Sarcomere Structure and Porcine Myocardium

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ABSTRACT

Our proposed experiment will shed light on the functioning of the sarcomere structure in porcine myocardium—a structure with proven similarities with the human heart. We will explore how the sarcomere structure responds in resting and contracting porcine myocardium by varying the temperature at which the sample is maintained (between 10°C and 37°C). X-ray diffraction analysis will be utilized at the BioCAT beamline 18ID at the Advanced Photon Source to look at the relative degree of association of myosin heads with the actin filaments. The porcine myocardium used for this experiment has been previously prepared and supplied. The sample is stretched to slack length using aluminum clips attached to stainless steel wire hooks, and the fiber bundle length and cross sectional area are measured.

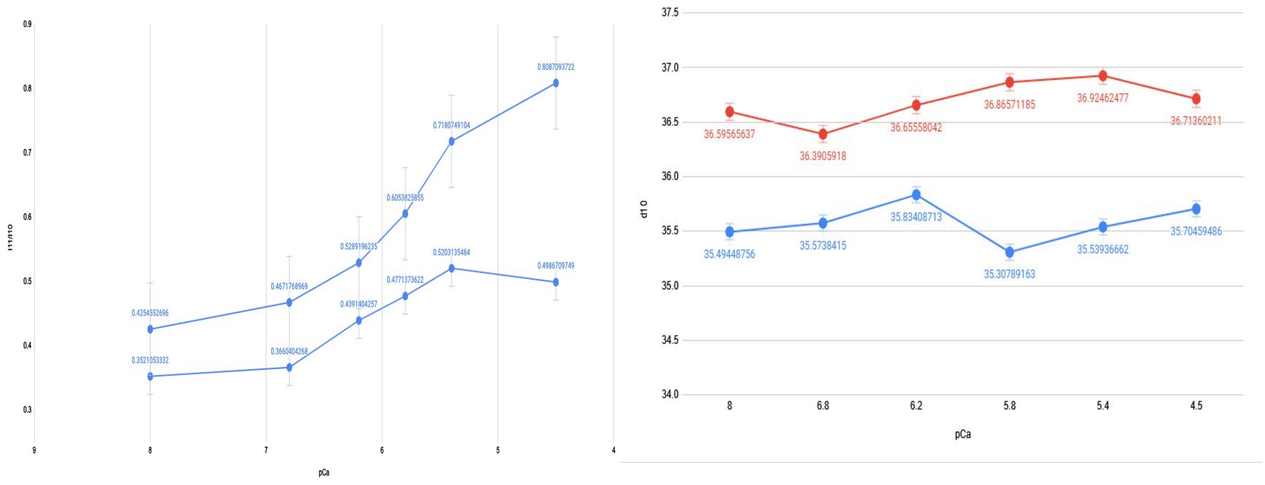
METHODS

Fibers from a porcine myocardium were extracted and stretched to a short sarcomere length of 2.1 μm. After initial measurements, these samples were placed in an experimental chamber to measure the force generated by the sample at different calcium concentrations. X-ray diffraction patterns were taken at each calcium concentration ranging from pCa 8 to 4. This experiment was repeated with a longer sarcomere length of 2.3 μm.

These samples are then placed in an experimental chamber between a strain gauge force transducer and a motor, to measure the force of the slack length sample. The samples will be studied using X-ray diffraction experiments, performed at the BioCAT beamline 18ID at the Advanced Photon Source, Argonne National Laboratory. The small angle scattering instrument on the beamline will be used to observe the various diffraction patterns for different temperatures of the myocardium. The myocardium samples will be oscillated at a velocity of 10 mm/s in the beam to protect the sample from excessive radiation damage. To conduct this experiment, three shifts of eight hours may be necessary, equating to 24 hours. This can be completed in one visit.

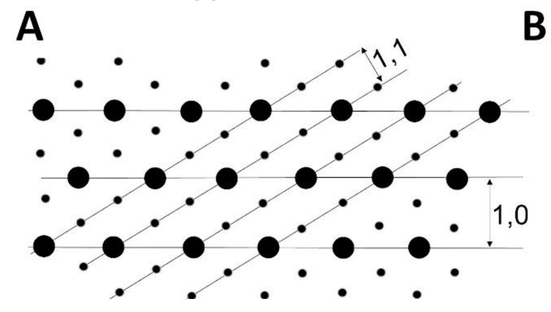
IMPACT

- This experiment allowed us to see if the response of the thick filaments to calcium is itself affected by sarcomere length.
- This turns out to be true but not in the way we expected.
- These results can inform medical research, as the effects of calcium concentration change on porcine hearts can be applied to human hearts as well.
- Heart muscles are usually overactive or underactive, so knowing how calcium concentration affects sarcomeres would help possible treatments to help the heart muscles move (or stop it from moving).

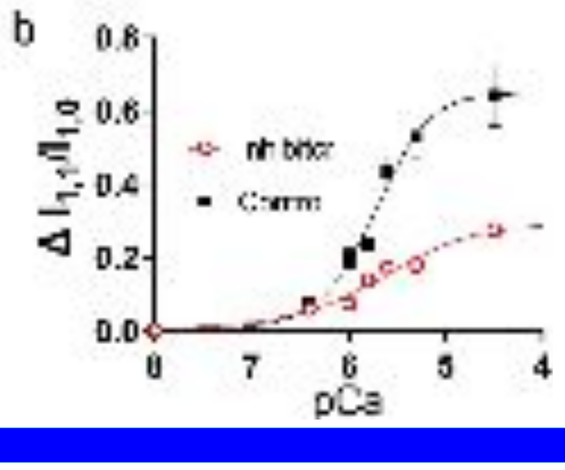


Sarcomere Length vs Intensity Ratio
Top Line- 2.1
Bottom Line- 2.3

Lattice Spacing as a measurement based on sarcomere length
Top Line - 2.1
Bottom Line - 2.3



A- Image of equatorial intensity ratio
B- Image of interfilament lattice spacing



MOTIVATION

- The impact different calcium concentrations have on the heart of mice and rats has been extensively researched
- Porcine heart muscles have been found to be much more analogous to human hearts
  - Research the effects of calcium concentration change on porcine hearts for future research and/or medical purposes relating to cardiology

CONCLUSION

Our data gave the opposite of the expected results:

- Unexpectedly, the response of the myosin heads to calcium was reduced at longer sarcomere lengths (2.3)
- Decrease in outward head movement does not correlate with increase in force
- Data shown by the lattice spacing graph does not explain the unexpected results from the equatorial intensity ratio graph

ACKNOWLEDGEMENTS

- Exemplary Student Research Program
- Argonne National Laboratory's Educational Program
- APS User Office
- U.S. Department of Energy
- Mrs. Vanessa Troiani of Metea Valley High School
- Dr. Thomas Irving and his team at Illinois Institute of Technology