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Authors' Affiliation:
[1]Consultant, Department of Rehabilitation, National Cancer Institute, Nagpur, Maharashtra, India
[2]Head of Department, Department of Rehabilitation, National Cancer Institute, Nagpur, Maharashtra, India
[3]Physiotherapist, Department of Rehabilitation, National Cancer Institute, Nagpur, Maharashtra, India
[4]Medical Director, Department of Medical Oncology, National Cancer Institute, Nagpur, Maharashtra, India
[5]Head of Department, Pediatric Oncology, National Cancer Institute, Nagpur, Maharashtra, India

***Corresponding author:**
Manjusha Hinge,
Consultant, Department of Rehabilitation, National Cancer Institute, Nagpur, Maharashtra, India.
Email.id: hinge.manjusha@gmail.com

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Rehabilitation Treatment Approach Towards Medulloblastoma (Posterior Fossa Syndrome): A Case Report

Manjusha Hinge[1*], Pradnya Pathak[2], Revati Hadap[3], Anand Pathak[4], Pankaj Dwivedi[5]

ABSTRACT

Posterior fossa syndrome (PFS) is a neurological complication that may occur following surgical resection of posterior fossa tumors, particularly medulloblastoma. It is characterized by reduced or absent speech, hypotonia, emotional lability, and impaired motor coordination. An 8-year-old male patient who developed PFS after decompression surgery for medulloblastoma. The patient complains of right upper and lower limb weakness, neck, stiffness, difficulty in moving neck and head tilted to one side, weakness in facial muscles, impaired speech, unable to sit-stand and walk, unable to perform activities of daily living (ADL). A rehabilitation program helps in improving muscle strength, balance, prehension and functional mobility. This study found that by incorporating structured rehabilitation program patient showed significant improvement in motor function, speech, and overall wellbeing during the rehabilitation period.

Keywords: Posterior Fossa Syndrome, medulloblastoma, pediatric, rehabilitation, motor function, speech therapy.

1. INTRODUCTION

Medulloblastoma is one of the frequent widespread and prevalent malignant brain tumors of childhood making up for 20% for all primary central nervous system tumor diagnose in patients less than 19 years of age. It is a primitive neuro ectodermal tumor (PNET) consisting of small, round, blue cells arising in the posterior fossa.

The incidence peaks between 5 and 9 years of age, but patients of all ages can be affected. Most patients present with symptoms of hydrocephalus due to tumor obstruction at the level of the fourth ventricle or cerebral aqueduct, and ataxia (Martin et al., 2014). Most common deficits include decreased speech or mutism, dysphagia, hypotonia, ataxia, mood changes and neurological deficits. Most commonly seen in children after posterior fossa tumor surgery. Standard of care treatment remains maximal up-front surgical resection followed by radiation and chemotherapy. The intensity of adjuvant therapy depends on the presence of risk

factors at diagnosis. Standard risk patients are those who are older than three years and without metastatic disease or evidence of anaplasia (Martin et al., 2014).

In recent decades, as survival rates have increased for brain tumor, rehabilitation approaches have played an important role in improving functional and cognitive impairments and QOL. Rehabilitation therapy is based on the principles of neural plasticity of the brain. It is a treatment approach that utilizes both cognitive and motor exercises to enhance functioning (Chieffo et al., 2022).

2. CASE PRESENTATION

An 8-year-old boy diagnosed case of medulloblastoma posterior fossa syndrome (PFS) and had undergone decompression surgery on 14/11/2022 at a private hospital. After surgery weakness was identified on Right-side upper limb and lower limb. Additionally, a ventriculo-peritoneal (VP) Shunt was implanted in the patient.

Clinical Assessment

The patient presented to the Rehabilitation Department of the National Cancer Institute (NCI) with weakness of the right upper and lower limbs, torticollis, and right-sided facial palsy (Figure 1). A comprehensive rehabilitation assessment was performed, including evaluation of communication and behavior, cranial nerve function, range of motion, muscle tone and reflexes, coordination, functional mobility, activities of daily living (ADLs), and motor development.



Figure 1. Pre Rehabilitation

Communication and Behavior

The patient was partially oriented to time, place and person and was able to follow the command. Ability to communicate by gestures and speech was slurred.

Visual and Facial Examination

Facial drooping was present with nystagmus (Right-sided facial palsy).

Range of Motion and Muscle Strength

Upper and lower limb Range of Motion: Full ROM

Neurological Examination

Muscle tone was found to be near normal. Deep tendon reflexes (DTRs) were graded as Grade 1 (trace response) in all tested reflexes. Coordination and motor control were impaired. The patient demonstrated difficulty maintaining visual focus on a specific object, along with reduced eye-hand coordination. Coordinated voluntary movements were also affected.

Functional Mobility and Activities of Daily Living
ADL: Affected (dependent)
Balance: impaired
Motor development: impaired

Seventh Cranial Nerve Assessment: Unable to close eyes and raise eyebrows
The outcome measures are presented in table 1.

Table 1. Outcomes measures

Sr. No	Outcome Measures	Pre-score (initial assessment)	Post-score (after rehabilitation)
1)	Barthel index	15/100 (indicating a high level of dependence in ADL)	80/100 (indicating improvement in functional independence)
2)	Pediatric Balance Scale	0/56 (improve functional balance)	45/56

3. INTERVENTIONS

Rehabilitation was started with active assisted exercises of UL and LL exercises. Neck exercises (active-assisted, passive stretches of sternocleidomastoid) to correct torticollis, soft sponge neck collar was prescribed along with neck stretching exercises to correct torticollis, cervical stretching for torticollis, and a soft sponge neck collar was prescribed along with neck stretching exercises to correct torticollis (Chieffo et al., 2022). Facial exercises were incorporated along with PNF and galvanic stimulation (Kisner et al., 2017). Lingual exercises and speech therapy was also provided (Fountain and Burke, 2017).

Task-oriented activities were used to improve grip, prehension, coordination, and upper-limb function (Schell et al., 2019) (Figure 2). With clinical improvement, exercises progressed from active-assisted to active and resisted activities (Kisner et al., 2017). Ball and toy-transfer activities were incorporated to facilitate upper-limb function (Schell et al., 2019). Speech activities included word repetition, colour naming, and nursery rhymes (Fountain and Burke, 2017).



Figure 2. During Rehabilitation

Gait training was continued throughout the rehabilitation period The home programme comprised standing lower-limb exercises, balance activities, ball kicking, tricycle riding, play, and self-feeding (Chieffo et al., 2022). Small-object manipulation was included to facilitate prehension (Schell et al., 2019). The detailed exercise dosage and progression are presented in Table 2.

The patient received concomitant chemoradiotherapy (Martin et al., 2014). Facial muscle stimulation was provided before radiotherapy (Fountain and Burke, 2017). Rehabilitation frequency was gradually reduced according to clinical progress Improvement was observed in gait, speech, torticollis, facial deviation, coordination, and muscle strength (Chieffo et al., 2022) (Figure 3 & 4). Preschool training was added for writing difficulties (Schell et al., 2019). Monthly follow-up was continued.



Figure 3. Post Rehabilitation



Figure 4. Post Rehabilitation

Table 2. Structured Rehabilitation Programme

Phase/Week	Intervention	Exercise/Activity	Sets × Repetitions / Duration	Frequency	Progression/Monitoring
Week 0	Baseline assessment	Pediatric Balance Scale, muscle strength, coordination, functional mobility and other study-specific assessments	-	-	Baseline functional status documented
Weeks 1–2	Warm-up and mobility	Active range-of-motion exercises for upper and lower limbs; trunk mobility	1–2 × 10 repetitions	3–5 days/week	Exercises performed within pain-free range

	Strengthening	Sit-to-stand, mini-squats, heel raises, bridging	2 × 8–10 repetitions	3 days/week	Begin with body weight and supervised performance
	Balance training	Static standing, feet together, semi-tandem and tandem standing	3 × 20–30 seconds	3–5 days/week	Progress from wide base to reduced base of support
	Coordination	Finger-to-nose, heel-to-shin, alternate foot tapping, target-reaching activities	2 × 8–10 repetitions	3–5 days/week	Increase accuracy and movement speed gradually
	Gait training	Straight-line walking, changes in direction and stepping over low obstacles	3 × 5 minutes	3–5 days/week	Progress distance and complexity according to tolerance
Weeks 3–4	Strengthening	Sit-to-stand, squats, step-ups, bridging and resisted limb exercises	2–3 × 10–12 repetitions	3 days/week	Increase repetitions/resistance gradually
	Dynamic balance	Weight shifting, reaching outside base of support, tandem walking and stepping activities	3 × 30–45 seconds or 8–10 repetitions	3–5 days/week	Reduce hand support and increase task complexity
	Coordination	Ball activities, reciprocal movements, target-reaching and alternating limb activities	2–3 × 10 repetitions	3–5 days/week	Increase speed, accuracy and task complexity
	Gait and functional training	Obstacle walking, stair practice, turning and variable-speed walking	3 × 5–10 minutes	3–5 days/week	Progress according to balance and safety
Weeks 5–6	Progressive strengthening	Squats, step-ups, heel raises, bridging and resistance-band exercises	3 × 10–15 repetitions	3 days/week	Increase resistance while maintaining correct technique
	Advanced balance	Single-leg stance as appropriate, tandem walking, multidirectional weight shifting and unstable-surface activities	3 × 30–60 seconds	3–5 days/week	Progress by reducing external support and increasing task difficulty
	Advanced coordination	Ball throwing/catching, alternating stepping, reciprocal upper- and lower-limb activities	3 × 10–15 repetitions	3–5 days/week	Increase speed and cognitive-motor challenge
	Functional training	Sit-to-stand, stair climbing, transfers and community-style mobility tasks	2–3 × 8–12 repetitions	3–5 days/week	Progress toward independent functional performance
Week 7	Integrated rehabilitation	Combined strengthening, balance, coordination, gait and functional activities	30–45 min/session	3–5 days/week	Individualized progression according to functional improvement
Week 8	Post-intervention assessment	Repeat all baseline outcome measures	1 assessment	Once	Compare with baseline findings

3-month follow-up	Follow-up assessment	Repeat functional, balance, coordination and strength assessments	-	-	Assess retention of rehabilitation gains
6-month follow-up	Long-term follow-up	Repeat study-specific outcome measures	-	-	-

4. DISCUSSION

The study focused on finding out the effect of rehabilitation intervention in a patient with posterior fossa syndrome following medulloblastoma. The present study included posterior fossa tumours, which constitute a major classification among brain tumour types (Chieffo et al., 2022). Packer et al. stated that medulloblastoma is the most common malignant brain tumour in pediatric patients and is a significant cause of cancer morbidity in children (Packer et al., 1999).

Participation in the rehabilitation programme for children with posterior fossa tumours was associated with improved postural stability and coordination, and indirectly with better overall physical performance in daily living activities. The study "Impact of physical activity on postural stability and coordination in children with posterior fossa tumour: randomized controlled phase III trial" by Mahmoud Usama et al. supports the value of adding postural stability and coordination training to the physiotherapy plan for children with posterior fossa tumours (Mahmoud et al., 2023). Mix et al., (2017) found that completed rehabilitation programmes increase mobility function in patients with brain tumours at a rate equivalent to motor function rehabilitation treatment in those with benign neurological disorders. Participation in rehabilitation is also linked to improved performance in day-to-day personal activities in patients with brain tumours.

Posterior fossa surgery is associated with greater morbidity and mortality and a wider range of complications than supratentorial surgery. Multiple reviews have shown that the extent of surgical resection is an important determinant of survival in children with posterior fossa tumours. Children with ependymoma, medulloblastoma, and pilocytic astrocytoma may experience neurologic and regional complications after posterior fossa surgery. Complications include cranial nerve VI and VII palsies, sometimes referred to as "Floor of the Fourth" syndrome. Transient or permanent cranial nerve palsies can occur after fourth ventricular surgery. These deficits are usually evident immediately in the recovery period. Cranial nerve VI and VII palsies are among the commonly reported deficits and may result from disruption of nerve fibres coursing beneath the fourth ventricular floor along the facial colliculus (Boop & Chuang, 2019).

In this study, the patient presented with facial nerve palsy, torticollis, and weakness of the right upper and lower limbs. Treatment included nerve stimulation, facial exercises, neck-stretching exercises, PNF, and a soft neck collar. The treatment progressed from active-assistive exercises to strengthening exercises (Kisner et al., 2017).

An important aspect of cerebellar function is its impact on cognition and emotion in children with cerebellar disorders (Levisohn et al., 2000). Levisohn et al., (2000) documented that cerebellar cognitive affective syndrome occurs in children as well. He also found characteristic behavioral deficits in 19 children aged 3 to 14 years who had undergone resection of cerebellar tumours. These included difficulties with initiation of language, impaired verbal fluency and word-finding difficulties, decreased story retrieval, deficits in sequencing, planning and maintaining set, and visuospatial deficits. The current case study observed that the patient initially had mutism and then slowly progressed to bisyllabic speech and continued to have nystagmus.

Cerebellar disorders commonly associated with ataxia, poor balance, gait instability, and incoordination of movement. In this current study patient was having ataxia in upper and lower limb, in-coordinated movement, unable to perform finger to nose test and gait instability with uneven step-length.

The basic deficit common to motor incapacity is impairment of the rate, rhythm, and force of contraction. In the early stages of cerebellar degenerative disorders, balance is poor, and there is an inability to stand on one leg or perform tandem gait. Dysmetria of the extremities is evident in dysdiadochokinesis, which is the impairment of alternating movements (Schmahmann, 2004). Nystagmus is a hallmark feature and may be present with horizontal and, less often, vertical gaze. Speech may be characterized by scanning dysarthria, with alterations in rate, rhythm, and force. Slurring of speech, tremor of the voice, and ataxic respiration may also occur (Schmahmann, 2004).

The current study found improvement in static and dynamic balance following balance-training exercises in sitting and standing, progressing from static to dynamic activities with alteration of the base of support. Balance exercises are useful for developing both static and dynamic balance and for enhancing motor skills, kinesthetic awareness, proprioception, and core muscle function in children.

Such activities may also contribute to psychological well-being in children with cancer (Zakaria et al., 2021). The effect of exercises on postural stability and co-ordination in children with PFS discovered that incorporating postural stability and co-ordination training to the rehabilitation program improves balance and co-ordination

The current study also found that post-treatment coordination was improved, as the patient was able to perform the finger-to-nose and heel-to-shin tests. Coordination exercises can assist in the development of muscle function, increase flexibility and agility, and improve functional performance (Brown, 2019). Somatosensory, visual, and vestibular information, together with a coordinated neuromuscular system extending from the motor brain to the spinal cord, are necessary for a coordinated response. The muscles' speed, distance, direction, timing, and precision are features of coordinated action (Schmahmann, 2004). Based on the results of the current study, postural stability and coordination improved physical activity in the child with a posterior fossa tumour (Mahmoud et al., 2023).

Therefore, early rehabilitation interventions may be beneficial for post-surgery medulloblastoma patients receiving chemotherapy and radiotherapy cycles. The rehabilitation interventions showed improvement in functional capacity, as reflected in the Barthel Index score, with gains in balance and coordination, muscle strength, and ataxia (Mahoney & Barthel, 1965).

5. CONCLUSION

The present study indicates that early rehabilitation interventions are effective in post-surgery medulloblastoma cancer patients those are receiving chemotherapy and radiotherapy cycles. The Rehabilitation interventions showed significant improvement in functional impairments and independence in ADL's in terms of Barthel Index score, improving balance and coordination and improving muscle strength and ataxia and improvement in gait. The current study also showed improvement in gross and fine motor movements as the writing skills and grasp was improved. Early rehabilitation interventions also improve quality of life of patients with post-surgery medulloblastoma receiving concurrent chemoradiotherapy.

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Authors' Contributions

Manjusha Hinge: Conceptualisation, study design, literature review, data collection, data analysis, interpretation of results, and manuscript preparation.
Pradnya Pathak: Study design, literature review, data collection, data analysis, and manuscript drafting.
Revati Hadap: Clinical assessment, rehabilitation-related data collection, interpretation of clinical findings, and critical revision of the manuscript.
Anand Pathak: Clinical oncology expertise, patient evaluation, interpretation of oncological findings, and critical review of the manuscript.
Pankaj Dwivedi: Pediatric oncology supervision, clinical guidance, interpretation of oncological findings, and critical revision of the manuscript.

Informed consent

Written & Oral informed consent was obtained from participant's parent. The participant's parent consented to the publication of photographs.

Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

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Conflict of interest

The authors declare that they have no conflicts of interest, competing financial interest or personal relationship that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on the reasonable request to the corresponding author.

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