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Original Research Article

Rehabilitation Outcome of Cerebral Palsy Patients Treated with Surgical Intervention

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Abstract

Background: Cerebral palsy children have musculoskeletal deformities, motor skill impairments, and muscle tone abnormalities. Orthotics increase gait biomechanics, functional independence, and repaired anomalies. Even though postoperative rehabilitation optimizes surgical benefits, the combined impact of surgery and rehabilitation on functional outcomes is underreported, especially in low-resource settings. At Nalanda Medical College and Hospital, cerebral palsy patients who underwent rehab surgery were referred for physical therapy.

Methods: Between August 2024 and February 2025, 60 CP children aged 3–18 who had rehab Surgery like tendon lengthening, combination therapy, and soft tissue release were selected for this study. Prior to and three months after surgery, the FMS, step length, cadence, gait speed, and VAS for discomfort were utilized to assess function. All tests employed pair t-tests, and p-values below 0.05 indicated there significance.

Results: After surgery, all functional findings improved dramatically. The average GMFM-88 score increased from 52.6 ± 10.4 to 67.8 ± 9.8 ($p < 0.001$). At a p-value < 0.001, FMS scores increased from 2.1 ± 0.8 to 3.0 ± 0.9 at 5 m and from 1.8 ± 0.7 to 2.7 ± 0.8 at 50 m. The improvements were considerable ($p < 0.001$): gait speed increased from 0.42 ± 0.12 to 0.57 ± 0.14 m/s, step length decreased from 23.4 ± 6.2 to 31.0 ± 5.8 cm, and cadence increased from 76.8 ± 10.5 to 88.6 ± 12.2 steps/min. Patient improvement was modest to significant in 87%. Functional gains were strongly correlated with rehabilitation adherence. The only modest effects were transitory stiffness (5%) and mild wound infection (6.7%).

Conclusion: Orthopaedic surgery and intense rehabilitation improved motor function, gait metrics, and mobility in cerebral palsy children. Early, ongoing rehabilitation improved results. Functional rehabilitation for CP sufferers requires surgery and therapy. Long-term, multicentre trials are recommended to confirm and expand these findings.

Keywords: Rehabilitation, Surgical Outcomes, Cerebral Palsy, Gait, Rehab Surgery.

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Introduction

A fetes or child with non-progressive brain defects can develop cerebral palsy (CP), a permanent mobility, posture, and muscle tone disability [1]. It's one of the biggest causes of childhood physical handicap worldwide, affecting mobility, autonomy, and quality of life. Brain damage persists despite deformities, contractures, and gait abnormalities [2]. Secondary deficits influence daily life; adolescents and children need interdisciplinary therapy. Spasticity, weakness, selective motor control, imbalance, and poor coordination characterize cerebral palsy [3]. These constraints impede social, educational, and ADL activities. For best care, paediatric neurologists, Physiatrist, physical, occupational, speech, and rehabilitation therapists must collaborate [4]. Collaboration promotes functional independence, prevents subsequent issues, and corrects irregularities.

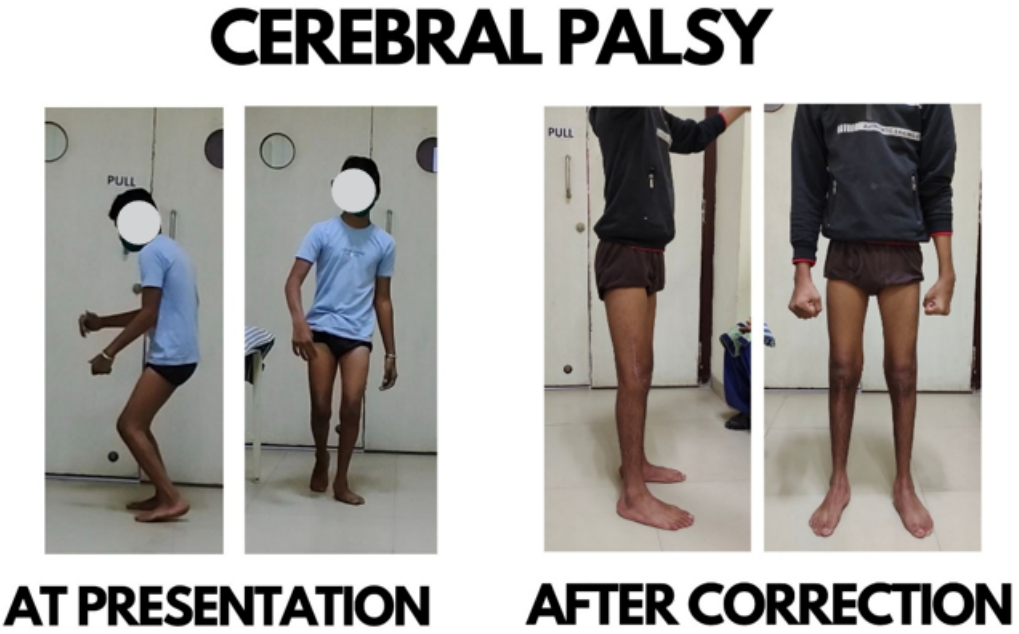

Figure 1: **Cerebral Palsy [5]**

Surgery is required when CP patients fail physical therapy, orthotics, and spasticity medicines [6]. Soft tissue release, tendon lengthening, transfer, selective dorsal rhizotomy, and femoral or tibial osteotomy are surgical procedures [7]. Muscular contractures, joint subluxation, rotational deformities, and fixed postural anomalies are treated. Surgery can repair biomechanical misalignments and spasticity anomalies to improve mobility and function [8].

After surgery, rehabilitation is needed for CP which requires postoperative therapy. To help patients adapt to biomechanical changes and enhance surgery outcomes, individualized, high-intensity rehabilitation programs strengthen muscles, balance, flexibility, gait training, and functional capacity [9]. Gait, neuromuscular coordination, and joint mobility increase with rehabilitation [10,11]. Regular rehabilitation is needed for long-term success because surgery only optimizes functional benefits for a short time.

Real-world efficacy of CP surgery depends on rehabilitation outcomes [12]. Even with standardised surgery, functional progress following surgery depends on age, CP type, deformity severity, treatment kind, and rehabilitation protocol adherence. Postoperative rehabilitation data can reveal clinical efficacy, treatment response, and outcomes predictors [13].

Doctors can also utilize this data to better monitor patients over time, devise tailored rehabilitation programs, and decide when surgery is needed. These outcomes must be identified in resource-limited settings to build structured care pathways because expert rehabilitation treatments may be unevenly available.

This retrospective study evaluated the rehabilitative efficacy of surgical operations for CP patients who reported at Nalanda Medical College and Hospital between 2024 and 2025. Surgery and rehabilitation help cerebral palsy patients. This study evaluate functional improvements, mobility changes, and postoperative recovery to advance that understanding.

Study Objectives

1. To perform standardized mobility and functional tests of cerebral palsy patients who have had rehab surgery to assess functional outcomes.
2. To determine how structured postoperative rehabilitation affected CP patients who had surgery to improve gait, muscle strength, and daily chores.
3. To evaluate if patient and surgical factors, such as CP, deformity severity, and rehabilitation program compliance, affect rehabilitation outcomes.

Materials and Methods

This retrospective study by the Department of Neurosurgery and Physical Medicine at Nalanda Medical College and Hospital examined rehabilitation outcomes in CP patients who underwent rehab surgery. The study ran from August 2024 to February 2025. A total of 60 suitable patients were studied.

Study Design and Setting: A retrospective observational study was used in this hospital study. Hospital records, surgery case files, physiotherapy follow-up notes, and rehabilitation facility papers provided patient data. Comprehensive postoperative and rehabilitative data sets were required for analysis.

Inclusion Criteria

- Patients diagnosed with cerebral palsy who underwent surgical intervention at Nalanda Medical College and Hospital.
- Age between 3 and 18 years.
- Availability of complete preoperative and postoperative functional assessment records.
- Patients who completed at least 3 months of postoperative rehabilitation.

Exclusion Criteria

- Patients with incomplete medical records or missing rehabilitation follow-up data.
- CP patients who underwent neurosurgical procedures such as selective dorsal rhizotomy without orthopedic surgery.
- Patients with associated severe cognitive impairments preventing functional assessment.
- Patients lost to follow-up within 3 months post-surgery.

Data Sources: Data was collected from medical records, surgical notes, physiotherapy logs, and follow-up clinic reports. Demographics, CP subtype, surgery type, rehabilitation period, and pre- and post-operation functional scores were factors.

Types of Surgical Interventions

The study included commonly performed orthopedic procedures in CP, such as

- Soft tissue release
- Tendon lengthening
- Tendon transfer
- Hip reconstruction procedures

These surgeries addressed deformities, spasticity-related contractures, and poor gait biomechanics.

Rehabilitation Protocol

Each patient followed a customized rehabilitation regimen. Major components were,

- Physiotherapy: stretching, strengthening, range-of-motion, and balance.
- Gait Training: parallel bars, assistive gadgets, treadmill gait therapy, and functional walking.
- Occupational Therapy: Improve fine motor, ADL, and upper-limb coordination as needed.

The first 6-8 weeks featured three weekly rehabilitation classes and as-needed guided visits.

Outcome Measures

- Gross Motor Function Measure (GMFM-88) scores
- Functional Mobility Scale (FMS)
- Gait as step length, cadence, and walking speed
- A visual analog scale (VAS) was used to measure pain levels.

Three-month postoperative scores were compared to preoperative scores.

Statistical Analysis: Excel input and SPSS calculation. The descriptive statistics included mean, SD, and frequency counts. Pre- and post-surgery outcomes were compared using paired t-tests. A p-value below 0.05 represented statistical significance.

Results

This retrospective review comprised 60 cerebral palsy patients who underwent orthopedic surgery and rehabilitation.

Demographic Profile of Patients: Patient's ages ranged from 4 to 18, averaging 10.4 ± 3.2 years. We had 38 men (63.3%) and 22 women (36.7%). Most patients were 6-12.

Table 1: **Demographic Characteristics**

Variable	Category	n (%)
Age (years)	3–6 years	12 (20%)
	7–12 years	32 (53.3%)
	13–18 years	16 (26.7%)
Gender	Male	38 (63.3%)
	Female	22 (36.7%)

Types of Cerebral Palsy: Out of sixty patients, 40% had spastic diplegia, 33% hemiplegia, and 27% quadriplegia.

Table 2: **Distribution of CP Subtypes**

CP Type	n (%)
Spastic Hemiplegia	20 (33.3%)
Spastic Diplegia	24 (40%)
Spastic Quadriplegia	16 (26.7%)

Surgical Procedures Performed: Tendon lengthening (30%), and soft tissue release (60%) were the most common operations. Fewer than 10% had two surgeries.

Table 3: **Types of Surgical Interventions**

Procedure	n (%)
Soft Tissue Release	36 (60%)
Tendon Lengthening	18 (30%)
Combined Procedures (Hip reconstruction + soft tissue releases)	6 (10%)

Functional Results Before and After Surgery: Functional findings were assessed using the GMFM-88, FMS, and patient gait. Every measure improved significantly.

Table 4: **Functional Outcomes Comparison**

Outcome Measure	Pre-operative Mean ± SD	Post-operative Mean ± SD	p-value
GMFM-88 Score	52.6 ± 10.4	67.8 ± 9.8	<0.001
FMS (5 m)	2.1 ± 0.8	3.0 ± 0.9	<0.001
FMS (50 m)	1.8 ± 0.7	2.7 ± 0.8	<0.001
Gait Speed (m/s)	0.42 ± 0.12	0.57 ± 0.14	<0.001
Step Length (cm)	23.4 ± 6.2	31.0 ± 5.8	<0.001
Cadence (steps/min)	76.8 ± 10.5	88.6 ± 12.2	<0.001

Patients exhibited improved cadence, stability, and step length during routine mobility activities. Quadriplegia individuals improved small but clinically, while spastic diplegia patients improved the most.

Improvement in Mobility/Gait Scores

Gait speed and FMS improved in 87% of individuals.

- Marked improvement: 34 patients (56.7%)
- Moderate improvement: 18 patients (30%)
- Minimal improvement: 8 patients (13.3%), mostly quadriplegic subtype

Rehabilitation helped children recover functionally, especially those who started therapy within two weeks of surgery.

Rehabilitation Adherence and Duration

Rehabilitation adherence was based on 3-month attendance and continuity.

Table 5: **Rehabilitation Adherence**

Adherence Level	Criteria	n (%)
High	Attended >80% sessions	36 (60%)
Moderate	Attended 50–80% sessions	18 (30%)
Low	Attended <50% sessions	6 (10%)

High-adherence patients had the largest functional improvements, with a mean GMFM gain of 18.2 points versus 8.4 points in low-adherence patients.

Complications or Adverse Events

Postoperative problems were tolerable.

- Mild wound infection: 4 patients (6.7%)
- Transient increase in spasticity: 3 patients (5%)
- Pain requiring extended analgesics: 6 patients (10%)
- No major complications, such as fixation failure or neurovascular injury, were noted.

Problematic youngsters succeeded in rehabilitation, but improvement was delayed.

The overall results show that rehab surgery and organized therapy improve cerebral palsy patients' functional performance and mobility. Positive outcomes were substantially linked to increased rehabilitation adherence.

Discussion

This retrospective study examined the rehabilitation outcomes of 60 CP patients who received rehab surgery at Nalanda Medical College and Hospital between 2024 and 2025. Systematic postoperative therapy improves overall mobility, gait measures, and gross motor function following surgery. These data support the idea that CP youngsters benefit most from teamwork.

GMFM-88, FMS, gait speed, step length, and cadence all improved statistically in Study 1. A mean GMFM improvement of more than 15 points indicates clinically substantial motor capability and mobility. In Study 2, most patients (87%) showed moderate to substantial functional improvement after the therapy corrected musculoskeletal problems.

Patients with spasticity who were already ambulatory and had more surgically treatable musculoskeletal patterns showed the greatest

benefits in Study 3. Spastic quadriplegic patients' problems required slower increments, but they progressed. The results suggest that carefully chosen surgical procedure and sustained therapy may improve functional outcomes for CP patients.

Comparison of Present Study with Existing Studies

Table 6: **Comparison with Existing Studies**

Study	Study Type & Sample Size	Key Findings	Limitations
Study 1 [14]	Prospective study; 25 CP patients	Multilevel soft-tissue release improved GMFM scores by 6–8 points at 6 months; reduced spasticity; younger age showed better gains.	Small sample; short follow-up; no control group; heterogeneous CP severity.
Study 2 [15]	Retrospective; 156 patients (213 limbs)	Significant improvement in knee, hip, and ankle kinematics at 1 year post soft-tissue surgery; better gait alignment.	Only kinematic outcomes; no standardized functional scales; retrospective nature.
Study 3 [16]	Pilot retrospective; 12 hemiplegic CP patients	Achilles tendon lengthening improved mobility, GMFM-D, and walking speed over 12–24 months.	Very small sample; only hemiplegic CP; single procedure; no comparison group.
Present Study (2024–2025)	Retrospective; 60 CP patients	Significant improvement in GMFM (52.6 → 67.8), gait speed, step length, and FMS; 87% showed moderate–marked improvement; rehab adherence strongly linked to outcomes.	Single center; short 3-month follow-up; retrospective design; limited generalizability.

Role of Surgery in Improving Function in CP: The majority of CP-related musculoskeletal issues are treated with rehab surgery. Tendon lengthening, derotation osteotomy, and soft tissue release can correct mobility-impairing contractures, rotational abnormalities, and alignment difficulties. Surgical correction improves biomechanics and function.

Soft tissue therapies are often the first surgical treatment for spasticity-related problems, which explains the high number of patients receiving them. Soft tissue release and combination therapies improved gait, especially for rotational malalignment patients. These interventions likely improved gait speed, step length, and cadence postoperatively. Surgical correction is necessary for structural realignment and patient rehabilitation.

Impact of Structured Rehabilitation on Mobility and Quality of Life: Optimal surgical outcomes require postoperative rehabilitation. Structured rehabilitation including occupational therapy, gait training, and physiotherapy helped patients strengthen and retrain motor patterns, adjust to biomechanical changes, and improve neuromuscular coordination. GMFM scores and gait improved with high therapy adherence.

Rehabilitation increased stability, stamina, and ADL autonomy, enhancing quality of life. Therapy-active kids had improved mobility and more extracurriculars activities. In addition to surgery, the results suggest extensive rehabilitation.

Factors Influencing Rehabilitation Outcome: Several factors impacted the cerebral palsy children's surgery. Due to neuroplasticity and adaptability, younger patients, especially 6-12-year-olds, healed faster throughout therapy. Children with spastic diplegia show better motor impairment than quadriplegics. Recoveries were long after multiple procedures for serious anomalies. Soft tissue releases and tendon lengthening improved gait faster. The surgical approach also affected outcomes. Rehabilitation adherence predicts functional gains, as patients who regularly adhered improved nearly twice as much as those who did not. These findings underscore the importance of preoperative counseling and postoperative therapy.

Strengths of the Study: By assessing real-world tertiary care outcomes, the study accurately reflects clinical practice. Functional outcome measurement is improved by GMFM and FMS. A complete mobility improvement image comes from gait measurements. Physicians can learn from the rehabilitation adherence study.

Limitations

This retrospective study relies on valid and comprehensive medical data. Single-center studies may not apply to other demographics or healthcare settings. A 60-patient sample prevents subgroup analysis and judgments on rarer surgeries or CP subtypes. Three months after surgery, were unable to evaluate long-term results, which are crucial for CP management.

Conclusion

Department of PMR at Nalanda Medical College and Hospital examined sixty cerebral palsy patients who had rehab surgery to determine their recovery. Surgery and intensive postoperative therapy improved mobility, gait, and motor function. The procedure significantly improved gait speed, step length, cadence, and GMFM-88 scores in most patients. Spastic diplegic children with rigorous therapy performed better. Long-term issues, biomechanical repair, and functional enhancement require urgent surgery.

Early and ongoing treatment improves motor control, neuromuscular re-education, and independence. Clinical patient outcomes improve with coordinated rehabilitation, caregiver engagement, and interdisciplinary teamwork.

Rehabilitation and monitoring are needed after surgery. The clinical team should advise families on adherence to improve results. Long-term follow-up to evaluate functional improvements, compare surgical techniques, and predict long-term benefits. More prospective, multicenter research is needed for CP surgical and rehabilitation management and generalizability.

Recommendations

A coordinated and rigorous approach across several levels of care is needed to improve cerebral palsy rehabilitation outcomes. Hospitals should prioritize paediatric rehabilitation facilities, where gait analysis, occupational therapy, and physical therapists can improve patient care using evidence-based techniques. Rehab exams during growth spurts can detect and treat CP concerns before they worsen or become permanent. Treatment pathways that link preoperative examination, surgical planning, and postoperative recovery can reduce patient wait times. Family education programs are essential for long-term compliance, home exercise, and functional goals.

Follow children for a long time is important because functional regression or new problems may occur. Early problem detection and growth maintenance require functional tests, gait evaluations, and follow-ups. Community-based rehabilitation therapies can enhance medical therapy in low-resource communities. Proactive, interdisciplinary, and coordinated care improves cerebral palsy patients' quality of life and function.

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