



THE USEFULNESS OF F-WAVE STUDY IN DIAGNOSIS OF LUMBOSACRAL RADICULOPATHY

KEYWORDS

F-wave study, lumbosacral radiculopathy, nerve conduction study

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ABSTRACT F-wave study can allow evaluation of the functional state of proximal portions of peripheral nerves affected in lumbosacral radiculopathy. Radiological imaging may have high rate of false positivity and negativity in diagnosing lumbosacral radiculopathy. Therefore, it is pertinent to study the usefulness of F-wave in diagnosis of lumbosacral radiculopathy. In this cross-sectional study, total of 283 subjects aged 40 years and above, diagnosed with lumbosacral radiculopathy were enrolled after getting ethical approval and informed written consent. All patients were subjected to electrophysiological evaluation using RMS EMG EP Mark –II machine through which their F-wave study was conducted. No statistically significant difference was observed between right and left sided values for all F-wave study parameters tested in peroneal and tibial nerves ($P > 0.05$). All parameters were found to have reliable sensitivity, specificity and accuracy in diagnosing lumbosacral radiculopathy. In conclusion, F-wave studies are useful supportive diagnostic tool for lumbosacral radiculopathy.

INTRODUCTION

Low back pain is a very common ailment in adults and it occurs in 40-80% of the population at least one time in their life.⁽¹⁾ The commonest factor responsible for low back ache is the diseases of the nerve roots which is also known as radiculopathy. This disease is commonly caused by the compression of nerve root while coming out of the intervertebral foramen. Studies have reported that lumbosacral radiculopathy affects 4-6% of the population at some point in their lives⁽¹⁾ and it has also been shown that L4-5 and L5-S1 are the most common level affected in lumbosacral radiculopathy.

The correct diagnosis of this disease is very essential for administration of timely and appropriate treatment. Electrophysiological studies are the useful and valuable methods in the diagnosis and prognosis of lumbosacral radiculopathies. Late response study which is one of the types of electrophysiological study, can allow evaluation of the functional state of the proximal segments of the peripheral nervous system, which are affected to a varied extent in the course of this pathological state.

F-wave is one of the types of late response in electrodiagnosis. The F-wave was first described by McDougal and Magladery in 1950, so named as it was originally recorded from foot muscles.⁽²⁾ It is thought to arise from the backfiring of motor neurons as impulses arrive antidromically from a peripheral site of nerve trunk stimulation. F-minimum latency is the most commonly used parameter of F-wave study in electrodiagnosis. However, some studies have suggested that other F-wave measurements may be more sensitive than minimal latency, including F-wave duration, mean F-latency, and chronodispersion (the interval between the shortest and longest F-latency in a consecutive series of stimuli).⁽³⁾

The diagnosis of lumbosacral radiculopathy by radiological imaging is having high degree of false positivity and rarely false negativity.^(4,5) Sometimes, surgical exploration is also unable to throw light on the clinical symptoms or physiological changes in these patients and moreover clinical presentation may also remain unconvincing. In such circumstances, it is reasonable to study the usefulness of various electrophysiological tests in diagnosis of lumbosacral radiculopathy. Therefore, the present study was undertaken to evaluate diagnostic efficacy of various F-wave parameters other than F-minimum latency in lumbosacral radiculopathy.

MATERIALS AND METHODS:

A total of 283 subjects aged 40 years and above who were clinically diagnosed as having lumbosacral radiculopathy were recruited in this cross-sectional study after getting ethics approval from the Institutional Ethics committee. The purpose and objectives of study were elaborated to the study subjects and the written Informed consent was taken from them before the study after explaining the details including the necessity for an examination. The study population was selected from patients attending orthopedic department, with supportive inclusion and exclusion criteria under supervision of consultant orthopedician. The subjects with Diabetes mellitus, Clinical or electrophysiological evidence of polyneuropathy, myopathy, myelopathy, neuromuscular transmission disorders, having symptoms of less than 3 weeks duration, in whom spinal surgery was performed within the preceding 15 years and the patients with local injuries/lesion that may interfere with the electrophysiological study were excluded from this study. The study population comprised of 168 males and 115 females. Detailed history taking and clinical examination was performed in all the subjects in structured format. After doing detailed clinical and neurological examination, all the patients were subjected to electrophysiological evaluation using RMS EMG EP Mark –II machine in Clinical Neurophysiology unit, Department of Physiology through which their F-wave study was conducted. All tests were performed under constant room temperature (30°C) to shortlist the errors.

F-wave study involved supramaximal stimulation of motor nerves. A large compound muscle action potential (CMAP) followed by small irregular shaped CMAPs were elicited. Minimum 10 stimuli were passed to obtain F-wave on raster scale and M-latency in milliseconds (ms), F-max. latency in milliseconds (ms), F-mean latency in milliseconds (ms), F-M latency in milliseconds (ms), F-velocity in meters per second (m/s) were recorded. For F-wave, setting was done as duration of 100 μ s, sweep speed of 10 ms/D and filter was between 2 Hz to 10 KHz.

Statistical Methodology:

Structured format was used to record the observations. Statistical analysis was done by using descriptive and inferential statistics using Kappa Statistics, z-test for difference between two means and diagnostic accuracy. The study observations were analyzed to find the Specificity, Sensitivity, Positive Predictive Value and Negative

Predictive Value. The software used in the analysis were SPSS 17.0 and Graph Pad Prism 5.0 and $p < 0.05$ was considered as level of significance ($p < 0.05$).

RESULTS:

The age and gender wise distribution of patients is shown in Table 1 and physiological variable of study subjects are depicted in Table 2. Descriptive statistics of F-wave study in peroneal and tibial nerves are illustrated in Table 3 and 4. No statistically significant difference was observed between right and left sided values for all the F-wave parameters tested in peroneal and tibial nerves ($P > 0.05$). The sensitivity, specificity, positive and negative predictive values of F-wave study parameters in peroneal and tibial nerves is shown in Table 5 and 6. All the F-wave study parameters were found to have reliable sensitivity and specificity in diagnosing lumbosacral radiculopathy. Accuracy of this electrophysiological parameter compared to gold standard test was also found to be consistent. By using kappa statistics, slight to fair agreement was found between F-wave study parameters and MRI (Table 5 and 6).

Table 1: Age and gender wise distribution of patients

Age Group (Years)	Male (N)	Female(N)	Total(N)
40-49	75(26.50%)	45(15.90%)	120(42.40%)
50-59	47(16.61%)	33(11.66%)	80(28.27%)
60-69	32(11.31%)	31(10.95%)	63(22.26%)
70-79	12(4.24%)	5(1.77%)	17(6.01%)
≥80	2(0.71%)	1(0.35%)	3(1.06%)
Total	168(59.36%)	115(40.64%)	283(100%)

Table 2: Physiological variable in study population

Physiological Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age(years)	283	40	81	53.31	9.89
Height(cm)	283	145	180	161.42	7.19
Weight(kg)	283	40	95	62.37	7.96
BMI(kg/m ²)	283	17.54	33.76	23.91	2.48

Table 3: Descriptive Statistics for F-wave study in Peroneal nerve

Electrophysiological Parameters	Right Side		Left Side		z-value	P-value
	Mean	SD	Mean	SD		
F-maximum latency(ms)	59.68	9.55	60.44	8.37	0.62	0.53
F-mean latency(ms)	53.01	7.97	53.69	8.80	0.46	0.64
F-M latency(ms)	41.87	7.90	42.77	7.70	1.00	0.31
F-velocity(m/s)	12.39	0.88	12.42	1.05	0.23	0.81

Table 4: Descriptive Statistics for F-wave study in Tibial nerve

Electrophysiological Parameters	Right Side		Left Side		z-value	P-value
	Mean	SD	Mean	SD		
F-maximum latency(mS)	63.25	8.9	64.39	8.33	1.31	0.19
F-mean latency(mS)	56.04	7.01	56.10	6.86	0.06	0.95
F-M latency(mS)	44.32	6.73	43.35	6.32	1.47	0.14
F-velocity(m/S)	15.13	2.23	14.81	1.61	1.92	0.05

Table 5: Diagnostic Accuracy of F-wave parameters in Peroneal nerve

Diagnostic Accuracy	F-Max Latency	F-mean latency	F-M Latency	F-Velocity
	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)
Sensitivity	67.11	63.60	65.79	63.60
Specificity	54.55	63.64	60	69.09
Positive Predictive Value	85.96	87.88	87.21	89.51
Negative Predictive Value	28.57	29.66	29.73	31.40

Accuracy	64.66	63.60	64.66	64.66
Likelihood Ratio	1.47	1.74	1.64	2.05
Kappa Statistics	0.19	0.19	0.186	0.22

Table 6: Diagnostic Accuracy of F-wave parameters in Tibial nerve

Diagnostic Accuracy	F-Max Latency	F-mean latency	F-M Latency	F-Velocity
	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)
Sensitivity	65.79	62.72	58.33	56.14
Specificity	72.73	69.09	70.91	74.55
Positive Predictive Value	90.91	89.38	89.26	90.14
Negative Predictive Value	33.90	30.89	29.10	29.08
Accuracy	67.13	63.95	60.77	59.71
Likelihood Ratio	2.41	2.02	2.005	2.20
Kappa Statistics	0.26	0.217	0.189	0.193

DISCUSSION:

F-wave is thought to arise from the backward projection of motor neurons as impulses reach antidromically from a peripheral site of nerve trunk stimulation. Various parameters of F-wave study like Minimal latency (Fmin), maximal latency (Fmax), latency difference between Fmin and Fmax (Fdif) and mean duration (Fdur) were reported to have sensitivity of 70% in diagnosis of lumbosacral radiculopathy.⁽⁶⁾ This observation coincides with our findings as we too have noted the sensitivity of various F-wave parameters in the range of 56% to 67%. They further concluded that F-wave study is clinically useful in evaluation of radiculopathy. This is also coexistent with our observations.

Various authors have published sensitivities of F-wave ranging from 13% to 69%.^(7,8,9) Our findings are comparable with these reports. Our reporting is in agreement with the observations by Frank Weber⁽¹⁰⁾ who examined the relative diagnostic sensitivity of various F wave parameters. They found that F chronodispersion was the most often abnormal parameter in lumbosacral radiculopathies and they concluded that F Wave studies should include minimum F wave latency and chronodispersion in diagnosis of lumbosacral radiculopathy.

Albeck MJ et al⁽¹¹⁾ reported that F-wave's sensitivity was 25%, specificity 62%, PPV 57% and NPV 29% in detecting lumbosacral radiculopathy. Our findings are in accordance with these observations as far as specificity and negative predictive value of F-wave were concerned. However, we recorded quite higher values of sensitivity and positive predictive values of F-wave parameters in diagnosing lumbosacral radiculopathy. Our findings goes hand in hand with the observations by Wells MD et al⁽¹²⁾ who reported sensitivity and specificity of F-wave studies to be 83.3% and 84.3% respectively. However, we could not record sensitivity to such a higher level.

Abnormality in F-wave studies in lumbosacral radiculopathy were also posted by Pastore Olmedo C et al⁽¹³⁾, Weber F⁽¹⁴⁾ and Aminoff and coworkers⁽¹⁵⁾. Our findings are supported by the previous studies by Pastore-Olmedo C et al⁽¹³⁾ and Toyokura M et al⁽¹⁶⁾ who narrated that if multiple features of F-wave are taken into account like minimum and maximum latency, chronodispersion, duration etc, they could be helpful in making the diagnosis. Our findings are identical with the reporting by Gencer M et al⁽¹⁷⁾ who recorded that all the F-wave parameters are quite useful in diagnosis of lumbosacral radiculopathy especially in patients with mild and early stage of the disease.

Our observations goes in contrast to the findings by Wilbourn AJ and Aminoff M⁽¹⁸⁾ who reported that F-wave study is having low

sensitivity and specificity to diagnose the radiculopathy and therefore is not useful for confirming radiculopathy. Mauricio EA et al⁽¹⁹⁾ marked that F-mean latency was insensitive in the assessment of S1 nerve root injury. This is not in agreement with our observations as we observed better degree of diagnostic efficacy of this parameters.

F-wave study reflects the status of proximal motor nerve conduction and excitability of motor neuron pool. Therefore, we get abnormal F-wave parameters in radiculopathy as in this condition excitability of motor neuron pool and conductive properties of different motor units are affected.^(15,20,21)

CONCLUSION:

F-wave studies are useful supportive diagnostic tool for lumbosacral radiculopathy. All the parameters of F-wave study have reliable sensitive and specific in diagnosing lumbosacral radiculopathy.

Acknowledgement: We are grateful to University Grant Commission, Pune for funding this project and all the study subjects who willingly participated in this study.

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