INTRODUCTION

Different muscle groups function in synchrony and coordination to perform a given task, wherein the activity of one muscle group closely affects that of another [1,3]. Osteoarthritis (OA), a chronic joint disease, is the most common musculoskeletal complaint worldwide characterized by pain, disability and progressive loss of function. It is associated with significant health and welfare costs [2,7]. The knee is the most frequently affected lower limb joint and prevalence of knee OA increases with age [6]. Several studies have shown that muscle recruitment patterns and neuromuscular efficiency are different for patients with OA compared to normal controls during simple closed chain activities [4,5]. However, no studies have investigated frontal plane control or the modulation of control due to, for example, a change in time or distance in OA [5,6]. This paper reports the results of a pilot study with healthy subjects to determine muscle activation patterns (electromyogram, EMG), and modulation of these patterns, in a frontal plane step initiation task.

METHODS

Four subjects, age 23-32 years, mean height and weight 165 cm and 75 kg respectively, participated in the study. EMG for the support limb was recorded from rectus femoris (RF), vastus lateralis (VL), vastus medius (VM), biceps femoris (BF), semi membranous (SM), tibias anterior (TA), gastrocnemius (GAS), gluteus medius (GM), and gluteus maximus (GMax) while the subjects side stepped up (at a fixed interval with feet on separate force plates) on a 4 or 8 inch step (Figure 1). Subjects completed 3 successful trials. Muscle activity and ground reaction forces (GRF) were recorded employing an 8 channel EMG system (Motion Lab Corp.) and dual force plates (AMTI) respectively. The signals were sampled at 1000 Hz and band-pass filtered (20-500 Hz) with the EMG full-wave rectified [3]. The recorded EMG and GRF data were averaged across these trials for each subject. The GRF data were used to identify the phases of movement and matched with the corresponding EMG data in Visual 3D software.

RESULTS AND DISCUSSION

Three distinct phases for the step up task were identified as shown in figure 2 for the 8 inch step. These were from initiation to toe-off (1-2), toe-off to contact (2-3), contact to loading and stabilization (3-4). It was observed that for the 8 inch step, there was both an increase in slope and the peak of ground reaction force. For example, the slope of mediolateral GRF (figure 2B) for the 8 inch step increased by 200% over the 4 inch step. Subjects completed the 8 inch step in relatively less time duration. The GM and GMax were also found to be more active from initiation to end of the stabilization phase. The RF was active from beginning of initiation to end of contact phase. However, the activity of the SM and GAS was quite insignificant. In addition, the EMG amplitudes also greatly increased in 8 inch step up task. The mean integral values increased for most muscles (figure 2 C-E) by approximately -50%.

Figure 1: Lateral step up task from 8 inch step on force plate.
CONCLUSIONS

These results provide a baseline standard for understanding lower extremity muscle group patterns actively involved in performance of lateral side stepping tasks. These distinct phases in the step up task were found to be consistent for all subjects. The results illustrate coordination in the muscle activity patterns of different muscle groups during task modulation with prominent firing of the quadriceps, hamstrings and the hip abductor/extensor muscles for the side step up task. Future studies will examine OA subjects and determine if there is both a phase shift and amplitude change. This could be useful in defining kinematic and activation patterns for identifying early onset of the disease as well as rehabilitation protocols prior to surgery.

REFERENCES
