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F-Wave Parameters of Normal Ulnar and Median Nerves

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Abstract

Twenty healthy volunteers (17 males) aged 19–46 years (Mean 28±6.8) without any history of previous numbness and pain in the hands or any other neurological disorder were included in this study. The normal median nerve F-wave parameters studied were: minimum latency 24.8±1.7 ms; maximum latency 29.8±2.8 ms; mean latency 26.8±1.4 ms; chronodispersion 5±2.8 ms; FM ratio 2±1, manual and computerized persistence mode 10. Persistence varied from 4 (40%) to 10 (100%) measured both manually and by computer.

The normal ulnar nerve F-wave parameters studied were: minimum latency 24.5±1.7 ms; maximum latency 28.2±1.8ms; mean latency 26.2±1.7 ms; chronodispersion 3.6±1.4 ms; FM ratio 3±5.2, persistence (mode) 10. Persistence varied from 5 (50%) to 10 (100%) measured both manually and by computer.

In both the median and ulnar nerves, difference between the right and the left F-waves parameters values were insignificant. There was significant difference between median and ulnar nerve F-waves maximal latency, chronodispersion and mean latency ($t=3.28$; $p<0.05$: $t=2.92$; $p<0.05$: $t=2.42$; $p<0.05$ respectively).

In conclusion, it was observed that there was increased median and ulnar nerves F-wave chronodispersions and significant difference was found between median and ulnar nerves' F-wave maximal latency, chronodispersion and mean latency in comparison to the previous studies.

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Introduction

Following the original description[1] and early clinical studies[2,3], the F wave has found a wide application in the assessment of peripheral nerve lesions. Consecutively recorded F waves vary in latency and amplitude, necessitating comparison of a train of responses. Most laboratories use persistence and minimum latency as the only practical measures[4,5,6]. Some advocate mean latency[7] and others chronodispersion, which is defined as the difference between minimum and maximum latencies, or the range of conduction time among all motor fibers[8,9,10].

The normative data described in the literature were mostly based on the analysis of only some aspects of the F waves. In our study various F-wave parameters were analyzed in healthy subjects, including some uncommonly studied aspects, such as F-waves FM ratios and manual persistence.

Methods

This study was performed in Physical Medicine and Rehabilitation Department, Prince Abdul Rahman Al-Sudairy Central Hospital, Sakaka, Al-Jouf, Kingdom of Saudi Arabia. A total of 20 (17 men) healthy volunteers (40 ulnar and 40 median nerves) aged 19–46 years (mean 28±6.8) without any history of previous numbness or pain in the hands or any other neurological disorder, gave a written consent to participate in this study. Nerve conduction studies were performed by Schwarzer Myos Plus EMG machine (Schwarzer GmbH Medical Equipment for Diagnosis, Baermannstr.38, D-81245, Munich) with filter setting at 20 Hz- 10000Hz, in a warm room, maintaining the skin temperature above 32 degree centigrade. A gain of 5000µV per division was used for all M response latency measurements. For the F-wave, amplifier gain was 200µV per division and a sweep speed of 5 ms was used.

F-wave studies consisted of applying ten supramaximal stimulations to the ulnar nerve with the cathode proximal to the anode at the wrist and recording F-waves from the abductor digiti minimi with active disk electrode placed over the belly and reference disc electrode over the tendon

of the muscle. Ground electrode was placed on the dorsal aspects of the wrist between the stimulation point and active electrode. Stimuli were delivered to relaxed subjects lying supine on a bed. Same procedures were applied for median nerve for the recording of F-waves with active disk electrode placed over the belly and reference disc electrode over the tendon of the abductor pollicis brevis muscle[11,12,13].

Chroni, Taub and Panayiotopoulos[14] studied the peroneal nerve F waves in 20 healthy subjects and 20 patients with neuropathy to assess the effect of sample size on the accuracy of measurements of the following F wave latency parameters: F wave minimum latency, mean latency, median latency and F chronodispersion. The values obtained from a large sample (65-110 F responses) were compared with the corresponding values from smaller samples of 10, 20 and 40 responses. The results indicated that equally accurate measurements for all parameters were provided by larger F wave samples in patients, compared with healthy subjects. A sample of 40 fulfilled the requirements for all F wave latency parameters of the peroneal nerve in almost all subjects, a finding which is in good agreement with that of a similar study for the ulnar nerve. Hence, 40 ulnar and 40 median nerves were studied in 20 volunteers.

Minimum latency, maximal latency, mean latency, chronodispersion, manual and automated computerized persistence and FM ratios of F-waves were measured and analyzed. Data were analyzed to study the difference between the right and the left sides within the same nerve and between the two nerves by applying Wilcoxon Signed Rank Test for persistence and t-test paired for other F-waves parameters.

Results

The normal median nerve F-wave parameters were: minimum F-wave latency 24.8±1.7 ms; maximum F-wave latency 29.8±2.8 ms; mean F-wave latency 26.8±1.4 ms; chronodispersion 5±2.8 ms; FM ratio 2±1 (Table 1). The median nerve persistence was measured in mode and not in mean because of the nature of the data was 10 for both manual and computerized persistence. Persistence varied from 4 (40%) to 10 (100%) both manually and by automated computer (Table 2).

The normal ulnar nerve F-wave parameters were: minimum F-wave latency 24.5±1.7 ms; maximum F-wave latency 28.2±1.8 ms; mean F-wave latency 26.2±1.7 ms; chronodispersion 3.6±1.4 ms; FM ratio 3±5.2 (Table 1).

In both the median and ulnar nerves the difference between the right and left F-waves parameters values were insignificant. There was significant difference between median and ulnar nerve F-waves maximal latency, chronodispersion and mean latency ($t=3.28$; $p<0.05$: $t=2.92$; $p<0.05$: $t=2.42$; $p<0.05$ respectively).

Table1. Normal F-waves Parameters of median and ulnar nerves. All measurements in ms.

	N	Min	Max	Mean	SD
RMFMIN	20	18.67	27.27	24.4570	2.24082
RMFMAX	20	24.22	33.28	29.7890	2.37171
RMDISP	20	2.03	12.97	5.3320	2.84071
RMMEAN	20	23.13	29.50	26.8095	1.50972
RMFM	20	0.56	4.55	1.9735	1.23856
LMMIN	20	23.52	27.42	25.2075	1.04416
LMMAX	20	25.23	36.95	29.9990	3.23236
LMDISP	20	0.85	11.33	4.7915	2.87056
LMMEAN	20	24.88	29.44	26.9495	1.42201
LMFM	20	0.62	3.54	2.1945	.89069
RUMIN	20	22.34	27.66	24.3210	1.68161
RUMAX	20	25.47	31.95	28.3905	1.96729
RUDISP	20	1.72	8.44	4.0695	1.68256
RUMEAN	20	23.98	29.98	26.1890	1.74189
RUFM	20	0.50	29.79	3.2150	6.32124
LUMIN	20	22.27	29.38	24.7585	1.85183
LUMAX	20	24.92	31.56	28.0270	1.80098
LUDISP	20	1.01	5.71	3.2685	1.03411
LUMEAN	20	23.99	30.36	26.2855	1.72366
LUFM	20	1.11	19.58	2.9090	4.00526
MMIN	40	18.67	27.42	24.8323	1.76687
MMAX	40	24.22	36.95	29.8940	2.80032
MDISP	40	0.85	12.97	5.0618	2.83208
MMEAN	40	23.13	29.50	26.8795	1.44933
MFM	40	0.56	4.55	2.0840	1.07068
UMIN	40	22.27	29.38	24.5398	1.75995
UMAX	40	24.92	31.95	28.2088	1.87071
UDISP	40	1.01	8.44	3.6690	1.43691
UMEAN	40	23.98	30.36	26.2373	1.71114
UFM	40	0.50	29.79	3.0620	5.22553

RMFMIN- Right median F waves minimum latency
RMFMAX -Right median F waves maximum latency
RMDISP- Right median F waves chronodispersion
RMMEAN- Right median F waves mean latency
RMFM- Right median F waves FM ratio
LMMIN- Left median F waves minimum latency
LMMAX- Left median F waves maximum latency
LMDISP- Left median F waves chronodispersion
LMMEAN- Left median F waves mean latency
LMFM- Left median F waves FM ratio
RUMIN- Right ulnar F waves minimum latency
RUMAX- Right ulnar F waves maximum latency
RUDISP- Right ulnar F waves chronodispersion
RUMEAN- Right ulnar F waves mean latency
RUFM- Right ulnar F waves FM ratio
LUMIN- Left ulnar F waves minimum latency
LUMAX- Left ulnar F waves maximum latency
LUDISP- Left ulnar F waves chronodispersion
LUMEAN- Left ulnar F waves mean latency
LUFM- Left ulnar F waves FM ratio
MMIN- Median nerve F-waves minimum latency
MMAX- Median nerve F-waves maximum latency
MDISP- Median nerve F-waves chronodispersion
MMEAN- Median nerve F-waves mean latency
MFM- Median nerve F-waves FM ratio
UMIN-Ulnar nerve F-waves minimum latency
UMAX- Ulnar nerve F-waves maximum latency
UDISP- Ulnar nerve F-waves chronodispersion
UMEAN- Ulnar nerve F-waves mean latency
UFM- Ulnar nerve F-waves FM ratio

Table 2. Normal F-waves persistence of Median and Ulnar nerve. All values in ms.

	N	Min	Max	Mode
RMMP	20	9.00	10.00	10
LMMP	20	8.00	10.00	10
MMP	40	8.00	10.00	10
RUMP	20	10.00	10.00	10
LUMP	20	9.00	10.00	10
UMP	40	9.00	10.00	10
RMCP	20	4.00	10.00	10
LMCP	20	6.00	10.00	10
MCP	40	4.00	10.00	10
RUCP	20	8.00	10.00	10
LUCP	20	5.00	10.00	10
UCP	40	5.00	10.00	10
Valid N (listwise)	20			

RMMP- Right median manual persistence
LMMP- Left median manual persistence
MMP- Median manual persistence
RUMP- Right ulnar manual persistence
LUMP- Left ulnar manual persistence
UMP- Ulnar manual persistence
RMCP-Right median automated computerized persistence
LMCP- Left median automated computerized persistence
MCP- Median automated computerized persistence
RUCP- Right ulnar automated computerized persistence
LUCP- Left ulnar automated computerized persistence
UCP- Ulnar automated computerized persistence

Table 3. Difference in median and ulnar nerves F-waves parameters.

		Paired Differences 95% CI Lower	of dif. Upper	t	Sig2tld
Pair 1	RMFMIN-LMMIN	-1.8367	0.3357	-1.446	0.164
Pair 2	RMFMAX-LMMAX	-1.7705	1.3505	-0.282	0.781
Pair 3	RMDISP-LMDISP	-1.2681	2.3491	0.626	0.539
Pair 4	RMMEAN-LMMEAN	-0.8568	0.5768	-0.409	0.687
Pair 5	RMFM-LMFM	-0.8939	0.4519	-0.687	0.500
Pair 6	RUMIN-LUMIN	-1.1793	0.3043	-1.234	0.232
Pair 7	RUMAX-LUMAX	-0.5044	1.2314	0.877	0.392
Pair 8	RUDISP-LUDISP	-0.1605	1.7625	1.744	0.097
Pair 9	RUMEAN-LUMEAN	-0.5358	0.3428	-0.460	0.651
Pair 10	RUFM-LUFM	-3.1466	3.7586	0.186	0.855
Pair 11	MMIN-UMIN	-0.3352	0.9202	0.943	0.352
Pair 12	MMAX-UMAX	0.6477	2.7228	3.285	0.002
Pair 13	MDISP-UDISP	0.4281	2.3574	2.920	0.006
Pair 14	MMEAN-UMEAN	0.1059	1.1786	2.422	0.020
Pair 15	MFM-UFM	-2.7338	0.7778	-1.127	0.267

Abbreviation used: 95% CI of dif: 95% confidence interval of differences; Sig2tld: Sig 2 tailed; rest of them are as explained below the Table 1.

Table 4. Difference between ulnar and median manual persistence performed by Wilcoxon Signed Rank test.

	Ulnar Manual Persistence – Median Manual Persistence
Z	-1.414
Asymp. Sig. (2-tailed)	0.157

Table 5. Difference between ulnar and median automated computerized persistence performed by Wilcoxon Signed Rank test.

	Ulnar automated persistence – Median automated persistence
Z	-1.368
Asymp. Sig. (2-tailed)	0.171

Discussion

In the reported literature the upper limit in the normal adult for minimal F latency is 31 ms for hand[15] and in this study it was 29.38 ms. Right to left asymmetry of minimum F latency exceeding 2 ms in hand is considered abnormal[15]. In this study the difference between the right and the left median mean minimum latency was -0.75 ms and the difference between the right and the left ulnar mean minimum latency was -0.43 ms which were well within normal limits. Alavian, Samadzadeh and Alavian-Ghavanini[16] studied that the maximum normal difference in F wave latency between right and left upper extremities with stimulation at the wrist for total group was 2.2 ms for median nerve and 2.4 ms for ulnar nerve. Maximum normal difference in F wave latency between median and ulnar nerve in an extremity with stimulation at the wrist for total group was 2.7ms. In this study the difference between the right and the left median nerve maximum F-wave latency was -0.21ms and difference between median and ulnar nerve maximum latency of F wave was 1.69ms.

The highest reported normal values for F wave chronodispersion (mean ± SD) for the median nerve (abductor pollicis brevis) are 3.6 ± 1.2 ms[17], for the ulnar nerve (abductor digiti minimi) 3.3 ± 1 ms[8]. In this study median nerve (abductor pollicis bravis) chronodispersion was 5±2.8ms and Ulnar nerve(abductor digiti minimi) chronodispersion was 3.6±1.4ms, both were higher than the previous reported values.

The upper limit of F amplitude is 5% of M wave[7]. Normal F/M ratios based on mean F-wave amplitudes reported were 2.2 ± 1.0 percent for the abductor pollicis brevis[18].

In this study it was 2.08±1.07 for abductor pollicis brevis and 3.06±5.22 for abductor digiti minimi.

The F-wave persistence was 8.3 ± 1.9 of ulnar nerve[19]. Another study[7] showed that the persistence of F wave for abductor digiti minimum and abductor hallucis were about 8 to 9 respectively. In this study the median nerve manual persistence minimum was 8 and maximum was 10 when mode was 10 and for ulnar nerve manual persistence minimum was 9 and maximum was 10 when mode was 10.

Puksa, Stalberg and Falck[18] observed no significant differences in any of the parameters except for the median nerve F-wave minimum latency and F-wave mean latency, which was 0.2 ms longer on the right than left. In this study the difference between the median and the ulnar nerve F-wave maximal latency, chronodispersion and mean latency was significant ($t=3.28$; $p<.05$: $t=2.92$; $p<.05$: $t=2.42$; $p<.05$ respectively). There was no significant difference between median and ulnar nerves F-waves minimum latencies, FM ratios and persistence.

Conclusion

In this study it was found that there was increased median nerve and ulnar nerve F-wave chronodispersions and there was significant difference between median and ulnar nerves F-wave maximal latency, chronodispersion and mean latency in comparison to previously reported studies.

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