A Study of F Wave Latencies, Chronodispersion and Persistence in Healthy Medical Undergraduates at BPKIHS

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ABSTRACT

Background

The F wave is a CMAP (compound muscle action potential) evoked by a supramaximal stimulation of a motor nerve. F waves are particularly useful for the diagnoses of polyneuropathies at a very early stage and proximal nerve lesions. F waves have a very high diagnostic role in neurophysiology; we would like to study different F wave parameters and effect of anthropometric variables on F wave parameters in normal healthy individuals.

Objective

To study the effect of anthropometric variables on F wave latencies, chronodispersion and persistence

Method

Healthy males (n=64) and females (n=26) medical students of BPKIHS with age 21.64±1.19 years were enrolled in the study. Anthropometric parameters and maximum and minimum F wave latencies, F persistence and chronodispersion of bilateral median, ulnar and tibial nerves were recorded in Neurophysiology Lab II of BPKIHS. Descriptive analysis was done for anthropometric and F wave parameters. Unpaired t test was applied for comparing anthropometric and F wave variables between males and females. Pearson correlation was applied between anthropometric variables and F wave parameters.

Result

Age, height and weight of the subjects were 21.64±1.19 years, 165.61±5.4 cms and 64.07±5.5 kg respectively. Minimum F wave latencies (ms) of right median, ulnar and tibial nerves were 24.09±1.95, 24.02±1.76 and 44.34±3.02 while on the left side were 23.92±1.96, 24.11±1.92 and 44.07±2.83 respectively. Anthropometric variables of male and females were statistically significant. Also, F wave latencies between groups were different which were statistically significant. F persistence was above 80% for all tested peripheral nerves. Height and weight showed a significant effect on F wave latencies ($p<0.001$). However, age did not show any significant effect on F wave parameters.

Conclusion

Males have prolonged latencies as compared to females. Height and weight showed a significant relationship with the F wave latencies of the tested peripheral nerves.

KEY WORDS

Anthropometric, Chronodispersion, F wave, Persistence

INTRODUCTION

The name F wave was derived from the initial recordings which were in the small muscles of the foot. The F wave is a compound muscle action potential (CMAP) evoked by supramaximal stimulation of a motor nerve. The pathway for the F wave involves antidromic excitation of all stimulated motor axons travelling to the spinal cord with reactivation of a small proportion of the anterior horn cell (AHC) axon hillocks and orthodromic action potentials (APs) of one or more motor axons travelling to the muscle. The F wave occurs after the direct motor potential or the M response. With more proximal stimulation, the latency of the M response increases while that of F wave decreases. F waves are useful in the assessment of proximal conduction slowing. The main nerves tested are the median, ulnar, peroneal and tibial nerves.[1]

F wave studies are most sensitive in detecting acquired demyelinating polyneuropathies, where they may be quite prolonged. In acute inflammatory demyelinating polyneuropathy (AIDP), this may be the only conduction abnormality. In chronic inflammatory demyelinating polyneuropathy, F waves may be absent.[2]

F waves have a very high diagnostic value in clinical neurophysiology. Therefore, we aim to study the different parameters of F waves in normal healthy individuals and to study the effect of anthropometric variables on F wave parameters.

METHODS

We conducted a descriptive cross sectional study done in BPKIHS in a period of 14 months from October 2016-January 2018. Healthy individuals of age (21.64±1.19 years) not on any medication, not a known case of any disorder, were included in the study. Those individuals with a history of tingling or numbness or trauma to the muscles or nerves were excluded from the study. A circular was provided to the medical students of BPKIHS and those students who voluntarily participated in the study were included as a subject. Male (n=64) and females (n=26) were finally recruited for the study. The sample size was calculated using one sample t test formula. Ethical approval was taken from the Institutional Review Committee, BPKIHS. Anthropometric variables were recorded using appropriate tools.

Recording of F wave

The active recording electrode (also known as G1) was placed on the center of muscle belly and a reference electrode (also known as G2) was placed distally, over the tendon to the muscle as is known as belly tendon montage system. The gain was maintained at 200 microvolts per division and sweep speed at 5 millisecond. The nerve was stimulated supramaximally distally with the cathode of the stimulator facing proximally. On an average, 20 stimuli were given at a frequency of 0.5 Hz with the current strength between 20-50 milliamperes.[3] A total of 8 F waves were obtained from the recording. From the recording obtained, F minimum and maximum latencies, chronodispersion and persistence were measured.

The data collected were entered into Microsoft Excel 2007 and converted it into the SPSS 11.5 version for statistical analysis. Descriptive analysis was done for anthropometric and F wave parameters. Unpaired t test was applied between males and females. Pearson's correlation was applied between anthropometric and F wave parameters. Data was considered significant at p value of < or = 0.05.

Table 1. Anthropometric variables

Variables	Males (n=64) Mean±S.D	Females (n=26) Mean±S.D	P value
Age (years)	21.5±1.24	22.00±0.98	**0.04**
Weight (kg)	65.52±5.20	60.50±4.70	**<0.001**
Height (cms)	167.50±4.92	160.96±3.45	**<0.001**
BMI (kg/m^2)	23.33±1.43	23.33±1.57	0.99

BMI-Body mass index, cm-centimeter, kg- kilogram, m-meter

Table 2. Anthropometric variables

Variables	Males (n=64) Mean±S.D	Females (n=26) Mean±S.D	P value
RMFMax	27.32±1.80	25.69±1.60	**<0.001**
RMFMin	24.70±1.74	22.61±1.63	**<0.001**
LMFMax	27.14±2.82	25.72±1.45	**<0.001**
LMFMin	24.37±1.87	22.81±1.74	**<0.001**
RUFMax	27.21±1.56	25.55±1.32	**<0.001**
RUFMin	22.64±1.41	22.48±1.60	**<0.001**
LUFMax	27.41±1.71	25.65±1.33	**<0.001**
LUFMin	24.64±1.82	22.74±1.43	**<0.001**
RTFMax	48.76±3.07	45.66±2.07	**<0.001**
RTFMin	45.21±2.88	42.21±2.20	**<0.001**
LTFMax	48.36±2.70	45.53±1.55	**<0.001**
LTFMin	44.83±2.83	42.18±1.80	**<0.001**

RMFMax- right median maximum F wave latency, RMFMin- right median minimum F wave latency, LMFMax- left median maximum F wave latency, LMFMin- left median F wave minimum latency, RUFMax- right median F wave maximum latency, RUFMin- right ulnar F wave minimum latency, LUFMax- left ulnar F wave maximum latency, LUFMin- left ulnar F wave minimum latency, RTFmax- right tibial F wave maximum latency, RTFMin- right tibial F wave minimum latency, LTFMax- left tibial F wave maximum latency, LTFMin- left tibial F wave minimum latency

RESULTS

Mean age, weight and height for male and female subjects were 21.5±1.24 years, 65.52±5.20 kg, 167.50±4.92 cms and 22.00±0.98 years, 60.50±4.70 kg and 160.96±3.45 cms respectively. And these values were statistically significant as shown in table 1. F wave latencies were significantly

different in males and females as shown in table 2 while F persistence were comparable between groups (shown in table 4). F chronodispersion was higher for right median and right ulnar nerves in females as compared to males as shown in table 3. Height and weight showed significant effect on F wave latencies while F chronodispersion and persistence did not show any relation with anthropometric variables as shown in table 5.

Table 3. F wave chronodispersion

Variables	Males (n=64) Mean±S.D	Females (n=26) Mean±S.D	P value
RMFCD	2.61±0.70	3.18±0.48	**<0.001**
LMFCD	2.75±0.66	2.90±0.60	**0.33**
RUFCD	2.57±0.71	3.07±0.37	**<0.001**
LUFCD	2.76±0.54	2.91±0.61	0.29
RTFCD	3.50±0.80	3.45±0.53	0.75
LTFCD	3.50±0.65	3.32±0.63	0.22

RMFCD- right median F chronodispersion, LMFCD- left median F chronodispersion, RUFCD- right ulnar F chronodispersion, LUFCD- left ulnar F chronodispersion, RTFCD- right tibial F chronodispersion, LTFCD- left tibial F chronodispersion

Table 4. F wave persistence

Variables	Males (n=64) Mean±S.D	Females (n=26) Mean±S.D	P value
RMFPS	7.80±0.40	7.77±0.43	0.78
LMFPS	7.84±0.36	7.92±0.27	0.26
RUFPS	7.84±0.40	7.77±0.43	0.78
LUFPS	7.91±0.29	7.96±0.19	0.30
RTFPS	7.98±0.12	8.00±0.00	0.32
LTFPS	7.97±0.17	8.00±0.00	0.15

RMFPS- right median F persistence, LMFPS- left median F persistence, RUFPS- right ulnar F persistence, LUFPS- left ulnar F persistence, RTFPS- right tibial F persistence, LTFPS- left tibial F persistence

Table 5. Correlation of anthropometric variables with F wave parameters

F wave variables (ms)	Anthropometric parameters	Pearson's correlation (r value)	P value
RMFMax (ms)	Age	-0.01	**0.92**
RMFMin (ms)	Age	-0.05	**0.64**
LMFMax (ms)	Age	-0.02	**0.79**
LMFMin (ms)	Age	0	**1**
RUFMax (ms)	Age	-0.11	**0.28**
RUFMin (ms)	Age	-0.11	**0.26**
LUFMax (ms)	Age	-0.07	**0.51**
LUFMin (ms)	Age	-0.05	**0.59**
RTFMax (ms)	Age	-0.05	**0.63**
RTFMin (ms)	Age	-0.06	**0.52**
LTFMax (ms)	Age	-0.03	**0.76**
LTFMin (ms)	Age	-0.02	**0.78**
RMFMax (ms)	Weight	0.48	**<0.001**
RMFMin (ms)	Weight	0.467	**<0.001**
LMFMax (ms)	Weight	0.347	**0.001**
LMFMin (ms)	Weight	0.295	**0.005**
RUFMax (ms)	Weight	0.354	**0.001**
RUFMin (ms)	Weight	0.332	**0.001**
LUFMax (ms)	Weight	0.459	**<0.001**
LUFMin (ms)	Weight	0.439	**<0.001**
RTFMax (ms)	Weight	0.226	**0.03**
RTFMin (ms)	Weight	0.245	**0.02**
LTFMax (ms)	Weight	0.306	**0.003**
LTFMin (ms)	Weight	0.286	**0.006**
RMFMax (ms)	Height	0.614	**<0.001**
RMFMin (ms)	Height	0.636	**<0.001**
LMFMax (ms)	Height	0.478	**<0.001**
LMFMin (ms)	Height	0.473	**<0.001**
RUFMax (ms)	Height	0.553	**<0.001**
RUFMin (ms)	Height	0.583	**<0.001**
LUFMax (ms)	Height	0.628	**<0.001**
LUFMin (ms)	Height	0.588	**<0.001**
RTFMax (ms)	Height	0.415	**<0.001**
RTFMin (ms)	Height	0.428	**<0.001**
LTFMax (ms)	Height	0.492	**<0.001**
LTFMin (ms)	Height	0.465	**<0.001**
RMCD (ms)	Age	0.07	0.49
LMCD (ms)	Age	-0.13	0.19
RUCD (ms)	Age	0.01	0.88
LUCD (ms)	Age	-0.009	0.93
RTCD (ms)	Age	0.06	0.55
LTCD (ms)	Age	0.005	0.96
RMCD (ms)	Weight	-0.02	0.82
LMCD (ms)	Weight	0.04	0.65
RUCD (ms)	Weight	-0.01	0.90
LUCD (ms)	Weight	-0.06	0.52
RTCD (ms)	Weight	-0.14	0.16
LTCD (ms)	Weight	0.05	0.60
RMCD (ms)	Height	-0.17	0.09
LMCD (ms)	Height	-0.10	0.34
RUCD (ms)	Height	-0.16	0.12
LUCD (ms)	Height	-0.01	0.92
RTCD (ms)	Height	-0.10	0.33
LTCD (ms)	Height	-0.05	0.61
RMFPS	Age	0.006	0.95
LMFPS	Age	0.103	0.33
RUFPS	Age	0.158	0.13
LUFPS	Age	-0.05	0.62
RTFPS	Age	0.147	0.10
LTFPS	Age	0.20	0.48
RMFPS	Weight	0.15	0.16
LMFPS	Weight	0.01	0.92
RUFPS	Weight	0.10	0.35
LUFPS	Weight	0.14	0.16
RTFPS	Weight	0.001	0.99

LTFPS	Weight	0.13	0.19
RMFPS	Height	0.10	0.32
LMFPS	Height	0.05	0.59
RUFPS	Height	-0.06	0.54
LUFPS	Height	0.01	0.87
RTFPS	Height	-0.04	0.67
LTFPS	Height	0.04	0.67

(p value significant at < or = 0.05)

DISCUSSION

The F wave is so named because it was originally studied in the small muscles of the foot. It is one of the several responses that may follow the direct motor (M) response evoked by electrical stimulation of mixed or motor nerves. The most commonly observed and diagnostically useful of these responses, however, is the F wave.[4]

F waves have a very diagnostic value in neurophysiology. Thus, the objective of the study was to study F waves in a healthy population and to study the effect of anthropometric variables on different F wave parameters.

We found that there were significant differences in F wave latencies between males and female subjects; females conduct faster than males. Right median and ulnar chronodispersion were also statistically significant between two groups. Meanwhile, F persistence were comparable between the groups. There was a significant positive correlation of F wave latencies with height and weight of a subject. However, F wave persistence and chronodispersion did not show any significant correlation with anthropometric variables. Also, age did not have influence of F wave parameters. It might be due the narrow range of age in our subjects.

Alavian et al. studied F wave latencies of tibial and peroneal nerves of 73 healthy individuals. Maximum normal F wave latency for tibial nerve was 55 ms with stimulation at ankle and 47 ms with stimulation at popliteal fossa while that for peroneal nerve was 54 ms with stimulation at ankle and 47 ms with stimulation at the fibular head.[5]

Ghosh et al. studied different F wave parameters (minimum, mean, maximum latencies, chronodispersion and F persistence) of ulnar and median nerves in twenty healthy volunteers aged 19-46 years.[6] The study concluded that there was a significant difference between median and ulnar nerve F wave maximal latency, mean latency and chronodispersion.[6] Likewise, a study done by Taksande et al showed gender, age and height had significant influence on F minimum latency of bilateral median, ulnar, tibial and peroneal nerves with $p<0.05$.[7] The study was done in normal healthy 175 subjects in an age group of 18-66 years. However, BMI did not show any effect on F minimal latency.[7] These findings are similar to our findings for gender and height effects on F wave parameters. Similarly, Soudmand et al. reported a positive correlation between height and F wave latency of median and peroneal nerves.[8]

Parmar et al. studied different F wave parameters (latency, amplitude, chronodispersion and persistence) in 59 healthy subjects between age group of 18-60 years and studied mainly F wave minimal latency of bilateral ulnar, median, deep peroneal and tibial nerves and their relation to limb length or height.[9] The study showed no significant side to side difference between minimum latencies of the same nerves. F min latency is highly correlated with height and limb length ($p<0.01$) and no significant correlation is found with age.[9] These findings are in accordance with our findings.

Peioglou et al. studied various parameters of F response, including minimum and maximum latencies, amplitude, chronodispersion and duration of bilateral median and ulnar nerves of 64 healthy subjects of both sexes in an age group of 12-81 years.[10] This study suggests strong correlations between min and max F latencies and height of the subject and between amplitude and age.[10]

Puksa et al. studied difference F wave parameters (F min, F mean and F max latency) and F no (no of F waves/20 stimuli) and F wave dispersion of median, ulnar, peroneal and tibial nerves in 196 healthy subjects with age range of 14-95 years.[11] The study showed that F wave latency increases with height in the arms by 0.2 ms/cm and in legs by 0.4 ms/cm; peroneal nerve has slightly longer F min latency than the tibial nerve while F number is higher in the tibial nerve than peroneal nerve.[11]

Similarly, Puksa et al. studied different F wave parameters of median, ulnar, tibial and peroneal nerves in healthy subjects of 3-20 years.[11] The study concluded that the height of the subjects had significant relationship with F min latency whereas the gender did not influence it. Also, F dispersion was not related to age, height or gender.[12] Our study also did not show any correlation of anthropometric parameters with F chronodispersion.

Along with the positive correlation of height with the F wave latencies, our study also showed a positive correlation of weight with the F wave latencies. Huang et al. reported a positive correlation of weight with F wave latencies of median, peroneal and tibial nerves.[13] These findings are in accordance with our studies. However, some studies done by Pawar et al. and Buschbacher et al. did not show significant effects of weight on F wave latencies.[14,15]

There is a significant relation of F wave parameters specifically latencies with weight and height of the subject. And these findings are in accordance with previous literatures.[7-11] More the height of a person, latency increases as the action potential through the nerve has to travel greater distance. Increase in weight means an increase in subcutaneous fat. Hence, increased amount of fat can cause compression of peripheral nerves resulting in slower conduction, resulting in an increase in latency.

F chronodispersion and F persistence did not show significant relation to anthropometric parameters. However, age did not show any significant relation to any of the F wave parameters. And this finding are in accordance with the study done by Parmar et al.[9]

As the height and weight showed a significant relation to F wave latency, these variables must be taken into consideration while reporting nerve conduction studies.

F/M ratio and F estimates could not be measured as due to time constraints. F waves in age group of different range could not be assessed.

CONCLUSION

Height and weight showed a significant relationship with the F wave latencies $p<0.001$ and $p<0.05$ respectively for most of the tested peripheral nerves.

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