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# CORRELATION OF SEVERITY OF SMOKING WITH THE SENSORY NEUROPATHY IN APPARENTLY HEALTHY ADULT MALE SMOKERS

Physiology

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## ABSTRACT

Tobacco smoke is a toxic mix of more than 7,000 chemicals. Some of the chemicals in cigarette smoke/bidi like nicotine, tar, carbon monoxide, cyanide etc. are toxic to the peripheral nerves. Previous studies have found neuropathy in COPD patients but very few studies were done in smokers to find out the nerve damage. In smokers, nerve damage is not diagnosed until the appearance of symptoms and is not yet an established fact. We performed Nerve Conduction Study (NCS) on sensory nerves of both upper and lower limbs among mild, moderate and heavy smokers as well as in non-smokers. The results of SNCV were found within normal values among smokers but when the results were compared with the non-smokers, it showed significant reduction in all the parameters of Sensory nerve conduction study and distal latency was the most affected parameter in heavy smokers. The results have also revealed dose-response relationship with the smoking. In the study, all the cases of neural dysfunction are sub-clinical in nature. These results make a strong foundation for future neuropathic changes in apparently healthy adult male smokers as observed in different studies in COPD patients.

## KEYWORDS

Smokers, Neuropathy, Smoking Index, Sensory Nerves, Nerve Conduction Study

## INTRODUCTION

Tobacco kills approximately 6 million people across the world each year with many of these deaths occurring prematurely. This total includes about 600,000 people who are also estimated to die from the effects of second-hand smoke.[1] Unless we act, the epidemic will kill more than 8 million people every year by 2030 as per WHO and more than 80% of these preventable deaths will be among people living in low-and middle-income countries.[2]

Tobacco smoke is a toxic mix of more than 7,000 chemical[3]. Some of the chemicals in cigarette smoke/bidi like nicotine, tar, carbon monoxide, cyanide etc. are toxic to the peripheral nerves. They cause a direct toxic effect on the myelin sheath. The resulting demyelination causes poor electrotonic conduction which later results in decrease in the conduction velocity of nerves.[4] Although demyelination and axonal damage might co-exist in CO intoxication, demyelination more than axonal damage is suggested in the literature.[5]

Motilal C.Tayade, et al[4] (2012) studied peripheral nerves status in smokers and found statistically significant changes ($P < 0.05$) in the sensory nerve (Median Nerve) conduction velocity and also observed that nerve conduction velocity was reciprocally related to smoking index; greater the smoking index, lesser was conduction velocity.

Nerve conduction studies(NCS) are considered as the most sensitive indices of the severity of peripheral neuropathy, including alterations in function that are not recognized clinically.[6] The NCS findings correlate with the clinical endpoints and nerve potential amplitudes reflect the degree of nerve fiber loss. Thus with the help of NCS diagnosis of neuropathy can be made even before the appearance of symptoms of neuropathy in the smokers.In this study, correlation of severity of smoking with the sensory neuropathy has been studied in mild, moderate and heavy smokers and comparative study is done with non-smokers of the same age group.

## MATERIALS & METHODS

This study was carried out in the Neurophysiology lab of Department of Physiology in People's College of Medical Sciences and Research Center, Bhopal (M.P.). The study was done in 40 apparently healthy male smokers and 40 apparently healthy non-smoker employees of various constituent institutes of People's University in the age group of 20 to 40 yrs after careful selection as per inclusion and exclusion criteria.

**Apparently Healthy (as per American Council on Exercise)**[7] can include individuals who are asymptomatic and (in our situation) have no significant disease or physical condition that prevents them from engaging in physical activity.

### Inclusion Criteria:

Apparently healthy male Smokers with duration of smoking of at least 2 bidis/cigarettes per day for the last 5 years in the age Group: 20-40 years were selected for the study.

### Comparison Group:

The comparison group were apparently healthy subjects between age 20-40 years who have never smoked in life and are not having any other exposure related to tobacco

### Exclusion Criteria:

- Presence of any other disease which may affect the neurological symptoms like diabetes mellitus, Peripheral circulation disorder, chronic renal failure, thyroid disorder
- Any Medication exceeding one week which may alter peripheral function
- Any acute illness (viral or bacterial) at the time of evaluation.
- History of any Chronic drug use like neurotic drugs
- Alcoholism, Severe malnutrition & anemia
- Any bleeding tendency ,cardio-implant, implanted intracranial device
- History of pace-maker placement

### Grouping of Subjects:

Smokers were grouped on the basis of smoking index, to assess the severity of smoking both in duration of as well as average numbers of cigarettes/bidi smoked per day.

Smoking Index[8] was used to determine smoking exposure of the body quantitatively. It was simply calculated by multiplying the average number of cigarettes smoked per day in last seven days & duration of smoking in years. According to Smoking Index the smokers were classified into:

**Group 1**. Light smokers: Smoking index < 100
**Group 2**. Moderate smokers: Smoking index 101-200
**Group 3**. Heavy smokers: Smoking index >200
**Group 4. Non-Smokers**

### METHODOLOGY:

Subjects were selected after taking meticulous history as per the inclusion and exclusion criteria from the campus of PCMS & RC, Bhopal. The study subjects were instructed to avoid smoking for 3 hours before examination. The cases were symptomatically evaluated

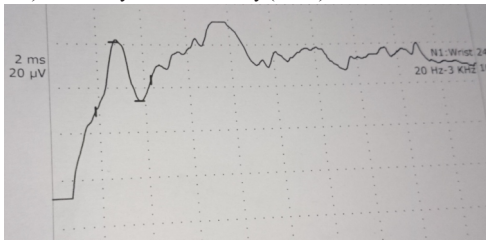
for sensory and motor neurological function.

**Instrument of NCS:**
Nerve conduction studies were performed using Neuroperfect Machine – "EMG, NCV, EP – Medicaid Machine 2000" by in the Neurophysiology laboratory of department of Physiology, PCMS & RC, Bhopal

**Nerves Tested -: In both Upper limbs:** Median & Ulnar sensory nerves were tested for latency, amplitude, and conduction velocity.

**In both Lower limbs** Sural nerve was tested for Sensory study – latency, Amplitude, Conduction velocity parameters were recorded.

**Procedure of NCV:**
- The subjects was made to lie down comfortably in supine position, Instrument was kept out of view of subject , Procedure was explain to the subject before the test then asked the subject to be relaxed.
- Surface electrodes were utilized for recording and stimulation of sensory nerves fixed to subjects skin by adhesive tape.
- Surface electrode was placed over the muscle and the recording electrode was placed on the skin over the area of sensory innervations of nerve. An orthodromic measurement was done by giving a stimulus on the nerve distally. A SNAP was recorded and Amplitude, Latency, and NCV were obtained.
- SNCV[9] = Distance between stimulating and recording electrodes (mm) divided by onset of latency (msec)




Graphical Record of SNCV

| Table Showing Site of Stimulation and Recording[9] | |
|---|---|
| **Upper Limb Nerves** | **Stimulation site** |
| 1. **Median** Sensory | Cathode: First interphalangeal joint of index finger<br>Anode: 3cm distal to cathode |
| 2.**Ulnar** Sensory | Cathode: First interphalangeal joint of little finger<br>Anode: 3cm distal to cathode |
| 3.**Sural** sensory | Cathode: Lateral Malleolus<br>Anode: Lower calf Muscles |

**OBERVATION AND RESULTS**
**The parameters analyzed for sensory Nerve Conduction Study (SNCS):**

1. Sensory Nerve Conduction Velocity (SNCV) in meter/sec.
2. Sensory Nerve Action Potential(SNAP) – Amplitude in microvolt
3. Distal Latency DL(S) in millisecond.

Average of SNCV, SNAP & DL (sensory) of all the 3 nerves was taken and one way ANOVA was applied. Finally results of peripheral sensory nerves are tabulated in table 1.

**Table 1: Effect of Smoking on Sensory Nerve Conduction study of Both upper and Lower limbs (One Way ANOVA)**

| Parameter | Group1 Light smoker | Group2 Moderate smoker | Group3 Heavy smoker | Group 4 Non -smoker | ANOVA F value | pValue |
|---|---|---|---|---|---|---|
| SNCV(m/sec) | 76.65±2.18 | 68.76±2.07 | 66.26±5.68 | 92.40±7.37 | 104.72 | <0.001 (HS) |
| SNAP(µV) | 42.24±12.5 | 22.88±11.57 | 18±7.6 | 51.37±17.13 | 144 | <0.05 (S) |
| DL (Sensory) (ms) | 2.06±0.0.5 | 2.27±0.65 | 2.4±.069 | 1.74±0.57 | 1877 | <0.001 (HS) |

**Values expressed as Mean± Standard Deviation**
**P<0.05 or P = 0.05 Significant, P<0.001or P=0.001 Highly Significant**

**Observations table 1:**
Sensory nerve conduction velocity (SNCV) is highly significantly reduced in smokers as compared to non-smokers. The reduction in SNAP (amplitude) in peripheral sensory nerves of smokers is also found to be statistically significant. And the distal latency is found to be highly significantly prolonged in smokers. Bar Diagram 1 showing SNCV Values

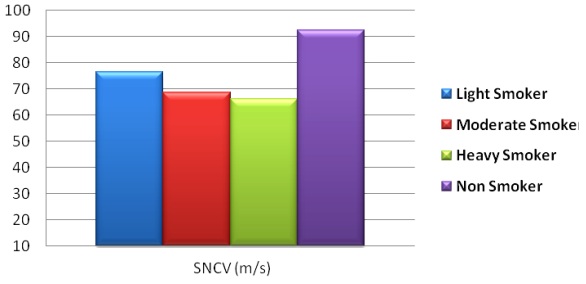
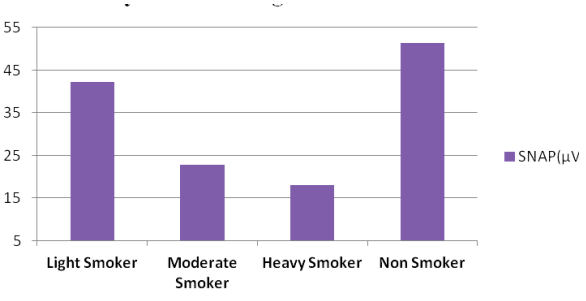



**Table 2 Tukey Post Hoc Analysis for Intragroup comparison of SNCV**

| Groups | MEAN DIFFERENCE | P VALUE |
|---|---|---|
| **1 vs 2** | 7.889 | 0.002 (S) |
| **1vs3** | 10.39667 | 0.002 (S) |
| **1vs4** | -15.74483 | <0.001(HS) |
| **2vs3** | 2.50667 | 0.691 (NS) |
| **2vs4** | -23.63483 | <0.001(HS) |
| **3vs4** | -26.14150 | <0.001(HS) |

**Observations Table 2:**
Tukey Post Hoc Analysis for intra-group comparison of SNCV shows non-significant reduction in heavy smokers as compared to moderate smokers while significant reduction is seen among light & moderate, light & heavy smokers. But when SNCV of each smoker group is compared with non-smokers, the differences are highly significant.




**Bar Diagram 2. Showing SNAP values**

**Table 3: Tukey Post Hoc Analysis for Intragroup comparison of SNAP**

| Groups | MEAN DIFFERENCE | P VALUE |
|---|---|---|
| **1 vs 2** | 20.06 | 0.003 (S) |
| **1vs3** | -24.24 | 0.003 (S) |
| **1vs4** | -9.19 | <0.001(HS) |
| **2vs3** | 4.88 | 0.691 (NS) |
| **2vs4** | -28.49 | <0.001(HS) |
| **3vs4** | -33.37 | <0.001(HS) |

**Observations Table 3:**
Tukey Post Hoc Analysis for intra-group comparison of SNAP shows non-significant reduction in heavy smokers as compared to moderate smokers while significant reduction is seen among light & moderate, light & heavy smokers. But when SNAP of each smoker group is compared with non-smokers, the differences are highly significant.

**Bar Diagram 3 showing Distal Latency**

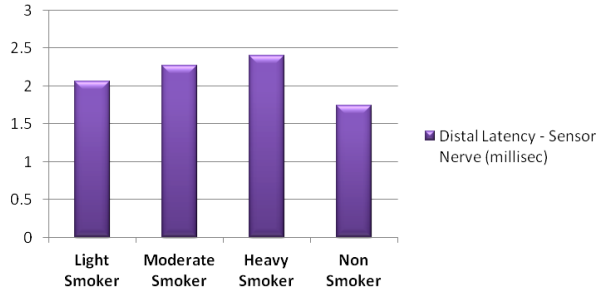



**Table 4: Tukey Post Hoc Analysis for Intra-group comparison of Distal latency of sensory nerves**

**Observations Table 4:**
Intra-group comparison of distal latency in peripheral sensory shows highly significant difference in smokers as compared to smokers as well as among all the groups.

## DISCUSSION

Sensory nerve conduction velocity (SNCV) is highly significantly reduced (P<0.001) in smokers as compared to non-smokers. The difference in SNAP (amplitude) in peripheral sensory nerves of smokers is also found to be statistically significant (P<0.05). But the distal latency is found to be highly significantly prolonged in smokers (P<0.001).

Another important observation is that conduction velocity is lowest and distal latency is prolonged more in heavy smokers. Hence, the results reveal the dose response relationship.

In our study, we found statistically significant dysfunction of sensory nerves in moderate smokers similar to previous studies. There are very few studies who studied peripheral nerve functions in healthy smokers. **Husstedt et al[10] 1988** , Smoking induces a slight dysfunction of the sural nerve, which is not completely reversible. The author studied only SNCV in Sural nerve cigarette smokers. They studied only one nerve & only one limb was studied. In our study, we have tested sensory nerves in all the four limbs and found statistically significant dysfunction in sensory study

**Motilal C.Tayade, et al[4] in 2012** stated that Statistically significant changes (P < 0.05) were found in the sensory nerve conduction velocity (Mean+ SD value in smokers was 55.11+ 2.32 m/s while in nonsmokers it was 57.09+ 4.21 m/s) .In our study, in heavy smokers, we found statistically significant dysfunction in sensory study.

Although the values of SNSV are within normal values[11], statistically significant reduction is seen in smokers as compared to non-smokers The above results reveals that though there is no frank neuropathy in apparently healthy adult smokers but dysfunction of peripheral nerves has been observed among smokers which definitely creates a background for the frank neuropathy found in COPD patients.(studies by Faden et al[12], Kayakan et al[13]).

## SUMMARY AND CONCLUSION

SNCV values are within normal range among smokers but statistically all the values of SNCV are significantly reduced as compared to the non-smokers which means neural dysfunction starts in early years of smoking. NCS study also shows dose response relationship in smoking and NCS. More the smoking Index, more is the dysfunction in peripheral nerves.

In the study, all the cases of neural dysfunction are sub-clinical in nature. These results make a strong foundation for future neuropathic changes in apparently healthy adult male smokers as observed in different studies in COPD patients.

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