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Original Research Article

Visual and Auditory Reaction Time in the Hands of Individuals with Endocrine Disorders like Hyperthyroidism

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Abstract

Background: In this study, we wanted to assess the visual and auditory reaction time in the hands of individuals with an endocrine disorder like hyperthyroidism.

Methods: The present study was conducted on 50 male hypothyroid patients, 50 male hyperthyroid and 50 male healthy subjects who were attending the OPD of Dr. M. H. Patwardhan's Endocrine Research Centre, Miraj.

Results: Reaction time in hypothyroid patients was increased and it was statistically highly significant. Reaction time in hyperthyroid patients was also increased and statistically highly significant.

Conclusions: Reaction time can be used for mass screening of patients with thyroid disease, and for follow-up of thyroid patients.

Keywords: Visual, Auditory, Reaction Time, Hands, Individuals, Endocrine Disorder, Hypothyroidism, Hyperthyroidism.

Introduction

Reaction time is the time interval between the application of stimulus & response obtained. It includes the time taken for central delay. Psychologists have named three basic kinds of reaction time experiments (Luce 1986, Welford 1980).

Simple: In reaction time experiments, there is only one stimulus and one response e.g. spot the dot and reaction to sound all measure simple reaction time.

Recognition: In reaction time experiments, some stimuli should be responded to (the memory set) and others should get no response (the distractor set). There is still only one correct response. Symbol recognition and tone recognition are both recognition experiments.

Choice: In reaction time experiments, the user must give a response that corresponds to a letter if the letter appears on the screen.

Mean reaction times: For about 100 years, the accepted figures for simple reaction times for college-age individuals have been about 190ms (0.19 sec) for light stimuli and about 160ms for sound stimuli (Galton, 1899 Fieandt et al. 1956 Welford. 1980, Brebner and Welford 1980).

Simple versus Recognition versus Choice reaction time- The pioneer reaction time study was that of Donders (1868). He showed that a simple reaction time is shorter than a choice reaction time & that the recognition reaction time is the longest of all. Laming (1968) concluded that simple reaction time averaged 220 msec,

but recognition reaction times averaged 384 msec. This is in line with many concluding that a complex stimulus (e.g. several letters in symbol recognition Vs one letter) elicits a slower reaction time (Brebner & Welford 1980, Teichner & Krebs 1974 Luce 1986). [1,2]

Such reaction time depends on various factors e.g. age, gender, fatigue, distraction, warnings, order of presentation, punishment, exercise etc. It may also depend on long-term & recent memory learning ability, criticism, perception & visuoperceptual skills.

Thyroid disorders can affect the nervous system. Thyroid hormones are essential for the development of the nervous system as well as the functioning of the nervous system and nerve conductions. Hence reaction time may get affected by any of the thyroid hormone abnormalities.

Reaction time is an important parameter to evaluate the nervous system. It is dependent on several factors starting from nerve conduction to coordinating systems in the central nervous system of our body including long-term and recent memory learning ability, criticism, perception and visuoperceptual skills.

So, it proves to be an important parameter for assessing the factors affecting reaction time. Also, it is a very easy, cheap and non-invasive test as compared to other expensive tests, for example, nerve conduction studies, electromyography etc.

Aims and Objectives

To record the visual and auditory reaction time in the hands of individuals with an endocrine disorder like hyperthyroidism.

To compare visual and auditory time in hands of individuals with and without hypothyroidism.

Methods

The present study was conducted on 50 male hypothyroid patients, 50 male hyperthyroid patients and 50 male healthy subjects who were attending the OPD of DR. M. H. Patwardhan's Endocrine Research Centre, Miraj.

The criteria applied for the selection of healthy subjects were:

1. Age group-30 to 50 years, males.
2. Health status- the health status of the subject was checked with the following points.

a. History taking- detailed history regarding any past or present disease was taken and also a history regarding any habits like tobacco chewing or alcoholism, and smoking was taken.
b. General and systemic examination: - it was carried out to rule out any gross systemic involvement.
c. Investigations: - the investigations like blood sugar levels and thyroid hormone levels to rule out thyroid and diabetic disorders were carried out.

The criteria for the selection of hypothyroid patients were: -

1. Age group- 30 to 50 year old male patients with minimum 2 years of history of hypothyroidism.
2. Health status- the hypothyroid status of the subjects was confirmed by history and thyroid hormone level estimations and blood glucose levels were estimated to rule out diabetes.

The selection of patients with the endocrine disease was done after matching the factors which may affect reaction time.

Reaction time was determined by an instrument called a response analyzer which could measure the reaction time in milliseconds. The response analyzer is a very advanced instrument to measure the performance of human beings in the field of reflexes to various types of stimuli.

Results

Table 1: Mean & standard deviation values in visual and auditory reaction time of hands in normal and hypothyroid patients.

Parameter	Visual Reaction Time				Auditory Reaction Time			
	Normal		Hypothyroidism Patients		Normal		Hypothyroidism	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R H	184.12	12.19	267.1	9.12	203.34	11.69	293.62	16.26
L H	196.02	12.17	279.44	15.42	197.62	6.09	306.72	16.16

Table 2: [A] Results of S.E. test for visual reaction time hypothyroidism

Sr. No.	Parameter	S.E. Test		'P' Value
		SE (X1-X2)	Z	
1	RH	2.15	38.59	P < 0.005
2	LH	2.77	30.11	P < 0.005

Table 3: [B] For auditory reaction time for hypothyroidism

Sr. No.	Parameter	S.E. Test		'P' Value
		SE (X1-X2)	Z	
1	RH	2.71	33.37	P < 0.005
2	LH	2.43	44.89	P < 0.005

This shows that reaction time in hypothyroid patients is increased, and it is statistically highly significant.

Table 4: Mean & Standard Deviation Values in Visual and Auditory Reaction Time of Hands in Normal and Hypothyroid patients.

Parameter	Visual Reaction Time				Auditory Reaction Time			
	Normal		Hyperthyroid		Normal		Hyperthyroid	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R H	184.12	12.19	246.42	13.6	203.34	11.69	266.44	13.62
L H	196.02	12.17	268.72	13.38	197.62	6.09	278.44	13.62

Table 5: Results of S.E. Test for Visual Reaction Time for Hyperthyroid patients

Sr. No.	Parameter	S.E. Test		'P' Value
		SE (X1-X2)	Z	
1	RH	2.58	24.14	P < 0.005
2	LH	2.55	24.58	P < 0.005

Table 6: Auditory Reaction Time

Sr. No.	Parameter	S.E. Test		'P' Value
		SE (X1-X2)	Z	
1	RH	2.51	25.13	P < 0.005
2	LH	2.10	38.46	P < 0.005

This shows that reaction time in hyperthyroid patients is increased, and it is statistically highly significant.

Discussion

Hypothyroidism

In the present study, the visual and auditory reaction times of RH and LH were recorded into two groups.

GROUP 1: comprised of 50 healthy male individuals in the age group 30-50 years.

GROUP 2: comprised of 50 male hypothyroid patients of age 30- 50 years.

All patients gave a history of hypothyroidism for not less than 2 years.

The observations were recorded and tabulated as per the section "observations and results". The values of reaction time for the right hand in case visual reaction time were 184.12 (mean) ± 12.19 (SD) msec. The values of reaction time for the left hand in the case of visual reaction time were 196.02(mean) ±12.17 (SD) msec. The values for auditory reaction time for the right hand were 203.34 (mean) ± 11.69 (SD) msec. The values for the left hand were 197.62 (mean) ± 6.09 (SD) msec. But the values for hypothyroidism patients for right-hand visual reaction time were 267.1 (mean) ± 9.12(SD) msec and for the left hand 279.44 ± 15.42 mesc. The values for auditory reaction time were 293.52 ± 15:26 msec for the right hand and 306.72 ± 16.15 msec for the left hand. Thus, the reaction time is significantly prolonged in hypothyroid patients which is statistically significant.

Similar results have been obtained by the following researchers:

The aim of a study done by Jonderko G. et al [3] was to answer the question of whether a determination of psychical reaction time may be useful for monitoring the treatment of hypothyroidism & hyperthyroidism.

They have shown that simple reaction time as well as choice reaction time was prolonged in hypo or hyperthyroidism. They have also documented the usefulness of simple reaction time & CRT for the determination of diagnosis & therapy maintaining functional disturbances of the thyroid gland.

Also, our results match completely with the study done by Pardeshi et al [4] where he determined simple reaction time to different stimuli in his research and he has shown that there is a significant prolongation of reaction time in primary hypothyroidism as well as hyperthyroidism and after thyroxine therapy found an early and significant improvement in S.R.T. (simple reaction time) for auditory stimuli.

He found a significant correlation between Ser. Thyroxine and S.R.T. to various stimuli ($P < 0.05$) Simple reaction time to various stimuli in hypothyroid at the beginning of treatment is significantly prolonged as compared to the euthyroid state ($P < 0.001$).

In agreement with our results on simple reaction time, following research can be quoted which indicates that reaction time is prolonged in patients with hypothyroidism.

In the study of Agnini Lombardi F.A. et al, they have found that reaction times are delayed in iodine-deficient children i.e. hypothyroidism delays reaction time. [5]

Ser Quijano T. et al, have documented that hypothyroid patients have a cognitive deficiency and also reduced attention which is manifested also increased reaction times. After hormonal treatment, a significant improvement occurred in all cognitive functions. [6]

Duffy RF. and Van den Boach J. have demonstrated neuromuscular findings in hyperthyroid and hypothyroid patients suggesting muscular weakness and axonal polyneuropathy in hyperthyroidism at the same time their muscle weakness and slow conduction in nerves in hypothyroid patients. [7]

Kaahsiung has demonstrated that there is a delay in central nerve conduction in hypothyroid patients. This is supported by the study of Lin RT et al and Ichedr EM, et al. [8]

They have documented that hypothyroid patients have peripheral neuropathy in 52%, axonal neuropathy in 9%, myopathy in 9% and CNS affected in 78% of patients. Thus, we suggest that by performing electrophysiological studies in hypothyroid patients even asymptomatic

ones, early in the course of the disease CNS involvement can be detected.

Thus, it can be stated for hypothyroid patients that-

There is weakness in muscles and contraction and relaxation are slow.

Decrease in nerve conduction because of neuropathy and mucinous deposits in and around nerve fibres.

Delay in central conduction and transmission of nerve impulses.

Alterations in levels of central neurotransmitters for example Serotonin, Catecholamines.

Because of all these factors' reaction time is prolonged in hypothyroidism.

Thus, there is a prolongation of simple reaction time in patients of hypothyroidism because of the involvement of the peripheral and central nervous systems. Reaction time has physiological significance and can be used to assess the involvement of central and peripheral nervous systems in patients with hypothyroidism. It is a simple, cheap and non-invasive reproducible and sensitive test. On the other hand, neurological techniques like a recording of evoked potentials require special apparatus and it requires great care.

Hyperthyroidism

In the present study, visual and auditory reaction times of RH and LH were recorded into two groups.

GROUP 1: comprised of 50 healthy male individuals in the age group 30-50 years.

GROUP 2- consisted of 50 male hyperthyroid patients of age 30 - 50 years. All patients gave a history of hyperthyroidism for not less than 2 years.

The observations were recorded and tabulated as per the section "observations and results". The values of reaction time for the right hand in case visual reaction time were 184.12 (mean) ± 12.19 (SD) msec. The values of reaction time for the left hand in the case of visual reaction time were 196.02 (mean) ± 12.17 (SD) msec. The values for auditory reaction time for the right hand were 203.34 (mean) ± 11.69 (SD) msec. The values for the left hand were 197.62 (mean) and 6.09 (SD) msec. But the values for hyperthyroidism patients for right-hand visual reaction time were 246.42(mean) 13.6 (SD) msec. And for the left hand 258.72 ± 13.38 msec. The values for auditory reaction time were 266.44 ± 13.62 msec for the right hand and 278.44 ± 13.62 msec for the left hand. Thus, the reaction time is significantly prolonged in hyperthyroid patients which is statistically significant.

Similar results have been obtained by AC Wagale, and SA Wagale and they have shown that hyperthyroidism causes an increase in reaction time markedly.

Such results obtained can be very well explained by the fact that in thyrotoxicosis, there is severe muscle weakness as it is discussed in the review of the literature. Also, it can be stated that the muscle weakness which is because of thyrotoxic myopathy is comparatively undiagnosed. The patients who present with myopathy represent only the tip of the iceberg as far as thyrotoxic myopathy is concerned. There are changes detected in motor endplate morphology and muscles in thyrotoxic patients. Because of these factors, reaction time is prolonged in thyrotoxicosis, sometimes it happens that, such thyrotoxic patients are on treatment with drugs like propranolol, which may prolong reaction times.

Munte TF et al, [9] have documented that short periods of subclinical hyperthyroidism in the range commonly induced in the treatment of thyroid cancer patients induce distinct alteration in brain electric activity. Also, there were variations in reaction times.

In the study of Jonderko G, et al, it aimed to answer the question of whether the

determination of psychical reaction time may be useful for maintaining the treatment of hypothyroidism & hyperthyroidism.

They have shown that simple reaction time as well as choice reaction time was prolonged in hypo or hyperthyroidism.

They have also documented the usefulness of simple reaction time & CRT for the determination of diagnosis & therapy maintaining functional disturbances of the thyroid gland.

Pardeshi has determined simple reaction time to different stimuli in his research and he has shown that there is a significant prolongation of reaction time in primary hypothyroidism as well as hyperthyroidism and after thyroxine therapy found an early and significant improvement in S.R.T. for auditory stimuli. [4]

In agreement with our results of prolongation of reaction time in hyperthyroid patients, following research works can be quoted which indicate prolongation of reaction time in hyperthyroid patients.

There may be tremors of hands, tongue on lightly closing of eyes, and tremors of eyeballs. Muscles show generalized weakness and there is axonal neuropathy. The cause of polyneuropathy is hypermetabolism.

There are changes in catecholamine levels and their metabolites which are responsible for changes in the cardiovascular system and central nervous systems.

There is an alteration in morphological organizations and modulatory actions in the thalamic sensory transmission.

T3 may play a neuromodulatory or neurotransmitter role in the adrenergic system. Heal D.J., and Smith S.Z., have demonstrated the T3 enhanced synthesis and turnover of 5-HT in the brain of the mouse. So, it appears that thyroid hormones may act to pronounce the antidepressant effects. [10]

Hefti F, Hartikka J. Bolger MB have demonstrated that thyroid hormones influence the expression of transmissions of specific enzymes by central cholinergic neurons, T3 was found to stimulate choline acetyltransferase activity in a dose-dependent manner. [11]

Sometimes there may be acute thyrotoxic neuropathy in some thyrotoxic patients. There is the axonal demyelinating motor and sensory peripheral neuropathy.

There is chronic inflammatory polyradiculoneuropathy associated with Grave's disease.

Also, for hyperthyroidism following points can be seen.

Muscles show weakness and tremors.

Decrease in nerve conduction because of neuropathy.

Alterations in central transmission and conduction.

Alterations in the levels of central neurotransmitters for example serotonin, and catecholamines.

Because of all these factors reaction time is prolonged in hyperthyroidism. Thus, there is a prolongation of simple reaction time in patients of hyperthyroidism because of the involvement of peripheral and central nervous system. Reaction time has physiological significance and can be used to assess the involvement of central and peripheral nervous systems in patients of hyperthyroidism. It is a simple, cheap and non-invasive reproducible, and sensitive test. On the other hand, neurological techniques like a recording of evoked potentials require special apparatus and it requires great care.

Conclusions

Reaction time is a valuable indicator in assessing the early involvement of the central nervous system in patients with

thyroid dysfunctions in a cheap and non-invasive way. Also, it helps for continuous monitoring and scrutiny of neurological and psychological functions in these patients. Reaction time has many applications in sports medicine, pharmacological research, anaesthesia research etc. It proves to be valuable and is a cheap non-invasive way for continuous monitoring and scrutiny of central nervous system function. It can be stated that parameter reaction time can be used for mass screening of patients with thyroid disease, and for follow-up of thyroid patients.

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