversely correlated with the Child-Pugh class and previous studies also suggested comparable results.

A study by Govindan NP et al. reported the Means of FT3 in CPS A, CPS B and CPS C were 3.17 ± 0.35, 2.94 ± 0.43, 2.78 ± 0.52 respectively and the difference in mean value was found to be significant with a p-value of 0.001.

TT3 levels: In the present study, the mean value of the total T3 of the severe group is significantly lower (0.89±0.32) than the Moderate group (1.07±0.19) and the mild group (1.261±0.36) [P = 0.01, Significant] for the CTPS group. It is observed that the level of severity of the CTPS group is increasing then the mean value of TT3 is decreased.

A study by Govindan NP et al,[18] reported the Means of T3 in CPS A, CPS B and CPS-C were 1.26 ± 0.26, 1.06 ± 0.27 and 0.87 ± 0.27 respectively and the difference in means was statistically significant with a p-value of 0.001.

fT4 levels: In the present study, the mean value of the fT4 of the severe group is higher (0.97 ± 0.29) than the Moderate group (1.14 ± 0.327) and the mild group (1.42 ± 0.59) [P = 0.308, Not Significant] for the CTPS group. It is observed that the level of severity of the CTPS group is increasing then the mean value of fT4 is increased. In a study by El-Feki et al., among 45 patients of cirrhosis group, the mean of fT4 for the CTPS group of Child C (0.7 ± 0.4) is significantly less when compared with Child B (1.3 ± 0.9) and Child A (1.1 ± 0.4) [P = 0.023].

In a study by Punekar et al., on comparing the mean serum level of FT4 between Child A, B, and C, the lowest levels found were in the Child C group (1.17 ± 0.51), followed by the Child B group (1.44 ± 0.54), while the Child A group was (0.76 ± 0.00) [P = 0.03].

TT4 levels: In this study, the mean value of the total T4 of the severe group is significantly lower (6.68 ± 1.10) than the Moderate group (7.70 ± 1.66) and the mild group (8.76 ± 2.15) [P = 0.029, Significant] for the CTPS group. It is observed that the level of severity of the CTPS group is increasing then the mean value of TT4 is decreased.

TSH levels: In this study, the mean value of the TSH of the mild group is higher (4.29 ± 1.29) than the severe group (3.83 ± 1.59) and the moderate group (3.98 ± 0.489). However, it shows that there is no significant difference between the means of TSH for the CTPS group [P = 0.121].

In a study by El-Feki et al. (2016), among 45 patients of cirrhosis group, the mean of TSH for the CTPS group of Child C (18.1 ± 14.3) is significantly higher when compared with Child B (3.3 ± 3.1) and Child A (1.5 ± 1.2) [P = <0.0001].

In the present study, there is a significant negative correlation for TT3 [r value = - 0.447, P value = 0.012], TT4 [r value = -0.398, P value = 0.027] and fT3 [r value = - 0.470, P value = 0.008] except for TSH [r value = 0.146, P value = 0.434] and fT4 [r value = 0.203, P value = 0.274] in CTPS group.

The Pearson correlation analysis between total CTP score and free T3 levels shows a correlation r-value of -0.470 with a statistical p-value of 0.008. Data shows a significant association exists between the CTP score and free T3 levels in patients with decompensated liver disease.

Area Under Curve values of Thyroid Profile for CTPS: In the present study, comparison of ROC values of for TT3, TT4, fT3 and fT4 of mild CTPS group, it is showed that TT4 (AUC = 0.777, P = 0.028) is significantly more accurate than the fT3 (AUC = 0.756, P = 0.042). However, TT3 (AUC = 0.746, P = 0.085) is also having higher AUC value and for TSH (AUC = 0.466, P = 0.749) and FT4 (AUC = 0.376, P = 0.246) but it doesn't show significant result for assessing the risk of mortality in mild CTPS group.

MELD score: In the MELD group, 22 (44%) patients are in the MELD score ≤ 9 groups, 18 patients are in the MELD score 10-19, 8 patients are in the MELD score 20-29, and 2 patients are in MELD score 30-35 group, respectively.

In the present study, the mean value of the total T3 of severe (MELD30-35) group is significantly lower (0.76±0.01414) than other groups [P = 0.029, Significant] for the MELD group. It is observed that the level of severity of the MELD group is increasing then the mean value of TT3 is decreased.

In the present study, the mean value of the total T4 of the severe group is significantly lower (5.95± 0.212132) than other groups [P = 0.003, Significant] for the MELD group. It is observed that the level of severity of the MELD group is increasing then the mean value of TT4 is decreased.

In the present study, the mean value of the TSH of the severe group is lower (2.45±3.040) than another group [P = 0.742, Not Significant] for MELD group. It is observed that the level of severity of MELD severity increases then the mean value of TSH also decreases.

In the present study, the mean value of the fT4 of the severe group is higher (0.75±0.0424) than the other groups [P = 0.446, Not Significant] for the MELD group. It is observed that the level of severity of the MELD group is increasing then the mean value of fT4 is also increased.

In the present study, the mean value of the fT3 of the severe group is significantly lower (1.14±0.0848) than another group [P = 0.008, Significant] for the MELD group. It is observed that the level of severity of the MELD group is increasing then the mean value of fT3 is decreased.

MELD correlation with thyroid profile: In the present study, there is a significant negative correlation for TT3 [r value = -0.539, P value = 0.002], TT4 [r value = -0.389, P value = 0.03] and fT3 [r value = -0.535, P value = 0.002] except for TSH [r value = 0.072, P value = 0.702] and fT4 [r value = 0.035, P value = 0.850] in MELD group.

Mansour-Ghanaei et al. (2012) were conducted a study with 72 cirrhosis patients and they showed that there is a significant negative correlation between MELD score and TT3 [r = -0.305, P = 0.014] and there is a negative correlation for CTP score Vs TSH [r = -0.016, P = 0.903], CTP score Vs TT4 [r = -0.204, P = 0.106], CTP score Vs fT3 [r = -0.058, P = 0.647] and CTP score Vs fT4 [r = -0.138,P = 0.279]. In a study by Punekar et al. (2018), fT3 and fT4 were shown a negative correlation and TSH was shown positive correlation.

In the present study, comparison of ROC curve values of for TT3, TT4, fT3 and fT4 of mild MELD group, it is showed that TT4 (AUC = 0.814, P = 0.003) is significantly more accurate than the fT3 (AUC = 0.786, P = 0.007), TT3 (AUC = 0.746, P = 0.021) except for TSH (AUC = 0.466, P = 0.749) and fT4 (AUC = 0.376, P = 0.246) for assessing the risk of mortality in mild MELD group.

The accuracy of the AUC for Predicting the Risk of Mortality between the NMELD and MELD scores was compared in a study by Abolghasemi et al.[19]

MELD and free T3 association: When MELD 20 was utilized as a cutoff for differentiating more severe disease from less severe disease, there was a strong inverse association between MELD score and free T3 levels in our study (p=0.01). We also identified a significant inverse correlation between free T4 levels and MELD score (p=0.01), which agrees with Dehghani SM et al.20 Increased conversion of free T4 to rT3 by type 3 deiodinase is most likely to blame. We identified no significant association between TSH and MELD scores, which is consistent with previous study.

Other biochemical variables: The student's t-test demonstrated a statistically significant association between low fT3 levels and elevated INR (p=0.038) and hyponatremia (p=0.004) among various biochemical parameters compared with the thyroid function test. Low free T4 was also found to have a statistically significant relationship with hyperbilirubinemia (p=0.049) and SGPT (p=0.008). TSH and different biochemical markers showed no significant association. Though sodium levels in patients with low free T3 levels were much lower. This could be owing to the euvolemic hyponatremia seen in hypothyroid patients, or it could be due to the increased severity of liver dysfunction and the resulting dilutional hyponatremia. Patients with low free T3 levels had disturbed coagulation parameters as compared to patients with normal free T3, and Dehghani SM found comparable results.[21]

Low free T3 levels were observed to have a significant correlation with serum bilirubin (p=0.01) and SGPT (p=0.01) levels.

Low free T3 levels correlations: Patients with chronic liver illness are usually diagnosed with low T3 syndrome.

The study population was categorized based on the severity of liver dysfunction assessed by Child-Pugh score as CPS-A, CPS-B, CPS-C, and the number of patients having T3 levels lower than the normal range (0.85 - 1.81 ng/mL) were found out. Of the total 22 patients with CPS-A, 5 patients (22.72%) had a total T3≤0.85, while 17 patients (77.27%) had T3 > 0.8.

Of the total of 20 patients with CPS-B, 3 patients (15%) had total T3 ≤ 0.8 and 17 patients (85%) had T3 > 0.8, while of the 8 patients with CPS-C, T3 ≤ 0.8 was present in 7 patients (87.5%) and total T3 > 0.8 in 1 patient (12.5%). 15 patients had lower total T3 levels in the studied population. A number of patients with a T3 level lower than the normal range significantly increased with a p-value of 0.000478, along with Child-Pugh scores A, B, and C.

The number of patients having free T3 levels lower than the normal range (2.1 - 3.90 pg/mL) was found out in each CPS group and the following observations were made of the total 50 patients in the CPS group. Of the total of 22 patients in the CPS-A group, 6 patients (27.27%) had FT3≤2.1, while 16 patients (72.72%) had FT3 > 2.1. Of the total of 20 patients in the CPS-B group, 11 patients (55%) had FT3 ≤ 2.1, and 9 patients (45%) had FT3 > 2.1. Of the 8 patients with CPS-C, FT3 ≤ 2.1 was present in 6 patients (75%) and FT3 > 2.1 was present in 2 patients (25%). Lower FT3 (≤ 2.1) was present in 27.27% of patients with CPS-A, 55% of patients with CPS B and 75% of patients with CPS-C. The number of patients with a Free T3 level lower than normal range significantly reduced with a p-value of 0.005 along with Child-Pugh scores A, B, and C.

The current study indicated that patients with low free T3 levels were most common in Child-Pugh class C (75%), followed by Child-Pugh class B (55%), and Child-Pugh class A (27.27%), with a p-value of 0.05 indicating that this difference was statistically significant.

Sudhir Kumar Verma et al,[22] in their Patients with low free T3 levels were found to be most common in Child-Pugh class C (82.76%), followed by Child-Pugh class B (60%), and Child-Pugh class A (50%), with a statistically significant difference (p=0.027).

The correlation of free T3 with the severity of liver disease as assessed by MELD score shows that patients with low free T3 having Patients with a MELD score of more than 20 had a greater mortality rate than those with a MELD score of less than 20. TSH levels and either Child-Pugh class or MELD score and free T4 with Child-Pugh class did not show a statistically significant difference.

In our present study, thyroid function parameters in each Child-Pugh group were compared using ANOVA. Means of total T3 in CPS-A, CPS-B, and CPS-C were 1.26 ± 0.36, 1.07 ± 0.19, and 0.89 ± 0.32 respectively and the difference in means was statistically significant with a p-value of 0.001. Means of FT3 in CPS-A, CPS-B and CPS C were 3.08 ± 1.12, 2.152 ± 0.833, 1.5225 ± 0.511 respectively and the difference in mean value was found to be significant with a p-value of 0.007.

Comparison of Free T3 implications in cirrhosis: The present study results show that patients with low fT3 levels were found to have a higher incidence of complications like ascites, hepatic encephalopathy, and bleeding varices. This correlation between low fT3 with severe ascites (p=0.03) and hepatic encephalopathy (p=0.02) was found to be statistically significant. No significant correlation was found between complications of cirrhosis of the liver and free T4 and TSH levels.

Ascitis and Total T3 implications:

The study population was grouped according to the severity of ascites.

In our study, each group number of patients having a total T3 levels lower than the normal range (0.85 - 1.81 ng/mL) were found out. Of the total 20 patients without ascites 3 (15%) had low T3 (≤0.85), while 17 patients (85%) had normal T3 (> 0.85) levels.

Out of the 16 patients with mild ascites, 2 patients (12.5%) had low T3 (≤ 0.85) levels, and 14 patients (87.5%) had normal T3 (>0.8) levels, while of the 10 patients with moderate ascites, lower T3 (≤ 0.8) was present in 6 patients (60%) and normal T3 (>0.8) was present in 4 patients (40%). Of the 4 patients with severe ascites, lower T3 (≤ 0.8) was present in 4 patients (100%) and no patients had normal T3 (>0.8) levels. 30% of patients had lower T3 levels(T3≤0.85). Present study results show that patients with low total T3 levels were 100% of the severe ascites group, followed by 60%of moderate ascites, and 12.5% of the mild ascites group, and this difference was found to be statistically significant with a p-value of 0.001927. Means of total T3 in no ascites, mild ascites, moderate, and severe ascites group were 1.307 ± 0.35, 1.103 ± 0.205, 0.96±0.277, and 0.765 ± 0.019 respectively and the difference in means was statistically significant with a p-value of 0.001.

Ascites and free T3 implications: It was shown that as the degree of ascites increases, the values of free T3 tend to decrease and become lesser than the normal range. The levels of serum-free T4 also show a decreasing trend with the increase in the degree of ascites. TSH also tends to decrease as the degree of ascites worsens and becomes lesser than the normal range.

Free T3 levels were shown to be significantly inversely associated with severe ascites in our study. Similar findings were found in a study by Al-Jarhi U et al., who found that individuals with decompensated liver cirrhosis had lower free T3 levels than those with compensated liver cirrhosis.[21]

The means of FT3 in each of the no ascites, mild ascites, moderate, and severe ascites were 3.198 ± 1.099, 2.137 ± 0.921, 2.015±0.498, and 1.195 ± 0.146 respectively and the difference in mean value was found to be significant with a p-value of 0.001.

Correlation of CTP with all biochemical variables: The total T3 levels show a declining trend and remain below the normal range as the degree of encephalopathy proceeds. The levels of free T4 and TSH tend to remain below the normal range. In the case of hyperbilirubinemia, the levels of free T3 decrease with an increase in the serum bilirubin and falls below the normal, and the levels of free T4 and TSH tends to be decrease with an increase in the serum bilirubin. As the hypoalbuminemia worsens the level of serum-free T3 falls below the normal, and the level of free T4 and TSH also tended to fall below

the normal level of albumin. As the coagulopathy worsens the levels of free T3 fall below the normal level, and T4 and TSH were also fall below the normal level of INR.

The Pearson correlation was found to be -0.840 for serum albumin and free T3 with a p-value of <0.01. With a p-value of 0.01, the Pearson correlation between Free T3 and serum bilirubin was found to be - 0.777. With a p-value of 0.01, the Pearson correlation between INR and free T3 was found to be -0.825. With a p-value of 0.01, the Pearson correlation between serum albumin and free T3 was found to be -0.840.

Hepatic encephalopathy and total T3 implications: In each group of HE, a number of patients having T3 levels lower than the normal range (0.85 - 1.81 ng/mL) were found out. Out of the 27 patients who did not show any evidence of HE, 5 (18.51%) patients had low T3 (≤0.8) while 22 patients had normal T3 (>0.8) levels. Of the total of 10 patients with grade 1 HE, 2 patients (20%) had low T3 (≤ 0.8), and 8 patients(80%) had normal T3 (> 0.8). 2 out of the 7 patients (28.57%) with grade 2 HE had low T3 (≤ 0.8). 2 out of the 4 patients (50%) with grade 3 HE had low T3 (≤ 0.8). While 2 out of the 2 patients (100%) with grade 4 HE had low T3 (≤ 0.8).

Low T3 was observed in 20%, 28.57%, 50%, and 100%in patients with grade 1 - 4 encephalopathy with a statistically significant difference with a P-value of 0.001.

Serum-free T3 correlation with etiology: We identified an association between the pathogenesis of cirrhosis and thyroid profile abnormalities, which was corroborated by prior study.

Alcoholic cirrhosis was the most prevalent cause of liver cirrhosis in our sample, accounting for 22 (44%), followed by hepatitis B-related cirrhosis (12 (24%), and hepatitis C-related cirrhosis (7 (14%).

Low free T3 levels were identified in 58.33% (n=7/12) of patients with hepatitis B-related cirrhosis, 42.85% (n=3/7) of patients with hepatitis C-related cirrhosis, 31.88% (n=7/22) of patients with alcoholic cirrhosis, and 66.67% (n=6/9) of patients with cryptogenic cirrhosis in the current study. Although a larger proportion of patients with cryptogenic cirrhosis had low free T3, this difference was not statistically significant. There was no statistically significant difference between free T4 levels and TSH levels.

Implication of serum-free t3 as a prognostic indicator: Mean serum-free T3 was lowest among decompensated patients (2.4618± 1.0967) with a p-value < 0.001. Serum-free T3 levels were significantly inverse correlation with severe ascites.

A cutoff Serum-free T3 level >3.198, indicates the absence of ascites in liver cirrhosis with a sensitivity of 60%, specificity of 80%, and AUROC of 0.658. A cutoff of fT3 level <2.13, indicates the presence of ascites in liver cirrhosis with a sensitivity of 80%, specificity 55%, and AUROC of 0.619. A cut-off Serum-free T3 level <1.971 was used to predict higher grade 3 ascites in liver cirrhosis.

A cutoff serum-free T3 score >2.83, indicates the absence of encephalopathy in liver cirrhosis with a sensitivity of 72%, specificity of 55%, and AUROC of 0.695. A cutoff fT3 levels <2.63, indicates the presence of encephalopathy in liver cirrhosis with a sensitivity of 60%, specificity 65%, and AUROC of 0.612.

Logistic regression analysis showed that low FT3, Ascites, and encephalopathy were independently associated with the development of cirrhosis of the liver (OR 95% CI: 1.1, 2.1 – 4.4).

A cutoff serum-free T3 level <1.09, indicates the risk of mortality in liver cirrhosis with a sensitivity of 66%, specificity of 50%, and AUROC of 0.605.

Low fT3 levels were found to have a higher incidence of complications like ascites, hepatic encephalopathy, and bleeding varices.

Prognostic Implication of Serum Free T3

The present study demonstrates that serum free T3 levels show a significant negative correlation with both CTP and MELD scores. Reduced fT3 levels were independently associated with ascites and encephalopathy. ROC analysis further supports its predictive value in assessing mortality risk.

Lower fT3 levels were strongly associated with severe liver dysfunction, suggesting that fT3 may serve as a simple, inexpensive, and reliable prognostic biomarker in decompensated liver disease.

Study Implications: Low total and free T3 levels in cirrhosis may represent an adaptive metabolic response aimed at reducing basal metabolic rate and conserving energy in hepatocytes. However, persistent depression of fT3 levels appears to correlate with disease progression and may reflect true endocrine dysfunction rather than merely an adaptive response.

The independent association between low fT3 and liver disease severity suggests that serum free T3 is more than just a biochemical abnormality—it may have pathogenic and prognostic significance.

CONCLUSION

The present study demonstrates a clear male predominance among patients with decompensated liver cirrhosis. Progressive worsening of liver disease severity, as assessed by the CTP classification, was associated with a significant decline in mean serum total T3 (TT3), total T4 (TT4), and free T3 (fT3) levels. Although free T4 (fT4) levels also showed a decreasing trend with increasing CTP severity, this association was not consistently statistically significant.

Among thyroid parameters, TT4 demonstrated the highest sensitivity in predicting severe CTP class, followed by fT3 and TT3. In mild CTP class, TT4 and fT3 showed better sensitivity compared to other thyroid markers. Free T3 exhibited a significant

negative correlation with CTP score (r = –0.470, p = 0.008), indicating that declining fT3 levels parallel worsening hepatic dysfunction.

Similarly, increasing severity of liver disease as measured by MELD score was associated with significant reductions in TT3, TT4, and fT3 levels. Significant negative correlations were observed between MELD score and TT3, TT4, and fT3, further supporting the relationship between thyroid hormone suppression and advanced liver disease.

Low fT3 levels showed a significant independent association with major complications of cirrhosis, particularly ascites and hepatic encephalopathy. Overall, patients with liver cirrhosis demonstrated reduced levels of T3, T4, and TSH, with free T3 showing the strongest and most consistent correlation with disease severity.

In conclusion, decreasing serum free T3 levels are significantly associated with worsening liver injury and disease progression. Free T3 may serve as a simple, cost-effective, and reliable prognostic biomarker in patients with chronic liver disease. Routine assessment of thyroid function, especially serum free T3, should therefore be considered in patients with liver cirrhosis for severity assessment and prognostic stratification.

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