DIFFERENCES BETWEEN VICON CLINICAL MANAGER AND VISUAL3D WHEN PERFORMING GAIT ANALYSES USING THE HELEN HAYES MODEL

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INTRODUCTION

Although the majority of clinical gait analyses have been accomplished using the Helen Hayes (HH) biomechanical model (Kadaba et al., 1989), newer, mathematically optimized techniques (6DOF) are emerging and may well overcome mathematical weaknesses in the former technique (Buczek et al., 1994). While HH is clinically easy to implement due to its basic marker set, markers used to track motion are shared by adjacent segments, and several of these are virtual. This is thought to cascade errors from the pelvis to more distal segments. 6DOF techniques avoid these limitations and may prove to be more accurate as a result. Our ultimate goal is to compare results of gait analyses using these two modeling techniques. Two building blocks for this overall project involve validation of HH and 6DOF techniques in commercial software used in our MAL. HH will be validated by comparisons with Vicon Clinical Manager (VCM) and Visual3D (V3D). 6DOF techniques will be validated through comparisons of Move3D, validated software developed at the National Institutes of Health, and V3D. The purpose for this abstract is to present results from the first step in this process, the comparison of clinically relevant data output from Helen Hayes models in both VCM and V3D.

METHODS

A single stride was analyzed in both VCM and V3D for each of 25 patients in this IRB exempt, retrospective study. Each signal was normalized to 51 data points. A custom program was developed to scan each program's output for a given stride. The custom program extracted 20 variables commonly used to make clinical decisions in our case reviews. We hypothesized that no significant difference would be detected between the two programs. Paired t-tests were used to detect differences in means for these 20 variables, using a Bonferroni adjusted, two-tailed, alpha of 0.05/20 (i.e., $p < 0.0025$). Because it is difficult to determine VCM smoothing techniques, this process was repeated four times producing four families of data. For a given family, VCM remained unaltered while the filtering steps of V3D were changed (Table).

Table: Smoothing parameters used in V3D.
POS = position data filtered at 6Hz,
GRF = ground reaction forces filtered at 15 Hz,
Link Model = output variables filtered at 15 Hz.

Family	POS	GRF	Link Model
1	X		
2	X		X
3	X	X	
4	X	X	X

RESULTS AND DISCUSSION

Families one through three showed no significant difference for fifteen out of twenty variables. Family four, the most heavily smoothed family, had no significant difference shown for sixteen out of twenty variables. It should be noted that no significant difference was found for all seven of the kinematic variables tested. The variables showing a significant difference were four out of six joint moments tested, specifically, max knee extension moment in late swing (Figure), max ankle plantar flexion moment, max hip abduction moment in early stance, and max hip extension moment in early stance.

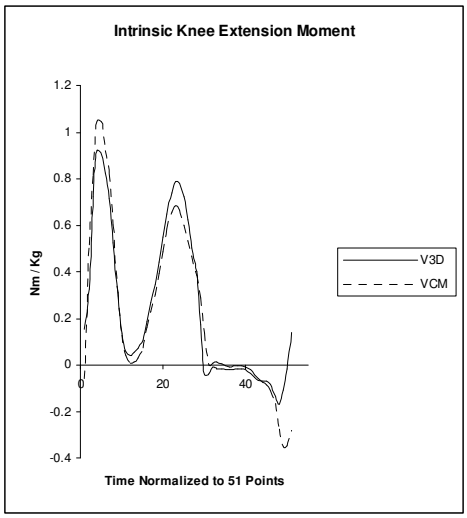

Figure: A representative example of one of the statistically different moment graphs.

Common trends in the discrepant variables were higher peaks and lower valleys as well as deviation at the end points. This can most likely be attributed to each program's smoothing and normalization techniques. VCM uses a bezier spline to perform both interpolation and filtering of force, position, velocity, and acceleration data (Roren, 2003). V3D uses a second order low pass Butterworth filter on position data and normalizes with a cubic spline.

SUMMARY

When switching biomechanical modeling software it is useful to note key differences between platforms. When using a given model like HH, it is important that clinical decisions remain unaffected by software platform changes. This study showed no statistical difference between the Helen Hayes modeling in VCM and V3D for 16 out of 20 variables key to our gait analyses. We are in the process of determining the clinical importance of the statistically significant differences. These findings allow us to move ahead with our validation of V3D against M3D, and 6DOF against Helen Hayes.

REFERENCES

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