DIFFERENCES OF SOMATOSENSORY EVOKED POTENTIAL PARAMETERS AT ATHLETES

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Abstract: The objective of our study was to measure the parameters (latencies and inter-wave latencies intervals) of somatosensory evoked potential (SEP) waves at 21 male athletes, 11 fencers and 10 handball players, active for at least 6 years in either one of the mentioned sports and to compare the results, in order to emphasize the influence of specific profesional training.

Responses obtained by stimulating the sportsmen' median nerve, bilaterally and successively, from fist articulation, were recorded and measured using the Nihon Kohden Neuropack MEB-9100 device. From the multitude of parameters provided by the analysis of recorded tracks, the values of SEP' waves latencies and of inter-waves latency intervals, were statistically processed.

The results has shown the existence of higher values of waves latencies, for the entire group, obtained by stimulating the right median nerve, compared to those obtained by stimulating the left hand, although subjects were right handed, due, probably to the effect of dominant member infra-clinic lesions. In comparison with the entire group, fencers had a particular aspect of left-right latency differences sense, which was inverted both for waves as for the interval that represents the specific cortex, while, handball subgroup presented significant statistical differences of the waves latencies representing the non-specific cortex.

By using modern functional exploration methods, as somatosensory evoked potentials, we were able to perform an original and complex study, regarding the influence of profesional training, specific to certain categories of sports over the neurocortical activity.

Key words: somatosensory evoked potentials parameters, profesional trainig, fencing, handball.

Introduction

The bio-electrical response generated by stimulation of a peripheral nerve represents the somatosensory evoked potential (SEP), a nervous system common investigation, with applicability in physical effort physiology, exploring the somatosensory system influx conduction, with a large participation of proprioperceptive receptors, involved in sports effort [1].

The objective of our study was to measure the parameters (latencies and inter-wave latencies intervals) of somatosensory evoked potential (SEP) waves at athletes and to compare the results, in order to emphasize the influence of specific profesional training.

Material and methods

The studied group was formed of 21 male athletes, 11 fencers and 10 handball players, active for at least 6 years in either one of the mentioned sports and although there are characteristic weight differences between the selected sports, the analysed group is homogenous both from the point of view of weight and height and age and training regime. Taking into account the fact that the investigations took place in equivalent conditions for all sportsmen, we can afirm that the determining factor for the different behaviour of the administered SEP tests were the changes induced by the specific profesional training [2].

The testing was performed under current ethical rules, each participant being informed of the experimental processes.

Responses obtained by stimulating the sportsmen' median nerve, bilaterally and successively, from fist articulation, were recorded and measured using the Nihon Kohden Neuropack MEB-9100 device.

The stimulation was performed through electrical stimuli, with a current intensity 3-4mA above the motor threshold, with a duration of 0.2 ms, and a 3Hz frequency. The evoked response was registered with surface electrodes placed on the scalp according to the electroencephalography 10-20 system. The Fz electrode was preferred as a reference electrode and the registration electrodes were placed laterally opposite the stimulation, 2 cm posterior to C3 (C3') and respectively C4 (C4')

On recorded tracks, P14, N20, P22-25, N25, P30, N35, P40 waves components were noted and their latencies, amplitudes and inter-wave intervals were calculated: P14-N20, N20-P25, N25-P30, P30-N35, N35-P40.

Results

From the multitude of parameters provided by the analysis of recorded tracks, the values of SEP' waves latencies and of inter-waves latency intervals, were statistically processed, using Student test, thus, were recorded results, that define both the entire studied group and the two sporting disciplines.

A differentiating left-right wave latency pattern is observed at the stuided group, by stimulating the left hand lower values for the wave latencies are obtained, the same for the values of inter-waves intervals, with the exception of P14-N20 and P30-N35 intervals (Table 1, Figure 1).

The left-right differences previously mentioned are not statistically significant, as Table 2 shows.

Table 1. Average values for the SEP wave latencies (ms) and for the SEP inter-waves intervals (ms) ± standard deviations for the group of sportsmen

SEP waves							SEP inter-waves intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
Left hand											
16.971	20.053	22.675	25.406	30.400	34.162	38.336	3.143	2.656	5.171	3.862	4.369
±0.779	±1.033	±1.140	±1.483	±3.296	±3.561	±2.730	±0.968	±0.488	±2.958	±1.994	±2.342
Right hand											
17.267	20.153	22.863	25.638	30.779	34.392	38.967	2.813	3.835	5.323	3.675	4.915
±1.234	±0.755	±0.947	±1.215	±2.892	±4.160	±2.685	±1.012	±0.382	±2.819	±1.686	±2.814

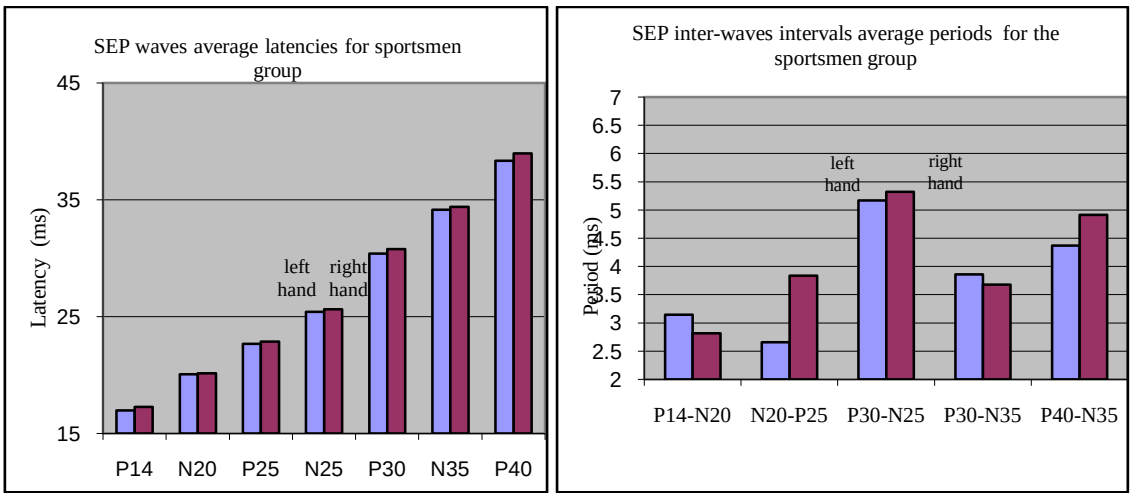

Figure 1. Graphs of the SEP waves average latencies and SEP inter-waves intervals periods in the sportsmen

Table 2. Values of p (Student test) on the statistical comparison of the SEP wave latencies obtained in the sportsmen group by stimulating the left hand with those obtained by stimulating the right hand

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
0.511	0.722	0.577	0.597	0.694	0.859	0.559	0.397	0.299	0.878	0.815	0.551

An analysis of the subjects from each sport type from SEP point of view was also performed.

In the handball subgroup, the SEP latencies values and latency intervals were recorded (Table 3), with the same left-right pattern present at the entire studied group. The signalled left-right differences are not statistically supported (Table 4).

Table 3. Average values for the SEP wave latencies (ms) and for the SEP inter-wave intervals (ms) ± standard deviations for the handball subgroup

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
Left hand											
17.080	19.917	22.433	24.833	31.267	34.980	39.900	3.020	2.517	6.433	4.520	4.920
±0.814	±0.588	±0.855	±1.483	±3.586	±4.123	±2.902	±0.672	±0.426	±2.944	±2.496	±2.495
Right hand											
17.550	20.433	23.200	25.867	31.750	35.000	40.017	2.883	2.767	5.883	3.900	5.017
±1.213	±0.582	±0.903	±0.734	±2.996	±4.787	±3.119	±0.725	±0.344	±3.313	±2.153	±3.134

Table 4. Values of p (Student test) on the statistical comparison of the SEP wave latencies obtained in the handball group by stimulating the left hand with those obtained for stimulating the right hand

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
0.480	0.157	0.162	0.157	0.805	0.994	0.951	0.755	0.290	0.767	0.685	0.957

For a more complex comparison, we have also chosen to compare the values of the handball subgroup to those of the fencing subgroup. For wave latencies, this comparison does not show differences, but the interwave intervals comparison showed differences for N25-P30 (Figure 2).

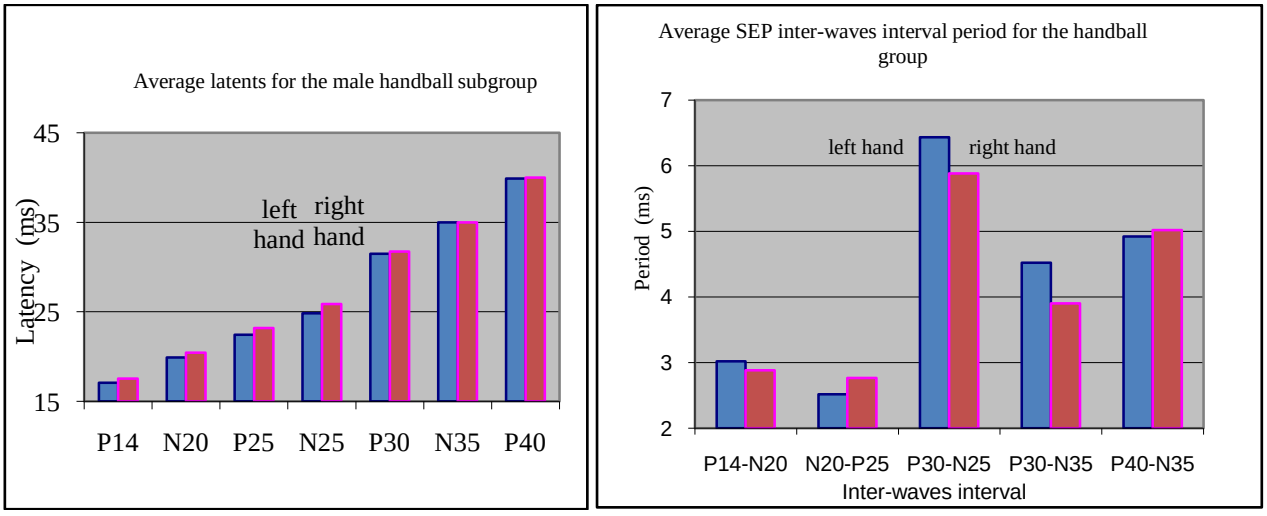

Figure 2. Graph of the average SEP wave latencies and SEP inter-wave intervals in the handball subgroup

Statistical comparison of studied values for entire group and handball subgroup does not reveal significant differences (Table 5). Male fencing subgroup is characterised by the values of SEP latency waves and intewave latency intervals from Table 6. Table 7 contains the 'p' values for the left-right differences and it allows the statement that this differences are not significant (for P40 wave there is a borderline significant value - 0.052).

Table 5. p values (Student test) on statistical comparison of the SEP waves latencies obtained in the sportsmen group with the handball subgroup ones

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
0.729	0.657	0.475	0.184	0.326	0.452	0.096	0.711	0.337	0.111	0.372	0.440
0.557	0.251	0.243	0.548	0.206	0.592	0.297	0.856	0.481	0.483	0.751	0.904

Table 6. Average values for the SEP wave latencies (ms) and for the SEP inter-wave intervals (ms) ± standard deviations for the fencing subgroup

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
Left hand											
17.200	20.317	23.150	25.817	28.575	32.567	36.550	3.020	2.833	3.200	3.400	4.233
±0.834	±1.380	±1.349	±1.436	±2.316	±2.219	±0.580	±1.287	±0.532	±1.857	±0.529	±2.511
Right hand											
17.740	20.033	22.783	25.317	29.075	33.200	37.475	2.060	2.750	4.500	3.733	4.367
±1.394	±0.905	±1.026	±1.589	±2.100	±2.946	±0.499	±1.201	±0.451	±2.003	±0.808	±2.589

Table 7. Values of p (Student test) on statistical comparison of the SEP wave latencies obtained in the fencing group by stimulating the left hand with those obtained by stimulating the right hand

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
0.478	0.683	0.608	0.580	0.760	0.781	***0.052***	0.257	0.776	0.378	0.582	0.952

The analysis of the left-right differences in the male fencing subgroup shows changes for a pattern that is characteristic to this group, compared to the same differences of N20, P22-25 and N25 waves for the studied group. The same analysis, applied to the interwave latency intervals shows differences between the two subgroups for N20-P22-25 and P30-N35 (Figure 3). Complete comparison through statistical analysis of SEP waves latencies and interwave intervals in the fencing subgroups and sportsmen group, not reveals significant differences (Table 8).

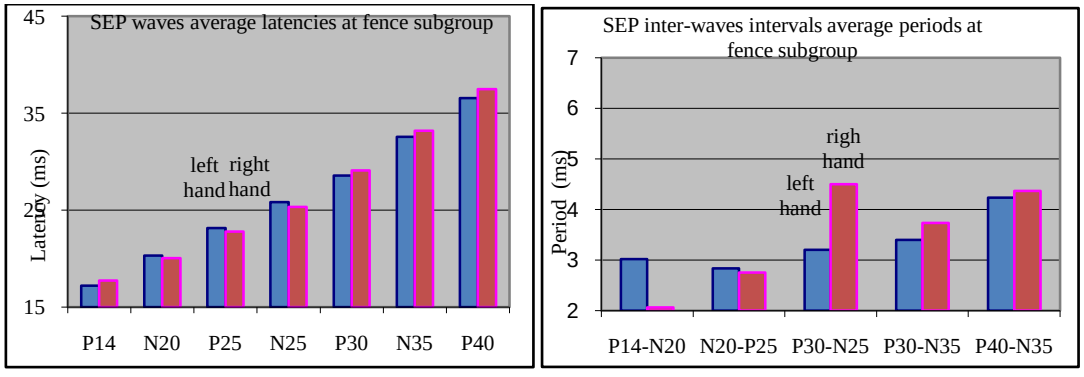

Figure 3. Graphs of the average SEP wave latencies and duration of inter-wave SEP intervals in the fencing

Table 8. Values of p (Student test) on statistical comparison of the SEP wave latencies obtained in the sportsmen group and fencing subgroup by stimulating the left hand and the right hand

SEP waves							SEP inter-wave intervals				
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
Left hand											
0.461	0.385	0.148	0.349	0.116	0.304	0.109	0.711	0.218	**0.064**	0.669	0.896
Right hand											
0.392	0.630	0.789	0.398	0.097	0.533	0.273	**0.072**	0.474	0.458	0.955	0.698

An inter-sport comparison was realised to obtain a more complex definition of the neurophysiological pattern specific to each sport. Thus, the comparison of SEP wave latencies values between handball and fencing shows a significant value for wave P40, both for the left and right hand (Table 9). For interwave latencies intervals values, there is a statistically significant difference for N35-P40 interval in the comparison of the handball and fencing subgroups for both right and left hands. The values of N25-P30 interval are statistically significant only for the left hand (Table 10).

Table 9. Values of p (Student test) on statistical comparison of the SEP wave latencies obtained in the fencing and handball subgroups by stimulating the left and right hand

Left hand							Right hand						
P14	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**	**P14**	**N20**	**P22-25**	**N25**	**P30**	**N35**	**P40**
0.842	0.430	0.471	0.671	**0.057**	**0.073**	**0.010**	0.801	0.619	0.359	0.402	0.130	0.251	**0.038**

Table 10. Comparison of the SEP wave latencies in the handball and fencing subgroups by stimulating the left and right hand

Left hand					Right hand				
P14-N20	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**	**P14-N20**	**N20-P25**	**N25-P30**	**P30-N35**	**N35-P40**
p values (Student test) in the statistical comparison of the SEP latent wave values									
0.618	0.729	**0.043**	0.175	0.801	0.167	0.440	0.441	0.225	0.541

Discussions

Studied sports where characterized by an uneven stress of upper limbs: fencing, where the effort is sustained predominantly by one of the upper limbs and handbal, where there is an intense participation of both upper limbs (with enhanced stress on one of them) and the lower ones. This option became available, by taking into account the more extensive representation of upper limbs in the motor cortex, thus, a higher number of plastic changes [3] are possible to appear as a result of repeated complex movements performed during specific training. Our studies aimed to compare two groups of sportsmen without including a sedentary subjects sample group, as the motor cortex did not display significant differences between professional sportsmen and sedentary groups. Data gathered from literature shows no significant differences between the SEP parameters in high-performing sportsmen (gymnasts, athletes) and sedentary subjects [4].

Comparison of the results we have obtained through SEP testing to the literature ones could only be partially made as the subject of our tests has been approached less in sportsmen and only with reference to waves generated by the specific cortex. The complex processing of all SEP waves and intervals has shown an unexpected aspect: the average wave latencies obtained by stimulating the right hand, for the entire group, was higher than the ones obtained by stimulating the left hand, although the sportsmen were right handed, with the exception of P14-N20 interval. It is worth noting that the left-right differences were not statistically significant.

Thomas does not discuss this aspect in his article, although he has processed SEP test

results for long distance runners, gymnasts and sedentary people, he mention that he has not found statistically significant differences in the tested groups. Compared with the entire group, where all waves latencies obtained by stimulating the left hand were lower in comparison with the stimulation of right hand, in handball players, P30 wave latencies were higher, another particularity of these sportsmen. Left-right differences sense for P14-N20 and N25-P30 interwave intervals is reverse for handball athlets compared to the entire group, probably due to the different stress levels on the two limbs in specific effort. The analysis of the data for fencing subgroup shows a sense of left-right differences reversed for N20, P22-25 wave latencies and N20-P22-25 interval, compared to the entire group, an aspect present only at this sport, so, this can be considered the expression of specific cortex functional changes induced by physical training specific to fencers, especially for the superior nervous level. It is also noticeable that the systematic differences are obvious for SEP components generated in the non-specific cortex, a location more functionally and plastically changed by specific sports training [5].

These observations can constitute original components of this study, as the specialized literature has payed attention only at the components generated by the specific cortex, both in sports medicine and in paraclinical exploration.

Conclusions

The results had shown the existence of higher values of waves latencies, for the entire group, obtained by stimulating the right median nerve, compared to those obtained by stimulating the left hand, although subjects were right handed, due, probably to the effect of dominant member infra-clinic lesions.

Handball subgroup players was characterised by left-right differences latency of the SEP components, that were not statistically significant.When comparing the handball subgroup with the entire group, there were significant statistical differences of the waves latencies representing the non-specific cortex.

In comparison with the entire group, fencers had a particular aspect of left-right latency differences sense, which was inverted, both for waves, as for the interval that represents the specific cortex, a modification which was caused by the different stress degree of the upper members in the specific sports effort.

By using modern functional exploration methods, as somatosensory evoked potentials, we were able to perform an original and complex study, regarding the influence of profesional training, specific to certain categories of sports, handball and fencing, over the neurocortical activity.

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