

CHANGES IN HIP KINEMATICS AS A RESULT OF RECTUS FEMORIS TRANSFERS WITH AND WITHOUT HAMSTRING LENGTHENING IN CHILDREN WITH CEREBRAL PALSY

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Summary/conclusions

In a small subgroup of patients treated with either an isolated rectus femoris transfer (RFT) or release (RFR) and no concurrent surgical procedures about the hip or knee, hip flexion at terminal stance significantly decreased as expected. When combined with a concurrent hamstring lengthening (HSL), the RFR detrimentally increased hip flexion at terminal stance. No significant difference in hip extension at terminal stance or hip flexion at terminal swing was found in a larger and more common subgroup of combined RFT and HSL or RFR and HSL. These results suggest that while surgical recommendations and procedures may be targeted at one joint, addressing a two-joint muscle and/or its antagonist may alter any expected secondary effect at the more proximal joint.

Introduction

The rectus femoris plays an important role in children with cerebral palsy (CP) who ambulate with a crouch or stiff knee gait pattern [1]. Distal RFT is commonly used to treat this gait deformity and is generally combined with a HSL to improve knee joint kinematics throughout the gait cycle [2]. These muscles cross both the hip and knee, so while a surgical procedure may target an impairment occurring principally at the knee, it may also affect hip motion. The purpose of this retrospective study was to compare the sagittal plane joint kinematics, pre- and post-operatively, of children with CP who had undergone a RFT, RFR, or HSL, or had been treated using a combined rectus femoris and HSL procedure.

Statement of clinical significance

Surgeons proposing single or multi-level surgery should be aware that altering a two-joint muscle will often affect the kinematics of both joints, and the results may differ from what is expected if the antagonist muscle is also treated.

Methods

All patients with spastic diplegic, hemiplegic, or quadriplegic CP who had undergone RFT, RFR, or HSL, and had pre- and post-operative gait studies at The Children's Hospital were included in this retrospective study. The primary kinematic variables analyzed were peak hip flexion in swing period and peak hip extension at terminal stance. These were separated into 7 groups by procedure and the timing of the combined procedures. Differences between pre- and post-operative values were calculated for each group to evaluate the difference between an isolated vs. combined procedures. The significance of the differences between these values was calculated using paired t-tests and an a priori $\alpha = 0.05$.

Results

The results of this investigation are shown in Table 1. Among the significant results, hip flexion at terminal swing decreased significantly towards normal in both the RFT and the RFR groups. Patients who were treated with a RFR and a HSL at the same time increased their hip extension at terminal stance, away from normal.

Table 1. Subject demographics and hip kinematics before and after procedures

Procedure (n)	Mean Age (yrs) at time of Surgery	Peak Hip Ext Terminal Stance (deg) normal = -10°					Peak Hip Flex Terminal Swing (deg) normal = 34°				
		Avg Pre	Avg Post	Δ	Std Dev	p	Avg Pre	Avg Post	Δ	Std Dev	p
RFT (4)	11.3 (9.3-13.2)	11.2	5.6	-5.6	3.8	0.060	62.2	51.3	-10.9	5.0	0.032
RFR (8)	11.6 (5.5-16.6)	12.3	7.5	-4.9	9.3	0.179	54.9	46.5	-8.4	5.0	0.002
HSL (50)	9.7 (3.6-20.6)	4.7	6.8	2.1	12.7	0.260	48.6	46.6	-2.0	12.3	0.268
RFT + HSL ST* (56)	11.6 (6.4-20.4)	10.7	11.6	0.9	10.9	0.530	52.3	50.3	-2.1	9.5	0.111
RFT + HSL DT* (10)	9.9 (7.0-13.0)	0.7	3.8	3.1	7.0	0.195	47.5	46.8	-0.6	9.8	0.848
RFR + HSL ST* (6)	17.5 (3.8-19.3)	14.9	20.2	5.2	3.0	0.007	49.0	49.3	0.4	5.6	0.883
RFR + HSL DT* (6)	10.4 (10.0-1.1)	12.3	11.3	-1.0	8.0	0.736	52.1	57.4	5.3	5.4	0.060

■ Significantly different pre- and post-operative values ($\alpha = 0.05$)

*ST = same time (simultaneous procedures) DT = different time

Discussion

Children utilizing a stiff knee gait pattern will compensate for their reduced limb clearance in swing due to decreased knee flexion by increasing hip flexion. Further review of the data showed that subjects treated with only a RFT had improved peak knee flexion in swing (as intended) as well as a significant decrease in peak hip flexion at terminal swing (Fig 1). In these subjects, the compensatory increase in hip flexion is no longer necessary to achieve foot clearance, so peak hip flexion at terminal swing decreases. Subjects who had undergone a RFR had a similar decrease in hip flexion (Fig. 2), but the changes in knee motion were mixed, implying that the decrease in hip flexion was a direct effect of releasing the rectus femoris muscle.

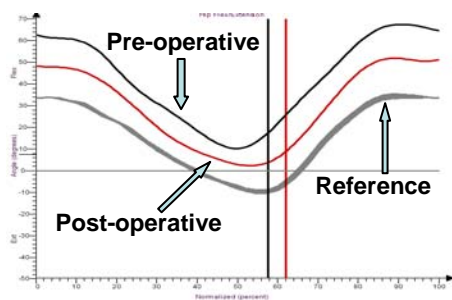


Figure 1. Sagittal hip flexion curve showing the effects of a RFT on a subject's pre-, post-operative kinematics, with normal reference

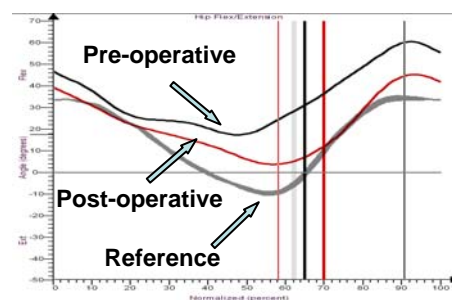


Figure 2. Sagittal hip flexion curve showing how a RFR changes a subject's pre-, post-operative kinematics, with normal reference

It was found that patients who had been treated with a concurrent RFR and HSL had decreased hip extension away from normal. This combined procedure may generate better kinematics at the knee joint, but the decreased hamstring tension allows the pelvis to fall forward increasing hip flexion while negating any positive effects the RFR may have gained at the hip.

References

- [1] Gage JR, et al., (1987), *Develop Med and Child Neuro*, 29: 159-166.
- [2] Ounpuu S, et al., (1993), *J Pediatr Orthop*, 13: 331-335.