



# Ex Vivo Biomechanical Analysis of Flexible versus Rigid Annuloplasty Rings in Mitral Valves with Dilated Annulus using a Novel Annular Dilator System



Yuanjia Zhu, MD<sup>1,2</sup>, Annabel M. Imbrie-Moore, MS<sup>1,3</sup>, Robert J. Wilkerson, BS<sup>1</sup>, Michael J. Paulsen, MD<sup>1</sup>, Matthew H. Park, MS<sup>1,3</sup>, Y. Joseph Woo, MD<sup>1,2</sup>

<sup>1</sup>Department of Cardiothoracic Surgery, Stanford University; <sup>2</sup>Department of Bioengineering, Stanford University;

<sup>3</sup>Department of Mechanical Engineering, Stanford University

## Background

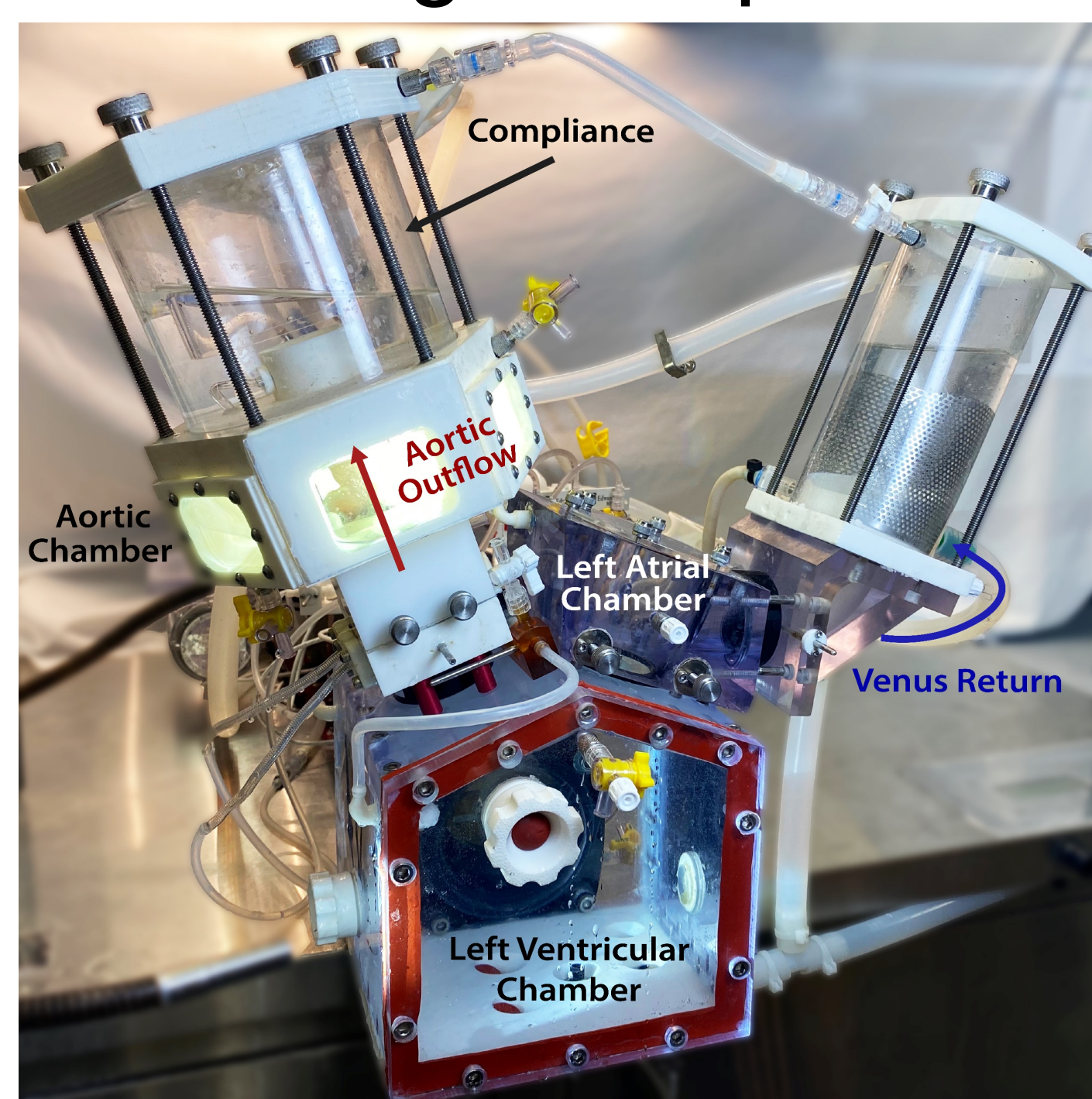
- Mitral annuloplasty rings are a fundamental component in mitral valve repair.
- They aim to restore annular dimensions to increase leaflet coaptation and prevent annular dilation.
- However, biomechanical evaluations of annuloplasty rings are lacking.

## Objective

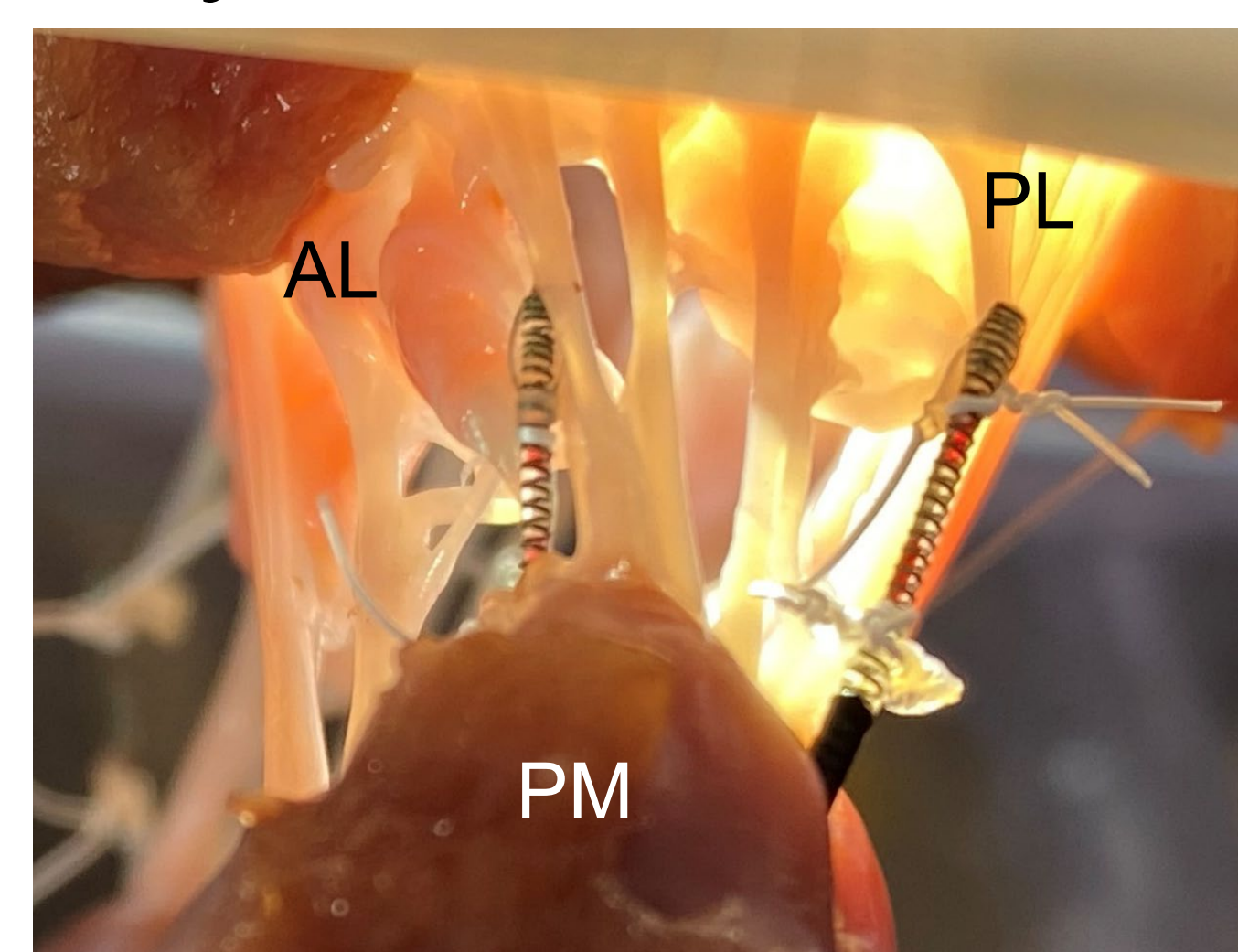
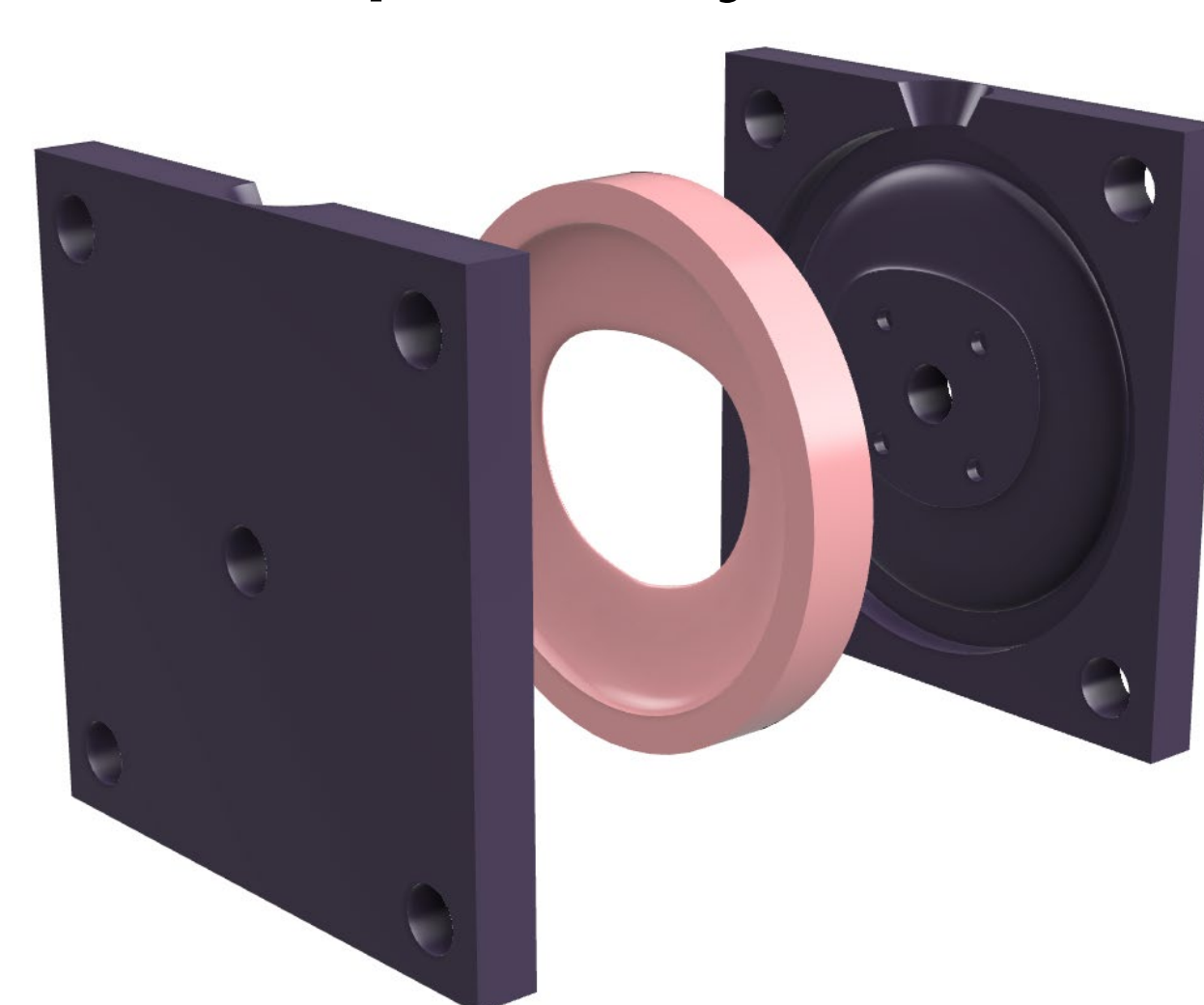
- We aim to compare flexible and rigid annuloplasty rings using an ex vivo mitral annular dilation model.

## Methods

- Porcine mitral valves (n=4) with intercommissural distance of 26-28 mm were mounted in a 3D-printed ex vivo left heart simulator.
- After baseline data collection, the valves were dilated to intercommissural distances of 40-42 mm using a 3D-printed dilator.



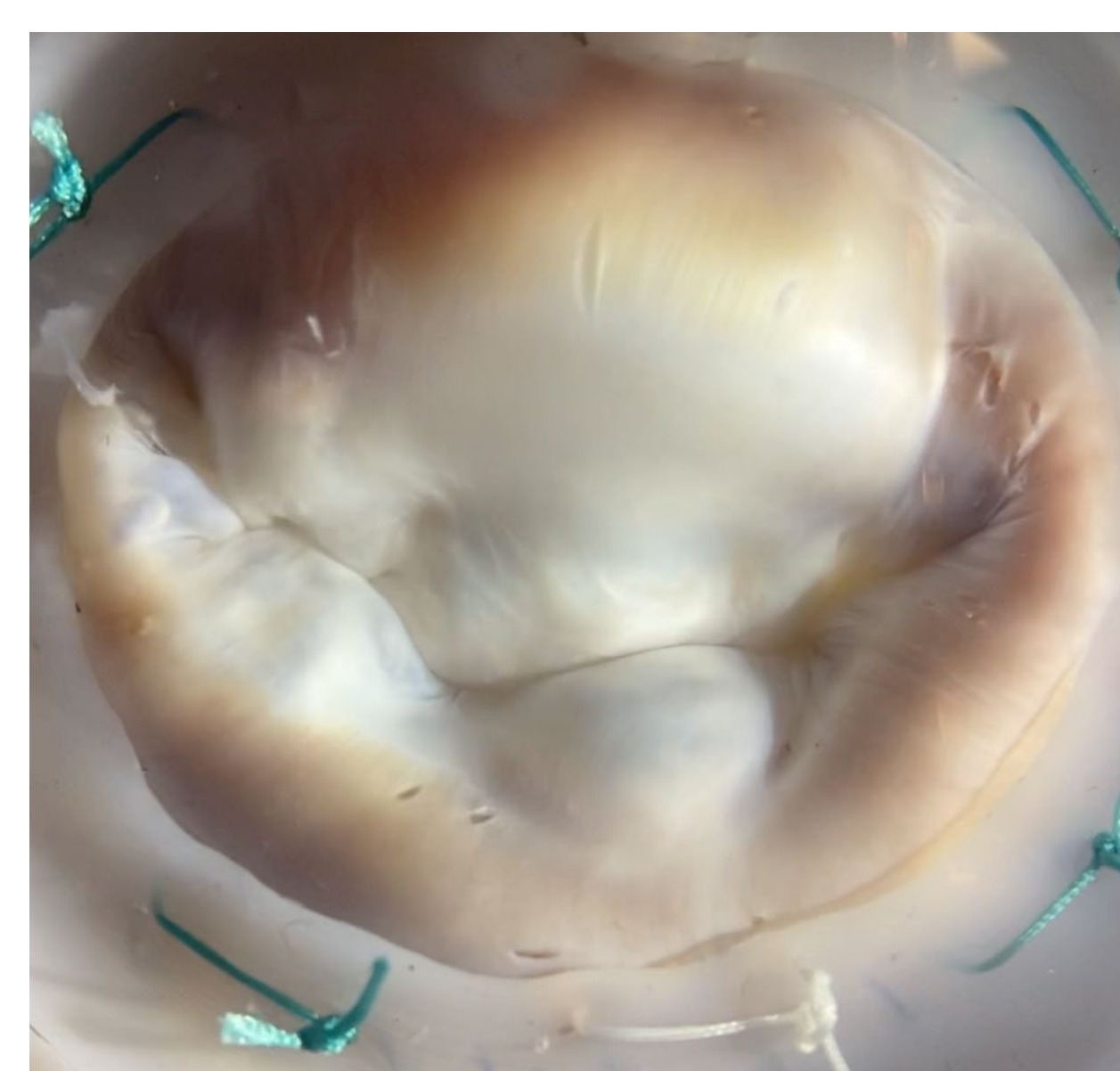
- The dilated valves were sewn to an elastic mount.
- Fiber Bragg Grating sensors were anchored to native primary and secondary chordae.



\*AL: anterior leaflet; PL: posterior leaflet; PM: papillary muscle

## Mitral Annuloplasty Ring Repair

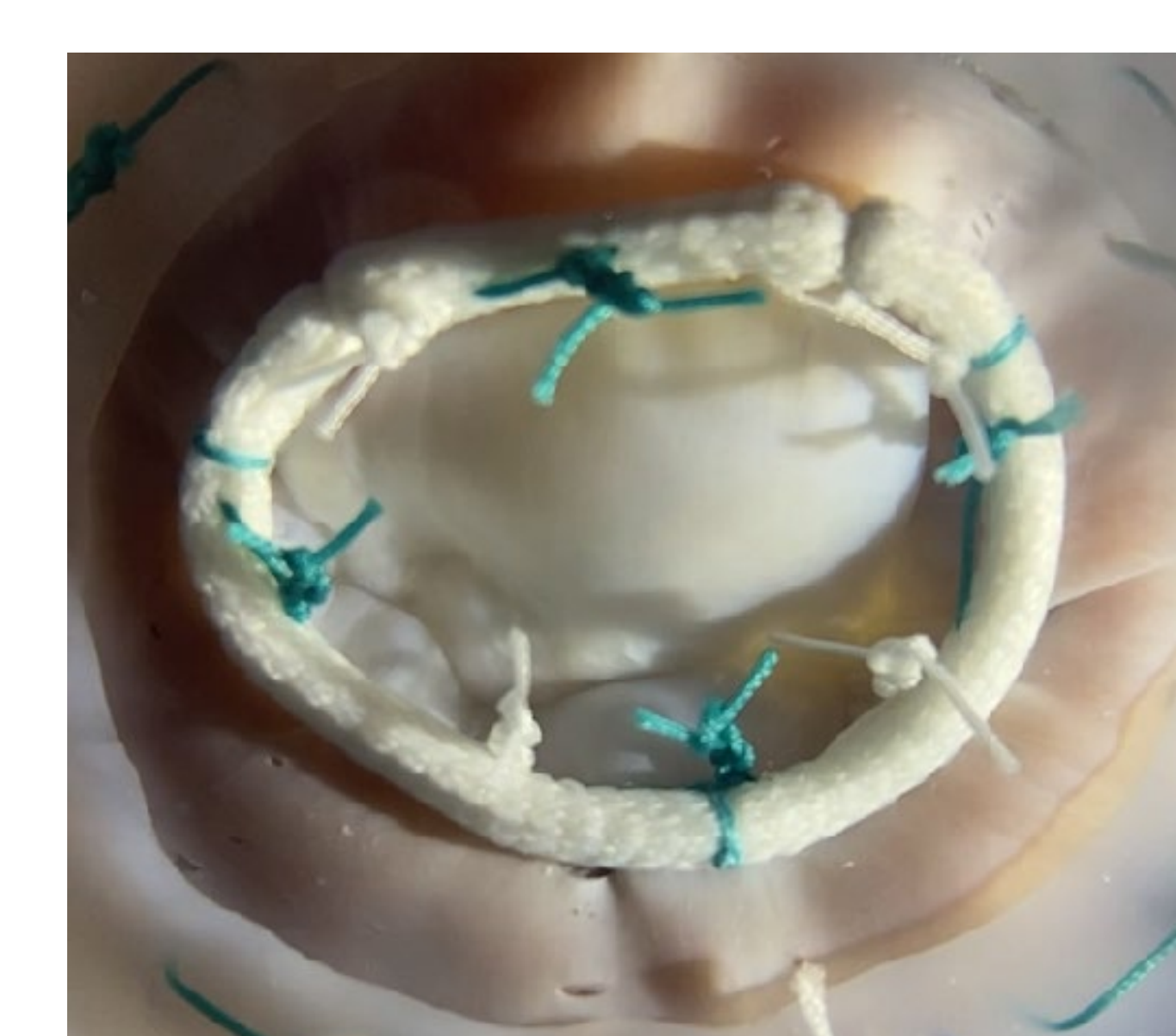
Dilated valve prior to repair



Rigid annuloplasty ring #28 (CE Classic, Edwards Lifesciences)

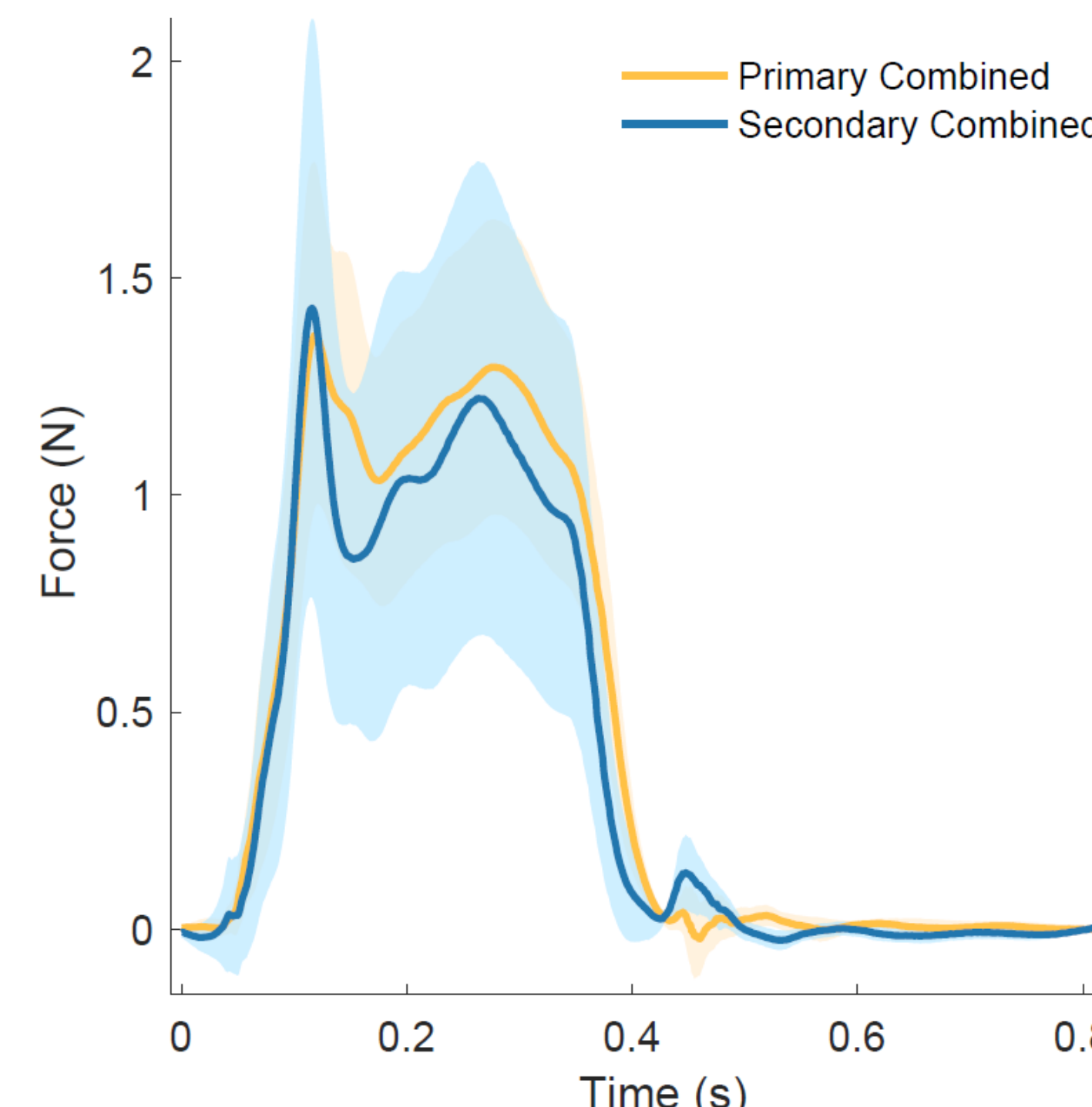


Flexible annuloplasty ring #28 (Annuloflex, LivaNova)

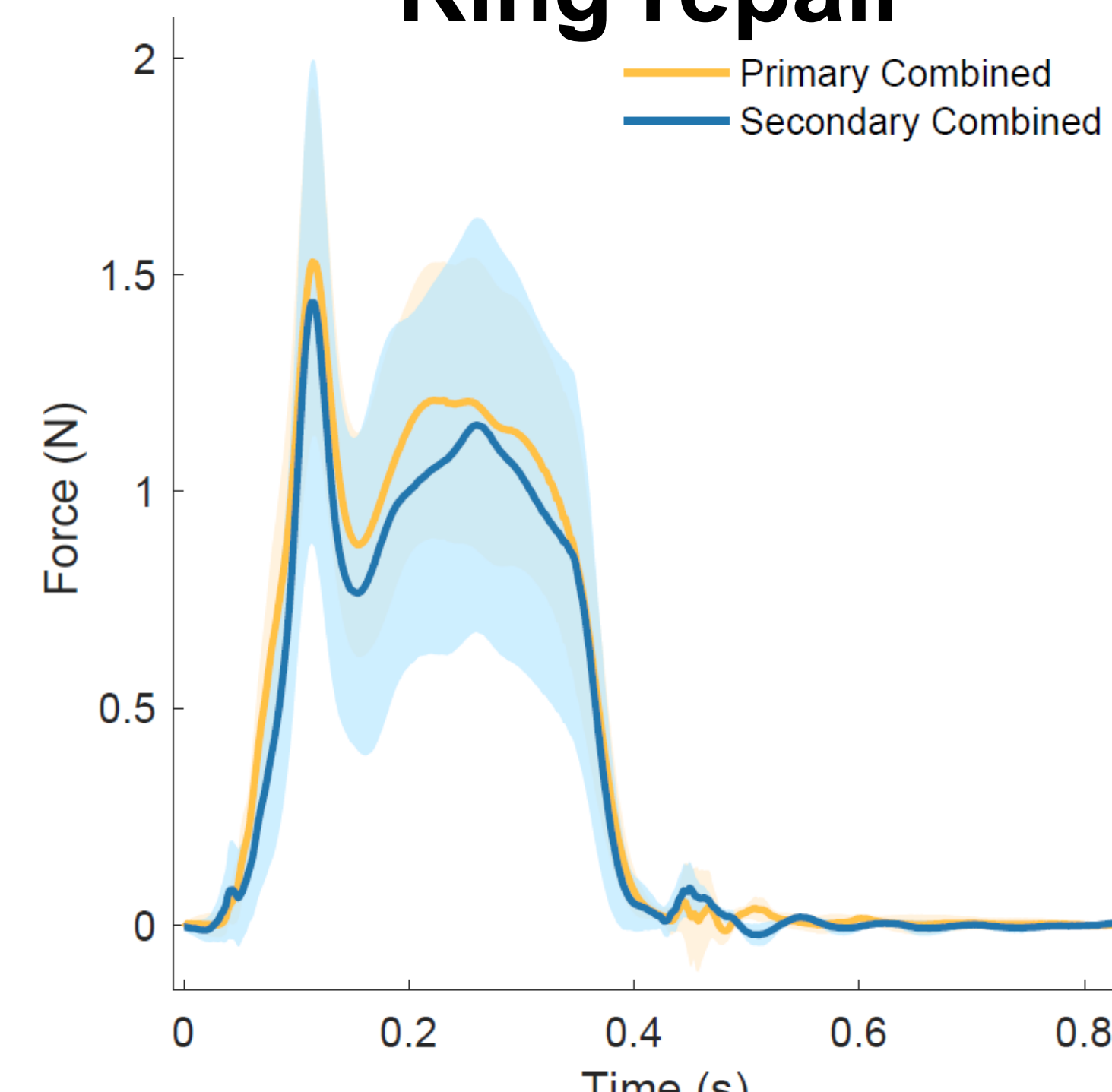


## Chordal Force Profiles

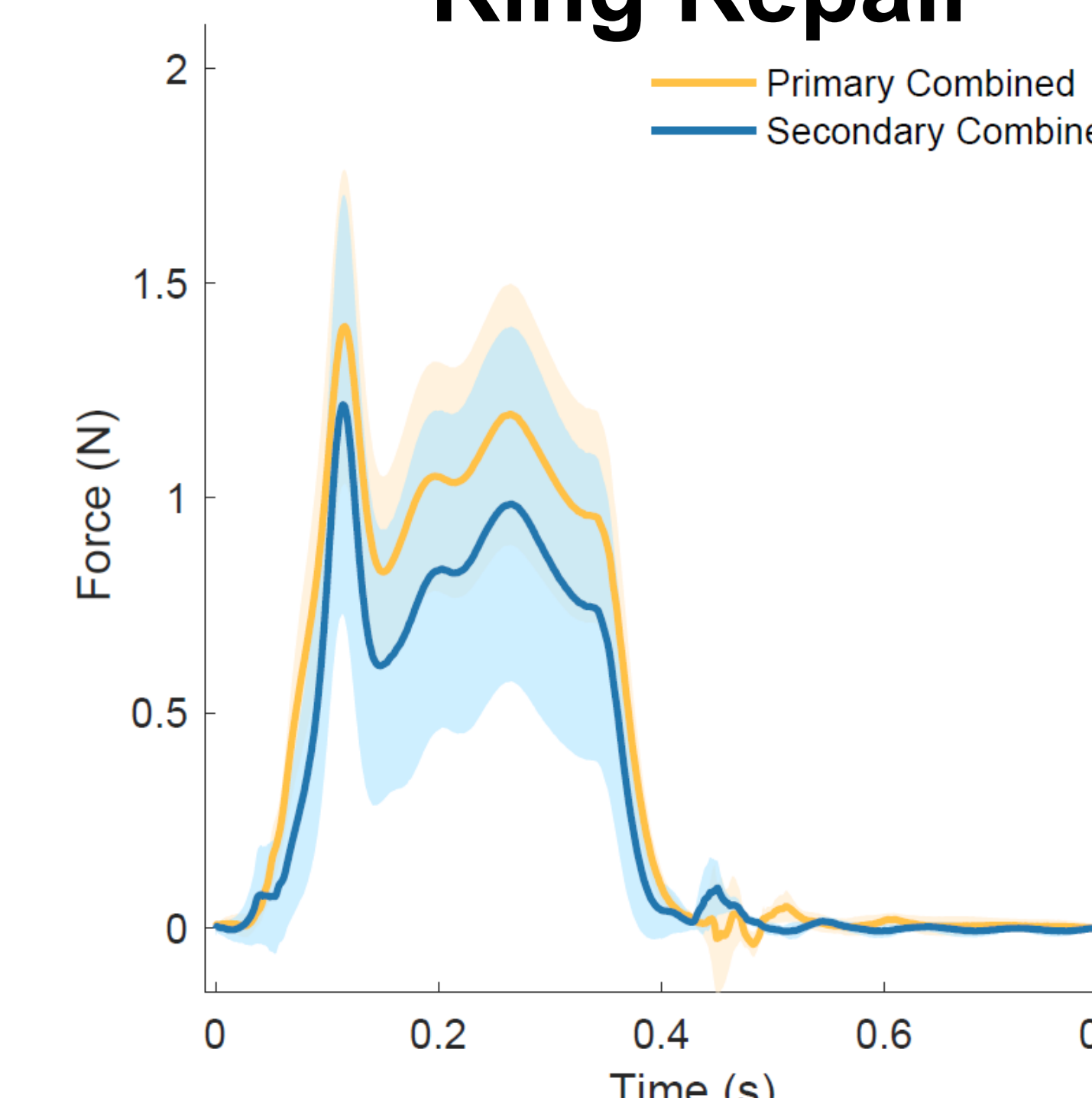
Dilated Baseline



Rigid Annuloplasty Ring repair



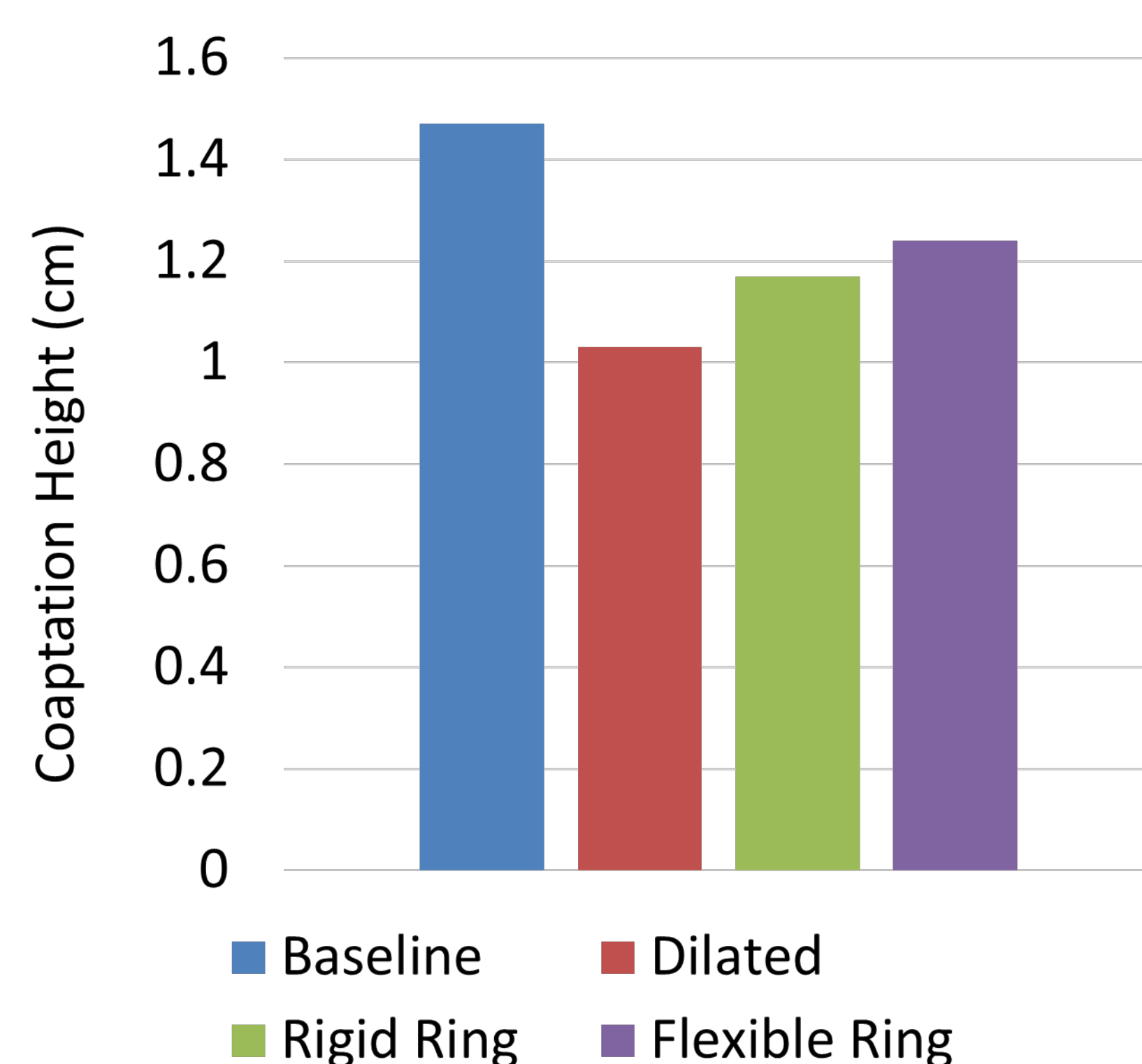
Flexible Annuloplasty Ring Repair



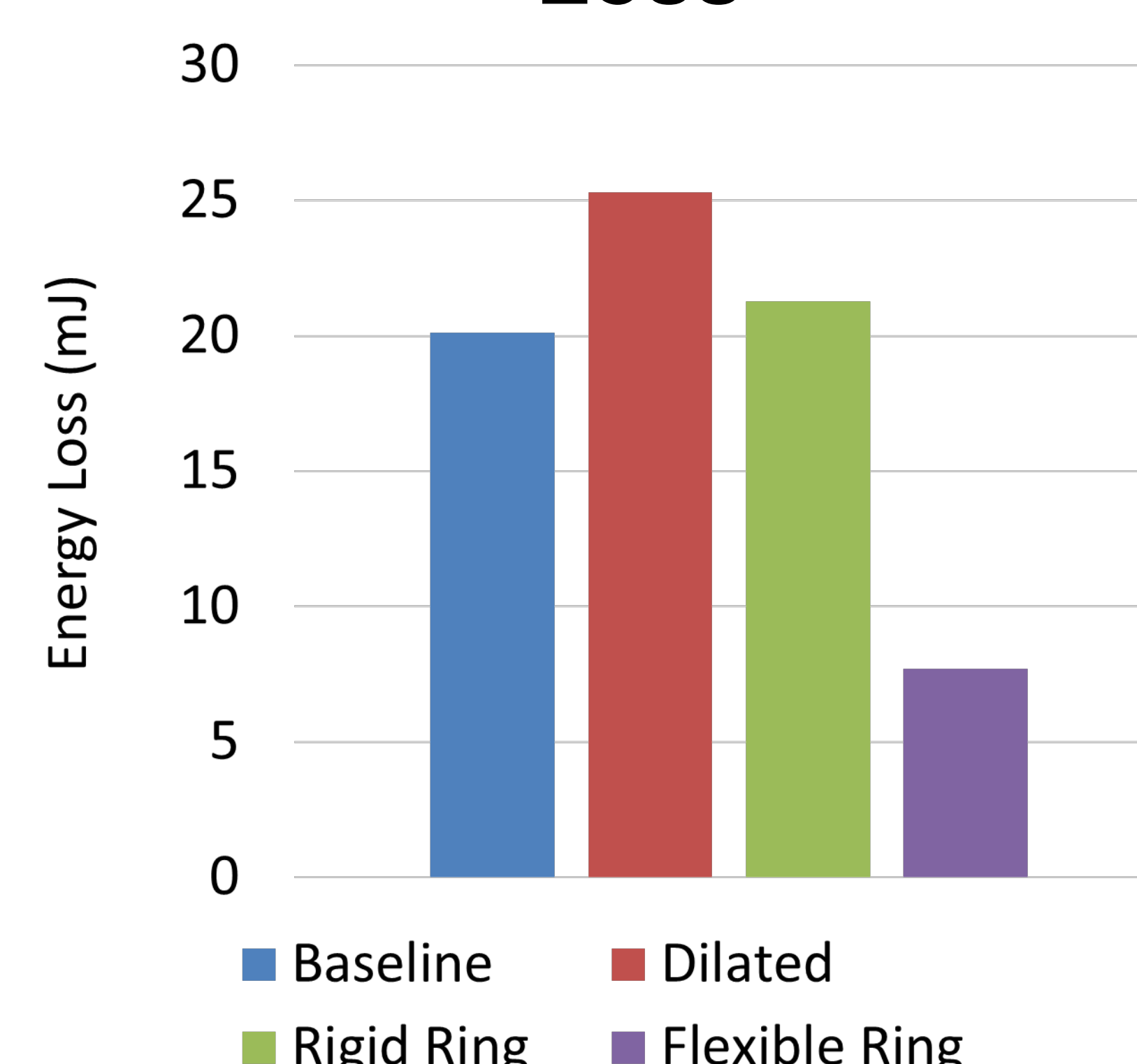
- Flexible ring was associated with decreased rate of change of force of both primary and secondary chordae compared to that from the dilated baseline.
- Flexible ring compared to rigid ring annuloplasty repair was associated with lower rate of change of force and peak force in the secondary chordae.

## Mitral Valve Hemodynamics

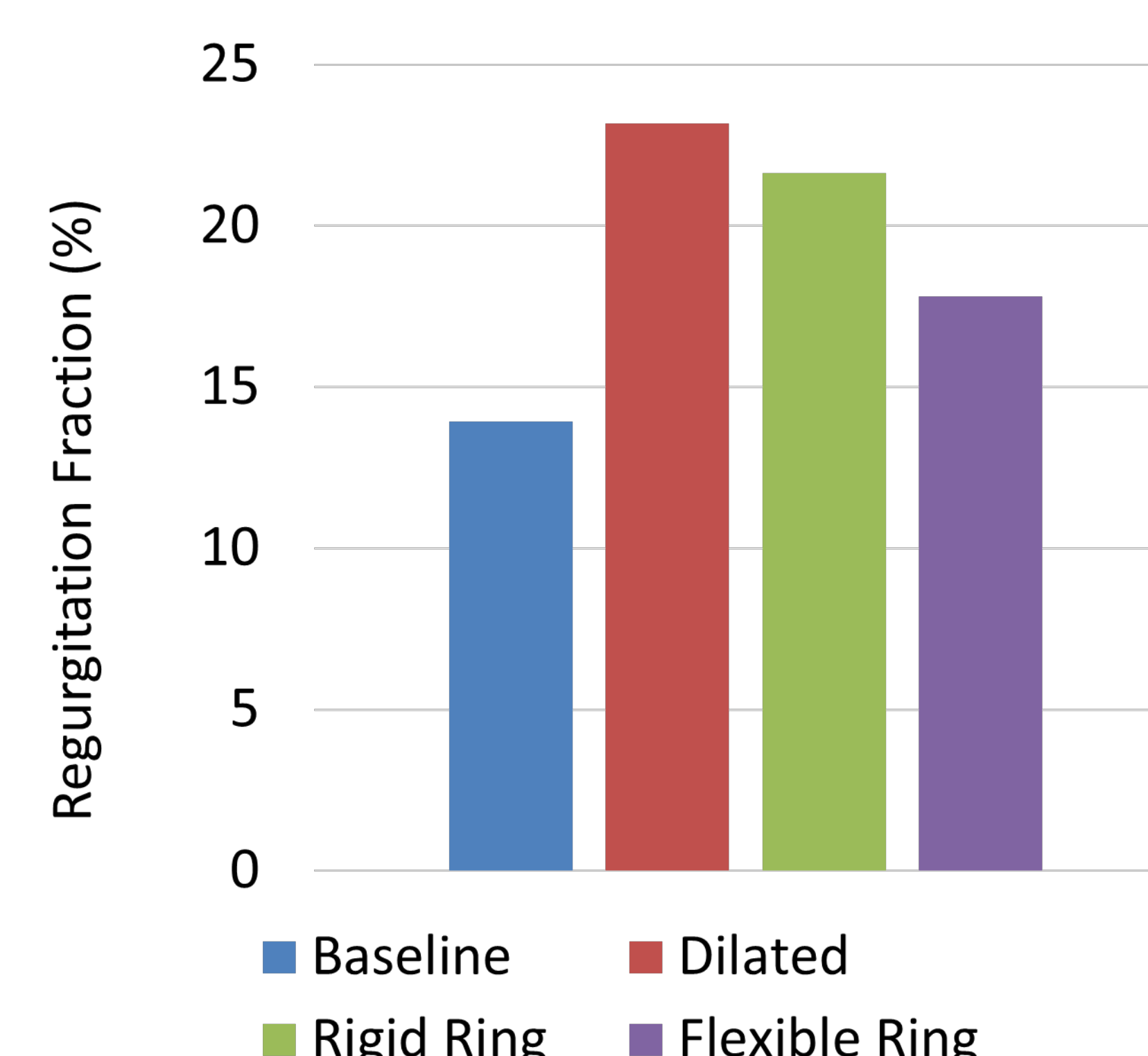
Leaflet Coaptation Height



Transmitral Leakage Energy Loss



Mitral Regurgitation Fraction



## Conclusions

- Both rigid and flexible annuloplasty rings are effective in increasing mitral leaflet coaptation height.
- Rigid rings were possibly more effective in mitral regurgitation reduction and minimizing transmitral leakage energy loss.
- Flexible rings were associated with lower chordal stress post-repair.
- In vivo* validation should be performed to enable direct translation to clinical patient care.

## Acknowledgment & Disclosure

This work was supported by the National Institutes of Health (NIH R01 HL089315-01, NIH R01 HL 152155, YJW), the Thoracic Surgery Foundation Resident Research Fellowship (YZ), the American Heart Association (17POST33410497, MJP), and the National Science Foundation Graduate Research Fellowship Program (AMI). The contents are solely the responsibility of the authors and do not necessarily represent the official views of the funders.