THE ACCURACY OF USING POSTURAL ASSESSMENT TO DETERMINE CUMULATIVE EXPOSURE

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INTRODUCTION

Cumulative loading, a know risk factor for low back pain [1] that is separate from peak loading [2] must be investigated to aid in workplace safety. Video-based task analysis in the workplace is often limited by equipment location and production line arrangement, therefore making it difficult to capture the motion in the sagittal plane. The purpose of this paper was to investigate the amount of error in calculating cumulative loading variables (compression, joint anterior shear, joint posterior shear, reaction anterior shear and extension moment) using a posture matching approach (3DMatch; [3]) compared to a 3D coordinate modeling approach (FASTRAK™ electromagnetic tracking system).

METHODS

Six participants (3 males & 3 females) performed five repeats of two symmetrical and two asymmetrical stoop lifts while being simultaneously recorded from different camera views. The lifts were videotaped at 0^0, 45^0, 60^0 and 90^0 from the frontal plane. For modeling purposes, participants were suited with eight FASTRAK™ sensors located on the occipital protuberance, posterior surface of the second metacarpal-phalangeal joints, center of mass of the posterior surface of the trunk, upper arms and lower arms.

Four hundred and eighty lifting trials (6 subject * 20 lifts * 4 camera views) were analyzed using 3DMatch. 3DMatch uses postures of the trunk and upper extremities that are selected on a frame-by-frame basis from a set of predetermined posture categories (bins), which are used along with the subjects' anthropometric measures and hand forces to calculate the peak and cumulative variables. Relative error scores were calculated between the cumulative values derived from posture matching for each camera view (3DMatch) and those derived from the coordinate data (FASTRAK™). Both approaches used the same biomechanical model.

RESULTS AND DISCUSSION

No significant difference ($p<.05$) in the relative error for any of the cumulative loading variables across the four different camera views were found. Furthermore the relative error for compression, joint anterior shear, reaction anterior shear and extension moment were all below 11% (Table 1). The high relative error for joint posterior shear was due to the different techniques used to determine the segment angle. The posture bin for the trunk was a 30^0 range with the neutral bin postures ranging from -15^0 to $+15^0$. The midpoint bin value (0 in this example) is used as input to the 3DMatch model, whereas FASTRAK™ uses the recorded segment angle. Figure 1 illustrates this problem. During frames 5 through 8 the neutral posture category was correctly chosen as the angle was $\sim14^0$ and therefore a segment angle of 0 was used. However, comparison with FASTRAK™ where the actual 14^0 angle was used, the simplification of choosing the midpoint of a category inflates the error.

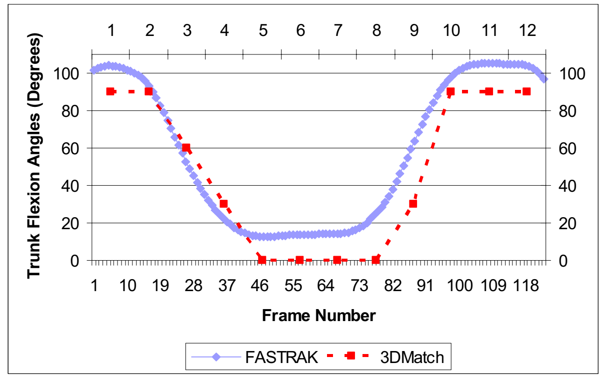

Figure 1: A trunk flexion angle graph representing a large difference between the data from the two model inputs.

CONCLUSIONS

These results suggest that 3DMatch is a promising tool for calculating cumulative low back loads as the relative error for all variables was below 11% when compared to a 3D biomechanical model.

REFERENCES

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Table 1: The relative mean (± standard deviations) percent error for each camera view across the four tasks

Variable	Camera View				
	0^0 view	45^0 view	60^0 view	90^0 view	Variable Mean
Compression	8 ± 6.0	8 ± 5.6	8 ± 5.9	7 ± 4.7	8 ± 5.6
Joint Anterior Shear	10 ± 7.8	10 ± 8.0	12 ± 10.5	11 ± 9	11± 8.9
Joint Posterior Shear	257 ± 611.8	252 ± 680.9	261 ± 686.5	260 ± 676.5	256 ± 662.4
Reaction Anterior Shear	9 ± 6.8	7 ± 5.9	8 ± 7.3	7 ± 5.4	8 ± 6.4
Extension Moment	9 ± 6.8	9 ± 6.8	10 ± 7.6	11 ± 7	10 ± 7.2
View Mean	58 ± 111.1	57 ± 108.8	60 ± 112.5	59 ± 112.0	59 ± 111.1
View Mean Excluding Joint Posterior Shear	9 ± 0.7	9 ± 1.4	9 ± 2.2	9± 2.4	9 ± 1.6