

F WAVE STUDY IN HEALTHY PEOPLE IN MALABAR REGION- EFFECT OF HEIGHT ON F WAVE MINIMAL LATENCY

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ABSTRACT

BACKGROUND

F wave is an important electrodiagnostic parameter which assesses conduction through both proximal and distal segments of nerve. It may vary between different population due to difference in physiological variables like height, arm length and temperature. So a normative reference data is to be created for using this parameter with sensitivity and specificity and to improve the diagnostic capacity.

AIM

Aim of this study was to derive normal reference value for F wave minimal latency in healthy people in Malabar region and to find out the effect of height on F wave minimal latency.

SETTING AND DESIGN

F wave study was done prospectively in 250 carefully screened healthy subjects of age group 15- 50 years. The study group included equal proportion of males and females. F wave minimal latencies of median and tibial nerves were done.

STATISTICAL ANALYSIS USED

All statistical analyses were done with SPSS software version 16. Average values of F wave minimal latencies of median and tibial nerves were calculated. Effect of height on F wave minimal latency was studied deriving Pearson correlation coefficient.

RESULT AND CONCLUSION

Normal reference data for F wave minimal latency is derived for Malabar region. F wave minimal latencies of tested nerves showed a positive correlation with height. So a height adjusted reference value is to be created for accurate interpretation of this electrodiagnostic parameter.

KEYWORDS

F wave study, F wave, minimal latency, effect of height, nerve conduction.

HOW TO CITE THIS ARTICLE: Naseem VHA, Rajalekshmi G, Zubaida PA. F wave study in healthy people in Malabar region- effect of height on F wave minimal latency. J. Evid. Based Med. Healthc. 2016; 3(31), 1449-1453.

DOI: 10.18410/jebmh/2016/330

INTRODUCTION: Nerve conduction studies are a group of electrodiagnostic techniques which helps in diagnosis and prognosis of peripheral nerve diseases. It includes motor conduction study, sensory conduction study and late response study. Late response study includes F wave study and H reflex study. F wave and H reflex studies evaluate conduction of nerves between limb and spinal cord whereas motor and sensory conduction studies evaluate conduction in the limb itself.¹

F waves are low amplitude late responses thought to be due to antidromic activation of motor neurons (anterior horn cells) following peripheral nerve stimulation, which then cause orthodromic impulses to pass back along the involved

motor axons.² Some electrophysiologists have called this a 'backfiring' of axons. It is called the F wave because it was first noted in intrinsic foot muscles. The F wave has small amplitude, a variable configuration, and a variable latency. Generally, F wave amplitudes are up to 5% of the orthodromically generated motor response (M response).²

Since each nerve contains hundreds of motor axons, it is usual to obtain 5-15 F waves from 20 stimulations. They differ in latency and shape since they normally represent activity from different motor units. The frequency of occurrence is reduced when there is a conduction block anywhere along the nerve. F wave measurements thus reflect conduction along the entire nerve and are therefore particularly useful in the study of general polyneuropathy and also when proximal segments are preferentially involved as in Guillain-Barré syndrome.³ In peripheral neuropathies, F waves may show clinically significant and measurable changes even before conventional nerve conduction studies are informative.⁴

Financial or Other, Competing Interest: None.

Submission 23-03-2016, Peer Review 11-04-2016,

Acceptance 16-04-2016, Published 18-04-2016.

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DOI: 10.18410/jebmh/2016/330

The minimal latency is most reliable and useful measurement. Study of Weber showed that F wave minimal latency is the most useful F wave parameter for the diagnosis of polyneuropathies.⁵ Study done by Islam M.R. et al suggested that F wave latency is more frequently and early involved conduction parameter in diabetic subjects.⁶ Study done by Henning Andersen et al showed that minimal F wave latency is the most sensitive measure for detection of nerve pathology and should be considered in electrophysiological studies of diabetic patients.⁷

Motor nerve conduction was assessed along the entire course of the nerve from the spinal cord to the muscle in patients with diabetic polyneuropathy by Jun Kimura et al by using the latencies of M response and F wave. They found that motor conduction abnormalities in diabetic polyneuropathy are diffuse over the total length of the nerve, but more intense in the distal than proximal segment.⁸ Study done by Kimiko Ohgaki et al suggested that the ratio of motor conduction velocity to F wave conduction velocity is very useful in distinguishing diabetic neuropathy from other polyneuropathies.⁹

The ratio of F wave amplitude to the associated M wave (F/M ratio) is a measure of proportion of motor neuron pool activated by antidromic stimulation. It helps in diagnosis of axonal neuropathy though not highly sensitive. Persistence of F wave is a measure of antidromic excitability of a particular motor neuron pool. It is decreased in axonal neuropathy. It is calculated by dividing the number of F responses to the number of stimuli.

F wave minimal latency is related to height, limb length and age. So it may vary between different ethnic groups due to the difference in these physiological variables. Every electrophysiology laboratory needs to establish normative reference data of F wave minimal latency for its population to identify abnormal subjects. Normal value of F wave minimal latency is derived in various populations in different studies.^{10,11,12} To best of my knowledge no such reference data is available in Malabar region. So the main aim of this study was to establish normal reference data in Malabar region and to find out the effect of height on F wave minimal latency.

MATERIALS AND METHODS: The present study was done to derive a normative data for F wave minimal latency and its correlation with height in people of Malabar region. It was a cross-sectional observational study done in normal individuals. The study was done after obtaining approval from the Institutional Ethics Committee. The study was conducted in 250 normal adults (125 males and 125 females) of age 15 to 50 years from North Kerala. Detailed history was taken and clinical examination was done to rule out any systemic or neuromuscular diseases.

Inclusion Criteria: Normal adults of age 15 to 50 years from Malabar region were included in the present study.

Exclusion Criteria: Individuals with systemic or neuromuscular diseases were excluded from the study. Individuals not belonging to Malabar region were also not included in the present study.

A RMS EMG EP Mark-II machine was used in the electrophysiology lab. Median and tibial nerves were tested. Subjects were acclimatised to standard room temperature (27°C +/-2°C) for 10 minutes. Supramaximal stimulus (25% above maximal) was used. Cathode is placed proximal to anode. The gain was set to 200 microvolts and the sweep speed to 5 milliseconds. At least 10-20 F responses were elicited. F wave minimal latency was calculated.

Three surface electrodes were used for recording - active electrode, reference electrode and ground electrode. The active electrode was placed over the muscle belly. The reference electrode was placed on a nearby tendon or bone away from the muscle. The ground electrode was placed between the stimulator and the active electrode. Grounding is important for obtaining a response that is free of too much artefact. Stimulator consists of two metal pad electrodes placed 1.5 to 3 cm apart. The conduction gel should be used to ensure electrical contact.

In median F wave study, active electrode was placed on the centre of abductor pollicis brevis. Reference electrode was placed at proximal phalanx of thumb 3-4 cm distal to active electrode. Stimulation was given 3 cm proximal to distal wrist crease between tendons of flexor carpi radialis and palmaris longus. In tibial F wave study, active and reference electrodes placed on the centre of abductor hallucis muscle and over the medial surface of the great toe respectively. Stimulation was done behind and proximal to medial malleolus.

All statistical analysis was done with SPSS version 16. Normal values of F wave minimal latency of median and tibial nerves were found. The F wave minimal latency with height was studied. Pearson correlation coefficients (r) were calculated. The value of the correlation coefficient varies from -1 to +1. A value near -1 indicates a strong negative correlation and a value near +1 indicates a strong positive correlation. All correlations were considered to be significant if p value was less than or equal to 0.05.

OBSERVATIONS AND RESULTS: 125 males and 125 females from Malabar region were examined. Average age and height of the population were calculated (Table 1). F wave minimal latencies of median and tibial nerves were derived in the study population (Table 2). F wave minimal latencies of all tested nerves were found to be positively correlated with height (Table 3). All tested nerves of both sides were studied for correlation with height separately in both gender, and found a positive correlation with height. This is represented as scatter- plot (Figures 1 – 8). All correlations obtained were statistically significant.

Gender	Age (years)		Height (cm)	
	Mean (SD)	Range	Mean (SD)	Range
Male (n=125)	33.54 (9.64)	17-50	170.48 (6.74)	150-183
Female (n=125)	35.62 (7.82)	18-50	162.3 (5.93)	150-178

Table 1: Basic information about the study population

Nerves	F wave minimal latency (ms)	
	Mean	SD
Median	31.96	1.7
Tibial	57.24	1.11

Table 2: Normal values - F wave study

Nerves	Males		Females	
	r	p value	r	p value
Rt. Median	0.709	< 0.001*	0.7	< 0.001*
Lt. Median	0.685	< 0.001*	0.687	< 0.001*
Rt. Tibial	0.7	< 0.001*	0.669	< 0.001*
Lt. Tibial	0.577	< 0.001*	0.658	< 0.001*

Table 3: Correlation of F wave minimal latencies with height

* Significant

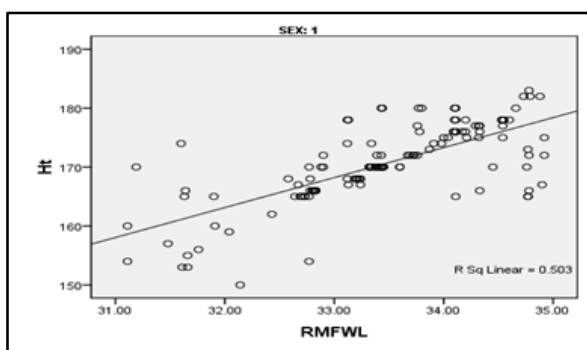


Fig. 1: Correlation of right median nerve F wave minimal latency (RMFWL) with height in males – Scatter plot

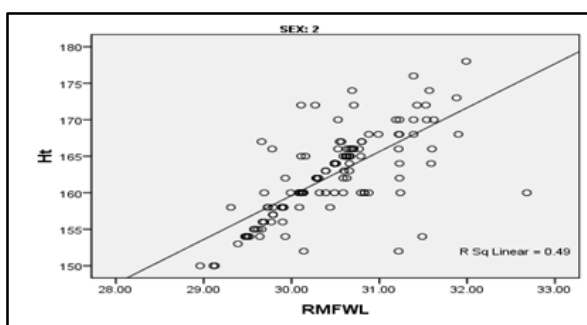


Fig. 2: Correlation of right median nerve F wave minimal latency (RMFWL) with height in females – Scatter plot

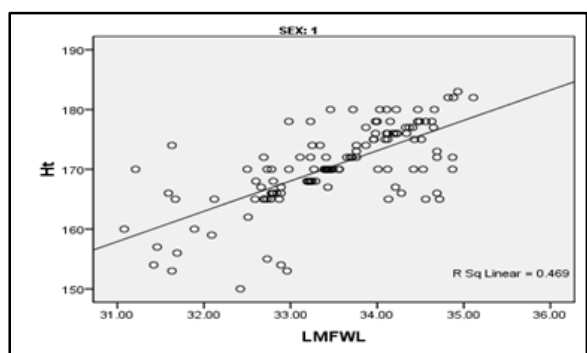


Fig. 3: Correlation of left median nerve F wave minimal latency (LMFWL) with height in males – Scatter plot

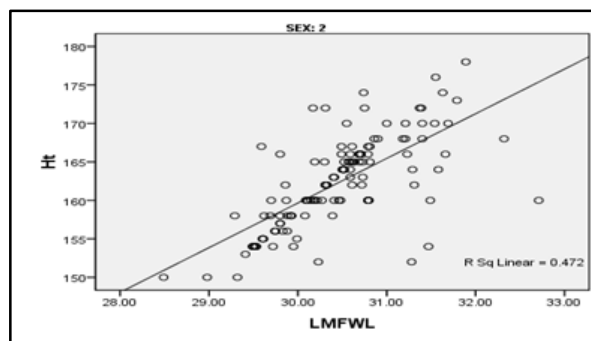


Fig. 4: Correlation of left median nerve F wave minimal latency (LMFWL) with height in females – Scatter plot

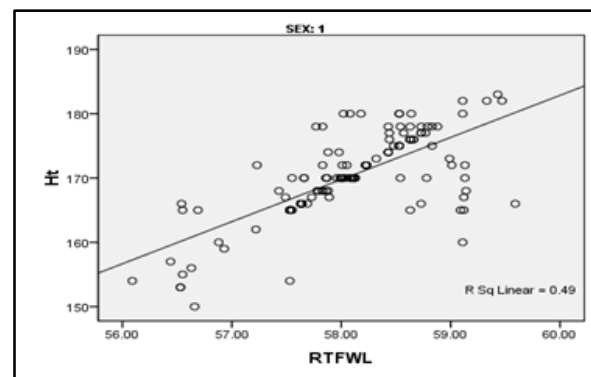


Fig. 5: Correlation of right tibial nerve F wave minimal (RTFWL) latency with height in males – Scatter plot

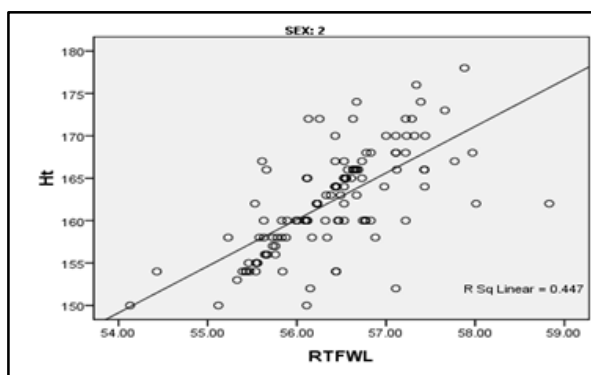


Fig. 6: Correlation of right tibial nerve F wave minimal latency (RTFWL) with height in females – Scatter plot

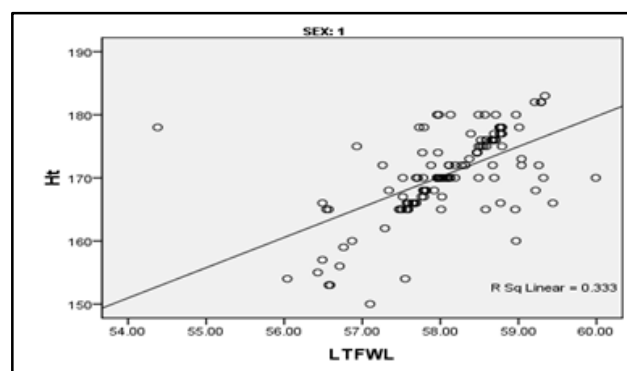


Fig. 7: Correlation of left tibial nerve F wave minimal latency (LTFWL) with height in males – Scatter plot

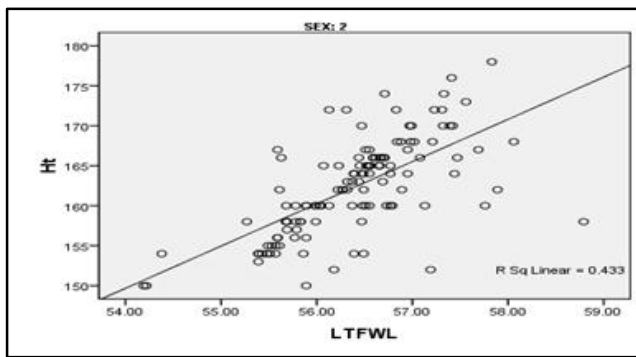


Fig. 8: Correlation of left tibial nerve F wave minimal latency (LTFWL) with height in females – Scatter plot

DISCUSSION: F wave is a late response recording from a muscle following supramaximal stimulation of its nerve. F wave response is of variable shape, size and latency. F wave parameters include minimal latency, amplitude, chronodispersion and persistence.¹³ Minimal latency is the most frequently used F wave parameter. It is the most sensitive and reliable nerve conduction measurement in patients with neuropathies. It is abnormal in various types of peripheral neuropathies, proximal nerve injuries and radiculopathies. It has a high sensitivity in acquired demyelinating neuropathies in which focal proximal demyelination may be the main pathological feature. Unlike the conventional nerve conduction studies F wave study detects proximal nerve abnormalities.

F wave minimal latencies of median and tibial nerves of the study population in the Malabar region were found out (Table 2). F wave minimal latency of median nerve was found to be 31.96 (1.7) ms. F wave minimal latency tibial nerve was found to be 57.24 (1.11) ms.

The difference in values obtained between different studies may be due to technical factors like difference in room temperature, and physiological factors like difference in average height and age of the population studied. This emphasises the necessity of normative electrodiagnostic data for every lab.

Nerve impulses conduct faster at a higher body temperature as seen after physical activity.¹⁴ The conduction velocity increases almost linearly by 2.4 m/s or approximately 5 percent per degree, as the temperature measured near the nerve increases from 29° to 38 °C. Very high temperatures induce a pronounced effect.¹⁵ A warm room at 26°–28 °C or even 30 °C minimises the temperature gradient along the course of a nerve.

References from literature show that age affects electrodiagnostic studies only in extremes of age. The effect of age is most significant from birth to one year when myelination is incomplete. In the newborn, nerve conduction velocities are approximately 50% of adult values. By one year of age the velocities reach 75% and by 3–5 years, myelination is complete and nerve conduction velocities are comparable to adult normative data.¹⁶ Older the person, the slower will be the nerve conduction velocity. These changes are fairly insignificant in the middle-aged adults.

F wave minimal latencies of median and tibial nerves showed a positive correlation with height in the present study (Table 3, Figures 1-8)). Some of the published studies also support this observation in the current study. Study done by Lin KP, Chan MH and Wu ZA showed that height was positively correlated with minimal latencies of H-reflexes and F responses.¹⁷ Study done by Chi Ren Huang et al showed that height is an important factor determining F wave minimal latency, with approximately 0.1 ms increase in upper limb and 0.3 ms increase in lower limb F wave minimal latency per one centimetre increase in height.¹⁸ Mark W. Cornwall and Charlene Nelson found a high positive correlation between F wave distal latency of median nerve and arm length.¹⁹

Logically, taller subjects have longer conduction time of F wave because of longer conduction distance. Many studies also showed that nerve conduction velocity also less in taller individuals. Study of Anup Patel, Saurin Sanghavi et al pointed out a negative correlation between upper limb motor conduction velocity and height.²⁰ Study done by Campbell et al showed that peroneal and sural conduction velocities varied inversely with height.²¹ Study conducted by Bodofsky showed that ulnar motor conduction velocity appears to be inversely proportional to the square root of height.²² Study done by Dia Shehab and Mohamed A.A. Moussa showed that peroneal, tibial and sural nerve conduction velocities were negatively correlated with height. The reason for this physiological difference in nerve conduction velocity may be abrupt distal tapering of axons, shorter internodal distance and progressive reduction in axonal diameter.¹³ So the longer conduction distance and slower conduction velocity together contribute for this increased F wave minimal latency in taller individuals. Clinical recognition of this height effect is important or else one would label an individual as abnormal with mildly elevated F wave minimal latency solely related to large stature. So height adjusted reference data is to be created for accurate comparison of this electrodiagnostic parameter.

CONCLUSION: F wave minimal latency is an important electrodiagnostic parameter which helps to diagnosis of both proximal and distal nerve diseases. Like other nerve conduction parameters, it varies from population to population. This is due to the influence of many technical factors such as room temperature and physiological factors such as average height of the population. So a unique reference data is needed for each electrophysiology laboratory to find out abnormal cases in its population. Normative data of F wave minimal latencies of median and tibial nerves were derived in the study population. This can be used as a reference data to detect conduction abnormalities with more sensitivity and specificity. F wave minimal latencies of median and tibial nerves showed a positive correlation with height. This may be due to increased conduction time due to increase in arm length and slower velocity of conduction in taller individuals. So an age adjusted reference data is to be created in each population to improve the diagnostic capacity of the parameter.

REFERENCES:

1. Mario P Smorto, John Basmajan. *Electrodiagnosis- a hand book for neurologists*. New York: Harper & Row 1977;73-98.
2. Lyn Weiss, Julie K Silver, Jay Weiss. *Easy EMG*. Philadelphia: Elsevier 2004;17-24,111-119.
3. Mallik A, Weir AI. Nerve conduction studies: essentials and pitfalls in practice. *J Neurol Neuro surg Psychiatry* 2005;76(Suppl II):ii23-ii31.
4. Zhijun Li, Xiaoqing Hu, Nai Tang. Significance of neuroelectro physiological tests in the early diagnosis of subclinical neuropathy with diabetes mellitus. *Journal of Huazhong University of Science and Technology* 2006;26(4):429-431.
5. Frank Weber. The diagnostic sensitivity of different F wave parameters. *J Neurol Neurosurg Psychiatry* 1998;65:535-540.
6. Islam MR, Bhowmik NB, Haque A, et al. F wave latency- a frequent and early involved nerve conduction parameter in young diabetic subjects. *Mymensingh Med J* 2005;14(1):46-49.
7. Henning Andersen, Erik Stalberg, Björn Falck. F wave latency, the most sensitive nerve conduction parameter in patients with diabetes mellitus. *Muscle Nerve* 1997;20(10):1296-1302.
8. Jun Kimura, Jamada T, Stevland NP. Distal slowing of motor nerve conduction velocity in diabetic polyneuropathy. *J Neurol Sci* 1979;42(2):291-302.
9. Kimiko Ohgaki, Nakano K, Shigeta H, et al. Ratio of motor nerve conduction velocity to F- wave conduction velocity in diabetic neuropathy. *Diabetes care* 1998;21(4):615-618.
10. Fierro B, Raimondo D, Modica A. F-response assessment in healthy control subjects. *Electromyogr Clin Neurophysiol* 1990;30(8):501-508.
11. Benatar M, Wu J, Peng L. Reference data for commonly used sensory and motor nerve conduction studies *Muscle Nerve* 2009;40(5):772-794.
12. Peioglou-Harmoussi S, Fawcett PR, Howel D, et al. F responses: a study of frequency, shape and amplitude characteristics in healthy control subjects. *Journal of Neurology, Neurosurgery, and Psychiatry* 1985;48:1159-1164.
13. Misra UK, Kalita J. *Clinical neurophysiology*. Elsevier: New Delhi 2006;1-7,26-27,103-113.
14. Halar EM, Hammond MC, Dirks S. Physical activity: its influence on nerve conduction velocity. *Arch Phys Med Rehabil* 1985;66(9):605-609.
15. Johnson EW, Olsen KJ. Clinical value of motor nerve conduction velocity determination. *JAMA* 1960;172(18):2030-2035.
16. Lin KP, Chan MH, Wu ZA. Nerve conduction studies in healthy Chinese: correlation with age, sex, height and skin temperature. *Zhonghua Yi Xue Za Zhi (Taipei)* 1993;52(5):293-297.
17. Chi-Ren Huang, Wen-Neng Chang, Hsueh-Wen Chang, et al. Effects of age, gender, height, and weight on late responses and nerve conduction study parameters. *Acta Neurol Taiwan* 2009;18(4):242-249.
18. Mark W Cornwall, Charlene Nelson. Median nerve F wave conduction in healthy subjects. *Physical Therapy* 1984;64(11):1679-1683.
19. Anup Patel, Saurin Sanghavi, Rachit Joshi, et al. Study of relation between motor nerve conduction velocity and height in healthy individuals. *International Journal of Basic and Applied Physiology* 2014;2(1):114-117.
20. Campbell WW, Ward LC, Swift TR. Nerve conduction velocity varies inversely with height. *Muscle Nerve*. 1981;4(6):520-523.
21. Bodofsky E, Tomao A, Campellone J. The mathematical relationship between height and nerve conduction velocity. *Electromyogr Clin Neurophysiol* 2009;49(4):155-160.
22. Dia Shehab, Mohamed AA Moussa. Normal values of lower limb nerve conduction in Kuwait. *Med Principles Pract* 1999;8:134-137.