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Effect of chronic alcoholism on whole body reaction time

Dipali V. Deshmukh[1,*], Charushila Jadhav[2]

[1,2]Assistant Professor, Dept. of Physiology, Dr. VM Govt. Medical College, Solapur, Maharashtra

***Corresponding Author:**
Email: divide8@gmail.com

Abstract
Aim: Our study is aimed to measure whole body reaction time in chronic alcoholics compared with age matched controls
Materials and Method: The study includes 30 chronic alcoholics with neuropathy, 30 Chronic alcoholic without neuropathy and their age matched controls. The test was analyzed using unpaired T- test
Result: The study revealed a highly significant decrease (p value < 0.001) in whole body reaction time when compared between controls and Chronic alcoholic with and without neuropathy. There is also decrease (p value < 0.001) whole body reaction time between patients with neuropathy and those without neuropathy.
Conclusion: The observation suggests that whole body reaction time (RT) helps to detect alcoholic neuropathy, before the signs and symptoms appear. It helps in early diagnosis and treatment of neuropathy.

Keyword: RT- reaction time, CNS- central nervous system, NCV- nerve conduction velocity, ALN- alcoholic neuropathy, SD- standard deviation

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Introduction
Alcohol abuse is a known social problem worldwide. Alcoholic polyneuropathy initially involves the distal ends of the longest axons with involvement of peripheral nerves throughout the body.[1] This nerve damage causes an individual to experience pain and motor weakness, first in the feet and hands and then progressing centrally. Vitamin deficiencies may add to development of Alcoholic polyneuropathy chronic alcoholism.

In most cases, individuals with alcoholic polyneuropathy have some degree of nutritional deficiency. Alcohol increases the metabolic demand for thiamine (vitamin B1) because of its role in the metabolism of glucose. Thiamine levels are usually low in alcoholics due to their decreased nutritional intake. In addition, alcohol interferes with intestinal absorption of thiamine, thereby further decreasing thiamine levels in the body.

Thiamine is important in three reactions in the metabolism of glucose: the decarboxylation of pyruvic acid, d-ketoglutaric acid, and transketolase. A lack of thiamine in the cells may therefore prevent neurons from maintaining necessary adenosine triphosphate (ATP) levels as a result of impaired glycolysis. Thiamine deficiency could explain the impaired nerve conduction in those with alcoholic polyneuropathy, but other factors likely play a part. Many alcoholics suffer from malnutrition which deprives them of important cofactors for the oxidative metabolism of glucose.

Lacking essential cofactors like thiamine, ATP, etc. and modulation of ion channels by alcohol increases current leakage and slows signal transmission. In addition, there are increased levels of acetaldehyde produced during ethanol metabolism. Acetaldehyde has been shown to be toxic to peripheral nerves. If the acetaldehyde is not metabolized quickly the nerves may be affected by the accumulation of acetaldehyde to toxic levels.

To give response to a stimulus is the basic property of any living organism. This property depends upon various physical, psychological and environmental factors. The simple way to examine this is by noting the reaction time, i.e. the interval of time between the presentation of the stimulus and the initiation of the response. Reaction time relates to, but is different from, reflex time, movement time, and response time.

Reflex time is a shortened reaction time wherein the thought or decision-making phase (central processing) is eliminated. In a reflex the impulses travel through the sensory nerves, across the reflex arc, and through motor nerves to the muscles. The reflex arc relays messages directly from sensory to motor nerves. Thus the reaction time differs from reflex time in that; it also includes time required for central processing.

Movement time starts where reaction time ends. It is the time that elapses between the beginning of a movement and its completion.

Response time is a combination of reaction time and movement time. It is the total time that elapses from the onset of the stimulus until the act is completed. Reaction time is used widely in the study of most of the psychological processes.

Reaction time of an individual measures elapsed time between the presentation of a sensory stimulus and the subsequent behavioral response. Alcohol, a CNS depressant, is known to slow down central nervous system and motor in coordination. Measurement of reaction time and demonstration of any alterations to the subjects could facilitate in counseling in chronic alcoholics.[2]

Materials and Method

The study was conducted in chronic alcoholic subjects and their age matched controls.

No.	Group	No. of subjects	Age group (yr)
I	Normal healthy controls	30	40-60
II	Chronic alcoholic without neuropathy	30	40-60
III	Chronic alcoholic with neuropathy	30	40-60

Symptoms such as numbness, parasthesia, hyperaesthesia, pain in calf muscle or burning in hands and feet were considered to have subjective neuropathy. These patients having signs and symptoms of subjective and/or objective neuropathy were grouped as 'Alcoholics with neuropathy' (ALN). Other patients not having signs and symptoms of subjective and/or objective neuropathy were grouped as 'Alcoholics without neuropathy'.

Reaction time was determined by using an instrument ''Reaction Time Apparatus" designed by Anand Agencies, Pune. It was determined using whole body reaction time apparatus which has four parts namely.

a. Central Boards – for keeping right and left foot,
b. Stepping Boards marked LEFT, FRONT, RIGHT and BACK which are placed in respective four directions a step away from central boards
c. Stimulus Board
d. Digital Chronoscopes-two in number which measure time in seconds

After familiarizing the subject with the instrument and after repeated practice, the subject was asked to move a step from the central board to the corresponding stepping board immediately in response to blinking of the arrow on the display box.

The time taken to lift the leg in response to stimulus (T1) and the time taken to keep the leg on corresponding stepping board (T2) were measured with the help of digital chronoscopes. Thus the (T1) gives the time taken by the subject to initiate an action and (T2) gives the time taken to complete the action. The time between the onset of stimulus and to initiate the action (T1) was reaction time proper and the total time from the onset of the stimulus to completion of the action (T2) was the response time. The difference between the response time and reaction time proper (T2 –T1) was the movement time.[3]

Observations and Result

Table 1: Showing mean values and standard deviation (S.D) of whole body reaction time (msec) in right direction

Parameter	Group	Mean±S.D.	Groups Compared	P Value	S/NS
Reaction Time	I	0.45 ± 0.05	I and II	<0.001	S
	II	0.62 ± 0.15	I and III	<0.001	S
	III	0.72 ± 0.15	II and III	<0.001	S
Movement Time	I	0.45 ± 0.12	I and II	<0.001	S
	II	0.63 ± 0.17	I and III	<0.001	S
	III	0.72 ± 0.14	II and III	<0.001	S
Response Time	I	0.9 ± 0.12	I and II	<0.001	S
	II	1.2 ± 0.21	I and III	<0.001	S
	III	1.4 ± 0.22	II and III	<0.001	S

Table 2: Showing mean values and standard deviation (S.D) of whole body reaction time (msec) in left direction

Parameter	Group	Mean±S.D.	Groups Compared	P Value	S/NS
Reaction Time	I	0.45 ± 0.05	I and II	<0.001	S
	II	0.61 ± 0.16	I and III	<0.001	S
	III	0.75 ± 0.11	II and III	<0.001	S
Movement Time	I	0.46 ± 0.14	I and II	<0.001	S
	II	0.61 ± 0.17	I and III	<0.001	S
	III	0.74 ± 0.14	II and III	<0.001	S
Response Time	I	0.9 ± 0.15	I and II	<0.001	S

	II	1.2 ± 0.22	I and III	<0.001	S
	III	1.5 ± 0.17	II and III	<0.001	S

Table 3: Showing mean values and standard deviation (S.D) of whole body reaction time (msec) in front direction

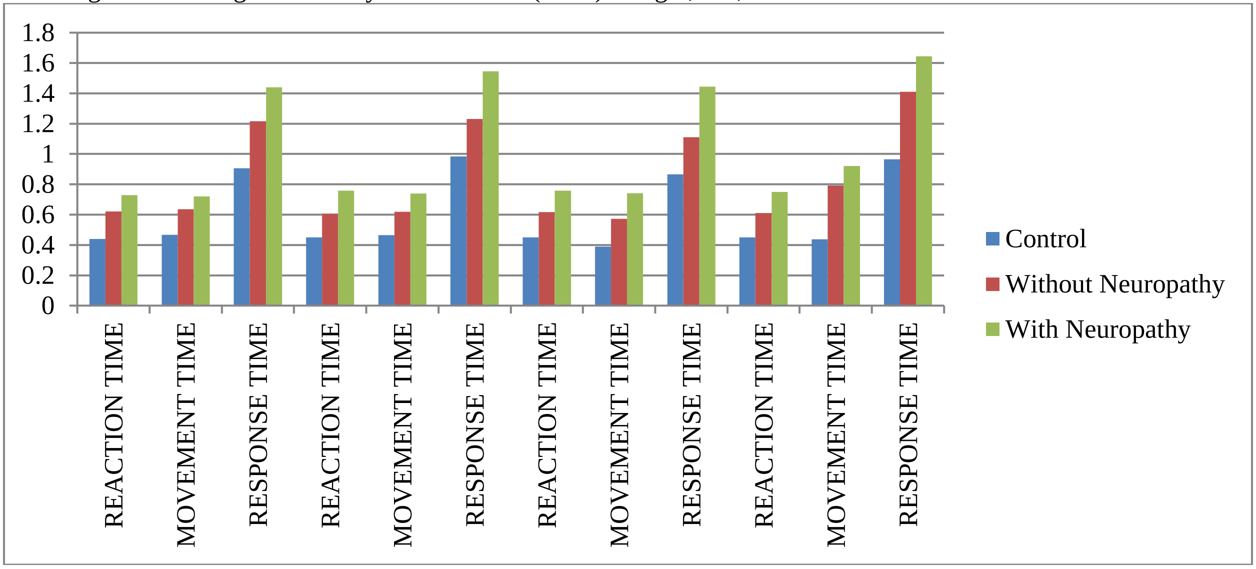
Parameter	Group	Mean±S.D.	Groups Compared	P Value	S/NS
Reaction Time	I	0.45 ± 0.05	I and II	<0.001	S
	II	0.61 ± 0.16	I and III	<0.001	S
	III	0.75 ± 0.11	II and III	<0.001	S
Movement Time	I	0.39 ± 0.12	I and II	<0.001	S
	II	0.57 ± 0.19	I and III	<0.001	S
	III	0.74 ± 0.13	II and III	<0.001	S
Response Time	I	0.8 ± 0.17	I and II	<0.001	S
	II	1.1 ± 0.22	I and III	<0.001	S
	III	1.4 ± 0.21	II and III	<0.001	S

Table 4: Showing mean values and standard deviation (S.D) of whole body reaction time (msec) in back direction

Parameter	Group	Mean±S.D.	Groups Compared	P Value	S/NS
Reaction Time	I	0.45 ± 0.05	I and II	<0.001	S
	II	0.61 ± 0.16	I and III	<0.001	S
	III	0.75 ± 0.11	II and III	<0.001	S
Movement Time	I	0.43 ± 0.12	I and II	<0.001	S
	II	0.79 ± 0.17	I and III	<0.001	S
	III	0.9 ± 0.18	II and III	<0.001	S
Response Time	I	0.9 ± 0.14	I and II	<0.001	S
	II	1.4 ± 0.27	I and III	<0.001	S
	III	1.6 ± 0.27	II and III	<0.001	S

From the above tables (Table 1, 2, 3 and 4) it is clear that whole body reaction time (msec) in right, left, front and back directions are significantly more in chronic alcoholics as compared to controls.
S- Significant, NS- Non significant

Bar Diagram: showing whole body reaction time (msec) in right, left, front and back directions.



Right Left Front Back

Discussion

In the present study whole body reaction time was determined in healthy controls and chronic alcoholics. The whole body reaction time was significantly ($p<0.001$) increased in chronic alcoholics without neuropathy and with neuropathy; when compared to their age matched controls. The values were significantly increased in chronic alcoholics with neuropathy ($p<0.001$); when compared to chronic alcoholics without neuropathy.

Ivashchenko OI and Vazhnova TN (1988)[4] observed the reaction time (RT) of correct decisions was increased in chronic alcoholics in comparison with the healthy subjects. These results are similar to our study.

Preedy V R, Peters TJ.(1990),[5] Adachi J, Ueno Y, Ahmed S, Mantle D, Mullatti N, Rajendram R (2001)[6] showed that, prolonged ethanol misuse causes skeletal muscle myopathy.

Bruce D Bartholow and Melanie Pearson (2003)[7] studied acute effects of alcohol on cognitive processing and performance. Analysis of behavioral data showed that alcohol influences response selection more than attentional processes per se.

Latha Rajendra Kumar (2008)[2] reported that, alcohol, a CNS depressant, is known to slow down central nervous system and can cause motor incoordination.

Causes or determinants of reaction time:

1. Latency in sensory neural code traversing the peripheral and central pathways
2. Central (cognitive) processing
3. Motor signal again traversing both central and peripheral neuronal structures.
4. Latency in end effector (e.g. muscle) activation.

Alcohol causes central or peripheral neuropathy causing reduced motor and sensory nerve conduction velocity, which prolongs reaction time. Alcohol affects somatosensory and auditory system. It slows pshychomotor responses and has cognitive effects characterized by slowing of mental speed and diminished mental flexibility, all of which may affect central (cognitive) processing; and in turn prolongs reaction time.

There is also evidence of myopathy in chronic alcoholics which may increase movement time particularly and also may contribute to delayed reaction time.

Wernicke's syndrome and Korsakoff's syndrome, which can occur together or separately, are due to the low thiamine (B vitamin) levels found in many alcohol-dependent people. Wernicke's syndrome results in disordered eye movements, very poor balance, and difficulty in walking. Korsakoff's syndrome affects memory and prevents new learning from taking place. Alcohol also causes alcoholic neuropathy and fetal alcohol syndrome.

Treatment of alcoholic polyneuropathy is directed towards halting further damage to the peripheral nerves and returning to normal functioning. This can be achieved by alcohol abstinence, a nutritionally balanced diet supplemented by all B vitamins, and rehabilitation.

The reaction time is an indirect index of the processing capability of central nervous system and also a simple means of determining sensory and motor performances. In alcoholic neuropathy, peripheral nerves as well as central nervous system are involved. Hence if nerve conduction velocity (NCV) is normal and reaction time is delayed it may indicate CNS involvement of alcoholic patients. So, reaction time measurement is a simpler test to assess effect of alcohol on body.

For assessing the functioning of nerve; reaction time test is simpler than other tests to assess nerve function like nerve conduction study. So, determination of reaction time alone without doing nerve conduction study; will help to diagnose alcoholic neuropathy at an early stage. Few workers have found that, in some alcoholics, reaction time is prolonged even if NCV was normal. Therefore, determination of reaction time is definitely useful in diagnosing alcoholic neuropathy at an early stage. So, the study may help in prognosis also.

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