Original Research Article

A comparative study of autonomic status in hypothyroid and euthyroid subjects

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Abstract

Background and Objective: Thyroid hormones have a profound effect on every tissue in the body. The cardiovascular system is one of the most important targets of thyroid hormone affecting either directly or indirectly which may be due to changes at the autonomic nervous system level. Hence hypothyroidism is associated with changes not only in cardiac and vascular function but is also believed to alter the autonomic regulation of heart. Though most of the time the complications related to autonomic dysfunction remains unnoticed, it is possible to prevent the development of various complications related to autonomic dysfunction by early diagnosis and treatment. Therefore the present study was undertaken to assess the autonomic status in newly detected hypothyroid female patients (cases) and euthyroids (controls) and compare the autonomic status between hypothyroid patients and euthyroids. **Methods:** 30 newly detected cases of hypothyroid female patients between the age group of 20-50years were selected from SDM College of Medical Science and Hospital, Sattur, Dharwad.30 age and sex matched individuals who are euthyroids were taken as controls. Height, weight and body mass index were recorded. Pulse rate, blood pressure and corrected QT interval were recorded in a resting condition. Cardiovascular autonomic function was studied by testing the sympathetic activity (Blood pressure response to immediate standing, cold pressor test, and sustained handgrip exercise) and parasympathetic activity (Heart rate variation at rest, during deep breathing and during Valsalva manoeuvre). **Result:** Result were analyzed by unpaired 't' test. In hypothyroid patients the BMI was significantly high. In there sting condition, the heart rate was significantly decreased, diastolic blood pressure was increased, and QT interval was normal. When tested for the sympathetic activity, Blood pressure response to immediate standing and cold pressure test did not show any significant difference when compared with euthyroids. Sustained handgrip test showed significant change in the diastolic blood pressure. Test reflecting the parasympathetic activity that is, heart rate variability (HRV) at rest showed significant smaller HF(MS2) values, higher LF (n.u) values and higher values of LF/HF ratio. Whereas the heart rate response to deep breathing and valsalvamanuovre did not show any significant changes. **Conclusion:** The findings of the present study show that the autonomic status in hypothyroid patient is altered, and there is increased sympathetic activity and decreased parasympathetic activity.

Key Words: Hypothyroidism, cardiovascular system, Sympathetic activity, Parasympathetic activity, sympathovagal balance.

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INTRODUCTION

Hypothyroidism is the most common clinical endocrine disorder of thyroid function, which is due to decrease in the synthesis and secretion of thyroid hormone thyroxine (T4) and triidothyronine (T3).[1] 99% of hypothyroidism cases are due to primary hypothyroidism, which may be caused by an abnormality in the thyroid gland itself and 1% of the cases are due to secondary and tertiary or central hypothyroidism, which may result from pituitary or hypothalamicdiseases.[2] Though the studies done in Indian population have assessed the autonomic status in thyroid dysfunction, but very less data is available on the

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changes in autonomic functions affecting cardiovascular system. Hence the present study was undertaken to assess the autonomic status in newly detected hypothyroid female patients attending SDM medical college, Sattur, Dharwad during the period, December 2010 to November 2011.

AIMS AND OBJECTIVES

1. To study the autonomic status of cardiovascular system in newly diagnosed hypothyroid patients(Cases).
2. To study the autonomic status of cardiovascular system in euthyroid (Controls)
3. To compare the autonomic status between hypothyroid patients and euthyroids (Cases andcontrols).

METHODOLOGY

The study was conducted in the laboratory set up of department of Physiology, SDM College of Medical Sciences and Hospital, Dharwar from December 2010 to November 2011.

Source of data:

Newly detected cases of hypothyroidism were taken from out patient department (OPD) of medicine, SDM College of Medical Sciences And Hospital, Sattur,Dharwad. Age and sex matched controls (euthyroids) were randomly selected from the same institution.

Method of collection of data:

30 newly detected cases of hypothyroid female patients between the age group of 20- 50 years, diagnosed on the basis of general history, clinical examination and by serum levels of FT3, FT4, and TSH were selected. 30 age and sex matched controls that were diagnosed as euthyroids on the basis of general history and clinical examination were randomly selected. Informed written consent for the conduction of study was obtained from hypothyroid patients and healthy controls after the detailed procedure and purpose of the study was explained to them. Institutional Ethical committee approval for the study was obtained. The subjects were categorized into two groups.

Group I - Newly detected case of hypothyroidism, with serum thyroid hormone level47 FT3 < 1.4 pg/ml. FT4 < 0.8 ng /dl TSH >5.6µIu/ml

Group I I- Normal healthy controls

INCLUSION CRITERIA:

-Newly detected hypothyroid patients.

-Female patients with age group of 20-50 years.

EXCLUSION CRITERIA:

-Previously diagnosed case of hypothyroidism and who are on treatment

-Persons with a history of diseases which are known to affect autonomic functions for example diabetes mellitus, renal diseases, psychiatric disease, electrolyte imbalance, cardiovascular diseases, central and peripheral nervous system diseases, anemia and pregnancy.

-History of acute / chronic infections.

Investigations: Cases of hypothyroidism were selected based on the estimations of serum FT3, FT4 and TSH levels in the hospital laboratory of biochemistry department. Estimations of serum FT3, FT4 and TSH levels were done by Acculite CLIA Microwellschemiluminesce Immunoassay manufactured by Monobind INC.U.S.A.

Methods of assessment of cardiovascular autonomic function tests

The following Six established autonomic functions tests were performed .Results of the tests were expressed as ratios and differences which have been accepted by Ewing and Clarke.

Test for sympathetic activity or (sympathetic function tests)

1. Blood pressure response to immediatestanding
2. Blood pressure response to Cold pressortest
3. Blood pressure response to sustained hand gripexercise

Test for parasympathetic activity or (parasympathetic function tests)

4. Heart rate variation during deepbreathing
5. Heart rate response during Valsalvamanoeuvre
6. Heart rate variability by power spectral analysis (PSA) at rest.

RESULTS

Mean and standard deviation (SD) values were evaluated for all measured parameters. The significance of difference in the mean value was analyzed using unpaired "t" test.

Age and Body mass index (BMI)

TABLE 4: MEAN AND SD OF AGE AND BMI BY STUDY GROUPS (CASES AND CONTROLS)

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t"value	„p" value	Significance
Age (yrs)	36.43±8.51	36.43±8.51	0.00	1.00	NS
BMI (kg/m²)	26.49±5.48	20.61±3.02	t=5.15	<0.05	S

*p<0.05

The mean and SD of age of study samples in cases (36.43±8.51) and control (36.43±8.51) groups are similar (t=0.00, p=1.00). A significant difference is observed between cases and controls with respect to BMI scores (t=5.15, p<0.05). The cases (26.49±5.48) have significantly higher BMI scores as compared to controls.

TABLE 5: MEAN AND SD SCORES OF THYROID PROFILES (FT_3PG/ML, FT_4 NG/DL AND TSH MIU/ML) IN CASES

Thyroid profiles	Mean	SD
FT_3pg/ml	1.72	0.71
FT_4 ng/dl	0.66	0.36
TSHμIU/ml	31.67	21.89

Results of the above table present the Mean and SD scores of thyroid profiles (FT3pg/ml, FT4 ng/dl and TSH μIU/ml) in cases.

TABLE 6: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO PULSE SCORES, SYSTOLIC, AND DIASTOLIC BLOOD PRESSURE (SBP AND DBP)

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
Pulse rate (bpm)	71.50±5.86	75.30±7.29	t=-2.22	<0.05	S
SBP (mm Hg)	126.13±21.19	118.53±11.86	t=1.71	>0.05	NS
DBP (mm Hg)	81.73±12.21	76.47±6.72	t=2.07	<0.05	S

*p<0.05

A significant difference is observed between cases and controls with respect to pulse scores (t=-2.22, p<0.05). The cases (71.50±5.86) have significant smaller pulse scores as compared to controls (75.30±7.29). A non-significant difference is observed between cases and controls with respect to Systolic BP scores (t=1.71, p>0.05). The cases (126.13±21.19) and controls (118.53±11.86) have similar Systolic BP scores. A significant difference is observed between cases and controls with respect to Diastolic BP (mm /Hg) scores (t=2.0694, p<0.05). The cases (81.73±12.21) have significant higher Diastolic BP (mm /Hg) scores as compared to controls (76.47±6.72Corrected QT interval (QTC).

TABLE 7: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO QTC SCORES

Parameter	Cases Mean ± SD	Control Mean ± SD	„t" value	„p" value	Significance
QT_C	400.20±68.68	381.53±15.97	t=1.45	>0.05	NS

A non-significant difference is observed between cases and controls with respect to QTC scores (t=1.45, p>0.05). The cases (400.20±68.68) and controls (381.53±15.97) have similar QTC scores.

TABLE 8: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO SYSTOLIC AND DIASTOLIC BP (SBP ANDDBP) DURING IMMEDIATE STANDING (MM /HG).

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
SBP (mmHg) during immediate standing	117.87±20.45	111.67±12.51	t=1.42	>0.05	NS
DBP(mm Hg)during immediate standing	78.07±12.35	73.87±6.08	t=1.67	>0.05	NS

A non-significant difference is observed between cases and controls with respect to Systolic BP on immediate standing (mm /Hg) scores (t=1.42, p>0.05).The cases (117.87±20.45) and controls (111.67±12.51) have similar Systolic BP scores on immediate standing (mm/Hg). A non-significant difference is observed between cases and controls with respect to diastolic BP on immediate standing (mm /Hg) scores (t=1.67, p>0.05).The cases (78.07±12.35) and controls (73.87±6.08) have similar diastolic BP scores on immediate standing (mm/Hg).

TABLE 9: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO SYSTOLIC AND DIASTOLIC B (SBPANDDBP) DURING COLD PRESSOR TEST (MM /HG)

Parameter	Cases Mean ± SD	ControlsMean ± SD	„t" value	„p" value	Significance
SBP (mmHg) during cold pressor test	129.73±20.75	126.93±10.32	t=0.66	>0.05	NS
DBP (mm Hg) during cold pressor test	82.40±10.70	81.73±6.58	t=0.29	>0.05	NS

A non-significant difference is observed between cases and controls with respect to Systolic BP on Cold pressor test (mm /Hg) scores (t=0.66, p>0.05).The cases (129.73±20.75) and controls (126.93±10.32) have similar Systolic BP scores on Cold pressor test (mm/Hg). A non-significant difference is observed between cases and controls with respect to diastolic

BP on Cold pressor test (mm /Hg) scores (t=0.29, p>0.05). The cases (82.40±10.70) and controls (81.73±6.58) have similar diastolic BP scores on Cold pressor test (mm /Hg).

TABLE 10: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO SYSTOLIC AND DIASTOLIC BP (SBPANDDBP) DURING HANDGRIP TEST (MM /HG)

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
SBP (mm Hg) during hand grip test	138.60±19.12	134.00±9.14	t=1.19	>0.05	NS
DBP (mm Hg) during hand grip test	90.53±9.58	85.33±6.27	t=2.49	<0.05	S

*p<0.05

A non-significant difference is observed between cases and controls with respect to Systolic BP on Handgrip test (mm /Hg) scores (t=1.19, p>0.05). The cases (138.60±19.12) and controls (134.00±9.14) have similar Systolic BP scores on Handgrip test (mm /Hg). A significant difference is observed between cases and controls with respect to diastolic BP on Handgrip test (mm /Hg) scores (t=2.49, p<0.05). The cases (90.53±9.58) have significant higher diastolic BP on Handgrip test (mm /Hg) scores as compared to controls (85.33±6.27).

TABLE 11: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO HEART RATE (HR) VARIATION DURING DEEP BREATHING

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
HR (bpm) variation during deep breathing	27.17±8.60	24.30±6.14	t=1.49	>0.05	NS

A non-significant difference is observed between cases and controls with respect to HRV during deep breathing (Beats /min) scores (t=1.49, p>0.05). It means that, the cases (27.17±8.60) and controls (24.30±6.14) have similar HRV during deep breathing (Beats /min).

TABLE 12: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO HEART RATE RESPONSE DURING VALSAVAMANOEUVRE (VALSALVA RATIO)

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
HR (bpm) Response during Valsalva manoeuvre (valsalva ratio)	1.42±0.26	1.48±0.16	t=-1.16	>0.05	NS

A non-significant difference is observed between cases and controls with respect to HRV during Valsavamanoeuvre (Valsalva Ratio) scores (t=-1.16, p>0.05). The cases (1.42±0.26) and controls (1.48±0.16) have similar HRV during Valsavamanoeuvre (Valsalva Ratio).

TABLE 13: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO LF (MS^2) AND HF (MS^2) SCORES IN HRV DURING REST

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p"value	Significance
LF(ms^2) (HRV by PSA at rest)	268.93±204.29	313.33±195.55	t=1.19	>0.05	NS
HF(ms^2) (HRV by PSA at rest)	262.67±197.62	495.37±327.07	t=-3.34	<0.05	S

*p<0.05

A non-significant difference is observed between cases and controls with respect to LF (ms2) scores (t=1.19, p>0.05). The cases (268.93±204.29) and controls (313.33±195.55) have similar LF (ms2) scores. A significant difference is observed between cases and controls with respect to HF (ms2) scores (t=-3.34, p<0.05). The cases (262.67±197.62) have significant smaller HF (ms2) scores as compared to controls (495.37±327.07).

TABLE 14: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO LF (N.U), HF (N.U) SCORES IN HRV DURING REST

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
LF(n.u) (HRV by PSA at rest)	51.42±13.65	42.49±16.33	t=2.30	<0.05	S
HF(n.u) (HRV by PSA at rest)	48.19±13.58	53.81±16.61	t=1.43	>0.05	NS

*p<0.05

A significant difference is observed between cases and controls with respect to LF (n.u) scores (t=2.30, p<0.05). The cases (51.42±13.65) have significant higher LF (n.u) scores as compared to controls (42.49±16.33). A non-significant difference is observed between cases and controls with respect to HF(n.u) scores (t=1.43, p>0.05). The cases (48.19±13.58) and controls (53.81±16.61) have similar LF (n.u) scores.

TABLE 15: COMPARISON OF CASES AND CONTROLS WITH RESPECT TO LF/HF RATIO SCORES IN HRV DURING REST

Parameter	Cases Mean ± SD	Controls Mean ± SD	„t" value	„p" value	Significance
LF/HF ratio (HRV by PSA at rest)	1.25±0.72	0.80±0.48	t=2.85	<0.05	S

*p<0.05

A significant difference is observed between cases and controls with respect to LF/HF scores (t=2.85, p<0.05). The cases (1.25±0.72) have significant higher LF/HF scores as compared to controls (0.80±0.48).

DISCUSSION

Thyroid hormones are the major regulators of the metabolism which in turn has a direct impact on autonomic nervous system. Affection of cardiovascular system is one of the most frequent and most serious clinical manifestations of thyroid dysfunctions. The autonomic nervous system maintains the internal physiological homeostasis. Any abnormalities in the autonomic function results in diverse clinical manifestations. The assessment of autonomic functions is an important part of the evaluation of peripheral and central nervous system. A number of autonomic function tests are considered reliable, noninvasive, reproducible, simple and quick to carry out. With this background information, the autonomic functions in hypothyroidism mainly affecting the cardiovascular system are discussed as below:

Since age and sex of cases and controls were matched, age and sex related differences in autonomic tests were avoided. **Body mass index:** In our study, the cases have statistically significant higher BMI scores as compared to controls. Karthik *et al*, also recorded similar results in hypothyroid subjects. According to them, Obesity in hypothyroidism is not a pure increase in adiposity as increase in body weight, in thyroid deficiency is mostly due to accumulation of water and mucopolysaccharides in subcutaneous tissues.[24]

Resting pulse rate: Our study shows that, the cases have significant smaller pulse scores as compared to controls. The study is similar to R.Poliker, A.G. Burger *et al*. Decreased HR is one of the important features of hypothyroidism. In hypothyroidism decreased thyroid hormone decreases the direct chronotropic effect on S.A node and heart, which is attributed to decreased β adrenergic receptor density sensitivity and also due to cardiac chronotropic response to adrenergic stimulation despite evidence of sympathetic over activity. It has also been suggested that decreased binding of catecholamines with β receptors in cardiac myocytes might be responsible for cardiovascular changes in Hypothyroids. Several investigators suggested that though plasma catecholamines are increased in hypothyroidism but overall depression of adrenergic responses at cardiac and peripheral level indicates desensitization both at the receptor or post receptorsite.[12]

Resting blood pressure: Statistically a significant difference is observed between cases and controls with respect to Diastolic BP scores in our study, which shows that, the cases have significant higher Diastolic BP scores as compared to controls.Bhat *et al*, recorded similar readings. 20 -40% of patients with hypothyroidism have hypertension. Diastolic pressure is increased more than the systolic blood pressure. Normally the thyroid hormone decreases the systemic vascular resistance, maintains the blood volume and smooth muscle relaxation of arterioles. In hypothyroidism the increase in diastolic blood pressure is due to increase in systemic vascular resistance, low blood volume and constriction ofarterioles.[21].Corrected QT interval (QTc): In our study, the recording of QT interval did not show any significant change in hypothyroid patients. But Galetta *et al*. recorded the prolonged QT interval in overt hypothyroidism. Experimental evidence suggests that thyroid hormones may selectively prevent the induction of fibrosis, by the inhibition of collagen type 1 synthesis and maintain the ventricular repolarization (QTinterval). Prolonged QT interval is considered to be one of the risk factors for developing arrhythmias. Contradictory findings in our study may be explained on the basis of duration of hypothyroidism.[22]

Autonomic function tests

Sympathetic tests

Blood pressure on immediate standing

Statistically the difference observed in Systolic and diastolic blood pressure on immediate standing between the two groups is not significant. Bhat *et al*. recorded the similar results. The maintenance of an adequate upright blood pressure on immediate standing from lying down position requires a normal baroreceptor mediated feedback loop and an intact sympathetic nervous system.

The result of our study may indicate the intact baroreflex function with stress and intact sympathetic nervoussystem.[21]

Cold pressor test

Our study result is similar to Sushil kumar *et al*. In hypothyroidism there is altered response to β adrenergic receptor. The Nor- adrenaline has more action on α receptors than that on β adrenergic receptor. Due to decreased β adrenergic receptor density and sensitivity there is less stimulation of β adrenergic receptor and less change in heart rate and force of contraction. The test lacks sensitivity because many normal subjects do not have a significant rise of blood pressure on coldimmersion.[26]

Sustained Handgrip test

The result of our study result is similar to Sushil kumar *et al*. The result can be explained as follows. In hypothyroidism decreased thyroid hormone decreases the direct chronotopic effect on S.A node and heart leading to bradycardia and decreased myocardial contractility, which is attributed to decreased β adrenergic receptor density and sensitivity. Even though there is increased sympathetic stimulation, there is less effect on β adrenergic receptor and less change in heart rate and force of contraction.[26] Sympathetic stimulation liberates Nor-adrenaline, which has more action on α receptors than that of β adrenergic receptor. In hypothyroidism direct stimulation of VMC lead to release of Nor-Adrenaline at the sympathetic nerve endings, which stimulates α receptors. This in turn increases systemic vascular resistance, aortic stiffness hence the diastolic blood pressure.

Parasympathetic tests

Heart rate response to deep breathing

In our study, non-significant difference is observed between cases and controls with respect to HRV during deep breathing, which is similar to Inkui et.al. Sinus arrhythmia consists of a variation in the heart rate with an increase heart rate during inspiration and decrease heart rate during expiration. It is a normal phenomenon and is due to fluctuation in the parasympathetic outflow to the heart rate. Hence the above result shows that the efferent parasympathetic or vagal (tone) activity is unaffected.[11] Heart rate response during Valsalva manoeuvre (valsalvaratio) A non-significant difference observed between cases and controls with respect to HRV during Valsavamanuovre (Valsalva Ratio) is similar to the results recorded by Bhat *et al*. [21] Valsalva manoeuvre reflects the changes in heart rate and blood pressure secondary to changes in intrathoracic pressure. These reflex changes are mediated through the baroreceptor of aortic arch and carotid sinus. The reflex pathway includes both parasympathetic and sympathetic fibres. Hence our study results show that the baroreflex function mediated via the parasympathetic activity is unaltered.

Heart rate variability by power spectral analysis at rest

Our study result is similar to Ahmed *et al*.Two major components of spectral band, HF Power and HF norm reflect the parasympathetic activity where as LF Power and LF norm reflect sympathetic activity on heart. LF/HF ratio is considered as a marker of sympathovagal balance. In our study Lower values of HF power (ms2) indicate their reduced vagal modulation of heart. Higher values of LF norm (n.u) in cases indicate increased sympathetic activity. Increased LF/HF ratio shows altered sympathovagal balance. So over all there is reduced parasympathetic and increased sympathetic activity. The site of action for thyroid hormone is also likely to be in the central nervous system for reducing the vagal tone, as the iodothyronine compounds have been isolated from various parts of nervous system including hypothalamus and medulla. Increase in sympathetic activity may be due to TRH which directly stimulate sympathetic outflow within the central nervoussystem.[25]

CONCLUSION

The following conclusions were drawn based on the analysis of results:

Body mass index (BMI) was significantly increased in hypothyroid patients, is mostly due to accumulation of water and mucopolysaccharides in subcutaneous tissues. In hypothyroid patients during the resting condition, the pulse rate was significantly decreased may be due to decreased direct effect of thyroidhormone on S.A node and heart. Significant increase in Diastolic blood pressure may be due to increased systemic vascular resistance and normal QT interval indicates less risk for cardiacarrhythmias. With respect to the alteration in autonomic functions, according to our study both sympathetic and parasympathetic activity is affected in hypothyroidism. But alteration in the sympathetic activity is more evident by power spectral analysis of heart rate variability (LF n.u and LF/HF ratio) than that of other tests such as cold pressor test and blood pressure response on immediate standing. Similarly, alteration in the parasympathetic activity is more evident by power spectral analysis of heart rate variability (HF ms2) than that of other tests such as heart variation during deep breathing and Valsalvamanoeuvre. We conclude that the autonomic status in hypothyroidism is altered; there is increased sympathetic activity and decreased parasympathetic activity. Power Spectral Analysis of HRV was more sensitive than conventional autonomic function tests in assessing autonomic dysfunction.

LIMITATION OF THE STUDY

- Wide range of age group, which may influence autonomic function
- The sample size is small
- Lipid profile is not done incases
- Euthyroid status in controls is not supported by laboratory investigation.

SCOPE OF THE STUDY

- In future the study can be continued on larger number of subjects
- To know the reversibility of autonomic function the same study can be repeated after the correction of hypothyroidism.

REFERENCES

1. Braverman LE, Utiger RD. Introduction to hypothyroidism. Werner and Ingbars the thyroid fundamental and clinical text.9th ed. Lippincott williams and wilkinspublication.2005;p.697.
2. Shah SN. API text book of medicine .8th ed. Associations of physicians of India, Mumbai.vol2.2008;p.1007.
3. Degroot LJ, Jameson JL.Endocrinology.4th ed. W.B Saunders Company. Vol 2.2001;p.268.
4. Boelaert k, Franklin JA. Thyroid hormone in health and disease. JEndocrinol.2005;187(1):1-15.
5. Roberts CG, Landenson PW.Hypothyroidism.Lancet.2004;363:793-803.
6. Kerber RE, Sherman B. Echocardiographic evaluation of pericardial effusion inmyxoedema. Circulation. 1975;52:823-7.
7. Wayne EJ. Clinical and metabolic studies in thyroid disease. Br Heart J.1960;78-85.
8. Murray JF, Kelly JJ, Brooklyn NY. The relation of thyroid hormone level to epinephrine response, a diagnostic test for hyperthyroidism. Ann Intern Med.1959;51:309.
9. Levey GS. Catecholamine sensitivity thyroid hormone and the heart.AM J Med.1971;50:413-9.
10. Columbe P, Dussault JH, Walker P. Plasma catecholamine concentration in hyperthyroidism andhypothyroidism.Metabolism.1976;25(9):973-8.
11. Inkuai T, Kobayashi I, Kobayashi T, Ishii A, Yamaguchi T, Yamaguchi Y, *et al*. Parasympathetic nervous system activity in hypothyroidism determined by R-R interval variations on electrocardiogram. J InternMed.1990;228(5):431-4.
12. R Polikar, AG Burger, UScherrer , P Nicod .The thyroid and theheart. Circulation .1993;87:1435–41.
13. McAllister, M Richard, D Michael, Laughlin, Harold M. Thyroid status and exercise tolerance, cardiovascular and metabolic considerations. Sports Med.1995;20(3):189-98.
14. Fadel BM, Ellahham S, Ringel MD, Lindsay J, Wartofsky L , Burman KD. Hypothyroid heart disease. Clin.Cardiol.2000;23:402-8.
15. Caccitori V, Gemma ML, Bellavere F, Castello R, De Gregori ME, Zoppini G, *et al*. Power spectral analysis of heart rate in hypothyroidism. Eur J Endocrinol.2000;143(3):327-33.
16. Foley M, Hasser EM. Thyroid status influences baroreflex function and autonomic contributions to arterial pressure and heart rate. Am J Physiol Heart Circ Physiol.2001;280:2061-8.
17. Xing H, Shen Y, Chen H, Wang Y, Shen W. Heart Rate Variability And Its Response to thyroxine replacement therapy in patient with hypothyroidism. Clin Med J.2001;114:906-8.
18. Klein I, Ojamaa K. Thyroid hormone and the cardiovascular system. N Engl J Med2001;344:501–509.
19. Gautam S, Tandon OP, Awashi R, Sekhri T, Sircar SS. Correlation of autonomic indices with thyroid status. Indian J PhysiolPharmacol.2003;47(2):164-70.
20. Fazio S, Palmieri E A, Lombardi G, Biondi B. Effects of thyroid hormone on the cardiovascular system, recent progress in hormone research.2004;59:31- 50.

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