

Gait Analysis in Children with Down Syndrome: The Effect of Flat Foot

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Introduction

Down syndrome (DS) is related to mental retardation, orthopedic problems, hypotonia, ligament laxity and consequently motor alterations. Flat Foot (FF) condition is present in a high number of patients with DS and the measure of the entity of FF is of fundamental importance.

A subjective analysis of Oster¹ indicated that 80% of children with DS had gait problems. The analysis of the gait pattern of children with DS is an important evaluation in order to provide informations for an intervention program.

The main aims of this work are 1) to objectively quantify gait strategies (both kinematic and kinetic aspects) of children with DS; 2) to measure the entity of FF in children with DS; 3) to evidence the effect of FF condition on gait pattern.

Statement of Clinical Significance

This study evidences the typical gait strategies of children with Down Syndrome (DS). In particular as FF is present in a high number of patients with DS this study measures the FF conditions and evidence the effect of FF on gait pattern. The results of this study provide objective data of the entity of FF and gait alteration in children with DS. These results represent a basis for comparison and therapeutic management.

Methodology

78 children with DS (mean age 11.7 years, range 6-15 years), 13 normal children with FF (mean age 10.7 years, range 6-12 years) and 30 children without pathologies (mean age 11 years, range 5-13 years) participated in this study. The groups formed by normal children with and without FF were evaluated in order to evidence the effect of FF on gait pattern on patients without DS. All patients were analyzed with an interdisciplinary clinical functional assessment, RX analysis of the foot, videorecording, 3 Dimensional Gait Analysis or 3DGA (8 TV motion measurement system ELITE Bts IT, 2 force platforms Kistler) and an electrical pedobarography (F-scan). In order to evaluate the entity of FF an index based on the ratio of foot length F_1 [mm], computed from kinematic data carried out from 3DGA (F_1 in Fig.1) and the area of the foot F_A [mm²] computed from the pedobarography data was defined as $I_{FF} = (F_1 /$

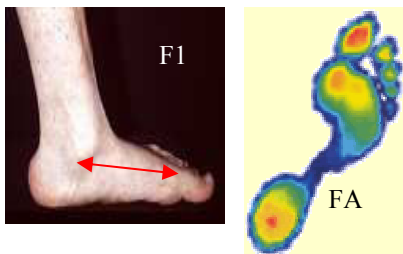


Fig.1: Parameters for the calculation of I_{FF}

$F_A) * 1000$ [mm⁻¹]. Using this index the typical gait pattern of children with DS were defined using the comparison of gait pattern of children with DS without FF and children with DS with FF as well as by the comparison of children with DS and FF and normal children with the same entity of FF condition (i.e same values of I_{FF}). Typical gait pattern were identified from statistical analysis (T-test, $p < 0.05$) applied to kinematic and kinetics parameters of 3DGA data.

Results

Normal subject (no DS and no FF) are characterized by $I_{FF} = 1.031 \pm 0.14$ mm⁻¹ (range 0.88-1.17). The results of pathological subjects are: 10 subjects with DS have no FF ($I_{FF} \geq 0.88$); 30

subjects with DS have a FF of gravity 1 ($0.70 < I_{FF} > 0.88$); 38 subjects with DS and 13 normal children with FF have FF of gravity 2 ($I_{FF} \leq 0.70$). The results of 3DGA showed that typical aspects of gait of children with DS related only to the DS status are (present in children with DS without FF): increased adduction of the hip joint in the swing phase, a limited ROM of hip joint in sagittal plane and a diminished values of hip extension at Terminal Stance Phase, increased flexion of the knee at initial contact and an increased dorsiflexion of the ankle joint during the stance phase and a diminished ankle joint plantar-flexion moment (Fig.2).

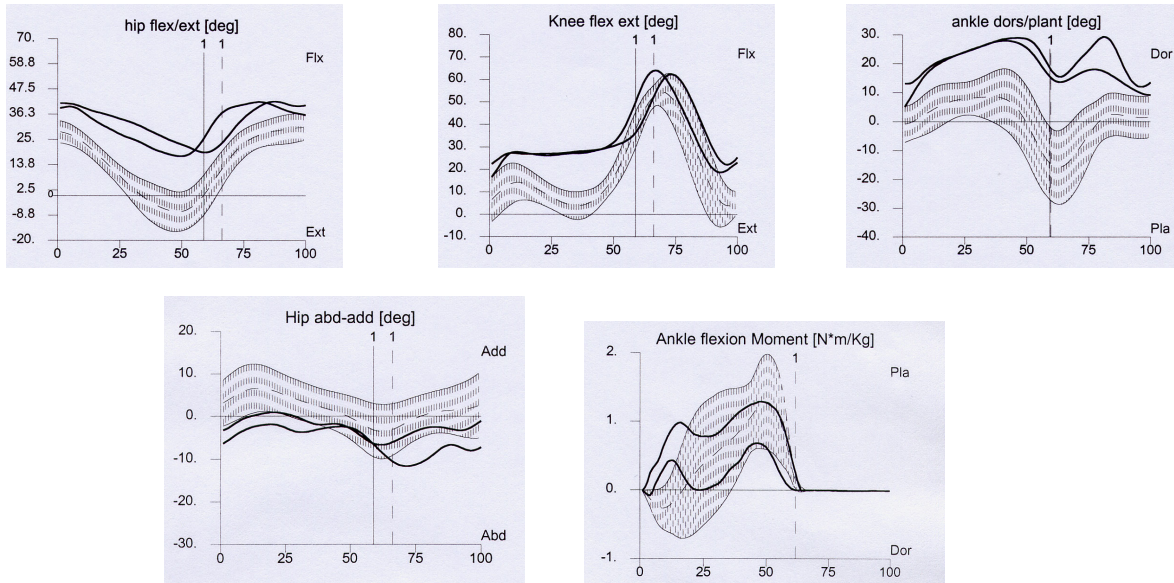


Fig.2: Gait pattern typical of patients with DS no FF

Typical pattern related to FF (present both in normal and DS subjects with FF) are: a modified pattern of Centre of pressure and a diminished push-off ability in ankle joint power (Fig.3).

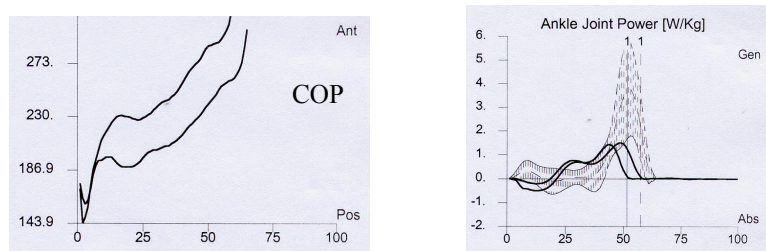


Fig.3: Gait pattern typical of patients with DS and FF and of patients without DS with FF

Discussion

In this study an index able to quantify the FF condition is proposed. Using this index it is possible to 1) quantify different levels of FF condition 2) distinguish gait pattern typical of children with DS and gait aspects related to FF. These information are very useful for therapeutic management of FF condition that occur in a great number of patients with DS.

References

- 1 Oster J. *Mongolism* . Copenhagen: Einar Munksgaard Forlag, pp.1-123, 1993
- 2 Galli, M., Albertini G., Crivellini M, Tenore N, "Gait Analysis in children with DS", Progress Report- Int. Review of Medical Science, V.13, pp 21-28, 2001.