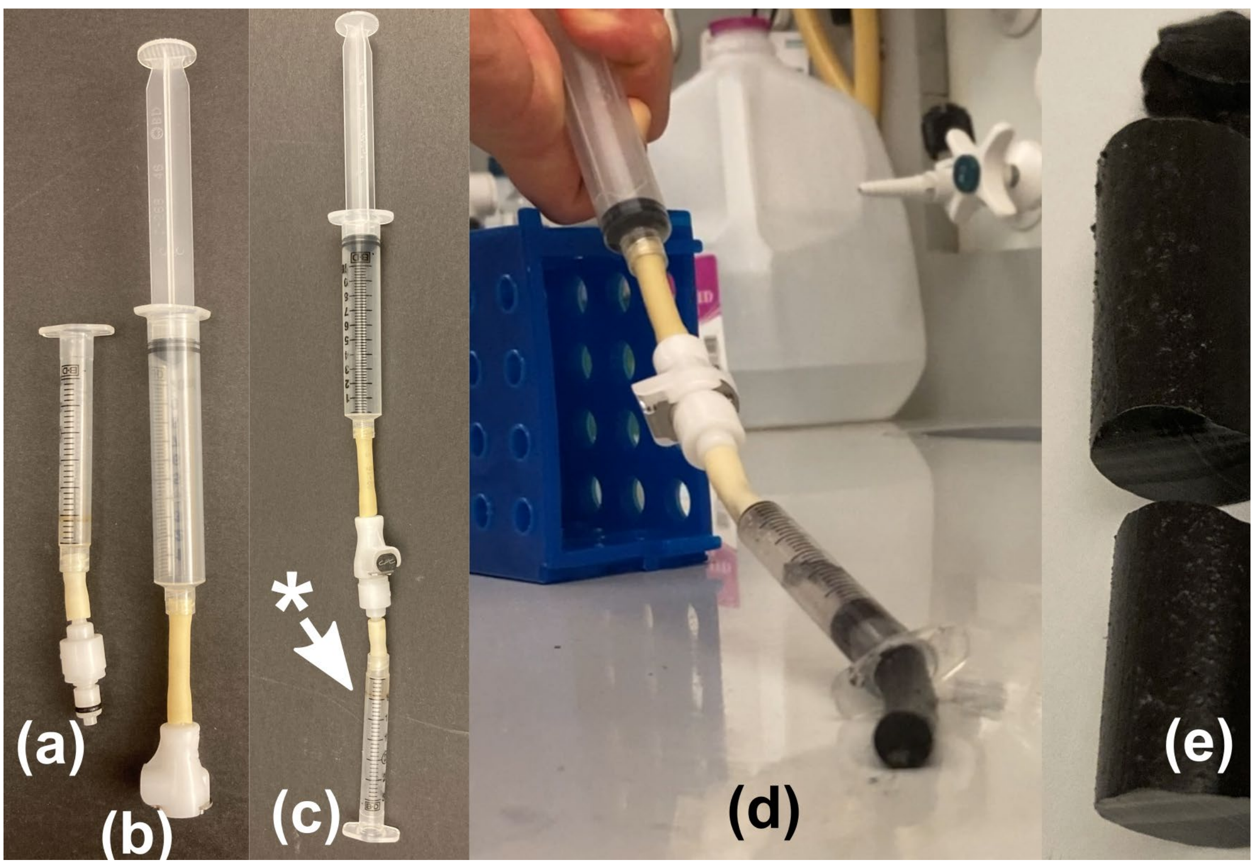
SUPPLEMENT I – GELATIN CYLINDER PROTOCOL

Gelatin cylinders used as thrombus-mimicking phantoms in this work were created according to the following procedure.

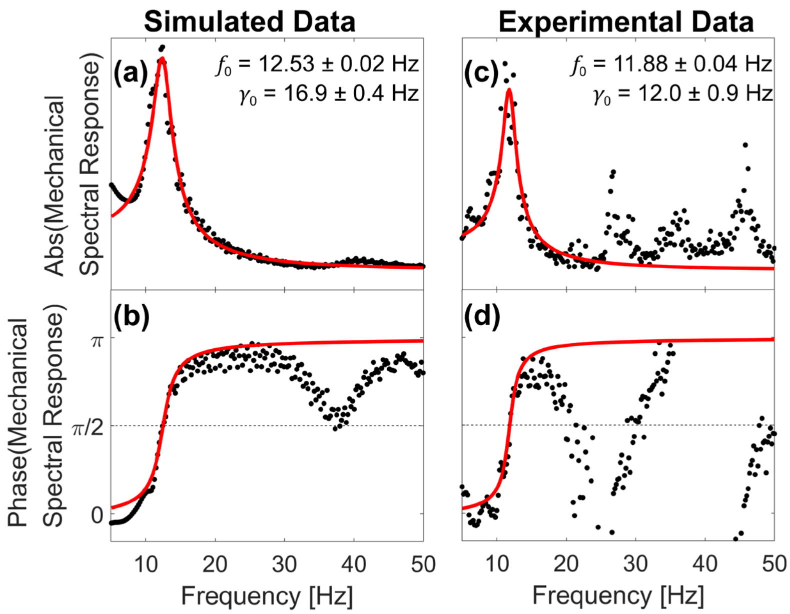
1. As shown in Supplemental Fig. 1a, the plunger was removed from the top of a 3-ml BD plastic "Slip Tip" syringe (Becton, Dickinson and Company, Franklin Lakes, NJ, USA), and the inside was coated in nonstick cooking spray. A **valved** female, 1/8-in inner diameter quick-disconnect hose fitting (Cole-Parmer Instrument Company, Vernon Hills, IL, USA) was attached to the tip of the syringe via a ~2-cm length of Masterflex L/S 16 Phar-Med BPT tubing, creating a watertight seal.
2. The warm gelatin solution described in Sec. II-B was then poured into the open top of the syringe, and placed vertically on ice to gel. The end of the syringe was covered with tape to limit evaporation.
3. After ten minutes, the syringe was removed from the ice, and placed vertically in the refrigerator for at least twelve hours.
4. The next day, the syringe was taken out of the refrigerator, and the tape was removed.
5. As shown in Supplemental Fig. 1b, an **un-valved** male, 1/8-in inner diameter quick-disconnect hose fitting was then attached to the end of a larger 10-ml BD plastic "Slip Tip" syringe via another short length of Masterflex tubing.
6. The plunger of this larger syringe was drawn back to its furthest extent (but not removed).
7. The two hose fittings were connected together as shown in Supplemental Fig. 1c, and in one rapid motion the plunger of the larger syringe was depressed, causing the gelatin cylinder to shoot out of the smaller syringe onto the counter. The result is shown in Supplemental Fig. 1d.
8. Finally, the cylinders were cut to size using a razor blade on a work surface coated with nonstick cooking spray. Examples are shown in Supplemental Fig. 1e.



Supplemental Fig. 1. A 3-ml syringe terminated with a valved quick-disconnect hose fitting (a) was used as a mold for gelatin cylinders, and a larger 10-ml syringe terminated with an un-valved fitting (b) was used to pump cylinders out of the mold after they have set. The two syringes are shown connected in (c). The location where the gelatin cylinder would be is denoted by the asterisk (*). The plunger of the larger cylinder was then depressed, shooting the gelatin out onto the tabletop (d), where it was cut to size (e). Note that the volume of gelatin used for each cylinder in this work was less than is depicted in (d) and (e).

SUPPLEMENT II – AMPLITUDE AND PHASE REPRESENTATION OF COMPLEX LORENTZIAN FITS

As described in Sec. II-G, resonance frequencies for experimental and simulated data in this work were determined via a single nonlinear least-squares fit applied to both the real and imaginary parts of the mechanical spectral response. This allowed for simultaneous fitting of the complex data (as opposed to averaging the results of amplitude and phase fits), and avoided phase wrapping. However, for those more familiar with the amplitude and phase representation, this approach may be less intuitive. Supplemental Fig. 2 displays the same data and fits present in Fig. 3, however this time the amplitude and phase of both the data and the fits are plotted, rather than the real and imaginary components.



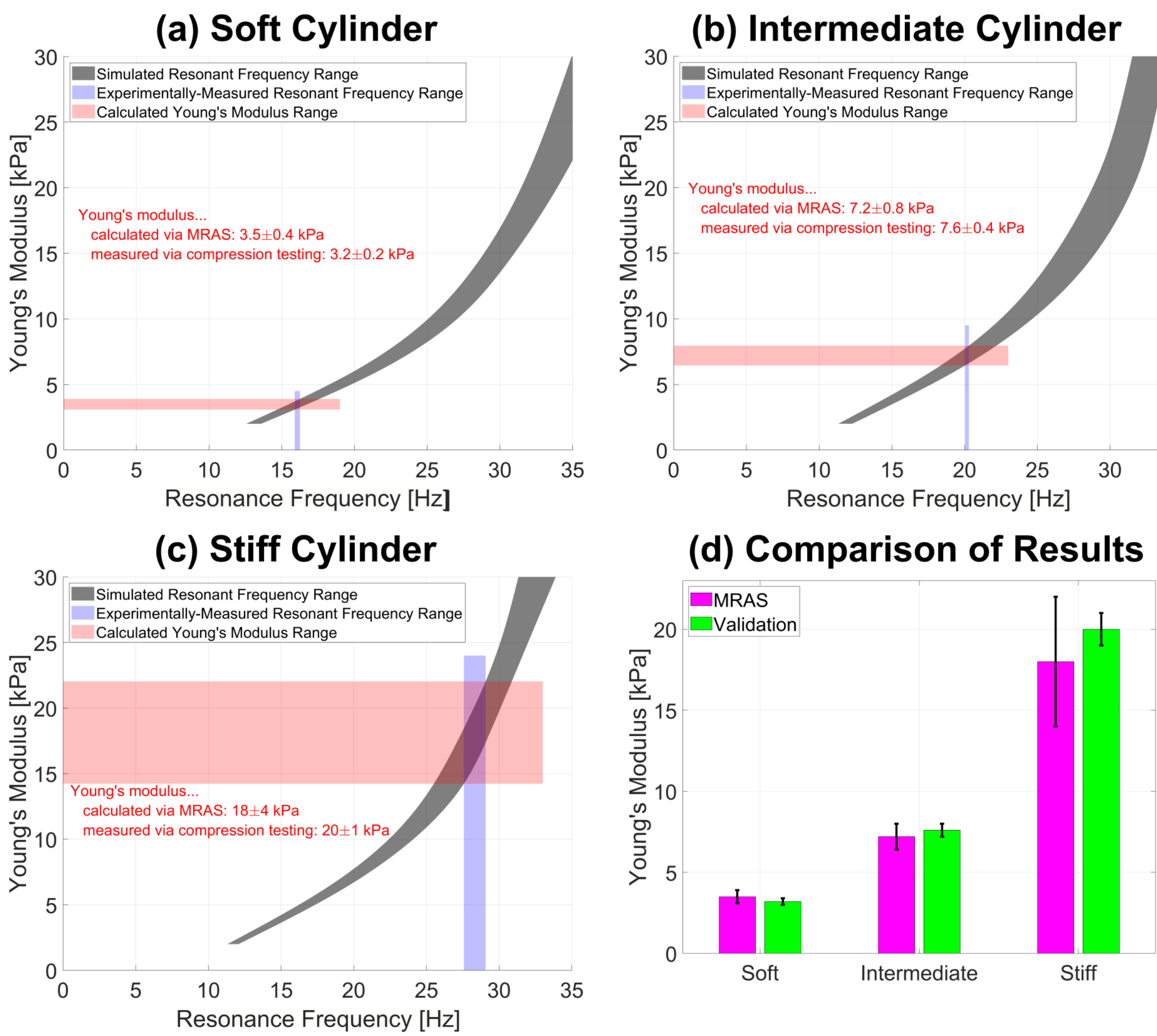
Supplemental Fig. 2. FEA and experimental fitting results for the same gelatin thrombus-mimicking cylinder analyzed in Fig. 3. The Lorentzian fits to the complex mechanical spectral responses are unchanged, however in this case the amplitude (a) and phase (b) of the simulated fit as well as the amplitude (c) and phase (d) of the experimental fit are shown (instead of the real and imaginary parts). Simulated and experimental data are shown as black dots, while fits are shown as red lines. The resonance frequencies displayed on the plots correspond to the peak in the amplitude spectrum and the π/2 crossing in the phase spectrum.

Supplement III – Full Elastometry Results

MRAS measurements were performed on three gelatin thrombus-mimicking cylinder phantoms, and the results are shown in Supplemental Fig. 3. The properties of each cylinder are listed below:

Cylinder (Gelatin Conc.)	*Length [mm]*	*Radius [mm]*	*Resonance Freq [Hz]*
(a) Soft (3.2 wt%)	9.1 ± 0.2	4.33 ± 0.06	16.1 ± 0.2
(b) Intermediate (4.5 wt%	10.2 ± 0.2	4.84 ± 0.06	20.2 ± 0.1
(c) Stiff (8.7 wt%)	10.4 ± 0.2	4.88 ± 0.06	28.3 ± 0.8

First, MRAS was performed on each cylinder to determine the resonance frequency. This frequency is indicated on plots (a)-(c) by a blue shaded region. The horizontal extent of the range indicates uncertainty in the measurement. In each case, a sweep of simulations with cylinder dimensions matching the phantoms and Young's moduli ranging from 3 to 30 kPa were performed. The resulting resonance frequencies with uncertainties determined via Sec. II-E3 are plotted as gray shaded regions. Consequently, the vertical extent of the overlap between the blue and gray regions indicates the one-standard deviation range of Young's moduli that are likely to have produced the observed resonance frequency. This range is depicted as a red shaded region. Numerical results are shown on the plots and in Supplemental Fig. 3d. In each case, the Young's modulus calculated using this procedure matched the value measured via compression testing within one standard deviation. Note also that it would be easy to tell these three cylinders apart, as their uncertainty ranges do not overlap.

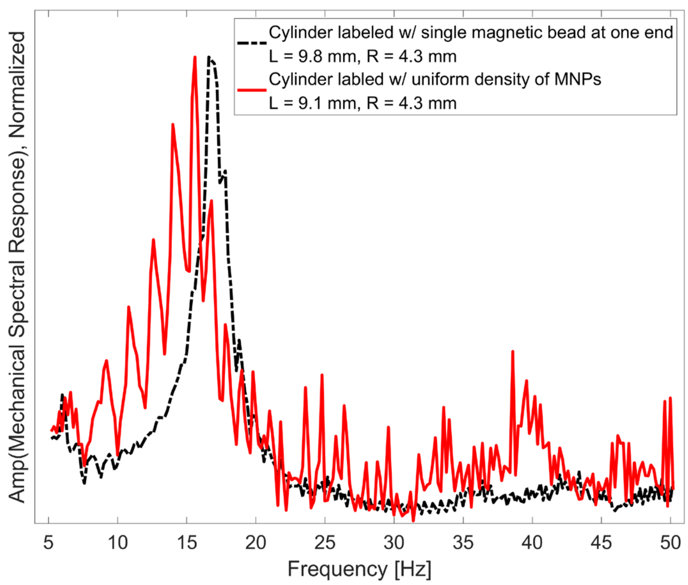


Supplemental Fig. 3. Elastometry results are given for the soft (a), intermediate (b), and stiff (c) cylinders, and the results are compared with compression testing validation findings in (d).

SUPPLEMENT IV – PRELIMINARY EVIDENCE FOR MINIMAL IMPACT OF NONUNIFORM LABELING

Although more work may be needed to understand the impact of nonuniform magnetic labeling on resonance frequencies, the following preliminary evidence shows minimal impact in one nonuniform labeling situation.

In Supplemental Fig. 4, the amplitude spectra of two similarly sized cylinders are shown. The solid red trace represents a cylinder labeled in the usual manner with a uniform distribution of MNPs. (This is one of the datasets used in Fig. 4 of the article). The black dashed trace, however, has no MNPs, and is instead labeled with a single 1-mm-diameter magnetic chrome steel ball. As such, it is nonuniformly labeled. Cylinder lengths were 9.1 mm for the uniformly labeled cylinder, and 9.8 mm for the nonuniformly labeled cylinder. Both cylinders had 4.3 mm radii. The locations of the peaks in the spectra are similar, so these preliminary findings suggest little effect due to nonuniform labeling. The slight discrepancy in peak position may be explained by a combination of differing cylinder lengths added mass from the magnetic ball.



Supplemental Fig. 4. Comparison of the amplitude spectra for two similarly sized gelatin thrombus-mimicking cylinders. One cylinder is labeled nonuniformly with a single magnetic ball (dashed black line), while the other is labeled uniformly with magnetic nanoparticles (solid red line).