

Multilevel Treatment of Ambulatory Children with Diplegia: An Outcome Assessment

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Introduction: With the evolution of gait analysis, surgeons have become more willing to correct multiple lower-extremity deformities during the course of a single operative procedure. So-called "Single event multilevel surgery to improve gait" is now being carried out at several centers [1]. Because multiple deformities are corrected during a single surgical procedure, the problem of evaluating the efficacy of multi-level surgery is complex. In addition to orthopaedic intervention, children may also undergo treatment for spasticity *via* selective dorsal rhizotomy (SDR). In order to understand the benefits of these treatments, appropriate technical and functional outcome measures must be evaluated [2].

Statement of Clinical Significance: Significant improvements in gait, energy consumption and overall function can be achieved through the appropriate use of gait analysis, orthopaedic surgery and spasticity reduction. Incorporation of gait analysis leads to a low rate of iatrogenic complications, and therefore augments the safety of clinical decision-making.

Methodology: A retrospective study design was used to evaluate the outcome of treatment for ambulatory children with cerebral palsy (CP). All individuals included in the study had a primary diagnosis of CP with a sub-type diagnosis of spastic diplegia. The cohort of patients for this study were selected based on the following criteria:

- 1) Subjects had previously undergone comprehensive pre- and post-operative gait analysis at Gillette Children's Specialty Healthcare between 1994 and 2002.
- 2) Subjects underwent gait analysis no more than 18 months before, and between 8 and 24 months after the date of the surgical intervention.
- 3) Surgical intervention consisted primarily of the correction of lever arm dysfunction, lengthening of short musculo-tendinous units, transferring of the rectus femoris to act in a more functional manner and spasticity reduction *via* SDR for qualifying patients.

The patients were categorized into three treatment groups based on the intervention received between the pre- and post-operative gait analyses: orthopaedic surgery only (*ORTHO*), orthopaedic surgery and SDR (*ORTHO+RHIZO*) or SDR only (*RHIZO*). The order of surgery for the combined intervention group was not used as a selection criteria or a grouping variable. Following the application of all inclusion and exclusion criteria 136 patients were available for the study. Gait, energy and functional data were extracted from the existing database in the motion analysis laboratory. Paired t-tests were performed to assess the statistical significance of pre-post changes in the outcome measures. The t-tests were performed on both overall and group-by-group bases. The "no-pathology" reference is included in the figures to indicate both the percentage of possible improvement and the amount of residual pathology.

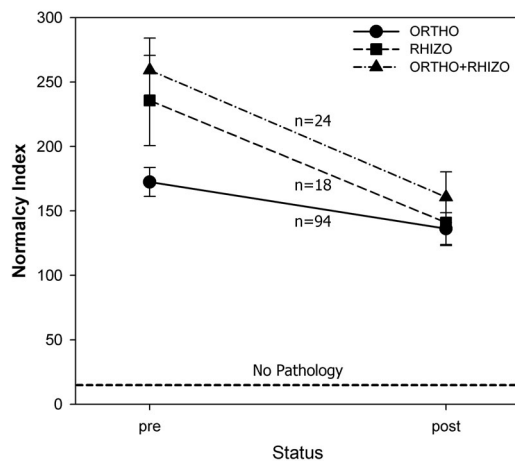


Figure 1. Improvement in overall gait pathology as measured by the normalcy index. All changes significant at the $p < 0.05$ level.

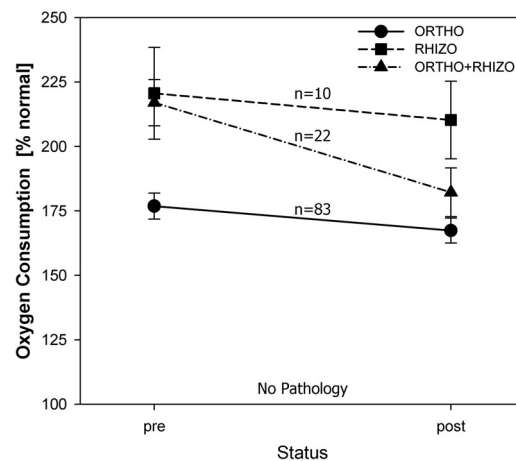


Figure 2. Improvement in overall gait efficiency as measured by normalized oxygen consumption. All changes significant at the $p < 0.05$ level.

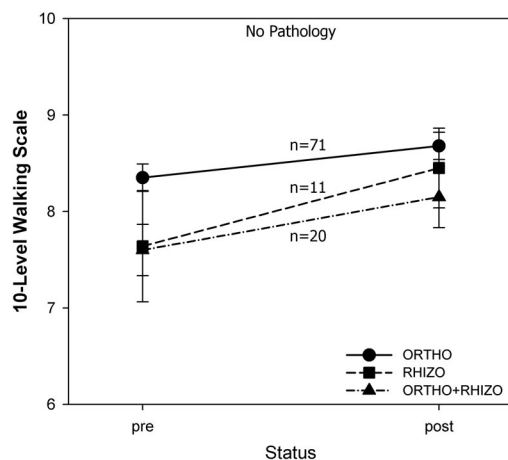


Figure 3. Improvement in community function as measured by the FAQ 10-level walking scale. All changes significant at the $p < 0.05$ level.

Results: This study showed that a comprehensive approach to diagnosis, treatment planning and surgery results in significant improvements in gait (NI), energy efficiency (O_2) and overall function (FAQ) of ambulatory children with CP.

Improvements were seen for each measure (NI, O_2 and FAQ) and for each surgery regimen (*ORTHO*, *RHIZO* and *ORTHO+RHIZO*). Improvements in two or more outcome measures were seen in 78/91 subjects (86%) for whom complete outcome data was available. Of these subjects, 41 improved on 3/3 measures and 37 improved on 2/3 measures. Of the 13 remaining subjects, only 2 worsened in all three measures. Safety is a major concern for families considering major surgical intervention. The low rate of worsening indicates that decision-making based on gait analysis results in a favorable

risk/benefit ratio and a low rate of iatrogenic worsening.

Discussion: The retrospective nature of this study design restricts the interpretive scope of the results. The improvements seen in these children are clinically and statistically significant. However, a generalization of these findings to a wider population must be done with caution. While this retrospective design is not ideal, there are no obvious sources of selection bias. Furthermore, the ethical and practical issues associated with a prospective study of multi-level/multi-intervention treatment create a nearly insurmountable obstacle. Subsequent studies are necessary to determine the long-term efficacy of this intervention in preventing the gait deterioration often seen in untreated ambulatory individuals with cerebral palsy [3].

References: 1. Gage JR and Novacheck TF, J Pediatr Orthop B, 10:265-74, 2001. 2. Butler C, et al., Dev Med Child Neurol, 41:55-9, 1999. 3. Gough M, et al. Gait Posture, 16:S33-4, 2002.