POSTURAL GAIT CHANGES ARE SEEN WITH SEVERE, NOT MODERATE, KNEE OSTEOARTHRITIS

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INTRODUCTION

Knee osteoarthritis (OA) is a very common disease of the musculoskeletal system that is a major cause of morbidity and disability in the world. It is a progressive disorder that involves multiple, interacting biomechanical and biochemical factors, making it very difficult to understand the pathological process of the disease. Although many biomechanical changes with knee OA have been identified (i.e. knee joint loading and orientation), most previous studies have included only patients with severe knee OA. Without data from patients from varying levels of knee OA severity, it is difficult to determine whether these factors are a result of the disease process, or are important to the onset and progression of the disease. Differences in the knee flexion angle during gait with knee OA have been found [2], but simultaneous changes that occur at the other joints in the lower limb have not been explored in previous studies.

Using a multidimensional gait data analysis technique, we compared the postural changes (hip, knee and ankle angles in the sagittal plane) over different levels of knee OA disease severity.

METHODS

Two patient populations, a moderate knee osteoarthritis (OA) population (n=40) and an end-stage knee OA population (n=38), as well as an age-matched control group (n=40) were included in this study. Disease severity of the moderate knee OA group was based on radiographs, physical exams and functional tests. The severe knee OA patients were within six months of total knee replacement surgery.

Three-dimensional kinematic and kinetic data during gait were collected for all patients using two optoelectronic motion analysis position sensors (Optotrak 3020, Northern Digital, Inc.), and a force platform (Advanced Mechanical Technology, Inc.) embedded in the walkway. These data were combined with specific anthropometric measures in an inverse dynamics model.

A multidimensional gait data analysis technique [1] that uses principal component analysis (PCA) and discriminant analysis was applied to the sagittal plane hip, knee and ankle angle waveforms to extract the important features of the data that describe differences in sagittal plane posture between the groups.

RESULTS AND DISCUSSION

A scree plot of the data indicated that the first three principal components (PCs) explained the majority of the variation in the sagittal plane waveforms. A stepwise discrimination procedure indicated that two of these three PCs, PC1 and PC3, contained valuable discriminatory information between the groups. The two discriminatory PCs, combined in linear discriminant functions that represented boundaries between the groups, successfully discriminated between the normal and severe knee OA groups (with a cross-validation error of 9%), but did not discriminate between the normal and moderate knee OA groups. Postural gait differences are therefore characteristic of severe knee OA gait, and not characteristic of moderate knee OA gait.

The third principal component, PC3, was the most discriminatory feature. This feature had equal contributions from all three lower limb angles, and therefore represented an overall range of motion of the lower limb. This difference is most important from late stance to early swing (approximately 40 – 80% of the gait cycle) (Figure 1a). The severe knee OA group had higher PC3 scores than the normal group, and these higher scores were associated with lower overall ranges of motion in all three joints (Figure 1b). These changes are likely in response to the increased levels of pain during gait that are common with end-stage knee OA. The lack of difference between the normal and moderate OA groups suggests that these postural changes are not involved in the pathomechanics of knee OA. PC1 was interpreted as a difference in the magnitude of the knee flexion angle during early stance, which supports the results of previous knee OA studies. The identification of PC3, however, points to the importance of synergism between the joints of the lower limb during gait.

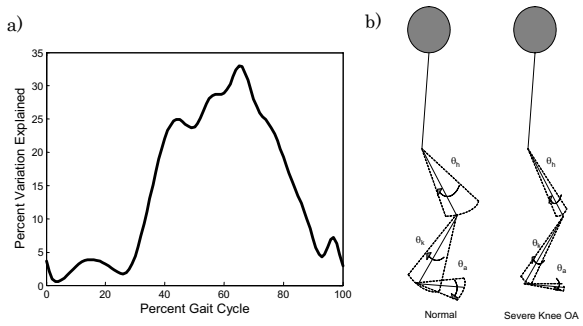

Figure 1: a) A plot of the percentage of the variation explained by PC3 at each percentage of the gait cycle shows that PC3 is most important from approximately 40-80% of the gait cycle. b) Severe knee OA patients exhibited less sagittal plane angular motion in all three lower limb joints during gait than normal subjects.

CONCLUSIONS

Postural gait changes between normal and severe knee OA subject groups were identified, but no significant postural changes were identified between the normal and moderate knee OA groups. This suggests that the kinematic changes are more a response of the disease than a contributing factor to the onset and progression of knee OA. The most discriminatory feature identified an important synchronicity in the joints of the lower limb that is often not accounted for in gait studies. The results of this study indicate the need for more simultaneous considerations of multiple joints in gait analysis.

REFERENCES

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