A. JAMES CLARK SCHOOL OF ENGINEERING

THE FISCHELL DEPARTMENT of BIOENGINEERING

UNIVERSITY OF MARYLAND

Team B2: Updated Gastrojejunostomy Tube - Limiting Tube Migration Patterns

Mark Boegner, Nikka Givpoor, Alison Grafton, Adriana-Isabela Melendez-Munoz, and Kate Tanchanco

Advisors: Dr. Gregg Duncan, Department of Bioengineering, University of Maryland / Dr. Diana Jo, Children's National Hospital

Motivation and Objective

Gastrojejunostomy (GJ) tubes are inserted through the stomach and fed through to the jejunum, providing nutrition to patients.

Problem:
GJ-tube slips out of the jejunum and into the stomach (Tube Flip), requiring immediate medical attention and causing adverse effects.

Objective:
Improve design of GJ tube to reduce tube flips with **mucoadhesive hydrogel.**

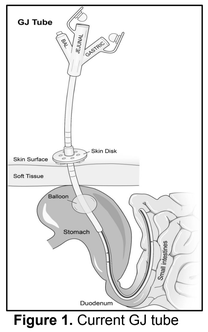

Figure 1. Current GJ tube

Methods

Table 1. Technical specifications.

Specification	Must-Haves
Mucoadhesive Layer Adherence	0.04 - 900 kPa
Cellulose Degradation Time	1 - 24 hours
Chitosan Degradation Time	> 6 months,
Tube Diameter	4.7 mm< D < 24 mm

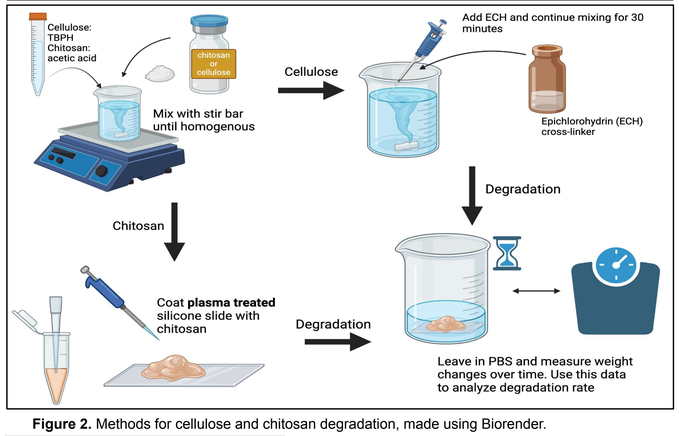

Figure 2. Methods for cellulose and chitosan degradation, made using Biorender.

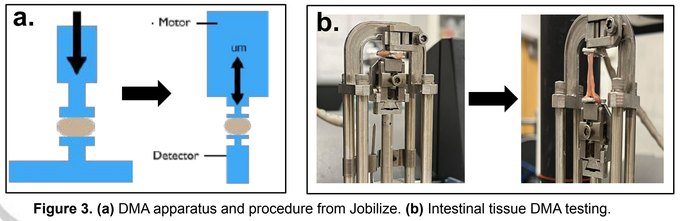

Figure 3. (a) DMA apparatus and procedure from Jobilize. **(b)** Intestinal tissue DMA testing.

Major Prototyping Results

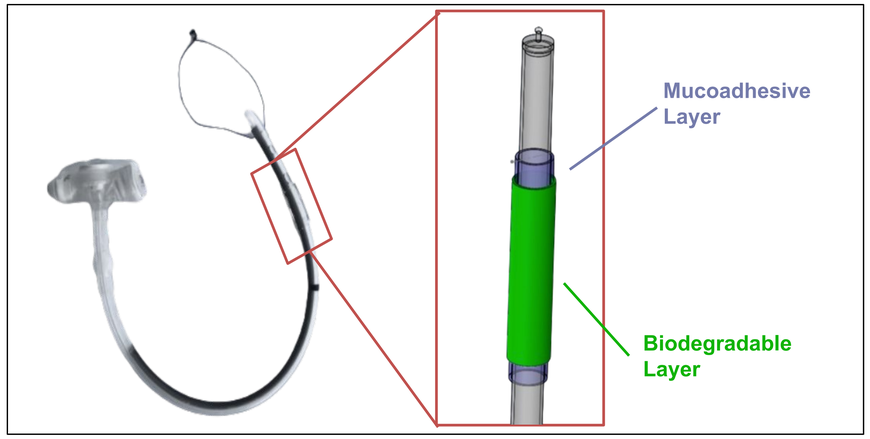

Figure 4. Prototype image with GJ tube and CAD model using solidworks.

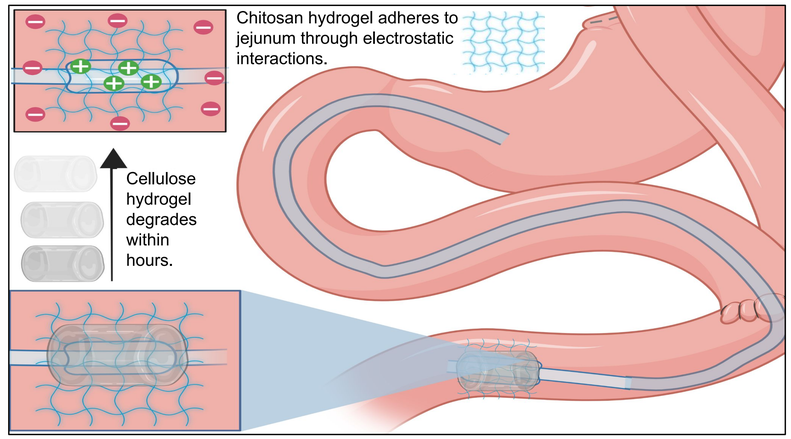

Figure 5. Theoretical function of our prototype, made using Biorender.

Degradation Results

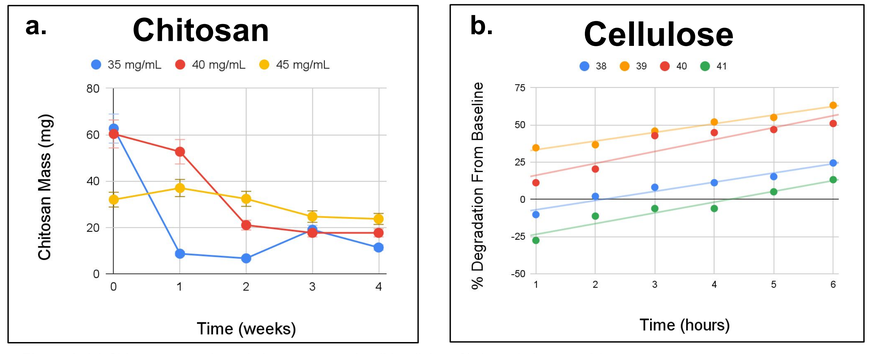

Figure 6. (a) Chitosan mass degradation over 4 weeks; **(b)** cellulose % degradation over 6 hours.

Adhesion (DMA) Results

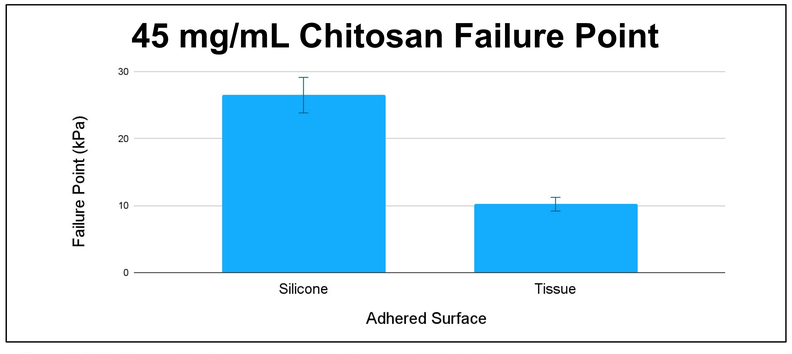

Figure 7. DMA failure points of chitosan applied to silicone and pig intestine.

Ethical Implications

Safety
Biocompatibility - No Toxicity

Inclusivity
Size differentiation - Account for patient size

Beneficence
Selective adhesion - No digestive obstruction

Conclusions

Quick (<24 hrs) Cellulose Degradation + **Strong (~26kPa) Chitosan Adhesion** → **Reduced Tube Flips & Hospital Return Visits**

Future Work

Quantifying Degradation
Using a rheometer to quantify degradation levels and assess thresholds of the material's ability to pass through the body.

Mucoadhesive Material Selection
Experiment with different biocompatible mucoadhesive hydrogels to identify materials with low degradation and high adhesion to the tissue and tube.

References

A. Sannino, C. Demitri, M. Madaghiele. "Biodegradable Cellulose-based Hydrogels: Design and Applications," Materials. Apr 2009 doi: 10.3390/ma2020353. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5445704/

"So Your Child Needs a Feeding Tube: Here's Everything You Need to Know," Parents. Accessed: Dec. 12, 2023. [Online].TM. Ways, WM. Lau, VV. Khutoryanskiy. "Chitosan and Its Derivatives for Application in Mucoadhesive Drug Delivery Systems," Polymers (Basel). Mar 2018 doi: 10.3390/polym10030267. PMID: 30966302; PMCID: PMC6414903. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6414903/

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