Predictive Value of the Duncan-Ely Test

Robert M. Kay, MD, Susan A. Rethlefsen, PT, John Kelly, MD, and Tishya A. L. Wren, PhD
Motion Analysis Laboratory, Childrens Hospital Los Angeles
Departments of Orthopaedics and Biomedical Engineering, University of Southern California

Introduction: Stiff-knee gait is a well recognized problem for individuals with cerebral palsy (CP) [1,2,3]. The stiff-knee often causes trouble with foot clearance, which can result in tripping and/or the use of compensatory mechanisms that increase energy cost. Though rectus femoris release has been reported as a treatment of the stiff-knee in patients with CP, more recent studies using computerized gait analysis have demonstrated the superior efficacy of distal rectus femoris transfers (DRFT) [1,2,3]. The indications for DRFT include decreased peak knee flexion in swing or decreased arc of knee motion from stance to swing on kinematic data, prolonged rectus femoris activity in swing phase on dynamic electromyographic examination, and a positive Duncan-Ely test for rectus spasticity. The purpose of this study was to evaluate the value of the Duncan-Ely test as a predictor of outcome following distal rectus femoris transfer in children with CP.

Statement of Clinical Significance: Distal rectus femoris transfer is commonly performed in children with cerebral palsy, stiff-knee gait, and overactivity of the rectus femoris in swing phase. Though the Duncan-Ely test is commonly performed on these patients, its value in pre-operative assessment is unclear. This study determines whether the Duncan-Ely test is a predictor of patient outcome following distal rectus femoris transfer in children with CP.

Methodology: The charts of all patients who had undergone distal rectus femoris transfers and pre- and post-operative computerized gait analyses from 1992 through 2001 at the authors' institution were retrospectively reviewed. Data were available for 56 patients who had undergone 94 distal rectus femoris transfers. Most of the subject limbs had additional simultaneous surgeries, including 66 hamstring lengthening and 42 calf lengthening procedures. Maximum knee extension in stance, peak knee flexion in swing, and knee arc were examined. In addition, the Duncan-Ely test was administered as described by Bleck [4]. With the patient prone, the knee was rapidly flexed. If ipsilateral hip rise occurred, the test was positive, and the knee flexion angle at which hip rise began was recorded. For positive tests, rectus femoris spasticity was graded using the Modified Ashworth Scale. Paired t-tests were used to compare pre- and post-operative measurements for all the study variables.

Results: 80 limbs (85%) had a positive Duncan-Ely test pre-operatively of which 34 (42.5%) remained positive (Group A) and 46 (57.5%) became negative (Group B) post-operatively. 14 limbs (15%) had a negative test pre-operatively of which 1 limb (7%) became positive (Group C) and 13 (93%) remained negative (Group D) post-operatively. Knee arc increased significantly in the limbs with positive Duncan-Ely tests pre-operatively ($P = 0.0002$ for Group A; $P = 0.0004$ for Group B) as they achieved greater extension in stance post-operatively ($P = 0.002$ for Group A; $P = 0.007$ for Group B) with no significant change in peak swing-phase knee flexion ($P = 0.36$ for Group A; $P = 0.45$ for Group B) (Table 1). In Group A, rectus femoris spasticity decreased ($P = 0.02$) and hip rise occurred at a greater knee flexion angle post-operatively (P < 0.0001). In group D, peak knee flexion in swing increased post-operatively (P = 0.04), but knee arc did not change (P = 0.24). The knee tended to lose extension in this group postoperatively although the change was not statistically significant (P = 0.18).

Table 1: Knee angles in degrees (mean ± SD).

	Group A (+/+) (N = 34)		Group B (+/-) (N = 46)		Group C (-/+) (N = 1)		Group D (-/-) (N = 13)	
	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop
Max extension in stance	22.2 ± 18.3	11.1 ± 21.6 [a]	17.6 ± 14.2	11.4 ± 11.7 [a]	35.7	25.0	14.9 ± 20.2	21.2 ± 15.0
Peak flexion in swing	52.3 ± 16.3	49.8 ± 11.7	51.9 ± 14.1	53.3 ± 9.2	49.2	53.0	48.7 ± 15.4	58.7 ± 9.6 [a]
Arc	30.1 ± 12.6	38.7 ± 16.4 [a]	34.3 ± 10.9	41.9 ± 13.7 [a]	13.5	28.0	33.8 ± 17.0	37.5 ± 13.4

Lower values indicate more extension and less flexion. [a] indicates significant change from preoperative based on paired t-test (P < 0.05).

Discussion: This study demonstrates that patients who have positive Duncan-Ely tests pre-operatively appear to achieve better results following distal rectus femoris transfers than those who have negative tests pre-operatively. The patients with positive pre-operative Duncan-Ely tests demonstrated an increased dynamic knee flexion-extension arc due to maintenance of peak knee flexion in swing and improvement of knee extension in stance. Even those patients whose Duncan-Ely tests remained positive after surgery (Group A) demonstrated a significant improvement in the arc of knee flexion, less rectus femoris spasticity (on the Modified Ashworth Scale), and later hip rise on Duncan-Ely testing post-operatively.

In contrast, those with negative pre-operative Duncan-Ely tests did not demonstrate a statistically significant increase in the dynamic sagittal arc of knee motion. These children gained knee flexion in swing but had worse knee extension in stance. Of the 13 children who had negative Duncan-Ely tests both pre- and post-operatively, 7 (54%) had an increased knee arc while 6 (46%) had a decreased arc. 5 of the 6 (83%) patients with a decreased arc lost knee extension in stance, compared with 3 of the 7 (43%) patients with an increased arc. Interestingly, none of the 7 patients with an increased arc had undergone lengthening of the triceps surae, while 5 of the 6 patients with a decreased arc had undergone gastrocnemius recession. Similar percentages of each group (5/7 of those with increased arc and 4/6 of those with decreased arc) had undergone simultaneous hamstring lengthenings. These findings suggest the importance of the knee extension-plantarflexion couple in the maintenance of knee extension and improvement of knee arc of motion in children with negative pre-operative Duncan-Ely tests.

References: [1] Gage J, et al. Dev Med Child Neurol 29:159-66, 1987. [2] Perry J. Dev Med Child Neurol 29:153-8, 1987. [3] Southerland D, et al. J Pediatr Orthop 10:433-41, 1990. [4] Bleck E. Orthopaedic Management in Cerebral Palsy, 1987.