Original Article

Electrophysiological Changes in Median Nerve among Young Male Cigarette Smokers

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Abstract

Background: *Cigarette smoking has been associated with numerous cardiovascular and respiratory disorders. Chronic smoking may also disrupt neuronal function and damage neurons in the peripheral nervous system. Median nerve conduction study is an important electrodiagnostic test for the detection of peripheral nerve dysfunction.*

Objectives: *To observe the impact of cigarette smoking on the electrophysiological status of median motor and sensory nerves in apparently healthy male cigarette smokers.*

Materials and Methods: *This case-control study was carried out in the Department of Physiology, Sir Salimullah Medical College, Dhaka, from July 2017 to June 2018 on thirty male cigarette smokers aged 25 to 40 years. For comparison, thirty age and BMI matched non-smoker healthy male subjects were selected as controls. Motor and sensory nerve conduction parameters (latency, amplitude and nerve conduction velocity) of right median nerve were evaluated by standard methods, using standard nerve conduction study and electromyography machines in the Department of Neurology, Dhaka Medical College Hospital. For statistical analysis, unpaired t test was performed.*

Results: *In this study, median sensory nerve latency was significantly prolonged ($p < 0.001$) and sensory nerve conduction velocity was significantly slower ($p < 0.001$) in cigarette smokers. The mean amplitude was also slightly reduced in smokers, but statistically, it was insignificant. However, the distal latency of median motor nerve was slightly prolonged whereas, the amplitude and motor nerve conduction velocity were slightly reduced in cigarette smokers in comparison to those of non-smokers. But the differences were not statistically significant. In addition, 10% of cigarette smokers had subclinical impairment in median sensory nerve function.*

Conclusion: *Chronic cigarette smoking induces significant electrophysiological changes in median sensory nerve fibers and causes sensory nerve dysfunction, while it does not markedly affect median motor nerve fibers in young individuals.*

Key words: *Smoking, Median Nerve, Peripheral Nerve Dysfunction, Nerve Conduction Study, Nerve Conduction Velocity.*

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Introduction

Smoking is a practice in which a substance is combusted and the resulting smoke is breathed in to be tasted and absorbed into the bloodstream. This is a common method of recreational drug use, and tobacco smoking is the most popular form, being practiced by over one billion people globally, the majority of whom are in developing nations.[1] Bangladesh is one of the top ten countries in the world with high current smoking prevalence of 18% among adults aged 15 years and above. Among the current smokers, 91.4% smoke tobacco every day.[2]

Studies revealed that the initiation of smoking occurs predominantly among young people, as adolescents are more susceptible to addiction than middle age groups. Most smokers start smoking between 14 and 25 years of age.[3] In Bangladesh, people initiate smoking at an average age of 18.6 years, and nearly all smokers begin smoking regularly before the age of 25 years.[2] People who smoke persistently have a significant reduction in their quality of life, and if smoking begins earlier in life, there is a greater chance of developing smoking-related illnesses.[4]

Smoking is a well-acknowledged primary risk factor for a variety of illnesses, including cancer, stroke, coronary heart disease, and chronic obstructive pulmonary diseases.[5] Recently there has been growing evidence that the chemicals in cigarette smoke also have detrimental effects on peripheral nerves, which can lead to peripheral neuropathy.[6-10]

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The nerve conduction studies can determine the presence and extent of peripheral nerve injury, including impairments in function that cannot be detected clinically. The nerve conduction velocity depends on the diameter of nerve fiber, degree of myelination and the internodal distance.[11] Other physiological factors such as age, temperature and height can also affect the nerve conduction velocity.[12] Nerve conduction studies evaluate the ability of electrical conduction of motor and sensory nerve fibers of the body.[13] Significant slowing of the nerve conduction velocity indicates impaired saltatory conduction caused by demyelination, and a smaller amplitude suggests a decline in the total number of functioning axons.[14]

The median nerve is an important nerve of the upper extremity that is responsible for the movement as well as the sensation of the hand.[15] The median nerve conduction study is one of the most commonly performed electrophysiological tests of upper extremity.[11] Despite few studies were conducted to determine the influence of smoking on median nerve function, the findings were inconsistent. While some researchers found significant motor or sensory nerve dysfunction in smokers, others reported no alterations in function.[16-18] The present study was, therefore, designed to investigate the impact of chronic cigarette smoking on the electrophysiological parameters (latency, amplitude, and nerve conduction velocity) of median motor and sensory nerves in young male subjects. It is expected that the finding of this study would guide the physicians for early detection and better management of peripheral nerve dysfunction in smokers.

Materials and Methods

This case-control study was conducted in the Department of Physiology, Sir Salimullah Medical College, Dhaka from July 2017 to June 2018. This study enrolled 30 apparently healthy male daily cigarette smokers, aged 25 to 40 years, who take at least 10 sticks per day and have a smoking history of more than 10 pack years. For comparison, 30 healthy male subjects with similar age, BMI, and socioeconomic status who never had any addiction related to tobacco were also enrolled as control. The subjects were selected from the hospital staff members of Sir Salimullah Medical College and Mitford Hospital and also from Dhaka Medical College Hospital on the basis of inclusion and exclusion criteria. A consecutive purposive sampling technique was used. Exclusion criteria included a history of hypertension, diabetes mellitus, peripheral neuropathy, or other neurological disorders; cardiac, renal, or thyroid diseases; or a history of addiction to other tobacco products or alcohol. This research work was approved by the Institutional Ethics Committee (IEC) of Sir Salimullah Medical College. After a briefing about the nature, purpose, and benefit of the study, written informed consent was obtained from the participants. A thorough personal and medical history was taken. Interviews with cigarette smokers focused on average daily cigarette consumption and smoking duration. Then the number of packs smoked per day was multiplied by the number of years the person has smoked to calculate the pack year of smoking.

Median motor and sensory nerve conduction studies were performed by standard methods using fully computerized NCS and EMG machines (Nihon Kohden Neuropack, Japan) in the Department of Neurology at the Dhaka Medical College Hospital. The subjects were instructed to refrain from smoking for an hour before the test in the morning. At first, they were informed of the procedure in order to assure maximum comfort and cooperation. Then they were instructed to take a supine position and rest comfortably on the bed. The temperature was constantly maintained at 25-28 ^{o}C in an air-conditioned room. The recording and stimulating areas were meticulously cleaned with spirit to get maximum electrical conductivity. For the median motor nerve conduction study, the recording site was the abductor pollicis brevis muscle (lateral thenar eminence). The active recording electrode was placed over the muscle belly, and the reference electrode was placed over the tendon at the first metacarpal-phalangeal joint. The ground electrode was positioned at the dorsum of the hand. Supramaximal stimulation was given in right median motor nerve at two points: distally at the middle of the wrist between the tendons to the flexor carpi radialis and palmaris longus, and proximally at the antecubital fossa, over the brachial artery pulse. A compound muscle action potential (CMAP) was recoded, and the latency and amplitude were measured. Then the distance between proximal and distal stimulation sites was measured, and the motor nerve conduction velocity was calculated. For the median sensory nerve conduction study, the recording site was the index or middle figure. The active recording electrode was placed over the metacarpal-phalangeal joint, and the reference electrode was placed 3–4 cm distally over the distal interphalangeal joint. The ground electrode was positioned at the dorsum of the hand. An antidromic measurement was done by stimulating the nerve in the middle of the wrist between the tendons to the flexor carpi radialis and palmaris longus. A sensory nerve action potential (SNAP) was recorded, and the latency and amplitude were measured. Then, the distance between stimulation and recording sites was measured, and sensory nerve conduction velocity was calculated.

The data were expressed as mean ± SD (standard deviation). All statistical analyses were performed using the statistical package of social science (SPSS) for Windows version 22. An unpaired t test was performed to compare data between two groups. A p value of ≤ 0.05 was regarded as significant.

Results

Table I presents the baseline general characteristics of the subjects in both groups. In this study, the mean distal latency of median motor nerve was slightly prolonged, whereas the mean amplitude was slightly reduced and motor nerve conduction velocity was slightly slower in smokers in comparison to those of controls (Table II). But the differences were not statistically significant.

Again, in our study, the mean latency of median sensory nerve was significantly ($p < 0.001$) prolonged, and sensory nerve conduction velocity was significantly ($p < 0.001$) slower in cigarette smokers in comparison to those of non-smokers (Table III). However, the mean amplitude was slightly reduced in smokers than in non-smokers (Table III), but the difference was not statistically significant. Furthermore, in electrophysiological studies, 10% of cigarette smokers showed subclinical impairment in median sensory nerve function (Figure 1).

Table I: General characteristics of the subjects in both groups (N = 60)

Parameters	Non-smokers (n=30)	Cigarette smokers (n=30)	p-value
Age (years)	33.27 ± 4.70 (25 - 40)	32.77 ± 4.30 (25 - 40)	0.669
BMI (kg/m^2)	23.48 ± 1.32 (19.82 - 25.35)	22.97 ± 1.17 (20.55 - 24.91)	0.115
Systolic BP (mm of Hg)	120.17 ± 7.71 (100 - 130)	122.83 ± 5.52 (110 - 130)	0.129
Diastolic BP (mm of Hg)	70.67 ± 6.91 (60 - 80)	73.00 ± 6.77 (60 - 85)	0.192
FBG (mmol/L)	4.80 ± 0.81 (3.42 - 5.96)	4.91 ± 0.73 (3.54 - 5.98)	0.585
S. Creatinine (mg/dl)	0.93 ± 0.17 (0.7 - 1.3)	0.99 ± 0.19 (0.7 - 1.4)	0.203

Data were expressed as mean ± SD. Figure in parentheses indicate ranges; N = total number of subjects; n = number of subjects in each group.

Table II: Median motor nerve conduction parameters in both groups (N = 60)

Parameters	Non-smokers (n=30)	Cigarette smokers (n=30)	p value
Distal latency (ms)	3.26 ± 0.29 (2.78 - 3.82)	3.28 ± 0.32 (2.62 - 3.85)	0.804
Amplitude (mV)	8.70 ± 1.66 (6.43 - 12.80)	8.46 ± 1.70 (5.76 - 12.69)	0.571
MNCV (m/s)	62.47 ± 3.54 (57.1 - 70.8)	61.48 ± 3.74 (56.5 - 69.7)	0. 295

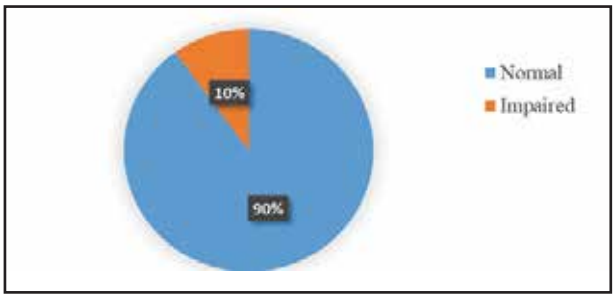
Data were expressed as mean ± SD. Figure in parentheses indicate ranges; Statistical analysis was done by unpaired t test; N = total number of subjects; n = number of subjects in each group; MNCV = motor nerve conduction velocity.

Table III: Median sensory nerve conduction parameters in both groups (N = 60)

Parameters	Non-smokers (n =30)	Cigarette smokers (n=30)	p value
Latency (ms)	2.37 ± 0.14 (2.15 - 2.69)	2.63 ± 0.16 (2.25 - 2.96)	<0.001***
Amplitude (μV)	47.24 ± 10.06 (29.30 - 62.02)	42.04 ± 11.76 (20.20 - 61.24)	0.081
SNCV (m/s)	60.03± 3.86 (52.0 - 65.5)	54.01 ± 3.64 (47.3 - 62.2)	<0.001***

Data were expressed as mean ± SD. Figure in parentheses indicate ranges; Statistical analysis was done by unpaired t test; N = total number of subjects; n = number of subjects in each group; SNCV = sensory nerve conduction velocity; *** = $p < 0.001$.

Figure 1: Distribution of cigarette smokers according to median sensory nerve function status (n = 30)



Discussion

Cigarettes release approximately 5,000 distinct chemicals when they burn, many of which are harmful.[19] Despite wide-ranging research being conducted to observe the influence of smoking on cardiovascular and respiratory systems, there is limited number of research that has investigated the effects on the peripheral nervous system. Therefore, the aim of this study was to assess the potential impact of cigarette smoking on median motor and sensory nerve functions in young male subjects.

The median motor nerve conduction studies carried out in cigarette smokers did not show significant prolongation of distal latency, reduction in amplitude, or marked slowing of motor nerve conduction velocity. These findings indicate that smoking does not cause significant impairment of median motor nerve function. A similar result was observed by other researchers.[17,18] But in a recent study, Arora et al. noted significant changes in median motor nerve function in cigarette smokers with history of very high tobacco consumption.[20]

The median sensory nerve conduction studies revealed highly significant prolongation of latency and highly significant slowing of sensory nerve conduction velocity in cigarette smokers. These findings indicate that smoking causes significant impairment of median sensory nerve function. A very similar result was reported in the research carried out by Tayade et al.[17] On the contrary, Singh et al. did not find significant alterations in median sensory nerve function among smokers.[16] This discrepancy might have occurred due to their smaller sample size and selection of study subjects with lower smoking exposure. Again, in our study, the mean amplitude of median sensory nerve was slightly reduced in smokers, though this change was not statistically significant. It revealed that cigarette smoking does not cause significant axonal loss in young individuals. This finding agrees with the results of Singh et al.[16]

In the present study, the neurophysiological findings of cigarette smokers did not show significant alteration in median motor nerve function, while significant sensory nerve dysfunction was observed, which probably resulted from sensory nerve demyelination. These data suggest that sensory nerve fibers are damaged earlier than motor nerve fibers in young smokers. Furthermore, in this study, we detected subclinical impairment of median sensory nerve function in 10% of cigarette smokers who had history of higher cigarette consumption than other subjects. This finding could not be compared with other studies due to the unavailability of published data. The direct cause of peripheral nerve impairment in smokers remains unidentified. However, some researchers have suggested the role of oxidative stress in this pathogenesis. The peripheral nerves are covered by myelin sheaths that facilitate rapid impulse transmission by saltatory conduction.[21] Demyelination of nerve fibers causes slowing of conduction.[11] Cigarette smoke contains a number of highly unstable free radicals, which accelerate lipid peroxidation and increase oxidative stress.[22] Moreover, smoking causes weakening of antioxidant defense system that also enhances oxidative stress.18 The myelin sheath is enriched in lipids and extremely susceptible to oxidative damage.[23, 24] Therefore, cigarette smoke-induced oxidative damage to myelin might be responsible for sensory neuronal dysfunction in cigarette smokers.

Conclusion

From the results of this study, it can be concluded that cigarette smoking induces significant electrophysiological changes in median sensory nerve fibers that cause median sensory nerve dysfunction. These neuropathic changes could be detected earlier by performing median nerve conduction studies. However, median motor nerve functions are not significantly affected by smoking in young adults.

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