Changes In Pelvic Rotation After Multi-Level Surgery With And Without Femoral Derotation Osteotomy In Cerebral Palsy

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Introduction: Foot progression during gait is affected by hip rotation (femoral anteversion), rotation below the level of the knee (caused by tibial torsion, forefoot adductus or varus), as well as rotation of the pelvis. When planning femoral derotational osteotomy (FDRO) for femoral anteversion, surgeons must decide how much intoeing is due to anteversion and how much is due to other factors. The surgeon must also decide whether or not pelvic rotation asymmetry is primary (due to spinal deformity) or secondary (a compensation to equalize foot progression) in order to determine whether or not pelvic rotation asymmetry can be expected to resolve postoperatively. Recent studies have shown reduction of compensatory pelvic external rotation after FDRO in hemiplegic subjects, but no change in diplegic subjects [1,2]. Because all subjects in these studies had simultaneous soft tissue surgeries at the time of osteotomy, the change in pelvic rotation postoperatively may not be attributable solely to femoral derotation. The purposes of the current study were to determine the effect of surgery on pelvic rotation in subjects undergoing soft tissue surgery both with and without FDRO and to compare the results in subjects with unilateral versus bilateral involvement.

Statement of Clinical Significance: Pelvic rotation plays an important role in transverse plane kinematics. The data in this study help clarify the influence of lower extremity surgery on pelvic rotation. This will aid surgeons in preoperative planning and counseling patients.

Methodology: A retrospective review of pre- and postoperative gait data from 59 patients with static encephalopathy who had undergone soft tissue surgery with or without simultaneous FDRO was conducted. Subjects who had concomitant tibial osteotomies or surgical procedures to the foot that could affect foot progression were excluded. Overall, there were 22 subjects with unilateral and 37 subjects with bilateral lower extremity involvement. For the subjects who underwent bilateral lower extremity surgery, the limb with more external pelvic rotation was analyzed. Of the limbs evaluated, 16 had undergone multi-level orthopedic surgery including FDRO (FDRO group), and 43 had undergone multi-level soft tissue surgery without FDRO (No FDRO group).

Analysis of variance (ANOVA) was performed to study the influence of femoral derotation osteotomy (FDRO or no FDRO) and involvement (unilateral or bilateral) on average hip rotation, pelvic rotation, and foot progression during the stance phase of gait. Unpaired t-tests were used to compare measurements from the study subjects with measurements from 18 able-bodied children. Paired t-tests were used to compare the pre- and postoperative measurements for the study subjects.

Results: No differences were found between unilaterally and bilaterally involved subjects, pre- or postoperatively. The only parameters that differed between the FDRO and No FDRO

groups were preoperative (P = 0.003) and postoperative (P = 0.02) foot progression and the pre- to postoperative change in hip rotation (P = 0.02).

Preoperatively, subjects in both the FDRO group (P = 0.001) and the No FDRO group (P < 0.0001) exhibited abnormal external pelvic rotation (Table 1). The FDRO group had abnormal internal hip rotation (P < 0.0001) and internal foot progression (P < 0.0001), while the No FDRO group had normal hip rotation (P = 0.16) and foot progression (P = 0.57) preoperatively. The abnormal hip rotation (P = 0.008), pelvic rotation (P < 0.001), and foot progression (P = 0.007) all changed significantly towards normal in the FDRO group. Pelvic rotation (P = 0.0006) and foot progression (P = 0.045) also changed significantly towards normal in the No FDRO group, but hip rotation did not change (P = 0.51) in these subjects. Postoperatively, none of the parameters studied differed significantly from normal for either the FDRO or No FDRO groups (P > 0.05).

Table 1: Kinematic parameters (mean ± SD).

	FDRO		No FDRO		Normal
	Preop	Postop	Preop	Postop	
Pelvic rotation	**-5.5 ± 5.7**	-0.9 ± 6.4 *a*	**-6.7 ± 6.2**	-3.0 ± 6.0 *a*	-0.4 ± 1.9
Hip rotation	**12.3 ± 11.3**	0.8 ± 15.8 *a*	3.6 ± 18.3	2.2 ± 13.6	-2.8 ± 7.7
Foot progression	**13.0 ± 17.9**	-0.2 ± 24.8 *a*	-8.2 ± 18.7	-13.1 ± 13.9 *a*	-10.8 ± 5.5

Negative values indicate external rotation and positive values indicate internal rotation. Bold indicates significant difference from normal (P < 0.05). *a* indicates significant change from preoperative based on paired t-test.

Discussion: Pelvic rotation has been recognized as a contributing factor to abnormal transverse plane kinematics in children with cerebral palsy. Recent studies have investigated the effects of femoral derotation on pelvic rotation in children with cerebral palsy [1,2]. Unlike previous studies, the current study evaluates the effect on pelvic rotation in children undergoing only soft tissue surgery, as well as in those undergoing FDRO. In both the FDRO and No FDRO groups, abnormal preoperative pelvic rotation and foot progression improved postoperatively. As expected, hip rotation changed significantly only in the FDRO group. Unlike other studies, the current study demonstrates improvement in pelvic rotation for both unilaterally and bilaterally involved children. For both the FDRO and No FDRO groups, none of the kinematic parameters measured differed significantly from normal postoperatively although sample size may have limited the ability to detect such a difference.

When planning lower extremity surgery for these children, the surgeon should be aware that the trailing hemipelvis will be more internally rotated postoperatively than preoperatively. Consequently, if the amount of femoral derotation is based on only the preoperative hip rotation and foot progression data, then the patient may have residual intoeing due to the postoperative change in pelvic rotation. For patients undergoing soft tissue surgery alone, both the pelvic and foot progression angles can be expected to improve postoperatively.

References: [1] Saraph V, et al. J Pediatr Orthop B 11:159-166, 2002. [2] Õunpuu S, et al. GCMAS 2002, p. 78.