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Designing a test to determine physical changes in explanted hernia meshes

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Abdominal hernias are painful conditions that affect about 4.5 million people in the USA alone. Surgeons suture a polymer mesh material to the peritoneal wall to provide support for the peritoneal wall as it heals. The meshes have helped to prevent the hernias from recurring, but they have problems that need to be addressed. The meshes can shrink and laminated meshes can delaminate, causing the mesh to become ineffective and allowing the hernia to recur. The meshes can also stiffen and cause damage to the peritoneal wall or abdominal organs and form attachments to the organs in the abdominal cavity. There are currently many different kinds of mesh materials and constructions being used by surgeons. Each type of mesh may undergo different chemical and physical changes that might affect its structural attributes. There is little in the current medical or engineering literature that deals with hernia meshes, so the goal of this project was to design a simple and repeatable test to determine five pertinent properties of the meshes: stiffness, displacement/percent elongation at physiological pressure, stress, strain, and Young's Modulus. A test was thus developed that used a texture analyzer to force a plunger into a known size of mesh at a known rate until the force generated by the plunger reached the peak known intra-abdominal pressure of 252 mmHg. A rounded plunger slightly smaller than the area of the mesh exposed by the machine's clamps pushes down into the mesh and the force at different displacements is recorded. The mesh's thickness was measured also. Determining these physical properties through experimentation will allow the performance capabilities of the meshes to be evaluated reliably and consistently. The results obtained from this plunger test substantiate the initial observations that the mesh has become stiffer while it is in the body.