MEASUREMENT OF MOTOR NERVE CONDUCTION VELOCITY IN THREE DIFFERENT SPORTS

ORIGINAL ARTICLE

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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 (M_{RG}, n=6), a group of sprint runners (S_{RG}, n=4) and a group of handball players (H_G, n=5) were analyzed and compared to a control group (C_G, n=9). Each volunteer was submitted to a single examination where data necessary to measure MNCV from the lower limbs of M_{RG} and of S_{RG}; upper limbs of H_G and both upper and lower limbs of C_G 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 C_G, as well as in the mean comparison of S_{RG} and M_{RG} (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 S_{RG} and CG and between M_{RG} and CG, but only in the D_L comparison in the last case. On the other hand, in the intragroup comparison, there was significant difference only in the comparison between D_L and N_{DL} of the H_G. 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 D_L and N_{DL}.

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

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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 (D_L) when compared with the non-dominant limb (N_{DL}) in trained subjects[1-4]. 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[5].

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[4,6]. 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[7].

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[4]. 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 (S_{RG}), a group of middle-distance runners (M_{RG}) and a group of handball players (H_G). These measurements were then compared with the MNCV of individuals who composed the control group (C_G).

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 26ºC[4,5,8-10].

The sample was composed of 15 healthy male individuals who regularly practice the athletic activities under consideration, being these four from the S_{RG}, six from the M_{RG} and five from the H_G. The C_G 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 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 D_L and N_{DL} of each athlete. In the H_G 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[11]. 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[11]:

$$\text{Time of conduction} = PL - DL$$

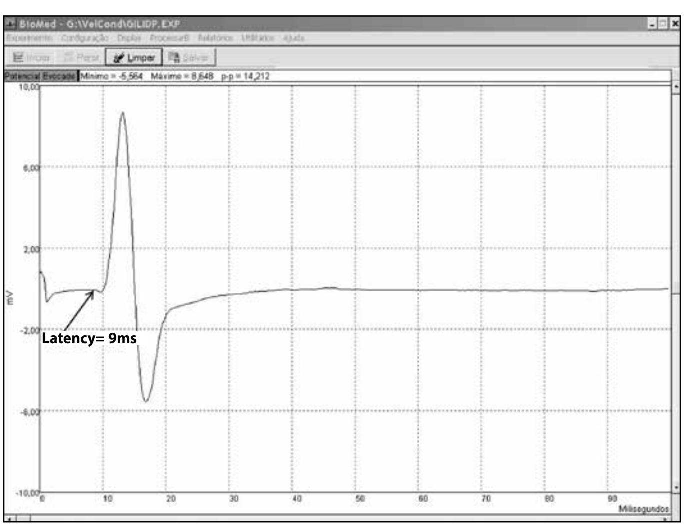

Figure 1. Screen of the applicative BioMed showing the M response (CMAP), acquired with stimulation of the common fibular nerve, distal stimulation, in one of the volunteers from the research. The latency pointed by an arrow was in this case nine milliseconds

The MNCV (in meters per second, m/s) was calculated using the following formula[11]:

$$\text{MNCV (m/s)} = \frac{\text{Distance between the two stimulation sites (mm)}}{\text{Time of conduction between the two stimulation sites (ms)}}$$

Supramaximal stimulation was used in the experiments to guarantee the correct latency measurement, an important recommendation in this kind of study[11,12]. 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 to15 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[11]. 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 proximately 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 portion of the short abductor muscle venter of the thumb (negative pole) and the electrode connected to the positive entrance of the amplifier to the base of the interphalangeal articulation of the thumb (positive pole). The reference electrode was placed on the flexor surface; that is, on the anterior surface of the forearm. The first place of stimulation (distal) was on the wrist, approximately five centimeters proximal to the negative recording electrode, between the two prominent tendons of the long palm muscle and radial carpal flexor. The second stimulation place was the inter-articular line of the elbow on the ulnar side of the brachial artery pulse[11]. Right after the stimulation, the length between the two stimulation sites was measured.

For the MNCV of the common fibular nerve, the volunteer was on lying on supine position, with the region of the heel outside the stretcher, arms along the body and head kept at neutral position. The recording electrodes also in bipolar configuration were placed in a way one was on the venter of the short extensor muscle of the fingers (negative pole) and the other on the base of the fifth toe (positive pole). The reference electrode was placed on the anteromedial side of the tibia. Concerning the stimulation sites, the first one (distal) was on the anterior part 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, postero inferiorly to the head of the fibula[11]. 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[13]. 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[14], 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.*[13]. 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 for independentsamples was used, comparing the means of the MNCV values of the groups of the athletes with the ones from the control group and the ones from the G_{SRG} with the ones from the M_{RG} (inter group comparisons). Paired *t* test was also used to compare the means of the MNCV between D_L and N_{DL} (intra group comparisons). The data were analyzed through the *software* for statistical analyses BioEstat 5.0.

RESULTS

Table 1 expresses the data concerning the anthropometric characterization of the sample. Tables 2 to 5 present the means and standard deviations of the MNCV values found, in meters per second, in the studied groups.

Table 1. Anthropometric data represented in mean and standard deviation of age, weight and height of the C_G and the three studied sports modalities.

Parameters	Control	Sprinters	Middle-distance runners	Handeball
Age (years)	20.22 ± 2.1	18.5 ± 3.7	25.6 ± 8.9	23.0 ± 2.8
Weight (kg)	72.9 ± 13.2	66.5 ± 3. 9	65.4 ± 6.2	85.0 ± 13.1
Height (m)	1.74 ± 0.03	1.67 ± 0.04	1.72 ± 0.06	1.73 ± 0.06

Table 2 shows the MNCV values of the lower limbs of the S_{RG} and the C_G. There was significant difference in the comparison between these groups, with the S_{RG} evidencing higher means, $p = 0.0053$ in the comparison among the D_L and $p = 0.0211$ in the comparison among the N_{DL}.

Table 2. Mean and standard deviation (SD) of the MNCV of S_{RG} and C_G.

MNCV (m/s)	Control		Sprint runners	
	M_d	M_{nd}	M_d	M_{nd}
Mean	52	52	61*	59*
SD	4.1	3.9	5.6	6.7

*Stastistically significant difference concerning the same limb of the C_G.

Table 3 shows the MNCV mean values of the lower limbs of the M_{RG} and the C_G. The MNCV mean of the D_L of the M_{RG} 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 D_L of the M_{RG} (58 m/s) and the D_L of the C_G (52.2 m/s), with $p = 0.0489$.

Table 3. Mean and standard deviation (SD) of the MNCV of the C_G and M_{RG}.

MNCV (m/s)	Control		Middle-distance runners	
	M_d	M_{nd}	M_d	M_{nd}
Mean	52	52	58*	53
SD	4.1	3.9	8.4	7.5

*Statistically significant difference concerning the same limb of the C_G.

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 (S_{RG} and M_{RG}). 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 S_{RG} and M_{RG}.

MNCV (m/s)	Middle-distance runners		Sprint runners	
	M_d	M_{nd}	M_d	M_{nd}
Mean	58	53	61	59
SD	8.4	7.5	5.6	6.7

Table 5 shows the means of the MNCV values of the upper limbs of the H_G and the C_G. Significant differences have not been found between the two groups; however, in the comparison between the D_L (61 m/s) and the N_{DL} (55 m/s) of the H_G there was significant statistical difference ($p = 0.0204$). Interestingly, the N_{DL} of the H_G presented the lowest mean of the MNCV, lower even than the mean of the MNCV of the N_{DL} of the C_G (59 m/s).

Table 5. Mean and standard deviation (SD) of the MNCV of the H_G and the C_G.

MNCV (m/s)	Control		Handball	
	M_d	M_{nd}	M_d	M_{nd}
Mean	60	59	61*	55
SD	5.9	6.3	8.1	8.5

*Statistically significant difference concerning the NDL of the same group.

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[2,3]. 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[1,5]. Our study showed that there was difference between trained and untrained individuals for the S_{RG} and the M_{RG}, remembering that in the M_{RG} only the D_L presented significant difference compared with the C_G. 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[6]; 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[4]. 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[1].

The results of this research did not present significant difference in the MNCV between D_L and N_{DL} in the studied groups, including the control group, except for the H_G. 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 D_L than in the N_{DL} of these subjects[4]. This study reports MNCV in baseball athletes and the authors believe that the higher MNCV in the D_L would occur due to adaptation responses induced by the characteristics of the sports modality itself. Our finding of higher MNCV in the D_L compared with the N_{DL} in the H_G 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[5,9]. In our study it was also observed in the H_G.

A curious fact found in our results was that in addition to the absence of significant difference between the H_G and the C_G, the N_{DL} of the H_G presented the lowest mean of MNCV (55 m/s), being even lower than the mean of the N_{DL} of the C_G (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[1]. Our study presented the same result when the S_{RG} (power) and M_{RG} (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 H_G, 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 S_{RG} and the M_{RG}. On the other hand, it brought new information, such as the non--difference between the MNCV values of the D_L and the N_{DL} of the S_{RG} and M^{RG}, 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.

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