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Research Abstracts

A Composite Hydrogel Small Bowel for Small Bowel Anastomosis Training

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Introduction: Small bowel anastomosis can frequently (3.02%) result in postoperative anastomotic leakage, greatly increasing patient mortality risks. Suture pullout is a common complication that contributes to leakage, but current training simulants like porcine, do not accurately replicate human pullout forces. This study aims to develop a new synthetic model for training human small bowel anastomosis and comparing it with the suture pullout forces (SPOF) of current training models.

Methods: Thirty-five fresh, unfixed human small bowel specimens were prepared for testing within 72 hours post cross-clamp. Fresh porcine intestine was purchased from a local grocery store. The mesentery was removed, and the bowel was bisected and cut into 10 mm x 20 mm strips.
Hydrogel small-bowel was developed by combining an aqueous Polyvinyl Alcohol (PVA) solution with Dimethylsulfoxide at 90°C. Titanium dioxide and acrylic pigment were added to reach the desired appearance prior to degassing. The hydrogel was cast into a 3D-printed mold (Fig. 1a) with a nylon mesh affixed (Fig. 1b). The hydrogel was subjected to freeze-thaw cycling prior to demolding and rinsing with deionized (DI) water. where they were retained until testing.
A uniaxial load frame measured the SPOF of human, porcine, and hydrogel small bowel. For each test, the sample was looped through with a 2-0 Polysorb^{TM} V-20 suture, gripped, affixed to the load cell via suture, and pulled to “tear” failure at 1.58 mm/s. The maximum force was recorded as the SPOF.

Results: The SPOF was calculated for human (4.62 ± 1.40 N), porcine (0.92 ± 0.19 N), and the hydrogel small bowel (4.18 ± 0.69 N). Compared to human SPOF, porcine was found to be significantly different ($p < 0.001$) while hydrogel was indistinguishable ($p = 0.49$).

Conclusions: The developed hydrogel-based small bowel simulator provides more accurate SPOF when compared to porcine for training anastomoses.

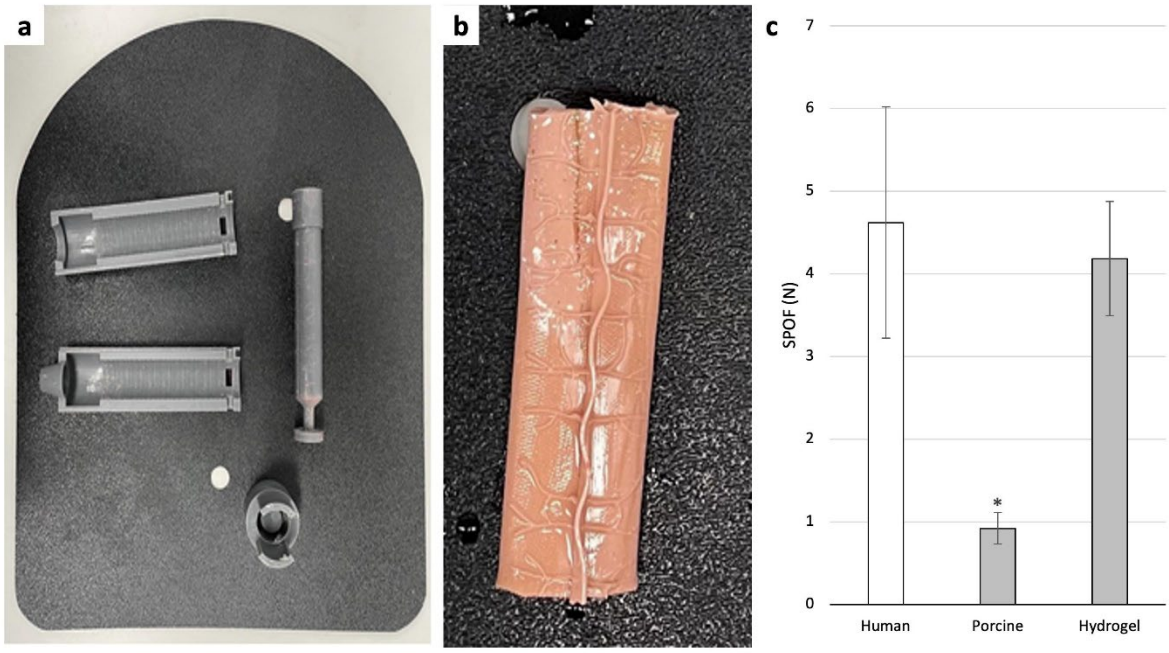

Figure 1: a) 3D printed small bowel mold. b) composite hydrogel small bowel with mesentery and mesenteric vessels. c) measured comparison of human, porcine, and hydrogel suture pullout forces.