



Ex-vivo animal testing of small bowel burst pressure and state of the art repair of bowel perforation

Ashkhan Hojati, Joseph Policarpio, Matthew Wheeler, PhD, Blair Rowitz, MD

Innovation Question

Is there a novel endoscopic suturing technique that is easy to use, reduces procedure time, and provides superior healing outcomes?



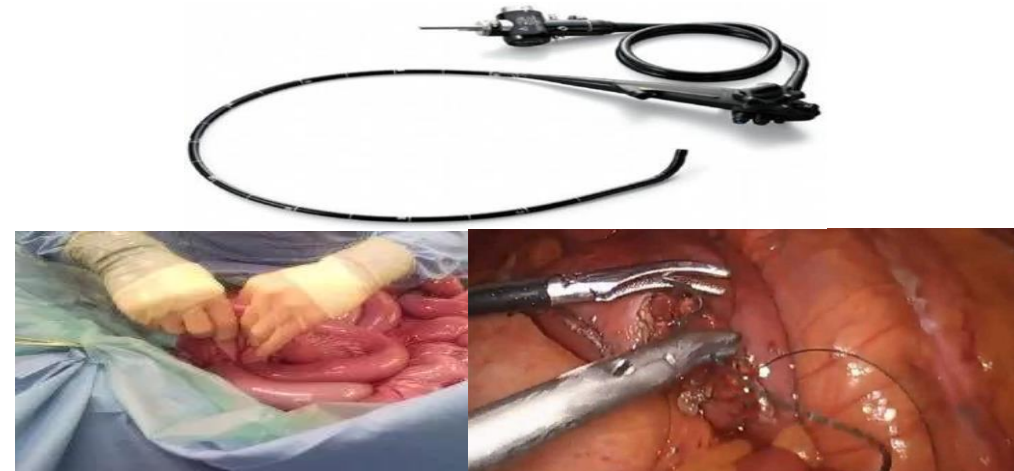
Bowel perforation is a full-thickness injury to bowel wall

- 1-7% in pediatric trauma
- 0.02-8% in adults [1,2]



Complications

- Hemorrhage
- Sepsis
- Death

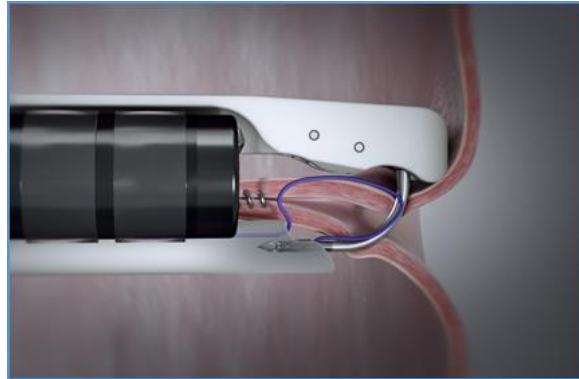


Management

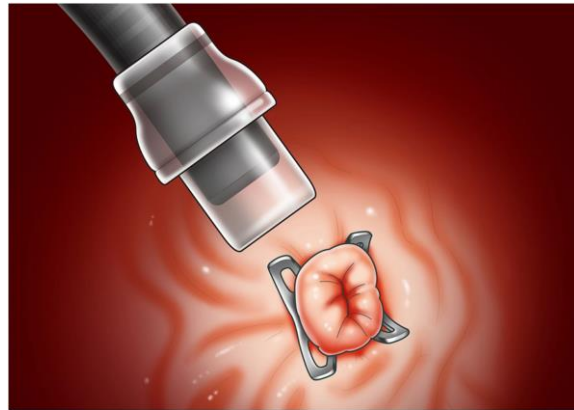
- Endoscopic clipping
- Stenting
- Suturing
- Laparoscopic procedures
- Open surgery

Current and Future Devices

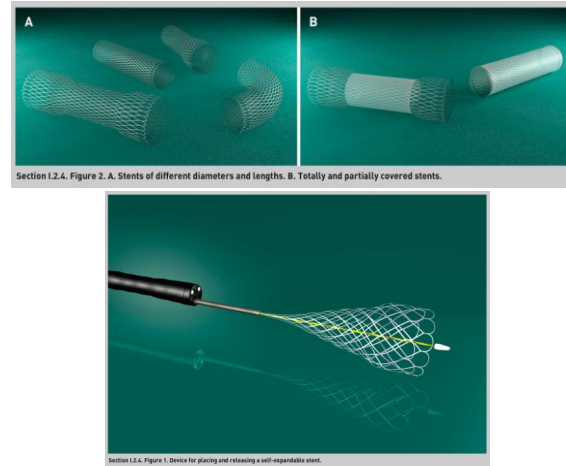
Overstitch



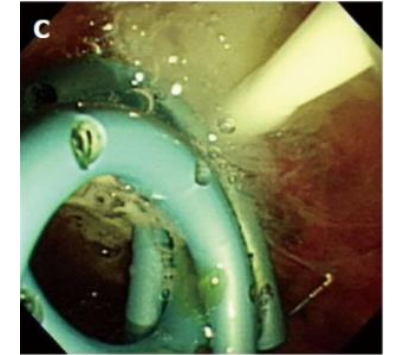
Clipping



Stents

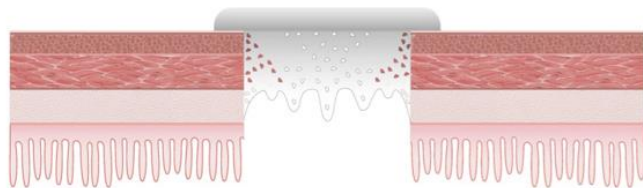


Sealant

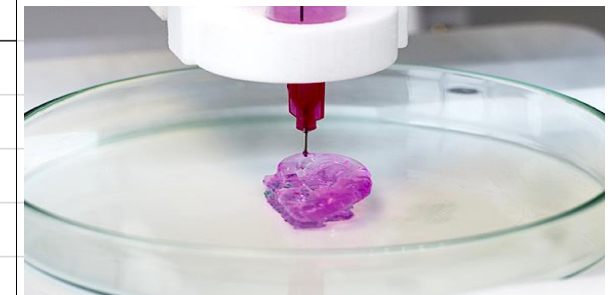


Biopatch

Biopatch serves as conduit for epithelial regeneration



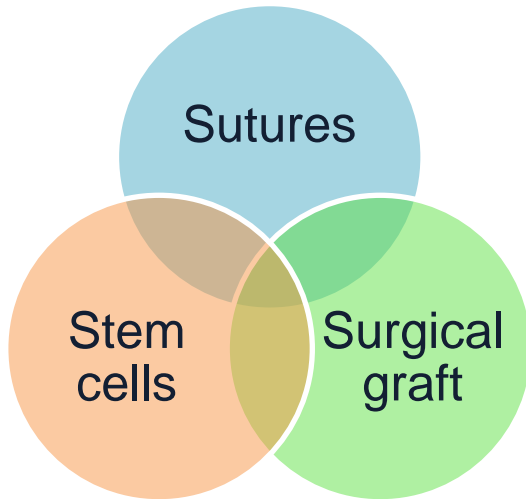
Adipocyte stem cell sheets 3D – printed matrix



<u>Device:</u>	<u>Pros</u>	<u>Cons</u>
Overstitch	Minimally invasive, full thickness closure	Requires high level of expertise
Clips	Multiple modalities	Location limitations
Stents	Self-expandable and covered versions	Risk of migration and incomplete seal
Sealants	Can amalgamate; can have tissue healing effects	Blood clotting complications
Biopatches/Stem Cells	Enhanced healing and antimicrobial	Less human data; Inflammation

Goals and Outcomes

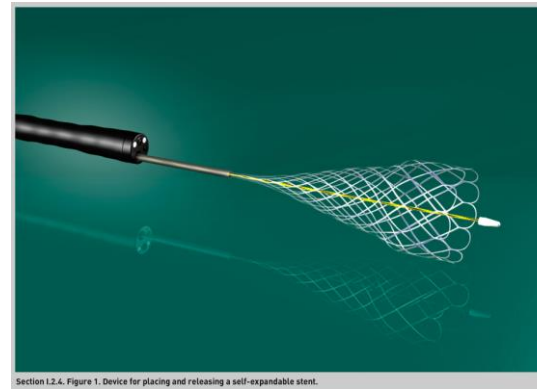
Combine current modalities



Utilize existing instrument ports

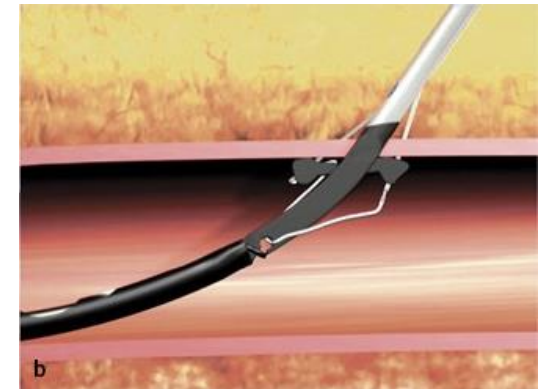


Self-expandable stent seals perforation when deployed



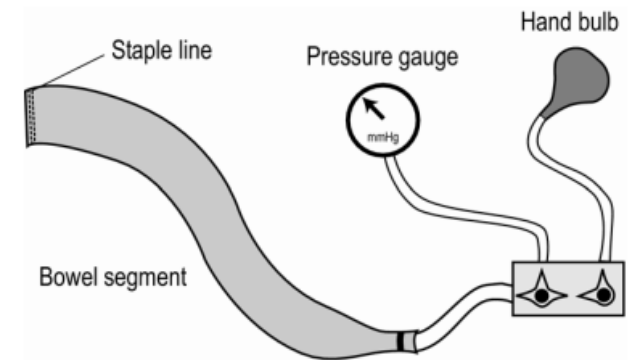
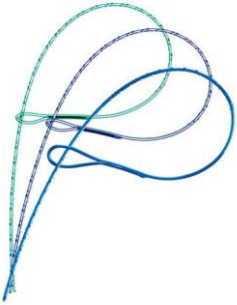
Section 1.2.4. Figure 1. Device for placing and releasing a self-expandable stent.

Graft-injection-with-auto-suture device

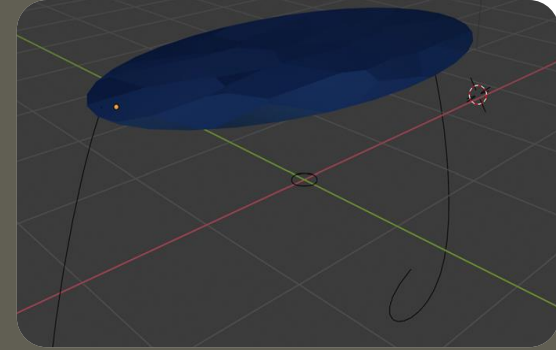
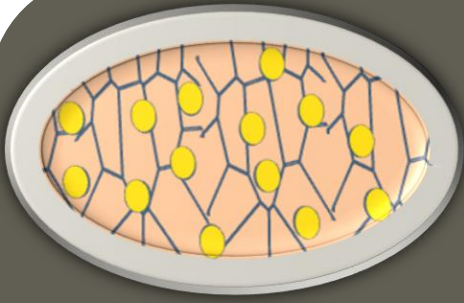


Research Plan

- Ex-vivo porcine model
- Burst pressure studies
 - existing methods
- Run in parallels
 - Sutured graft or stent vs sutures only
 - Graft on luminal side vs serosal side
 - Varying graft shapes and material
 - Varying suture techniques and material
 - Barbed vs standard
- Prototype



Prototype



Serosa

Muscularis Externa

Submucosa

Mucosa

Thank you!

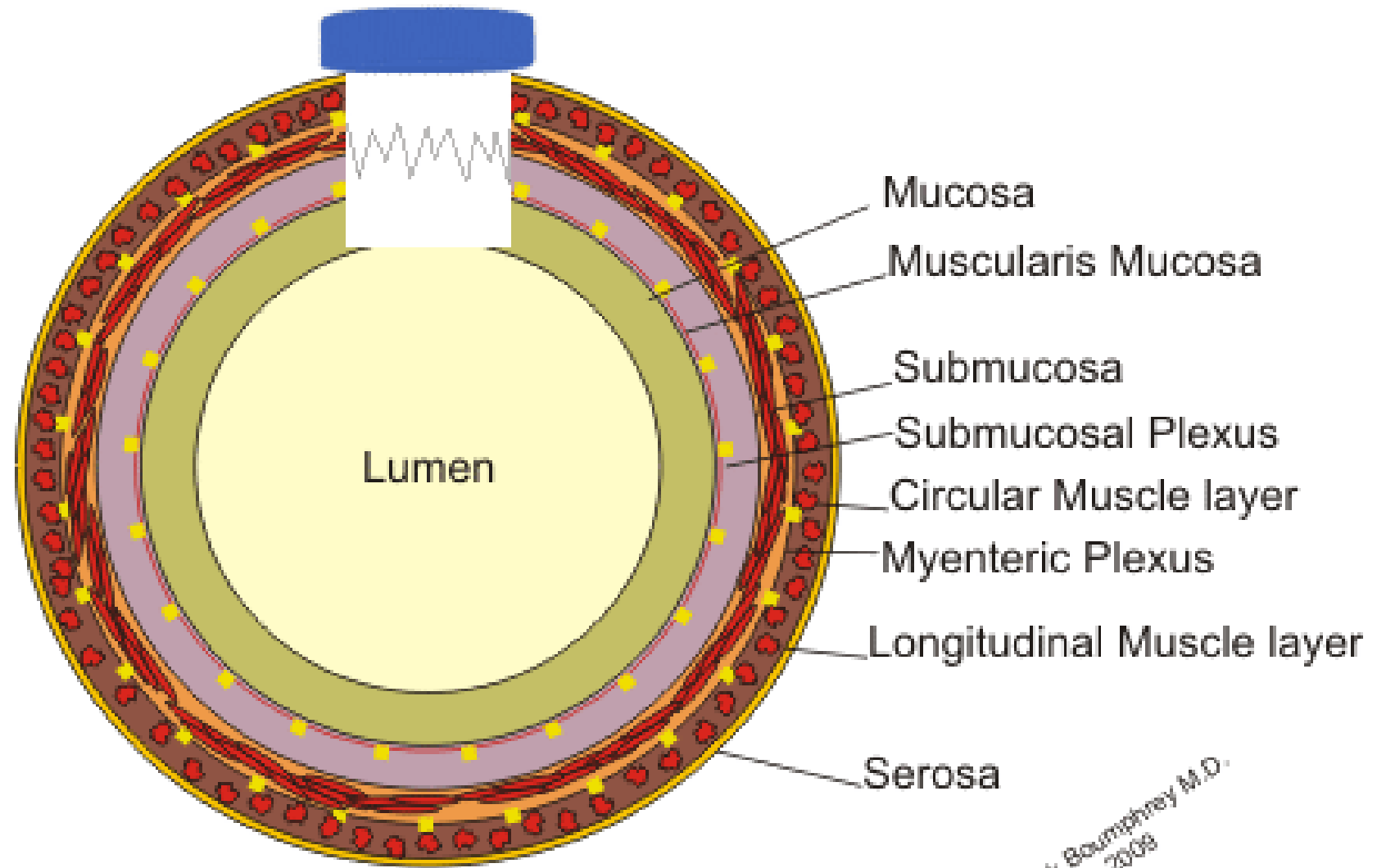
References:

1. de'Angelis N, Di Saverio S, Chiara O, Sartelli M, Martínez-Pérez A, Patrizi F, et al. 2017 WSES guidelines for the management of iatrogenic colonoscopy perforation. *World J Emerg Surg.* 2018;13:5.
2. Jones MW, Kashyap S, Zabbo CP. *Bowel Perforation.* Treasure Island (FL); 2021.
3. Pinheiro JS, Correa JL, Cohen R V, Novaes JA, Schiavon CA. Staple line reinforcement with new biomaterial increased burst strength pressure: an animal study. *Surg Obes Relat Dis Off J Am Soc Bariatr Surg.* United States; 2006;2:397–9, discussion 400.
4. Mery CM, Shafi BM, Binyamin G, Morton JM, Gertner M. Profiling surgical staplers: effect of staple height, buttress, and overlap on staple line failure. *Surg Obes Relat Dis Off J Am Soc Bariatr Surg.* United States; 2008;4:416–22.
5. Giusto G, Iussich S, Tursi M, Perona G, Gandini M. Comparison of two different barbed suture materials for end-to-end jejunum-jejunal anastomosis in pigs. *Acta Vet Scand [Internet].* BioMed Central Ltd.; 2019;61. Available from: <https://pubmed.ncbi.nlm.nih.gov/30611301/>
6. Wang, H., Ge, W., Liu, C., Wang, P. & Song, C. Design and performance evaluation of a powered stapler for gastrointestinal anastomosis. *Minim. Invasive Ther. Allied Technol.* (2021) doi:10.1080/13645706.2020.1867585.
7. Vrakopoulou, G. Z. et al. Impact of deserosalization on small bowel anastomosis healing in swine: A pilot study. *In Vivo (Brooklyn).* 34, 2423–2429 (2020).
8. Nandakumar, G., Richards, B. G., Trencheva, K. & Dakin, G. Surgical adhesive increases burst pressure and seals leaks in stapled gastrojejunostomy. *Surg. Obes. Relat. Dis.* 6, 498–501 (2010).
9. Lacitignola, L. et al. Swine Small Intestine Sealing Performed by Different Vessel Sealing Devices: Ex-Vivo Test. *Vet. Sci.* 8, 34 (2021).
10. Barbed Sutures - V-Loc™ Wound Closure Device | Medtronic.
11. Maina RM, Barahona MJ, Geibel P, Lysy T, Finotti M, Isaji T, et al. Hydrogel-based 3D bioprints repair rat small intestine injuries and integrate into native intestinal tissue. *J Tissue Eng Regen Med [Internet].* John Wiley and Sons Ltd; 2021 [cited 2021 Apr 11];15:129–38. Available from: <https://onlinelibrary.wiley.com/doi/10.1002/term.3157>
12. Khamaysi I. New technique: removal of embedded esophageal partially covered stent by endoscopic sub-stent space dissection. *Ann Gastroenterol [Internet].* Hellenic Society of Gastroenterology; 2021 [cited 2021 Apr 11];34:282. Available from: <https://pubmed.ncbi.nlm.nih.gov/37903574/>

Images:

1. <https://www.medtronic.com/covidien/en-us/products/wound-closure/barbed-sutures.html>.
2. Sepsis image: https://upload.wikimedia.org/wikipedia/commons/thumb/e/e1/Gabriel_Metsu_-_La_Fille_malade.jpg/300px-Gabriel_Metsu_-_La_Fille_malade.jpg
3. Open surgery image: https://rainlandfarm.com/wp-content/uploads/2018/07/Normal_Small_Intestine-300x184.jpg
4. Laparoscopy image: <https://www.surgicaloasis.com/wp-content/uploads/2020/04/Laparoscopic-small-bowel-resection-1000x500.jpg>
5. Overstitch image: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.overstitch.com%2Foverstitch-sx&psig=AOvVaw3G-6bLoxnJdwnr5b2ZsFum&ust=1618376473565000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCODWjKy4-u8CFQAAAAAdAAAAABAD>
6. OTSC image: https://www.google.com/url?sa=i&url=https%3A%2F%2Fonlinelibrary.wiley.com%2Fdoi%2Ffull%2F10.1111%2Fjgh.14402&psig=AOvVaw2_2eE6vKl09zrcvllcGpEW&ust=1618376724083000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCOiKIMG5-u8CFQAAAAAdAAAAABAJ
7. Stent image: <http://endoinflamatoria.com/i-2-4-self-expandable-stents/>
8. Sealant image: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4671050/>
9. Biopatch: <https://onlinelibrary-wiley-com.proxy2.library.illinois.edu/doi/10.1002/term.3157#term3157-bib-0028>
10. Adipose stem cell sheet (bioink image): https://www.biogelx.com/wp-content/uploads/2018/09/28_3_18_Biogelx_5-1-1.jpg

Supplemental



Frank Baumgartner M.D.
2008