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Effect of active muscle forces on knee injury risks for pedestrian standing posture at low-speed impacts.

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Abstract

OBJECTIVES: The objective of the present study is to investigate the effect of muscle active forces on lower extremity injuries for various impact locations and impact angles for a freely standing pedestrian.
METHODS: FE simulations have been performed using a validated lower extremity FE model with active muscles (A-LEMS). In all, nine impact orientations have been studied. For each impact orientation, three different pre-impact conditions of a freely standing pedestrian, representing a cadaver, and an unaware and an aware braced pedestrian, have been simulated. Stretch-based reflexive action was included in the simulations for an unaware pedestrian.
RESULTS: Strains in knee ligaments and knee joint kinematics have been compared in each impact orientation to assess the effect of muscle activation. It is observed that strain in knee ligaments is dependent on impact locations and angles and the MCL is the most vulnerable ligament. Further, due to muscle effects, except when the impact is on the knee, peak strain values in all the ligaments are lower for an unaware pedestrian than either for a cadaver or for a fully braced pedestrian.
CONCLUSIONS: It is concluded that active muscle forces significantly affect the knee kinematics and consequently reduce strains in knee ligaments.