Carolyn Van Toen is a Ph.D. student in the Injury Biomechanics Laboratory at the University of British Columbia. Her area of research is spine and spinal cord injury mechanics involving computational and experimental models. She also has experience reconstructing injuries resulting from falls, sporting accidents, and automotive collisions at Synaptic Analysis Consulting Group.

Preventing Fall-Related Vertebral Fractures: Effect of Floor Stiffness on Lumbosacral Spine Forces
Van Toen, C., Sran, M.M., Cripton, P.A., Robinovitch, S.N.

Vertebral fractures are relatively common in elderly patients and these are most frequently associated with falls from a standing height or less [1]. In a backward fall, floor forces at impact are known to decrease with a decrease in floor stiffness, which suggests a possible strategy for injury prevention [2], however the effects on spine forces are unknown. The objectives of this study were to develop and validate a multibody model of the lumbosacral spine for simulation of spine forces during a backward fall and to determine the effect of floor stiffness on spine forces. A six degree of freedom multibody model (upper body to pelvis) was created using inertial and material parameters based on published data. The model was validated using experimental data of ten volunteers falling onto three types of flooring [2]. Subject masses (62-117 kg), floor stiffnesses (59 kN/m, 67 kN/m, and 95 kN/m) and fall velocities (2.5-4.1 m/s) were input into the model and simulated floor forces (peak values and time to peak values) were compared to experimental values. The effect of floor stiffness was investigated by simulating falls onto the three types of flooring at the average experimental velocity (3.47 m/s). The mean error in ground force was -11% (standard deviation 13%) and the mean error in the time to peak ground force was 13% (standard deviation 7%). Spine forces increased with an increase in ground force and with floor stiffness. Spine forces were approximately 76.9, 73.7, and 68.8% of the floor forces at L5/S1, L4/5, and L3/4, respectively (coefficients of determination were 0.93, 0.94, and 0.94, respectively). This model could be used with in vitro tolerance data to determine optimum characteristics of flooring for reducing osteoporotic spine fractures due to backward falls.