pelvis and trunk were assessed at eight instances during the gait cycle, representing initial contact, loading response, mid stance, terminal stance, preswing, initial swing, mid swing and terminal swing. To determine intra- and interrater reliability, the Intraclass Correlation Coefficient (ICC), the Standard Error of Measurements (SEM) and the Smallest Detectable Difference (SDD) were calculated for each joint and for each phase of the gait cycle.

**Results:** Intrarater reliability was good for the tibia, ankle, knee and pelvis and moderate to good for the trunk. Interrater reliability was good for the tibia, ankle and knee, moderate to good for the hip and pelvis and moderate for the trunk. All angles could be measured with errors (SEM/SDD) ranging from 0.7–6.8 degrees/1.8–18.8 degrees (see table 1).

Table 1

| | Intrarater reliability | | | Interrater reliability | | |
|---|---|---|---|---|---|---|
| | ICC | SEM (°) | SDD (°) | ICC | SEM (°) | SDD (°) |
| Tibia | 0.92–0.99 | 0.7–6.0 | 1.8–16.5 | 0.91–0.99 | 0.7–1.5 | 1.9–4.2 |
| Ankle | 0.89–0.98 | 1.7–3.5 | 4.7–9.6 | 0.83–0.96 | 2.6–4.0 | 7.2–11.2 |
| Knee | 0.85–0.98 | 1.3–3.3 | 3.5–9.3 | 0.88–0.97 | 1.7–2.9 | 4.7–7.9 |
| Hip | 0.75–0.95 | 2.3–3.3 | 6.4–9.1 | 0.67–0.93 | 3.1–5.3 | 8.6–14.8 |
| Pelvis | 0.76–0.92 | 1.4–2.4 | 4.0–6.7 | 0.55 -0.86 | 2.8–3.9 | 7.7–10.9 |
| Trunk | 0.58–0.85 | 2.2–6.0 | 6.1–16.5 | 0.48–0.72 | 3.1–6.8 | 8.6–18.8 |

**Discussion:** We consider video screen measurement of sagittal joint/segment angles useful for the clinical setting. It allows assessing sagittal gait kinematics with acceptable measurement errors and enables to detect changes – for example before and after an intervention. However, in a scientific setting, instrumental gait analysis should be preferred.

**References**

[1] Out L, Harlaar J, Doorenbosch, CAM (2006). (tele)MoXieViewer – XML-based sharing of movement analysis results. Gait & Posture 24S2, S136–137.

**P039**

**Three-dimensional evaluation of knee function in anterior cruciate ligament-deficient and reconstructed knee**

B. Callewaert[1], P. D'Hooghe[2], J. Bellemans[3], G. Molenaers[1,2,3], K. Desloovere[1,4]. [1]*Clinical Motion Analysis Laboratory, University Hospital Leuven;* [2]*Department of Orthopaedic Surgery, University Hospital Leuven;* [3]*Department of Musculoskeletal Sciences, Catholic University Leuven; Department of Musculoskeletal Sciences, Department of Orthopaedic Surgery, Clinical Motion Analysis Laboratory, Catholic University Leuven;* [4]*Department of Rehabilitation Sciences, Catholic University Leuven, Belgium*

**Summary:** Results of this study indicate that patients with deficient anterior cruciate ligament (ACL) present with abnormal patterns of walking and descending a stair. Postoperatively, particularly peak knee flexion moment and peak knee rotation remain significantly different from normal, especially in walking.

**Conclusions:** Patients with anterior cruciate ligament deficiency present with abnormal knee function. After reconstruction of ACL, three-dimensional evaluation does not reveal significant improvement in dynamic knee function, as described in previous studies[1]. Avoiding excessive stress and decreased quadriceps muscle strength are suggested as a possible cause of significant deviations in walking and descending a stair after reconstruction.

**Introduction:** The success level of anterior cruciate ligament reconstruction is often assessed by knee laxity and isokinetic muscle strength. However, these measurements cannot assure the dynamic functional restorement of the knee. The aim of this study was to explore functional knee stability during walking and descending a stair, in pre and postoperative condition.

**Patients/Materials and Methods:** 12 subjects, unilateral ACL injured (5 female, 7 male, mean age 32.3±12 years) were evaluated. The inclusion criteria were a primary complete ACL rupture, no other ligament injury and no history of significant damage to the contralateral limb. All subjects underwent single bundle ACL reconstruction. Evaluation was performed proximally 6 weeks after injury and 6 months postoperatively. Kinematic and kinetic data were collected using an eight-camera VICON system (612 data capturing system measuring at 100 Hz, with lower limb PlugInGait marker set), and 2 AMTI force plates. Knee flexion/extension axis of the Grood & Suntay Joined Coordination System was calibrated by the Knee Alignment Device during a static trial.[3] The best calibration out of 4 was selected, based on minimal coronal knee range of motion during swing and consistency between pre and postoperative evaluation. Data were collected during walking and descending a stair, all averaged over 3 valid trials. A set of 14 variables was selected from the kinematic (joint angles) and kinetic (internal moments) results at specific points in the gait cycle, with focus on the knee in 3 planes. The affected knee was compared to the reconstructed ACL knee and to age matched control subjects (N = 10). Statistical analysis was performed with use of a Wilcoxon signed rank test. Quadriceps and hamstrings muscle strength of all patients were also tested by use of the Cybex® dynamometer.

**Results and Discussion:** During walking, a significant decrease of maximal knee rotation was found in the ACL injured group compared to the control group ($p = 0.007$), maybe related to avoidance of excessive stress on the knee. A similar tendency was recognized for subjects in the reconstructed group ($p = 0.056$). No significant differences were seen for knee rotation angles between different groups. A significant lower maximal knee flexion moment was found both in the ACL injured and reconstructed group compared to the control group ($p = 0.001$). However, maximal knee extension angle in stance was only found to be statistically significant in the reconstructed knee ($p = 0.004$) compared to control subjects. The ACL reconstructed group also tended to a higher knee flexion at initial contact ($p = 0.018$) compared to the control group. Decreased maximal knee flexion moment and increased knee flexion at initial contact maybe related to decreased quadriceps muscle strength, detected in the operated knee by the Cybex® dynamometer.[2] When compared to the injured condition, the reconstructed knee revealed a significant higher maximal hip abduction moment ($p = 0.01$), related to an increase of the foot progression angle. When descending a stair, knee flexion at initial contact was higher in the injured leg ($p = 0.008$) and the reconstructed leg ($p = 0.038$) compared to control subjects. We recognized a clear tendency of decreased internal knee rotation at toe off in the injured ($p = 0.015$) and the reconstructed condition ($p = 0.024$), and a decreased maximal knee flexion moment in the injured knee ($p = 0.024$) compared to control subjects. No significant difference was found between the ACL injured and reconstructed knee.

**References**

[1] Ristanis et al., 2003, Knee Surg Sports Traumatol Arthrosc, 11 (6), 360–365.

[2] Georgoulis et al., 2003, Am J Sports Med, 31 (1), 75–79.

[3] Grood E.S., Sunday W.J. J., 1983, Biomech Eng, 105(1), 36–144.

## P040

### Medial unicompartimental vs total knee arthroplasty patients performance during gait: a focus on muscular activity at the knee

M.G. Benedetti[1], F. Catani[2], L. Berti[1], A. Frizziero[1], S. Giannini[2]. [1]*Movement Analysis Laboratory, Istituti Ortopedici Rizzoli;* [2]*Orthopaedic Surgery and Movement Analysis Laboratory, Istituti Ortopedici Rizzoli, Italy*

**Introduction:** Functional outcome in Total Knee Arthroplasty (TKA), as measured by means of gait analysis for kinematics, kinetics, and muscular activity around the knee shows abnormalities even in patients with excellent clinical outcome. Knee flexion during loading response phase is reduced, accompanied by co-contraction of knee extensors and flexors. Such subtle failure in knee performance during loading absorption was claimed to depend on several factors: quadriceps weakness, prosthetic design, pre-surgical pattern, proprioception disruption. It was supposed to damage the implant in time. The lack of the anterior cruciate legament seems to play a major role in the loss of control of the roll back pattern of the condyles on the tibial plateau in TKA patients. Previous works on unicondylar knee artrhoplasty (UKA) demonstrated better gait performance when anterior cruciate ligament was preserved allowing the patients to maintain normal quadriceps mechanics. The aim of the present work is to evaluate UKA patients knee function during gait compared to TKA with the hypothesis that UKA ensures more physiological knee loading response pattern of movement and a more phasic muscular activation, thus reducing the risk of failure.
**Patients/Materials and Methods:** Twenty patients with Oxford/Exactech UKA (mean age 70 (SD 7.9), mean follow-up 2 years) were evaluated by means of a Vicon 612–8 cameras system, two Kistler forceplates and Telemg respectively for knee 3D kinematics, kinetics and muscular activity. Data of UKA were compared to those of a control population of ten healthy subjects and ten patients with TKA matched for age and follow up. Mean UKA-IKS score at the time of gait analysis was 90.
**Results:** Time-distance parameters evidenced a slight slow gait with reduced stride length and cadence and a symmetric longer stance phase with respect to TKA and controls. Knee kinematics on the sagittal plane showed knee flexion during loading response very close to controls and a reduced but phasic pattern of joint moments on the sagittal plane. Adduction moment at the knee was normal. EMG showed controversy results as some patients had a regular pattern of activation of rectus femoris and hamstrings without co-contraction whereas other patients had co-contraction.
**Discussion:** These results indicate that UKA allows in most patients a quite normal knee kinematics and kinetics, although some abnormalities persist in quadriceps activation. Further research is required to understand these findings assessing other factors which could influence quadriceps activity such as age, proprioception, and muscular strength.

## P041

### A comparison of two functional methods for calculating joint centers and axes in a clinical setting

A. Rozumalski, M.H. Schwartz. *Center for Gait and Motion Analysis, Gillette Children's Specialty Healthcare, USA*

**Summary:** Two algorithms for functional model calibration were compared in a clinical setting.
**Conclusions:** Two functional model calibration methods, one developed by Schwartz and Rozumalski, and the other by Ehrig et al., produced nearly identical results. The method of Ehrig et al. is about 200x faster.
**Introduction:** In the clinical setting, accuracy and repeatability are very important when determining hip centers and an effective flexion/extension axis of the knee. So too is speed and ease of implementation. A functional method developed by Schwartz and Rozumalski (Schwartz Transformation Technique – or – STT) has been shown to be objective and repeatable in a clinical setting [1,2]. However, the calculations can be time consuming – taking up to 6 minutes per subject. Both the STT method and the symmetrical center of rotation estimation/symmetrical axis of rotation approach (SCoRE/SARA) developed by Ehrig et al. impose the constraint that joint centers/axes remain constant relative to the adjacent segments [3,4]. The two methods were shown to produce nearly identical results when applied to simulated data [3,4]. The present study compares the two methods in a clinical setting on actual patient data.
**Patients/Materials and Methods:** We analyzed 794 hip range-of-motion (ROM) trials and 793 knee ROM trials for patients seen for analysis in our gait analysis laboratory during 2007 and 2008. Approximately 70% of the patients had been diagnosed with Cerebral Palsy, while the other 30% had widely varying diagnoses ranging from Myelomeningocele to Attention Deficit Hyperactivity Disorder. Both the SCoRE/SARA and STT methods for calculating the hip joint center and the knee joint axis were applied to the trials. The hip centers from the two methods were compared (distance), as were the knee axes (angle). Computation time was also examined.

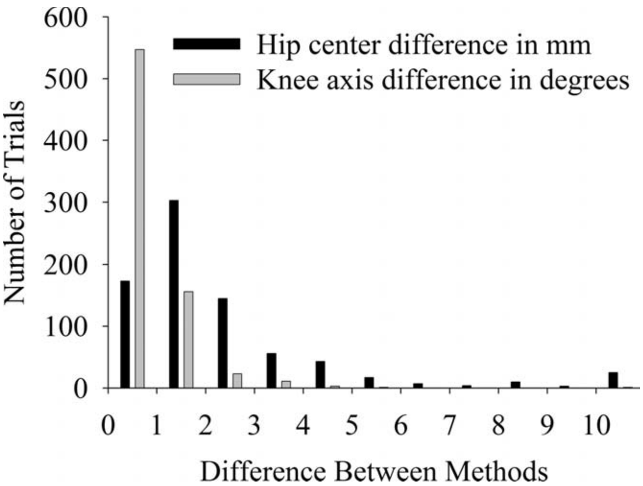


Figure 1. Difference between two joint parameter calculation methods.

**Results:** The mean distance between the STT and SCoRE hip centers was 2.5 (3.2) mm, with no meaningful bias in any