A COMPARISON OF NORMAL KINEMATICS FOR VICON CLINICAL MANAGER AND PLUG IN GAIT

Robin D. Dorociak
Motion Analysis Laboratory, Shriners Hospitals for Children, Portland, OR. rdd@shcc.org

Introduction

Vicon Clinical Manager (VCM) is a commercial gait analysis software package whose underlying model is based on those devised by Kadaba, et al., (1990) and Davis, et al., (1991). VCM calculates lower extremity kinematics and kinetics. Recently, a model named Plug in Gait (PIG) was developed to emulate VCM with some slight differences in filtering. The purpose of this study is to determine whether there is a difference in kinematics when using VCM and PIG.

Statement of Clinical Significance

Many labs compare preoperative and postoperative data to see if a particular outcome was achieved. If we find differences when we compare data that was processed with VCM and that of PIG, then we need to determine whether those differences are due to the intervention or the software.

Methods

Computerized gait analysis was performed on 20 normals (mean age 11.65 ±5.4) using a 6-camera VICON 370 system (Oxford Metrics) with two AMTI force plates. Thirteen reflective markers were placed on the lower extremities in accordance with the model described by VCM. For each subject, a static trial was collected before the dynamic trials. For data analysis purposes, one side was randomly chosen and one representative dynamic trial for each subject was selected. Static and dynamic data were processed with VCM. The static offsets and gait events were recorded. The dynamic trial was then re-processed with PIG using the MSE filter setting of 20, and the VCM static offsets, gait events and marker size. The PIG C3D file and the VCM GCD file were imported into Polygon (Oxford Metrics) and kinematic data was extracted into Excel.

The following variables were extracted: maximum hip extension (HEmax), peak knee flexion (KFmax), and peak plantarflexion (PFmax). A t-test was performed to determine if significance existed between the VCM and PIG variables. Significance was set as $p<.05$. To provide a more holistic approach, the difference between VCM and PIG was calculated for the following curves at each 2% interval: pelvic tilt (PT), pelvic obliquity (PO), pelvic rotation (PR), hip flexion/extension (HFE), hip abduction/adduction (HAA), hip rotation (HR), knee flexion/extension (KFE), knee varus/valgus (KVV), knee rotation (KR), ankle dorsi/plantarflexion (ADP), and foot rotation (FR). The mean curve difference across all subjects was obtained for all variables.

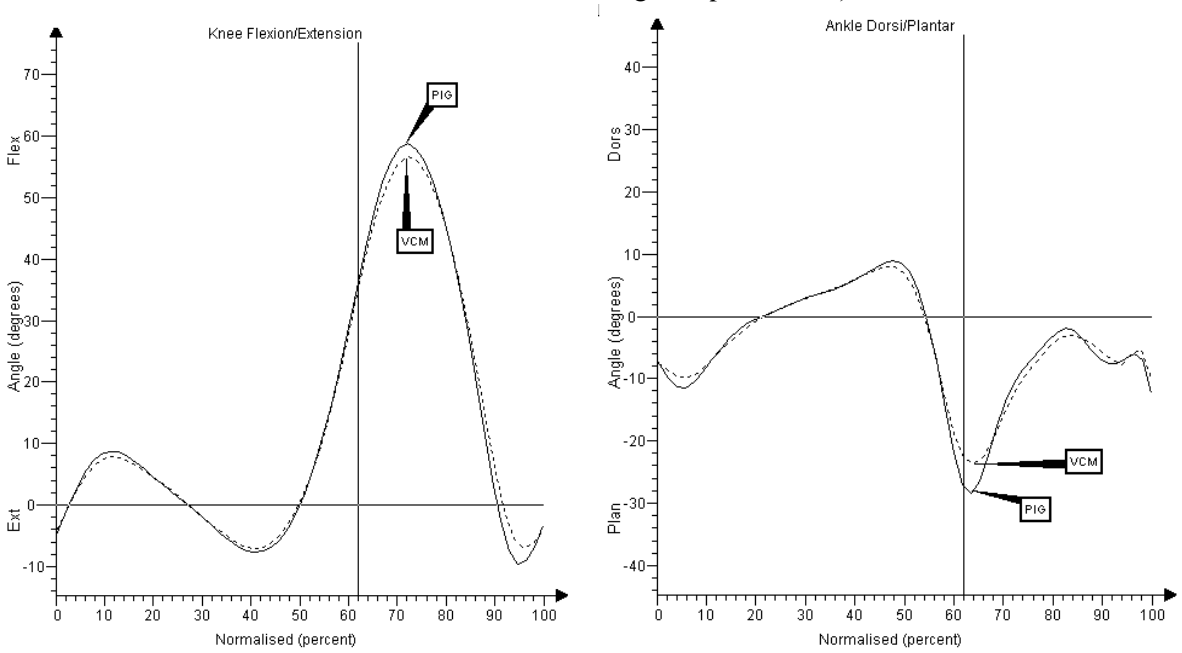
Results

Significant differences were found for HEmax, KFmax, and PFmax at $p < 0.0001$. The mean differences of all of the curves were less than 1°, and many were near 0°.

VCM (SD)	PIG (SD)

HEmax	-8.1 (7.1)	-9.0 (7.1)*
KFmax	55.3 (3.1)	57.7 (3.4)*
PFmax	-19.9 (6.0)	-23.3 (7.2)*

Table 1. * Kinematic variables in degrees ($p < 0.0001$)



Graph 1 and 2. Knee flexion/extension and ankle dorsi/plantarflexion for one subject where the solid line is PIG and the dotted line is VCM.

Discussion

The mean difference of less than 1° for all of the kinematic curves shows that the two models are very close. However, the t-test revealed that there are differences at the peak points of interest, especially at large inflection points (i.e. peak knee flexion and peak plantarflexion). Graphs 1 and 2, from a representative subject, show that the PIG output seems to have larger peaks than the VCM output. If this data represented a preoperative study and postoperative study, then we might make improper conclusions on the success or failure of an intervention.

The differences seen at the inflection points are likely due to the differences in the smoothing algorithms used by the models. The recommended MSE filter setting of 20 for PIG does not seem to match the one used in VCM. Further investigation of smoothing algorithms must be done to ensure backward compatibility for comparison of motion data.

References

Davis, RB, et al. *Human Movement Science*, 10:575-587, 1991
Kadaba, MP, et al. *J Orthop Res*, 8:383-392, 1990

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