Relevance to Musculoskeletal Condition
This study quantified lower leg muscle activation prior to and during the ground contact phase of dynamic activities commonly associated with ankle injuries. The findings, which suggest open loop feedforward control can have a substantial influence on rehabilitative approaches to ankle injuries.

Introduction
Ankle sprains, one of the most common ligamentous injuries, frequently occur in jumping sports. During jumping, while athletes are in the air, the foot normally falls into the plantarfexion and inversion where the mechanical stability of the ankle complex is reduced. At landing, the dorsiflexor and the evertors need to bring the foot to a more neutral position. Therefore improper timing of the ankle joint positioning during landing often results in ankle injuries. However, feedback-driven reflexive joint stabilization, including the stretch reflex, is inadequate or too slow to protect a malpositioned ankle complex from inversion injury. Therefore, the ankle complex might be reliant on open loop, feedforward muscle activation for dynamic stabilization for safe landing. The purpose of this study was to determine the activation characteristics of the peroneus longus (PL) and tibialis anterior (TA) prior to, and during the ground contact phase of vertical jumps and side-cuts. We hypothesized that the activation data would support the presence open loop, feedforward activation.

Moreover, the influence of semi-rigid bracing, one of the most common prophylactic methods for ankle treatment, on the activation characteristics of these muscles was investigated.

Materials and Methods
Ten healthy subjects were recruited to participate in this institutionally approved study. Branched surface electrodes(1) were used to acquire electromyographical signals from the PL and the TA. A 3 ms supra-maximum stimulation was applied to the common peroneal nerve to elicit maximum muscle activation responses (Mmax) of the peroneus longus and the tibialis anterior. Mmax was established as the mean from five stimulations. The subjects performed five trials of maximum side-cuts and vertical jumps. Both tasks were initiated from a standardized standing position on a strain gauge force plate. For side-cuts, subjects were instructed to move as quickly as possible from one force plate to a second force plate placed 150 cm from the first and then move back as quickly as possible to original position. For vertical jumps, the subjects were instructed to jump as high as possible and to land on the force plate. The tasks were performed with and without a semirigid ankle brace. For the side-cuts, EMG analysis was performed 100 ms prior to landing (airborne phase) and during the entire ground contact phase. For the vertical jumps, EMG analysis was performed 100 ms prior to landing and for 100ms following ground contact. The baseline-to-peak amplitude (peak amplitude) of the EMG signals were expressed as a percentage of Mmax. The primary statistical design was repeated measures ANOVA.

Results
The onset of the PL and TA activation was evident about 50 to 60 ms prior to the instant of ground contact for the side-cuts and vertical jumps. For the airborne phase of the side-cut, the peroneus longus and the tibialis longus activations were 13±8 % and 24±20 % of Mmax, respectively. For the ground contact phase the peroneus longus and tibialis anterior activations were 28±11% and 46±34% Mmax, respectively. Activations during the ground contact phase were significantly (p<0.02) larger than those collected under the airborne phase (Fig. 1A). For airborne phase of the vertical jump, the peroneus longus and the tibialis longus activations were 13±6% and 18±15% Mmax, respectively. During the ground contact phase, the peroneus longus and the tibialis anterior activations were 13±6% and 44±35%, respectively (Fig. 1A). During the ground contact phase, side-cuts resulted in significantly (p<0.05) higher peroneal activation than that of vertical jumps.

Effect of Bracing on the Activation Characteristics and Force Plate Data:
Application of the semi-rigid brace did not result in different activation levels of the PL and the TA during side-cuts and vertical jumps (Fig. 1A,B). There was no significant difference between the duration of the landing phases of the side-cuts with (411±84 ms) and without (407±68 ms) application of the brace. Vertical ground reaction force and horizontal shear force collected during the landing phase of side-cuts and vertical jumps under braced condition were not significantly different from those collected under non-bracing condition

Discussion
This study revealed that lower leg muscles are already activated before landing of dynamic activities, which is in contrast with previous findings where the peroneal muscles were found to be relaxed at the time of foot-ground contact in walking and running(2). This discrepancy is probably because that the types of activity we chose for this study (side-cuts and vertical jumps) were more strenuous than walking and running. Our data are consistent with the presence of open loop feedforward -driven ankle complex stabilization in preparation for and during the ground contact phase of the tasks. Based on the expected electromechanical delay between the onset of muscle activation and the development of meaningful muscle force, the onset of muscle activation prior to ground contact is consistent with preparation for ground contact. Application of the semi-rigid brace did not result in different EMG and force plate data when compared with those collected under non-braced condition, and did not seem to have any interference with muscle activation during dynamic activities.

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*Ozaki, T., Lord, D. R., **Mizuno, K., *Grabiner M. D., *Department of Biomedical Engineering, Wb-3,The Cleveland Clinic Foundation, 9500 Euclid Ave., Cleveland, OH, 44106; (216)444-7276, Fax(216)444-9198, grabiner@bme.ri.mcf.org

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