

Calcaneal Sliding Osteotomy Versus Calcaneal Lengthening Osteotomy for Valgus Foot Deformity Correction in Children with Cerebral Palsy

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INTRODUCTION: Progressive foot deformity is often seen in children with cerebral palsy (CP)^{1,3} and can adversely affect a child's gait and function as they age. The odds of pes valgus and out-toeing increase with age and history of prior surgery in children with CP.¹ In ambulatory patients, correction of pes valgus is performed to relieve pain and improve transverse plane alignment with the hope of improving stance phase stability and functional ambulation.^{1,3} At our facility, medial calcaneal sliding osteotomy (CS) and (LCL) are the two main osseous surgeries performed for the correction of pes valgus deformity. Medial column surgery, most commonly talonavicular joint capsulorrhaphy (TNCC) or talonavicular joint fusion (TNF), is often performed concomitantly with the calcaneal osteotomy. We have anecdotally observed postoperative development of pes varus deformity after LCL and have replaced it with CS with the aim of preventing this unintended result.

CLINICAL SIGNIFICANCE: The purpose of this study was to compare the effectiveness of CS and LCL procedures for correction of valgus foot deformities in ambulatory children with CP. We hypothesized that the two approaches would be equivalent with respect to deformity correction and improvement in gait characteristics, but that the incidence of post-operative pes varus would be higher after LCL than CS.

METHODS: Retrospective medical record review (including 3D gait analysis data) of patients with CP functioning at GMFCS levels I-III, who underwent LCL or CS at our facility. Data extraction included complications (modified Clavien-Dindo system), change in standing foot position (modified Yoo system)², and change in gait kinematics and kinetics pre- to post-operatively. Groups were compared using paired t-tests, Fisher's exact test, and survivorship analysis using Cox proportional hazard models.

RESULTS: Seventy-two eligible participants (119 limbs) were identified, 41 male (57%) and 31 female (43%). Average age at surgery was 11.1 (SD 2.5) years. All participants were ambulatory with or without assistive devices, and 38 (53%) functioned at GMFCS level III at the time of surgery. Age at surgery, sex distribution, and distribution of GMFCS levels were similar between groups. The CS group had significantly shorter follow-up time than the LCL group ($p=0.0004$). The CS group had a higher rate of concomitant TNF (48% vs. 0%, $p<0.001$), while the LCL group had a higher rate of TNCC (89% vs. 22%, $p<0.001$). Complication rates were acceptably low ($\leq 23\%$) in both groups and did not differ significantly between groups ($p=0.14$). Successful maintenance of deformity correction was achieved according to the modified Yoo² ratings in 52/73 limbs (71%) in the CS group and 16/44 limbs (36%) in the LCL group ($p<0.001$). Recurrent pes valgus was more common in the LCL group ($p=0.003$), as was the need for repeat foot surgery ($p=0.001$). Development of pes varus was more common in the LCL group than the CS group, but the difference did not reach the level of statistical significance and

the rate was low in both groups (13% for LCL, 4% for CS). (Table 1) To account for the difference in length of follow-up between the two groups, survivorship analysis was performed to predict the occurrence of recurrent valgus, development of varus, and repeat foot surgery as a function of time since surgery. Because TNF had a significant effect on outcomes, the survivorship analysis compared three groups: LCL (no TNF was done with LCL), CS (without TNF), and CS+TNF. This analysis confirmed that the risk of recurrent pes valgus was significantly lower when TNF accompanied CS ($p<0.04$) but did not differ significantly between the LCL and CS groups without TNF ($p=0.58$). Similar results were observed for repeat foot surgery. The risk of developing pes varus did not differ significantly between groups ($p>0.20$). Ankle kinematics and kinetics showed no significant change pre- to post-operatively in either group, and the amount of change was not significantly different between groups.

Table 1: Frequency of recurrent pes valgus, development of pes varus and repeat foot surgery

	Lateral column lengthening (46 limbs)	Calcaneal sliding osteotomy (73 limbs)	p-value
Recurrent pes valgus	15 (33%)	7 (10%)	0.003
Development of pes varus	6 (13%)	3 (4%)	0.09
Repeat foot surgery	14 (30%)	5 (7%)	0.001

DISCUSSION: Successful correction was maintained in 71% of limbs after CS and 36% of limbs after LCL. However, this difference appears to be due to longer follow-up in the LCL group rather than a true difference in outcome between the two surgical procedures. This study highlights the frequent need for concomitant medial column surgery at the time of CS or LCL in children with CP, due to the frequency of midfoot breaks in this population. None of the patients who underwent CS with concomitant TNF experienced recurrent valgus. In fact, survivorship analysis showed no recurrent pes valgus and very little need for repeat foot surgery up to 15 years after initial intervention. Despite excellent results of patients who underwent TNF, we only advocate this in three main groups of patients: 1) lower functioning patients, 2) those who are obligate brace wearers, and 3) those whose midfoot breaks are so severe that sufficient correction would not be feasible without TNF. For children with CP functioning at GMFCS levels I-III, both CS and LCL result in long-term (up to 15 years) maintenance of correction of pes valgus. Concomitant talonavicular fusion is key to success of CS for lower functioning patients with severe deformities, and obligate brace wearers.

REFERENCES: ¹ Bell KJ, et.al. (2002) J Pediatr Orthop, 22(5):677-82. ² Yoo WJ, et al. (2005) J Pediatr Orthop, 25(6):781-5. ³ Rethlefsen SA, et. al. (2107) Dev Med Child Neurol, 59(1):79-88.

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