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CHANGES IN MOTOR FUNCTION AFTER PSYCHOMOTOR REHABILITATION IN POST-ISCHEMIC STROKE PATIENTS: A CONTROLLED STUDY USING FUGL-MEYER ASSESSMENT

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Abstract. *Stroke remains one of the leading causes of long-term disability worldwide, with motor impairment being the most common consequence affecting functional independence and quality of life. The aim of this study was to evaluate changes in motor and sensory functions in patients after ischemic stroke undergoing psychomotor rehabilitation using the Fugl-Meyer Assessment (FMA). A prospective controlled clinical study was conducted involving 100 patients with ischemic stroke who were randomly assigned into two groups: a psychomotor rehabilitation group (n = 50) receiving psychomotor therapy in addition to standard rehabilitation, and a control group (n = 50) receiving standard rehabilitation only. The rehabilitation program lasted eight weeks and consisted of four sessions per week, each lasting 60 minutes. Motor and sensory functions were evaluated using the Fugl–Meyer Assessment scale before and after the intervention. At baseline, the groups were comparable in clinical and functional characteristics, with Barthel Index scores of 71.2 ± 7.73 and 71.7 ± 9.01 in the intervention and control groups, respectively. After rehabilitation, significant improvements were observed in both groups across several FMA domains. In the psychomotor group, lower limb motor function increased from 23.26 to 32.48 points (+9.22), sensory function from 16.6 to 27.5 points (+10.9), and joint motion from 22.3 to 41.94 points (+19.64). Mixed-design ANOVA demonstrated a significant effect of time across all FMA subcomponents ($p < 0.001$), indicating substantial functional recovery during the rehabilitation period. Moreover, significant time × group interactions were observed for sensory function, joint motion, and lower limb motor function, suggesting additional therapeutic benefits of psychomotor rehabilitation. These findings indicate that psychomotor-based rehabilitation may enhance motor recovery after ischemic stroke and contribute to improved functional outcomes.*

Keywords: *stroke rehabilitation; psychomotor therapy; neurorehabilitation; motor recovery; Fugl-Meyer Assessment; post-stroke recovery; sensorimotor integration*

Introduction. Ischemic stroke remains one of the leading causes of long-term disability worldwide and continues to pose a substantial challenge for healthcare systems. According to global epidemiological analyses, stroke accounts for a significant proportion of neurological morbidity and mortality, with millions of new cases occurring each year. Despite improvements in acute stroke management and prevention strategies, a considerable number of survivors experience persistent functional deficits that require prolonged rehabilitation [1, 5]. Recent global burden estimates indicate that stroke remains a major contributor to disability-adjusted life years (DALYs), particularly in low- and middle-income countries where access to comprehensive rehabilitation services is often limited [2].

Motor dysfunction is among the most frequent and disabling consequences of ischemic stroke. Clinical observations suggest that up to 70–80% of patients develop varying degrees of motor impairment during the acute stage of the disease, and many of these deficits persist during the chronic phase [7, 13]. These impairments commonly include hemiparesis, reduced coordination, impaired balance, and decreased motor control, all of which significantly limit patients' independence in daily activities and reduce quality of life [8]. As a result, restoring motor function has become one of the primary goals of post-stroke rehabilitation.

Over the past decades, advances in neuroscience have improved the understanding of neuroplasticity and its role in functional recovery after stroke. Neuroplasticity refers to the brain's ability to reorganize neural networks and establish new functional connections following injury. Rehabilitation approaches that incorporate repetitive, task-oriented and sensorimotor training are believed to stimulate these adaptive mechanisms and facilitate recovery of motor function [6, 9]. Within this context, psychomotor rehabilitation has emerged as a promising therapeutic approach that integrates movement, sensory perception and emotional regulation into structured therapeutic activities. By addressing motor control together with sensorimotor integration and body awareness, psychomotor interventions may enhance functional recovery beyond the effects of conventional exercise-based rehabilitation [4, 12].

To evaluate the effectiveness of rehabilitation interventions, reliable and standardized outcome measures are essential. Among the available clinical scales, the Fugl-Meyer Assessment (FMA) is widely considered one of the most comprehensive tools for assessing motor recovery after stroke. Developed specifically for post-stroke patients, the scale evaluates multiple domains including motor function of the upper and lower extremities, sensory function, balance, joint motion and joint pain [3]. Numerous clinical trials and systematic reviews have demonstrated the reliability and validity of the FMA as a sensitive measure of motor recovery in stroke rehabilitation studies [11, 10]. Consequently, the scale has become a standard outcome measure in both clinical practice and research.

Despite growing interest in psychomotor rehabilitation, evidence regarding its effectiveness in improving motor recovery after ischemic stroke remains limited, particularly in clinical settings where traditional rehabilitation approaches predominate. Further investigation is therefore needed to determine whether integrating psychomotor components into rehabilitation programs can enhance functional recovery and improve clinical outcomes.

The aim of the present study was to evaluate changes in motor function in post-ischemic stroke patients undergoing psychomotor rehabilitation using the Fugl-Meyer Assessment scale.

Objective of the study. The aim of this study was to evaluate changes in motor and sensory functions in patients after ischemic stroke undergoing psychomotor rehabilitation using the Fugl-Meyer Assessment scale, and to compare the effectiveness of psychomotor-based rehabilitation with standard rehabilitation approaches in improving functional recovery.

Materials and Methods. This study was designed as a prospective controlled clinical study aimed at evaluating the effectiveness of psychomotor rehabilitation in patients after ischemic stroke. The research was conducted in cooperation with the neurology department and specialized rehabilitation centers in Tashkent, Uzbekistan.

All procedures were performed in accordance with international ethical standards for biomedical research involving human participants. Participation in the study was voluntary, and all participants provided written informed consent before inclusion.

Patients received standard neurorehabilitation therapy according to clinical practice guidelines. In addition, patients in the intervention group underwent structured psychomotor rehabilitation sessions conducted by trained rehabilitation specialists.

Participants. A total of 130 individuals were initially screened for participation in the study. Among them, 100 patients with ischemic stroke met the inclusion criteria and were included in the final statistical analysis, while 30 healthy individuals were recruited as a control group for baseline comparison.

Patients with ischemic stroke were randomly assigned into two groups using a simple randomization method (Table 1):

- Psychomotor rehabilitation group (n = 50) - psychomotor therapy combined with standard rehabilitation
- Control rehabilitation group (n = 50) - standard rehabilitation only

Healthy volunteers (n = 30) were included as a reference control group.

Table 1.

Distribution of participants across study groups

Group	Number of participants
Psychomotor rehabilitation	50
Standard rehabilitation	50
Healthy control	30
Total	130

Participant inclusion and exclusion were determined according to the following predefined criteria (Table 2).

Table 2.

Inclusion and exclusion criteria for participant selection

Inclusion criteria	Exclusion criteria
confirmed diagnosis of ischemic stroke	recurrent stroke
age 30–70 years	severe somatic or psychiatric disorders
post-stroke rehabilitation stage	severe cognitive impairment
NIHSS score 5–20	epilepsy or uncontrolled cardiovascular disease
preserved cognitive ability	inability to participate regularly
stable neurological condition	absence during final evaluation
written informed consent	-

After applying these criteria, 30 patients were excluded, leaving 100 patients for final analysis.

Clinical and instrumental assessment. The diagnosis of ischemic stroke was confirmed using magnetic resonance imaging (MRI) and computed tomography (CT). MRI examinations included DWI, FLAIR, T1-weighted and T2-weighted sequences to identify ischemic lesions.

Additional diagnostic procedures included Doppler ultrasonography of the brachiocephalic arteries, electrocardiography (ECG), and echocardiography (EchoCG). These examinations were carried out to further clarify the etiology of ischemic stroke and to identify possible comorbid cardiovascular conditions that could influence the clinical course of the disease and the rehabilitation process.

Distribution of stroke localization. Stroke localization was classified according to vascular territory using MRI findings (Table 3, Figure 1).

Table 3.

Distribution of ischemic stroke localization

Localization	Psychomotor group (n=50)	Control group (n=50)
Left hemisphere (ACA + MCA)	11 (22%)	13 (26%)
Right MCA territory	17 (34%)	18 (36%)
Vertebrobasilar territory	22 (44%)	19 (38%)

No statistically significant differences between groups were observed at baseline ($p > 0.05$).

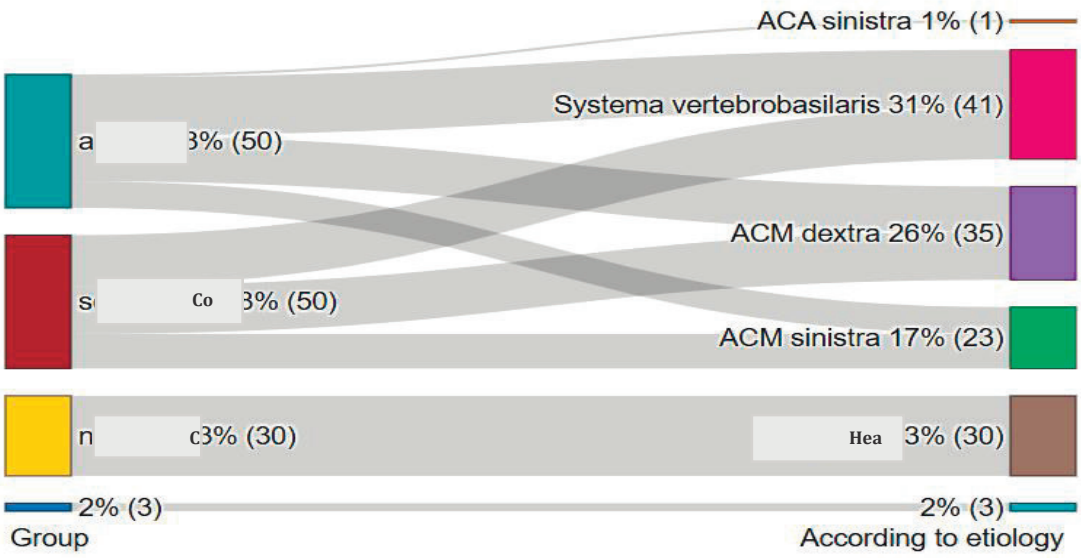


Figure 1. Distribution of stroke localization by vascular territory

Rehabilitation protocol. All participants received standard rehabilitation therapy including therapeutic exercises and functional training.

Patients in the intervention group additionally underwent psychomotor rehabilitation sessions consisting of:

- sensorimotor integration exercises
- coordination training
- rhythmic motor exercises
- task-oriented movement training
- body awareness exercises

The rehabilitation program lasted 8 weeks, with four sessions per week, each session lasting 60 minutes (Table 4).

Table 4.

Psychomotor rehabilitation protocol

Parameter	Value
Session duration	60 minutes
Sessions per week	4
Program duration	8 weeks
Total sessions	32

Recommended diagram structure:

- Warm-up (10 min)
- Sensorimotor exercises (15 min)
- Coordination and balance training (15 min)
- Task-oriented motor exercises (15 min)
- Relaxation and body awareness (5 min)

Functional outcome measures. Motor function was assessed using the Fugl-Meyer Assessment (FMA) scale. The scale evaluates motor recovery after stroke across several domains including motor function, sensory function, balance, joint range of motion and joint pain (Figure 2).

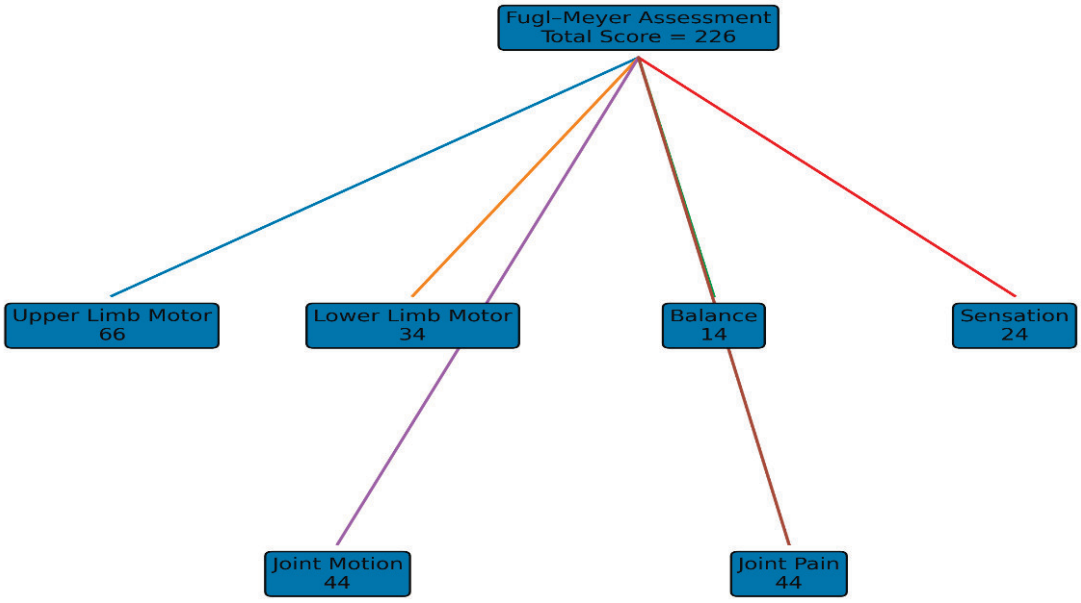


Figure 2. Fugl-Meyer assessment domains

Motor assessments were performed before rehabilitation and after completion of the intervention.

Statistical analysis. Statistical analysis was performed using the NumiQo statistical software package. Descriptive statistics were presented as mean values with standard deviations (mean ± SD) together with 95% confidence intervals. Prior to inferential analysis, the normality of data distribution was assessed using the Shapiro–Wilk test. Differences between groups were analyzed using the independent samples t-test, while changes within each group before and after the intervention were evaluated using the paired samples t-test. In addition, a mixed-design analysis of variance (ANOVA 2×2) was applied to examine the interaction between time (before and after rehabilitation) and group (psychomotor rehabilitation vs. standard rehabilitation). Statistical significance was set at $p < 0.05$. To estimate the magnitude of treatment effects, effect sizes were calculated using partial eta-squared (η^2p).

Results and Discussion. Motor and sensory recovery following rehabilitation was evaluated using the Fugl-Meyer Assessment (FMA) scale. Analysis of the FMA subcomponents demonstrated substantial improvements in motor and sensory functions during the rehabilitation period. At baseline, the psychomotor rehabilitation group and the comparison group had comparable scores across all FMA domains, indicating similar levels of neurological impairment prior to intervention. This comparability allowed subsequent changes to be attributed to the effects of the rehabilitation program.

In terms of upper limb motor function, the FMA score in the psychomotor rehabilitation group increased from 33.56 to 42.92 points, corresponding to an improvement of +9.36 points. In the comparison group, the score increased from 32.18 to 43.34 points, representing an improvement of +11.16 points. Although improvements were observed in both groups, the mixed-design ANOVA revealed a highly significant effect of time ($F = 764.03$; $p < 0.001$; $\eta^2p = 0.89$), confirming substantial motor recovery over the course of rehabilitation.

Recovery of lower limb motor function was more pronounced in the psychomotor rehabilitation group. The FMA score increased from 23.26 to 32.48 points, representing a gain of +9.22 points, whereas in the comparison group the increase was from 22.82 to 29.06 points (+6.24 points). Statistical analysis demonstrated a significant time effect ($F = 1118.16$; $p < 0.001$; $\eta^2p = 0.92$) as well as a significant time × group interaction, indicating faster recovery in the psychomotor rehabilitation group.

Substantial improvements were also observed in sensory function. In the psychomotor rehabilitation group, sensory scores increased from 16.6 to 27.5 points (+10.9 points), while in the comparison group the increase was from 18.78 to 24.14 points (+5.36 points). The mixed ANOVA results showed a highly significant time effect ($F = 1619.29$; $p < 0.001$; $\eta^2p = 0.94$) and a significant time × group interaction ($p < 0.001$), indicating greater sensory recovery in the psychomotor rehabilitation group.

Joint mobility showed the most pronounced improvement among the FMA domains. In the psychomotor rehabilitation group, the joint motion score increased from 22.3 to 41.94 points (+19.64 points), while in the comparison group the improvement was from 22.22 to 32.96 points (+10.74 points). The ANOVA analysis revealed a very strong time effect ($F = 2932.3$; $p < 0.001$; $\eta^2p = 0.97$) as well as a significant time × group interaction, indicating a clear advantage of the psychomotor rehabilitation approach.

In contrast, improvements in the joint pain component were similar in both groups. The psychomotor rehabilitation group demonstrated an increase from 28.42 to 33.18 points (+4.76 points), while the comparison group improved from 28.68 to 33.76 points (+5.08 points). Statistical analysis showed a significant effect of time ($F = 417.06$; $p < 0.001$; $\eta^2p = 0.81$), but no significant group effect or interaction between time and group (Figure 3).

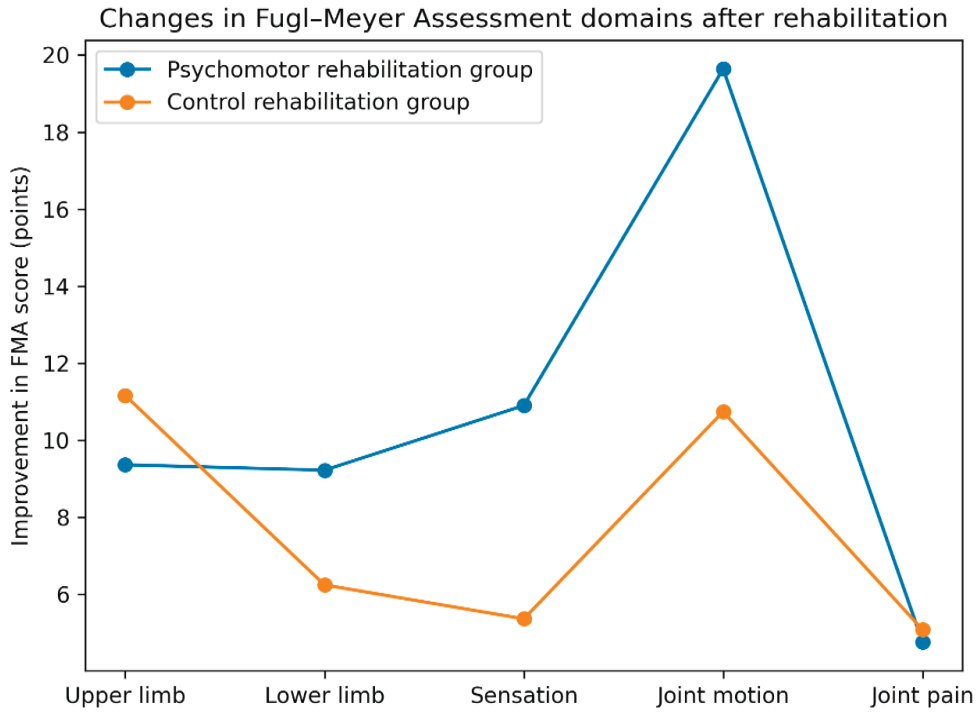


Figure 3. Comparative improvement in Fugl-Meyer Assessment domains after rehabilitation in psychomotor and control groups

The mixed-design ANOVA results demonstrated that the time factor was highly significant across all FMA subcomponents ($p < 0.001$), confirming that rehabilitation contributed substantially to improvements in motor and sensory functions. However, the time × group interaction indicated that rehabilitation incorporating psychomotor components produced greater improvements in sensory function, joint mobility, and lower limb motor recovery, while improvements in upper limb motor function and joint pain were comparable between the groups (Table 5).

Table 5.

Changes in Fugl–Meyer Assessment subcomponents after rehabilitation

FMA Domain	Psychomotor group (Before–After)	Improvement	Control group (Before–After)	Improvement
Upper limb motor	33.56 → 42.92	+9.36	32.18 → 43.34	+11.16
Lower limb motor	23.26 → 32.48	+9.22	22.82 → 29.06	+6.24
Sensation	16.6 → 27.5	+10.9	18.78 → 24.14	+5.36
Joint motion	22.3 → 41.94	+19.64	22.22 → 32.96	+10.74
Joint pain	28.42 → 33.18	+4.76	28.68 → 33.76	+5.08

Clinical interpretation. The findings demonstrate that rehabilitation interventions produced significant improvements in all domains of the Fugl–Meyer Assessment. However, the rehabilitation approach incorporating psychomotor components showed clear clinical advantages in sensory recovery, joint mobility, and lower limb motor function, suggesting that sensorimotor integration and body-awareness training may enhance neuroplastic recovery mechanisms following stroke.

Discussion. The present study evaluated the effectiveness of a rehabilitation approach incorporating psychomotor components on motor and sensory recovery in patients after ischemic stroke using the Fugl-Meyer Assessment (FMA) scale. The obtained results demonstrated significant improvements across all major FMA subcomponents during the rehabilitation period. Mixed-design ANOVA analysis revealed a highly significant effect of time across all domains ($p < 0.001$), confirming that rehabilitation interventions substantially contributed to the recovery of motor and sensory functions after stroke.

One of the most important findings of this study is the differential pattern of recovery across FMA domains. Although both rehabilitation approaches produced improvements in upper limb motor function, the final outcomes between groups did not differ significantly. In the psychomotor rehabilitation group, upper limb motor function improved from 33.56 to 42.92 points, while in the comparison group the score increased from 32.18 to 43.34 points. This finding suggests that conventional rehabilitation strategies may already be effective in improving upper limb motor function in post-stroke patients. Similar observations were reported by Kwakkel et al. (2015), who noted that upper limb recovery often depends on complex cortical motor network reorganization and may require longer rehabilitation periods to demonstrate clear intergroup differences.

In contrast, more pronounced improvements were observed in lower limb motor function in the psychomotor rehabilitation group. Lower limb FMA scores increased from 23.26 to 32.48 points (+9.22 points), compared with an increase from 22.82 to 29.06 points (+6.24 points) in the comparison group. This finding may be explained by the integrative nature of psychomotor therapy, which emphasizes body awareness, postural regulation, and coordinated sensorimotor activity. Previous studies have shown that gait and lower limb motor control rely heavily on sensorimotor integration processes involving both cortical and subcortical structures. According to Langhorne et al. (2011), rehabilitation strategies incorporating repetitive and task-oriented motor training can significantly enhance lower limb functional recovery after stroke.

Another important finding of this study concerns sensory function recovery. In the psychomotor rehabilitation group, sensory FMA scores increased from 16.6 to 27.5 points, whereas the comparison group demonstrated a smaller improvement from 18.78 to 24.14 points. The strong time × group interaction observed for this domain indicates that psychomotor therapy may have a particularly strong effect on sensory integration mechanisms. These findings support the concept that rehabilitation approaches focusing on proprioceptive stimulation and body schema reorganization can

facilitate neural plasticity and improve sensorimotor processing. Similar results were reported by Carey et al. (2016), who demonstrated that targeted sensory rehabilitation strategies significantly improve sensory discrimination and motor outcomes in post-stroke patients.

The most pronounced improvement was observed in joint motion, where the psychomotor rehabilitation group demonstrated an increase from 22.3 to 41.94 points, compared with an increase from 22.22 to 32.96 points in the comparison group. The very large effect size observed in this domain suggests that psychomotor-based rehabilitation may enhance joint mobility through mechanisms beyond passive mobilization. Specifically, the integration of intentional movement, proprioceptive feedback, and coordinated motor patterns may facilitate more efficient neuromuscular activation and functional joint movement. According to Krakauer et al. (2012), repetitive sensorimotor training promotes cortical reorganization and strengthens neural networks responsible for coordinated movement control.

In contrast, improvements in the joint pain component were similar in both groups. Although both groups demonstrated reductions in pain-related limitations over time, the absence of a significant time × group interaction suggests that pain reduction may be primarily associated with general increases in physical activity and joint mobilization rather than with the specific rehabilitation approach used.

Overall, the findings of this study indicate that rehabilitation programs incorporating psychomotor components may provide additional therapeutic benefits in several key domains of the Fugl-Meyer Assessment, particularly sensory recovery, joint mobility, and lower limb motor function. These domains are closely related to postural control, gait stability, and functional movement coordination, which are essential for regaining independence after stroke. The results therefore support the growing body of evidence suggesting that rehabilitation approaches integrating sensorimotor and body-awareness training may enhance neuroplastic recovery mechanisms and improve functional outcomes in post-stroke rehabilitation.

Conclusion. The findings of this study demonstrate that rehabilitation interventions significantly improved motor and sensory recovery in post-ischemic stroke patients according to the Fugl-Meyer Assessment (FMA) scale. At baseline, both study groups showed comparable levels of impairment across all FMA domains, allowing the observed improvements to be interpreted as the effect of the rehabilitation intervention.

Upper limb motor function improved in both groups during the rehabilitation period. In the psychomotor rehabilitation group, the FMA upper limb score increased from 33.56 to 42.92 points, corresponding to an improvement of +9.36 points, while in the comparison group the score increased from 32.18 to 43.34 points (+11.16 points). These results indicate that both rehabilitation approaches were effective in enhancing upper limb motor performance.

More pronounced differences were observed in lower limb motor function, where the psychomotor rehabilitation group demonstrated a greater improvement. The FMA lower limb score increased from 23.26 to 32.48 points (+9.22 points) in the psychomotor group, compared with an increase from 22.82 to 29.06 points (+6.24 points) in the comparison group.

Substantial improvements were also identified in sensory function. Sensory FMA scores increased from 16.6 to 27.5 points (+10.9 points) in the psychomotor rehabilitation group, whereas the comparison group demonstrated a smaller increase from 18.78 to 24.14 points (+5.36 points).

The largest improvement was observed in joint motion, where the psychomotor rehabilitation group demonstrated an increase from 22.3 to 41.94 points (+19.64 points), compared with an increase from 22.22 to 32.96 points (+10.74 points) in the comparison group. Improvements in the joint pain component were similar between groups, with increases of +4.76 points and +5.08 points, respectively.

Overall, statistical analysis confirmed a highly significant time effect across all FMA subcomponents ($p < 0.001$), indicating substantial improvement in motor and sensory functions

during the rehabilitation period. In addition, the observed time × group interaction suggests that rehabilitation incorporating psychomotor components may provide additional clinical benefits, particularly in improving sensory function, joint mobility, and lower limb motor recovery.

These findings indicate that integrating psychomotor elements into rehabilitation programs may enhance functional recovery mechanisms and contribute to more effective restoration of motor and sensory functions in patients after ischemic stroke.

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