MRI anteversion angles were calculated computer-based. For data evaluation the parameters from MRI, 3D gait analysis and clinical exam were compared by Pearson's correlations. Additional unpaired t-test was used for pre-post comparison. P-values below 0.05 were treated as significant.

Table 1: Pre-post-results of MRI and Gait-analysis variables

Parameters	Pre	post	p
GGI	519±623	255±254	<0.001
mPelRotSt	−0.1±6.7	0.0±7.1	0.787
mHipRotSt	15.2±13.6	1.6±10.6	0.174
mFPASt	13.4±15.0	0.3±8.4	<0.01
FA (MRI)	32.4±10.8	10.3±13.1	0.314
Dero-angle	25.8±7.8		

GGI = Gilette Gait Index; m, mean; Pel, Pelvic; FA, femoral anteversion.

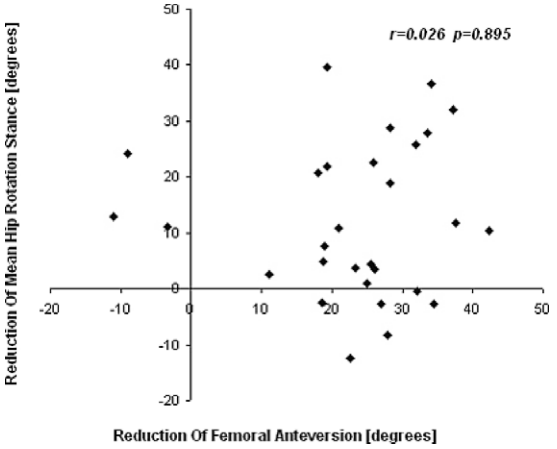

Figure 1. Correlation of MRI and 3D Gait Analysis.

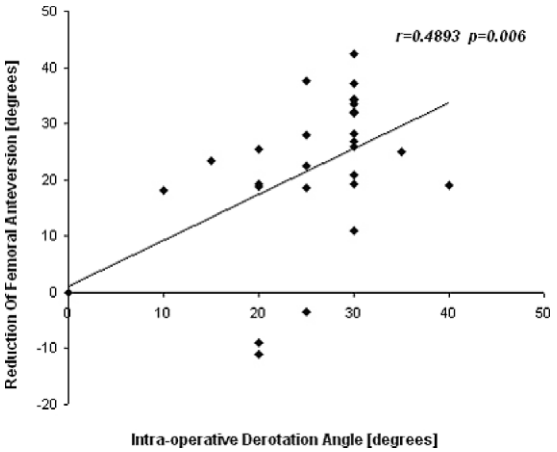

Figure 2. Correlation of Derotation Angle and MRI.

Results: The overall results (mean values of all 29 legs) of gait analysis variables and femoral anteversion (MRI) are displayed in Table 1 (p-values obtained by unpaired t-test). The correlations between MRI and 3D gait analysis as well as MRI and intra-operative derotation angle are shown in Fig 1+2. No significant correlation between mean hip rotation in stance and femoral anteversion (MRI) was found neither pre- ($r = 0.08$, $p > 0.05$) nor post-operatively ($r = -0.03$, $p > 0.05$). Reduction of femoral anteversion did not correlate with the decrease of mean hip rotation in stance (Fig 1). The mean derotation (26 degrees) resulted in an overall reduction of femoral anteversion of 22 degrees (Fig 2). However, due to a large variance, this difference was not significant.

Discussion: Increased femoral anteversion is very common in children with spastic diplegia and seen as the main cause for internal rotation gait [4]. The femoral derotation osteotomy represents the standard treatment. Initially, satisfactory results after FDO were reported [3]. However, recent studies found over- and under-corrections [1] and recurrence [2] following FDO. This implicates, that increased anteversion is not the only cause for internal rotation gait. Internal rotation gait is of multidimensional cause and should be divided into a static and a dynamic component. The recent study shows that femoral anteversion is common in diplegic patients with internal rotation gait but is not useful as predictor for mean hip rotation in gait analysis, neither pre-, nor post-operatively. Improvements in rotation patterns at the hip during walking cannot be guaranteed by the correction of FA. Further investigations should address the dynamic components of internal rotation gait. Until pathogenesis of internal rotation gait is not completely clarified, FDO is indicated with caution, considering over- and under-correction.

References

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O013

Development of a 'Kinetic Index' to quantify abnormal lower limb moments during gait

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Summary: We describe the development of a 'Kinetic Index' (KI) aimed at quantifying abnormal lower limb moments in children with cerebral palsy (CP). The index uses the same approach as the Gillette Gait Index (GGI) and could be used as a complementary tool to the GGI to evaluate different aspects of gait pathology.

Conclusions: This preliminary work indicates that the KI may be a useful outcome measure for evaluation of treatment and long term monitoring of children with cerebral palsy.

Introduction: In normal gait lower limb moments and powers are optimised for efficient walking. In children with cerebral palsy (CP), the consequences of lack of selective control, muscle weakness and spasticity result in inefficient locomotion which may be observed in abnormal joint moments and powers. Outcome measures that summarise large amounts of gait data exist for the kinematic parameters that describe motion [1]. We aim to investigate the viability of a 'Kinetic Index' (KI) that can quantify abnormalities in lower limb joint moments.

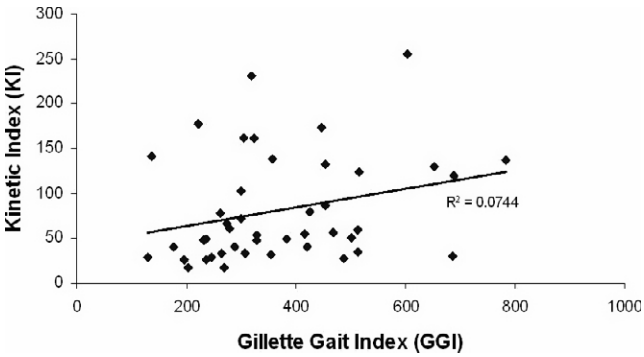
Patients/Materials and Methods: The index was derived using the method described by Schutte et al [1], and based on a control group of 20 asymptomatic children (10 male, 10 female, age range 8 to 18 years). Eight summary variables were selected and calculated for the control group. These values were then used to calculate the KI. The KI was calculated for each limb of the

control population (40 limbs) to give a range of normality, and for 22 children with a diagnosis of cerebral palsy diplegia or hemiplegia (44 limbs). For these children the KI was compared to the Gillette Gait Index (GGI). The KI was recalculated with each variable excluded in turn to establish the sensitivity to each component variable. Three experienced clinicians were asked to rate a subset of nine CP children (18 limbs) as either mild, moderate or severe based on a full set of kinetic data. Their ratings were then compared to the kinetic index arranged in ascending order representing increasing severity as an initial validation exercise.

Results: For the control population the mean KI was 7.8 (range 1.9 to 18.5). In the CP group the KI ranged from 17.1 (mild) to 255.5 (severe), with a mean of 80.9. Correlations for the KI with all variables and each excluded variable are given in Table 1. There was a trend between increasing values of the KI and clinician rating of severity (Spearman rank correlation = 0.82). There was a weak correlation with the GGI (Figure 1).

Variable descriptions and correlations for KI with all variables and each excluded variable

Variable description	Correlation
Hip flexion moment at contralateral toe off	0.994
Hip abduction moment at contralateral toe off	0.996
Hip abduction moment at contralateral initial contact	0.990
Minimum knee flexion moment in stance	0.924
Knee flexion moment at contralateral toe off	0.996
Knee flexion moment at contralateral initial contact	0.877
Ankle flexion moment at contralateral toe off	0.928
Peak ankle power in stance	0.997



Correlation of KI and GGI.

Discussion: The strong correlations between the KI with all 8 variables and the KI with each variable excluded in turn indicates that there may be some redundancy in the current set of variables. The weakest correlation was for knee flexion moment at contralateral initial contact, which suggests that this variable may have more influence on the KI than the others. The correspondence with the clinician ratings suggests that the KI is meaningful in terms of how clinicians interpret gait kinetics. The weak correlation between the GGI and the KI suggests that the indices measure different aspects of gait pathology and thus may complement one another in assessing gait abnormalities in CP.

References

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Oral Session 3: Cerebral palsy – Muscle & EMG

O014

Movement coordination of the pelvis in a virtual game environment

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Summary: Movement training specifically targeted at rotation of the pelvis may help to improve/overcome the primary component of pelvic retraction in patients with cerebral palsy (CP). Healthy subjects when placed in a novel virtual environment provided evidence for a pre-established pattern of coordination, suggesting that well-practiced core control cannot be improved over a short period of time through movement of the pelvis.

Conclusions: The results indicate that minimal learning occurred during testing, therefore future research will look at learning over a greater period of time. Further research on the differences in learning patterns of coordination between healthy subjects and CP patients will need to be established.

Introduction: Primary problems that exist in children with CP include loss of selective muscle control and muscular imbalance [1] including the pelvic region, resulting in detrimental effects to everyday living tasks such as walking. Progression of the swing limb in normal gait leads to protraction and retraction on opposite sides of the pelvis. Abnormal pelvic retraction associated with CP hemiplegia improves in response to surgical intervention [2] but reduced movement control of the core remains a functional limitation. A virtual reality based game advocated by Barton et al. [3], may improve movement coordination by focusing training on the pelvic region.

Patients/Materials and Methods: Four healthy male participants (19–22 years) stood on a CAREN movable platform (MOTEK, Amsterdam, Netherlands) facing a video screen. The objective of the game was to burst balloons in a virtual environment by directing a "magic carpet" through three dimensional movement of the pelvis, where tilting the pelvis up/down and left to right controlled the direction of the carpet. A pre-determined trajectory was chosen that ensured pelvic rotation (PR) and tilt (PT) occurred simultaneously. In our definition a measure of coordination between PR and PT was the straightness of the carpet trajectory when approaching balloons, quantified as the cumulative difference between PR and PT for each trajectory. A 5th order polynomial was used to illustrate the trends of coordination as it changed over time.

Results: The trajectories for each subject show dissimilar patterns in coordination between PR and PT. Subject 1 showed a greater consistency in performing both simultaneously, represented by an almost constant difference in area between PR and PT (85% hit rate). Subject 2 produced a more variable pattern of coordination, showing slightly greater variability in the trend line, but still had a successful hit rate (85%). Subject 3 controlled PR and PT better as he approached the target (93% hit rate), highlighted by variability in the trend line towards the beginning of testing but an improvement in later trials. Subject 4 showed greater variability in co-ordinating PR and PT along the trajectory path (50% hit rate). The trend line suggests subject 4 underwent the greatest period