Correlation of Two-point Discrimination and Finger Dexterity with the Hours of Computer Usage among Computer Users in South India

Aysha L.V.[1], Smitha D.[2]

[1]Post Graduate Student, [2]Associate Professor, Department of Physiotherapy, Yenepoya Physiotherapy College, Mangalore, India

Abstract

Background: In this era of technology, computers have become an integral part of daily life. Repeated use of fingers and hands as in computer use may lead to sensory-motor abnormalities. Functional evaluation of hand is crucial, as physical evaluation does not measure patient's inability to offset for the loss of range of motion, sensation, strength and disability. This study was undertaken to assess the Two Point Discrimination (TPD) and Finger Dexterity (FD) in computer users and find correlation of TPD and FD to the number of hours of computer usage.

Materials and Method: This study is a cross-sectional study and 296 individuals who met the inclusion criteria were enrolled in this study and were grouped into three categories based on the hours of computer usage. TPD of all the participants were assessed using aesthesiometer and FD were assessed using Purdue pegboard

Results: There was significant change in TPD between the three groups of computer users for both the dominant and non-dominant hand; however, there was no significant change in the FD among the three groups. There was a positive correlation between the hours of computer usage and TPD, while a negative correlation was observed for FD in the assembly score measured using the Purdue pegboard.

Conclusion: Significant changes were observed in TPD of all the participants which suggests early sensory abnormalities among the computer users.

Keywords: *Two-point discrimination, Finger dexterity, computer users, Aesthesiometer, Purdue pegboard.*

Introduction

Computer has an integral role to play in daily life and is inescapable through the modern society. Operating computers require fine motor skill. It cannot be denied that repeated exposure to such fine motor tasks is often associated with symptoms and complaints in the upper extremities. According to epidemiological studies, some form of upper extremity, musculoskeletal disorder, mostly being carpal tunnel syndrome (CTS) and tendonitis are seen in between 9-50% of computer users.[1]

Hand function is evaluated as a qualitative and quantitative process. Some of the studies suggest that repetitive use of hand can also lead to sensory-motor abnormalities.[1] Motor learning and motor performances are inextricably linked to sensation. Cutaneous sensation is important to get information from external environment. The skin of the hands is designed to detect the spatial and temporal cues that subserve texture

Corresponding Author:
Aysha L.V.
Yenepoya Physiotherapy College, Mangalore, India
e-mail: ayshasalamlv@gmail.com

and form, particularly the glabrous or hairless skin on the palmar surface.[2] Sensory information from all the environmental input as well as from touch, movement and awareness of body insight, space, sound and smell is continually dealt with the human system. Sensory receptors are located at the distal end of an afferent nerve fibre. Once stimulated, they give rise to perception of specific stimulus. They have property of receptor specificity and labelled line principal.[3]

Two-point discrimination (TPD) is one of the sensory discriminative modalities, which give the information of subject's spatial acuity. It measures minimal distance at which an individual perceives two points of stimuli presented simultaneously with the same pressure. It is a precise and reproducible tool for assessing the process of peripheral nerve repair.[3] In clinical practice two-point discrimination is widely used to assess the severity of peripheral nerve injuries and to observe patient recovery and response to treatment.[4]

Manual dexterity is a skill which is important for activities of daily living and occupational task. Fine-motor tasks mainly include repetitive motions, which can lead to fatigue and contribute to the risk of injury. Risk of Work Related Musculoskeletal disorders (WMSD) is common amongst various occupations, it is not surprising that workers largely reliant on manual dexterity tasks, such as in manufacturing industries, are at a great risk of developing WMSD.[5]

Whether sensory assessment using aesthesiometer and finger dexterity using Purdue pegboard help to identify early sensory motor changes in finger among computer users is an area which has been not explored. This study aims to assess the sensory discriminative function and manual dexterity in different groups of computer users. These findings will have important implications for the assessment of hand function and in jobs requiring repetitive movement.

Methodology

Study Design: This study is a Cross Sectional, Analytical study

Source of Data: Male and Female computer users between 20-40 years of age.

Method of Data Collection: 296 Computer users who satisfy inclusion and exclusion criteria was recruited for the study.

Inclusion Criteria:

Study participants will be computer users:

1. Participants should be between 20-40 years of age.
2. Participants are required to be using computer for at least two years and above.
3. Participants with normal sensory modalities (pain, touch, temperature) and tendon reflexes.

Exclusion Criteria:

1. Participants having musculoskeletal disease in Upper limb.
2. Participants with sensory symptoms.
3. Participants with skin disease, scar, burns or dermal hypersensitivity.
4. Previous history of diagnosed neuropathy or diseases commonly associated with peripheral neuropathy, (Renal disease, diabetes, rheumatoid arthritis).
5. Participants with history of usage of drugs which may cause sensory deficit or influence cooperation.

Sample Method: Convenience Sampling

Sample Size: Based on 26% population of internet users 5% precision 95% confidence level sample size required is 296.

Statistical Analysis: Statistical analysis was done using One way-ANOVA with Posthoc Tukey test. Karl-Pearsons correlation was used to correlate between parameters. Level of significance was set at <0.05(1-tailed) and <0.01 (2-tailed) If p-value is <0.05 was considered statistically significant.

Procedure: Informed consent was obtained from the participants before beginning the study. The hand used to sign the consent form was identified as the participant's dominant hand. During examination, it was made sure that participants were in a comfortable and relaxed position.

The participants were asked to sit on a comfortable chair and were asked to put their arm resting on the surface of the table. During the test participants were not allowed to see their hand, a cardboard block with the surfaces was held in place by the examiner during the exploration. The assessment was done on both the hands.

TPD was estimated by using a handheld aesthesiometer described by Catley MJ et al, 2013 [4].

The Purdue Pegboard test addresses both gross coordination of arm/hand/fingers as well as fine coordination of fingers by placement of pins, collars and washes on pegboard and this was carried out as described by Desia et al, 2005[6]. The participants were seated at a table with the Purdue Pegboard directly in front of them. The evaluator was seated to their right. Participants were given opportunity to practice 3 times, each subtest before the timed test to ensure understanding

Results

296 individuals were enrolled for the study with equal male (n=148, 50%) and female (n=148, 50%) participants. The mean age of study participants was 27.29 (range:21-39 years). Mean age of males were 27.69 (range: 21-39 years) and mean age of females were 26.89 (range:21-39 years). Of the 296 participants, 295 were right handed (99.7%) while one was left handed (0.3%).

Mean of TPD of distal inter-phalangeal joint of dominant hand of index finger was 3.2mm (range 1mm-8mm) and that of little finger was 3.5mm (range 1mm-8mm). Mean of TPD of DIP of non-dominant hand of index finger was 2.2mm(range:1 mm-6 mm) and that of little finger was 2.4 mm(range:1 mm-6 mm). Mean dexterity score of right hand was 15.5(range:11-19.33) and that of left hand was 13.67(range:9-19.33). Mean dexterity score of both hands was 11.52(range:7.67-15.67). Mean dexterity score for assembly was 30.71(range:20-46.68). (table 1)

The mean hours of computer usage of study participants were 5.74 hours with the minimum hours of computer usage being reported was 1 hour and maximum being 18 hours.

One-way ANOVA showed that there were significant changes in the TPD among different group of computer users while no significant changes were observed in MD of different computer user groups. DIPJ of index finger of both dominant and non-dominant hand as well as the DIPJ of small finger of both dominant and non-dominant hand showed significant changes ($p<.05$). Posthoc turkey test showed that there were significant changes in TPD among different computer user groups while no significant changes were observed in MD . DIPJ of index finger and small finger pf the dominant hand showed significant changes between group 1 and group 2 as well as group 1 and group 3 while no significant changes were observed between group 2 and group 3.

All the parameters used to measure the TPD showed a positive correlation with hours of computer usage. With increase in the hours of computer usage, there is an increase in the TPD in all parameters which is statistically significant either at 0.01 (two tailed) level or 0.05 level (two tailed) – table 2.

Distal interphalengeal joint of index finger - Dominant hand showed the highest r value of 0.412 which may be interpreted as good correlation and was statistically significant with a p value<.0001 (2 -tailed), followed by the distal interphalengeal joint of small finger - dominant hand. Distal interphalengeal joint of index finger - Non-dominant hand and Distal interphalengeal joint of little finger - Non-dominant hand had lower value of $r = 0.175$ and $r = 0.119$ respectively which may be interpreted as poor correlation. However these were statistically significant at 0.05 level with p values of 0.002 and 0.045 respectively

Except for "average assembly" none of the parameters used to measure manual dexterity showed correlation which is statistically significant. Average- Right hand and Average- Left hand showed poor positive correlation with r values of 0.049 and 0.043 with p values of 0.398 and 0.462. Average- Both showed poor negative correlation with an r value of -0.007 and a p value of .899 which was not statistically significant. The average assembly score showed poor negative correlation with an r value of - 0.124 which was statistically significant with a p value of 0.033 (1-tailed), table 3.

Table 1. One-way ANOVA to compare the groups of computer users with two-point discrimination and manual dexterity scores

Area	Groups	N	Mean	Welch Statistics (*)/F (Anova)	P-value
DIPJ of index finger - DH	1	99	0.2545	33.895*	<0.001
	2	156	0.3526		
	3	41	0.3902		
	Total	296	0.325		
DIPJ of small finger - DH	1	99	0.2778	24.841*	<0.001
	2	156	0.384		
	3	41	0.4171		
	Total	296	0.353		
DIPJ of index finger - NDH	1	99	0.2051	4.069*	0.018
	2	156	0.2359		
	3	41	0.2415		
	Total	296	0.2264		
DIPJ of little finger - NDH	1	99	0.2242	3.798*	0.024
	2	156	0.2423		
	3	41	0.278		
	Total	296	0.2412		
Average- Right hand	1	99	15.42394	0.219	0.804
	2	156	15.54231		
	3	41	15.58585		
	Total	296	15.50875		
Average- Left hand	1	99	13.6495	0.741	0.478
	2	156	13.6159		
	3	41	13.93512		
	Total	296	13.67135		
Average- Both	1	99	11.52253	0.058	0.943
	2	156	11.5409		
	3	41	11.46415		
	Total	296	11.52412		
Average- Assembly	1	99	31.8257	2.96701	0.053
	2	156	30.2647		
	3	41	29.7234		
	Total	296	30.712		

DIPJ-Distal inter-phalangeal joint, DH-Dominant Hand, NDH-Non-Dominant Hand, SD-Standard Deviation
*Significant at >0.05 level

Table 2. Pearsons correlation for correlation two-point discrimination with hours of computer use

Parameters		DIPJ of index finger – DH	DIPJ of small finger - DH	DIPJ of index finger - NDH	DIPJ of little finger - NDH
Hours of Laptop usage	Pearson Correlation	.412**	.363**	.175**	.119*
	Sig. (2-tailed)	.000	.000	.002	.041
	N	296	296	296	296

**. Correlation is significant at the 0.01 level (2-tailed)., *. Correlation is significant at the 0.05 level (1-tailed).

Table 3. Pearsons correlation for correlation of the manual dexterity with hours of computer use

Parameters		Average-Right hand	Average-Left hand	Average-Both	Average Assembly Score
Hours of laptop usage	Pearson Correlation	.049	.043	-.007	-.124*
	Sig. (2-tailed)	.398	.462	.899	.033
	N	296	296	296	296

*. Correlation is significant at the 0.05 level (1-tailed).

Discussion

The present study is one of the few studies that was undertaken in India to assess the TPD and manual dexterity among computer users and to assess the correlation between the hours of computer usage with TPD and manual dexterity. All the study participants completed the tasks assigned to them.

Study participants were grouped into three based on the hours of computer usage. The main criterion for this classification was based on the computer usage with respect to the working hours. Those who used computers for less than half of the working hours (<4hrs) were group one (n=99,33.4%), those who used for more than half of the working hours but not more than the entire working hours (5-8 hrs) were group two (n=156, 52.7%) and those who used computers for more than the working hours (>8 hrs) were group three (n=41, 13.9%).

The comparison of mean of TPD of DIP of index finger of dominant hand among the groups indicate that >8 hours has highest value of 3.9mm and <=4 hours has the least value of 2.5mm. This difference is statistically significant (p <0.001). Comparing <=4 hours and >8 hours groups show statistical significance (p<0.001). Comparing 5-8 hours and >8 hours show no significance (p=0.143).Comparison of distal interphalangeal joint of small finger of dominant hand between three group shows that >8 hours highest value of TPD 4.71 and<=4 hours has the least value of 2.7 mm. This difference was found statistically significant. The similar pattern was seen in non-dominant hand users. In the present study, Pearson's correlation was used to identify if there were perceivable changes in TPD with hours of computer usage. It was found that all the parameters used to measure the TPD showed a positive correlation with hours of computer usage which is statistically significant either at 0.01 (two tailed) level or 0.05 level. Thus, concluding that with increase in the number of hours computer usage there will be increase in the TPD value. Crosby et al established normative value of static two-point discrimination with aesthesiometer for index finger as 2.6+/-0.67mm and little finger is 2.6+/-0.74mm and found that TPD of nerve injured of index finger is 3.7+/-1.24mm of index finger and 4.2+/- 1.34mm for little finger.[7] Since prolonged use of computer can lead to carpal tunnel syndrome thus affecting two-point discrimination, it may be inferred that changes in TPD is an early sign of CTS or sensory-related disorder.[1] Another study done by Tomasz Wolny et al found that in mild and moderate forms of Carpal Tunnel Syndrome, there is a significant difference in the two-point discrimination compared with healthy individuals which may affect the efficiency of work of individuals affected by this disease. Nancy Byl et al in 2017 in their study suggested that healthy individuals who did repetitive tasks with their hands do not necessarily have preexisting tactile discrimination problems. However, persons with repetitive strain injury such as tendinitis or focal dystonia may have measurable sensory motor problems, particularly interpreting tactile stimuli.[8]

Normative value for assembly job of right hand is 17.86, left hand is 16.60,both hands is 14.38 and assembly is 43.58 according to the Lafayette manual.[9] Comparison of the mean of finger dexterity score of right hand between three groups shows that >8 hours group has the highest value of 15.5 and <=4 hours has the least value 15.42. But this difference is statistically not significant. Comparing 5-8 hours and >8 hours also wasn't statistically significant. The similar pattern was seen in score of left hand and both the hands. Comparison of the mean of finger dexterity score of assembly between three group shows that<=4 hours group has highest value of 7.9 and >8 hours has the least value of 7.4. This difference is statistically insignificant (p=0.053). Comparing 5-8 hours and >8 hours group is not significant (p=0.85).Even though a difference of mean was observed among the groups but they weren't statistically significant. Pearson's correlation was used to identify if there were perceivable changes in manual dexterity with hours of computer usage. Except for "average assembly" none of the parameters used to measure manual dexterity showed correlation which were statistically significant. The average assembly score showed poor negative correlation with an r value of - 0.124 which was statistically significant with a p value of 0.033 (2-tailed).Study done by Tremblay[1] on early tactile changes and manual dexterity in computer users showed that it is possible to detect early changes in hand function and it was detected in female than male and are predisposed to hand and wrist disorder. Tremblay concluded that there is decrease in TPD and finger dexterity in women who frequently use computers at work place. In the present study no difference is seen between genders. The study helps to create awareness about computer related health disorder. The test used to asses hand function could be important in outcome measure.If tactile interpretative issues are identified, sensory discrimination activities should be initiated to restore accuracy and speed in processing cutaneous information with the hand.

References

1. Tremblay F, Mireault A C, Letourneau J, Pierrat A, Bourrassa S. Tactile perception and manual dexterity in computer users. Somatosensory and motor research. 2002;19(2):101-108:10.1080/08990220120113066
2. Tittiranonda P, Burastero S, Rempe D. Risk factors for musculoskeletal disorders among computer user.Occupational medicine .1999;I4:17-38.
3. Tamuraa Y, Hoshiyama M, Inuia K, Kakigi R. et al Central mechanisms for two-point discrimination in humans.Sensorysyndromes in parietalstroke.1993; 43 : 1942–1949.
4. Catley MJ, Tabor A, Wand BM, Moseley GL. Assessing tactile acuity in rheumatology and musculoskeletal medicine—how reliable are two-point discrimination tests at the neck, hand, back and foot?. Rheumatology. 2013 Apr 22;52(8):1454-61.
5. Minn S, Côté JN. Gender differences in sensorimotor characteristics associated with the performance of a manual dexterity task at shoulder height. Journal of Electromyography and Kinesiology. 2018 Oct 1;42:143-50.
6. Desai K, Kene K, Doshi M, More S. Normative Data Of Purdue Pegboard On Indian Population. The Indian Journal of Occupational Therapy.2005; 37:69-72.
7. Crosby PM, Lee Dellon A. Comparison of two-point discrimination testing devices. Microsurgery. 1989;10(2):134-7.
8. Nolan MF. Two-point discrimination assessment in the upper limb in young adult men and women. Physical therapy. 1982 Jul 1;62(7):965-9.
9. Instrument L. Purdue Pegboard Test: User Instructions. Lafayette, IN: Lafayette Instrument. 2002.