**Method**

We conducted simulations to further examine the properties of the GT20-PTH10 hydrogel, which exhibits a low stiffness but high adhesion at 37°C. The typical stomach volume of the mice used for the *in vivo* GP study ranges from 1.5-2 mL, and the maximum volume that can be infused into the stomach is around 0.9 mL. Therefore, we modeled the stomach as a hollow sphere with inner radius 7.10 mm, calculated from the stomach volumes, and thickness of 0.5 mm corresponding to literature values of the stomach wall thickness1. A mixed finite element formulation for displacements and pressures was implemented in FEniCS2,3, where the hyperelastic incompressible neo-Hookean material model was used. The material properties of the GT20-PTH10 hydrogel can be determined by assuming material properties close to incompressiblity, with a Poisson’s ratio of 0.49, and determining the Young’s modulus from the stress-strain curves in Fig. 2A. This calculation yields a shear modulus of 18.2 Pa for the hydrogel, and the shear modulus of a rat’s stomach was found from literature to be 2.86E4 Pa1.

For the first step, the hollow sphere modeled with the stomach material properties was prescribed an inner displacement to expand the model to an inner radius of 8.31 mm consistent with the limit of the stomach volume after infusion with liquid. The displacement determined from the first setup is then applied to the inner boundary of a dual material setup, and the nominal stresses and stretches on the plug surface can be determined.

**Results**

The evolution of the nominal stress magnitude can be seen in Fig. #, where the overall setup was loaded until the final stretches at the plug surface can be calculated to be: and . This yielded a bi-axial stress state where the hydrogel plug surface experienced the lowest overall stress magnitude, at 18.9 Pa. Fig. # displays components of the nominal stress and the deformation gradient, which quantifies the change between the reference and deformed configuration (see supplemental). The principal stress aligned with the x direction on the plug surface is equivalent to the principal stress aligned with the y direction, Pa.

Fig. 3B quantifies the adhesion strength of the GT20 hydrogels to glass slides in the 100 kPa range and higher, with GT20-PTH10 having the highest adhesion strength. While, we do not have a comparison of the adhesion strength of the hydrogel to the stomach, the stresses are more than four orders of magnitude smaller indicating that the threshold for detachment of the adhesive hydrogel will not be met under physiological loading conditions.

**Supplemental**

The deformation gradient can be determined from the displacement, **u**

where **I** is a second order identity tensor. The right Cauchy Green tensor, **C,** can be defined from the deformation gradient

The first invariant of the right Cauchy green tensor and the third invariant of the deformation gradient are defined as follows

The strain energy function of a neo-Hookean incompressible material model is given

where is the shear modulus, p is the pressure, and the corresponding nominal stress, **P**, is

**References**

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