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A review on thyroid hormones associated with cardiovascular disease

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ABSTRACT: The cardiovascular system is significantly impacted by thyroid hormones, which also have an impact on different organs and metabolic functions. Even small variations in thyroid hormone concentration can affect cardiovascular physiology due to the presence of thyroid hormone receptors in the myocardium and vascular tissue. Endothelial dysfunction, variations in blood pressure, myocardial systolic and diastolic dysfunction, and dyslipidemia are a few possible processes that connect cardiovascular illness to thyroid dysfunction. A hyper dynamic cardiovascular state may result from hyperthyroidism, which is defined by an overproduction of thyroid hormone. High cardiac output and low systemic vascular resistance, which lead to an accelerated heart rate, improved left ventricular function, and an elevated risk of supraventricular tachyarrhythmia's, notably atrial fibrillation, characterize this state. Conversely, cardiovascular function alters with hypothyroidism, which is defined by diminished thyroid hormone action. Changes in myocardial contractility or loading circumstances are the main causes of the modifications in cardiac performance linked to overt thyroid disease. However, subclinical thyroid dysfunction, which is characterized by small but persistent alterations in thyroid hormone levels, might have an adverse effect on cardiovascular health. Increased heart rate, atrial arrhythmias, increased left ventricular mass, impaired ventricular relaxation, decreased exercise capacity, and an increased risk of cardiovascular mortality are all consequences of subclinical thyroid dysfunction.

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INTRODUCTION:

Thyroid hormones, which regulate the development and metabolism of different organs linked to the cardiovascular system, have the circulatory system as one of their primary targets [1]. Thyroid hormones target particular genes by attaching to thyroid hormone receptors and activating ion channels in the heart's cell membranes [2]. In recent decades, subclinical thyroid dysfunction has been identified as a possible risk factor for cardiovascular disease [3]. Patients with overt hyperthyroidism or hypothyroidism frequently have cardiac symptoms and signs because thyroid hormone

affects the heart and vascular system more or less, causing hemodynamic disturbances. Changes in blood volume, heart rate, systemic vascular resistance, left ventricular ejection fraction, and isovolumic relaxation time are among these abnormalities [4]. It is still unclear how thyroid hormone specifically impacts the cardiovascular system. Thyroid hormone, however, may affect hemostasis and control the transcription of genes encoding proteins involved in cardiovascular function, according to research [5]. Poor outcomes in diverse groups of cardiac patients have been linked to low levels of the thyroid hormone triiodothyronine (T3) [6]. Thyroid hormone insufficiency can affect the heart in a number of ways, including reducing cardiac output, raising systemic vascular resistance, delaying the healing of wounds, and impairing the immune system [7].With little and inconsistent evidence available, the prognostic significance of minor thyroid dysfunction in individuals with cardiac illness is still up for debate [8]. Some research claims that moderate thyroid dysfunction is not connected with an increase in cardiovascular deaths, but other investigations have produced unexpected results [9]. The balance of thyroid hormone release is maintained by the hypothalamic-pituitary-thyroid axis [10]. Catecholamines and thyroid hormones interact in a way that increases the binding of beta-receptors, which in turn affects heart rate, cardiac output, contractility, and stroke volume [11].

HYPOTHYROIDISM IN CARDIOVASCULAR DISEASE:

A significant amount of US cohort studies and 5 to 10 % of the general population are affected by the prevalent endocrine disease known as hypothyroidism [12]. Patients with hypothyroidism frequently have abnormal electrocardiograms (ECGs) that show a prolongation of the QT interval and a flattening or inversion of the T wave, among other abnormalities. These ECG alterations show an extension of the cardiac action potential [13]. The prolonged isovolumic relaxation phase and early deterioration of cardiac diastolic function seen in hypothyroid individuals can be attributed to the complicated interplay between the thyroid hormone (T3) and the myocardium [14]. Another common condition is subclinical hypothyroidism, which is a mild form of hypothyroidism that is more common in older people and women [15]. Cardiovascular disorders are more likely to develop as a result of various cardiovascular risk factors, including overt and subclinical hypothyroidism. By increasing the amount of highly atherogenic low-density lipoprotein (LDL) cholesterol particles, causing diastolic hypertension, changing coagulability, and having an immediate impact on vascular smooth muscle, hypothyroidism raises the risk of atherosclerosis. Additionally, hypothyroidism interacts with other heart disease risk factors like insulin resistance and cigarette smoking [16]. Reduced ejection fraction, decreased arterial compliance, an increased risk of heart failure, increased angiotensin-aldosterone axis activation, increased vasoconstriction, increased sympathetic activity, decreased renal blood flow, and decreased glomerular filtration rate are other symptoms of subclinical hypothyroidism [17]. Triglyceride (TG) and low-density lipoprotein (LDL) cholesterol levels are higher in hypothyroid people. These increases are explained by modifications in LDL receptor expression and lipoprotein lipase activity. When hypothyroidism is left untreated, these lipid abnormalities have a significant impact on the emergence of atherosclerosis [18]. Hypothyroid patients have greater TG and LDL cholesterol values than controls [19]. Oxidative stress and coronary lipid risk factors are linked to hypothyroidism and atherogenic dyslipidemia, respectively [20]. Despite the fact that LDL cholesterol is usually acknowledged as the main atherogenic lipoprotein, hypothyroid individuals have decreased clearance of TG-rich lipoproteins. Particularly, remnants of very low-density lipoprotein (VLDL) are important in the development of atherogenesis [21]. These leftovers are ingested by macrophages in the artery walls, causing foam cells to develop, which play a significant role in atherosclerosis [22]. According to recent studies, those with hypothyroidism who have low levels of T3 are more likely to die from heart failure [23]. Since thyroid hormones are so important in controlling the structure and functioning of the left ventricle in the late post-myocardial infarction stage, hypothyroidism is also linked to myocardial infarction [24].

HYPERTHYROIDISM IN CARDIOVASCULAR DISEASE:

Low thyrotropin levels and normal levels of free thyroxine (FT4) and triiodothyronine (T3) are the hallmarks of hyperthyroidism [25]. These hormones alter the cardiovascular system biologically in a number of ways, including by raising heart rate, left ventricular mass, and plasma fibrinogen concentrations [26]. Observational studies have shown a link between

hyperthyroidism and coronary heart disease, as well as an increased risk of atrial fibrillation and cardiac dysfunction [27]. Patients with hyperthyroidism frequently experience cardiac arrhythmias, which appear as irregularities on electrocardiograms including sinus tachycardia and shorter PR and QT intervals [28]. The most typical rhythm abnormality seen in hyperthyroidism patients is sinus tachycardia [29]. Patients who have hyperthyroidism or hypothyroidism may experience cardiac failure [30]. It is essential to detect hyperthyroidism as promptly as possible, even at small levels, to stop the development of more severe problems such as arrhythmias, cardiac enlargement, and increased blood volume, which can eventually cause heart failure. For patients with hyperthyroidism, prompt treatment is crucial to managing these cardiovascular symptoms [31].

PATHOPHYSIOLOGY OF ATRIAL FIBRILLATION:

Decreased expression of m-RNA for L-type calcium channels. KV 1.5 m-RNA is expressed more frequently. Shorter action potential duration was the outcome of the previous modifications, which enhanced outward current and decreased inward current [32].

Action Potential Duration (APD) reduction. Increase in pulmonary vein cardiomyocytes' spontaneous activity. Cardiomyocytes refer to the heart's contraction-causing cells. Increased occurrence of delayed following depolarization in cardiomyocytes of the pulmonary vein that are both beating and not beating. Cardiomyocytes that are beating exhibit increased after-depolarization [33].

PATHOPHYSIOLOGY OF HEART FAILURE:

In the short-term Hyperthyroidism:

Heart blood volume increases, which causes the left ventricular end-diastolic volume to rise. As a result, the systemic vascular resistance decreases, and the left ventricular end-diastolic volume increases. The previous problem also causes an increase in heart rate and stroke volume. Heart failure arises as a result of the increased cardiac output.

In the long-term Hyperthyroidism:

Increased cardiac workload and left ventricular large quantities cause the heart's inability to recover properly. As a result, they cause the atrial heart to get larger and the artery walls to become thicker. The risk of heart failure, atrial fibrillation, and coronary heart disease rises as a result of the walls' stiffness [34].

DISCUSSION:

Studies have revealed that abnormalities in lipid profile elements, such as increased triglycerides and LDL cholesterol, are linked to hypothyroidism. These lipid alterations are very important in the growth of atherosclerosis in hypothyroidism that is left untreated. Additional factors that aid in this process include oxidative stress, atherogenic dyslipidemia, and changed coronary lipid risk factors such as lipid peroxidation [35]. While it is well known that LDL cholesterol is a primary atherogenic lipoprotein, hypothyroidism also results in decreased clearance of triglyceride-rich lipoproteins, particularly chylomicron remnants. Foam cells, which are a risk factor for atherosclerosis, are created when these leftovers build up in the artery walls. An elevated risk of cardiovascular disease is linked to high thyroid dysfunction. Increased thyroid hormone levels may affect myocardial contractility, and heart rate, and encourage hypercoagulability [36]. Higher thyroid hormone levels can also increase oxygen consumption and the creation of reactive oxygen species, which can cause DNA damage and cell death. According to the 2013 cholesterol guidelines from the American College of Cardiology (ACC) and the American Heart Association (AHA), a diagnosis of hypothyroidism is consistently associated with higher levels of LDL cholesterol and triglycerides. In conclusion, hypothyroidism impacts lipid metabolism and raises the risk of dyslipidemia and other cardiovascular risk factors. Patients with thyroid dysfunction should be managed taking into consideration of these effects, which are changeable [37].

CONCLUSION:

The goal of our study was to compare the life expectancy (LE) of people with hypothyroidism, euthyroidism, and hyperthyroidism with regard to cardiovascular disease (CVD). The primary study showed that patients with hypothyroidism had higher life expectancies than those with euthyroidism. We found gender-specific differences in the number of years lived with and without CVD among hyperthyroid patients. In addition, our results are consistent with earlier studies showing higher atherogenic markers in hypothyroid patients, which raise their risk of cardiovascular disease. Numerous studies have also suggested that changes in thyroid hormone metabolism and changes in thyroid

function may play a role in the development of cardiovascular disease.

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