Motion Analysis

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DEVELOPMENT OF A BESPOKE BIOMECHANICAL MODEL FOR REAL-TIME CALCULATION OF LOWER LIMB KINEMATICS.

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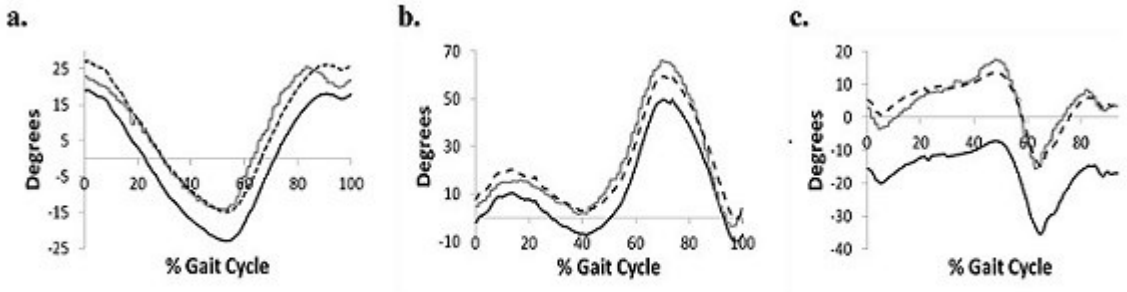
Introduction and Objectives: Human movement analysis may be considered an essential tool in clinical and research biomechanics[1,2]. A number of commercially available systems allow the accurate and quantitative description of a participant's gait[3]. However, the use of these systems generally limits the user to predefined models or requires users to have significant technical expertise for creating bespoke models. Further, while it is possible to manipulate certain aspects of the established motion analysis process, current platforms do not allow complete customisation. The aim of this investigation was to build a customisable, bespoke biomechanical model (LJC) using an object-oriented application development package with integrated Lua based programmatic scriting modules; D-flow (Motek Medical, The Netherlands). The components of the model include a marker set, a method of calibrating a participant and calculation of kinematics.

Methods: A bespoke cluster marker set with strategically placed anatomical markers was implemented. Marker trajectory data was captured, labelled and streamed into D-Flow using Vicon hardware and acquisition software (Vicon Motion Systems, Oxford, UK). A static calibration method was devised whereby the offsets of the calibration markers from the clusters are calculated for each segment. The Winter method[4] was used to reconstruct calibration markers during dynamic trials and the Grood and Suntay[5] method was used to calculate kinematics. This was implemented in D-Flow using bespoke scripting modules written in Lua programming code. Pilot testing against Plug in Gait (PIG; Vicon Motion Systems, Oxford, UK) was completed with one typically developing adult participant.

Results: Flexion angles of the hip, knee and ankle were examined during normal treadmill walking (figure 1). Results demonstrated similarities in trace and range of motion (ROM), however, for all joint angles there was a consistent offset of absolute angle. When the mean difference between datasets was added to PIG data, there was much stronger agreement.

Figure 1. Black - PIG; grey - LJC; dashed - PIG plus mean difference. **a.** Hip **b.** Knee **c.** Ankle.



Conclusion: Initially, results do not indicate good agreement between PIG and LJC. However, the offset between data sets appears to be consistent across all joints. It may be that inaccurate PIG marker placement contributed to errors in PIG data. Tibial and femoral wands were not used which could contribute to inaccuracies. Further, PIG ankle data suggests that no dorsiflexion occurs throughout the cycle. This is highly unlikely for a typical adult which suggests that there may be some error in PIG data. Work is ongoing to determine the source of the errors.

The development of a bespoke biomechanical model allows complete customisation. The model can be altered to allow a choice of marker set or calibration methods. The possibility also exists to build specific functionalities for specific users, providing an advantage over commercially available models.

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Disclosure of Interest: None Declared