Investigation of Freezing and Decay Effects on Material Properties of Porcine Abdominal Organs

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Abstract:
Cadaveric and human numerical models are playing an important role in assessment and optimization of novel restraint systems for reducing the abdominal injuries (about 5% of total injuries). While some concerns were raised regarding the rapid degradation of abdominal organs after death, the investigation of tissue preservation techniques is required for developing appropriate testing methodologies for quantifying the whole response of human and material properties of abdominal tissues. To better understand the freezing and decay effects, this study analyzes statistically the data obtained from indentation performed on porcine abdominal organs.

Specimens with a constant thickness of 20mm were cut with a custom blade assembly from 15 fresh porcine organs (5 livers, 5 kidneys and 5 spleens) obtained from a local slaughterhouse. Indentation ramp-hold tests with 2 min hold time and 1 mm displacement peaks were first conducted on fresh specimens at eight locations of each organ. All samples were submerged in physiological (0.9%) saline at room temperature during testing. Half of the specimens of each organ were then frozen and re-tested after 30 days under the same testing condition, and the other half of the specimens were re-tested at day 2, 5, 10, 20, and 30, and were cooling between every two sequential tests.

Indentation force and displacement data recorded in more than 400 indentation tests were analyzed using a quasi-linear viscoelastic model. The model parameters of instantaneous elastic response and reduced relaxation function were identified using optimization for each test. Generalized estimating equations statistical modeling approach, which considers the dependency of observations, was applied to the longitudinal test data to compare averaged parameters for each organ.

It is believed that the results of this study may help in development of appropriate preservation methodologies for abdominal organs and better understand the published results of whole body abdominal tests.