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Thyroid Dysfunction and Cardiovascular Health: A Prospective Study on Cardiac Patients in Uttarakhand Region

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Thyroid dysfunction, including both hypothyroidism and hyperthyroidism, is a common comorbidity in cardiac patients with significant clinical and prognostic effects. This study shows the critical reference in cardiac patients the overall patients included in the study is 150 in which all have some kind of cardiac issues in their life span as thyroid hormones are critical for maintaining cardiac function, as they regulate heart rate, myocardial contractility, vascular resistance, and lipid metabolism. Hypothyroidism is linked to bradycardia, increased systemic vascular resistance, and an elevated risk of atherosclerosis and heart failure [2]. In contrast, hyperthyroidism is characterized by tachycardia, atrial fibrillation, and a higher likelihood of developing cardiomyopathy and congestive heart failure. Subclinical thyroid disorders, which are often under diagnosed, can lead to arrhythmias and other adverse cardiac events, especially in individuals with preexisting heart conditions. This study is conducted on the confirmed cardiac patients to explore the mechanisms connecting thyroid dysfunction with cardiac biomarkers, assesses clinical outcomes, and emphasizes the necessity of early detection and management of thyroid disorders in cardiac patients. As all patients' samples were processed for endocrinology and cardiological parameters

at the DNA Labs A Centre for Applied Sciences. The study mainly pivots on the personalized therapeutic strategies addressing thyroid dysfunction may provide an effective means to reduce cardiovascular morbidity and mortality, highlighting the importance of integrated care between endocrinology and cardiology.
Keywords: Hypothyroidism, Bradycardia, Tachycardia, Endocrinology, Personalized therapeutic.

1. Introduction

The interconnection between endocrine and cardiovascular systems underscores the importance of thyroid hormones in maintaining cardiac health [1, 2, 3, 4]. Thyroid dysfunction, which encompasses hypothyroidism, hyperthyroidism, and subclinical thyroid disorders, has emerged as a prominent comorbidity among cardiac patients [5]. These conditions are not only highly prevalent but also significantly influence cardiovascular health, clinical outcomes, and long-term prognoses. The growing body of evidence linking thyroid dysfunction to various cardiac pathologies underscores the critical need for multidisciplinary approaches to their diagnosis, management, and treatment [6].

Thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3), are essential regulators of metabolic processes, impacting nearly every organ system, including the heart. These hormones exert their effects directly on cardiac myocytes and indirectly through vascular resistance and lipid metabolism [7]. The balance between adequate thyroid hormone levels is critical for optimal cardiovascular function. A deficiency or excess in these hormones disrupts this equilibrium, triggering pathological changes such as altered heart rate, myocardial contractility, vascular resistance, and lipid metabolism [8]. Such alterations predispose patients to complications including arrhythmias, cardiomyopathy, and heart failure. Even subtle variations in thyroid function, such as those seen in subclinical disorders, can contribute to significant cardiovascular morbidity [9].

Hypothyroidism, characterized by insufficient production of thyroid hormones, is closely associated with bradycardia, diastolic dysfunction, and increased systemic vascular resistance. These changes often lead to diastolic hypertension, atherosclerosis, and a heightened risk of coronary artery disease [10].

Subclinical thyroid dysfunction—a condition where thyroid hormone levels are marginally abnormal without overt symptoms—further complicates the clinical picture. Despite the absence of noticeable symptoms, subclinical hypothyroidism and hyperthyroidism are linked to adverse cardiac events [11]. Subclinical hypothyroidism is associated with endothelial dysfunction, increased arterial stiffness, and impaired left ventricular diastolic function, whereas subclinical hyperthyroidism predisposes patients to atrial fibrillation and thromboembolic events [12]. The clinical significance of these subclinical states is becoming increasingly evident, necessitating timely screening and intervention to prevent progression to overt disease and reduce cardiovascular risks [13].

Cardiac biomarkers play a pivotal role in understanding the interplay between thyroid dysfunction and cardiovascular health. These biomarkers, including troponins, B-type natriuretic peptides (BNP), and high-sensitivity C-reactive protein (hs-CRP), provide valuable

insights into the extent of cardiac injury and inflammation in the setting of thyroid dysfunction [14]. Alterations in these biomarkers reflect the systemic impact of thyroid hormones on the heart and vasculature. For instance, elevated BNP levels are frequently observed in hypothyroid patients with heart failure, while troponin elevations can signal myocardial injury in hyperthyroid-induced tachyarrhythmias. By exploring these biomarkers, clinicians can gain a deeper understanding of the mechanisms linking thyroid dysfunction to cardiac pathology, aiding in risk stratification and tailored treatment strategies.

The bidirectional relationship between thyroid dysfunction and cardiovascular disease emphasizes the need for integrated care between endocrinologists and cardiologists. Early recognition and appropriate management of thyroid disorders in cardiac patients are crucial to improving clinical outcomes and reducing morbidity and mortality. However, the underdiagnosis of thyroid dysfunction, particularly in its subclinical forms, remains a significant barrier to effective care. Routine screening for thyroid function in patients with cardiovascular disease, particularly those with unexplained arrhythmias, heart failure, or coronary artery disease, can help identify at-risk individuals and facilitate timely intervention.

This study aims to delve deeper into the relationship between thyroid dysfunction and cardiac health, focusing on confirmed cardiac patients. By exploring the mechanisms through which thyroid hormones affect cardiac biomarkers and assessing the clinical outcomes associated with thyroid dysfunction, the research seeks to provide actionable insights for clinical practice. The findings are expected to highlight the importance of early detection and management of thyroid disorders in cardiac patients, paving the way for personalized therapeutic approaches. These strategies could significantly mitigate cardiovascular morbidity and mortality, underscoring the value of a multidisciplinary approach to patient care.

Given the high prevalence of thyroid dysfunction among cardiac patients and its profound impact on cardiovascular outcomes, this study addresses a critical gap in understanding the underlying mechanisms and clinical implications of this relationship. By integrating insights from endocrinology and cardiology, it emphasizes the need for comprehensive care models that consider the complex interplay between these systems. Such an approach holds promise for improving patient outcomes and advancing the management of thyroid dysfunction in cardiac settings.

2. STUDY PLAN

To investigate the relationship between thyroid dysfunction and cardiac biomarkers, assess clinical outcomes, and highlight the importance of early detection and management of thyroid disorders in cardiac patients. This study aims to bridge the gap in understanding the interplay between thyroid dysfunction and cardiac health in the Uttarakhand region. The findings will provide valuable insights for clinicians to optimize diagnosis and management, ultimately improving patient outcomes and reducing cardiovascular morbidity and mortality

Study Design: A prospective observational study conducted on 150 confirmed cardiac patients (96 males and 54 females) aged between 32 and 80 years from the Uttarakhand region.

Patient Recruitment:

Inclusion Criteria: As we the confirmed cardiac patients with diagnoses such as heart failure, arrhythmias, coronary artery disease, or cardiomyopathy aged between 32 and 80 years and all are residents of Uttarakhand.

Exclusion Criteria: Patients with known primary thyroid disorders undergoing treatment and Patients with end-stage cardiac disease or those unable to provide consent.

Study Population Details: In the study the sample size is150 patients with Demographics:96 males (64%), 54 females (36%) and age distribution are between 32 to 80 years. Detailed medical history, including cardiovascular and thyroid disease history was examined and Physical examination to assess signs of thyroid dysfunction and cardiac health. Collection of demographic data (age, gender, lifestyle factors, comorbidities).

3. MATERIAL AND METHODOLOGY

This study was conducted to assess various parameters related to thyroid function, cardiac biomarkers, and lipid profiles in 150 confirmed cardiac patients. The evaluation of these parameters involved a combination of laboratory investigations, diagnostic tests, and clinical assessments, who were selected based on a clear diagnosis of cardiac conditions such as ischemic heart disease, heart failure, arrhythmias, or other cardiovascular disorders. The patients were enrolled from a hospital or clinic setting, with informed consent obtained from all participants in the different regions of Uttarakhand.

LABORATORY INVESTIGATION: -

Blood samples were drawn from each participant in the study after a 12-hour fasting period to ensure accurate lipid profile results. Samples were collected in appropriate tubes (serum separator tubes) and processed immediately or stored at -20°C for later analysis. Serum samples were analysed for thyroid function and cardiac biomarkers on Snibe Maglumi 800 further lipid profile using a Mindry semi- automated clinical chemistry analyser. The laboratory procedures followed standard protocols and quality control measures to ensure accurate and reproducible results.

Thyroid Function Tests

Serum levels of Free Triiodothyronine (Free T3) and Free Thyroxine (Free T4) were measured to assess thyroid hormone activity and function. These tests were conducted using a chemiluminescent immunoassay (CLIA) on the Snibe Maglumi 800 analyser, a highly sensitive and accurate method for detecting thyroid hormones in serum samples. The levels of Free T3 with reference value 0.2-50 Pg/dl

and Free T4 with reference value 1.0-120 Pg/dl provide insight into the thyroid's ability to produce and regulate hormones essential for metabolism. Additionally, Thyroid Stimulating Hormone (TSH) levels were measured with normal range between 0.50-4.1 uIU/ml to further evaluate thyroid function. High TSH levels typically indicate hypothyroidism with higher than >10.0 uIU/ml, suggesting an underactive thyroid, while low TSH levels with lower < 0.40 uIU/ml are often indicative of hyperthyroidism, pointing to an overactive thyroid. The TSH

test was performed using an immunometric assay, which is based on Chemiluminescence assay (CLIA), Snibe Maglumi 800, ensuring precise and reliable measurement of TSH in the serum. Together, these tests provided crucial data for diagnosing thyroid dysfunction in the study participants.

Subclinical and overt thyroid dysfunction were classified based on the levels of thyroid hormones. Subclinical hypothyroidism was defined by elevated TSH levels > 4.1 uIU/ml with normal Free T3 (0.2- 50 Pg/dl) and Free T4, (1.0-120 Pg/dl) indicating that the thyroid is not functioning optimally despite normal levels of circulating thyroid hormones. Overt hypothyroidism was characterized by elevated TSH levels combined with low Free T3 and Free T4, indicating a clear deficiency in thyroid hormone production and signalling. On the other hand, subclinical hyperthyroidism was identified by low TSH levels while Free T3 and Free T4 remained within normal ranges, suggesting that the thyroid is hyperactive, but the thyroid hormones are still being regulated at normal levels. Lastly, overt hyperthyroidism was classified by low TSH levels alongside elevated Free T3 and Free T4, indicating an overproduction of thyroid hormones, which is typically seen in conditions such as Graves' disease or thyroiditis. These classifications allowed for a detailed understanding of thyroid function and its potential impact on the cardiovascular health of the patients.

Cardiac Biomarkers

Troponin Levels: Cardiac troponin I or T levels were measured to evaluate myocardial injury. Elevated Troponin I level with range > 0.10 ng/ml and Troponin T level with > 26.20 ng/dl level indicate myocardial damage and are critical for diagnosing acute coronary syndromes. Troponin levels were determined using on the Chemiluminescence assay (CLIA) Snibe Maglumi 800 analyser

B-type Natriuretic Peptide (BNP): BNP levels were measured to assess heart failure. Elevated BNP levels indicate heart failure, particularly when the levels exceed thresholds of > 125 pg/ml established for diagnosis. BNP concentrations were measured using on the Chemiluminescence assay (CLIA) Snibe Maglumi 800 analyser

High-sensitivity C-reactive Protein (hs-CRP): This biomarker was used to evaluate inflammation and cardiovascular risk. Increased hs-CRP level >1.0 mg/dl are associated with systemic inflammation and can predict adverse cardiovascular events.

Lipid Profile

Total Cholesterol: Total cholesterol levels <200 mg/dl were measured to provide an overview of cholesterol status. Elevated total cholesterol is a known risk factor for cardiovascular diseases. Measurement was performed using enzymatic colorimetric methods on Semi Automated analyser Mindry BA-88A.

Low-Density Lipoprotein (LDL): LDL cholesterol was calculated using the Friedewald formula or measured directly using a lipid electrophoresis technique. Elevated LDL levels with range of >150 mg/dl are linked to a higher risk of atherosclerosis and cardiovascular events.

High-Density Lipoprotein (HDL): HDL cholesterol was measured to assess the protective lipid fraction. Higher levels of HDL >65 mg/dl are associated with a lower risk of cardiovascular disease and lower level of HDL with <35 mg/dl is linked with the higher the cardiac risk.

Triglycerides: Triglycerides levels were measured using an enzymatic method. Elevated triglycerides with > 170 mg/dl are a risk factor for atherosclerosis and cardiovascular diseases.

4. Results

The study involved 150 patients, comprising 96 males (64%) and 54 females (36%), with an age distribution of 30-50 years (30%), 51-70 years (50%), and above 70 years (20%). Thyroid function analysis revealed subclinical hypothyroidism in 45 patients (30%), characterized by elevated TSH (>4.1 uIU/ml) with normal Free T3 and Free T4, while overt hypothyroidism was identified in 25 patients (16.7%), marked by significantly elevated TSH (>10.0 uIU/ml) and reduced Free T3 (<0.2 Pg/dl) and Free T4 (<1.0 Pg/dl). Subclinical hyperthyroidism was noted in 20 patients (13.3%) with low TSH (<0.40 uIU/ml) but normal Free T3 and Free T4, whereas overt hyperthyroidism, characterized by low TSH (<0.40 uIU/ml) and elevated Free T3 (>50 Pg/dl) and Free T4 (>120 Pg/dl), was observed in 15 patients (10%). The remaining 45 patients (30%) had normal thyroid function (euthyroid).

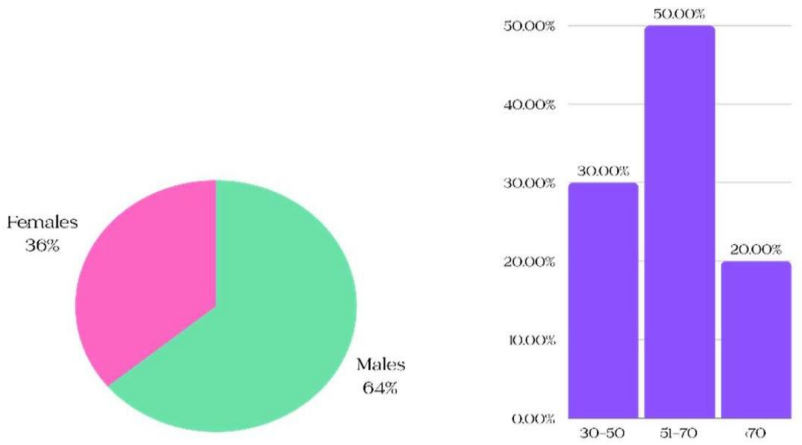

Fig. 1.0 :- Gender & Age Distribution

Cardiac biomarker analysis showed elevated Troponin levels (>0.10 ng/ml) in 40 patients (26.7%), predominantly associated with overt hyperthyroidism (60%) and overt hypothyroidism (40%). BNP levels (>125 pg/ml) were elevated in 50 patients (33.3%), with significant correlations to overt hypothyroidism (50%) and subclinical hypothyroidism (30%). Additionally, elevated hs-CRP levels (>1.0 mg/dl) were observed in 60 patients (40%), predominantly in overt hypothyroidism (50%) and overt hyperthyroidism (25%). Lipid profile analysis revealed elevated total cholesterol (>200 mg/dl) in 70 patients (46.7%), predominantly linked to overt hypothyroidism (60%). Similarly, LDL cholesterol (>150 mg/dl) was elevated in 55 patients (36.7%), primarily associated with overt hypothyroidism (50%) and subclinical hypothyroidism (30%). Low HDL cholesterol (<35 mg/dl) was found in 40 patients (26.7%), most commonly in overt hyperthyroidism (50%), while elevated triglycerides (>170 mg/dl) were detected in 65 patients (43.3%), strongly associated with overt hypothyroidism (45%) and subclinical hypothyroidism (30%).

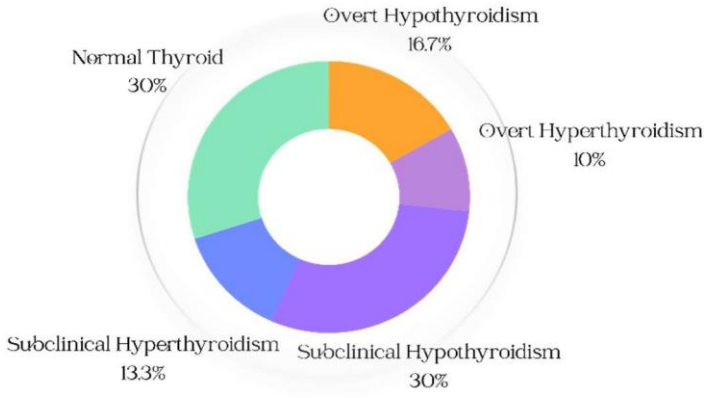

Fig. 2.0 :- Thyroid function analysis

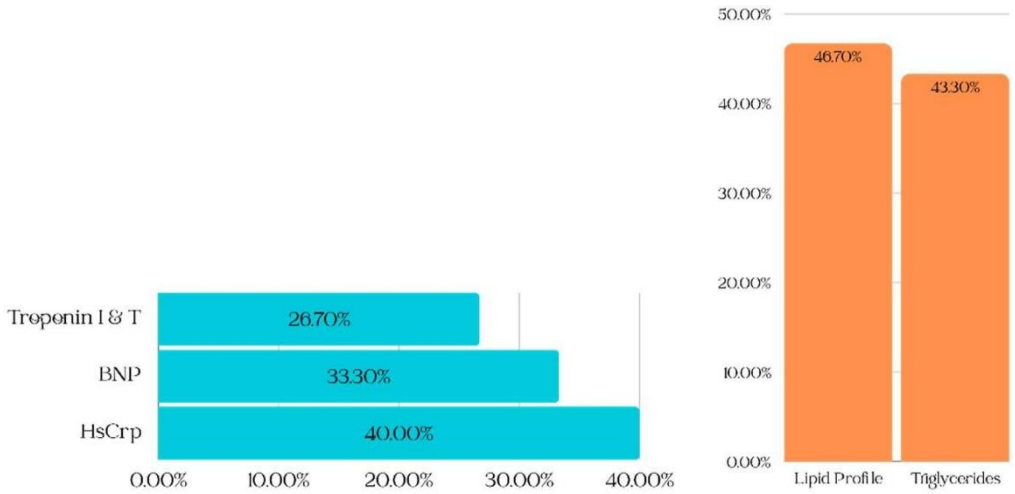

Fig. 3.0 :- Cardiac Biomarker analysis with Lipid profile and Triglycerides

Analysis of the association between thyroid dysfunction and cardiac biomarkers indicated that high TSH levels in hypothyroidism (subclinical and overt) were significantly linked to increased BNP ($p < 0.01$), hs-CRP ($p < 0.01$), and LDL cholesterol ($p < 0.01$). Overt hypothyroidism exhibited the highest levels of total cholesterol, LDL, and triglycerides, with elevated BNP correlating with diastolic dysfunction and heart failure (HFpEF). Conversely, low TSH levels in hyperthyroidism (subclinical and overt) were significantly associated with increased Troponin levels ($p < 0.01$), indicative of myocardial injury, particularly in overt hyperthyroidism. Subclinical hyperthyroidism was linked to elevated hs- CRP levels and a predisposition to arrhythmias ($p < 0.05$), while overt hyperthyroidism strongly correlated with atrial fibrillation and elevated Troponin levels. Subclinical hypothyroidism showed moderate associations with increased LDL and hs-CRP levels ($p < 0.05$), and subclinical hyperthyroidism was linked to elevated Troponin and hs-CRP levels, indicating early cardiac involvement ($p < 0.05$). These findings highlight the significant interplay between thyroid

dysfunction and cardiovascular health, underscoring the importance of early diagnosis and management.

5. DISCUSSION

The study highlights the significant relationship between thyroid dysfunction and cardiovascular health, emphasizing the need for early diagnosis and management. Subclinical hypothyroidism, observed in 30% of patients, demonstrated moderate elevations in LDL cholesterol and hs-CRP, suggesting its role in early atherosclerosis and systemic inflammation. Overt hypothyroidism (16.7% of patients) was associated with more pronounced metabolic and cardiac dysfunction, including significantly elevated total cholesterol, LDL, triglycerides, BNP, and hs-CRP. These findings suggest overt hypothyroidism contributes to diastolic dysfunction and heart failure with preserved ejection fraction (HFpEF), underlining the importance of lipid and cardiac biomarker monitoring in hypothyroid patients. Hyperthyroidism also revealed notable cardiac implications. Overt hyperthyroidism (10%) was strongly associated with elevated Troponin, indicating myocardial injury, and a predisposition to atrial fibrillation. Subclinical hyperthyroidism (13.3%) exhibited early cardiac involvement, as evidenced by elevated Troponin and hs-CRP levels. These results emphasize the potential cardiovascular risks even in milder forms of thyroid dysfunction. Notably, euthyroid patients accounted for 30% of the study population, serving as an important control group for comparisons. This study reinforces the critical interplay between thyroid hormones and cardiac function, demonstrating that both hypo- and hyperthyroidism contribute to distinct cardiovascular risks. Routine assessment of thyroid and cardiac biomarkers could enhance early detection and mitigate long-term complications.

6. Conclusion

This study highlights the strong association between thyroid dysfunction and cardiovascular health in cardiac patients. Both overt and subclinical thyroid disorders were linked to adverse cardiac biomarkers and lipid profiles, emphasizing the need for routine thyroid function screening in cardiac patients. Early diagnosis and targeted management could reduce cardiovascular morbidity and mortality, underscoring the importance of an interdisciplinary approach involving cardiologists and endocrinologists.

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Conflict of interest

No conflict of interest was found.

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