Original Research Article

Effect of supine, sitting and standing posture on reaction time: A cross sectional study at tertiary care centre

Anita Gaule[1], Gourav Bhattad[2*]

[1]Assistant Professor, Topiwala National Medical College and B.Y.L Nair Hospital, Mumbai -400008.INDIA.
[2]II MBBS Student, Topiwala National Medical College and B.Y.L Nair hospital, Mumbai -400008.
Email: anita.shrikrishan@gmail.com, gouravbhattad99@gmail.com

Abstract

Background: Reaction time is a simple, non-invasive means of determining sensorimotor co-ordination and performance of an individual. Due to location of reticular activating system within the brainstem, it is likely that with change in the posture, there can be a change in the RT as well. **Aim:** To compare the effects of supine, sitting and standing postures on RT. **Material and Methods:** An observational cross-sectional study was carried out for 2 months in the Department of Physiology on 60 subjects (30 males and 30 females). Visual and Auditory choice reaction times of subjects were measured in supine, sitting and standing postures for green, red and yellow colors and high, medium and low frequency sounds. **Results:** The mean VRT was found to be highest in supine and lowest in standing posture though there was no statistical significance between standing and sitting posture as shown in table 4 but supine posture had significantly high reaction time as compared to both sitting and standing posture ($p<0.05$). Exactly same pattern was found for ART. **Conclusion:** The VRT was found to be highest in supine and lowest in standing posture and supine posture had significantly high reaction time as compared to both sitting and standing posture.
Keywords: Reaction time, posture, sitting, standing, supine

[*]**Address for Correspondence:**
Dr Gourav Bhattad, II MBBS student, Topiwala National Medical College and B.Y.L Nair hospital, Mumbai -400008.
Email: gouravbhattad99@gmail.com
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INTRODUCTION

Reaction time (RT) can be defined as the time between the application of the stimulus and the response.[1] There are various methods to evaluate RT, which utilizes the time with reference to the distance and gravity. It provides an indirect index of the integrity and processing ability of the central nervous system[2] and a simple, non-invasive means of determining sensorimotor co-ordination and performance of an individual.[3] The receipt of information (visual or auditory), its processing, decision making, and giving the response or execution of the motor act are the processes which follow one another and make what we call the reaction time.[4-6] The connection between arousal, consciousness and motivation in relation to body posture is found in brainstem in the reticular activating system (RAS). The RAS is an ascending pathway. It carries sensory information to higher orders of the brain.[7] The descending reticular formation of brainstem, is the center of posture control of the body.[8] Due to their location within the brainstem, it is likely that with change in the posture, there can be a change in the RT as well. The RT gets significantly prolonged in supine compared to sitting and standing posture.[9,10] Considering RT as a good indicator of cognition, sensorimotor co-ordination and performance of an individual and keeping in view the inconsistent findings relating to changes in cognitive performance associated with postural position in literature, this study was designed to compare the effects of supine, sitting and standing postures on RT.

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MATERIAL AND METHODS

The present observational cross-sectional study was carried out over a period of two months in the Department of Physiology at a medical college of a tertiary care hospital. Ethical clearance was duly obtained from the Institutional Ethics committee.

Inclusion criteria: Apparently healthy medical students of age between 18-24 years. BMI of all ranges. Females in the follicular phase of their menstrual cycle

Exclusion criteria: Smoking, alcohol or tobacco addiction. Any drug consumption that may affect the nervous system like opioids, anticonvulsants, barbiturates, antidepressants, etc. Subjects having any physical deformity and is unable to stand erect.

Sample size: It included a total of 60 adults (30 males and 30 females). Sample size was taken as convenience sample as there are no Indian reference study for the same and the study had to be completed in a stipulated duration of 2 months.

METHODOLOGY

Subjects were explained in detail about the purpose of the study and the procedure to be performed to their satisfaction. Written informed consent was obtained from each subject. Complete history was obtained and clinical examination was done. The tests were carried out in an isolated room in the Department of Physiology so as to prevent any kind of disturbance/distraction which can affect cognitive functions. They were asked to refrain from ingesting caffeinated products (i.e. coffee, tea) for at least three hours, and alcohol for at least fifteen hours prior to testing. Auditory (Rinne's test and Weber test) and visual screening (Snellen's chart and Jaeger's chart) was also carried out on the subjects to rule out any auditory or visual impairment. The basic data of the participants such as Age, Sex, Handedness, medical history was taken. Each subject was asked to be seated for 5 minutes and then baseline heart rate and blood pressure were recorded of each subject. Baseline heart rate was recorded by measuring the pulse by "three finger method." Blood pressure was recorded using a mercury sphygmomanometer by auscultatory method in supine position. Choice Reaction Time **(**CRT) assesses psychomotor abilities, processing speed, attention, response inhibition and stimulus categorization. The reaction time apparatus RTM-608 manufactured by Bio-Tech, India was used in this study. Examiner sat on side of primary control while participant sat on opposite side with secondary control. An opaque partition was placed in the slot provided on the unit so as to prevent subject from seeing which button the examiner was pressing. There was a digital time display on the side of examiner. Below the digital time display, there was a press button for resetting the machine to zero timing. Power "on" and "off" button was present at the side of the apparatus. Headphone was provided to the subject for auditory reaction time. Subject was instructed at the start of test to press the appropriate corresponding button as quickly as possible. Subject used his index finger to press appropriate button. The CRT was recorded in supine, sitting and standing postures. For each posture three readings were taken and the mean of the three was considered. All the 3 positions in the subject were studied in same single sitting, at the same time of the day in all the subjects (between 9am to 10 am) to overcome the effect of diurnal variation and fatigue. The reaction time in supine position was assessed by giving 30 degree reclining position on a head tilt table and placing the reaction time apparatus on a table of adjustable height across the bed as per the convenience for the subject to operate the apparatus. In case of Visual Choice Reaction Time (VRT), the examiner presented with any of the three visual stimuli (Red, Green or Yellow Lights) at random to the subject. The reaction timer started immediately and the corresponding light glows on both sides. The subject saw the light (Red, Green or Yellow) displayed on his side and pressed the appropriate corresponding button as quickly as possible. Once subject pressed the button, reaction timer stopped immediately and indicated the reaction time for the subject in seconds. Maximum resolution of time was 0.0001 seconds (milliseconds). In case wrong button was pressed, the timer continued to run and stopped after the appropriate button was pressed. The same procedure was repeated for Auditory Choice Reaction Time (ART), where the buttons for High, Medium, Low frequencies were used by the examiner and the subject heard corresponding sound through headphone. In this study, before taking readings of choice reaction time tests, six to seven practice sessions were given to subjects. Before presenting any stimulus, a warning signal in the form of a verbal instruction "Ready" was given to each subject. Fixed fore-period of 2 seconds was used. Fore-period is time interval between the warning signal and the actual presentation of the stimulus. Three readings were taken for each visual and auditory choice reaction time test and the average of the three readings was taken as final result.

Statistical analysis

After data collection, the data entry was done in Microsoft excel program and statistical analysis was done by Statistical Package for the Social Sciences (SPSS) version 25.0 software. Quantitative data was presented with the help of Mean and Standard deviation (SD). For the analysis, Multivariate Analysis of Variance (MANOVA) was used to compare among VRT and ART with reference to posture. P value less than 0.05 was taken as significant level.

RESULTS

The VRT and ART were recorded in supine, sitting and standing postures. For each posture three readings each of VRT and ART were taken and the mean of the three was considered (Table 1 and 2).

Table 1: Comparison between 3 colors of VRT with respect to posture

Colors	P					
	Sitting		Standing		Supine	
	Mean	SD	Mean	SD	Mean	SD
Green	.3495	.0561	.3346	.0587	.4151	.0639
Red	.3094	.0593	.3092	.0656	.3962	.0684
Yellow	.2791	.0602	.2771	.0558	.3493	.0785

Table 2: Comparison between frequencies of ART with respect to posture

Frequency	Posture					
	Sitting		Standing		Supine	
	Mean	SD	Mean	SD	Mean	SD
High	.4554	.0921	.4461	.0956	.5225	.0996
Medium	.4633	.0914	.4664	.0901	.5247	.0900
Low	.5136	.0842	.5044	.0970	.5584	.0875

The mean VRT was found to be highest in supine and lowest in standing posture (Table 3).

Table 3: Estimates of VRT in different posture irrespective of colour

Measure: MEASURE_1				
P	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Sitting	.313	.007	.299	.326
Standing	.307	.007	.294	.320
Supine	.387	.007	.373	.400

Table 4 compares each posture with other two. There is significant difference in VRT between standing with supine, sitting with supine, supine with sitting and standing both, irrespective of colors (*P-value < 0.05 is significant).

Table 4: Pairwise comparisons

Measure: MEASURE_1						
(I) P	(J) P	Mean Difference (I-J)	Std. Error	b Sig.	b 95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Sitting	Standing	.006	.010	.553	-.013	.025
	Supine	-.074*	.010	.000	-.093	-.055
Standing	Sitting	-.006	.010	.553	-.025	.013
	Supine	-.080*	.010	.000	-.099	-.061
Supine	Sitting	.074*	.010	.000	.055	.093
	Standing	.080*	.010	.000	.061	.099

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 5: Overall Mean irrespective of posture

	Mean	Standard Deviation
High	.4746	.1012
Medium	.4848	.0943
Low	.5254	.0923

DISCUSSION

In present study, as shown in Table 3 mean VRT was found to be highest in supine and lowest in standing posture though there was no statistical significance between standing and sitting posture as shown in table 4 but supine posture had significantly high reaction time as compared to both sitting and standing posture ($p<0.05$). Exactly same pattern was found for ART as shown in table 5. Results from previous studies by Vercruyssen *et al*, who have done extensive research spread over many years, depicts that postural stimulation significantly improves speed of response.[9] The group has reported that the young are sensitive to the posture effect when performing tasks of moderate difficulty. Therefore, if the posture effect is due to a biological effect it appears to occur regardless of age or whether the person possesses an under aroused CNS. But, if increased stimulation of the ARAS occurs upon standing and is responsible for faster RTs the effect should be consistent within subjects. However, not all subjects were consistently faster when standing (probably due to practice). Systolic blood pressure and heart rate did consistently increase in all subjects when standing. On the physiological level, evidence suggests that the difference in orthostatic load between sitting and supine posture leads to changes in firing rate of baroreceptors. It has been suggested that a decrease in baroreceptor firing in the upright posture contributes to elevated arousal, as evident in increased EEG beta activity. In turn the supine posture has been associated with attenuated levels of arousal and has been discussed as sleep promoting factor. This provides evidence that a physiological mechanism such as increased arousal in the ARAS could improve RTs when standing. This provides evidence that a physiological mechanism such as increased arousal in the ARAS may improve RTs when standing. In a study by Anitha *et al*, the RT appeared to be faster in standing posture than in sitting posture, stating an advantage of standing posture over sitting in the preparedness of the muscles.[11] Different upright sitting postures result in different trunk muscle activation patterns; similarly, core stability of the spine may play a role in the activation of upper limb to complete the desired function.[12]

CONCLUSION

The VRT was found to be highest in supine and lowest in standing posture and supine posture had significantly high reaction time as compared to both sitting and standing posture.

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