MEASUREMENT OF MOTOR NERVE CONDUCTION VELOCITY IN THREE DIFFERENT SPORTS

ABSTRACT

Introduction: Electrodiagnostic tests such as nervous conduction studies are mainly aimed at the general public, not at athletes. Therefore, information about motor nervous conduction velocity (MNCV) is scarce for trained subjects, especially when comparing different sports. Objective: Was to measure MNCV of the median and common fibular nerves in three groups of sport modalities. Methods: A group of middle distance runners (MrG, n=6), a group of sprint runners (SrG, n=4) and a group of handball players (Hg, n=5) were analyzed and compared to a control group (CG, n=9). Each volunteer was submitted to a single examination where data necessary to measure MNCV from the lower limbs of MrG and of SrG; upper limbs of Hg and both upper and lower limbs of CG were collected. Data analysis presented normal distribution and homogeneous variances in all cases; therefore, a Student’s t test for independent samples ws used to compare means of MNCV of the athlete groups and the CG, as well as in the mean comparison of SrG and MrG (intergroup comparison). The paired Student’s t test was used to compare MNCV means of the dominant limb (DL) and non-dominant limb (NDL) (intragroup comparison). Results: Significant difference was found in the comparison between SrG and CG and between MrG and CG, but only in the DL comparison in the last case. On the other hand, in the intragroup comparison, there was significant difference only in the comparison between DL and NDL of the Hg. Conclusion: This study suggests that MNCV benefits from physical exercise, especially in those sports where lower limbs are predominantly used. It also suggests that greater use of one upper limb over the other could lead to significant differences in MNCV values of DL and NDL.

Keywords: sports, neural conduction, motor evoked potential, motor neurons.

INTRODUCTION

There are reports in the literature that strength and muscle power athletes present higher motor nervous conduction velocity (MNCV) than endurance athletes, despite not having significant difference between these modalities, as well as that the MNCV of trained individuals is greater than in untrained and injured individuals. It has also been reported that the MNCV is greater in the dominant limb (DL) when compared with the non-dominant limb (NDL) in trained subjects. On the other hand, it has been mentioned that hypertrophy of muscles adjacent to the nervous tract of the dominant limb of trained individuals may lead to compression of the nerve and consequent delay in the nervous impulse.

It should be considered that some factors such as lower fat percentage the subjects submitted to sports practice present and the functional overload generated by physical exercise, positively contribute to higher MNCV. Added to these factors, we should remember that physical exercises, besides causing alterations in the musculoskeletal structure, also cause alterations in the functioning of the motor units, increasing for example, its excitability.

However, the guidelines for the electrodiagnostic tests, as the study of the nervous conduction, have been established for the general population, but not for athletes, due to the reduced number of studies about this theme in this population, in a way that there is need for information on the MNCV measurement in individuals who are submitted to regular physical effort, especially when different sports modalities are compared. The understanding about the MNCV characteristics may serve as a very useful instrument, both for the assessment of individuals who are submitted to sports training, as a prognostic parameter for athletes who go through rehabilitation process.

The aim of this work was to measure the MNCV of the median nerve and the common fibular nerve, in three groups of individuals who practice distinct sports modalities: a group of sprint runners (SrG), a group of middle-distance runners (MrG) and a group of handball players (Hg). These measurements were then compared with the MNCV of individuals who composed the control group (CG).

MATERIALS AND METHODS

The study followed all the recommendations of the resolution 196/96, was approved by the Ethics Committee in Research of the University Center of João Pessoa – UNIPÊ, and was performed in the Physiology Laboratory of this institution, with controlled room temperature and kept always at around 26°C.

The sample was composed of 15 healthy male individuals who regularly practice the athletic activities under consideration, being these four from the SrG, six from the MrG and five from the Hg. The CG was composed of nine healthy individuals, non-practitioners of any type of regular physical activity in a total of 24 volunteers.

The used criteria for inclusion of the individuals in the sample were: to have practiced the athletic modality for at least one year; regular physical effort, especially when different sports modalities are compared. The understanding about the MNCV characteristics may serve as a very useful instrument, both for the assessment of individuals who are submitted to sports training, as a prognostic parameter for athletes who go through rehabilitation process.

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The used criteria for inclusion of the individuals in the sample were: to have practiced the athletic modality for at least one year; regular
practice and guidance from a certified trainer; presence of previous history of musculoskeletal injury of the limb under study; absence of pain; burning or paresthesia in the examined limb; absence of use of any medication which would alter the nervous function. Subjects who could not have the direct motor response collected – M response (CMAP – compound muscle action potential), due to anatomic variations which made the identification of the correct anatomic point for electrical stimulation impossible were excluded from the sample.

After selection, the subjects were submitted to a single assessment which consisted in the stimulation in two distinct points of the median and common fibular nerves, with the registration electrodes of the M response positioned on the short abductor of the thumb and short extensor of the fingers muscles, respectively, for each studied nerve. The measurements were performed both for the D1 and N2 for each athlete. In the HG the MNCV was measured only on the upper limbs. In the groups S rG and M rG the MNCV of the Time of conduction. This time, expressed in milliseconds (ms), may latency – Pl) and distal (distal latency – Dl) stimulation sites; that is, the stimulus took to cover the distance between the proximal (proximal site of stimulation which consisted in the stimulation in two distinct points of the thumb and short extensor of the fingers muscles, respectively, for each studied nerve. The measurements were performed both for the D1 and N2 for each athlete. In the HG the MNCV was measured only on the upper limbs. In the groups S rG and M rG the MNCV of lower limbs only was measured in the control group the MNCV of both limbs was measured.

The beginning of the experiment consisted in the verification of weight and height for anthropometric characterization of the sample. Right after that, the skin was defatted and the corneal layer was removed by abrasion, using a piece of cotton soaked in a mixture of alcohol and ether. This cleaning was performed in the sites of stimulation and recording.

Latency may be defined as the time between the application of the stimulus and the beginning of the deflection of the M response obtained in the two sites of stimulation; proximal and distal (figure 1). In order to have the distance between the two sites of stimulation measured, the center between the electrodes used for application of the stimulus was marked, both on the proximal and distal stimulation sites, measuring hence in millimeters (mm) the distance between them. The MNCV was calculated through determination of the time the stimulus took to cover the distance between the proximal (proximal latency – PL) and distal (distal latency – DL) stimulation sites; that is, the Time of conduction. This time, expressed in milliseconds (ms), may be calculated by the following formula:

\[
\text{Time of conduction} = \text{PL} - \text{DL}
\]

Supramaximal stimulation was used in the experiments to guarantee the correct latency measurement, an important recommendation in this kind of study. The MNCV increase was followed in the computer monitor as the stimulus intensity increased. Whenever the CMAP did not present any increase in amplitude, the amplitude of the applied pulse was increased in about 25% of the value previously used to obtain the maximal CMAP amplitude. It is worth mentioning that before the beginning of the experiment the volunteers were warned about the muscle shake that occurs as consequence of the stimulation; therefore, they were more aware of what would occur during the experiment and hence became more helpful and accepted more easily the supramaximal stimulation. During the entire procedure, the inter-stimulus interval used was of about 10 to 15 seconds in order to avoid possible neuromuscular fatigue. The signals were picked with Skintact Ag-AgCl disposable surface electrodes in bipolar configuration, being one placed on the muscle venter and the other on the tendon. The stimulus electrodes, cathode and anode, are mounted in a pen device, with approximately 0.6 mm away from each other, being the anode distally placed and the cathode proximally placed.

In the MNCV measurement protocol of the media nerve the volunteer remained standing with the sustaining base balanced and head kept at neutral position, look steady on the horizon and forearm kept extended with palm facing up. The recording electrodes in bipolar configuration, were placed in a way that the electrode connected to the negative entrance of the amplifier was on the medial point between the lateral and medial malleolus, on the side of the tibia. Concerning the stimulation sites, the first one (distal) was on the top of the ankle, approximately eight proximal centimeters to the negative recording electrode, on the medial point between the lateral and medial malleolus, on the top of the ankle. The second site (proximal) was on the knee, posterior
inferiorly to the head of the fibula. As in the case of the MNCV measurement of the medial nerve, after stimulation, the length (in mm) between the two sites was measured using the medial point between the stimulation electrodes of each site as reference.

The stimulation used a biological stimulator which permits that the stimulation pulses amplitude range between 0 and 200 V, the repetition frequency of the pulses between 0.1 and 100 Hz and adjust the pulses duration to 0.1; 0.5; 1.0 or 2.0 ms values. The biological stimulator offers in the exit the option of pulse train or single pulse. The obtention, recording and processing of the signals used the Biomed digital polygraph, using a microcomputer with an A/D converting plaque of 12 bits of resolution and 16 channels of entrance. The signal was obtained using a biological amplifier for surface EMG capture with gain which can be adjusted to 350, 750, 1,500 and 3,000 values; high entrance impedance; high rejection ratio of common mode (> 100 dB) and frequency response range of 10 to 470 Hz. The signal obtained was converted to a digital format with sampling frequency of 4,000 samples/s. In the signals obtention technique evoked in the BioMed applicative, the computer screen scanning (figure 1) is initiated synchronized with the stimulus trigger. All the technical details for the signals obtention evoked may be found in the study by Rodrigues et al. The stimulation pulse duration was set in 0.5 ms, applying single pulses to obtain the evoked potentials. The gain of the amplifier was set in 350. All MNCV data found presented normal distribution and homogeneous variances. Thus, the Student’s t test was also used to compare the means of the MNCV of the groups of the athletes with the ones from the control group and the ones used, comparing the means of the MNCV values of the groups of the two groups; however, in the comparison between the groups of athletes who practice sports which specially develop these limbs (SrG and MrG), the paired t test did not report any statistically significant difference in this comparison.

Table 3 shows the MNCV mean values of the lower limbs of the Mrg and the Cg. The MNCV mean of the Dl of the Mrg was higher than all the means of the other limbs of these two groups; however, the only statistically significant result occurred in the comparison of the means of the MNCV of the Dl of the Mrg (58 m/s) and the Dl of the Cg (52.2 m/s), with p = 0.0489.

Table 3. Mean and standard deviation (SD) of the MNCV of the Cg and Mrg.

<table>
<thead>
<tr>
<th>MNCV (m/s)</th>
<th>Control</th>
<th>Middle-distance runners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mrg</td>
<td>MrG</td>
</tr>
<tr>
<td>Mean</td>
<td>52</td>
<td>58*</td>
</tr>
<tr>
<td>SD</td>
<td>4.1</td>
<td>3.9</td>
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</tbody>
</table>

Table 4 compares the means of the MNCV of the lower limbs of the two groups of athletes who practice sports which specially develop these limbs (SrG and MrG). The paired t test did not report any statistically significant difference in this comparison.

Table 4. Mean and standard deviation (SD) of the MNCV of the SrG and MrG.

<table>
<thead>
<tr>
<th>MNCV (m/s)</th>
<th>Middle-distance runners</th>
<th>Sprint runners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MrG</td>
<td>MrS</td>
</tr>
<tr>
<td>Mean</td>
<td>58</td>
<td>53</td>
</tr>
<tr>
<td>SD</td>
<td>8.4</td>
<td>7.5</td>
</tr>
</tbody>
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Table 5 shows the means of the MNCV of the upper limbs of the Hc and the Cg. Significant differences have not been found between the two groups; however, in the comparison between the Dl (61 m/s) and the NDL (55 m/s) of the Hc, there was significant statistical difference (p = 0.0204). Interestingly, the NDL of the Hc presented the lowest mean of the MNCV, lower even than the mean of the MNCV of the NDL of the Cg (59 m/s).

Table 5. Mean and standard deviation (SD) of the MNCV of the Hc and the Cg.

<table>
<thead>
<tr>
<th>MNCV (m/s)</th>
<th>Control</th>
<th>Handball</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mrg</td>
<td>MrH</td>
</tr>
<tr>
<td>Mean</td>
<td>60</td>
<td>59*</td>
</tr>
<tr>
<td>SD</td>
<td>5.9</td>
<td>6.3</td>
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DISCUSSION

This study was conducted with the purpose to compare the MNCV presented by practitioners of specific sports modalities (sprinters, middle-distance runners and handball players) with the one presented by normal subjects and verify if the athletic activities regularly practiced and with suitable training lead to some alteration in this physiological parameter. We should observe that there few published articles about this topic in the specialized literature.

Some research has demonstrated that the MNCV of trained individuals is higher than the one of untrained ones. In fact, training with high loads may lead to adaptation responses of muscles, bones, tendons and nerves and the training frequency and volume may affect the MNCV. Our study showed that there was difference between trained and untrained individuals for the Srg and the Mrg, remembering that in the Mrg only the Dl presented significant difference compared with the Cg. Two factors may be used to explain
the higher MNCV of individuals who are submitted to regular sports training: first, the lower body fat percentage of that population seems to have an opposite relation with the MNCV, and may lead to better efficiency of the integration function of the neuromuscular system, facilitating the neural transmission; second, the functional overload which these athletes are submitted to may contribute to the increase of the diameter of the nervous fibers and the myelin sheath, leading to higher velocity of nervous conduction. One of the main benefits of higher MNCV is that it can be an indication of a short refractory period, which, in its turn, may lead to increased frequency of impulses to the muscle, increasing the levels of muscular activation.

The results of this research did not present significant difference in the MNCV between DL and NDL in the studied groups, including the control group, except for the HG. It is important to highlight that we have not found investigations in the literature with MNCV studies in handball groups. Wei et al. Suggest that, besides the MNCV being higher in trained individuals, it would also be higher in the DL than in the NDL of these subjects. This study reports MNCV in handball athletes and the authors believe that the higher MNCV in the DL would occur due to adaptation responses induced by the characteristics of the sports modality itself. Our finding of higher MNCV in the DL, compared with the NDL in the HG, corroborates this result, and we should note that the gestures in handball and baseball in the load throw (the ball), is similar. Nonetheless, in the other modalities this fact did not occur, probably due to the absence of predominance of use of one limb over the other in the remaining studied groups. Some studies report absence of significant difference among athletes who have the upper limb as basis for their practice (tennis and volleyball athletes) and the control group. In our study it was also observed in the HG.

A curious fact found in our results was that in addition to the absence of significant difference between the HG and the CG, the NDL of the HG presented the lowest mean of MNCV (55 m/s), being even lower than the mean of the NDL of the CG (59 m/s). This finding remains unexplained and the reduced number of our sample does not make the result possible to be generalized.

It was stated that strength and muscle power athletes present MNCV higher than in endurance athletes, despite the absence of statistically significant difference between these parameters. Our study presented the same result when the SsG (power) and MsG (endurance) were compared. This information suggests that regardless of the kind of training (either power or endurance), the neuromuscular factors which condition higher MNCV equally benefit in the two modalities. The size of our sample was small for the many modalities, especially by the great difficulty in recruiting athletes in João Pessoa city, Brazil, athletes who met the inclusion criteria such as minimum of one year of training by a skilled trainer.

Due to the reduced size of the sample, we should also consider that the assessed groups were not homogeneous for data such as age, weight and height, which is a limitation of the study and make it difficult to reach to conclusions and make more accurate suggestions. However, interesting data were raised about the HG, despite the reduced number of the sample, which encourages us to carry on with the studies.

CONCLUSION

The present study presented results similar to studies in the literature concerning comparisons between the SsG and the MsG. On the other hand, it brought new information, such as the non-difference between the MNCV values of the DL and the NDL of the SsG and MsG, information which the literature does not report, as well as when it assessed the MNCV behavior in the HG, results without previous reference in the consulted literature either.

All authors have declared there is not any potential conflict of interests concerning this article.

REFERENCES