

# Correction of foot deformity by lateral column lengthening through calcaneus in children with cerebral palsy

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**Abstract** : The study is done to evaluate the effectiveness of lateral column lengthening through calcaneus for planovalgoid and equinovalgoid foot deformity in spastic diplegic cerebral palsy. 15 children required the operation and their mean age at surgery was 10y 9 m (ranging from 5y 2 m to 15y 2 m). The mean follow-up duration was 4y 1 m (range of 1y 6 m to 9y 8 m). The results were evaluated clinically and radiologically. Of these 9 feet had good, 4 had fair, and 2 had poor outcome. Poor outcome resulted from recurrence of deformity which was mainly due to noncompliant nature of the patients toward brace wear and physiotherapy.

## Introduction

Foot deformity in the form of planovalgoid and equinovalgoid is common in spastic diplegic cerebral palsy patients because of spasticity and subsequent contracture of gastrocnemius-soleus complex and peroneus muscles. Deformity is characterised by forefoot abduction, heel valgus, plantarflexion of talus and calcaneus with eversion of subtalar complex during weight bearing. Navicular is abducted and dorsiflexed on head of talus. These combination create a sag in medial longitudinal arch of foot resulting in pain, lever arm dysfunction, and ulceration of skin.

Initial attempts to stabilize the deformity is made with injection of Botulinum toxin in spastic muscle, physiotherapy and splints. In some patients these measures fail to halt the deformity and operative treatment is necessary. Operative

treatment can be individualized in the form of fusion of one or multiple joints, such as subtalar fusion or triple arthrodesis, arthroerisis of sinus tarsi by plastic plug, staple or screw, correctional osteotomies such as lateral column lengthening. The aim of this study is to know the outcome of calcaneal lengthening for planovalgoid and equinovalgoid foot deformity in ambulatory and non ambulatory children with cerebral palsy.

## Patients and Methods

15 children (30 feet, 10 ambulatory and 5 non ambulatory) with spastic diplegic cerebral palsy and flexible deformity (6 planovalgoid and 9 equinovalgoid) received bilateral lateral column lengthening. Calcaneal lengthening was performed as one of multiple simultaneous surgeries performed to improve the entire gait pattern. These surgeries were performed between Aug

Table 1.

patient	Age yrs + m	sex	Previous treatment	Walking ability	deformity	Concurrent surgeries	result
1	5+2	M	Physiotherapy (PT)	Ambulatory	Equinovalgoid	B/L Hamstring & Tendoach. Apo lengthening	Poor
2	7+3	M	Inj Botox + PT	Ambulatory	Equinovalgoid	Peroneus brevis lengthening	Good
3	11+0	M	Physiotherapy	Nonambulatory	Planovalgoid	B/L hamstring. Rectus apo. release	Good
4	14+3	F	Inj Botox + PT	Ambulatory	Planovalgoid	B/L hamstring apo. release. post. tibial plication	Fair
5	15+2	M	Physiotherapy	Ambulatory	Equinovalgoid	B/L hamstring. Rectus apo. release	Poor
6	15+2	M	Inj Botox + PT	Ambulatory	Planovalgoid	B/L hamstring. Rectus psoas apo. Release B/L EHL, EDL & peroneus brevis lengthening	Good
7	6+0	M	Inj Botox + PT	Ambulatory	Equinovalgoid	B/L hamstring. apo. release	Good
8	9+3	M	Inj Botox + PT	Ambulatory	Equinovalgoid	B/L hamstring. apo. release	Good
9	12+1	M	Physiotherapy	Nonambulatory	Planovalgoid	B/L hamstring, Rectus Ileo-psoas apo. release	Fair
10	12+6	F	Inj Botox + PT	Nonambulatory	Equinovalgoid	B/L hamstring. Rectus apo. release	Fair
11	14+2	M	Inj Botox + PT	Ambulatory	Equinovalgoid	Peroneus longus lengthening	Good
12	14+3	M	Inj Botox + PT	Nonambulatory	Planovalgoid	B/L hamstring. Rectus Ileo-psoas apo. release	Good
13	9+5	M	Inj Botox + PT	Nonambulatory	Equinovalgoid	B/L hamstring. apo. release	Good
14	12+3	M	Physiotherapy	Ambulatory	Equinovalgoid	B/L hamstring & psoas. apo. release	Good
15	9+9	F	Inj Botox + PT	Ambulatory	Planovalgoid	B/L hamstring. Rectus apo. release	Fair

1998 and Feb 2006. The average age at surgery was 10.9 years (range ; 5.2-15.2). The average follow up is 4.1 years (range ; 1.5-10). Precise patients data were summarized in Table 1.

### Evaluation

Patients were evaluated on the basis of clinical and radiological parameters on preoperative, postoperative, and follow up visits. Clinical parameters consisted of cosmesis, pain, talar head prominence, and increase in postoperative walking distance or reduction in amount of support required for walking.

Radiologically, the patients were evaluated on standing x-ray of both feet in AP and Lateral

planes. In lateral plane, calcaneal pitch, talo-1<sup>st</sup> metatarsal angle, talo horizontal angle, and talocalcaneal angle were measured (Fig. 1). In anteroposterior plane, talo-1<sup>st</sup> metatarsal angle, alignment of navicular over talus, and talocalcaneal angle were measured (Fig. 2).

At follow-up visits, results were graded as Good, Fair and Poor as follows :

Good : Good cosmesis, increase in walking distance (with or without support) no pain, decrease in talar head prominence.

Fair : Moderate cosmetic improvement, static postoperative ambulatory status, some discomfort.

Poor : Recurrence of deformity



Fig. 1. Roentgenographic parameter in lateral view : Calcaneal pitch, talo-1<sup>st</sup> metatarsal angle, talo horizontal angle, and talocalcaneal angle were measured.



Fig. 2. Roentgenographic parameter in antero-posterior view : Talo-1<sup>st</sup> metatarsal angle, alignment of navicular over talus, and talocalcaneal angle were measured.



Fig. 3. An example of preoperative view

### Surgical technique

For lateral column lengthening, sinus tarsi was first exposed through an incision parallel and anterior to peroneus brevis tendon. After that calcaneocuboid joint is visualized, then a transverse osteotomy was made between anterior and middle facet of calcaneus and exiting medially in the anterior aspect of middle facet. The osteotomy is opened with 10-15 mm wide with the help of specially designed distractor and tricortical graft from iliac crest was inserted in the gap of the osteotomy site. Fixation of graft was done with one or two Kirschner wires.

Medial incision was given over talonavicular joint and capsular plication was done. Posterior tibial tendon advancement and peroneal tendon lengthening was judged according to correction

of deformity. Usually only peroneus brevis was lengthened except one case that required peroneus longus lengthening. An Achilles tendon lengthening was performed in all cases.

A non-weight bearing above knee cast was given for six week in all cases and Kirschner wires were removed at six week depending on healing of osteotomy. Then the cast was changed to a weight-bearing cast for four weeks. After that cast was discarded, splints were given.

### Results

Clinical and radiological assessment was done at the follow-up visit. Eighteen of the 30 feet had good results, 8 of 30 feet had fair results, and 4 feet poor. Pain and talar head prominence was decreased. Callosity were eradicated. Hind foot deformity was corrected. A longitudinal arch was created (Fig. 3 & 4). Ulceration has not occurred with the patient bearing weight as far as the patient were cooperative for brace and regular physiotherapy were taken by them. Four out of 30 feet with poor results required repeat calcaneal lengthening (Fig. 5). These patients were uncooperative for brace wear and physiotherapy.



Fig. 4.

An example of postoperative view



Fig. 5.

An example of recurrence

Table 2.

Case	Side	LATERAL VIEW				AP VIEW		
		Calcaneal pitch	Talo 1 <sup>st</sup> metatarsal angle	Talo horizontal angle	Talo calcaneal angle	Talo 1 <sup>st</sup> metatarsal angle	Alignment of talonavicular joint	Talocalcaneal angle
1	R	0/14	36/8	40/22	36/30	40/0	s/l/ok	40/14
	L	0/32	36/6	42/20	48/32	50/12	s/l/ok	40/4
2	R	5/22	18/8	34/28	36/56	55/24	s/l/ok	52/26
	L	5/22	18/2	30/36	38/54	55/20	Ok/ok	48/16
3	R	0/18	35/10	45/20	25/30	15/6	s/l/ok	42/16
	L	0/20	35/8	45/20	40/42	25/22	Ok/ok	38/18
4	R	0/12	30/8	40/24	30/46	23/8	s/l/ok	20/0
	L	12/22	10/4	28/20	38/48	34/6	Ok/ok	20/2
5	R	9/21	41/9	40/18	36/50	42/4	s/l/ok	50/10
	L	12/26	46/20	30/15	46/56	30/12	Ok/ok	42/6
6	R	2/12	24/10	30/15	34/60	40/15	Ok/ok	34/10
	L	6/17	28/5	20/10	40/62	36/10	Ok/ok	44/8
7	R	-15/12	35/8	38/26	15/38	20/12	s/l/ok	52/20
	L	-12/14	30/10	45/26	25/40	16/6	s/l/ok	60/30
8	R	6/18	20/4	45/22	18/44	55/28	Ok/ok	48/18
	L	8/16	34/10	50/32	22/52	48/26	s/l/ok	54/26
9	R	3/15	41/8	39/22	50/60	34/14	Ok/ok	44/12
	L	8/22	36/8	38/10	52/64	38/16	Ok/ok	52/16
10	R	8/18	26/6	40/20	20/34	40/12	s/l/ok	26/2
	L	10/26	28/6	44/30	30/40	28/6	s/l/ok	30/4
11	R	12/20	10/0	25/14	48/54	17/2	s/l/ok	38/12
	L	12/22	12/2	30/20	32/50	27/4	Ok/ok	40/10
12	R	11/25	38/12	40/18	36/54	36/14	s/l/ok	34/16
	L	16/28	40/8	38/21	42/58	38/12	s/l/ok	40/12
13	R	9/25	19/0	53/26	22/38	20/2	s/l/ok	22/2
	L	15/24	16/4	51/27	26/40	26/4	Ok/ok	30/6
14	R	10/12	0/0	36/18	42/60	24/12	s/l/ok	34/4
	L	26/32	0/0	40/22	36/52	22/4	Ok/ok	38/4
15	R	0/26	5/0	28/20	34/36	35/2	s/l/ok	40/20
	L	10/18	10/2	32/14	24/40	38/4	s/l/ok	34/8

s/L--subluxated



Radiographic union was seen in 6 week and for complete remodeling it took one year. The procedure took approximately 3 hours. But since it is done in conjunction with surgeries at other level, exact determination of time duration was difficult. Surgery was done under a tourniquet so blood loss was minimum. Postoperatively, patients were comfortable with no wound dehiscence and no infection. Closure was done with absorbable subcuticular stitches, so good cosmesis was obtained. Subtalar motion was preserved in all cases.

Results of radiological assessment were summarized in Table 2. They were correlated well with the value given in literature. (Lateral talo-1<sup>st</sup> metatarsal angle ; average normal value of 6.2 degrees (range ; 0 to 20), Lateral talo horizontal angle ; average normal value of 21.2 degrees (range ; 10 to 36), Calcaneal pitch angle ; average normal value of 19.7 degrees (range ; 12 to 32))

The correlation between clinical and radiological result seemed to be little but there were definite changes between preoperative and postoperative radiographs.

### **Complication**

Though there were reported complication of subtalar fusion, nonunion and slippage of graft, we have taken utmost precaution and did not have any of them.

### **Discussion**

Different operations are proposed for correction of planovalgoid deformities as follows : 1) Arthroereisis of sinus tarsi by plastic plug, staple or screw, 2) Subtalar arthrodesis, 3) Triple arthrodesis, and 4) Lateral column lengthening through calcaneus. The procedure undertaken

should be on basis of clear understanding and good long-term follow-up results. Long-term result of subtalar and triple arthrodesis have proven to be unsatisfactory, because there were undercorrection, overcorrection, nonunion, recurrence of deformity, avascular necrosis of talus, instability of ankle, technical difficulties, and development of substantial degenerative arthrodesis in the ankle and other adjacent joints of the foot. Lateral column lengthening may be superior to arthroereisis of the sinus tarsi as lateral column lengthening is not troubled by complication associated with the introduction of foreign body in the foot.

The result of this study demonstrate that calcaneal lengthening provide good correction of deformity, reliably relieves symptoms, restore function of subtalar complex. If degenerative osteoarthritis develops later then arthrodesis of these joints can be done later with relative ease as deformity is already been corrected. It is also important that deformity at the hip and knee joints, which lead to failure, should be prevented after surgery so that axis of weight transmission remain aligned by continuous physiotherapy and brace wear.

### **Conclusion**

Calcaneal lengthening can be an effective procedure in correcting foot deformity in children with cerebral palsy, careful assessment of severity of radiographic deformity and examining the spasticity of muscle around the foot and ankle joint should be done before undertaking calcaneal lengthening.

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