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CORRELATION BETWEEN NEUROLOGICAL LEG DEFICITS AND REACTION TIME OF UPPER LIMBS AMONG LOW-BACK PAIN PATIENTS

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ABSTRACT. The purpose of the study was to examine how neurological deficits of the leg, i.e. sensory deficit, deficient reflexes and muscular weakness, correlate with reaction times of upper limbs in a group with chronic low-back pain. Thirty-two patients were studied. Three sets of measurements of simple reaction time and choice reaction time of upper limbs were conducted at one-week intervals. Neurological deficits of the leg were recorded by a physician and the subjects answered a questionnaire about the severity of their low-back symptoms (Oswestry's index). We also defined a neurological index which reflected the total sum of the three types of leg deficits experienced by each of the subjects. Sensory deficit of the leg and the neurological index correlated strongly with slower reaction times of upper limbs, while the other two neurological deficits did not reach a level of significance. Sensory deficits of the leg seem to be an indicator of much greater motor disability than has been thought so far. The motor disability not only appears distally from the lumbar radicular damage caused for example by an intervertebral herniation, it also seems to relate to psychomotor reaction more generally, even on upper limbs.

Key words: low-back pain, reaction time, neurological deficits.

No single etiology for chronic low-back pain (LBP) has been found as chronic LBP is a symptom rather than a single disease. Degenerative, inflammatory, anatomical and traumatic factors either as single accident or cumulative microtrauma, have been suggested to play important roles in chronic LBP (7, 9, 17). Furthermore, chronic LBP involves psychological, psychogenic and social components (1, 10, 11, 14).

Nykvist et al. (12) observed in a sample of 276 patients that in the rehabilitation of patients with sciatica only some clinical findings had prognostic value for long-term outcome. Sensory deficit of leg indicated the severity of the initial radicular damage caused by the prolapse, and the impact that such a damage has on the overall rehabilitation process (13).

The relationship between slow reaction time and chronic LBP was observed in a cross-sectional study by Taimela et al. (15). The chronic LBP group was slower in simple reaction time, decision time and total choice reaction time as compared with a control group matched for age and sex. The differences were significant both among men and women. Movement time also tended to be slower among men in the chronic LBP group as compared with controls, but not among women. Taimela et al. (15) hypothesized that one factor in the development of LBP may be injury of low-back structures due to slow reaction time, or inversely, slow reaction time may be a consequence of existing low-back pain, or possibly both slow reaction time and low-back pain have their origins in a third, unknown, cause.

In our earlier study (16) we found that the men in the chronic LBP group were significantly slower in simple reaction time, movement time and total choice reaction time than the men in the control group. Significant differences between the women in the two groups were not found. A slight learning effect was detected in the values of decision time and it was more evident in the control group.

The purpose of this study was to study how neurological deficits correlate with reaction times in a group with chronic LBP.

METHODS

Subjects

The study group consisted of 32 chronic LBP patients (15 women and 17 men). Information about age, weight, height and educational level was collected by questionnaire. Educational level was scaled from 1 to 5 so that those with value 5 had the best education. The basic data of the study group are presented in Table I.

Table I. *Basic data on the study group (mean values and standard deviations)*

Variable	Men and women ($n = 32$)	Men ($n = 17$)	Women ($n = 15$)
Age (yrs)	42 ± 7	42 ± 7	42 ± 7
Weight (kg)	78 ± 11	85 ± 9	70 ± 12
Height (cm)	174 ± 6	180 ± 5	167 ± 6
Educational level	3.2 ± 1.0	3.2 ± 0.9	3.1 ± 1.1

Measurements

Three measurements of simple reaction time and choice reaction time of upper limbs were conducted at 1-week intervals. Choice reaction time was fractionated into decision time and movement time. The details of simple reaction time and choice reaction time testing have been presented earlier (16).

Neurological deficits of the leg, i.e. sensory deficit, deficient reflexes and muscular weakness, were recorded by a physician and scaled 0–1. The subjects also answered a questionnaire about the severity of their low-back symptoms (Oswestry's index) (6).

Statistics

The intercorrelations of the measured variables were studied with the aid of Pearsson's correlations.

RESULTS

The clinical data on the study group subjects are given in Table II. We also defined a neurological index, ranging from 0 to 3, which reflected the sum total of the three types of neurological leg deficits found in each of the subjects. The correlations between reaction times and neurological deficits in the combined group of men and women are shown in Table III. Sensory deficit of the leg and the neurological index

Table II. *Clinical data on the study group (mean values, standard deviations and relative frequencies)*

Variable	Men and women ($n = 32$)	Men ($n = 17$)	Women ($n = 15$)
Oswestry's index	27.1 ± 14.8	31.5 ± 16.2	22.0 ± 11.5
Length of LBP (yrs)	9.6 ± 7.0	11.1 ± 7.3	7.9 ± 6.5
Back operations (%)	28.1	29.4	26.7
Radiation of pain (%)			
No radiation	34.4	41.2	26.7
Rad. into the leg	65.6	58.8	73.3
Neurol. deficits (%)	43.8	41.2	46.7
Sensory deficit (%)	28.1	29.4	26.7
Deficient reflexes (%)	18.8	11.8	26.7
Muscular weakness (%)	18.8	17.6	20.0

Table III. *Product-moment correlations between reaction times and neurological deficits*

	Sensory deficit	Deficient reflexes	Muscular weakness	Neurological index
Simple reaction time				
Week 1	0.47 **	0.22	−0.03	0.34 *
Week 2	0.56 ***	0.13	0.26	0.48 **
Week 3	0.45 **	0.09	0.20	0.37 *
Choice reaction time				
Week 1	0.51 ***	0.23	0.20	0.47 **
Week 2	0.52 ***	0.04	0.24	0.40 *
Week 3	0.47 **	0.01	0.27	0.38 *
Decision time				
Week 1	0.53 ***	0.19	0.10	0.41 *
Week 2	0.52 ***	0.01	0.21	0.38 *
Week 3	0.39 *	−0.04	0.11	0.23
Movement time				
Week 1	0.38 *	0.22	0.21	0.39 *
Week 2	0.45 **	0.05	0.22	0.36 *
Week 3	0.45 **	0.05	0.33	0.41 *

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table IV. *The numerical distribution of combinations of the neurological deficits* ($n = 32$)

Sensory deficit	No other deficits	Deficient reflexes	Muscular weakness	Def. refl. & musc. weakn.
yes	3	3	2	1
no	18	2	3	0

correlated strongly with slower reaction times while the other two neurological deficits did not reach statistical significance ($p > 0.05$). The numerical distribution of different combinations of the neurological deficits is shown in Table IV.

To further confirm the correlation observation, we compared the mean values of the choice reaction time (week 1) between patient groups with variant neurological deficits and all the other cases (Table V). The confidence limits showed that the only statistically significant difference was between the subjects with sensory deficits of the leg ($n = 9$) and the other cases ($n = 23$).

It is interesting to note that in the case of choice reaction time it is the decision time rather than the movement time that tends to be the more significant component responsible for the high correlations with sensory deficit.

The relatively small number of men and women made any sex-related conclusions uncertain. However, some sex-related differences were evident in our results. In the group of men, sensory deficits of the leg as well as the neurological index tended to correlate more strongly with slower reaction times.

DISCUSSION

Studies on the effects of physical activity and exercise have mostly concentrated on the traditional dimensions of physical capacity. The status of these systems has usually been described by means of aerobic capacity, muscular strength, and flexibility.

The question has been asked whether physical activity might also have beneficial effects on certain other important dimensions of functional capacity such as the speed of reactions. In the field of reaction-time research a few studies have analyzed the possibilities of improving psychomotor speed through physical training. The intervention studies of physical training suggest that the likelihood of inducing improvement in psychomotor functions is in fact possible, but the results are not unequivocal enough for final conclusions (2, 3, 4, 8). It is possible that many of the differences in psychomotor and sensory functions between physically more and less active groups of people also reflect the effects of other factors associated with physical activity.

In the rehabilitation of patients with chronic LBP, factors of prognostic value regarding the long-term outcome could prove beneficial for intervention, and also in evaluating rehabilitative progress with respect to fitness and capacity for work. Nykvist et al. (12) observed that basic neurological deficits lead to impairment of mechanisms regulating spinal posture and muscle function. This is associated with a poor long-term outcome. Sensory deficits of the leg indicated the severity of the initial radicular damage caused by a prolapse, and the impact that such damage has on the overall rehabilitation process (13). Era et al. (5) tested in a cross-sectional study the sensitivity of the skin and subcutaneous tissues to mechanical stimulation on the inner malleolus of the ankle. They compared physically more active men with less active men, and found better performance

Table V. *The choice reaction time (msec) in patient groups with variant neurological deficits compared to the choice reaction time of all the other cases*

The mean values ±95% confidence limits of the choice reaction time (week 1).

	Deficient cases	All the other cases
Sensory deficit	715 ± 63 ($n = 9$)	609 ± 31 ($n = 23$)
Deficient reflexes	683 ± 84 ($n = 6$)	628 ± 35 ($n = 26$)
Muscular weakness	678 ± 105 ($n = 6$)	630 ± 33 ($n = 26$)

of these peripheral sensory functions among the more active men. Like in our study the deficient sensory perception indicated poor performance capacity in both of their studies (5, 13).

Sensory deficits of the leg may be a more sensitive and significant indicator of motor control than deficient reflexes or minor muscular weakness of LBP patient. The neurological index used in this study carries the weight of all three types of deficits. The correlation of the neurological index with slow reaction times would seem to be mainly due to the high correlation with sensory deficits. Deficient reflexes and muscular weakness seem to decrease the correlation. This is the reason why the correlation of the neurological index with slow reaction times is lower than that of mere sensory deficit.

In our earlier study (16) we observed that in the choice reaction time test the differences between the chronic LBP group and the control group were evident only when the task incorporated a movement component, i.e. the neuromuscular implementation of the process of motor control. Coupled with the fact that neurological deficits of legs correlate with slow reaction times of upper limbs, this suggests that further studies should be focused on various overall motor abilities of the chronic LBP subjects.

Pain can cause a disturbance of sensory perception that is not restricted to the area where pain is perceived. Such changes can be expected to influence the reaction times. This remains, however, speculation and the mechanisms involved behind our observation remains obscure in the present study.

Independent of the explanation of the phenomenon, sensory deficits of the leg seem to be an indicator of much greater motor disability than has been thought so far. The motor disability not only appears distally from the lumbar radicular damage caused, for example, by an intervertebral herniation, but also seems to relate to psychomotor reactions more generally, even on upper limbs. More pertinent studies are necessary to clarify the role of reaction times and motor training in the rehabilitation of low-back pain patients.

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