Effect of Thyroid Disorder on Audio-Visual Reaction Time

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Abstract: Introduction: Reaction time is the time interval between onset of stimulus and occurrence of response. Normal thyroid functions are essential to the attentiveness and alertness. The patients suffering from the thyroid disease have an altered reaction time. Hence, this study was aimed to find any association between thyroid disorders and Reaction Times namely Auditory and Visual. Method: This case control study had a total of 90 subjects included, 60 study subjects having thyroid disorders (hypothyroid and hyperthyroid) and 30 euthyroid cases, aged between 16-45 years. The subjects were evaluated for their anthropometric measure, haemogram estimation, thyroid profile which was followed by the measurement of auditory reaction time and visual reaction time. Result: The results of the ART and VRT values in all the subjects were compared and analysed statistically. Conclusion: The ART & VRT values were increased in subjects having thyroid disorders when compared to their normal control. The Values was found to be higher in hypothyroid subjects when comparison was made amongst the study subjects. [S Gupta , Natl J Integr Res Med, 2018; 9(4):7-12]

Key Words: Auditory Reaction Time (ART), Visual Reaction Time (VRT), hyperthyroid and hypothyroid.

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Introduction: Human body gives desired and purposeful voluntary response to stimulus, within a definite time period. Time response is supposed to be the best indicator for the management of homeostasis which we call as reaction time.[1] Thus reaction time is defined as a time interval between the application of a stimulus and initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as early as possible[2,3] Reaction time has physiological significance and is a simple and non invasive test for peripheral as well as central neural structures.[4] Reaction time is found to be altered by a number of factors both physiological and pharmacological[4,5].

Major factors that affect reaction time are:-Types of reaction time experiments, Stimulus (Auditory, Visual, pain, touch, Temp.), age, gender, cerebral dominance (handedness), central v/s peripheral vision (Pattern of stimulation), distraction, exercise, practice, fatigue. [6]

The reaction time is also affected by mood, memory, psychological states, stress, first time performance and behavioral and mental attitude of the individual.[7] Among all the endocrine diseases present in India, thyroid disorders are the most common and approximately forty two million Indians suffer from the thyroid disorders.[8] Indian thyroid society has declared January month as "Think Thyroid Month" and American thyroid society declared 25th May as "Awareness day of Thyroid".[9]

Thyroid disorder may manifest as:

A). Hyperthyroidism, with overactive thyroid when people very often experience nervousness or anxiety, insomnia, mood swings, irritability and hyperreflexia, light or absent menstrual cycles. Hyperthyroid person at advance age, show myelin deficit which may be due to the damage produce by the oxidative stress generated by an excess of thyroid hormones.[10] Hyperthyroidism has the potential to affect the reaction time.

B). Hypothyroidism, a common form of thyroid disorder. It is highly prevalent in India with 1 out of 10 people in the country diagnosed with the condition. The older population (above the age of 35 years) seems to be at a higher risk of hypothyroidism than the younger population. It is known to be associated with mental retardation, lack of concentration, motor dysfunction, memory deficits, lethargy, visual and hearing impairment, rarely delirium and coma.[11]

Hypothyroidism is also associated to bipolar affective disorders, depression, or loss of cognitive functions, especially in the elderly.[12]

Both, hypothyroidism or hyperthyroidism can lead to mood disorders, dementia, confusion, and personality changes. However, most of these disorders are usually reversible with proper treatment. According to some studies the thyroid disease patients have increased visual and auditory reaction time. A study mentions that the normal thyroid functions are essential to the

attentiveness and alertness, a necessary prerequisite to tests involving measurement of reaction time.[11]

Retardation of peripheral or central processes may be partly a cause for delayed audiovisual reaction time in hypothyroids when compared to Hyperthyroids. [11,13,14] but after the proper treatment of thyroidism, leads to decrease in auditory and visual reaction time.[14]

Hence, this study was taken up to find any association between the Thyroid disorders and Auditory and Visual Reaction Time.

Method: This case control study with a sample size of 90 subjects, was conducted in the Department of Physiology, MGMC&H , Jaipur between May 2016 to April 2017 after getting the institutional ethical committee clearance. The subjects were selected from the Department of Medicine & Endocrinology. The written consent (which was explained in the vernacular language) was taken from all the 90 subjects prior to the tests.

A questionnaire was used to obtain the information regarding their demographic profile, the social, personal and occupational history was also evaluated in detail. The subjects were then subjected for the blood investigations of Haemogram and Thyroid profile estimations. Based on their thyroid profile, according to the Vitros Eci Guideline [15] the subjects were grouped as euthyroid, hyperthyroid and hypothyroid patients. There were 30 subjects in each group.

i) Group I – Controls (Euthyroid subject): 30 normal person
T3 value were in the range of - 0.97 – 1.69 ng/ml
T 4 value were in the range of – 5.53 - 11.0 ug/dl and
TSH value were in the range of – 0.46 – 4.68 uIU/ml

ii) Group II (Hyperthyroid subject): subjects included had their thyroid level as
T3 value - >1.69 ng/ml
T4 value- >11.0 ug/dl and the
TSH value - <0.46 uIU/ml

iii) Group III (Hypothyroid subject): subjects included had their thyroid level as
T3 value was lower than - 0.97 ng/ml
T 4 values was lower than - 5.53 ug/dl and
TSH value was more than - 4.68 uIU/ml

Inclusion Criteria: Newly diagnosed thyroid patient, between the age of 16-45 year, of either sex and having a normal vision and no hearing disability (which was accepted on the basis of self reporting) and who were willing to participate in the study.

Exclusion Criteria:

- Unwilling, unstable and uncooperative patients of thyroid disorders.
- Patient suffering from Obesity, Depression, Diabetes Mellitus, Hypertension.
- Patients with history of drug abuse.

The selected participants were then subjected to the recording of their audio-visual reaction time. The reaction time test was conducted in the department of Physiology in a comfortable and noise free room. The apparatus used to measure reaction time is, 'Research reaction time apparatus' supplied by Medisystem, Yamunanagar. It is a portable device with inbuilt four digit chronoscope with least count of 1/1000 sec i.e. 1 millisecond.

The apparatus has two modes of stimulus: Auditory & Visual. In this system there are two sides – one is operator's side and the other one is trainer's side. The switches on operator's side are responsible to glow the light while switches on trainer's side are to turn off light. Glow any light suddenly and then ask the trainer to turn off light immediately from his side. The time taken by a trainer is called reaction time which is displayed on the screen.Similarly in the second mode there are two different melodies tones. Green light was used for visual stimulus and High pitch (7dB) sound for auditory stimulus. The display indicates the Reaction Time (RT) in seconds. Both the audio and visual stimulus modes were utilized. Subjects were asked to respond to the stimulus given by pressing the response key with the index finger. A total of three readings were taken and averaged for the final reading.

Observations and Result: Descriptive test were used to describe average value of the study parameter like age, body, mass index, haemogram and the auditory reaction time and visual reaction time values.

Unpaired t-test was applying for the test of significance, along with One Way ANOVA which was used to make comparison in between the group. The data are presented as mean, ±SD.

Table 1: Comparison of the variables ie. Age, BMI and Haemogram in the study and euthyroid groups

Groups	n = 90	Age Mean	BMI Mean	Hb% Mean
Euthyroid	30	29.23	22.80	14.58
Hyperthyroid	30	32.40	22.65	14.18
Hypothyroid	30	31.46	22.28	13.98
p Value		0.36	0.58	0.08

n=number of subjects

p value at 0.05, there is non-significant (p>0.05)

Table 2: Comparison of mean ± SD of ART and VRT between study groups

groups	n	ART(sec.)		p value	VRT(sec.)		p value
		Mean	SD		Mean	SD	
Euthyroid	30	0.201	0.029	0.000**	0.205	0.034	0.000**
Hyperthyroid	30	0.359	0.047		0.355	0.051	
Hypothyroid	30	0.395	0.046		0.379	0.040	

n= No. of subjects **= Highly Significant

ART =Auditory Reaction Time VRT= Visual Reaction Time. A statistically significant difference (p<0.001) between control and test groups was found by the using of One-Way ANOVA.

Table 3: Comparison of mean ± SD of AVRT between Control & Hyperthyroid

groups	n	ART(sec.)		p value	VRT (sec.)		p value
		Mean	SD		Mean	SD	
Euthyroid	30	0.201	0.029	0.000**	0.205	0.034	0.000**
Hyperthyroid	30	0.359	0.047		0.355	0.051	

n= No. of subjects **= Highly Significant

ART =Auditory Reaction Time VRT= Visual Reaction Time.

A statistically significant difference (p<0.001) between Euthyroid (control) and hyperthyroid groups was found by the using of One-Way ANOVA.

Table 4: Comparison of mean ± SD of AVRT between Control & Hypothyroid

Groups	n	ART(sec.)		p value	VRT (sec.)		p value
		Mean	SD		Mean	SD	
Euthyroid	30	0.201	0.029	0.000**	0.205	0.034	0.000**
Hypothyroid	30	0.395	0.046		0.379	0.040	

n= No. of subjects **= Highly Significant

ART= Auditory Reaction Time VRT=Visual Reaction Time

A statistically significant difference (p<0.001) between control and hypothyroid groups was found by using One-Way ANOVA.

Table 5: Comparison of mean ± SD of AVRT between Hyperthyoid & Hypothyroid

groups	n	ART(sec.)		P value	VRT (sec.)		P value
		Mean	SD		Mean	SD	
Hyperthyroid	30	0.359	0.047	0.004*	0.355	0.051	0.047**
Hypothyroid	30	0.395	0.046		0.379	0.040	

n= No. of subjects *= Significant

ART= Auditory Reaction Time VRT=Visual Reaction Time

A statistically significant difference of ART and VRT values at (p<0.05) between hyperthyroid and hypothyroid group were found by using One-Way ANOVA.

Discussion: Thyroid hormones are essential for brain maturation, thyroid diseases can lead to various clinical manifestations. Hypothyroidism or Hyperthyroidism can lead to mood disorders, dementia, confusion, and personality changes. Most of these disorders are usually reversible with proper treatment, indicating that thyroid hormone alterations of adult onset do not leave permanent structural defects.[12]

Table no. 1 included the variables which may be responsible for any change in the reaction time recordings. Hence to establish that the study and control group of homogenous, all the mentioned parameters of age, body mass index (BMI) and haemogram values of all the three groups were compared using One Way ANOVA. In our study, the age parameter were found to be statistically non significant when compared between the study and control groups. Other study done by Miles[16] and Bells[17] have reported that the reaction time increases with age and is more at an senescence age rather that the middle age. Chandak[18] et al in their study have compared the two groups for the age 21-45 and 46-60 and reported that there is an increase in the reaction time in the older age group. A similar study done by Batra[19] et al shows that the reaction time in less in younger age group than the older age group. The next parameter of BMI was found to be statistically non significant at p value when compared amongst of three groups. Karthik et al[20] have reported higher body weight in the hypothyroid patient. In our study, the BMI of all subjects was within a normal range which could be because the cases were newly diagnosed cases of thyroid disorder.

Haemogram, when lower than the normal range tends to cause anemia, which has a direct effect on values of reaction times. Thus table no. 1 parameters did not affect the value of reaction time and any changed observed is due to prevailing clinical condition.

Table no. 2 shows the mean and standard deviation of ART and VRT in different studied groups. On comparison using One-Way ANOVA a statistically significant difference was observed between these studied groups. A similar study was reported by Shah SH and Nahar PS (2012),[14] who reported Audio-Visual reaction time to be significantly higher in hyperthyroid and hypothyroid patient when compared to euthyroid.

Table no. 3 shows intergroup comparison between euthyroid and hyperthyroid, the mean value of ART and VRT was found to be significantly higher in hyperthyroid subjects as compared to euthyroid at p value (0.000).

It is known well fact, that the thyroid hormone affect myelination, thus any increase in the level of these thyroid hormones may lead to oxidative damage to the myelin membrane[8,11] leading to decrease in conduction velocity of nerve impulse to the effector organ which may be responsible for increase in reaction time observed in our study.

A study "Neuromuscular findings in thyroid dysfunction: a prospective clinical and electrodiagnostic study" done by Duyff et al.[21] found that 52% of patients had symmetric proximal muscle weakness. The muscle weakness in hyperthyroidism occurs often, evolves rapidly, and is severe; recovery is fast and good. Because of the significant correlation between severity of hyperthyroidism and clinical muscle weakness, it may be better to speak of a functional muscle disorder in hyperthyroidism.

Thus the increase in reaction time (ART and VRT) observed in our study in patients of hyperthyroidism may be due to a combined effect of change in the state of myelination and a functional muscle weakness leading to decrease in conduction velocity of sensory nerve impulse and decrease effector organ response. This explanation appears to be plausible as the patients included in our study were freshly diagnosed untreated cases of hyperthyroidism. Another possible cause may be due to the sensori motor axonal neuropathy which occur in about 20% of the patients of hyperthyroidism.[21]

Table no. 4 shows the auditory reaction time and visual reaction time to be significantly higher in hypothyroid patient than control (euthyroid) subjects. This is probably because of generalized decrease in metabolic rates, affecting the sensory receptors, neural pathways and skeletal muscles also. The thyroid hormone is necessary for the maintenance of normal basal metabolic rate by acting on protein, carbohydrate and lipid metabolism.[14]

It is a known fact that thyroid hormone has profound effect on functions on central as well as peripheral nervous system.[22] Thyroid hormone deficiency, even

of short duration may lead to irreversible brain damage, the consequences of which depend not only on the severity, but also on the specific timing of onset and duration of the deficiency.[11,23] Similar findings have also been reported by Vedavathi KJ et al (2013) in their study showed that hypothyroid patients had longer reaction times which were statistically highly significant.[13]

On further analyzing, by comparing mean of ART and VRT in hypothyroid and hyperthyroid subjects by applying One-Way ANOVA a statistically significant difference was found in both ART and VRT values (**table no. 5**). It was also observed that the mean value of ART and VRT was higher in hypothyroid subject. Deficiency of thyroid hormone effect the sensory perception, that causes slow reflex. Sivaraj et al[24] performed a test to evaluate the effect of thyroid on sensory perception, mental speed, neuronal excitability and ion channel regulation. Their study indicate that the most prominent symptom after four weeks of thyroid hormone withdrawal is beginning decline in the speed of central neural information processing, which are reflected in decrease in the speed of visual perception, speed of speech as well as of visual spatial orientation. Hearing and smelling thresholds was slightly changed, reflecting that thyroid hormone deficiency causes a general decrease in neuronal excitability.

Summary and conclusion: The result also showed that the ART and VRT was found to be higher in the hypothyroid patient when compared to the hyperthyroid patients and also the ART and VRT were increased in thyroid disorders when compared to their normal controls.

The factors which may be responsible for this increase in the reaction time the thyroid patient could be the slowing of the basal metabolic rate in the hypothyroid structural changes in the auditory and visual perception pathway leading to delayed perception. In hyperthyroid patients there is damage to the myelin sheath, along with possible functional muscle weakness causing delayed reaction due to ineffective effector organ response.

Thus it can be concluded that both ART and VRT were significantly increased in patients of hyperthyroidism and hypothyroidism when compared to the normal euthyroid patient.

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