Hertz Contact Based Scaling of Puncture Forces for Large Scale Needle Prototypes Using a Gelatinous Tissue Phantom

Stacy L. Figueredo and Alexander H. Slocum
Massachusetts Institute of Technology

In order to test small scale medical devices, it is often necessary to prototype them on a larger scale such that proof-of-concept tests can be made more affordably and design details can be tested more easily. This article discusses a method of scaling large needle prototypes for testing in a gelatin phantom such that puncture forces match those expected for the actual-size needle when puncturing tissue. Using Hertz contact force equations to account for the differences in prototype materials and size, as well as for the tissue phantom properties, 10× scale prototype needles were inserted into a gelatin phantom and puncture forces were compared with those of a real scale prototype in bovine liver tissue. Results showed that for a 19 gauge (1.06 mm) stainless steel needle tip, where a maximum doctor-applied load of 5 N was desired to pierce liver tissue, loads of 0.44 N using Hertz point contact, and 0.31 N using Hertz line contact methods were predicted to puncture liver tissue, and an average load of 0.31 N was observed in force-displacement measurements. With a 10× scale stereolithographed needle prototype, Hertz point contact predicted a load of 0.31 N to puncture a gelatin phantom, Hertz line contact theory predicted 0.37 N, and an average load of 0.73 N observed in force displacement measurements. Similar contact mechanics based scaling methods might be applied to cutting devices.

Design of an Endoscope Lens Shielding Device for Use in Laparoscopic Procedures

Sterling Anderson, Julia Zimmerman, Emily Houston, Kevin Farino, and Nikolai Begg
Massachusetts Institute of Technology

In recent years, laparoscopic surgical procedures have revolutionized many gynecological and abdominal procedures, leading to dramatic reductions in recovery time and scarring for the patient. While techniques and instruments for performing laparoscopic surgery have improved over the years, loss of vision through the endoscopic lens caused by fog, liquid, and solid debris common to laparoscopic procedures remains a significant problem. In this paper, a shielding mechanism that maintains visibility through the laparoscope by removing debris from the distal end of the lens is presented. This device provides an inexpensive and convenient alternative to the current practice of removing, cleaning, and re-inserting the laparoscope during surgical procedures. This device is shown in multiple trials to repeatably remove debris from the distal tip of the lens, thereby restoring vision for the surgeon without requiring removal or reinsertion of the endoscope.

