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Case Series

Clinical reflections on single event multilevel surgery in children with cerebral palsy: a case series of 10 patients

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ABSTRACT

Single event multilevel surgery (SEMLS) is a comprehensive orthopedic surgical approach designed to correct multiple musculoskeletal deformities in a single operative session in patients with cerebral palsy (CP). This journal reflects on the principles, benefits, limitations, and a clinical case outcome of SEMLS, with emphasis on functional improvement and rehabilitation challenges. SEMLS remains a gold standard surgical approach in moderate to severe spastic CP cases with multilevel involvement. Long-term success hinges on meticulous planning, postoperative care, and patient compliance with rehabilitation protocols.

Keywords: Cerebral palsy, SEMLS, Gait abnormality, Orthopedic surgery, Spastic diplegia, Rehabilitation

INTRODUCTION

Cerebral palsy is a non-progressive neuromuscular disorder characterized by motor impairment due to early brain injury. Spastic cerebral palsy (CP), the most common type, often results in musculoskeletal deformities that worsen with growth. Single event multilevel surgery (SEMLS) offers an opportunity to address these deformities simultaneously, reducing the need for multiple surgical interventions and minimizing cumulative anesthesia exposure, it also facilitates more efficient postoperative rehabilitation and accelerates functional gains when applied with proper patient selection.[1-3]

CASE SERIES

The study was conducted in BMCRC, Ballari, Karnataka, India with prior approval from ethical committee and written consent from every patient in the year 2023 to 2024. This is an institution based prospective study. This study was conducted to reflect clinically on the outcomes, challenges, and rehabilitation journey of children undergoing SEMLS for cerebral palsy with the objectives to describe the indications and planning criteria for SEMLS in CP, to evaluate short- and mid-term functional outcomes post-SEMLS, to reflect on perioperative and postoperative challenges in clinical practice, to assess the role of multidisciplinary rehabilitation in recovery, to identify barriers to access and adherence to postoperative care. This study was conducted over a period of one year, focusing on the clinical and functional outcomes of SEMLS in children diagnosed with spastic cerebral palsy. Inclusion criteria of the study involve children aged 6–14 years with spastic CP, GMFCS Levels II–IV, presence of fixed contractures or rotational deformities, underwent SEMLS involving ≥2 anatomical sites, minimum 12-month follow-up. Exclusion criteria involve non-spastic types of CP (e.g., ataxic, dyskinetic), GMFCS level V (non-ambulant), history of previous orthopedic surgery in the last 2 years, Incomplete rehabilitation follow-up. The study followed a prospective design, where patients were evaluated pre-operatively, underwent SEMLS, and were followed for one year post-operatively. Functional outcomes were assessed using the gross motor function measure (GMFM-88), and classifications were based on the gross motor function classification system (GMFCS). A total of 10 children with spastic cerebral palsy participated in the study. The age range was 7 to 12 years, with a gender distribution of 8 males and 2 females. GMFCS distribution included 3 patients at level II and 7 patients at Level III.

Figure 1: (a) pre op lower limb deformity, (b) popliteal angle (>90⁰), (c, d) intra operative pictures of Tendoachillis hamstrings lengthening, (e) long leg cast application immediate post op, (f) 6-week post operative follow up pt is able to walk with calipers un assisted.

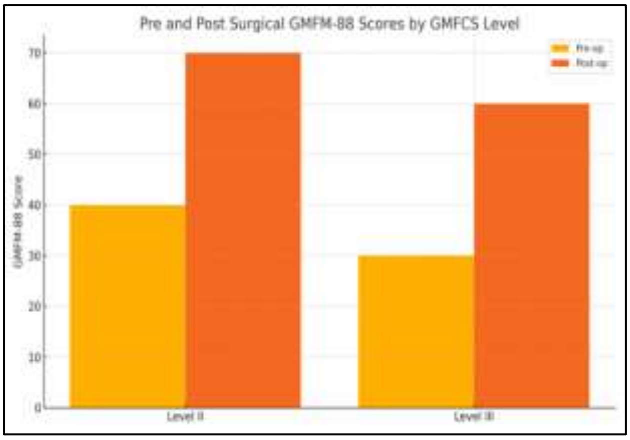

Figure 2: Pre- and post-operative GMFM-88 scores by GMFCS level.

Patients were selected based on eligibility criteria including ambulatory potential, absence of fixed bony deformities unsuitable for correction, and cognitive ability to participate in post-op rehabilitation. All patients underwent SEMLS, which included a combination of soft tissue lengthening (e.g., hamstring, adductor, and gastrocnemius lengthening) and/or bony procedures (e.g., femoral derotation osteotomy) as indicated by individual gait assessments and clinical examinations. GMFM-88 and GMFCS were used to assess gross motor function and classify severity. Example: 10-year-old child with GMFCS 3 with hamstrings contracture, adductor contracture, bilateral tendo chillis contracture underwent bilateral hamstring lengthening, adductor release, tendoachillis lengthening under spinal anesthesia. post operatively, patient condition improved from GMFM 30 to GMFM60 and was ambulating independently by 6months with ankle foot arthroses. All patients received standardized post-operative rehabilitation, beginning with immobilization and passive range-of-motion exercises in the first few weeks, followed by active strengthening, gait training, and orthotic fitting. Pre and post operative GMFM 88 scores were analysed using paired t-tests. The results indicated a statistically significant improvement ($P<0.05$) in motor function scores across the cohort.

Table 1: Case series.

Pt no.	Age/Sex	Type of CP	GMFCS level	Procedures done	Pre-op GMFCS	Post-op GMFCS	Gait improvement	Complications
1	8/M	Spastic diplegia	III	Bilateral hamstring & heel cord lengthening	3	1	yes	None
2	10/M	Spastic diplegia	III	Adductor tenotomy, bilateral hamstring and tendoachillis lengthening	3	1	Yes	None
3	12/M	Spastic quadriplegia	IV	Hamstring release, tendoachilles lengthening	3	2	Yes	None
4	9/F	Spastic diplegia	III	Hamstring & psoas release,	3	1	Yes	None

Continued.

Pt no.	Age/Sex	Type of CP	GMFCS level	Procedures done	Pre-op GMFCS	Post-op GMFCS	Gait improvement	Complications
5	11/M	Spastic quadriplegia	IV	Achilles lengthening, hip adductor release	2	1	Yes	None
6	7/F	Spastic diplegia	II	Rectus femoris transfer, hamstring lengthening	2	1	Yes	None
7	13/M	Spastic diplegia	III	hamstrings lengthening, adductor correction	3	1	Yes	None
8	9/M	Spastic diplegia	II	Heel cord lengthening, adductor release	2	1	Yes	None
9	14/M	Spastic quadriplegia	IV	Knee flexor release, Achilles lengthening	3	2	Yes	None
10	6/M	Spastic diplegia	III	Bilateral hamstring and Achilles lengthening	3	1	yes	None

DISCUSSION

SEMLS represents a paradigm shift in managing musculoskeletal deformities in ambulatory children with spastic cerebral palsy (CP). In our series of 10 children, SEMLS resulted in notable improvements in functional mobility, particularly in those with good preoperative function and consistent rehabilitation. These findings align with previous studies that have demonstrated significant improvements in gait quality and efficiency following SEMLS. Gough and Shortland (2008) established that SEMLS can effectively improve gait kinematics by simultaneously addressing multiple deformities, reducing the cumulative surgical burden on the child.[1] Similarly, Novacheck et al, reported that SEMLS led to meaningful functional gains when performed with appropriate patient selection and postoperative care.[2] The data showed that children with higher preoperative GMFCS levels (i.e., II and III) experienced quicker and more sustained improvements. This is consistent with the observations of Hoang et al, who identified preoperative function as a strong predictor of postoperative outcome.[3]

Quantitative assessment using the gait deviation index (GDI) and GMFM-88 showed objective gains across all cases. The use of GDI, as proposed by Schwartz and Rozumalski et al, offers a comprehensive metric to detect changes in overall gait pathology and supports our findings of biomechanical improvement post-SEMLS.[4] However, the outcomes were not uniform. Children who lacked access to regular physiotherapy or faced financial or geographic constraints showed slower recovery. The importance of consistent, multidisciplinary rehabilitation has been emphasized in literature, including the long-term analysis by Dreher et al, which showed sustained gait improvement only in children who adhered to rehabilitation protocols.[5]

Psychosocial barriers also played a role in recovery, echoing themes in Thomason et al pilot study, where parental education and home-based therapy support were found to influence functional outcomes.[6] Our study reinforces the need for an integrated approach-incorporating surgical, rehabilitative, and family-centered care-for optimal benefit. Long term results like those reported by Lobert et al validate the lasting impact of SEMLS on function and quality of life over a 10-year period.[7] adjuncts such as botulinum toxin, as described by Kay et al, also optimize results in selected cases.[8] Limitations in our series include a relatively small sample size and variability in follow-up duration. However, the trends observed are consistent with existing international literature and underscore the real-world challenges and successes of SEMLS in developing country settings. Post-surgical assessments demonstrated significant improvements in gross motor function and mobility among children who underwent SEMLS.

Gross motor function measure -88 scores

Level II patients improved from an average pre-surgery score of 40 to 70 post-surgery. Level III patients improved from an average score of 30 to 60 post-surgery.

Gross motor function and classify severity level changes

No complete level changes were noted, but Level III patients exhibited functional progress approaching Level II standards (e.g., improved walking distance, reduced assistance needs).

Gait improvements

Reduction in crouch gait and better knee extension during stance phase. Improved balance, stride length, and cadence.

Muscle strength & range of motion

Notable gains in hip flexor and knee extensor strength. Decreased spasticity and improved joint alignment.

Rehabilitation outcomes

Level II patients achieved faster rehab milestones (independent walking, stair climbing) within 6 months. Level III patients showed slower but consistent improvements, with functional gains evident by 12 months. While SEMLS is highly effective, it is resource-intensive. Access to gait labs, pediatric orthopedic expertise, and long-term physiotherapy can be limiting factors in low-resource settings. Moreover, complications such as over-lengthening, joint stiffness, or relapse may occur if procedures are not meticulously planned or if rehabilitation is inadequate.

The integration of newer technologies-such as robotic-assisted gait training, botulinum toxin as an adjunct to surgery, and AI-supported gait analysis—offers exciting avenues for optimizing SEMLS outcomes. Longitudinal studies are still needed to assess the durability of functional gains over decades, especially in GMFCS levels IV and V.

CONCLUSION

SEMLS remains a gold standard surgical approach in moderate to severe spastic CP cases with multilevel involvement. SEMLS in children with spastic cerebral palsy results in improved gait, reduced spasticity, and high caregiver satisfaction while more effective in diplegias CP, benefits are also seen in quadriplegic cases with appropriate selection and care. The procedure is safe functionally effective and can drastically reduce the number of surgical exposures needed in a child's life. Long-term success hinges on meticulous planning, postoperative care, and patient compliance with rehabilitation protocols.

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