DOES TESTER EXPERIENCE INFLUENCE THE RELIABILITY OF 3D-GAIT ANALYSIS? A COMPARISON OF THE FUNCTIONAL AND PREDICTIVE APPROACHES

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INTRODUCTION:
Anatomical marker placement reliability is an important consideration in 3D gait analysis given its influence on defining joint centers, anatomical coordinate systems (ACSs), and ultimately the resulting joint kinematic outputs. It has been postulated that gait kinematic reliability could be improved using a functional (FUN) method compared to a manual marker placement approach (MAN) [1,2]. This seems logical given that FUN methods would be less reliant on precise anatomical marker placement. However, two studies have reported minor or no differences in gait kinematic reliability when comparing FUN and MAN methods [1,2]. The authors in both studies speculated that similar reliability between the two techniques may have been due to the use of experienced testers. Specifically, an experienced tester may be able to locate anatomical landmarks with greater precision than a novice tester. Therefore, the purpose of the study was to determine whether tester experience influences the reliability of gait kinematics when using a FUN or MAN method. It was hypothesized that: 1) the experienced tester (EXP) would demonstrate greater within-tester reliability using the MAN technique compared to the novice (NOV) tester; 2) EXP and NOV testers would demonstrate similar reliability using the FUN technique; 3) Between-tester reliability would be greater in the FUN method compared to MAN.

METHODS:
Prior to the reliability testing, a four-part training session was conducted by the EXP tester (8 years gait analysis experience) with the intended purpose of training the NOV tester (physical therapist with no gait analysis experience) on anatomical marker placement. After completion of the training, 10 subjects (6F, 4M, 23±3 years of age) visited the lab on two occasions separated by a minimum of two days. During each visit to the lab, subjects underwent two gait analyses performed by each tester. Testers were only present during their own data collections. Reflective markers were placed on anatomical landmarks and technical marker clusters were placed on the pelvis, thigh, shank, and foot for tracking purposes. Following a standing calibration trial and removal of anatomical markers, functional movements of the hip and knee were performed [2]. Subjects then walked on a treadmill while kinematic data was collected for five consecutive footfalls. Using Visual 3D software, two custom models were developed for the MAN and FUN methods. The MAN model used anatomical markers to predict the hip and knee joint centers, which were then used to create segmental ACSs. In the FUN approach, the hip and knee joint centers together with the flexion-extension axis of rotation for the knee were defined functionally [3]. The within- (both testers) and between-tester gait kinematic reliability of the FUN and MAN techniques was estimated for the hip and knee in the x, y, and z planes using root mean square error (RMS). RMS provides an estimate of the absolute offset of curves between days by calculating the angular difference between two corresponding points on curves of similar shape [2].

RESULTS AND DISCUSSION:
Contrary to our first hypothesis, within-tester RMS values were not statistically different between the EXP and NOV testers when using the MAN approach (Figure 1). It was expected that the EXP tester would show improved within-tester reliability as compared to the NOV tester using the MAN technique given the experienced tester’s previous experience in placing anatomical markers. This was not observed in the RMS measures across any plane of movement in the hip or knee. The similarity in reliability using the MAN technique may be attributable to the inexperienced tester having four years’ experience as a physical therapist and thus familiarity in anatomical land-marking within a clinical setting.

Given its reduced reliance on anatomical marker placement, the FUN technique was expected to produce similar reliability findings for each tester. Supporting this hypothesis, the FUN method resulted in similar RMS error values in the EXP and NOV testers (Figure 2).

Between-tester reliability was improved in both the hip and knee across all planes of movement using the FUN method as compared to the MAN method (Figure 3). This was particularly evident in the transverse plane where RMS values were over 2° lower in the FUN method. However, the differences between the two methods were still of a small enough magnitude to have questionable significance to the practicing clinician.

**CONCLUSIONS**

Tester experience does not seem to influence the within-tester reliability of 3D gait analysis regardless of whether a FUN or MAN approach is utilized. The FUN method does appear to improve between-tester reliability in the transverse plane but the observed improvement was small.

**REFERENCES**


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