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Neurodevelopmental Treatment for Sitting Balance in Microcephaly: A Case Report

Mira Virdiana Azhahroh[1], Yeni Tri Nurhayati[2], Rizka Asna Rahmawati[3]

[1,3]Diploma Program in Physiotherapy, Faculty of Health Sciences, Universitas Muhammadiyah Lamongan, Lamongan, East Java, Indonesia
[2]Department of Physiotherapy, Faculty of Health Sciences, Universitas Muhammadiyah Lamongan, Lamongan, East Java, Indonesia

Corresponding author:
Name: Yeni Tri Nurhayati
E-mail: yenitrinurhayati@umla.ac.id
Phone: +62 856-0704-7208

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Abstract

Introduction: Microcephaly often leads to delayed gross motor development, including poor head control, low trunk stability, and unintegrated primitive reflexes.

Objective: This case report aimed to describe the effects of Neurodevelopmental Treatment (NDT) on sitting balance and gross motor function in a child with microcephaly.

Methods: A 12-month-old male patient was treated at the Medical Rehabilitation Clinic, Muhammadiyah Hospital Lamongan. NDT sessions were conducted once weekly for four weeks, each lasting 30–45 minutes, focusing on head control, trunk stability, and sitting balance using a gym ball. Techniques included visual stimulation, handling at key points of control, and transitional position training. Outcome measures included the Gross Motor Function Measure (GMFM), head circumference, and Spinal Galant reflex assessment.

Results: GMFM dimension A scores increased from 25.4% to 86%, and dimension B from 30% to 61%. The Spinal Galant reflex, initially positive, became negative after therapy. Head circumference remained unchanged at 41 cm. Clinically, the patient showed improved head-lifting ability, the capacity to sit with minimal assistance, and greater trunk stability.

Conclusion: NDT improved gross motor function in a child with microcephaly, particularly head control, trunk stability, and sitting balance. Active family involvement in home exercises supported therapy success, suggesting that collaborative management between physiotherapists and families should be encouraged for similar cases.

Keywords
Microcephaly; Postural Balance; Motor Skills Disorders; Physical Therapy Modalities; Neurologic Rehabilitation

Introduction

Children are a vital asset to the nation as the next generation; therefore, maintaining the quality of their growth and development is essential. Growth refers to quantitative aspects such as height, weight, and head circumference, while development encompasses improvements in motor, sensory, language, and social abilities.[1] Developmental delay (DD) is a condition in which a child lags behind peers of the same age in one or more developmental domains.2 In Indonesia, the prevalence of DD in children was reported to be 11–16% in 2013 and increased to 13–18% in 2015.3 The 2016 Indonesian Health Profile also noted that 56.4% of children under five years of age experienced growth and developmental disorders.[4]

Developmental delays may be caused by prenatal factors (e.g., maternal malnutrition, poor environmental hygiene during pregnancy), perinatal factors (e.g., prematurity), or postnatal factors such as infections or structural brain abnormalities.[5] One postnatal condition that can impact motor development is microcephaly, defined as a head circumference more than two standard deviations below the mean for a given age and sex.[6] This condition is commonly associated with reduced brain volume, intellectual disability, and motor impairments, including speech disorders. Etiologies may include genetic abnormalities, metabolic disorders, infections, and injuries during the perinatal or postnatal periods. Prognosis varies depending on whether the condition is congenital or postnatal and on the underlying cause.

The patient in this report was a 12-month-old male presenting with difficulty maintaining a sitting position without assistance and weak head control. Examination revealed the persistence of unintegrated primitive reflexes. There was a history of prematurity or perinatal infection, and the patient had never received physiotherapy prior to this evaluation.

Research on the effectiveness of Neurodevelopmental Treatment (NDT) in children with a combination of microcephaly and delayed motor development is limited in Indonesia. NDT is a physiotherapy approach aimed at correcting or preventing abnormal posture and movement patterns, promoting normal posture and movement, and facilitating purposeful movement to support daily activities.[7]

This case is noteworthy as it demonstrates the successful application of NDT over a short intervention period in a child with combined motor developmental delay and microcephaly, a condition rarely documented in Indonesian physiotherapy literature. Therefore, this study aims to describe the implementation of NDT in a child with motor developmental delay due to microcephaly and the outcomes achieved following the intervention.

Methods

This study employed a single-case design conducted at the Medical Rehabilitation Clinic of Muhammadiyah Hospital Lamongan, involving a one-year-old male diagnosed with delayed motor development *et causa* microcephaly. The patient was referred by a pediatrician after presenting with motor developmental delays, including inability to control the head, inability to sit independently, a slouched sitting posture, and upward head tilting. Prenatal history revealed folic acid deficiency during pregnancy, premature birth with low birth weight, atrial septal defect, and microcephaly. Differential diagnosis excluded cerebral palsy due to the

absence of spasticity and other pathological reflexes. NDT was selected for intervention as it focuses on facilitating postural control according to the patient's needs.

The study was conducted in January 2025 over a four-week period, comprising four therapy sessions. During anamnesis with the parents, it was reported that the child was unable to transition independently from supine to sitting, had unstable head control, and demonstrated suboptimal trunk control. The child also tended to sit with a slouched posture and upward head tilt. Functional activities were assessed using the Gross Motor Function Measure (GMFM-88) to evaluate gross motor ability.

According to Yusri, the GMFM is an assessment tool used to measure changes in functional ability in children through standardized gross motor activities.[8] The assessment requires approximately 40–60 minutes. In this case, the child was unable to perform prone head lifting, prone forearm support, or prone head lifting with extended arms (dimension A), and could not maintain a seated position on a mat with both hands supported for 20 seconds (dimension B). Spinal Galant reflex testing remained positive, interfering with the child's ability to maintain focus while sitting. Head circumference measurement was conducted due to the history of microcephaly, using a measuring tape and compared with WHO standards (42 cm, <3rd percentile). The Spinal Galant reflex remained positive, and muscle tone was hypotonic.

Physiotherapy intervention focused on stimulating and facilitating postural control using NDT techniques with a gym ball, including exercises for head control, trunk control, and sitting balance. Training positions included prone, sitting, and side sitting, with specific handling points and key points of control. Each session lasted 30–45 minutes, conducted twice weekly over four weeks (eight total sessions). Interventions were modified according to the child's progress; for example, in the third session, emphasis shifted to positional transitions due to improved head control, while the fourth session focused on maintaining independent sitting for more than 30 seconds. Parents were educated on continuing exercises at home.

The intervention techniques consisted of three main approaches. Technique 1 focused on head control, where stimulation and facilitation of head lifting were provided using toys. The child was placed in a prone position on a gym ball and gently rocked forward and backward until head lifting occurred (Figure 1). Technique 2 targeted trunk control, involving stimulation and facilitation of trunk muscle activation with the aid of toys. In this technique, the child was positioned prone on a gym ball while the therapist activated trunk muscles through guided facilitation (Figure 2). Technique 3 emphasized sitting balance, in which the child was seated on a gym ball while the therapist provided trunk support with hands. Sensory stimulation was used to encourage the child to adjust posture in order to maintain balance (Figure 3).

Figure 1. Neurodevelopmental Treatment with prone head-lifting stimulation (head control).

Figure 2. Neurodevelopmental Treatment with facilitation and stimulation to improve trunk control.

Figure 3. Neurodevelopmental Treatment with facilitation and stimulation for sitting balance.

Evaluation was conducted during each session using GMFM scores, head circumference, and primitive reflex integration. Data were analyzed descriptively by comparing pre- and post-intervention results to monitor motor progress. This procedure enabled systematic tracking of patient improvement and allowed replication in similar cases

The intervention program was carried out over four consecutive weeks, with each therapy session focusing on the gradual development of motor functions, including head control, trunk stability, sitting balance, and positional transitions. The observed changes were systematically recorded throughout the intervention period. These details are presented in Table 1.

Table 1. Intervention Timeline and Observed Changes

Week / Session	Main Activities	Observed Changes
Week 1 / Session 1	Initial assessment, head control exercises on gym ball	Head control began to improve
Week 2 / Session 2	Trunk control and sitting balance exercises	Sitting posture became more stable
Week 3 / Session 3	Facilitation of positional transitions	Increased duration of independent sitting
Week 4 / Session 4	Movement integration training	GMFM scores increased significantly

Results

This study was conducted in January 2025 on a 12-month-old male patient diagnosed with delayed motor development *et causa* microcephaly. The patient underwent intervention using the Neurodevelopmental Treatment (NDT) method for four weeks, with one session per week. The intervention consisted of various stimulation and facilitation techniques aimed at improving head control, trunk control, and sitting balance. The functional evaluation of the patient was conducted using the Gross Motor Function Measure (GMFM), which provided a structured assessment of motor abilities across various domains. This evaluation enabled objective monitoring of progress over the course of therapy. The detailed results are presented in Table 1.

Table 1. Functional evaluation results (GMFM)

Dimension	T1 (%)	T2 (%)	T3 (%)	T4 (%)
Dimension A (lying & rolling)	25.4	37.2	47	86
Dimension B (sitting)	30	36.6	48	61

Based on Table 1, there was an improvement in prone positioning with forward gaze, head lifting with extended arms (Dimension A), and sitting on the mat with both arms propped for 20 seconds (Dimension B), as measured by GMFM. Head circumference was measured to assess cranial growth as an important parameter in developmental monitoring, particularly in children with delayed motor development associated with microcephaly. The measurement outcomes, which reflect cranial size and growth trajectory, are shown in Table 2.

Table 2. Head circumference evaluation results

Measurement Point	T1	T2	T3	T4
Head circumference	41 cm	41 cm	41 cm	41 cm

Table 2 shows that the head circumference remained unchanged at 41 cm from T1 to T4. An assessment of primitive reflexes was performed to evaluate the persistence or integration of reflex responses, which serve as indicators of central nervous system maturity. The findings of this evaluation, which are critical for understanding the patient's neurodevelopmental status, are summarized in Table 3.

Table 3. Primitive reflex evaluation results

Primitive Reflex	T1	T2	T3	T4
Spinal Galant reflex	+	+	+/-	-

As shown in Table 3, the Spinal Galant reflex, which was present at T1, gradually diminished and disappeared entirely by T4. The therapeutic interventions employed in this case focused on stimulation and facilitation techniques specifically designed to improve head control, trunk control, and sitting balance. A comprehensive overview of these approaches, including their clinical application, is provided in Table 4.

Table 4. Summary of stimulation and facilitation techniques targeting head control, trunk control, and sitting balance

Parameter	T1	T2	T3	T4
Head Control	Unable	Lifts for ~5 sec	Lifts 30° and holds for 12 sec	Lifts and maintains in various directions on gymball
Trunk Control	Requires full support	Sits upright with minimal support for 30 sec	Contracts trunk and maintains for 10 sec	Actively lifts head and chest, minimal support, maintains for 30 sec
Sitting Balance	Unstable	Sits stably with minimal support for 30 sec	Sits stably even when moved, moderate support	Sits stably with hand resistance, minimal support

The overall outcomes of the four-session intervention program are synthesized to highlight the patient's progress across motor control, balance, and functional independence. These results demonstrate the effectiveness of the therapeutic strategies implemented. A concise overview of these findings can be found in Table 5.

Table 5. Summary of intervention results

Parameter	Outcome	Description
Head Control	Improved	Patient progressed from being unable to lift head (T1) to actively lifting and maintaining head position while prone on gymball (T4).
Trunk Control	Improved	Patient progressed from requiring full assistance (T1) to minimal assistance (T4) while sitting.
Sitting Balance	Improved	Patient progressed from unstable sitting despite support (T1) to stable sitting with resistance (T4).
Gross Motor Function	Improved	GMFM Dimension A increased from 25.4% to 86%, and Dimension B increased from 30% to 61%.
Head Circumference	Unchanged	Remained at 41 cm from T1 to T4.

Discussion

Based on Table 4, the application of the Neuro Development Treatment (NDT) method through stimulation and facilitation techniques demonstrated significant improvements in the patient's head control, trunk control, and sitting balance. Initially, the patient was unable to lift the head, required full assistance for trunk control, and exhibited unstable sitting posture. After four intervention sessions over four weeks, the patient was able to actively lift and maintain the head, control the trunk with minimal assistance, and sustain a seated position with hand support. These improvements were influenced not only by the physiotherapist's intervention but also by the active involvement of the parents, who received education during therapy sessions and continued stimulation at home.

These results are consistent with findings by Kumar et al., who reported that NDT effectively enhances head control in children with motor disorders through prone positioning, which activates the extensor muscles of the neck and upper trunk while stimulating the sensorimotor system.[9] Furthermore, Park et al. highlighted the effectiveness of NDT in improving trunk control and postural stability, particularly when exercises are performed consistently and parents are engaged as co-therapists.[10] The improvement in the patient's sitting balance is also in line with the work of Labaf and Sreejisha et al., which demonstrated that trunk-focused NDT protocols effectively enhance sitting posture and functional capacity in children with developmental disorders.[11,12]

The clinical significance of these findings suggests that even in cases of permanent neurological conditions such as microcephaly, improvements in gross motor function can be achieved through structured interventions combined with active family participation. The absence of change in head circumference throughout the intervention is consistent with the non-progressive structural nature of microcephaly; however, this did not preclude motor function improvement in the patient.

Limitations of this case include the single-subject design, relatively low therapy frequency (once per week), short intervention duration (four weeks), absence of a control group, and GMFM assessment limited to dimensions A and B. Long-term follow-up was also not performed to evaluate the sustainability of the outcomes. Nevertheless, the active engagement of parents and home exercise implementation may have facilitated the transfer of motor skills into daily activities.

This case emphasizes that NDT, when combined with active parental involvement, can result in substantial improvements in postural control and gross motor function, even in children with developmental delays accompanied by permanent neurological conditions. These findings support the use of NDT-based physiotherapy for patients with microcephaly and underscore the need for more robust study designs to confirm these outcomes.

Conclusion

The patient, An. A, aged 12 months, diagnosed with delayed motor development secondary to microcephaly, underwent Neuro Development Treatment (NDT) intervention using stimulation and facilitation techniques for four therapy sessions. Post-intervention evaluation demonstrated notable improvements in head control, trunk control, and sitting balance. Enhancement in gross motor function was confirmed by higher Gross Motor Function Measure (GMFM) scores at the end of therapy. Clinically, the patient was able to perform prone head lifting, activate trunk muscles in the prone position, and maintain a sitting position with greater stability. The Galant reflex was absent in the final assessment. The therapeutic success was supported by the active involvement of the family in performing home exercises, which contributed positively to the child's motor development.

Author Contribution

Mira Virdiana Azhahroh contributed to the conceptualization of the study, data collection, intervention implementation, and manuscript drafting.
Yeni Tri Nurhayati contributed to study supervision, methodological design, data analysis, and critical revision of the manuscript.
Rizka Asna Rahmawati contributed to data interpretation, literature review, and manuscript editing.
All authors read and approved the final manuscript.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest associated with this study.

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Ethics Statement

Ethical approval was obtained from the relevant institutional authority. Written informed consent was obtained from the patient's parents prior to participation, with assurance of confidentiality and anonymity.

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