ORIGINAL ARTICLE

ASSOCIATIONS BETWEEN THE UPPER EXTREMITY FUNCTION AND COGNITION IN POST-STROKE PATIENTS

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ABSTRACT

The aim: Was to determine the relations between the the upper extremity function and cognition in post-stroke patients.

Materials and methods: Totally there were 86 patients examined in the 1-year period after first-ever anterior circulation ischemic stroke. Examination of the upper extremity function was performed with the Fugl-Meyer assessment (FMA). Cognitive function was assessed with the Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Frontal Assessment Battery (FAB), Trail-making Test A and B (TMT) and the Clock Drawing Test (CDT).

Results: Motor dysfunction mostly manifested in low "Wrist" and "Hand" subtests scores (5 and 7 , respectively) and therefore resulted in decreased "Total motor function" score of 40 . The most significant relations were found out between the FMA "Hand", "Total motor function" subtests and CI indices. MoCA score correlated with FMA "Wrist" (r=0.34; p=0.021), "Hand" (r=0.52; p=0.001) and "Total motor function" (r=0.48; p=0.003) scores. "Hand" score also correlated with the FAB (r=0.43; p=0.012), CDT (r=0.22; p=0.016), TMT-A (r=-0.31; p=0.023) and TMT-B (-0.48; p=0.009) scores. There was no significant correlation between the sensory FMA subtests.

Conclusion: Our findings suggest that upper extremity motor impairment, especially hand and wrist dysfunction, are associated with cognitive impairment and executive functions disorder in particular.

KEY WORDS: cognitive impairment, stroke, upper extremity function

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INTRODUCTION

Stroke remains one of the major causes of disability nowadays. A significant decrease in stroke mortality within the recent decades and its constantly high incidence are contributing to an increasing number of disabled stroke survivors [1]. The most active and effective recovery takes place within the first 3 months after stroke [2]. However, rehabilitation of post-stroke patients in later periods becomes even more important due to delay or ineffectivity of the early rehabilitation.

Motor and cognitive dysfunction are the most prevalent among the stroke consequences and have a high impact on the patients' life quality [3, 4]. These syndromes are usually studied and treated as distinct entities, though both of them may influence each other's course and manifestations. It is known that cognitive impairment (CI) and especially dementia decrease the effectivity of motor rehabilitation [5]. However, there is an emerging evidence that motor dysfunction may also contribute to occurrence of CI and its progression. It was reported that the gait speed and grip strength may be risk factors of cognitive decline in elderly patients [6]. Manual dexterity and fine motor skills are considered one of the most important predictors influencing the further CI in patients with cardiovascular diseases [7,8]. Detailed study of these associations in post-stroke patients may be helpful in development of the rehabilitation strategies which could influence both cognition and motor function and be the most beneficial for patients' recovery.

THE AIM

The aim of study was to determine the relations between the motor and sensory parameters of the upper extremity function and cognition in patients 1 year after ischemic stroke.

MATERIALS AND METHODS

The study was performed in the department of neurology and neurosurgery of Ivano-Frankivsk National Medical University and the vascular neurology department of Ivano-Frankivsk Regional Hospital in 2018-2020. All patients signed an informed consent before involvement into the study. Totally there were 86 patients (51 males, 34 females; mean age 64 [55; 74] years) examined in the 1-year period after first-ever anterior circulation ischemic stroke. Stroke was localized in the left cerebral hemisphere in 41 (47.7%) patients and in the right hemisphere in 45 (52.3%) patients.

Exclusion criteria:

1. hemorrhagic stroke;
2. recurrent stroke;
3. posterior circulation stroke;
4. age <50 and > 80;
5. left-handed patients;
6. period of <12 month and >24 month after stroke;
7. plegia or severe paresis of the upper extremity;
8. sensory or severe motor aphasia;
9. malignancy and systemic comorbidities;

Table I. Parameters of the upper extremity function in post-stroke patients, Me [Q25%; Q75%]

FMA parameter (range)	Score
Upper extremity (0-36)	24 [18; 32]
Wrist (0-10)	5 [2; 7]
Hand (0-14)	7 [3; 9]
Speed / coordination (0-6)	4 [3; 5]
Total motor function (0-66)	40 [26; 53]
Sensation (0-12)	8 [5; 10]
Passive joint movement (0-24)	14 [10; 20]
Joint pain (0-24)	18 [16; 21]

Table II. Parameters of cognitive function in post-stroke patients, Me [Q25%; Q75%]

Parameter (range)	Score
MMSE (0-30)	24 [20; 26]
MoCA (0-30)	23 [17; 25]
FAB (0-18)	13 [12; 15]
CDT (0-10)	7 [5; 8]
TMT-A (sec)	56 [43;71]
TMT-B (sec)	142 [122; 175]

10. severe depression (Hospital Anxiety and Depression Scale (HADS) score >11);
11. previous disability (orthopedic etc).

Examination of the upper extremity function was performed with the Fugl-Meyer assessment (FMA) (Fugl-Meyer AR et al., 1975). Cognitive function was assessed with the Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Frontal Assessment Battery (FAB), Trail-making Test A and B (TMT) and the Clock Drawing Test (CDT). Screening for depression was performed with the help of HADS scale; pre-existing CI was excluded with the IQ-code questionnaire.

Statistical analysis of the results was carried out with the help of statistical data analysis software "Statistica 6.0" and "MS Excel" using nonparametric evaluation methods. Data are shown as Median (Me) and interquartile interval [Q25%; Q75%]. Correlation between the parameters was estimated with the Spearman's rank correlation coefficient. Statistical significance was defined as p-value < 0.05.

RESULTS

Examination of patients' upper extremity function with the FMA detected motor dysfunction, which mostly manifested in low "Wrist" and "Hand" subtests scores (5 [2; 7] and 7 [3; 9], respectively) and therefore resulted in decreased "Total motor function" score of 40 [26; 53] out of 66 maximally possible (Table I). Evaluation of cognitive functions determined decreased total MMSE, MoCA, FAB and CDT tests score compared to cut-off levels, and increase of TMT-A and TMT-B performance time (Table II).

Table III. Correlations between the motor and cognitive function parameters in post-stroke patients

FMA parameter	r	p-value
MMSE		
Upper extremity	0.21	0.166
Wrist	0.38	0.093
Hand	0.27	0.081
Speed / coordination	0.12	0.219
Total motor function	0.29*	0.026
Sensation	0.21	0.587
Passive joint movement	0.09	0.245
Joint pain	0.15	0.421
MoCA		
Upper extremity	0.19	0.097
Wrist	0.34*	0.021
Hand	0.52*	0.001
Speed / coordination	0.34	0.068
Total motor function	0.48*	0.003
Sensation	0.16	0.159
Passive joint movement	0.08	0.328
Joint pain	0.14	0.166
FAB		
Upper extremity	0.19	0.116
Wrist	0.38	0.073
Hand	0.43*	0.012
Speed / coordination	0.23	0.089
Total motor function	0.44*	0.009
Sensation	0.09	0.216
Passive joint movement	0.15	0.302
Joint pain	0.11	0.124
CDT		
Upper extremity	0.08	0.746
Wrist	0.11	0.183
Hand	0.22*	0.016
Speed / coordination	0.29	0.053
Total motor function	0.26*	0.034
Sensation	0.32	0.182
Passive joint movement	0.14	0.351
Joint pain	0.06	0.224
TMT-A		
Upper extremity	-0.36	0.128
Wrist	-0.41	0.073
Hand	-0.31*	0.023
Speed / coordination	-0.18	0.096
Total motor function	-0.39	0.074
Sensation	-0.27	0.528
Passive joint movement	-0.09	0.269
Joint pain	-0.11	0.134
TMT-B		
Upper extremity	-0.23	0.059
Wrist	-0.31*	0.026
Hand	-0.48*	0.009
Speed / coordination	-0.22*	0.047
Total motor function	-0.41*	0.012
Sensation	-0.18	0.236
Passive joint movement	-0.11	0.188
Joint pain	-0.13	0.365

Note: * – significance of correlation.

The most significant relations were found out between the FMA "Hand", "Total motor function" subtests and CI indices (Table III). MoCA score correlated with FMA "Wrist" (r=0.34; p=0.021), "Hand" (r=0.52; p=0.001) and "Total motor function" (r=0.48; p=0.003) scores. "Total motor function" score also correlated with the MMSE (r=0.29; p=0.026), FAB (r=0.44; p=0.09), CDT (r=0.026; p=0.034) and TMT-B (r=-0.41; p=0.012) scores. "Hand" score also correlated with the FAB (r=0.43; p=0.012), CDT (r=0.22; p=0.016), TMT-A (r=-0.31; p=0.023) and TMT-B (-0.48; p=0.009) scores.

There was no significant correlation between the FMA subtests "Sensation", "Passive joint movement", "Joint pain" and CI manifestations in examined patients.

DISCUSSION

Interactions between cognitive and motor impairment became a subject of great interest within the last years. Prevalence of post-stroke CI is high and varies from 19 to 92%, depending on severity and the method used for its detection [3, 4]. Upper extremity motor impairment is a leading factor that impacts long-term disability due to a major role of manual dexterity in patients' self-care and functional independence.

McGrath R. et al. [7] reported that handgrip weakness and asymmetry are associated with CI. Similar data were obtained in the elderly population [6] and cardiovascular patients' cohort [8]; these findings consider hand motor dysfunction a probable predictor of further cognitive decline. Presence of hand motor impairment was also associated with worse cognitive performance in patients with mild CI and dementia [9].

In our study the most significant correlations were observed between the arm motor functioning and cognitive scales which include examination of the executive functions (TMT A and B, FAB, MoCA), while traditionally used MMSE didn't show so much significance. Fine motor skills impairment, which resulted in decreased FMA "Hand", "Wrist" and "Total motor function" scores also appeared to be the most important risk factor of CI; upper arm functioning score didn't correlate with cognition in examined patients. There was also no evidence of sensory dysfunction influence on CI manifestations.

These findings may be explained by the role of the frontal lobe in providing of both executive functions and motor control, which is the underlying basis for coexistence and close interactions between cognition and fine motor skills [10]. It may also provide a pathogenetical support for use of rehabilitation activities which target fine motor skills and manual dexterity improvement and may also contribute to cognition. There is similar evidence about the favorable influence of general physical activity on cognitive functioning of patients with mild CI and dementia [11]. Although benefits of general physical activity for post-stroke patients have also been reported [12], they have not focused on precise evaluation and improvement of hand motor function. That is why further studies of this problem are relevant and may create a wide prospective post-stroke patients' rehabilitation, functional independence and life quality improvement.

CONCLUSIONS

Our findings suggest that upper extremity motor impairment, especially hand and wrist dysfunction, are associated with cognitive impairment and executive functions disorder in particular. Further research is needed in regard to the prognostic significance of these findings and their impact on the treatment and rehabilitation strategies.

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