SYMPATHETIC SKIN RESPONSE IN ACUTE ISCHEMIC STROKE – HEMISPHERIC ASYMMETRY

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ABSTRACT

Modern knowledge indicates greater scope and complexity of autonomic dysfunction after acute stroke. In addition to cardiovascular and respiratory disorders there are disturbances in sweat regulation and the responses of the sympathetic skin reflex in cerebrovascular disease. Bilateral changes in the parameters of the sympathetic skin response, as a result of unilateral cortical lesions are associated with the influence of inhibitory or stimulatory effects of the cerebral cortex and the reticular formation, which have a complex association with the contralateral cortical structures of the sympathetic system.

The results of our study of patients with acute hemispheric ischemic stroke showed significant difference in the amplitude and latency between the affected and unaffected limbs, only in the group of patients with ischemic stroke in the territory of the right middle cerebral artery with involvement of the insular cortex. When we compared our results from patients with stroke in the left hemisphere with those with stroke the in right hemisphere, we established longer latency times and lower amplitudes in patients with right hemispheric strokes, The most marked ones are the abnormal values in patients with ischemic stroke in the territory of the right middle cerebral artery with involvement of the insular cortex.

Keywords: *sympathetic skin response, stroke, autonomic dysfunction*

INTRODUCTION

Modern knowledge of the spectrum of autonomic disorders after cerebral stroke shows that they have a larger range and complexity than it was thought earlier. In addition to the cardiovascular and respiratory disorders there are also disturbances of the sweat regulation and the responses of the sympathetic skin reflex in cerebrovascular disease. The disturbances of the sympathetic flow are a well-known consequence of a hemispheric or brain stem damage. Although the exact pathogenetic mechanism is not clear, they are often associated with an increased activity of the sympathetic nervous system.

From a pathogenetic point of view it is thought that the changes in the sympathetic skin response (SSR) are a result of the interruption of the efferent sympathetic pathways, the severity of which depends on the character of the brain damage as well as the cerebral edema (1).

The existence of an anatomic and functional connection between the efferent motor and sudomotor fibers is suggested on the basis of proof from the close anatomic location of the descendant sudomotor fibers and the lateral cortical tract on a spinal level, as well as the established correlation between the

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changes in SSR and the magnetic motor-evoked potentials in patients with multiple sclerosis (2).

The prolonged latency or the asynchronous response are assumed as criteria for abnormality when they correlate with disturbances of other tests of the autonomic function (3).

SSR are also an objective criterion for evaluation of the depth of the cerebral lesions and if they are followed dynamically – of the outcome of the disease. Following the lesions from the cortex to the stem structures shows dependence which is characterized with an increase of the asymmetries and the quantitative data of the parameters of SSR (4).

It has been established that the amplitude of SSR is decreased in the acute and chronic stages of ischemic stroke, while the latency is prolonged only in the acute stage (5).

The bilateral changes in the SSR parameters as a consequence of unilateral cortical lesions are connected with the impact of the inhibitory or stimulatory effects of the cerebral cortex and the reticular formation, which have a complex association with cortical structures of the contralateral sympathetic system (6).

In a comparative analysis of the SSR parameters in patients with acute ischemic stroke, some authors do not find a significant difference in regard to the latency and amplitude between the affected and unaffected limbs (7,8,9,10). But in their study of 40 patients with stroke, H. Erciyas et al. (1999) report that the amplitude of the response recorded on the hemiplegic side is significantly lower than the one on the unaffected side (11). L. Muslumanoglubet et al. *(2002)* did not find a latency difference in the lead of the hemiplegic and the unaffected limbs, respectively, but they report that the amplitudes from the hemiplegic limbs are significantly lower than the amplitudes from the unaffected side (9).

Some authors report a more serious SSR damage in patients with discrete right hemisphere lesions, which is connected to a prevalence of the sympathetic cerebral lateralization in the right hemisphere. Changes in the SSR parameters are observed in patients with lesions in the ventrolateral prefrontal bilateral cortex, in the anterior bilateral cingulate gyrus and the right inferior parietal lobule, as well as in stem damages. Functional MRI shows an association between excitatory SSR and the predominantly localized activity in the right orbitofrontal cortex and in the anterior insular cortex which confirms right hemispheric sympathetic lateralization (7,11).

H. Erciyas et al. (1999) studied the hemispheric dependence of the sympathetic skin activity responses and established that in right hemispheric lesions the observed amplitudes of SSR were lower in comparison to the same lesions in the left hemisphere (2). The lower amplitudes in patients with right hemispheric stroke support the view that despite the bilateral sympathetic control of distribution of ANS, the right hemisphere has a dominating role (13).

AIM

The aim of this paper is to conduct a comparative analysis of the SSR parameters based on the localization of the cerebral stroke in patient with acute hemispheric ischemic cerebral stroke.

MATERIALS AND METHODS

50 patients with acute hemispheric ischemic cerebral stroke were observed. They were selected by specific inclusion and exclusion criteria.

Standardized methods were used (14). The SSR study was done under standard conditions in an unlit and quiet room with an air temperature of 22-24 degrees Celsius and body temperature of 32-36 degrees Celsius. The patients were awake during the study, with closed eyes, relaxed in a supine position. The study was performed with a two-channel electromyograph (*Neuron-Spectrum-5)* through electrical stimulation of a sensory nerve (*n. medianus, n.tibialis*) with a length of 0.2-0.5 ms with application of gradually increasing electrical stimulation of 20-40 mA, at intervals of 60 to 120 ms. We analyzed the latency time and the amplitude of the highest of the five consecutive potentials registered in the hands and the legs, left and right, respectively, during ipsilateral stimulation.

For the purposes of our study, the patients were divided into four groups: 1) Ischemic cerebral stroke (ICS) in the territory of the right middle cerebral artery (RMCA) with insular cortex (IC) involvement (*ICS in RMCA with IC*); 2) Ischemic cerebral stroke in territory of the right middle cerebral artery without insular cortex involvement (*ICS in RMCA without IC*); 3) Ischemic cerebral stroke in the territory of

the left middle cerebral artery (LMCA) with insular cortex involvement (*ICS in LMCA with IC); 4)* Ischemic cerebral stroke in the territory of the left middle cerebral artery without insular cortex involvement (*ICS in LMCA without IC*).

RESULTS

No significant differences were found in regard to the SSR latency times and amplitudes between the affected and the unaffected limbs except for the upper and lower limb latencies in patients with ICS in RMCA with IC ($p<0.05$) (Tables 1, 2, 3, 4).

When comparing the obtained results from patients with left hemispheric and those with right hemispheric strokes we have concluded that there are longer latency times and lower amplitudes in patients with right hemispheric strokes with the most marked abnormal values being in patients with ICS in RMCA with IC.

The conducted analysis showed the most significantly longer latency times for upper and lower limb, 2.09s and 2.9s, respectively, in patients with ICS in RMCA with IC (Fig. 1).

The results show the lowest amplitude in patients with ICS in RMCA with IC, 1.07 mV for the upper limb and 0.88 mV for the lower limb (Fig. 2).

Table 1. Latency and amplitude comparison in patients with ICS in RMCA with IC

	Affected side	Healthy side	p	Controls	p
Latency – upper limb (ms)	2.09±0.73	1.96±0.67	<0.05	1.25±0.58	<0.01
Amplitude – upper limb (mV)	1.07±0.58	1.18±0.75	>0.05	1.93±0.77	<0.05
Latency – lower limb (ms)	2.90±0.95	2.36±0.62	<0.05	1.53±0.33	<0.01
Amplitude – lower limb (mV)	0.88±0.35	0.99±0.41	>0.05	1.48±0.52	<0.001

Table 2. Latency and amplitude comparison in patients with ICS in RMCA without IC

	Affected side	Healthy side	p	Controls	p
Latency – upper limb (s)	1.72±0.65	1.71±0.55	>0.05	1.25±0.58	<0.05
Amplitude – upper limb (mV)	1.22±0.62	1.26±0.51	>0.05	1.93±0.77	<0.01
Latency – lower limb (s)	2.11±0.80	2.01±0.54	>0.05	1.53±0.33	<0.001
Amplitude – lower limb (mV)	1.05±0.79	1.10±0.77	>0.05	1.48±0.52	<0.01

Table 3. Latency and amplitude comparison in patients with ICS in LMCA with IC

	Affected side	Healthy side	p	Controls	p
Latency – upper limb (s)	1.58±0.34	1.51±0.33	>0.05	1.25±0.58	<0.05
Amplitude – upper limb (mV)	1.31±0.93	1.39±0.93	>0.05	1.93±0.77	<0.01
Latency – lower limb (s)	2.06±0.28	2.00±0.48	>0.05	1.53±0.33	<0.001
Amplitude – lower limb (mV)	1.03±0.69	1.12±0.85	>0.05	1.48±0.52	<0.01

Table 4. Latency and amplitude comparison in patients with ICS in LMCA without IC

	Affected side	Healthy side	p	Controls	p
Latency – upper limb (s)	1.57±0.40	1.41±0.41	>0.05	1.25±0.58	<0.01
Amplitude – upper limb (mV)	1.15±0.70	1.17±0.48	>0.05	1.93±0.77	<0.01
Latency – lower limb (s)	1.76±0.77	1.81±0.64	>0.05	1.53±0.33	<0.01
Amplitude – lower limb (mV)	0.96±0.57	0.85±0.45	>0.05	1.48±0.52	<0.001

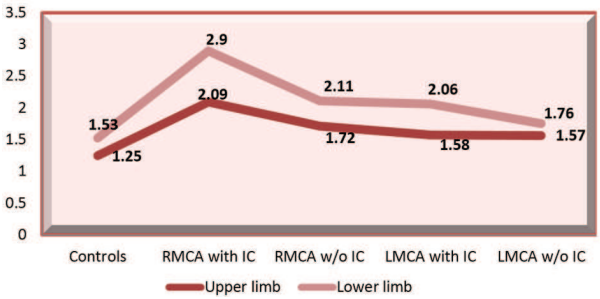

Fig. 1. Distribution of the median values of the latencies depending on the localization of the stroke

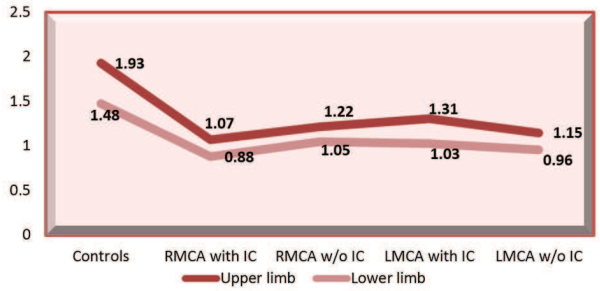

Fig. 2. Distribution of the median values of the amplitudes depending on the localization of the stroke

CONCLUSION

The analysis conducted by us did not show a significant difference in the amplitude and the latency in the studied patient groups when comparing affected and unaffected limbs with the exception of the latency times in the group of patients with ICS in RMCA with IC. When we compared the obtained results from the patients with left hemispheric and those with right hemispheric strokes, we determined longer latency times and lower amplitudes in patients with right hemispheric strokes with the most marked abnormal values being in patients with a stroke in the territory of RMCA with IC. These results confirm the dominating role or the right insular cortex in the lateralization of the sympathetic function.

The bilaterally prolonged latencies and lowered amplitudes of SSRs as a consequence of a unilateral ischemic lesion in our patients, can be explained by the impact of the complex bilateral associations of the medullar reticular formation with the cerebral cortex.

The sympathetic sudomotor dysfunction in the acute stage of the ischemic stroke can be associated with reduced or missing excitatory effect of the cortical structures on the sympathetic of the autonomic nervous system which is partially restored during the chronic stage due to cortical compensation and neurological recovery (3).

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