# A Novel Planning Paradigm for Augmentation of Osteoporotic Femora

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## Introduction

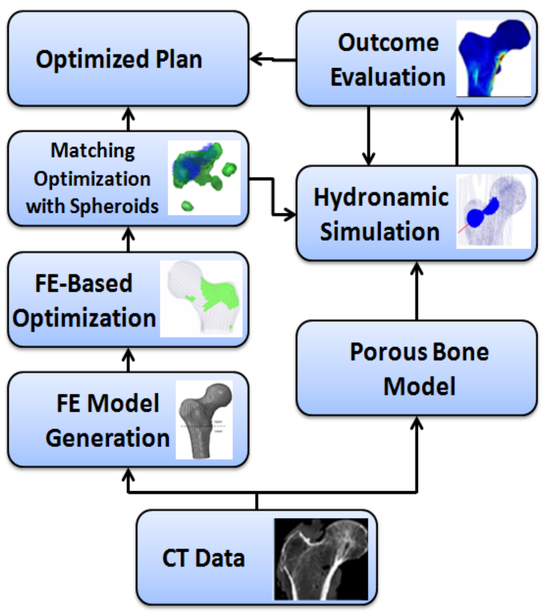
- Osteoporotic hip augmentation with PMMA is a potential therapeutic approach to reduce the risk of fracture due to falls in an elderly individual.
- The goal of this project is to address the potential risk of thermal necrosis associated with femoroplasty.
- Area of the research
  - Image-guided surgical system
  - Clinical biomechanics

## The Problem

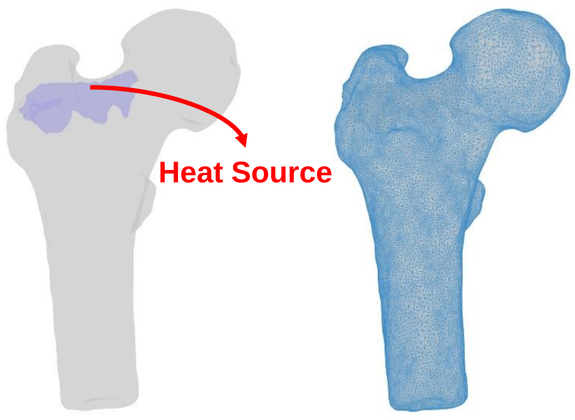
- Osteoporotic hip fractures are responsible for thousands of deaths and billions of dollars of treatment and hospitalization costs in the US annually.
- The risk of a second hip fracture increases 6-10 times in elderly with osteoporosis.
- The one-year mortality rate after osteoporotic hip fracture in elderly is 23%.
- Higher volumes of PMMA injection may introduce the risk of thermal necrosis caused by exothermic polymerization of PMMA

## The Solution

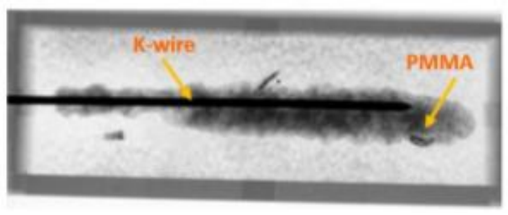
- New Planning Paradigm for Femoroplasty
  - New Planning approach constrains the injection volume of cement to 10cc
  - Plan was evaluated in 4 cadaveric experiments




- Temperature evaluation and cooling system development
  - COMSOL Finite element (FE) heat transfer model was developed capable of bone temperature estimation prior to augmentation with homogenous material property inside the bone and a uniform heat flow from the bone-cement-interface towards the bone surface

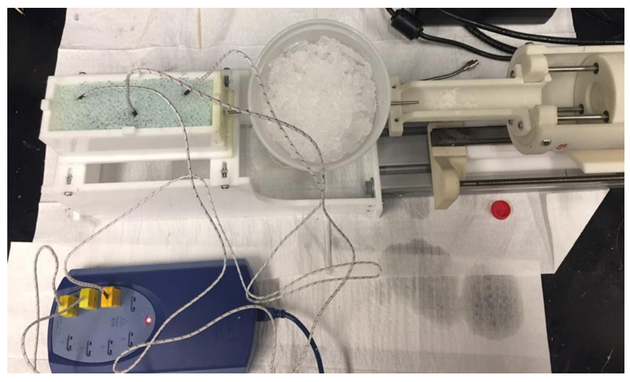



FE Mesh



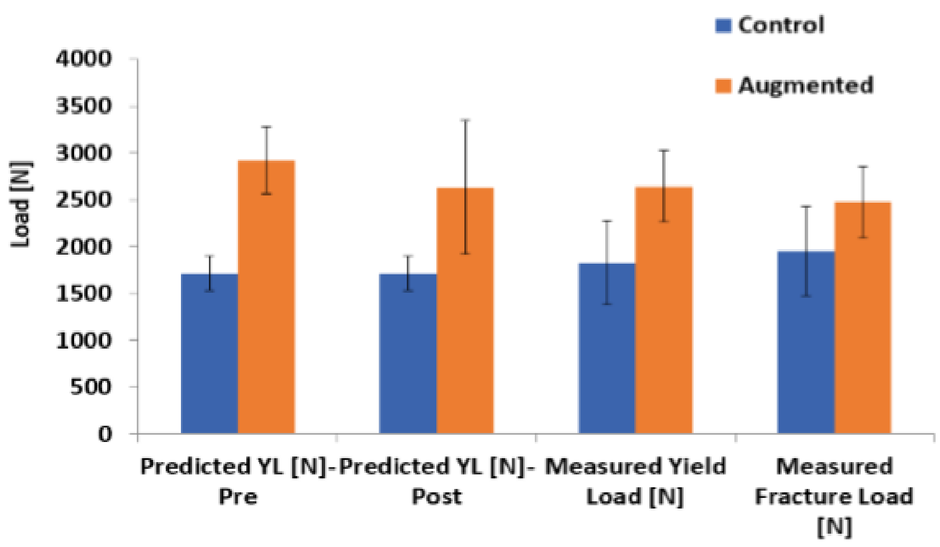

Sawbone Cooling Experiment

  - Cooling system contained a 3mm K-wire attached to an ice-water bath inserted inside the bone cement profile
  - Sawbone experiments were conducted with static and rotating k-wire

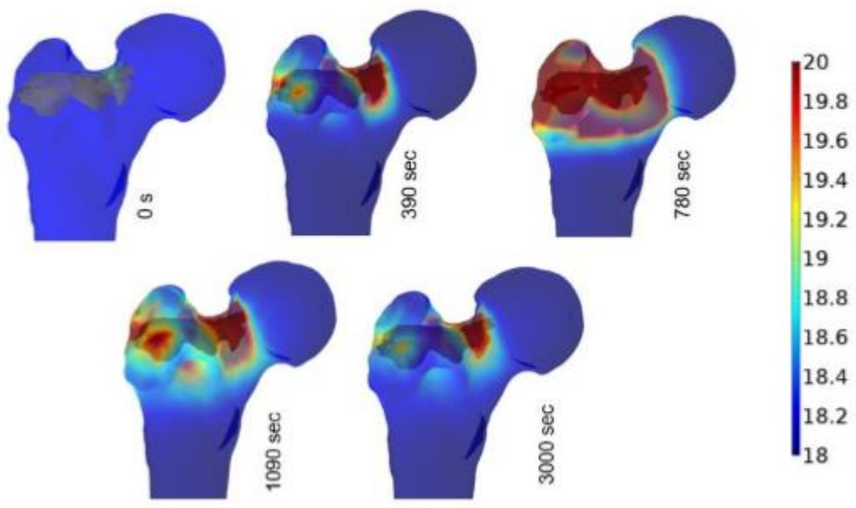


## Outcomes and Results

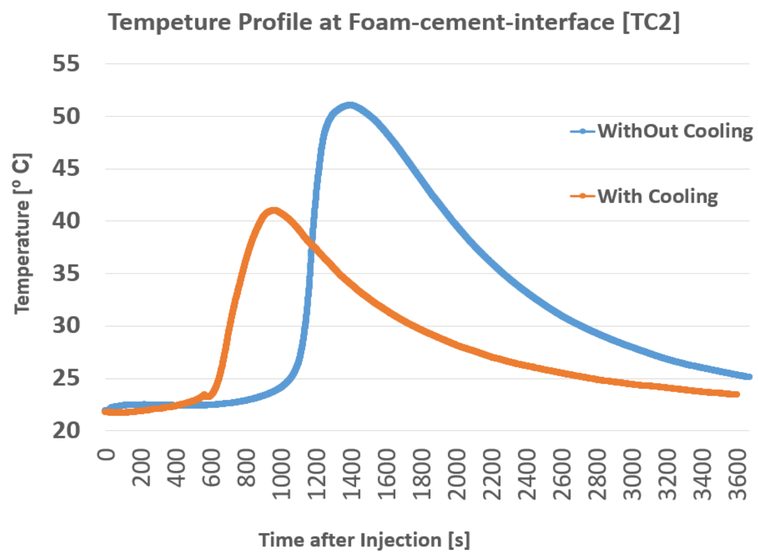
- Augmentation significantly increased:
  - Yield Load : 27.1 %
  - Yield Energy: 48.8%




- COMSOL FE Simulation




- Colling experiment




## Lesson Learned & Future Work

- Both the COMSOL estimations of the bone surface temperature and cooling system have shown promising first-attempt results
- Additional cooling experiments and heat transfer simulations are needed to fully validate the outcome of this study

## Credits

- Both Mahsan and Amirhossein were fully involved in the study and preparation of the results

## Publications

- Farvardin, A., Bakhtiarinejad, M., Murphy, R.J., and Armand, M., 2017. Novel Planning Paradigm for Osteoporotic Bone Augmentation: A cadaver validation study. *Journal of biomechanics* [In Progress]

## Support by and Acknowledgements

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