Gastrocnemius recession in children with cerebral palsy

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Introduction

Equinus deformity of the ankle is one of the most common deformities in children with cerebral palsy (CP). Triceps surae lengthening procedures include Achilles tendon-lengthening procedures and gastrocnemius recessions. Although both procedures result in improvements in ankle kinematics, there is no clear consensus on the best procedure.

Materials and methods

The study included 21 patients with ambulatory spastic CP with static equinus contracture who underwent 32 open distal gastrocnemius recessions. Fourteen patients had spastic diplegia, whereas seven patients had hemiplegia. The average age of the patients was 7.4 years (range 5–14), and the average follow up was 26 months (range 15–34). Outcome measures assessed preoperatively and postoperatively were passive dorsiflexion range of motion with the knee flexed and extended, dorsiflexion and plantarflexion strength, and calf spasticity with the knee flexed and extended in addition to the Gait Pattern Scale.

Results

All outcome measures showed a statistically significant improvement after gastrocnemius recession, except dorsiflexion and plantarflexion strength. Two limbs (6%) developed recurrence of equinus. No limbs developed overcorrection.

Conclusion

Gastrocnemius recession utilizing the technique described in this study has a satisfactory clinical outcome in ambulatory children with CP and clinically relevant gastrocnemius equinus contracture. The recurrence rate is acceptable in the short term.

Keywords:
cerebral palsy, equinus, gastrocnemius recession

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Introduction

Equinus deformity of the ankle is one of the most common deformities in children with cerebral palsy (CP), and leads to gait disturbance and functional limitations [1–3]. Children with dynamic equinus deformity may be treated with orthosis, manipulative therapy, and botulinum toxin injections. However, static equinus contracture usually requires lengthening of the musculotendinous unit of the gastrocnemius–soleus complex to achieve a satisfactory static range of motion and optimize joint position throughout the gait cycle [2,4].

The majority of stretch in the posterior superficial compartment is because of the muscle bellies of the gastrocnemius and soleus and not the tendo-Achilles complex. A functional equinus contracture is often because of gastrocnemius, not soleus tightness [5].

Triceps surae lengthening procedures include tendo–Achilles lengthening (TAL) procedures and gastrocnemius recessions (GR). Although both TAL and GR result in improvements in ankle kinematics, there is no clear consensus on the best procedure. Some studies in the literature report that both TAL and GR show comparable potential for undercorrection and overcorrection [2,6–9]. Other studies report a less common rate of overcorrection in GR [10].

The aim of this study is to present the short-term clinical results of distal GR in ambulatory spastic children with CP with static equinus contracture of the ankle.

Patients and methods

A prospective study was carried out during the period between May 2008 and August 2009. The study included 21 patients with ambulatory spastic CP with static equinus contracture who underwent 32 open distal GR. Fourteen patients had spastic diplegia, whereas seven patients had hemiplegia. Of the 14 diplegic patients, only 11 underwent bilateral GR, whereas two patients underwent GR on one side and TAL on the other side. Only one diplegic patient underwent GR on one side and no surgery on the other side. Patient demographics and associated procedures are presented in Tables 1 and 2.

Table 1 Patient demographics

	Patients (21)
Age (years)	7.4 [range (5–14)]
Sex	13 males, 8 females
Geographic distribution	7 hemiplegics, 14 diplegics
GMFCS	8 level I, 3 level II, 10 level III
Follow-up (months)	26 [range (15–34)]

GMFCS, General Motor Function Classification System.

Table 2 Associated procedures

Procedure	Number
Adductor tenotomy	14
Hamstring lengthening	13
Split tibialis anterior transfer	2
Intramuscular lengthening of tibialis posterior	6
Split tibialis posterior transfer	2
Femoral derotation osteotomy	2
Extra-articular subtaloid fusion	1
TAL	2

TAL, tendo-Achilles lengthening.

Patient selection

According to the Gross Motor Function Classification System, only ambulatory patients with level I–III were included in the study [11]. Level I represents children who can walk without restrictions, but have limitations in more advanced gross motor skills. Level II represents those who can walk without restrictions, but have limitations walking outdoors and in the community. Level III represents those who can walk with assistive mobility devices, but with limitations in walking outdoors and in the community.

The Silfverskiold test was performed on all patients (Fig. 1a and b). A prerequisite was that the ankle can be passively dorsiflexed with the knee flexed, but not with the knee extended. Caution was exercised to avoid eversion of the fore and midfoot through the mid tarsus.

Inclusion criteria

(1) The lower age limit was 5 years.
(2) Static equinus contracture of the ankle.
(3) A positive Silfverskiold test.
(4) Ambulatory spastic children with CP.

Exclusion criteria

(1) Patients who had undergone previous TAL or GR.
(2) Patients who had received a previous botulinum toxin injection.
(3) Patients with mental retardation.

Patient evaluation

The outcome measures recorded were passive dorsiflexion range of motion with the knee flexed and extended, dorsiflexion and plantarflexion strength, and calf spasticity with the knee flexed and extended. Range of motion for the ankle was measured using a goniometer. Muscle strength was assessed using the traditional 0–5 grade scale. Calf spasticity was measured according to the modified Ashworth scale [12] (Table 3). Foot–floor contact was also measured according to the Gait Pattern Scale (GPS) [13] (Table 4).

Surgical procedure

A posterior longitudinal incision was made over the middle of the calf at the level of the musculotendinous junction. Before incising the fascia, the sural nerve was identified and protected either superficial or deep to the deep fascia. The aponeurosis of the gastrocnemius was incised transversely from lateral to medial together with the plantaris tendon. The ankle was brought to slight dorsiflexion to separate the two ends of the aponeurosis. The aponeurosis of the soleus may be incised if further correction is required. Caution was exercised not to disturb the soleus muscle itself.

A below-knee plaster cast was applied with the ankle in neutral dorsiflexion for 6 weeks and patients were allowed to weight bear according to tolerance. Postoperatively, patients were instructed to wear a daytime ankle foot orthosis for 6 months. A regular physical therapy program to maintain ankle dorsiflexion was continued.

Statistical analysis

Descriptive statistics were obtained for all variables in the study using the SPSS (version 11). For quantitative variables, the mean, range, ± SD, and ± SEM were calculated. Comparison of quantitative data was carried out to compare preoperative and postoperative results. To compare parametric data, the paired *t*-test was used. To compare nonparametric data, the Wilcoxon signed-ranks test was used.

Comparison of categorical data was performed using the χ^2-test. A *P*-value was considered significant if less than 0.05 and highly significant if less than 0.001.

Results

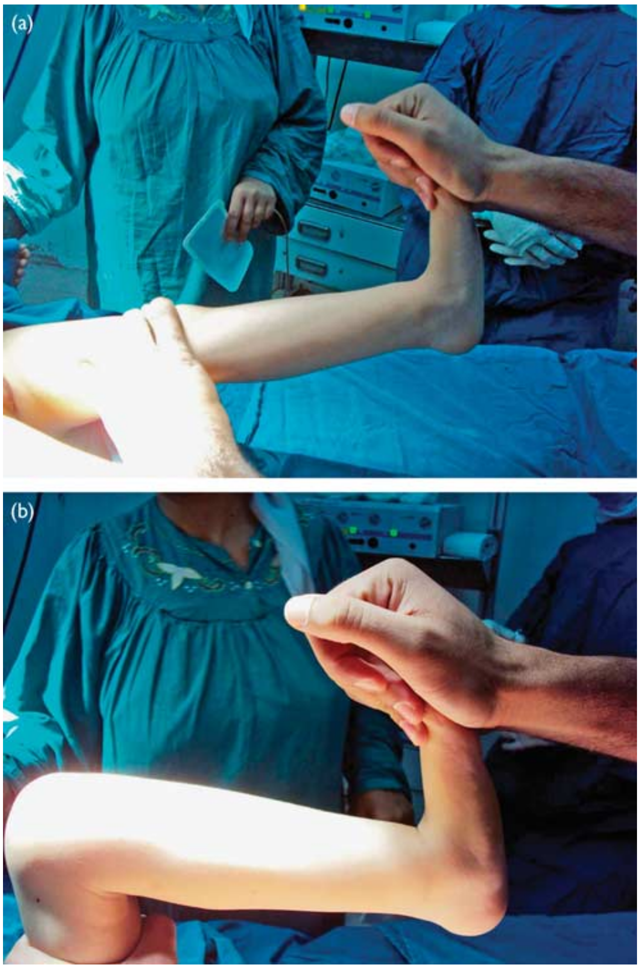
The mean preoperative and postoperative limb scores (32 limbs) for outcome measures are presented in Table 5. According to the GPS [13], two limbs (6%) developed recurrence. No overcorrected limbs were encountered. Limbs that maintained toe or forefoot initial foot contact at the last follow-up visit were considered recurrent. The 10 patients who used gait-assistive devices preoperatively continued to use the same devices postoperatively.

There was a statistically significant improvement in all outcome measures except dorsiflexion and plantarflexion strength (Table 5). The difference in improvement between the diplegic and the hemiplegic limbs was not statistically significant.

Discussion

In the current study, all static and dynamic outcome measures showed a statistically significant improvement

Figure 1



(a) Preoperative Silfverskiold test with the knee extended, (b) with knee flexion.

Table 3 Modified Ashworth scale [12]

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is(are) moved in flexion or extension
1 +	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance through the rest of the range of motion but the affected part(s) is(are) easily moved
2	More marked increase in muscle tone through most of the range of movement, but the affected part(s) is easily moved
3	Considerable increases in muscle tone, passive movement difficult
4	Affected part(s) is(are) rigid in flexion or extension

following GR, except dorsiflexion and plantarflexion strength. A nonsignificant improvement in static dorsiflexion and panterflexion strength has been reported previously by Kay *et al.* [2]. Nevertheless, Kay *et al.* [2] reported a statistically significant improvement in push-off power as a dynamic outcome measure. Improvement in push-off power following GR has been reported previously [2,14,15].

Table 4 Gait Pattern Scale [13]

Gait parameter	Definition	Limb score
Initial foot contact	Toe	0
	Forefoot	1
	Footflat	2
	Heel	3
Foot contact at midstance	Toe/toe (equinus)	− 1
	Footflat/early heel rise	0
	Footflat/no early heel rise	1
	Occasional heel/footflat	2
	Heel/toe (normal roll over)	3
Gait-assistive devices	Walker with assistance	0
	Walker (independent)	1
	Crutches, sticks	2
	None, independent for 10 m	3
Total score (score, − 1 to 9 per limb)		

The current study found a significant improvement in the GPS, the only dynamic outcome measure used. The study by Kay *et al.* [2] reported similar findings following GR and TAL. Nevertheless, Kay *et al.* [2] used slow motion biplaner video analysis to assess the gait pattern. This contrasts to the current study, in which the author used a real-time clinical assessment.

The literature reports that the incidence of postoperative equinus following triceps surae lengthening in children with CP ranges from 5 to 48% [8,9,16–19]. The incidence of postoperative equinus in the current study was 6%, which falls in this range. It is noteworthy that many recurrences may not be included in short follow-up studies such as the current study.

Some studies have concluded that the incidence of recurrent equinus in CP following triceps surae lengthening is significantly less in children who were at least 6 years old at the time of surgery compared with children who were 4 years old or younger [7,18,19]. In the current study, the lower age limit was 5 years and the incidence of recurrence was 6% (two limbs). However, the relatively low incidence of recurrence in the current study may not be attributed to age alone.

The commonly reported incidences for overcorrection and consequent calcaneal gait following triceps surae lengthening range from 0 to 36% [8,9,14,16–18]. Kay *et al.* [2] have reported a 21% incidence of calcaneal gait following GR in CP. That contrasts with the current study, in which no limbs with overcorrection and calcaneal gait were encountered. It has been suggested that the incidence of calcaneus gait will increase with time as the children become taller and heavier, especially if they are diplegic or quadriplegic [2].

Although Kay *et al.* [2] reported a higher rate of overcorrection than the current study, they did not find any statistically significant difference between the GR and the TAL groups for overcorrection in their comparative study. Kay *et al.* [2] report that this finding may be attributed to sample size limitations, insufficient length of time from surgery to follow-up, or appropriate surgical decision-making. Nonsignificant differences between GR and TAL groups for overcorrection have been reported previously [9]. The author of this study suggests that

Table 5 Mean (±SD) limb scores for clinical outcome measures (32 limbs)

Outcome measures	Preoperative	Postoperative	Change	*P*-value
Dorsiflexion range				
Knee flexed	10.3±2.9	17.5±4.1	7.1±3.1	<0.001
Knee extended	−5.44±4.2	9.44±4.4	14.8±5.5	<0.001
Dorsiflexion strength	2.4±0.6	2.4±0.5	±0.6	>0.05 (0.56)
Plantarflexion strength	2.4±0.6	2.6±0.5	0.16±0.6	>0.05 (0.16)
Calf spasticity				
Knee flexed	2.9±0.7	1.7±0.6	1.3±0.9	<0.001
Knee extended	2.8±0.7	2.2±0.6	0.6±1	<0.05 (0.002)
GPS	2.3±0.9	6±1.3	3.6±1.6	<0.001

GPS, Gait Pattern Scale [13].

such findings may create controversy as for the best procedure for triceps surae lengthening.

It is noteworthy that it is difficult to compare the success rates of different studies on lengthening of triceps surae in general and GR specifically in equinus contracture in children with CP because of the use of variable procedures and selection criteria.

In the current study, 67% of the children were diplegic, whereas 33% were hemiplegic. The prevalence of bilaterally affected children with CP compared with unilaterally affected children in a series treating equinus contracture by GR has been reported in the literature [2].

The limitations of the current study are acknowledged. Computerized gait analysis was not used to assess kinematic and kinetic variables because of unavailability. The relatively short follow-up period is another limitation. A longer follow-up period is required to assess the true incidence of recurrence.

GR utilizing the technique described in this study has a satisfactory clinical outcome in appropriately selected ambulatory children with CP and clinically relevant gastrocnemius equinus contracture. The recurrence rate was acceptable in the short term, with no cases of overcorrection reported.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1. Fulford GE. Surgical management of ankle and foot deformities in cerebral palsy. Clin Orthop 1990; 253:55–61.
2. Kay RM, Rethlefsen SA, Ryan JA, Wren TA. Outcome of gastrocnemius recession and tendo–Achilles lengthening in ambulatory children with cerebral palsy. J Pediatr Orthop B 2004; 13:92–98.
3. Wren TA, Rethlefsen S, Kay RM. Prevalence of specific gait abnormalities in children with cerebral palsy: influence of cerebral palsy subtype, age, and previous surgery. J Pediatr Orthop 2005; 25:79–83.
4. Wren TA, Allison P, Cheatwood AP, Rethlefsen SA, Hara R, Perez FJ, Kay RM. Achilles tendon length and medial gastrocnemius architecture in children with cerebral palsy and equinus gait. J Pediatr Orthop 2010; 30:479–484.
5. DiGiovanni CW, Kuo R, Tejwani N, Price R, Hansen ST Jr, Cziernecki J, Sangeorzan BJ. Isolated gastrocnemius tightness. J Bone Joint Surg Am 2002; 84:962–970.
6. Segal LS, Thomas SE, Mazur JM, Mauterer M. Calcaneal gait in spastic diplegia after heel cord lengthening: a study with gait analysis. J Pediatr Orthop 1989; 9:697–701.
7. Rattey TE, Leahey L, Hyndman J, Brown DC, Gross M. Recurrence after Achilles tendon lengthening in cerebral palsy. J Pediatr Orthop 1993; 13:184–187.
8. Etnyre B, Chambers CS, Scarborough NH, Cain TE. Preoperative and postoperative assessment of surgical intervention for equinus gait in children with cerebral palsy. J Pediatr Orthop 1993; 13:24–31.
9. Borton DC, Walker K, Pirpiris M, Nattrass GR, Graham HK. Isolated calf lengthening in cerebral palsy. Outcome analysis of risk factors. J Bone Joint Surg Br 2001; 83:364–370.
10. Sawyer JR. Cerebral palsy. In: Canale ST, Beaty JH, editors. *Campbell's Operative Orthopaedics*. 11th ed. Philadelphia: Mosby Elsevier; 2008. pp. 1333–1388.
11. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 1997; 39:214–223.
12. Mutlu A, Livanelioglu A, Gunel MK. Reliability of Ashworth and Modified Ashworth Scales in children with spastic cerebral palsy. BMC Musculoskelet Disord 2008; 10:9–44.
13. Boyd RN, Graham HK. Objective measurement of clinical findings in the use of botulinum toxin type A for the management of children with cerebral palsy. Eur J Neurology 1999; 4:23–35.
14. Rose SA, DeLuca PA, Davis RB III, Ounpuu S, Gage JR. Kinematic and kinetic evaluation of the ankle after lengthening of the gastrocnemius fascia in children with cerebral palsy. J Pediatr Orthop 1993; 13:727–732.
15. Yngve DA, Chambers C. Vulpius and Z-lengthening. J Pediatr Orthop 1996; 16:759–764.
16. Gaines RW, Ford TB. A systematic approach to the amount of Achilles tendon lengthening in cerebral palsy. J Pediatr Orthop 1984; 4:448–451.
17. Moreau MJ, Lake DM. Outpatient percutaneous heel cord lengthening in children. J Pediatr Orthop 1987; 7:253–255.
18. Abdelaziz TH. Slide lengthening of the heel cord in cerebral palsy. Pan Arab J Orthop Trauma 2008; 12:46–50.
19. Olney BW, Williams PF, Menelaus MB. Treatment of spastic equinus by aponeurosis lengthening. J Pediatr Orthop 1988; 8:422.