Energy Expenditure in Cerebral Palsy During Level Walking

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Introduction: Measurement of energy expenditure as a routine component of the clinical assessment of the child with cerebral palsy is not common place, but is becoming increasingly important as functional measures of treatment outcome are in higher demand. When the goal of surgical intervention in walking is to improve function or ease the effort of the task, energy assessment provides a unique, but important assessment. Recent work has demonstrated the interconnectivity between gait laboratory outcome measures and energy expenditure [1,2]. It has been documented for decades that children with cerebral palsy can expend up to 3x the energy of their able-bodied counterparts [3], but a large scale study of the gait deviation characteristics that may contribute to this increase energy expense has not been presented.

Statement of Clinical Significance: The assessment of energy in children with cerebral palsy may be one of many clinical tools used in treatment decision-making. It is important to understand the influence of common differentiating factors on energy expenditure to assure optimal decision-making when using this information.

Methodology: A retrospective analysis was used to evaluate the energy expenditure of a group of children with a primary diagnosis of cerebral palsy (CP). All underwent indirect calorimetry measurement of metabolic energy as a routine aspect of their clinical gait analysis assessment (Med Graphics CPX-D System) between January 1988 through December 2000. None of the children had a history of previous surgery related to their CP and none had intramuscular medications within 6 months of their visit. All children were allowed to use their typical assistive devices for testing and all walked without their typical orthotics. Gait analysis assessment also included 3-D kinematics and kinetics (when appropriate) (Vicon Motion Systems), and clinical examination.

Metabolic measurement protocol included data collection during 1.5 minutes of quiet resting in sitting, 1.5 minutes of quiet standing, 6 minutes of level ground walking at a self-selected velocity, and a variable duration recovery period of quiet sitting with return of heart rate, respiration, and O2 uptake levels to baseline. Breath-by-breath measurements of oxygen uptake, carbon dioxide output, ventilation and tidal volumes, respiratory rate, and heart rate were collected. A three-minute period of data during steady state exercise was used for analysis. The rate of oxygen consumption (milliliters of O2 per kg. body mass per minute) and oxygen cost (milliliters of O2 per kg. body mass per meter). As noted each was normalized by body weight. Energy data was evaluated by topographic diagnosis, functional ambulation level, presence of contractures, use of assistive devices and an index of gait deviation [4] to determine which variable(s) would best correlate with increasing energy expenditure and therefore be useful in guiding treatment.

Results: Following the application of the selection criteria 765 (307 F, 458 M) patients were included in the study. The average age was 8.23 $\pm$ 4.78 years. The distribution of patients based on diagnosis, functional ambulation level, presence of contractures and use of assistive

devices are presented in the following tables. The relationship of oxygen consumption to patients grouped by diagnosis and ambulation level can be found in Figure 1.

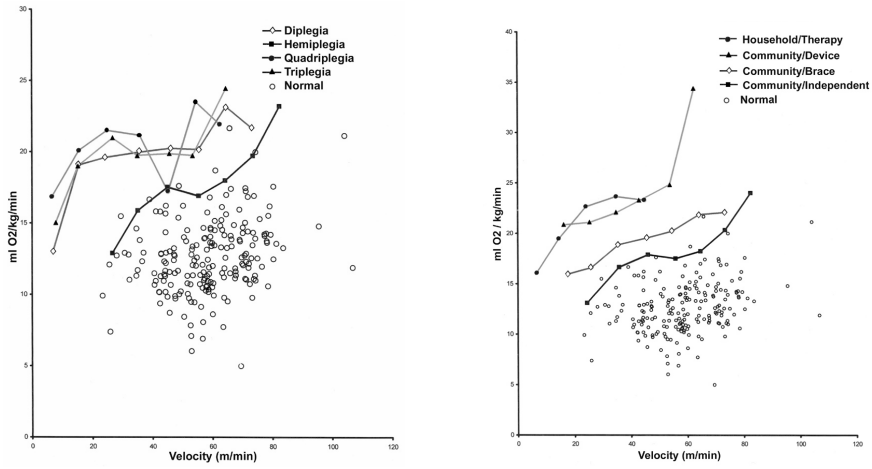
Diagnosis	N
Hemiplegia	195
Diplegia	376
Triplegia	78
Quadriplegia	112

Functional Ability	N
Comm/indep	242
Comm/orthotics	331
Comm/devices	91
House/Therapy	99

Assistive Device	N
No Devices	581
Devices	184

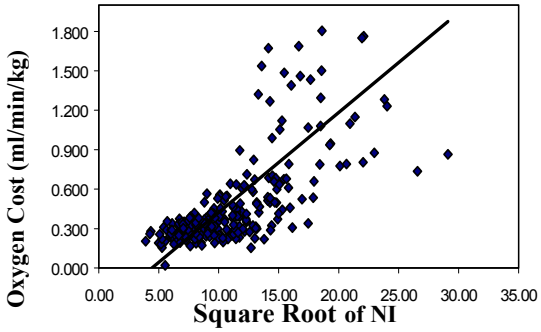
Contractures	N
No HFC	377
HFC	388
No KFC	571
KFC	194

Figure 1:



Stepwise regression and analysis of Pearson correlation coefficients among selected variables indicate that oxygen cost is a more reliable index of energy expenditure than oxygen consumption. Oxygen cost was also found to demonstrate a strong linear correlation to the normalcy index as an indicator of gait deviation.

Discussion: The data suggest that traditional sub-groupings of patients may not be sufficient in guiding treatment when considering energy expenditure. Oxygen cost is a more reliable index than oxygen consumption. When used in combination with a gait deviation index such as the normalcy index energy expenditure becomes a useful tool to guide treatment.



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