Ankle sprains are among the most common musculoskeletal injuries, and up to 70% of people who sprain their ankles develop chronic ankle instability (CAI). Moreover, people who develop CAI have a significantly higher risk of developing ankle osteoarthritis. Recent research has identified neuromuscular deficits that may be responsible for the high recurrence rates of ankle sprains and for the progression towards ankle osteoarthritis in people with CAI. Unfortunately, current rehabilitation strategies are not completely successful because the mechanisms responsible for these deficits are not fully elucidated. Therefore, the purpose of this dissertation was to investigate individual muscle forces and force generating capacities, the contributions of individual muscles to ankle joint contact forces, muscle activation patterns in the time-frequency domain, and central nervous system control strategies in people with CAI.

Eleven people with CAI and 11 matched healthy control performed landing, anticipated cutting, and unanticipated cutting tasks, while three-dimensional movement, ground reaction force, and muscle activation data were collected with motion capture system, force plate, and electromyography, respectively. In the first study, a musculoskeletal model and static optimization were used to estimate the force and force generating capacity of individual muscles. In the second study, an additional joint reaction analysis was used in combination with the musculoskeletal model to estimate the contribution of individual muscle forces to ankle joint contact forces. In the third study, wavelet transformation and principal component analysis were used to analyze the time-frequency domain of muscle activation patterns. In the final study, non-negative matrix factorization was used to extract muscle synergies in order to identify central nervous system control strategies. Results from all analyses were compared between people with and without CAI.

The primary findings of this dissertation were that, compared to healthy controls, people with CAI exhibit 1) greater muscle forces and/or force generating capacities in proximal muscles, 2) greater ankle anterior shear forces during early and late stance phases of unanticipated cutting, 3) lower intensity of muscle activation and a task-dependent inability to shift activation towards higher frequencies, and 4) similar complexity in neuromuscular control from a central nervous system perspective.