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Original Article

Comparison of single event vs multiple event soft tissue surgeries in the lower extremities with cerebral palsy

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ABSTRACT

In children with spasticity of multiple muscle groups, the need for repeat surgical interventions increases with advancing age.

Aim: The present study aimed to investigate retrospectively whether there are any clinical and functional differences between single-event multilevel surgeries and multiple surgical events at a single level.

Method: The medical records of 109 patients with cerebral palsy (CP) were used. The patients, who met the inclusion and exclusion criteria, were assigned into following 4 groups based on the surgical procedures. The Gross Motor Function measure-88 (GMFCS) and Functional Independence Measure for Children (WeeFIM) were used for assessments.

Results: When compared to groups, there was no significant difference. This study showed that both surgical techniques resulted in improvements in GMFCS and WeeFIM levels.

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1. Introduction

Nowadays, the advances in medical care of premature infants as a result of scientific, technological and economic progress have dramatically increased the rate of cerebral palsy (CP).¹ The increased need for socialization as well as the increased parental expectations in parallel with advancing age in children with CP has highlighted the importance of orthopedic surgeries aiming to improve movement abilities in children

with CP and to enable them to meet their basic needs.² The growing need for orthopedic surgeries associated with increased rate of CP has resulted in the minimization of hospital readmissions, enabling children with CP to return to social life in the early period and the management of multiple problems at a single event.

Spasticity of the involved muscle groups in patients with CP is likely to be at a level not to interfere with daily functions, whereas it may lead to significant problems regarding mobility and hygiene in some patients. In children with spasticity of

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multiple muscle groups, the need for repeat surgical interventions increases with advancing age. Some authors have suggested that simultaneous surgical procedures on dysfunctional muscle groups are associated with increased bleeding, prolonged duration of surgery, repositioning of patient during surgery and prolonged postoperative recovery time, as well as delayed rehabilitation.^{3,4} However, single event multilevel surgery is the gold standard for the treatment of CP to avoid from repeat surgical procedures.⁵ On the other hand, as far as we are aware, there are no studies in the literature that compare these two techniques. In this context, the present study attempts to investigate retrospectively, whether there are any clinical and functional differences between single-event multilevel surgeries and multiple surgical events at a single level.

2. Materials and methods

In this study, medical records of 109 patients aged 18 and below with CP who had soft tissue surgery for at least 2 regions in the lower extremities including release and lengthening operations between 2004 and 2010 were screened. Among them, the subjects who had undergone same rehabilitation program in our center following surgery were invited. The patients were excluded if they had undergone previous joint surgery and/or bone osteotomy. The other exclusion criteria were a specific condition such as neoplasm, osteonecrosis, recent trauma, ascertained/suspected pregnancy for girls and poor general health status that would interfere with the functional assessments.

Data on patients' socioeconomic status, and their prenatal, perinatal and postnatal histories were obtained from the patient him/herself or from the caregiver (Figs. 1 and 2).

All surgeries were carried out according to a standardized protocol (DeLuca et al., 1998, Gough et al., 2004, Schwartz et al., 2004, Gupta et al., 2008) by two surgeons. All patients were given epidural analgesic catheters with Bupivacaine (1 mg/mL), Phentanyl (μ g/mL), and adrenaline (2 μ g/mL) for postoperative pain treatment. Surgical procedures were given in Table 1. The patients were assigned into following groups based on the surgical procedures: Group 1: The patients with single event surgery for 2 regions, Group 2: The patients with single event surgery for ≥ 3 regions, Group 3: The patients with

Fig. 1 – Total pre [gray] and postoperative [black] GMFCS scores of the Groups 1 and 2.

Fig. 2 – The distribution of pre [gray] and postoperative [black] number of patients according to the WeeFIM levels.

multiple surgical events for 2 regions, Group 3: The patients with multiple events surgery for ≥ 3 regions.

Motor development of patients with CP was evaluated using the Gross Motor Function measure-88 (GMFCS), and functional performance using the Functional Independence Measure for Children (WeeFIM).⁶⁻⁸ Assessments were carried out preoperatively and at least 3 months later after the operations. Postoperative rehabilitation followed a standardized protocol.

2.1. Statistical analysis

Data were analyzed using the SPSS 15.0 and p value of <0.05 was considered statistically significant.

Patients' pre-and postoperative scores on the GMFCS and WeeFIM were analyzed using the Wilcoxon test. The Mann Whitney U test was used for the comparison of two groups. Four groups based on operations were compared by Kruskal Wallis test.

3. Results

Table 2 presents demographic characteristics of the patients.

Among the medical data of 109 patients screened, 46 patients met the inclusion and exclusion criteria. While the patients with single event surgery were 26 (18 and 8 were group 1 and 2, respectively), 20 patients had multiple surgical events (14 and 6 were group 3 and 4, respectively).

Table 1 – Surgical procedure.

	n
Psoas tenotomies	15
Adductor tenotomies	32
Rectus femoris transfers	8
Hamstrings tenotomies	26
Gastrocnemius slides	13
Achilles lengthenings	25
Total	119

Table 2 – Demographic and clinical characteristics of patients.

	The patients with single event surgery n = 26		The patients with multiple surgical events n = 20	
	2 regions	≥3 regions	2 regions	≥3 regions
	Group 1	Group 2	Group 3	Group 4
	n = 18	n = 8	n = 14	n = 6
Age (mean ± SD)	11.3 ± 4.1	10.7 ± 3.2	14.4 ± 2.7	15.4 ± 6.8
Age at time of surgery (mean ± SD)	7.8 ± 3.4	8.1 ± 5.1	11.8 ± 5.5	12.3 ± 6.0
Form of CP (n)				
Monoplegic	0	1	0	0
Diplegic	7	3	3	2
Triplegic	0	2	2	1
Quadriplegic	6	1	4	3
Paraplegic	1	1	1	0
Hemiplegic	4	0	4	0
Prenatal problems (n)	13	5	6	4
Perinatal problems (n)	4	2	8	2
Postnatal problems (n)	1	1	0	0
Comorbidities (n)				
Epilepsy	6	1	3	0
Mental retardation	5	2	4	1
Dental problems	4	2	1	0
Ocular problems	3	1	1	
Hearing disorders	2	0	1	0
GIS disorders	1	1	0	1

Abbreviations: CP, cerebral palsy; SD, standard deviation; GIS, gastrointestinal system.

Of all patients enrolled in this study, 28 (60.9%) patients had prenatal problems, 16 (34.8%) had perinatal problems and 2 (4.3%) had postnatal problems. An assessment of additional comorbidities showed mental retardation in 12 (26%) patients, epilepsy in 10 (21.7%) patients, dental problems in 7 (15.2%) patients, ocular problems in 5 (10.9%) patients, hearing disorders in 3 (6.5%) patients and gastrointestinal symptoms in 3 (6.5%) patients. It was found that parents of 6 patients were related by 2nd or 3rd degree of consanguinity.

According to GMFCS levels, the most of the patients were at level 2, level 3 and level 4 in all groups (Table 3). No patient's level retrograded after the operations. Among the patients, 3 of 18 patients in Group 1 (1 and 2 patients at levels 5 and 4, respectively), 2 patients in Group 3 (at level 4) and 1 patient in Group 4 (at level 4) did not show any increase at her/his level. Others had improvement in each group. When compared to groups, there was no significant difference.

Table 3 – The patients' "Gross Motor Function measure-88" results.

	The patients with single event surgery n = 26			The patients with multiple surgical events n = 20		
	2 regions	≥3 regions	Total	2 regions	≥3 regions	Total
	Group 1	Group 2		Group 3	Group 4	
	n = 18	n = 8		n = 14	n = 6	
Preoperative GMFCS (n)						
Level 1	2	1	3	1	0	1
Level 2	4	2	6	5	2	7
Level 3	6	2	8	3	2	5
Level 4	5	2	7	5	2	7
Level 5	1	1	2	0	0	0
Postoperative GMFCS (n)						
Level 1	3	2	5	2	0	2
Level 2	5	3	8	6	2	8
Level 3	7	2	9	4	3	7
Level 4	2	1	3	2	1	3
Level 5	1	0	1	0	0	0

Abbreviation: GMFCS, Gross Motor Function measure-88.

Table 4 – The patients' "Functional Independence Measure for Children" scores.

	The patients with single event surgery n = 26			The patients with multiple surgical events n = 20		
	2 regions	≥3 regions	Total	2 regions	≥3 regions	Total
	Group 1	Group 2		Group 3	Group 4	
	n = 18	n = 8		n = 14	n = 6	
Preoperative WeeFIM (n)						
Level 1	0	0	0	0	0	0
Level 2	3	1	4	2	0	2
Level 3	4	2	6	1	2	3
Level 4	7	5	12	6	3	9
Level 5	4	0	4	4	1	5
Level 6	0	0	0	1	0	1
Level 7	0	0	0	0	0	0
Postoperative WeeFIM (n)						
Level 1	0	0	0	0	0	0
Level 2	2	1	3	1	0	1
Level 3	5	2	7	4	2	6
Level 4	5	3	8	5	0	5
Level 5	5	2	7	4	3	7
Level 6	1	0	1	0	1	1
Level 7	0	0	0	0	0	0

Abbreviation: WeeFIM, Functional Independence Measure for Children.

WeeFIM levels were given in Table 4. According to results, 1 patient's level in Group 1 and 1 patient's level in Group 3 retrograded. Other patients showed improvements. Similarly, there was no significant difference among the groups.

4. Discussion

This study presented no statistically significant difference in terms of the effects of single event vs multiple event orthopedic surgeries on the GMFCS and Wee-FIM levels. In clinical terms, single event orthopedic surgery was associated with more improved GMFCS levels, which however did not reach the level of statistical significance. Both surgical techniques resulted in improvements in GMFCS and WeeFIM levels.

CP, the most common cause of physical disability in the pediatric population, is a disorder of movement or posture caused by a non-progressive injury that occurs while the child's brain is under development. However, associated secondary conditions may develop or change over time. Hypotonia may be replaced by spasticity during early infancy and involuntary movements, athetosis or a mixed type including signs of both may appear. The orthopedic clinical sign of CP is a disorder of movement and posture.⁹ Spastic CP, which is characterized by increased muscle tone, accounts for almost 70–80% of all CP cases, being the most common type of CP. More rarely are seen dyskinetic [athetosis] and hypotonic subtypes. The combination of spasticity with athetosis is common in the mixed type. Even though the types of CP according to topographic classification differ among several studies in the literature, 32% patients had diplegia, 30.4% had quadriplegia, and 17.4% had hemiplegia, whereas 2.2% had monoplegia, being the least common, in this study.

It has been reported that 25% of spastic quadriplegic patients with minimal limitations in ambulation, self-care needs and activities are less dependent on others, whereas, 25% of these patients are unable to ambulate independently and need total assistance.¹⁰ In this study, 28% of patients with spastic quadriplegia were at GMFCS level 3 having the ability to meet their basic needs with minimal assistance whereas 57% were at GMFCS level 4 and 15% were at GMFCS level 5, with no ability to mobilize, requiring full assistance.

Surgical interventions targeting the locomotor system play an important role in the management of patients with CP. Surgical intervention for lower extremity soft tissue is indicated to correct contractures and deformities of the joints by lengthening of the spastic muscle. Surgical procedures on the soft tissue including tenotomy, tendon transfers, fractional or Z plasty lengthening of the tendon can be performed for this purpose. There are no standardized studies in the literature providing evidence for the most effective surgical procedure or the superiority of one procedure over another, which can be attributed to the fact that patients with CP differ widely in terms of age, and the severity or type of CP. Today, most authors recommend performing multiple soft tissue surgeries and osteotomies, if needed, in a single event in patients with CP.¹¹ Rang recommends all lower extremity problems to be resolved in a single event, thus preventing unnecessary lengthening procedures or repeated surgical interventions in children with CP, which is well known to lead to "birthday syndrome", in which the child is in the hospital every year of his/her life getting an operation.¹² A number of authors have suggested that release of a single joint in the early period prevents contractures, which however is refused by several authors because of the short follow-up period.¹³ Similarly, the results of our study demonstrated that multiple soft tissue surgeries at a single level had no

significant effects on the range of joint motion and contractures as compared to single-event soft tissue release and lengthening procedures on multiple joints.

On the other hand, more satisfactory outcomes were achieved clinically in the GMFCS with single-event multilevel surgeries, though no significant differences were observed in the GMFCS and WeeFIM levels between the groups. This finding can be attributed to the fact that though associated with delayed rehabilitation, single-event surgery enables non-interrupted rehabilitation without the need for subsequent surgical procedure. A study by Gupta et al.¹⁴ reported that single-event multilevel soft tissue surgery was associated with significantly decreased GMFCS scores in a total of 34 CP patients aged between 4 and 16 years, 22 of whom had diplegia, 4 had quadriplegia and 8 had hemiplegia, which is also consistent with the findings of our study. Godwin et al.¹⁵ demonstrated that single-event multilevel orthopedic surgery could affect the stability of the GMFCS classification in 84 patients with CP over a 5-year follow up time. In this study, all soft tissue orthopedic surgeries, independent of the type of surgery, resulted in improved GMFCS level and increased range of joint motion. In a study of 24 ambulatory patients with CP by Koca et al.,¹⁶ single-event bilateral multilevel orthopedic surgery including soft tissue surgery and osteotomies performed in the right indication was effective with improvements in GMFCS scores and physical examination findings.

In this study, all soft tissue release procedures performed in the pediatric population yielded favorable results in the GMFCS and WeeFIM. The comparison of single-event vs multiple-event groups revealed no statistically significant difference. On the other hand, it was concluded that even though single-event soft tissue release and lengthening procedures have disadvantages including prolonged duration of surgery, increased bleeding, prolonged exposure to anesthesia, need for repositioning of patient during surgery, and delayed rehabilitation due to longer recovery time, it also offers several advantages including lack of need for repeated surgeries and long-term rehabilitation as a result of loss of correct posture, gait and sitting functions that had been acquired long after surgery in the subsequent procedure.

5. Conclusion

In this study, all soft tissue release procedures, independent of type of surgery and patient age, had positive effects on functional outcomes. Since the recurrence rate is high because of growth after soft tissue procedures among children with CP and it has not been fully clarified yet how effective preoperative administration of botulinum toxin and physiotherapy is in which spastic muscle group and at what age, when new spasticity occurs in a growing child and at what age surgical procedures yield more satisfactory results,¹⁷ future studies aiming at reducing the frequency of multiple event orthopedic surgeries will be of greater value.

Conflicts of interest

The authors have none to declare.

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