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RESEARCH ARTICLE

# F-wave latencies of median nerve in smokers from Southern Rajasthan: A case-control study

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## ABSTRACT

**Background:** Tobacco and its byproducts have hazardous effect on multiple organs of our body including nerves. Long-term exposure to the chemicals found in tobacco smoke results in demyelination of nerve fibers affecting the nerve conduction. F-wave study is a reliable tool to assess the proximal segment of peripheral nerve and has not been studied much. **Aim and Objective:** The aim of the study is to measure F-wave latencies in nerve conduction studies in the median nerve in smokers (S) and nonsmokers (NS). **Materials and Methods:** The present study recruited normal healthy participants (18–50 years) divided in two groups, namely Group S and Group NS. It was designed to be a cross-sectional case–control study. Median nerve was examined for motor and sensory nerve conduction velocities. The detailed late responses, for example, F-wave latencies including F-minimum latency, F-maximum latency, and F-mean latency were studied, and data are analyzed using descriptive statistics and Mann–Whitney test. **Result:** A statistically significant increase ($P < 0.0001$) was found in all F-wave latencies in S as compared to NS. **Conclusion:** The present study suggested that long-term exposure to tobacco results in compromised nerve conduction velocities and increases latencies in peripheral nerves. The increased latencies could be attributed to peripheral demyelination or radiculopathy.

**KEY WORDS:** Nerve Conduction Study; Smoking; Median Nerve; Late Responses e.g., F-wave

## INTRODUCTION

Nerve conduction study (NCS) is an electrophysiological tool which helps us in the assessment of the overall functioning of nervous system, so it has been diagnostically helpful in the identification and characterization of disorders involving nerve roots, peripheral nerves, muscle, and neuromuscular junction.[1] Among the NCS, nerve conduction velocities are considered as one of the most sensitive indicators in diagnosing the severity of the neuropathy.[2] The localization of lesion as well as the severity and type of the pathological changes which causes an alteration in the functions can be easily recognized with the help of these tests which otherwise are missed clinically. Therefore, NCS has emerged as the most reliable, non-invasive, and sensitive test.

Usually, major mixed peripheral nerves are used for neuroelectrodiagnostics, which provides reasonable information regarding segmental neural health, conductivity, and integrity. Electrical stimulation of peripheral nerves, as done in electro diagnostics, is helpful in understanding the etiology and deciding its management for a better prognosis of various diseases. It is apparent that the routine motor and sensory nerve conduction does not provide much information about the proximal segments of the peripheral nerves. Hence, the F-wave studies are required to find the conduction of electrical impulses in the nerve roots. When the motor neurons of the anterior horn cells are fired, there

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is antidromic propagation of the stimulus on the motor nerve and the F-wave generated [Figure 1].[3] Thus, F-wave is useful in the diagnosis of certain types of peripheral neuropathy.

F-wave has been utilized to demonstrate multiple clinical conditions such as lumbosacral radiculopathy, axonal, and demyelinating polyneuropathies at the earliest and also helpful to monitor the changes in the motor neuronal pool and central nervous system.[4] Lengthened F-wave latencies are indicators of various grades of symptomatic or asymptomatic radiculopathies.[5]

There is abundant literature documenting the presence of toxic and carcinogenic chemicals which present in cigarette smoke, comprising nicotine, tar, and carbon monoxide which affects the hemodynamics [6,7] and resulting in atherosclerosis, neural ischemia, myelination, and neural dysfunction. These toxic chemicals directly exhibit the toxic effect on myelin sheath of nerves leading to demyelination and hence diminish the nerve conduction velocity.

Nerve conduction velocity is affected by many factors such as age,[5] gender, height, weight,[8] and limb length. It has also been observed that chronic smoking has a significantly more effect on the sensory fibers as compared to the motor fibers, in a mixed nerve, thereby reducing the sensory nerve conduction velocity.[9] However, there is not much literature available to document the effect of long-term smoking on the late motor responses (F-wave). Hence, the present study was designed to an assess how smoking can affect the late motor responses such as F-wave, which gives us an idea whether proximal segment of the nerve is involved or not.

## MATERIALS AND METHODS

The present study was designed to be a cross-sectional case–control study and conducted in the Clinical Neurophysiology Unit of the Department of Physiology, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India. Before starting of the study, ethical approval was taken from the institutional ethical committee. The sample size was calculated to be 90.[10] Study population was randomly selected from people working as contract labor and housekeeping staff. The non-smoker (NS) group (NS; $n$ = 30) was designated as controls whereas smoker (S) group (S; $n$ = 60) as study group, with heaviness of smoking index more than 200.[11] For both groups, the participants with obesity, systemic/endocrine disorder, peripheral neuropathy, alcohol addiction, and severe anemia were excluded from the study. Both the groups were age and demographically matched to avoid the selection bias. Before starting of the study, the purpose of the study was explained to all the participants and took the written consent from them. The information regarding age, socioeconomical status, family history, previous and current medical history, and smoking history and information regarding any kind of addiction were taken with the help of questionnaire.

### Electrophysiological Study

The test was performed in a noise-free room with an ambient temperature maintained at 23–26°C using a fully computerized electromyography (EMG) and NCV machine (Neuroperfect, EMG 2000, Medicaid, Chandigarh).[8] The participant was made to lie down comfortably on the bed. The surface electrodes were applied to the patient's skin with conducting paste and fixed with adhesive tape after cleaning the skin with spirit to remove the oils from it. The recording electrode was placed on the belly of abductor pollicis brevis, and the reference electrode was placed at distal phalanx of the thumb, 3 cm from the recording electrode. Ground electrode was placed between the stimulating and recording electrode as shown in [Figure 2].

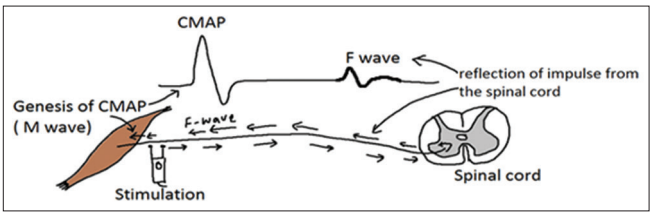


**Figure 1:** Genesis of F-wave

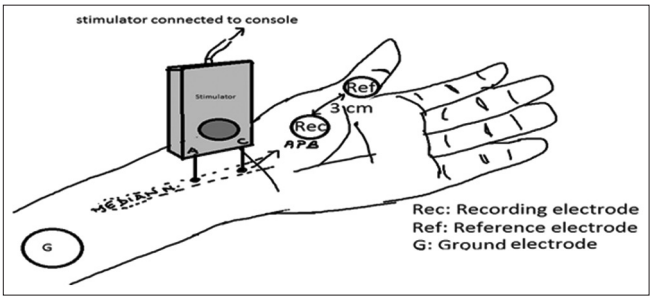


**Figure 2:** Arrangement of electrode placement and stimulation site of median nerve for F-wave examination

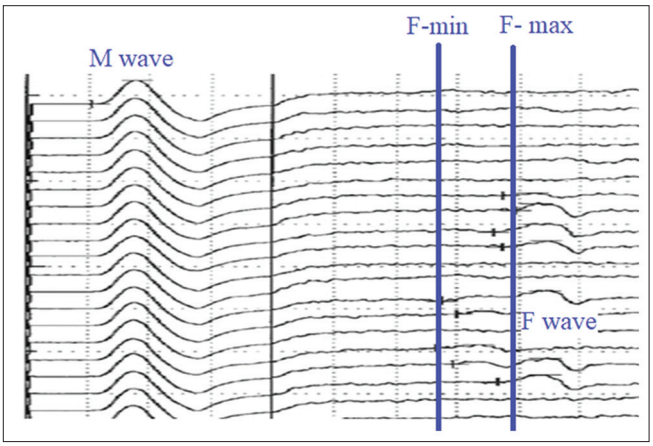


**Figure 3:** Recording of F-wave parameters – M-wave, F-minimum latency, F-maximum latency, F-mean latency

| Sensitivity | Low frequency filter | High frequency filter | Sweep speed | Notch filter | Supramaximal stimulation | Number of stimuli | Amplitude |
|---|---|---|---|---|---|---|---|
| 500uV/div. | 2 Hz | 3 Hz | 5 ms/div | Off | 30–45 mv | 20 | 5% of M-wave |

**Table 1:** Comparison of NS and S interpreted by Mann–Whitney *U*-test

| Test statistics by Mann–Whitney U-test | F-minimum latency | | F-maximum latency | | F-mean latency | |
|---|---|---|---|---|---|---|
| | NS (40) | S (71) | NS (40) | S (71) | NS (40) | S (71) |
| Median | 27.9400 | 29.8100 | 30.6250 | 32.3800 | 29.6550 | 30.9400 |
| Mean rank | 44.51 | 62.47 | 45.86 | 61.71 | 44.44 | 62.51 |
| Sum of ranks | 1780.50 | 4435.50 | 1834.50 | 4381.50 | 1777.50 | 4438.50 |
| Mann–Whitney U-test | 960.500 | | 1014.500 | | 957.500 | |
| Asymptomatic significance (two tailed) | 0.005* | | 0.013* | | 0.004* | |

*$P$<0.05 is statistically significant, NS: Nonsmokers, S: Smokers

The nerve was stimulated supramaximally along its course at two points, distally at wrist between the tendon of palmaris longus and flexor carpi radialis on the palmar aspect of the wrist joint, 2 cm distal to wrist crease. Continuous 20 stimuli were given to median nerve, and artifact-free responses were recorded. Each response comprised a M-wave followed by the F-wave. The onset latencies of the F-wave were recorded and calculated as F-minimum latency, F-maximum latency, and F-mean latency. The upper limb length was measured from the stimulus point to $C_7$ spinous process with a measuring tape for the length of nerve [Figure 3].

### Ethical Approval

The study was approved by the Institutional Ethics Committee of Geetanjali University, Udaipur, Rajasthan, India (Ref. No. GU/UCE/EC/2013/296 dated 15/05/2013).

### Statistical Analysis

The data were analyzed using SPSS version 16.0 and Microsoft office excel 2007. Data were skewed and not under normal distribution, so Mann–Whitney U-test was applied. Median was used for nonparametric data. $P < 0.05$ (two tailed) was used to find the statistical significance.

## RESULTS

The findings of the present study are depicted in Table 1.

## DISCUSSION

The present study was designed to find the effect of the chronic smoking on the late motor responses in the median nerve, which was carried out on chronic S and NS. It was observed that various F-wave latencies, namely F-min, F-max, and F-mean were lengthened in S. Hence, it reflects the delayed conduction in the proximal segments of the motor nerve fibers. It is documented that the peripheral sensory nerves are affected in chronic S while the motor fibers are spared. However, the F-wave studies have highlighted that even if the distal segments of the motor nerves are not affected, but still, nerve roots show a considerable damage to manifest on the electrodiagnostic screening. Hence, F-wave latency could be better parameter than motor nerve conduction velocity in determining the radicular damage, if any.

These changes in the neural health could be attributed to many factors, which are described below:

1. Long-term use of smoking results reduced airway lumen due to inflammatory changes in the respiratory units with loss of elastic recoil, resulting in decreased forced expiratory volume in 1 sec. (FEV1) and FEV1/forced vital.
2. Reduced partial oxygen tension causes hypoxemia which causes harmful effect to the vasa nervorum affecting all parts of the neuron, connective tissue, or blood supply, resulting in peripheral nerve damage leads to delayed conduction and increased latency.[12]
3. Smoking disturbs the balance between the production of reactive oxygen radicals and antioxidant defense system in our body and leads to oxidative stress. Increased oxidative stress can result in reduced nerve blood flow as well as nerve conduction.[6]
4. Smoking increases the carbon monoxide level, and cholesterol level in the body will lead to damage the tunica intima, resulting neural ischemia leads to nerve dysfunction and increasing the latencies of F-wave of NCS.

### Limitation of the Study

The only limitation of the study is sample size, which could be taken care of, by choosing a larger sample from the population.

## CONCLUSION

Lengthened latencies of F-wave are early predictors of impending demyelinating radiculopathy in the preclinical

asymptomatic stage. These changes may be caused due to neural ischemia, resulting due to carbon monoxide-induced hypoxia or atherogenic changes in microvasculature. There is associated with increased oxidative stress and reduced antioxidant defense system which might accentuate the progression of neural damage.

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