Characterization of the Human Anterior Longitudinal Ligament using a transversely isotropic material model

In the present study, 30 cadaveric spine test specimens of the human anterior longitudinal ligament (ALL) were tested to failure and force deformation data was collected. The specimens were tested using an anisotropic quarter punch test (AQPT) technique that facilitated the acquisition of anisotropic material response data from a single small test specimen. A finite element simulation of the experimental test was developed using a transversely isotropic material model for the ligaments that comprehensively characterized the ligament material using 6 independent parameters. This finite element simulation was repeated using an optimization routine to find material parameters that produced a force deformation curve closest to that obtained from the physical experiments. The material model correlated well with the experimental response (R2 ≥ 0.98). The results show that the human ALL has a lower stiffness and a higher strain to failure when compared to other major spinal ligaments that where characterized using similar methods and material models. The resulting material parameters may be used to model the nonlinear anisotropic response of the human ALL in finite element analysis, providing a more fidelic representation than the current common practice of modelling the ligament as a simple line element.