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The Functional Outcome of Single Stage Multi-Level Surgery of Spastic Cerebral Palsy

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Abstract **Original Research Article**

Introduction: Cerebral palsy is a heterogeneous disorder that makes the child handicapped. The incidence is about 2 per 1000 live births with the highest rates in premature babies and those of multiple births. It should be treated in a multi-disciplinary approach with the combination of a pediatrician, neurologist, or orthopaedic surgeon & physiotherapist. ***Aim of the study:*** The aim of the study was to assess the outcome of single-stage multilevel surgery of spastic Cerebral Palsy (CP). ***Methods:*** This prospective Experimental Study (quasi experimental Study) was conducted from July 2012 to June 2014 at the Department of Orthopaedics, Dhaka Medical College Hospital, and different clinics in Dhaka city. Twenty patients with diplegic and hemiplegic spastic cerebral palsy were recorded. Preoperative and post operative GMFCS and gait pattern of each patient were recorded for evaluation of results. Among them 12-patient were diplegic and 08 patients were hemiplegic. Data was collected and recorded sequentially and analyzed by SPSS computer software program, version 20 and MS-Excel 2016. ***Results:*** Mean follow up time was 13 months. There were 15 (75%) excellent, 5 (25%) good results assessed clinically by comparing preoperative and post operative gait pattern and GMFCS scoring system. Complications including superficial skin infection in 4 cases. There was no recurrence. ***Conclusion:*** Single-stage multilevel soft-tissue surgery in the lower limb(s) in children with spastic CP yields good results for locomotion and good trunk control.

Keywords: Cerebral palsy; Single stage multi-level surgery; GMFCS.

INTRODUCTION

Cerebral palsy is a heterogeneous disorder of movement and posture that has a wide variety of presentations, ranging from mild motor disturbance to severe total body involvement. Because of this variability in clinical presentation and the absence of any definitive diagnostic test, defining exactly what cerebral palsy is, has been difficult and controversial [1]. The incidence is about 2 per 1000 live births with the highest rates in premature babies and those of multiple births [2]. Known causal factors are maternal toxaemia, prematurity, perinatal anoxia, kernicterus and post-natal brain infection or injury, birth injury, though often blamed, is a distinctly unusual problem. The main consequence is the development of neuromuscular incoordination, dystonia weakness and spasticity. Oro-facial motor incoordination may make speech and swallowing difficult and drooling is a frequent problem [3]. History and physical examination are the primary tools in making the diagnosis of cerebral palsy. The history should include a thorough investigation of the pregnancy and delivery. With the exception of several rare conditions, such as familial spastic paraparesis and congenital ataxia, there is no known genetic component to cerebral palsy. Ancillary studies, such as radiographs, hematological studies, chromosomal analysis, CT, MRI, and positron emission tomography, rarely are needed to make the diagnosis but may be helpful in determining the type and extent of cerebral palsy present [4]. Diagnosis of cerebral palsy before age 2 years can be very difficult [1]. Multi-level surgery (MLS), an orthopaedic approach to surgically realign abnormal joint angles is performed with an aim to improving gait in ambulatory children with CP [5]. It has been defined as a procedure involving one or both limbs, including at least three joints. However, to our knowledge there is no literature examining issues related to the postoperative rehabilitation following MLS within the community such as postural tone and recurrence of

tightness for children with CP indicated by GMFM and EVGS. Of the four classifications of CP (Spastic, Athetoid or Dyskinetic, Ataxic and Mixed), the spastic type is the most common [6]. Around 75% of all cases are spastic and around 60% of these are diplegic (meaning it affects both limbs, usually the legs) [7]. Spastic diplegia results from periventricular leucomalacia, where oligodendrocytes are damaged by hypo-perfusion of the periventricular areas predominantly affecting the corticospinal tracts supplying the legs [7]. This results in a deficit in the development of the white matter forming the insulation around those nerves and consequently compromises the signal transduction to the legs [7]. As spastic diplegia is the most common type of CP, and the presenting symptoms are considered fewer complexes than the other types, patients with spastic diplegia were chosen for participation in the current studies [8]. The use of single-event multilevel surgery has been shown to improve both upper and lower extremity function as well as quality of life while minimizing a patient's exposure to repeated hospitalizations and rehabilitation [9]. Newer techniques, such as percutaneous muscle lengthening and osteotomies, may show promise in terms of decreased blood loss, operative time, and return to mobilization. Operative treatment of deformities related to cerebral palsy can be divided into several groups, including procedures to (1) correct static or dynamic deformity, (2) balance muscle power across a joint, (3) reduce spasticity (neurectomy), and (4) stabilize uncontrollable joints [10]. When the clinical picture requires surgery, it is important to pay attention to the age at which the intervention will be realized, because the results are directly related to patient age. Surgery of the upper extremity is recommended to be done between 6 and 8 years, while that of the lower limbs at 7 to 8 years. Pre-school age children often suffer from a recurrence of contractures as a result of continuous growth. Children aged 7 or 8 years develop a mature gait pattern, and cooperate better in the realization of a postoperative physiotherapeutic programme [11]. The aim of the study was to assess the outcome of single stage multilevel surgery of spastic Cerebral Palsy (CP).

METHODOLOGY

This Prospective interventional study (Quasi Experimental type) was conducted in the Department of Orthopedics and Traumatology, DMCH, Dhaka from 1st September 2012 to 31st March 2014. It took 18 months to get the result. All patients with history, sign-symptoms and clinical examination suggesting spastic cerebral palsy involving lower limb attended in Dhaka Medical College Hospital for treatment. Purposive sampling technique was used to collect the study data and also followed the inclusion and exclusion criteria. Informed written consent was taken from the patient's guardian after duly informing the procedure of treatment, anticipated result, possible advantages, disadvantages and complications considering all ethical issues. Most children with cerebral palsy are diagnosed during the first 2 years of life. But if a child's symptoms are mild, it can be difficult for a doctor to make a reliable diagnosis before the age of 4 or 5. Neuroimaging techniques that allow doctors to look into the brain (such as an MRI scan) can detect abnormalities that indicate a potentially treatable movement disorder. Data were collected with a pre-tested structured questionnaire containing history, clinical examination, laboratory investigations, pre-operative, per-operative, postoperative follow up findings and complications. Twenty patients with diplegic and hemiplegic spastic cerebral palsy were recorded. Preoperative and post operative GMFCS and gait pattern of each patient were recorded for evaluation of results. Among them 12-patient were diplegic and 08 patients were hemiplegic. Every patient got single stage multi-level surgery. Every patient had regular follow-up. Statistical analysis was done among those twenty patients. There were 13 male and 7 female with a mean age of 29.90 (range 18-45) years. Patients were followed 2 weekly intervals till wound healing then 4 weekly up to one year. Improvement in functional abilities and locomotion was assessed preoperatively and postoperatively using GMFCS scores and by gait pattern. The progress of healing as well as occurrence of any complication was recorded. Data was collected and recorded sequentially and analyzed by SPSS computer software program, version 20 and MS-Excel 2016.

Inclusion criteria

i) Age of the patient from 07 years to 16 years.
ii) Both sexes.
iii) Patients with spastic paralysis 35.

Exclusion criteria

i) Below 07 years and above 16 years.
ii) Patients with mental retardation.
iii) Patients with paraplegic cerebral palsy.
iv) Patients suffering from other congenital anomaly or other comorbidities.

RESULTS

Preoperatively, all the children had static deformities in the lower limbs. All 8 hemiplegic children and 5 out of 12 diplegics were ambulatory preoperatively albeit with deformities. The purpose of the soft-tissue surgery was to correct the deformity so that they can stand upright, don the orthoses, and can ambulate using it with or without assistive device for walking and improve personal hygiene in cases of adductor spastic contractures. Deformities in all the joints were recorded. There were 26 static equinus deformities, 20 static hip flexion deformities, 4 hip adductor deformities, and 83 hamstring static deformities (medial and lateral hamstrings) in 20 patients (40 legs). Mean hip flexion deformity was

26.36 ± 8.34°, mean popliteal angle was 98.12 ± 15.42°, and mean equinus deformity was 27.52 ± 9.38° preoperatively. Overall, 153 operative procedures were done in the patients with average of 4.5 procedures per child. All children attained complete or nearly complete correction of deformities after surgery. Improvement in functional abilities and locomotion was assessed preoperatively and postoperatively using GMFCS scores and by physical examination. No complications were noticed at hip (both for flexion and adductor sites) and knee at the operated site. Four children (four legs) with equinus deformity developed wound dehiscence at the suture line with loss of skin. Their length of stay was prolonged, antibiotics and daily wound dressing was done, and wounds healed with no further complications. Two patients each with quadriplegia and hemiplegia had spastic (dynamic) contractures in wrist and finger flexors bilaterally and in the affected upper limb, respectively. Both quadriplegic children were able to hold the walker for ambulation at the time of discharge [Table-1]. Fourteen children with spastic diplegia were advised bilateral AFO for locomotion postoperatively. Out of these, 12 children also received bilateral knee gaiters. Two children with spastic diplegia and three with quadriplegia were advised bilateral KAFO for ambulation. All eight children with hemiplegia received AFO postoperatively. However, all four children with quadriplegia and 12 with diplegia required walker as assistive device. Two children each required axillary and elbow crutches as assistive device for walking. Mean duration of follow-up in the study was 13.12 ± 6.07 months (3–24 months). Three children (8.82%) were therapeutic/exercise walker, 17 (50%) were ambulatory in the household/functional ambulators, and 14 children (41.17%) were community walker at the time of follow-up. Among the therapeutic walkers two had quadriplegia. All parents and children were satisfied with the results of surgery and reported improvement in functional abilities and locomotion in the follow-up. Their quality of life was better, and many of the children who were not at all able to stand before surgery were standing and walking with orthoses and assistive devices [Table-2].

Table-1: Gross motor functional classification scale scores in the preoperative and postoperative period

GMFCS	Number of patients		Significance (P Value)
	Preoperative	Postoperative	
Level-I			
Level-II		10	0
Level-III	12	8	
Level-IV	8	2	
Level-IV			

Table-2: Level of mental retardation among the patients in the study

Level of mental retardation	IQ	Number of patient	Percentage
Borderline	70-79	6	30
Mild	50-69	4	20
Moderate	35-49		
Severe	20-34		
Profound	>20		
Normal	>80	10	50

DISCUSSION

Spastic CP is the most common subtype of all CP cases, and diplegia, hemiplegia, and quadriplegia are the most frequent clinical presentation, in that order in the spastic subtype. Awareness among parents of these children is increasing in developing countries like Bangladesh, especially in urban areas, and many cases are seen in the specialized tertiary centers at a very early age. However, there are still a significant proportion of CP cases that are brought only after the child is more than 3–5 years of age and has not started standing or walking [12]. Apart from inability to walk, these children would already develop static/dynamic deformity across the various joints in the lower limb. Some of these ambulatory patients would be walking using the bamboo/hockey sticks or proper cane.

When such non-ambulatory cases with multiple static deformities in the lower limbs are brought first time to a tertiary care center from far off places, a single-stage multilevel corrective surgery along with physiotherapy may be more pragmatic than planning multistage surgical procedures with rehabilitation. It improves the treatment outcome of patients with spastic CP [13].

As complete recovery in spastic CP is impossible because of the brain lesion, surgical interventions are performed to provide, maintain, or improve musculoskeletal system function and to significantly improve the quality of life of these patients [14]. The functional status of the child before surgery is an indication of the biomechanical disturbances within the limbs and joints and the child's overall neurophysiological condition. By restoring muscular

balance, surgical treatment influences the presence and extent of dynamic and static joint deformity and improves the child's general condition [15]. Zwick *et al*., in a case-control study involving 20 patients with spastic diplegia, observed that patients who underwent single-stage multilevel surgery walked faster with increased stride length and considerably increased knee joint range of motion when compared with the control group. These patients had improved knee extension during the stance phase of gait, which caused improved stance limb stability and facilitate an unhindered swing phase of the opposite limb after surgery [16].

Consideration of age while planning corrective surgeries in spastic CP patients is very important. As cases with spastic diplegia and quadriplegia do not attain stable gait pattern before the age of 3–4 years, surgery is not advisable before the age of 4 years. In our study also, no patient was younger than 4 years of age at the time of surgery [17].

As most of the patients in our study had hamstring surgery at the same time along with Achilles tendon lengthening and as these patients also received knee gaitors or KAFOs after surgery, such complications were not observed till the time of follow-up. Our follow-up duration was short (13 months), and these children may develop complications later, thereby requiring constant supervision. There are reports of deterioration of gait over a period of time following single-stage multilevel soft-tissue surgeries in patients with spastic CP [18, 19]. Gough *et al*. suggested that surgical intervention, which results in the stabilization of a child's gait pattern without change in the kinematics, represents an improvement on the natural history in the short term [20]. The authors believe that the long-term outcome is less promising, as patients developed deformities after attaining skeletal maturity, irrespective of surgical or conservative management. Johnson *et al*., in a longitudinal study of patients with spastic diplegia, showed similar results with deterioration in gait over a mean of 32 months, irrespective of the age of the child or history of previous operative intervention [18]. The gait of those children who already had surgical intervention continued to deteriorate at the same rate as those who had not had surgical intervention. Although we did not observe any deterioration of the gait during follow-up, these studies warrant cautious approach and long-term follow-up of all operated cases.

Orthoses are frequently used to improve the gait and to correct or maintain the deformity in CP. Understanding of the biomechanics of the various joints of the lower limb during normal gait, the pathophysiology and pathomechanics of gait disruption in children with CP, and the biomechanical characteristics of various orthoses is imperative to prescribe appropriate splint. Design, indications, and cost should be considered when choosing an orthosis [21]. Various splints prescribed in the study were in accordance to the needs of the patients with the aim of not only to maintain the correction achieved during the surgery but also to improve the gait characteristics such as velocity, endurance, and cadence. Patients maintained the improvement during the follow-up, they achieved in the postsurgery period and at the time of discharge. Preoperative and postoperative (and the follow-up) GMFCS scores were used to assess the functional improvement in the patients after surgery. This is a commonly used and validated scale for functional assessment in CP. In our study showed at least one grade improvement in GMFCS scores after surgery, which was maintained till the time of last follow-up. Thus, there was significant functional improvement in all the patients after the surgery. Patients and their parents were satisfied with the results of surgery and were happy that their children have become functionally independent after surgery albeit using orthoses with or without assistive devices.

Limitations of the Study

The foremost limitations being the small sample size and a short follow-up period. Some of the complications like recurrence of deformities and deterioration of gait appearing years after corrective surgery could not be observed in the present study.

CONCLUSION

This study suggests that cerebral palsy patients with good trunk control and static contractures at multiple joints in the lower limbs can be ambulated with a single-stage multilevel soft-tissue surgery. In developing countries like Bangladesh, where the patients would not turn up for multistage surgery and follow-up, this is a cost-effective and logical approach. Almost all children showed satisfactory results with minimal complications after corrective surgery and their functional ability improved significantly. In order to achieve a satisfactory outcome, the surgeon and the rehabilitation team must work together during the postoperative period.

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