Discussion: Analysing the movement of the upper limb is difficult due to the variability and complexity of the mechanics available to complete any given task. Nonetheless, cyclic movement has shown to be clinically useful in assessing impairment and deviation from normal. Applying this repetitive method of analysis to the upper limb has allowed comparison between 2 measurement systems, with good agreement. This indicates the usefulness and reliability of the Xsens system to track movements making it a potential candidate to be integrated in a home-based rehabilitation system. Further validation of the Xsens graphs with the Vicon system is currently in process.

References

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O044

Changes in upper limb isometric strength and error tracking following training using functional electrical stimulation

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Summary: Based on existing motor control theory, an intervention involving a robot, ILC and FES was developed and tested on five chronic stroke patients. Improvements were seen in isometric strength and error tracking.

Conclusions: ILC mediated by FES enabled five chronic stroke subjects to accurately track a range of trajectories. Over time this related to an improvement in motor control reflected by increasing accuracy observed in unassisted tracking, and in isometric strength.

Introduction: Current opinion in motor learning, reinforced by clinical evidence, supports the use of FES and robot therapy to improve motor control [1–3]. ILC is a technique applicable to processes which repeatedly perform a task with a view to sequentially improving accuracy such as trajectory following in robots. The aim of this study is to test the feasibility of applying ILC to neurological rehabilitation.

Patients/Materials and Methods: 5 hemiplegic stroke subjects underwent screening tests, and baseline assessments including isometric strength. Subjects used a robotic workstation to track 2 dimensional trajectories, over 18 intervention sessions within a 3 month period. At the beginning and end of each intervention session the ability of the stroke subject to track four trajectories without any FES or robot assistance was assessed. During the treatment sessions, ILC was used to modulate the FES applied to their triceps muscles in terms of timing and amplitude to improve tracking performance, whilst encouraging a maximal voluntary contribution to the task. Assessments of isometric muscle strength in six directions from a mid position were repeated after the eighteen sessions and for two subjects after an additional seven sessions.

Results: Improvements in isometric strength were seen for all individual subjects after the intervention, with significant improvements for five out of six directions. Unassisted performance of the tracking tasks improved significantly for 3 out of the 4 tasks across the group. Subjects who performed poorly on the initial visit, showed the biggest improvements in tracking.

Discussion: Analysis of the variability of the results may assist in the identification of good responders. Future work with the existing system includes assessing the potential for use with other neurological conditions, such as cerebral palsy and incomplete spinal cord injury. A subsequent study will develop a system for reaching in three dimensions and include opening the wrist and hand using 'Smart glove' as a position sensor.

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Oral Session 8: Quality assurance

O045

Validity of the gait deviation index (GDI) calculated with non-native control data

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Summary: The validity of the GDI calculated from non-native control data is shown through comparisons with the Gillette Gait Index (GGI) and Gillette Functional Assessment Questionnaire (FAQ).

Conclusions: Preliminary findings from this study suggest that absolute GDI values calculated with different control data are not comparable.

Introduction: The GDI is a new measure summarising specific kinematic gait information into a single number. The GDI is the scaled difference between a subject's 15 'gait features' (mutually independent joint rotation patterns) and a control data set [1]. To date, validation of the GDI has concentrated on comparisons of the GDI to the GGI and FAQ from a native data set [2]. Face validity on non-native data has been demonstrated through comparison with an observational gait scale [3] and pre/post operation results of 3 subjects [4]. The aims of this study were: to provide further evidence regarding the validity of the GDI calculated from non-native data; to investigate whether GDI values calculated with different control data can be compared.

Patients/Materials and Methods: Representative strides were identified from 143 subjects with Cerebral Palsy for whom both an FAQ level and kinematic data had been collected at SCH, between 2005 and 2008. The GGI was calculated for each subject using an internally developed program. The GDI was calculated using a spreadsheet supplied by Schwartz [2], using SCH control data ($n = 56$), and recalculated using supplied control data (Gc $n = 166$). As the GGI represents a distance squared, GGI values were transformed when comparisons with GDI were made: $GGI^* = \ln(\sqrt{GGI})$ [2].

Results: Between GDI and GGI* $r^2 = 0.71$, $n = 286$. Unlike GGI (Kruskal Wallis test, $p = 0.10$), GDI values were shown to be significantly different between FAQ levels 6–10 (1-way ANOVA, $p < 0.0001$). However, using Tukey tests significant differences were only found between FAQ levels 10v7, 10v6, 9v6 and 8v6. The mean difference in the coefficient of variation (COV) between the GGI* and GDI at each FAQ level was 75.80±8.98 (1 SD), and between studies 9.55±3.49 and 2.66±2.86 respectively. The mean GGI and GDI calculated for FAQ levels 10–6 and typically developing subjects (TD) are shown in Figures 1 and 2.

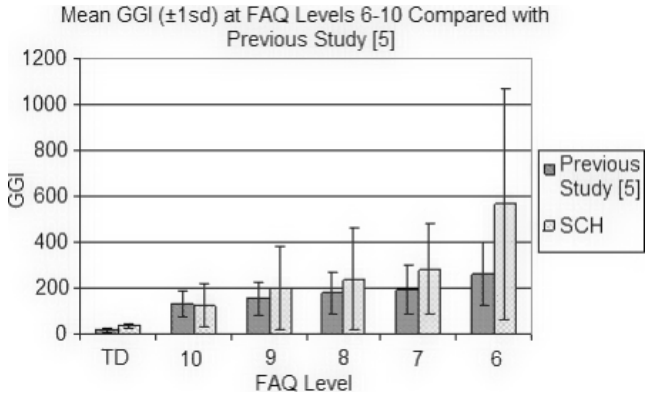

Figure 1. Mean GGI versus FAQ level.

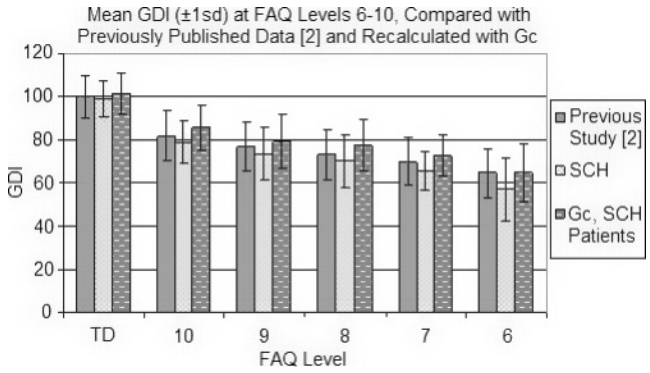

Figure 2. Mean GDI versus FAQ level.

Discussion: Concurrent validity of the GDI is shown through the strong correlation with GGI* ($r^2 = 0.56$), which is greater than that previously found [2]. When compared to assigned FAQ levels both mean GGI and GDI showed similar trends to previous data, with GGI increasing and GDI decreasing with lower FAQ levels. This also suggests face and concurrent validity. Statistical analysis indicates that GDI is better able to stratify patients between FAQ levels as, unlike GGI, normal distributions were seen within FAQ levels and significant differences seen between them. In this study the GDI was not found to be significantly different between all levels. COV values showed GDI to be less varied and more comparable between sites than GGI. The differences seen between studies may be attributable to the populations, the subjective nature of the FAQ, and the control data used. However, mean absolute differences of 6.2±1.9 when reprocessing data with different control kinematics implies that, with a control set of $n = 56$, GDI's calculated at different sites are not comparable.

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O046

Validity of a commercial video software package for recording sagittal plane movements during gait

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Summary: The validity of a commercial video analysis software package for detection of the sagittal knee angle during gait was assessed. ROM at the knee measured by the software was compared against that measured by a Coda mpx30 motion analysis system. 20 pathological limbs (CP) were examined with results showing good overall correlation between measurements but poor clinical agreement.

Conclusions: This study has shown that the commercial software has some potential as a tool for single plane gait analysis but further assessment of validity is needed under changed system conditions before it could be confidently used in clinical practice.

Introduction: Due to the nature of some 3D gait assessments (problems tolerating full marker set, behavioral problems etc.) it can be difficult or sometimes impossible to carry out a full 3D gait analysis. In this case video analysis could be used to provide more objective and precise data relating to kinematics. While there are a number of studies examining in-house systems [1,2], few look at the reliability and suitability of commercially available systems for gait analysis purposes. The aim of this study was to assess the validity of the sagittal plane knee kinematics measured by a commercial video analysis software.

Patients/Materials and Methods: This study examined 10 random pathological subjects presenting for routine gait analysis (6 male and 4 female, age range 5–33 yrs). Video analysis was conducted on a Panasonic AW-E600E positioned perpendicular to the lab walkway. Each subject had high visible stickers (25 mm dia.) placed on the lateral aspect of each leg at the greater trochanter, the knee and ankle. 4 full gait cycles were taken for each leg. 3D analysis was conducted by the same clinician using a Coda mpx30 system (Charnwood Dynamics Limited, Leicestershire, England). Post processing 2D video data involved digitization of the raw data and importing into Dartfish software (Dartfish Ltd., 1705 Fribourg, Switzerland). The software provides an option for angles to be drawn between points and automatically tracked. 3D data processing involved setting gait events in CODA software. Data from both systems was exported directly to Microsoft Excel. All 2D video and 3D Coda data were time normalized to 100% of the gait cycle with the 2D video data re-sampled through linear interpolation at 1% time increments. An average for each limb was determined for both systems with results then statistically compared. The relationship between systems was assessed with Spearman's rho correlation (ρ) and Bland & Altman limits of agreement [3].

Results: Correlation was high for all measurements across both limbs however further analysis using the limits of agreement suggested a large variation in measurements and an overall poor