

COMPLEX ASSESSMENT AND MULTIDISCIPLINARY INTERVENTION IN CHILDREN AFTER PEDIATRIC STROKE USING MYRO: SYSTEMATIC CASE STUDY

Edita Satinská¹, & Marcela Dabrowská²

¹Department of Special Needs, Faculty of Education, University of Ostrava (Czechia)

²Department of Rehabilitation and Sports Medicine, Faculty of Medicine, University of Ostrava (Czechia)

Abstract

Background: Pediatric stroke is a rare but serious neurological condition associated with persistent motor, cognitive, and functional deficits in up to 40–70% of affected children. Technology-assisted multidisciplinary rehabilitation may improve functional outcomes; however, evidence remains limited. **Objective:** To evaluate functional changes in upper-limb motor function, manual dexterity, grip strength, graphomotor performance, and self-care abilities following a structured MYRO®-based intervention in two children with hemiparesis after pediatric stroke. **Methods:** A systematic longitudinal case-study design was applied. Two children (7 and 11 years) with confirmed pediatric ischemic stroke completed a 10-session individualized MYRO®-assisted intervention delivered over 10 weeks within a multidisciplinary rehabilitation framework. Standardized pre- and post-intervention assessments included Box and Blocks Test (BBT), Nine-Hole Peg Test (NHPT), JAMAR dynamometry, graphomotor assessment (DiaGraMo/MaTeRs), self-care evaluation (Čadová scale), and MYRO® digital metrics. Clinically meaningful change was evaluated using minimal detectable change (MDC95) and Reliable Change Index (RCI) where applicable. **Results:** Both participants demonstrated clinically meaningful improvements in manual dexterity, grip strength, graphomotor coordination, and self-care independence. Improvements exceeded MDC thresholds in key motor outcomes, and affected-limb functional use increased in both cases. **Conclusion:** Integration of interactive MYRO®-based therapy within multidisciplinary pediatric neurorehabilitation may contribute to clinically relevant improvements in motor and functional outcomes. Systematic longitudinal case monitoring represents a methodologically appropriate approach in low-incidence pediatric conditions.

Keywords: Pediatric stroke, case study, MYRO, graphomotor skills, self-care, motor recovery.

1. Introduction

Pediatric stroke represents a rare but clinically significant neurological condition associated with long-term motor, cognitive, and participation limitations. Reported annual incidence rates are approximately 1–2 per 100,000 children for ischemic stroke and 1–1.7 per 100,000 for hemorrhagic stroke, while perinatal stroke occurs more frequently (Lehman et al., 2018; Paulasová Schwabová & Paulas, 2022; Gao et al., 2023). Despite the relatively low prevalence, 40–70% of affected children develop persistent neurological deficits, particularly unilateral motor impairment affecting activities of daily living (ADL) and school participation (Rivella et al., 2022; Champigny et al., 2024; Singh et al., 2024).

The low incidence of pediatric stroke substantially limits the feasibility of large randomized trials and frequently results in small heterogeneous research samples. Consequently, systematic longitudinal case-study designs represent a methodologically appropriate approach for investigating recovery trajectories and evaluating intervention effects at the intra-individual level (Cooper et al., 2019; Mota et al., 2022). Repeated standardized measurements allow detection of clinically meaningful change using indicators such as minimal detectable change (MDC) and Reliable Change Index (RCI), providing clinically interpretable evidence in exploratory intervention research involving rare pediatric conditions.

Current rehabilitation recommendations emphasize multidisciplinary approaches integrating task-oriented practice and technology-assisted therapy targeting both motor capacity and functional performance (Hart et al., 2022; Mrakotsky et al., 2022). Interactive rehabilitation systems such as MYRO® enable task-specific practice with real-time feedback and objective performance monitoring; however, systematic evidence regarding their use in pediatric stroke rehabilitation remains limited.

Therefore, this study aimed to examine functional changes following a structured MYRO®-based multidisciplinary intervention.

2. Methods

2.1. Study design

This study employed a systematic longitudinal case-study design with identical pre- and post-intervention assessments. Given the rarity of pediatric stroke and the heterogeneity of recovery trajectories, systematic case-study approaches represent an appropriate methodology for monitoring individualized functional change over time in pediatric neurorehabilitation research (Hollist et al., 2021; Malone et al., 2022). Repeated standardized measurements further enabled interpretation of clinically meaningful functional change using indicators such as minimal detectable change (MDC95) and Reliable Change Index (RCI) (Jacobson & Truax, 1991).

2.2. Participants

Two children (female, 7 years; male, 11 years) diagnosed with pediatric ischemic stroke and unilateral hemiparesis were recruited using purposive sampling.

Participants met the following inclusion criteria: confirmed pediatric stroke diagnosis, age between 6 and 15 years, and ability to participate in structured therapeutic activities requiring interaction with rehabilitation tasks.

Exclusion criteria included other neurological diagnoses, neuromuscular disorders, epilepsy, moderate-to-severe intellectual disability limiting task interaction, and severe receptive aphasia interfering with comprehension of instructions.

2.3. Ethical considerations

Written informed consent for participation and publication of anonymized data was obtained from the legal guardians of both participants. All procedures were conducted in accordance with institutional ethical standards and the principles of the Declaration of Helsinki (Hollist et al., 2021).

2.4. Intervention

Participants completed ten individualized MYRO®-based therapy sessions lasting 30 minutes each over approximately ten weeks. Therapy was delivered by an occupational or physiotherapist in collaboration with a special educator within a multidisciplinary rehabilitation framework. Multidisciplinary and task-oriented rehabilitation approaches supported by interactive technologies are increasingly recommended as part of contemporary pediatric stroke rehabilitation strategies (Hart et al., 2022; Mrakotsky et al., 2022; Malone et al., 2022).

The intervention targeted upper-limb coordination and strength, visuomotor integration, bilateral motor use, and cognitive-motor functions including attention and motor planning.

2.5. Outcome measures

Motor and functional outcomes were assessed using standardized instruments:

- Box and Blocks Test (manual dexterity)
- Nine-Hole Peg Test (fine motor coordination)
- JAMAR dynamometer (grip strength)
- DiaGraMo / MaTeRs (graphomotor performance)
- Self-Care Assessment Scale¹ (Čadová et al.)
- MYRO® digital performance indicators

Clinically meaningful change was evaluated using MDC95 and Reliable Change Index (RCI) where available.

3. Results

Both participants demonstrated improvement across motor, functional, and participation-level indicators. Gains were consistent with clinically meaningful intra-individual change and reflected increased functional use of the affected limb.

¹Czech assessment scale developed and focused on school environment, can be administered by special needs teacher

Table 1. Pre-post outcomes by case.

Outcome	Case	Pre-test	Post-test	MDC95	RCI	Interpretation
Box and Blocks Test (affected limb)	Case 1	0 blocks	measurable functional performance	1.9–1.7	$\approx +6$	Restoration of functional use
	Case 2	13.3 blocks	improved beyond MDC	1.9–1.7	$\approx +13.1$	Clinically meaningful dexterity gain
Nine-Hole Peg Test	Case 1	25.32 s	23.1 s	2.16	–2.02	Reliable fine-motor improvement
	Case 2	not executable	executable post-test	—	—	Recovery of task ability
Grip strength (JAMAR)	Case 1	3.1 kg / 0 kg	7.3 kg / 0.8 kg	n/a	n/a	Clinically meaningful strength gain
	Case 2	17.4 kg / 3.8 kg	increased values	n/a	n/a	Functional improvement
Graphomotor performance	Case 1	unstable performance	improved coordination and bilateral use	n/a	n/a	Improved graphomotor control
	Case 2	reduced stability	improved stability and spatial control	n/a	n/a	Functional graphomotor gain
Self-care independence	Case 1	dependence level 3–4	level 1–2	n/a	n/a	Increased independence
	Case 2	assistance required	reduced assistance	n/a	n/a	Improved ADL performance

4. Discussion

The present systematic case study demonstrated clinically meaningful improvements in motor performance, functional independence, and graphomotor abilities following a short MYRO®-based multidisciplinary intervention.

Importantly, improvements were not limited to motor capacity but extended to daily functional performance, particularly self-care activities, suggesting transfer of therapy effects to real-life contexts. This aligns with contemporary neurorehabilitation models emphasizing task-oriented functional training.

Given the rarity of pediatric stroke and resulting methodological challenges in conducting large trials, longitudinal systematic case-study designs provide valuable clinically interpretable evidence and enable detailed monitoring of individualized recovery trajectories.

Limitations include small sample size and absence of long-term follow-up; nevertheless, systematic repeated measurement and multimodal assessment strengthen the internal validity of findings.

5. Conclusion

A short MYRO®-based multidisciplinary intervention produced clinically meaningful improvements in motor function, graphomotor performance, and independence in daily activities in two pediatric stroke cases. Technology-supported functional training combined with standardized monitoring may represent a promising approach for individualized pediatric neurorehabilitation.

References

- Champigny, C. M., Feldman, S. J., Beribisky, N., Desrocher, M., Isaacs, T., Krishnan, P., Monette, G., Dlamini, N., Dirks, P., & Westmacott, R. (2024). Predictors of neurocognitive outcome in pediatric ischemic and hemorrhagic stroke. *Child Neuropsychology*, 30(3), 444–461. <https://doi.org/10.1080/09297049.2023.2213461>
- Cooper, A. N., Anderson, V., Greenham, M., Hearps, S., Hunt, R. W., Mackay, M. T., Ditchfield, M., Coleman, L., Monagle, P., & Gordon, A. L. (2019). Motor function daily living skills 5 years after paediatric arterial ischaemic stroke: A prospective longitudinal study. *Developmental Medicine & Child Neurology*, 61(2), 161–167. <https://doi.org/10.1111/dmcn.13915>
- Gao, L., Lim, M., Nguyen, D., Bowe, S., MacKay, M. T., Stojanovski, B., & Moodie, M. (2023). The incidence of pediatric ischemic stroke: A systematic review and meta-analysis. *International Journal of Stroke*, 18(7), 765–772. <https://doi.org/10.1177/17474930231155336>
- Hart, E., Humanitzki, E., Schroeder, J., Woodbury, M., CokerBolt, P., & Dodds, C. (2022). Neuromotor rehabilitation interventions after pediatric stroke: A focused review. *Seminars in Pediatric Neurology*, 44, 100994. <https://doi.org/10.1016/j.spen.2022.100994>
- Hollist, M., Au, K., Morgan, L., Shetty, P. A., Rane, R., Hollist, A., Amaniampong, A., & Kirmani, B. F. (2021). Pediatric stroke: Overview and recent updates. *Aging and Disease*, 12(4), 1043–1055. <https://doi.org/10.14336/AD.2021.0219>
- Jacobson, N. S., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology*, 59(1), 12–19. <https://doi.org/10.1037/0022-006X.59.1.12>
- Ledochowski, J., Slim, M., Westmacott, R., Desrocher, M., deVeber, G., Moharir, M., MacGregor, D., & Dlamini, N. (2024). Motor functioning during early recovery after childhood arterial ischemic stroke is associated with intellectual abilities. *Applied Neuropsychology: Child*. Advance online publication. <https://doi.org/10.1080/21622965.2024.2435991>
- Lehman, L. L., Khoury, J. C., Taylor, J. M., et al. (2018). Pediatric stroke rates over 17 years: Report from a population-based study. *Journal of Child Neurology*, 33(7), 463–467.
- Malone, L. A., Levy, T. J., Peterson, R. K., Felling, R. J., & Beslow, L. A. (2022). Neurological and functional outcomes after pediatric stroke. *Seminars in Pediatric Neurology*, 44, 100991. <https://doi.org/10.1016/j.spen.2022.100991>
- Mota, L. A. T., Silva, D. R. B., & Pfeifer, L. I. (2022). Functional outcomes in children related to self-care, mobility, and social function after stroke in early childhood: A cohort study. *Arquivos de Neuro-Psiquiatria*, 80(1), 13–22. <https://doi.org/10.1590/0004-282X-ANP-2021-0019>
- Mrakotsky, C., Williams, T. S., Shapiro, K. A., & Westmacott, R. (2022). Rehabilitation in pediatric stroke: Cognition and behavior. *Seminars in Pediatric Neurology*, 44, 100998. <https://doi.org/10.1016/j.spen.2022.100998>
- Paulasová Schwabová, J., & Paulas, L. (2022). Ischemická cévní mozková příhoda v dětském věku. *Neurologie pro praxi*, 23(4), 306–311.
- Rivella, C., Zanetti, A., Bertamino, M., Severino, M., Primavera, L., Signa, S., Moretti, P., & Viterbori, P. (2022). Executive functions and psychosocial impairment in children following arterial ischemic stroke. *Child Neuropsychology*, 29(2), 276–298. <https://doi.org/10.1080/09297049.2022.2083093>
- Singh, J., Slim, M., Moharir, M., Westmacott, R., Krishnan, P., MacGregor, D., Dlamini, N., Parthasarathy, S., Musaphir, S., Domi, T., & deVeber, G. (2024). Long-term neurologic outcomes in pediatric arterial ischemic stroke: The impact of age and lesion location. *Stroke*, 55(11), 3312–3321. <https://doi.org/10.1161/STROKEAHA.124.046518>