

Outcome of Single Event Multilevel Soft Tissue Release for Spastic Diplegic Cerebral Palsy

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Objective: We evaluated the results of single event multilevel surgery for treatment of contractures of lower extremities in spastic diplegic cerebral palsy patients in Phramongkutklao Hospital.

Material and Method: The present study included 40 patients (23 boys, 17 girls, mean age 8.9 years) with spastic diplegic cerebral palsy, who underwent single event multilevel surgery for the treatment of soft tissue contractures in lower extremities secondary to spasticity between 2006 and 2009. Evaluations were based on pre- and post-operative (follow-up for three years), physical examination, and video observational gait pattern on the Gross Motor Function Classification System (GMFCS) scores and Functional Mobility scales (FMS).

Results: Range of motion of all operated joints were increased post-operatively, resulting in significant improvement in posture, gait, and balance of patients. The mean GMFCS scores were 4.2 pre-operatively, 4.1 at post-operatively 1-year, 3.8 at post-operative 2-year, and 3.0 at post-operative 3-year, which were significantly improved two and three years post-operative period ($p < 0.05$). The mean FMS scores were improved at 5 meters post-operative at 1-, 2-, and 3-year ($p < 0.05$). The mean FMS scores at 50 meters were improved at 3-year post-operative period.

Conclusion: Single event multilevel surgery can help spastic diplegic cerebral palsy patients improve range of motions, gait patterns, and mobility functions.

Keywords: Cerebral palsy, Single event multilevel surgery, Gross motor function classification system (GMFCS) scores, Functional mobility scale (FMS)

J Med Assoc Thai 2017; 100 (3): 301-5

Full text. e-Journal: <http://www.jmatonline.com>

Cerebral palsy is a syndrome that mainly affects to motor functions in immature brain. The brain lesion is constant while musculoskeletal deformities increase by age. Starting from imbalance of muscle power leading to imbalance posture and then joint contracture^(1,2).

Spastic diplegia is the most common type of cerebral palsy in which four limbs are involved, mainly in lower limbs. Gait patterns usually deteriorate with growth and patients need surgery to improve walking ability^(1,2,17).

The purpose of treatment is to improve muscle balance, increase ability of mobility, and prevent joint contracture. Multidisciplinary approach is accepted for treatment in cerebral palsy. Surgery is recommended when rehabilitation programs cannot maintain or improve functional limb abilities. Recently, single event multilevel surgery (SEMLS) for cerebral palsy

has been proven by many researches that it can help patient improve lower limb functions, can reduce complications and chance of re-operation⁽³⁾. The surgery consists of tendon or muscle surgery at pelvis, hip, knee, ankle, and foot in single operative event in order to correct torsional deformity, to increase range of motion (ROM), and to improve posture and gait ability.

Gait ability monitors widely accepted are Gross Motor Function Classification System (GMFCS) and Functional Mobility Scale (FMS) for evaluating functional level of self-initial motor function.

The purpose of the present study was to retrospectively evaluate results of SEMLS for spastic diplegic patients. The outcome measurements included ROM, GMFCS, and FMS after surgery over 3 years follow-up compared with pre-operative conditions.

Material and Method

A retrospective study conducted in our institute for evaluating results of single event multilevel soft surgery (SEMLS) for 40 cerebral palsy patients between 2006 and 2009. After approval from the Ethic Committee of Phramongkutklao Hospital and College

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of Medicine, patient data, and medical records were collected and reviewed, including walking VDO records of each patient before and after surgery. Data included age, sex, and surgical procedures. Pre-operative and 1, 2, and 3 years post-operative ROM of hip, knee and ankle, GMFCS, and FMS were evaluated.

SEMLS was considered by gait pattern evaluation and physical examination. When muscle imbalance of lower limb causes poor gait ability, ROM of each joint was assessed. Surgical procedures were indicated in patient whom physical examination showed: 1) greater than 30° of hip flexion contracture by Thomas test, 2) less than 30° of hip abduction, 3) greater than 45° of popliteal angle, and 4) less than 0° of ankle dorsiflexion in knee fully extend.

Exclusion criteria were: 1) patients had previous surgery, 2) patients received intrathecal baclofen, 3) patients were injected botulinum, 4) patients were performed dorsal rhizotomy, and 5) incomplete data collection.

Surgery was performed by two pediatric orthopedic surgeons. Iliopsoas tendon lengthening was performed over pelvic brim for full hip extension, hip adductor muscles released via medial approach near pelvic attachment until hip could abduct 45°, only medial hamstrings lengthening for knee contracture until popliteal angle was 30°, and tendoachilles lengthening for ankle equinus were corrected to 5° dorsiflexion.

All patients were immobilized with plaster cast for a month. Standing with assistance while casting was encouraged for all patients after pain subsided.

Hips were abducted at least 45° with a pillow or a brace for adductor muscle release 12 hours per day. Ankle foot orthosis (AFO) was used for splinting ankle in neutral position overnight time in all cases. Physical therapy usually began two weeks after surgery. Combination of stretching, isotonic strengthening, standing, and gait training were adjusted for each patient (1 to 3 hours). Five sessions per week of physical therapy were trained for first four months then three sessions per week for six months later. After ten months, one or two sessions of training per week were maintained. However, home programs were performed every day.

Statistical methods

Descriptive analysis was used for evaluation:

1) Demographic data, comparative of pre-operative, and post-operative ROM in percentage, mean, median, and standard deviation.

2) GMFCS and FMS monitoring at pre-operation and 1, 2, and 3 years post-operation with Wilcoxon signed ranks test.

Results

We treated 40 patients between 2006 and 2009. The average age was 8.9 with a range of 6 to 12 years. There were 23 boys and 17 girls. The mean sites of surgery were 6.65 per case as shown in Table 1.

As Table 2, GMFCS showed improvement at least one level in 80% of cases. Average pre-operative GMFCS was 4.2 while post-operative follow-up at 1-, 2-, and 3-year were 4.1, 3.8, and 3.6, and significant improvement two years after the operation.

FMS at 5 m pre-operative was 1.8 and at follow-up at 1-, 2-, and 3-year was 2.0, 2.3, and 2.6 respectively. FMS at 50 m pre-operative was 1.3 while at follow-up at 1-, 2-, and 3-year was 1.3, 1.4, and 2.1 respectively. However, FMS at 500 m did not change significantly.

ROM of the joints from Table 2 showed that hip abduction in extension and flexion were better than pre-operation significantly ($p < 0.05$), while hip flexion and rotation were not different.

ROM of knee joint showed that knee extension and popliteal angle were significantly improved ($p < 0.05$) while knee flexion was not.

Ankle dorsiflexion during knee flexion and extension was improved significantly ($p < 0.05$). Ankle plantarflexion was not changed.

Discussion

Cerebral palsy is an abnormality of the immature brain^(1,2). Although the disease is not progress but the abnormality of bone, muscle, and joint systems are progress while patients growing up. There are several severities of this disease and many abnormalities of other systems such as visual impairment, respiratory dysfunction, and gastrointestinal abnormality. Some

Table 1. Characteristic of patients

Characteristics	Number (%)
Age (mean ± SD)	8.9±1.5
Sex	
Male	23 (57.5)
Female	17 (42.5)
Number of operations	
4	6 (15.0)
6	19 (47.5)
8	11 (27.5)
10	4 (10.0)

Table 2. Comparison of range of motion before and after surgery

	Pre-operation		Post-operation		<i>p</i> -value
	Mean ± SD	Median (min to max)	Mean ± SD	Median (min to max)	
Hip flexion (degree)	85.4±7.1	85 (70 to 100)	86.0±8.6	86 (80 to 120)	0.12
Hip extension (degree)	-6.0±6.0	-10 (-15 to 0)	-3.3±4.7	0 (-10 to 0)	0.02
Hip abduction (degree)	22.0±5.4	20 (10 to 30)	35.1±5.6	35 (30 to 50)	<0.001
Hip abduction in extension (degree)	24.84±10.00	26 (19 to 35)	33.89±6.80	36 (30 to 41)	0.025
Hip flexion contracture (degree)	38.9±9.8	40 (15 to 55)	22.5±5.4	20 (15 to 35)	<0.001
Knee flexion (degree)	110.4±9.9	115 (100 to 130)	105.6±7.5	110 (70 to 130)	0.21
Knee extension (degree)	-54.1±8.7	-50 (-80 to 40)	-25.9±5.5	-25 (-35 to 15)	<0.001
Ankle dorsiflexion (degree)	13.3±6.5	-15 (-25 to 0)	2.5±5.3	0 (-10 to 10)	<0.001
Ankle Plantarflexion (degree)	25.4±4.9	25 (15 to 35)	26.9±5.5	30 (10 to 35)	0.172

Wilcoxon signed ranks test compared with pre-operation

patients may have few symptoms that they can walk or run as normal people, however, their ability may decrease with time that they were unable to walk and depended totally on wheelchair throughout their life. The multidisciplinary approach was definitely needed to treat these patients^(1,2,11).

Spastic diplegic patients are the most common pattern of cerebral palsy, around 65 to 80%. Although the patients have development slower than normal children, their walk begins at 4-year-old and can develop until 7-year-old^(1,2,7,8,11). Conservative treatments were developed such as botulinum toxin injection, phenol nerve blockage, muscle relaxant agents, and rehabilitation programs. These conservative treatments helped them to improve degree muscle contraction. Nevertheless, they could not change natural history of the disease. Surgery is still a standard of treatment for these patients^(3,6).

Surgery to correct deformities should be performed in single event because deformities connected among hips, knees, and ankles. Individual surgery to correct only one would result in difficulty of gait and standing control. Patients need to be performed surgery every single year leading to decrease a quality of life, increase mental problems, and decrease social participation^(5,7,8,10,14).

The present study aimed to evaluate results of SEMLS performed in our institute, we enrolled cerebral palsy patients between 6 and 12 years of age. Because development of gait function among this period is steady, the surgery in the very young child is high-risk of recurrence, and the older patients cannot change their gait ability^(14,16,17).

The determination of type of surgery for each patient depended upon physical examinations and

their gait patterns. The present study used GMFCS score, FMS score, and ROM of the joint in order to evaluate results of operations. The study showed that GMFCS score⁽¹⁸⁾ was easy for evaluation and good inter-observer validity by video recording gait patterns before and after operation. FMS was more precise measurement ability of gait pattern in terms of capability of walking distance^(12,17).

The present study showed pre-operative GMFCS score was 4.2 which quite severe because patients have to use gait aid for walking. Post-operative GMFCS score at first year was improved but it was not significant. Nevertheless, GMFCS at second and third year were significantly improved. Seventy percent of patients improved GMFCS score one level, 10% of them improved the score two level. While 20% of patients were the same. These results were consistent with previous study that most of patients were improved at least 1 to 2 levels of GMFCS score but they need to be followed more than two years.

FMS score showed improvement at 5 meters of walking significantly from year 1 to year 3 after surgery. At 50 meters of FMS, score was improved three years after surgery. However, FMS score of 500 meters were not changed. These can infer that operations could improve walking ability at short distance and the walking ability of the longer distance was not worsened from the pre-operation⁽¹²⁾.

ROM of hip abduction in knee extension improved significantly ($p<0.05$) according to previous study result in improvement of crouch gait. Ankle dorsiflexion improved significantly resulting in improvement of tip-toe gait and decreased energy consumption while walking.

The present study showed that SEMLS can help spastic diplegic cerebral palsy patients improve their ability of short distant walking and ROM of hip, knee, and ankle. This retrospective study has limitation that we evaluated from medical records and video recordings and did not use gait analysis for evaluating gait patterns.

Conclusion

Surgical treatments for cerebral palsy patients can improve capability of walking, decrease using gait aid, and increase ROM. The results of operation not only depend upon surgery but also severity of disease and post-operative rehabilitations. The present study reaffirms that single event multi-level surgery should be used for treating spastic diplegic patients.

What is already known in this topic?

Surgery to correct deformities should be performed in a single multilevel event because the deformities were connected among hips, knees, and ankles. Individual surgery to correct only one joint would result in the difficulty of gait and standing control. Moreover, patients need to be performed surgery every year leading to decrease a quality of life, create mental problems, and reduce social participations.

As the previous studies, most of the patients improved their walking ability at least 1 to 2 level of GMFCS score but they need to be followed for longer period of time.

What this study adds?

This study added that the SEMLS can help spastic diplegic cerebral palsy patients improve their ability to walk only for a short distance as shown from FMS score, while walking longer distance did not improve significantly.

Potential conflicts of interest

None.

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ผลการรักษาการผ่าตัดกล้ามเนื้อและเส้นเอ็นขาหลายตำแหน่งในผู้ป่วยโรคพิการทางสมองที่มีการหดเกร็งของกล้ามเนื้อขา

ปวิณ กชเสนี, พัฒนเกติ ชีวะก้องเกียรติ, ปัญญา สุริย์จามร, ธรรมบุญ ศรีสอ้าน

วัตถุประสงค์: เพื่อศึกษาผลของการผ่าตัดแก้ไขความผิดปกติทางการเคลื่อนไหวโดยพร้อมกันในครั้งเดียว บริเวณข้อสะโพก ข้อเข่า และข้อเท้า (single event multilevel surgery) หลายตำแหน่ง ในผู้ป่วยโรคพิการทางสมอง

วัสดุและวิธีการ: ข้อมูลย้อนหลังผู้ป่วยพิการทางสมองที่ทำการผ่าตัดกล้ามเนื้อและเส้นเอ็นหลายตำแหน่งที่โรงพยาบาลพระมงกุฎเกล้า ช่วง พ.ศ. 2549 ถึง พ.ศ. 2552 โดยใช้ข้อมูลจากแฟ้มประวัติโรงพยาบาล แฟ้มประจำตัวของผู้ป่วย และวิดีโอบันทึกการเดิน พัฒนาการ รวมถึงการเปลี่ยนแปลงของผู้ป่วยทั้งก่อนและหลังผ่าตัดเพื่อเก็บข้อมูล ประกอบด้วยข้อมูลพื้นฐานของผู้ป่วย ได้แก่ อายุ เพศ ข้อมูลการผ่าตัด ข้อมูลการวัดระยะการเคลื่อนไหวของข้อสะโพก ข้อเข่า และข้อเท้า ก่อนและหลังผ่าตัด ข้อมูล *Gross Motor Function Classification System (GMFCS)* และ *Functional Mobility Scale (FMS)* เก็บรวบรวมข้อมูลข้างต้น ก่อนผ่าตัด หลังผ่าตัดที่ 1, 2 และ 3 ปี

ผลการศึกษา: ผู้ป่วยที่ผ่านเกณฑ์การคัดเลือกเข้าการศึกษาทั้งหมด 40 ราย มีอายุเฉลี่ย 8.9 ปี เพศชาย (57%) มากกว่าเพศหญิง (42%) การผ่าตัดเฉลี่ยต่อคนอยู่ที่ 6.65 ตำแหน่ง โดยเอ็นร้อยหวายเป็นตำแหน่งที่มีการผ่าตัดมากที่สุด (93%) ความสามารถในการเคลื่อนไหวของผู้ป่วยโดยวัดจาก *GMFCS score* พบว่าผู้ป่วยส่วนมาก (80%) จะมีระดับ *GMFCS score* ดีขึ้นอย่างน้อย 1 ระดับ *GMFCS score* ค่าเฉลี่ยก่อนผ่าตัดอยู่ที่ 4.2 ที่หลัง ผ่าตัด 1 ปี 2 ปี และ 3 ปี อยู่ที่ 4.1, 3.8 และ 3.6 ตามลำดับ พบว่าระดับ *GMFCS score* ดีขึ้นหลังผ่าตัดเมื่อเทียบกับก่อนผ่าตัด และมีนัยสำคัญทางสถิติที่ 2 และ 3 ปี *FMS score* ที่ 5 เมตร ก่อนผ่าตัดมีค่าเฉลี่ย 1.8 หลังผ่าตัด 1 ปี 2 ปี และ 3 ปี เท่ากับ 2.0, 2.3 และ 2.6 พบว่า *FMS score* ที่ 5 เมตร ดีขึ้นอย่างมีนัยสำคัญทางสถิติตั้งแต่ 1 ปี หลังผ่าตัดจนถึง 3 ปี *FMS score* ที่ 50 เมตร ก่อนผ่าตัดมีค่าเฉลี่ย 1.3 หลังผ่าตัด 1 ปี 2 ปี และ 3 ปี มีค่าเฉลี่ย 1.3, 1.4 และ 2.1 พบว่า *FMS score* ที่ 50 เมตร ดีขึ้นที่หลังผ่าตัด 3 ปี อย่างมีนัยสำคัญทางสถิติ *FMS score* ที่ 50 เมตร พบว่าทั้งก่อนและหลังผ่าตัดไม่แตกต่างกัน

สรุป: การผ่าตัดกล้ามเนื้อและเส้นเอ็นขาหลายตำแหน่งในเด็กพิการทางสมองที่มีการหดเกร็งของกล้ามเนื้อขา ช่วยให้ผู้ป่วยสามารถเดินได้ดีขึ้น ใช้อุปกรณ์ในการช่วยเดินลดลงและเพิ่มพิสัยการขยับของข้อได้มากขึ้น การผ่าตัดควรทำการผ่าตัดในทุกตำแหน่งที่ตรวจพบความผิดปกติพร้อมกันในครั้งเดียว
