CONCENTRIC NEEDLE JITTER ON VOLUNTARY ACTIVATED FRONTALIS IN 20 HEALTHY SUBJECTS

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Abstract: Introduction: Normative data for jitter parameters using a disposable concentric needle have been described in a few studies. Methods: Jitter, expressed as the mean consecutive difference (MCD), was measured in the frontalis muscle in 20 subjects by voluntary contraction. Results: Mean MCD for individual studies (20, Gaussian), all potentials (400, non-Gaussian), and 18th highest value (20, Gaussian) were 19.9 ± 2.9 μs, 19.9 ± 6.6 μs, and 26.9 ± 4.4 μs, respectively. Conclusion: The suggested upper normal limit for mean MCD is 26 μs and for outliers is 36 μs.


S single-fiber electromyography (SFEMG) measures neuromuscular jitter. With volitional activation (v-jitter), action potentials from 2 muscle fibers belonging to the same motor unit are identified by triggering on 1 of them; their combined jitter is displayed in the non-triggered component.1 Jitter is a sensitive measurement of neuromuscular transmission and is most valuable clinically in the evaluation of patients with suspected myasthenia gravis.

Due to the increasing concern for the transmission of infections,2,3 disposable concentric needle electrodes (CNEs) are being used for jitter analysis, instead of the reusable and expensive SFEMG needle electrode (SFE).

For CNE jitter measurements, the low-frequency filter should be raised from 500 Hz to 1 kHz to suppress activity from distant muscle fibers.1 As the signals obtained with CNE recording do not always represent a single-fiber action potential (SFAP), but rather a summation of many, the term “jitter recorded with CNE” is suggested. The term “apparent SFAP” (ASFAP)4 is preferred over SFAP.

METHODS

This investigation was a prospective study of 20 healthy subjects, 7 men and 13 women, with a mean age of 39 ± 8.9 years (range 22–59 years).

None had been diagnosed with a neuromuscular disorder or any unrelated medical condition, nor were they taking medications that could have interfered with the study, such as calcium channel blockers.13 The study was approved by the ethics committee of Faculdade de Medicina de São José do Rio Preto, and informed consent was obtained from each subject.

A portable electromyography device (Keypoint-Net; Medtronic, Skovlunde, Denmark) was used for recording and analysis, using a peak detection algorithm for time measurements. A CNE with a diameter of 0.30 mm and a recording area of 0.019 mm² (Alpine BioMed, Skovlunde, Denmark) was used.

Recording was done during voluntary contraction of the frontalis muscle (FR). Both the examiner and the Keypoint software selected only potentials with a short rise time, a well-defined peak, and a “constant shape” on consecutive discharges. Care was taken to get ASFAP pairs with a clear separation (>150 μs) with no or minimal “riding” of 1 signal on the other. Recordings with an interspike interval >4 ms were skipped. Jitter was expressed as the mean of mean consecutive differences (MCDs) in 20 pairs of potentials. Pairs with jitter <5 μs, occurring rarely, were skipped.

For each jitter analysis, a minimum of 50 and an ideal 100 consecutive traces of pairs were recorded (Fig. 1). Twenty different ASFAP pairs were calculated for each study subject. The mean value of MCDs and mean sorted data differences (MSD) were calculated. If the MCD/MSD ratio was >1.25, then the MSD was used instead of the MCD as the jitter value.

Filter settings were set at 1 kHz to 10 kHz. MCD parameters were analyzed using the mean and standard deviation (SD) for Gaussian and percentiles for non-Gaussian distributions. The upper limit of normal was set at mean + 2 SD for Gaussian and 97.5th percentile for non-Gaussian distributions.

RESULTS

The mean ± SD calculated from all means of 20 MCD values of individual subjects was 19.9 ± 2.9 μs (+ 2 SD = 25.6 μs). Values ranged from 13.9 to 25.5 μs and had a Gaussian distribution. The mean of the

Abbreviations: ASFAP, apparent single-fiber action potential; CNE, concentric needle electrode; FR, frontalis muscle; MCD, mean consecutive difference; MSD, mean sorted difference; OO, orbicularis oculi; SFAP, single-fiber action potential; SFE, single-fiber electrode; SFEMG, single-fiber electromyography; v-jitter, voluntary jitter

Key words: concentric needle electrode, frontalis, jitter, single-fiber electromyography, voluntary jitter

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18th MCD values in each subject was 26.9±6.6 µs (range 5.2–42.2 µs), with a non-Gaussian distribution. The 97.5th percentile was 34.8 µs.

**DISCUSSION**

Jitter values from the voluntarily activated FR muscle were obtained to define reference values from 20 healthy subjects. It is inevitable that the spikes recorded with CNE often represent >1 SFAP, despite the fact that obvious summation signals have been excluded. Therefore, separate normative data from those published for SFE should be collected for CNE recordings. For CNE jitter, a few laboratories have reported reference values.

Our findings for an individual patient suggest a mean MCD upper limit of 26 µs. For outlier limit (individual pairs) we chose 36 µs, which is the higher of the 2 ways to express this parameter: the mean 18th MCD value or the mean of all MCD values for the 400 individuals pairs.

If we compared the suggested upper normal limit for mean MCD values of SFE to CNE from our other reference articles, we found a lower jitter of 5.4 µs for ED, 9.4 µs for orbicularis oculi (OO), and 9.5 µs for FR. The 95% upper confidence limit of normal for individual pairs was 53.5 µs for all SFAPs, thus 17.5 µs higher than with CNE. Some of the difference could be attributed to summation, analysis methods used, the relatively small number of subjects, and the more standardized approach in this single-center study. Age was quite similar in all our reference data.

For comparison with a volitional CNE study of the FR, Kokobun et al. reported mean MCD 22.4 ± 3.9 µs (95%, 30.2 µs), slightly higher than ours (26 µs), and 22.5 ± 10.3 µs from all 1185 pairs (95%, 43.1 µs). Our 95% value for all pairs was 34.8 µs. The proposed outlier limit was 56.8 µs, much higher than ours (36 µs), and even higher than SFE (53.5 µs). One of the reasons for this difference is that our study was from a single laboratory with a single type of equipment, and we used traditional statistical methods for analysis.

Peak detection rather than amplitude level for the time markers seems better for ASFAPs, because there is less influence from summation, particularly for riding signals.

CNE is an acceptable alternative to SFEMG for acquiring ASFAPs. Still, a level of caution must be maintained before a study using CNE is declared normal or abnormal in situations of borderline jitter values until a larger reference population has been studied in a multicenter effort.

**REFERENCES**


**FIGURE 1.** Pair of apparent single-fiber action potentials of the same motor unit recorded from the frontalis of a normal subject (female, 42 years of age) with a concentric needle electrode during minimal voluntary activation. Filter setting: 1 kHz / 10 kHz. Calculated jitter: 9.5 µs.

18th MCD values in each subject was 26.9±4.4 µs (+2 SD = 35.8 µs), with a range of 16.7–35.8 µs and a Gaussian distribution. The mean ± SD of all MCD values for the 400 individual ASFAP pairs was 19.9±6.6 µs (range 5.2–42.2 µs), with a non-Gaussian distribution. The 97.5th percentile was 34.8 µs.