The sensitivity comparison of bar electrode and disposable ring electrode for recording of lateral femoral cutaneous nerve

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Abstract

Objectives: To compare the sensitivity of bar electrode and disposable ring electrode for recording of lateral femoral cutaneous nerve (LFCN)

Materials and Methods: A total of 23 subjects (13 females, 10 males, mean age: 49.6 ± 9.6 (range: 29-63) were recruited in the study. A total of 36 recordings were obtained with each electrode (with bar and disposable ring electrodes) from the subjects. The comparison of data was performed with percentages and student T-table test. Results: The response rate was 98% (35 out of 36 recordings) with bar electrode and 88% (32 out of 36 recordings) with disposable ring electrode. Although the sensitivity rate of bar electrode is slightly higher than of disposable ring electrode, there were no statistically significant differences in detecting the onset latency, peak latency, and amplitude of LFCN. Conclusion: The recording sensitivity of LFCN is higher with bar electrode than disposable ring electrode. However, disposable ring electrode can be used alternatively.

Key Words

Bar electrode, disposable ring electrode, lateral femoral cutaneous nerve, LFCN, meralgia paresthetica, nerve conduction studies

Introduction

Meralgia Paresthetica (MG) is a peripheral nerve disorder caused by compression and/or dysfunction of lateral femoral cutaneous nerve (LFCN). LFCN is derived from the second and third lumbar roots and pure sensory nerve. Thus, MG clinically manifests with paresthesias and numbness over the anterolateral part of the thigh. LFCN, overlapping of LFCN response by shock artifact or motor response from the quadriceps, and obesity, the recording of LFCN with NCS is usually challenging for physicians and technicians. Different techniques have been developed for obtaining the sensory nerve action potential (SNAP) of LFCN to improve sensitivity of NCS. The purpose of our study was to describe a method that provides larger SNAP amplitude of LFCN and the better rate of recorded SNAP with disposable ring electrode than bar electrode.

Materials and Methods

A total of 23 subjects (13 females, 10 males, mean age 49.6 ± 9.6 (range: 29-63) were included in the study. The samples consisted of 23 normal subjects, without signs or symptoms of peripheral nerve disorders. A total of 36 recordings were obtained with each electrode (with bar and disposable ring electrodes) from the subjects. Bilateral recordings were performed in 13 subjects and unilateral recording was performed in 10 subjects.

NCS of the LFCN was performed by the same technician (initials: MR) with Cadwell Sierra electromyography machine using bar electrode (Shielded bar electrode with 5-pole, Cadwell, USA) and disposable ring electrodes [Wrap-around, silver/silver chloride ring electrodes; dimensions: 10 cm (4 in) long, 0.6 cm
(0.25 in) wide, Cadwell, USA) for recording and a bipolar surface electrode for stimulation. Filter settings included frequency 30-20,000 Hz, sensitivity 5-20 μV per division, and sweep speed 2 ms/division. Stimulation intensity ranged from 6 mA to 42 mA with 0.1-ms duration. No averaging was performed. Temperature of the limb was maintained at 33°C. Electrophysiological testing of the LFCN was performed on each subject with two different electrodes with the same technique. Before performing the NCS test, the skin was cleaned with alcohol to decrease impedance. The stimulation electrode was placed 4 cm distal to the anterior superior iliac spine (ASIS). The pick electrodes [bar electrode [Figure 1a] and disposable ring electrode [Figure 1b] were placed 10 cm distal to the site of the ASIS on a line connecting the ASIS to the lateral border of the patella. The subjects were asked to notify the operator when they felt stimulation to the anterolateral aspect of the thigh. No averaging was used. Each SNAP was obtained at least three times in each trial to confirm the variability of the nerve conduction results between the different trials. It took one to three trials to find the stimulation site.

The comparison of data was performed with percentages and student T-table test. A P-value less than or equal to 0.05 was considered as a statistically significant.

Results

The sensory NCS of LFCN results with the bar and disposable ring electrodes are summarized in Tables 1 and 2. Mean SNAP latency was measured at 1.59 ms [standard deviation (SD) = 0.29] with mean amplitude 7.76 μV (SD = 4.97) with bar electrodes, and at 1.62 ms (SD = 0.32) with mean amplitude 7.03 μV (SD = 4.23) with disposable ring electrodes. The response rate was 97% (35 out of 36 recordings) with bar electrode and 88% (32 out of 36 recordings) with disposable ring electrode. In three recordings, LFCN response was unobtainable with disposable ring electrode but obtainable with bar electrode. In only one recording, LFCN response was unobtainable with bar electrode but obtainable with disposable ring electrode.

Discussion

The use of NCS in the diagnosis of MG was first performed by Butler et al. in 1974. In the first technique, surface electrodes are placed antidromically to record the action potential of the LFCN following stimulation at a site located 1 cm medial to the ASIS. Then, Russo et al. described an alternative technique involving the placement of bar electrode antidromically to record the action potential of the LFCN following stimulation 4 cm distal to the ASIS. The response rate was 35% with the traditional technique, whereas it was 90% with the new alternative technique. The new technique is more sensitive than the traditional technique. In the el-Tantawi study, the traditional technique was performed that may explain their low sensitivity rate (28.1%) with sensory NCS. We performed the new technique in our study. The sensitivity rate was 98% with bar electrode and 88% with disposable ring electrode. Overall, bar electrode was more sensitive than disposable ring electrode in recording LFCN.

The values of mean SNAP amplitude and latency have shown variation in different studies. In Laroy et al.'s study involving 58 healthy subjects, mean SNAP latency of LFCN was measured at 1.7 ms (SD = 0.23) with mean amplitude of 10.5 μV (SD = 0.4) by using surface disc electrodes for recording. In their study, antidromical stimulation was performed with the bipolar electrode placed at 4.0 cm on vertical line distal to the ASIS. In their study, antidromical stimulation was performed with the bipolar electrode placed at 4.0 cm on vertical line distal to the ASIS.

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In Lagueny et al.'s study, the mean SNAP amplitude was 16 ± 7 μV with orthodromic recording (stimulation was performed with a bipolar fixed distance 23 mm surface electrode, 12 cm distal to the subcutaneous needle recording electrodes (interelectrode distance, 25 mm). In our study, although the sensitivity rate of the bar electrode recording was higher than of the disposable ring electrode recording, there were no statistically significant differences in mean values of onset latency, peak latency, and amplitude of LFCN between bar and disposable ring electrodes.

In conclusion, the bar electrode recordings is more sensitive than disposable ones but is less reliable and less sensitive than antidromic recording performed by Lagueny and Laroy and than orthodromic recording performed with near-the-nerve or subcutaneous needle electrodes.

Table 1: The comparison of bar electrode and disposable ring electrode

|            | Amp (μV) | Lat (ms) | PkLat (ms) |
|------------|----------|----------|------------|
| Bar electrode (mean±SD) | 7.76±4.97 | 1.59±0.29 | 2.19±0.31  |
| Ring electrode (mean±SD) | 7.03±4.23 | 1.62±0.32 | 2.18±0.37  |
| P-value    | 0.06     | 0.42     | 0.83       |

Amp = Amplitude, Lat = Latency, PkLat = Peak latency, SD = Standard deviation
Table 2: Recordings data from bar and ring electrodes

|                | Onset (ms) | Peak (ms) | Amp (μV) |                | Onset (ms) | Peak (ms) | Amp (μV) |
|----------------|------------|-----------|----------|----------------|------------|-----------|----------|
| Bar electrode  |            |           |          | Ring Electrode  |            |           |          |
| P1 left        | 2.3        | 2.9       | 3.1      | P1 left        | 2          | 2.8       | 3.9      |
| P1 right       | 1.5        | 1.9       | 1.7      | P1 right       | 1.8        | 2.4       | 5        |
| P2 left        | 2          | 2.9       | 4.6      | P2 left        | 1.5        | 2.2       | 9.5      |
| P2 right       | 1.6        | 2.3       | 2.3      | P2 right       | NR         | NR        | NR       |
| P3 left        | 1.5        | 1.9       | 7.1      | P3 left        | 1.6        | 2.1       | 10.5     |
| P4 right       | 1.6        | 2.2       | 4.9      | P4 right       | NR         | NR        | NR       |
| P5 left        | 1.2        | 1.7       | 5.2      | P5 left        | 1.3        | 1.7       | 1.7      |
| P5 right       | NR         | NR        | NR       | P5 right       | 1.5        | 2         | 4        |
| P6 left        | 1.8        | 2.3       | 4.3      | P6 right       | 1.5        | 1.9       | 1.5      |
| P7 left        | 1.5        | 2.4       | 8.5      | P7 left        | 1.3        | 2         | 7.3      |
| P7 right       | 1.1        | 2         | 12.4     | P7 right       | 1.1        | 1.8       | 13.3     |
| P8 left        | 1.3        | 1.8       | 9.5      | P8 right       | 1.2        | 1.9       | 9.8      |
| P8 right       | 1.3        | 2.1       | 11.2     | P8 left        | 1.2        | 1.8       | 8.9      |
| P9 left        | 1.4        | 2         | 5.5      | P9 left        | 2.3        | 2.8       | 3.9      |
| P9 right       | 1.4        | 1.9       | 10.9     | P9 right       | 1.6        | 2         | 5.3      |
| P10 left       | 1.8        | 2.2       | 3.7      | P10 left       | 1.8        | 2.3       | 0.9      |
| P10 right      | 2          | 2.6       | 4.7      | P10 right      | 2.3        | 2.8       | 5.8      |
| P11 left       | 1.9        | 2.3       | 3.1      | P11 left       | 1.3        | 1.9       | 3.7      |
| P11 right      | 1.3        | 1.9       | 5.1      | P11 right      | 1.7        | 2.1       | 4.6      |
| P12 left       | 1.6        | 2.2       | 7.4      | P12 left       | 1.8        | 2.6       | 6.6      |
| P12 right      | 1.6        | 2.1       | 6.7      | P12 right      | 1.4        | 2         | 5.5      |
| P13 right      | 1.3        | 1.8       | 12.9     | P13 right      | 1.3        | 1.7       | 7.1      |
| P14 left       | 2.4        | 2.8       | 4.8      | P14 right      | NR         | NR        | NR       |
| P14 right      | 1.6        | 2         | 5.8      | P14 right      | NR         | NR        | NR       |
| P15 left       | 1.6        | 2.2       | 12.6     | P15 right      | 1.6        | 2.1       | 9.4      |
| P15 right      | 1.5        | 2.1       | 19.4     | P15 right      | 1.5        | 2         | 10.2     |
| P16 right      | 1.7        | 2.3       | 5.4      | P16 right      | 1.8        | 2.3       | 6.5      |
| P17 left       | 1.3        | 2.1       | 25.4     | P17 right      | 1.7        | 2.4       | 24       |
| P17 right      | 1.7        | 2.2       | 5.5      | P18 left       | 1.7        | 2.5       | 7.8      |
| P18 right      | 1.8        | 2.4       | 7.9      | P18 right      | 1.4        | 1.8       | 4.8      |
| P19 right      | 1.3        | 1.8       | 4.2      | P19 right      | 1.3        | 1.6       | 4.7      |
| P20 right      | 1.6        | 2.1       | 10.1     | P20 right      | 1.6        | 2.2       | 6.7      |
| P21 left       | 1.4        | 2.3       | 8.1      | P21 left       | 2.3        | 3.1       | 7.5      |
| P22 right      | 1.4        | 2.1       | 14       | P22 right      | 1.6        | 2.4       | 11.2     |
| P23 left       | 2          | 2.8       | 5.3      | P23 left       | 2          | 2.6       | 6.7      |
| P23 right      | 1.6        | 2.2       | 8.2      | P23 right      | 1.7        | 2.1       | 6.5      |

P = Patient, amp = amplitude, NR = No response, onset = Onset latency, peak = peak latency

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