# DEVELOPMENT OF A MOTION ANALYSIS PROTOCOL FOR USE IN ROUTINE CLINICAL CARE

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## INTRODUCTION

There is widespread agreement that motion analysis is currently the gold standard for measuring human movement in a non-invasive manner [1]. Current commercially available systems, such as Vicon Plug in Gait (PiG, Vicon Motion Systems, Oxford, UK) have been developed over a number of years and are capable of providing a biomechanical analysis which is robust enough to dictate complex treatment plans, such as multi-level surgery [1]. However, due to the vast capabilities of PiG, it is a time consuming and technically complex protocol to deliver. Additionally, there are currently limited options for delivering motion capture using other protocols which vastly limits the use of motion analysis in other aspects of clinical care, such as outpatient rehabilitation. Cluster based marker sets may provide a faster and less technically complex alternative to models such as PiG; however these are currently not commercially available and have thus far been restricted to research environments. Therefore, the aim of this study was to develop a bespoke cluster based motion analysis protocol (Strathclyde Cluster Model; SCM) capable of calculating lower limb kinematics which could be implemented in routine clinical care in order to expand the use of motion analysis beyond research and complex clinical cases. Further aims included an assessment of the kinematic output and reliability of SCM in comparison to PiG.

## METHODS

The bespoke marker set comprised seven 3D printed, rigid plastic plates, each with 4 markers attached, for each segment of the lower body. Participant calibration was completed using a digitiser which negated the use of skin surface markers and thus allowed participants to wear their own clothing, providing anatomical landmarks could still be palpated. Anatomical reference frames were calculated in accordance with the International Society of Biomechanics recommendations [2] and the Grood and Suntay [3] method was used to calculate kinematics. To compare the kinematic output of SCM to PiG, five participants completed 10 overground walking trials each whilst wearing both marker sets and flexion/extension (flex/ext), ab/adduction (ab/ad) and internal/external rotation (int/ext) were compared for the hip and knee. Ankle plantar/dorsi flexion was also compared. To assess the reliability of SCM in comparison to PiG, the mean kinematic output, variability and coefficient of multiple correlation (CMC) were compared between and within assessors for six assessors using both models and one subject for all assessments.

## RESULTS AND DISCUSSION

Results of the kinematic comparison revealed some significant differences between the two models (figure 1). Differences in flex/ext and ab/ad outputs are likely due to differences in anatomical reference frame definition and kinematic calculation. Differences in int/ext were more evident; however previous studies suggest that there are few similarities in this output when compared between models [4] and therefore this is not a surprising result.

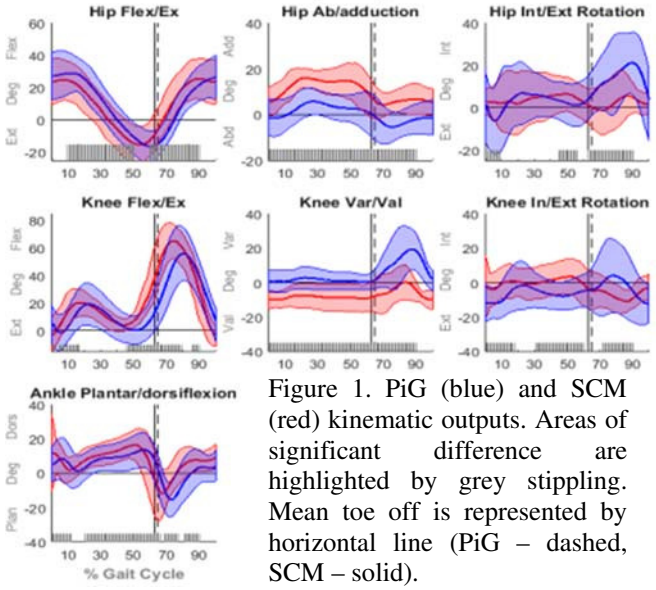


Figure 1. PiG (blue) and SCM (red) kinematic outputs. Areas of significant difference are highlighted by grey stippling. Mean toe off is represented by horizontal line (PiG – dashed, SCM – solid).

For inter-assessor reliability, both models demonstrated high or moderate reliability for all joint rotations. SCM compared favourably to PiG for all rotations except hip int/ext where SCM demonstrated a CMC value of 0.53 compared to 0.94 for PiG. Previous studies are in agreement with these results [5] although this result could also be a reflection of the different calibration methods in that assessors were more confident using pelvic markers in PiG than the digitiser in SCM to calibrate the pelvis and thus calculate the hip joint centre, which would have an effect on kinematic calculation. For intra-assessor analysis, both models demonstrated high CMC values for all joint rotations except hip int/ext in SCM, which exhibited similar values to those seen in inter-assessor results (0.59). However, examination of the kinematic curves revealed limited variability so it is likely that one or two SCM hip int/ext curves were not correlated, but didn't deviate far from the mean, thus resulting in a low CMC but a tight confidence band.

## CONCLUSIONS

SCM is a motion analysis protocol which has been developed for routine clinical use, such as outpatient rehabilitation and therefore application of markers and participant calibration is quicker and easier than current commercial alternatives. Further, kinematic output and reliability are comparable between SCM and the current clinical gold standard. Therefore, SCM is a suitable alternative for providing an objective assessment of function and outcome in routine clinical practice.

## REFERENCES

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