

Assessment of Gross Motor Function in Pediatric Patients Aged 5–12 Years with Hemiplegia Before Treatment and Two Years After Medical Rehabilitation

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ABSTRACT

Background: Pediatric hemiplegia is a spastic form of cerebral palsy characterized by paralysis of one side of the body, most often resulting from impaired cerebral circulation. It affects the contralateral brain hemisphere, typically causing more damage to the face and upper limb than the lower limb. Evaluating gross motor function in these patients using the Gross Motor Function Measure (GMFM) is essential for assessing the effectiveness of rehabilitation.

Objectives: The study aimed to implement rehabilitation treatment in patients with pediatric hemiplegia and improve the corresponding motor functions. This is a highly relevant and necessary area of research, particularly considering Georgia's specific context.

Methods: A total of 36 pediatric patients with hemiplegia were included and divided into four age groups: 5-6 years (n=10), 7-8 years (n=8), 9-10 years (n=9), and 11-12 years (n=9). Gross motor function was assessed using the GMFM-88 scale, which includes six functional domains: (i) lying and rolling, (ii) sitting, (iii) crawling and kneeling, (iv) standing, (v) walking, and (vi) total gross motor score. Each item was scored on a 0–3 scale. Patients underwent 40 rehabilitation courses (384 procedures) over two years, with individualized treatment plans developed by an interdisciplinary team. The severity of pediatric hemiplegia was evaluated by determining the child's ability to move independently. Based on these functions, five levels of disease severity were defined. Statistical analysis was conducted using the Mann-Whitney U test with significance set at $P < 0.05$.

Results: All age groups showed statistically significant improvement in GMFM scores after two years of treatment as indicated by the Mann-Whitney U test ($P < 0.05$). The most notable improvements were observed in the 5-6-year age group, followed by 7-8, 9-10, and 11-12-year age groups. Younger patients demonstrated greater percentage increases in motor function scores, indicating a stronger response to rehabilitation when started earlier.

Conclusions: Medical rehabilitation significantly improves gross motor function in children with hemiplegia across all age groups - early treatment initiation results in better outcomes. Rehabilitation should be tailored individually based on age, disease severity, and each patient's specific functional deficits, as determined through interdisciplinary evaluation.

Keywords: Age-related outcomes; cerebral palsy; Gross Motor Function Measure (GMFM-88); gross motor function; individualized treatment; motor development; pediatric hemiplegia; rehabilitation.

BACKGROUND

Pediatric hemiplegia is a form of spastic cerebral palsy characterized by paralysis affecting one side of the body. It most commonly arises due to impaired blood circulation in the brain. In such cases, the face and one of the upper limbs are typically more affected than the lower limb. The damaged hemisphere of the brain is contralateral to the paralyzed side of the body. Pediatric hemiplegia is a significant cause of developmental disability in children. The clinical manifestations of neurological deficits in affected children depend on the type and extent of brain injury, the location of irreversible damage, the adaptability of the central nervous system, and its capacity for reorganization following the injury.

Treating spasticity is crucial in hemiparesis to prevent complications. Treatment outcomes are better when physical and occupational therapists get involved earlier, as they teach patients proper exercises and positioning. Treating spasticity is rather complex, so exercise should be intensive. Mobility limitations in patients represent a major global issue. Inactivity increases the risk of developing chronic diseases; therefore,

patients require aerobic, anaerobic, and strength-based exercise programs.¹

Orthoses are often used in hemiparesis to improve joint function and prevent soft tissue and joint deformities.^{2,3}

Spasticity limits a patient's ability to perform daily activities, causing pain and spasms. The stiffness of soft tissues prevents proper joint mobility. Orthotics help improve standing posture. In hemiplegia, orthoses improve gait and ankle flexion.^{4,5}

Evaluating gross motor function in children with hemiplegia using the Gross Motor Function Measure (GMFM) is crucial for assessing the effectiveness of medical rehabilitation interventions. This study aimed to conduct a rehabilitation program for pediatric patients with hemiplegia and evaluate improvements in motor function. This topic is particularly relevant and warrants investigation, especially in the context of Georgia's healthcare landscape.



METHODS

The study was conducted at the Ken Walker University Clinic of Medical Rehabilitation. It was based on measuring gross motor function in children with hemiplegia, with data collected at two time points: before the initiation of treatment and two years after the completion of rehabilitation. A total of 36 patients were included in the study: 10 patients aged 5-6 years, 8 patients aged 7-8 years, 9 patients aged 9-10 years, and 9 patients aged 11-12 years.

The results of the study consisted of the quantitative data expressed in percentages based on the assessment of six qualitative characteristics: (i) lying and rolling, (ii) sitting, (iii) crawling and kneeling, (iv) standing, (v) walking, (vi) total gross motor function score.

Patients underwent a comprehensive rehabilitation program based on individualized rehabilitation plans, developed using an interdisciplinary approach and tailored to the severity of the disease and the specific treatment goals. The rehabilitation team included a physiatrist, neurologist, physical therapist, occupational therapist, speech therapist, orthopedist, and orthotist. These specialists had received four years of training under the Physical Rehabilitation Strengthening Project in Georgia, led by specialists from Emory University in Atlanta, USA. The treatment of patients enrolled in the study was carried out under their supervision and lasted for two years. Each patient underwent 40 treatment sessions, totaling 384 procedures.

The Gross Motor Function Measure (GMFM), specifically the GMFM-88 version, was used in the study. This measure assesses the six qualitative characteristics mentioned above. Each item was scored from 0 to 3. The severity of pediatric hemiplegia was evaluated based on the child's ability to move independently. Five levels of severity were defined based on the performance of these functions.

The collected data were statistically analyzed using SPSS software. To test the null hypothesis (H_0), the Mann-Whitney U test was used, with a significance level of $\alpha=0.05$ (95% confidence interval) and degrees of freedom=14. The critical value of the criterion was equal to 13.

RESULTS

As seen from the tables, the U criterion was less than the critical value in all age groups, indicating that the difference between the first and second evaluations, before treatment and two years after rehabilitation, was statistically significant ($P<0.05$).

Notably, in all age groups, the average score two years after treatment was significantly higher than the scores recorded prior to treatment. A comparison was made between the results of different age groups, both before treatment and two years after rehabilitation, to determine whether there were significant differences in the quantitative scores (expressed as percentages) for the six qualitative characteristics: (i) lying and rolling, (ii) sitting, (iii) crawling and kneeling, (iv) standing, (v) walking, (vi) the final gross motor function score.

When comparing the 5-6 and 7-8-year-old age groups, the statistical analysis showed that prior to treatment, the differences in the third (crawling and kneeling) and fifth (walking) characteristics were not statistically significant, as the condition $U>U$ critical was met (with U critical=17), indicating $P>0.05$ (Tab.1 and Tab.2).

TABLE 1. Gross motor function measurement (GMFM) results before and 2 years after treatment in 5-6-year-old patients with childhood hemiplegia

	Gross motor function	First assessment (Before treatment) X±S	Second assessment (2 years after treatment) X±S
1	Lying and rolling	61.9±6.23	89.4±5.6
2	Sitting	69±8.05	95.4±1.49
3	Crawling and kneeling	46.7±4.93	83.8±3.69
4	Standing	52.3±2.76	96.3±5.23
5	Walking	46.9±3.38	82.1±2.69
6	Total Gross Motor Function Score	55.5±3.07	92.7±25.1

TABLE 2. Gross motor function measurement (GMFM) results before and 2 years after treatment in 7-8-year-old patients with childhood hemiplegia

	Gross motor function	First assessment (Before treatment) X±S	Second assessment (2 years after treatment) X±S
1	Lying and rolling	60.0±4.07	83.6±3.42
2	Sitting	52.7±0.72	93.8±1.99
3	Crawling and kneeling	46.7±4.93	81.5±5.2
4	Standing	50.1±3.36	92.95±2.3
5	Walking	46.9±3.38	79.9±3.39
6	Total Gross Motor Function Score	51.3±2.39	89.1±2.75

However, after two years of treatment, the comparison of all six qualitative characteristics showed statistically significant differences ($U<U$ critical, $P<0.05$), with the 5-6 age group demonstrating superior outcomes. This indicates that patients aged 5-6 years responded more favorably to treatment than those aged 7-8 (Tab.1 and Tab.2).

When comparing the 7-8 and 9-10-year-old age groups, it was found that before treatment, the difference in the second characteristic (sitting) was not statistically significant, as the condition $U>U$ critical was again met (with U critical=15, $P>0.05$). For the remaining five qualitative characteristics, statistically significant differences were observed between the two age groups ($U<U$ critical, $P<0.05$) (Tab.2 and Tab.3).

After two years of treatment, statistically significant differences were observed across all six qualitative characteristics in the mentioned age groups, as the condition

U<U critical was fulfilled for each U criterion ($P<0.05$), with the 7-8-year-old age group showing superior results. This suggests that patients in the 7-8 age group responded better to treatment than those in the 9-10 age group. (Tab.2 and Tab.3)

TABLE 3. Gross motor function measurement (GMFM) results before and 2 years after treatment in 9–10-year-old patients with childhood hemiplegia

	Gross motor function	First assessment (Before treatment) X±S	Second assessment (2 years after treatment) X±S
1	Lying and rolling	56.7±3.59	80.2±2.93
2	Sitting	52.7±0.72	93.8±1.99
3	Crawling and kneeling	40.7±1.17	52.19±6.46
4	Standing	48.1±3.36	82.9±3.86
5	Walking	42.3±2.5	75.9±4.74
6	Total Gross Motor Function Score	48.1±2.9	76.6±2.73

In the comparison between the 9-10 and 11-12-year-old age groups, it was found that, prior to treatment, the differences in the first (lying and rolling, $U=40$), second (sitting, $U=31$), and fifth (walking) characteristics were not statistically significant, as they met the condition $U>U$ critical ($P>0.05$). The critical value for the U criterion in this case was 17. However, for the remaining three qualitative characteristics, statistically significant differences were found between the two groups ($U<U$ critical, $P<0.05$) (Tab.3 and Tab.4).

TABLE 4. Gross motor function measurement (GMFM) results before and 2 years after treatment in 11–12-year-old patients with childhood hemiplegia

	Gross motor function	First assessment (Before treatment) X±S	Second assessment (2 years after treatment) X±S
1	Lying and rolling	56.7±3.59	79.1±2.37
2	Sitting	52.7±0.72	90.1±4.29
3	Crawling and kneeling	37.4±3.24	47.5±5.3
4	Standing	47.5±6.68	79.4±1.99
5	Walking	42.3±2.5	71.98±2.07
6	Total Gross Motor Function Score	47.4±5.38	73.6±2.45

After two years of treatment, comparing the two age groups revealed statistically significant differences across all six qualitative characteristics ($U<U$ critical, $P<0.05$), with the 9-10-year-old age group demonstrating better outcomes. This indicates that patients in the 9-10 age group responded more effectively to treatment than those in the 11-12 age group (Tab.3 and Tab.4).

DISCUSSION

The statistical analysis demonstrated that age plays a significant role in rehabilitation outcomes for children with hemiplegia. While all age groups showed improvement, younger children, particularly those aged 5-6 years, exhibited the highest percentage increase in GMFM scores. This trend was consistent, with decreasing improvement observed as the age group increased: 5–6 years showed the best improvement, followed by 7-8, 9-10, and finally 11-12 years.

These results support the importance of early intervention and intensive, individualized rehabilitation programs guided by interdisciplinary collaboration. Each child's treatment plan was shaped by age, disease severity, and the most prominent functional deficits, ensuring a targeted approach maximizing recovery potential.

In hemiparetic paralysis, motor and sensory impairments occur, including loss of tactile sensation. Correctly identifying the sensory deficit is essential, as it limits limb usage. A multidisciplinary team conducts treatment. It is necessary to determine which muscles are involved in spasticity. Additionally, attention must be given to standing posture.^{5,6}

Patients often exhibit foot deformities caused by muscle tone abnormalities. They may have knee flexion, which hinders extension of the hip joint. Distally, muscle weakness is observed, with activation of the hip and foot flexor muscles.

Deformities are frequently seen in the upper limb's shoulder, elbow, and wrist joints in children with hemiparesis. Physical therapy programs to improve motor function strengthen the muscular system, increase endurance, and improve joint range of motion. Exercises reduce contractures and improve muscle strength through resistance exercises involving all major muscle groups. Low-resistance exercises, when performed frequently, enhance muscle endurance.^{7,8}

CONCLUSIONS

Based on the research, pediatric hemiplegia treatment should not be based only on the severity of the condition and the patient's age. It must also be individualized, determined through a collaborative assessment by various specialists. This assessment should consider the most pronounced problems specific to the patient's condition.

Among children with hemiplegia, the most significant improvement in gross motor function scores (measured as percentage increase) was observed in the 5-6 age group, followed in sequence by the 7-8, 9-10, and 11-12 age groups. It was determined that the earlier the two-year treatment program (consisting of 384 procedures) is initiated, the greater the improvement in gross motor function outcomes, meaning

that treatment outcomes are significantly better when rehabilitation starts at a younger age.

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