ORIGINAL ARTICLE

Walking further. How surgery can help the cerebral palsy child

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ABSTRACT

Introduction: The prevalence of cerebral palsy (CP) in Malaysia is estimated at 2.6 per 1000 live births which is comparable to that of Australian and European data with ranges of 2.3- 4.2[1,2]. Surgical intervention for the improvement of gait function and mobility in CP is a common practice, however scarce literature of its outcomes is available in Southeast Asia. This paper aims to address and compare outcomes of surgical interventions in our centre with other countries.

Material and Methods: Patients with Spastic CP with Gross Motor Function Classification System (GMFCS) I-III that underwent lower limb surgical intervention in our centre from 2008-2018 were retrospectively reviewed for The Spinal Alignment and Range of Motion Measure ROM subscale (SAROMM) scores and Functional Mobility Scale (FMS) 18 months after surgery. Changes in SAROMM, FMS scores and minimal clinically important difference (MCID) were determined.

Results: 19 patients were included in the study with mean age of 12.58. All patients underwent muscle tendon procedures. Box plot analysis of SAROMM showed reduction of median scores at 6(26.3%) and 12(47.4%) months which plateaus at 18 months post-surgery. Repeated measure ANOVA analysis showed there was a statistically significant effect of time on SAROMM scores ($p < 0.001$) with MCID of 13.4. Improvement of FMS scores was the most at 50m with 13 children ($p < 0.05$), one at 5m and five at 500m. None reported worsening of FMS scores at 18 months. There were no changes of GMFCS levels by the end of 18 months.

Conclusion: Surgeries performed on GMFCS I-III patients with the aim of gait improvement translates into improved mobility with results comparable to other countries.

KEYWORDS:
Cerebral palsy, SAROMM, Functional Mobility Scale, Contracture release

INTRODUCTION

Cerebral palsy (CP) is an umbrella term to describe a group of disorders characterised my abnormalities of movement and posture, causing activity limitation due to a non-progressive brain damage during early development. Even though CP is a static encephalopathy, the musculoskeletal pathology is progressive leading to secondary deformities of bones and joints with loss of function and deterioration of their walking pattern.

There are currently no cure or treatment for the brain damage suffered by CP patients which causes the complex musculoskeletal dysfunctions. Physical therapy, medical and neurosurgical interventions serve to reduce and regulate the hypertonia while orthopaedic interventions aim to restore anatomical structures in an attempt to preserve the walking function as well as patients' activity level and therefore their quality of life.[3] Appropriate holistic care of children with CP requires myriad of disciplines to improve their long-term care considering their medical and social aspects as well as their rehabilitation, education, and assistance.[4]

Surgical intervention aims to improve gait, increase mobility and treat hip subluxation or dislocations. In a randomised control trial of surgery vs conservative treatment of CP patients by Thomason et al in 2011, the authors discovered that surgery improved the gait after one year of follow up with good quality of life and functional mobility observed at 2 years of follow up.[5] These findings were further substantiated by Firth et al., Feger et al., and Chang et al., with outcomes showing surgical intervention to be superior to conservative treatment of CP in the long run.[6–8]

MATERIALS AND METHODS

This study is a medical record review of 32 children with spastic CP that underwent orthopaedic surgical intervention between 2008-2018 at a tertiary referral university hospital for sub-specialised orthopaedic care. Nineteen patients were included in the study based on our inclusion criteria which included a diagnosis of Spastic CP of GMFCS I-III and completed 18 months of follow up. Patients that are more

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than 18 years old at time of surgery, history of dorsal rhizotomy or intrathecal baclofen surgery were excluded from the study.

Surgery was done by three surgeons throughout the 10 years who are experienced in performing these surgeries with experience of 5-20 years between them. The surgical indications included gait dysfunction, restricted knee extension and flexion, inability to achieve neutral ankle position. [5–7,9]

Patients were assessed preoperatively by a multidiscipline team of neuropaediatrician, rehabilitation physician and paediatric orthopaedic surgeon prior to decision for surgery as well as determination of surgical level and method.

Adductor release of adductor longus and gracilis were done as described by Shore et al.[10] Hamstring release involves the fractional lengthening of the semitendinosus and semimembranosus. If the increment of popliteal angle achieved is <20° then biceps femoris is also released.[11] Surgical correction of equinous deformity includes gastrocsoleus recession and triple hemisection of Achilles tendon. Both procedures involve the identification of the muscle belly and Achilles tendon with subsequent lengthening as described by Firth et al and Takahashi et al.[6,12] All patients were kept on casts for two weeks after surgery which is then continued for 6 weeks total after wound inspection. They are then changed to orthoses throughout their rehabilitation period and follow up.

Outcome data collected were changes in Gross Motor Function Classification System (GMFCS) levels[13] , Functional Mobility Scale (FMS)[14] and Spinal Alignment and Range of Motion Measure Range of Motion subscale (SAROMM).[15] Statistical analysis of data collected were analysed using SPSS version 24. Repeated measure ANOVA test was used to evaluate the statistical significance of score changes at 18 months and pre surgical intervention scores.

RESULTS

Nineteen children were included in the study with age ranging from 5-18 years old (mean=12.58). Nine male and 10 female children were enrolled. There were five GMFCS I, seven GMFCS II, and seven GMFCS III. Fifteen patients underwent single level surgery, while 4 patients underwent surgery of at least 2 levels. In total 27 lower limbs underwent surgical intervention. All patients underwent muscle tendon procedures (Table I).

There were no post-surgical intervention complications such as haemorrhage, surgical site infection. Box plot analysis of SAROMM showed reduction of median scores at 6 months and 12 months which then plateaus at 18 months (Figure 1). Repeated measure ANOVA analysis showed there was a statistically significant effect of time on SAROMM scores with mean change of 13.4 ($p < 0.001$, Standard Deviation, SD = 8.7) at 18 months after surgery.

The FMS scores at 18 months post-surgery were compared with their baseline for the distance of 5m, 50m, 500m. Improvement of FMS scores was the most at 50m with 13 children ($p < 0.05$), one at 5m and five at 500m (Table II). None reported worsening of FMS scores at 18 months. There were no changes of GMFCS levels by the end of 18 months.

DISCUSSION

The purpose of this study was to assess the impact of orthopaedic surgical intervention on children with cerebral palsy. In addition to measuring the range of motion of their joints, we also evaluated changes in their mobility, aiming to determine whether surgical intervention and concurrent physical therapy had a meaningful impact on the quality of life on these children.

The role of surgical intervention for children with cerebral palsy is to improve function and decrease discomfort with the assumption that by gait improvement, the general function of the patient will improve.[16] The SAROMM which has fair to good construct validity was used to detect change in ROM from baseline and follow up.[17] In addition, to determine if change in score is clinically relevant, the minimal clinically important difference (MCID) is also determined. The results garnered from our study shows that there is a mean change in score of 13.4 which is more than the MCID reported by Chen et al., of 4.07.[17] Thus, surgical intervention improves the ROM of contracted joints within 12 months to be of clinical significance.

Improvement in SAROMM scores peaks by 12 months and is the same at 18 months. indicating that after surgical intervention, the maximal improvement of ROM is seen by 12 months and is preserved at 18 months. Apart from this, there were no cases of recurrence detected within the 18 months period of follow up. However, recurrence of contractures, maintenance of functional levels or functional decline may not be apparent within the short period of follow up as it may require at least 5 years of follow up and up to early adulthood to detect recurrence and fully evaluate the results of contracture release.[18]

The mobility and ROM gains observed among CP children are not due to surgery alone and is in synchrony with physical therapy. Surgical intervention must be combined with an intensive post-operative rehabilitation programme individually catered and performed under the guidance of experienced physical therapists to maximise functional improvement.[5] However, in our setting, the postsurgical intervention physical therapy was not strictly controlled and the changes in physical therapy may have been confounded similar to Chang et al.[8] Couple this with inadequacy of records of therapy sessions, the impact of physical therapy on ambulatory gains are difficult to assess.

To our knowledge, this is the first study in our region to look at outcomes of surgical intervention and rehabilitation objectively among CP children. The results achieved are similar to other studies in improvements of ROM and functional mobility. The study is limited by its small sample size despite a review of 10 years. This may be due to lack of awareness and how misunderstood CP is among Malaysians. We also postulate that parents are reluctant to subject their

Table I: Summary of patients

Age	Gender	GMFCS	Limb involvement	Level involvement	Procedure
5	Female	III	Bilateral	Knee	HR
5	Male	I	Left	Ankle	GR
8	Male	II	Left	Ankle	PR + TAL
9	Female	III	Bilateral	Ankle	GR
11	Male	III	Bilateral	Knee	HR
11	Male	I	Left	Ankle	GR
12	Female	II	Left	Knee	HR
13	Female	III	Bilateral	Hip + Knee	HR + TAL
13	Female	II	Left	Knee + Ankle	HR + TAL
14	Female	III	Bilateral	Knee	HR
14	Female	II	Right	Knee	HR
14	Male	II	Right	Knee + Ankle	HR + TAL
14	Female	III	Bilateral	Ankle	TAL
15	Male	I	Left	Ankle	GR
15	Female	II	Bilateral	Ankle	TAL
15	Male	I	Right	Ankle	TAL
16	Male	I	Right	Knee + Ankle	HR + TAL
17	Male	II	Right	Ankle	GR
18	Female	III	Bilateral	Knee	HR

*HR = Hamstring release, GR = Gastrocsoleus recession, PR = Plantar release, TAL = Tendon Achilles lengthening, AR = Adductor release

Table II: FMS score improvement at 5m, 50m, 500m at 18 months compared to pre-surgery

	5M (p value)	50M	500M
N	1	13	5
	(0.351)	(0.027)	(0.351)
GMFCS I	1	3	2
GMFCS II	0	4	3
GMFCS III	0	6	0
Mean	4.74	4.32	3.89
SD	1.66	1.73	2.13

GMFCS = Gross Motor Function Classification System
SD= standard deviation

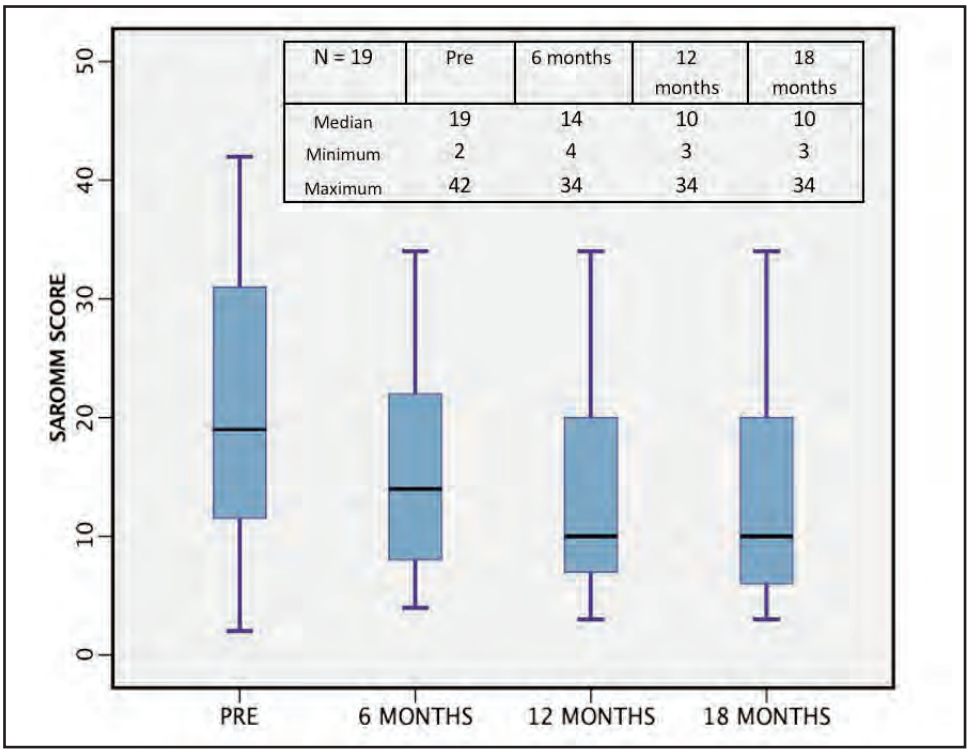

Fig. 1: Boxplot analysis of SAROMM showing reduction of median scores at 6 & 12 months which then plateaus at 18 months.

children to painful surgery for the sake of gait improvement. Apart from that, this study is limited to one centre and results are not to be generalised to the whole country to reflect the lack of access to surgical and rehabilitative facilities available for CP children.

Furthermore, the lack of a dedicated gait analysis facility at our centre hampers our ability of making accurate and concise surgical planning retarding the growth and development of Single Event Multi-Level Surgery (SEMLS) which is commonly practised in other countries. We were also concerned that the ambulatory function ratings were assigned retrospectively using the information available, which could have impacted their accuracy.

CONCLUSION

With available data from this research, surgeries performed on GMFCS I-III patients with the aim of gait improvement does translate into better mobility outcome which are comparable to present available literature[5,6,19]. This research should prove to be a steppingstone to expand the research by having longer follow up of patients thereby increasing the sample size thus the strength of the study. Longer follow up also allows us look for recurrences and how surgery has impacted the quality of life and functionality in the community. Furthermore, an addition of gait analysis facilities may enhance the decision-making process and allow more accurate surgical prescription for contracture release among CP children.

REFERENCES

1. Sellier E, McIntyre S, Smithers-Sheedy H, Platt MJ. European and Australian cerebral palsy surveillance networks working together for collaborative research. Neuropediatrics. 2020;51(02):105-112.
2. Kamaralzaman S, Ying TC, Mohamed S, Toran H, Satari N, Abdullah N. The economic burden of families of children with cerebral palsy in Malaysia. Malaysian Journal of Public Health Medicine. 2018; 2018(Specialissue1).
3. Novak I, McIntyre S, Morgan C, Campbell L, Dark L, Morton N, et al. A systematic review of interventions for children with cerebral palsy: state of the evidence. Dev Med Child Neurol. 2013; 55(10): 885-910.
4. Bulekbayeva S, Daribayev Z, Ospanova S, Vento S. Cerebral palsy: a multidisciplinary, integrated approach is essential. Lancet Glob Health. 2017; 5(4): e401.
5. Thomason P, Baker R, Dodd K, Taylor N, Selber P, Wolfe R, et al. Single-Event Multilevel Surgery in Children with Spastic Diplegia. J Bone Joint Surg. 2011; 93(5): 451-60.
6. Firth GB, Passmore E, Sangeux M, Thomason P, Rodda J, Donath S, et al. Multilevel surgery for equinus gait in children with spastic diplegic cerebral palsy medium-term follow-up with gait analysis. Journal of Bone and Joint Surgery - Series A. 2013; 95(10): 931-8.
7. Feger MA, Lunsford CD, Sauer LD, Novicoff W, Abel MF. Comparative Effects of Multilevel Muscle Tendon Surgery, Osteotomies, and Dorsal Rhizotomy on Functional and Gait Outcome Measures for Children With Cerebral Palsy. PM and R. 2015; 7(5): 485-93.
8. Chang CH, Chen YY, Yeh KK, Chen CL. Gross motor function change after multilevel soft tissue release in children with cerebral palsy. Biomed J. 2017; 40(3): 163-8.
9. Kerr Graham H, Selber P. Musculoskeletal aspects of cerebral palsy. J Bone Joint Surg Br. 2003; 85(2): 157-166.
10. Shore BJ, Yu X, Desai S, Selber P, Wolfe R, Graham HK. Adductor surgery to prevent hip displacement in children with cerebral palsy: the predictive role of the Gross Motor Function Classification System. J Bone Joint Surg Am. 2012; 94(4): 326-34.
11. Ahmed AAY, Rafalla AAA. Clinical outcome of hamstring lengthening to correct flexed knee gait in patients with spastic diplegia. Egypt Orthop J. 2017: 352-8.
12. Takahashi S, Shrestha A. The vulpius procedure for correction of equinus deformity in patients with hemiplegia. J Bone Joint Surg Br. 2002; 84(7): 978-80.
13. Palisano R, Rosenbaum P, Bartlett D, Livingston M, Walter S, Russell D, et al. Gross Motor Function Classification System Expanded and Revised. Reference: Dev Med Child Neurol. 2007; 39: 214-23.
14. Graham HK, Harvey A, Rodda J, Nattrass GR, Pirpiris M. The Functional Mobility Scale (FMS). J Pediatr Orthop 2004; 24(5): 514-20.
15. Bartlett DJ. The use of the spinal alignment and range of motion measure with children and young people with cerebral palsy. Dev Med Child Neurol. 2013; 55(8): 685-6.
16. Davids JR, Ounpuu S, DeLuca PA, Davis RB. Optimization of walking ability of children with cerebral palsy. Instr Course Lect. 2004; 53(11): 511-22.
17. Chen CL, Wu KPH, Liu WY, Cheng HYK, Shen IH, Lin KC. Validity and clinimetric properties of the spinal alignment and range of motion measure in children with cerebral palsy. Dev Med Child Neurol. 2013; 55(8): 745-750.
18. Joo SY, Knowtharapu DN, Rogers KJ, Holmes L, Miller F. Recurrence after surgery for equinus foot deformity in children with cerebral palsy: assessment of predisposing factors for recurrence in a long-term follow-up study. J Child Orthop. 2011; 5(4): 289-96.
19. Harvey A, Graham HK, Morris ME, Baker R, Wolfe R. The Functional Mobility Scale: ability to detect change following single event multilevel surgery. Dev Med Child Neurol. 2007; 49(8): 603-7.