Ergonomics in Agriculture

Fadi Fathallah

Department of Biological and Agricultural Engineering

WCAHS Fall Symposium

October 25, 2018 – International Center, UC Davis

Ergonomic and Biomechanical Evaluation of Mechanical and Robotic Strawberry Harvest-aids (WCAH Current Core Project)

Research Team: Victor Duraj, Tyler Hunter, Vicente Munguia, and Professor Stavros Vougioukas (Co-PI)

Traditional Strawberry Harvest

- Select/Pick/Pack load into a cart in furrows (300’ long)
- Walk to loading station at end of furrows (**30-40% of the time**)

vs.

Traditional

- Pros:
  - Low cost
  - Walking = break = low back relief
- Cons:
  - Low productivity

Harvest Aids

- Pros:
  - Increased productivity
  - Reduced transport time
- Cons:
  - High capital investment
  - Difficult to transport
  - Slow moving to accommodate slowest workers
  - Worker continuous stooping

Multi-Person Harvest Aids

- Workers walk a short distance to unload fruit trays into the harvest aid

- Potential labor savings of 30%-50% have been reported for these aids

Collaborative Robot/ Instrumented Carts

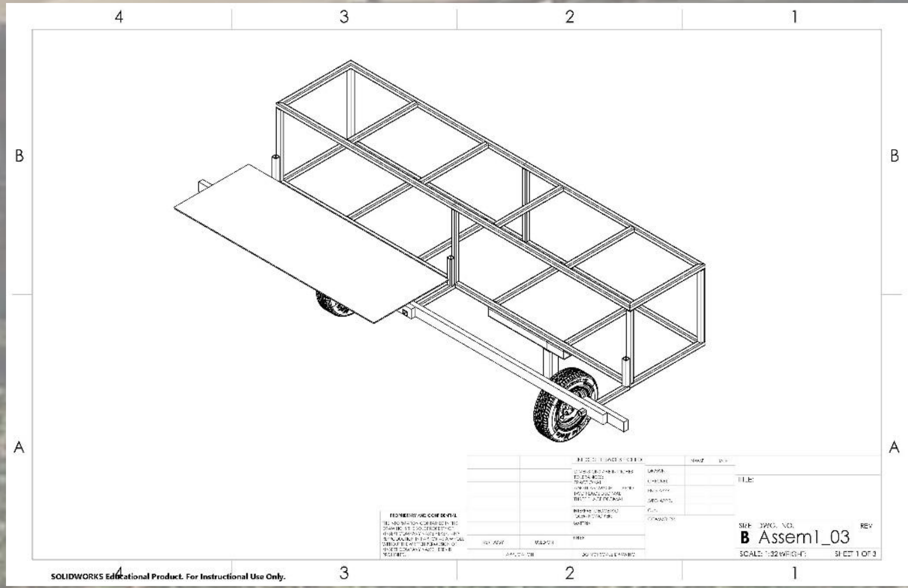
- Approach is developed to optimize worker's productivity w/o compromising health effects

Project Goal

- Investigate the combined effects of operating speed and time breaks for multi-person machines and co-bot on productivity, biomechanical response, fatigue and symptoms of musculoskeletal disorders

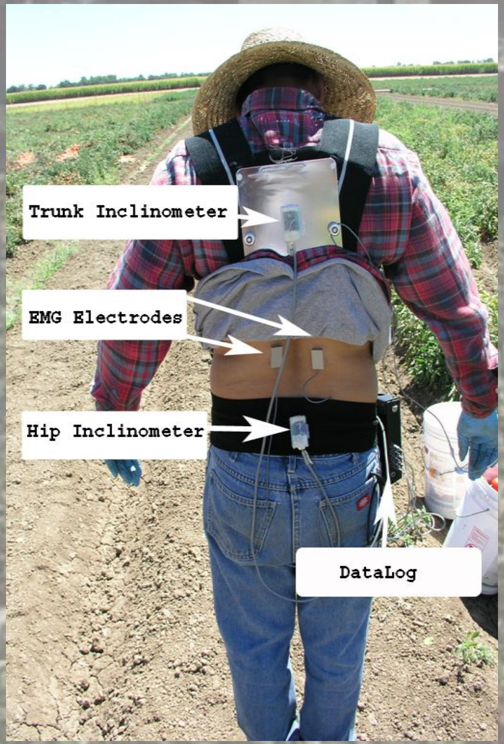
Project Update

- **Completing development and building of harvest aid system to simulate various speeds and field configurations**



Project Update

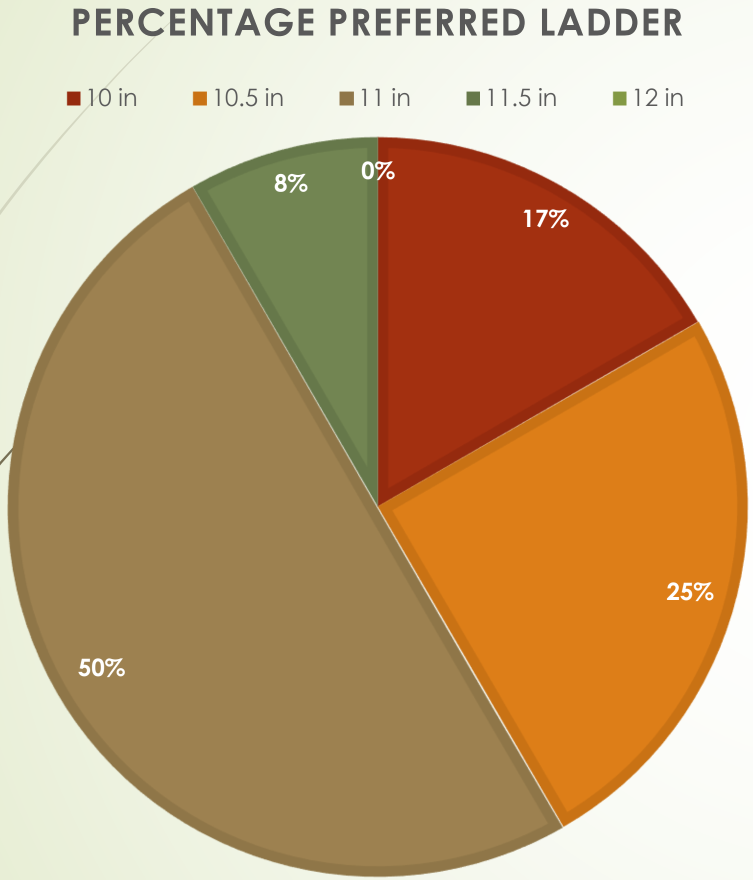
- Piloting optimal worker's biomechanical response
- Piloting symptom surveys
- Collaborating with the Strawberry Center at Cal Poly on biomechanical studies and access to strawberry growers

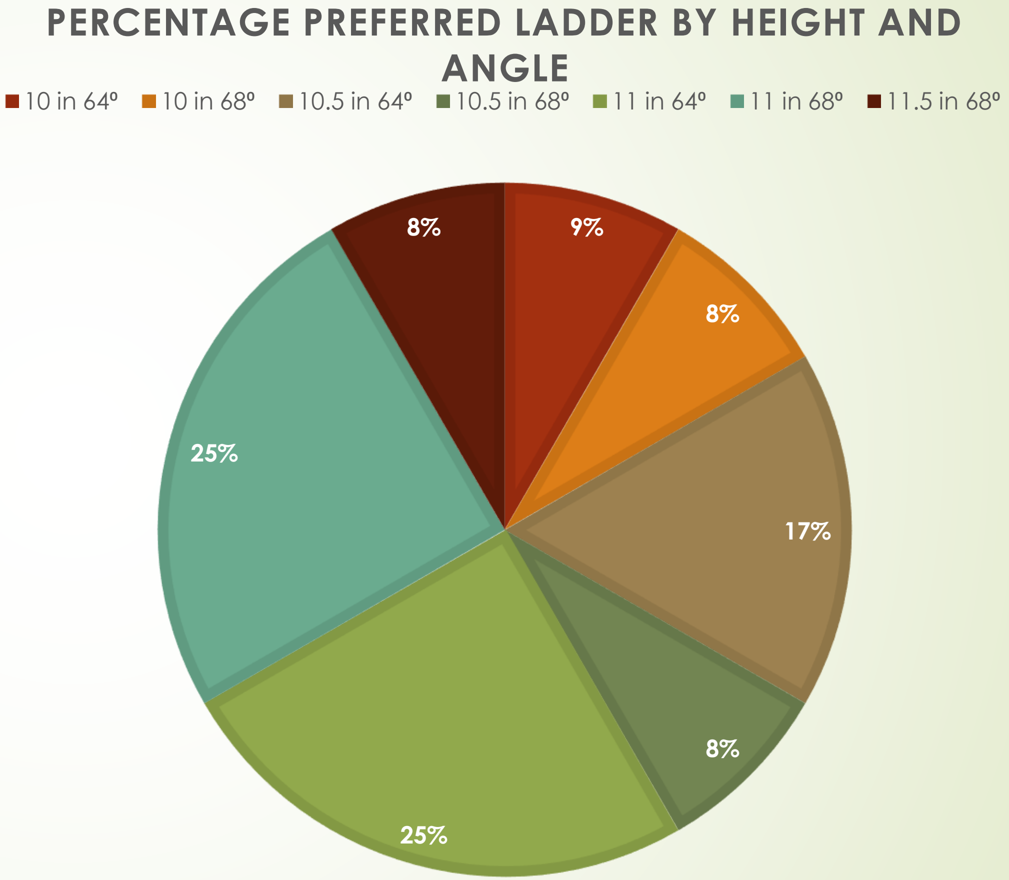


Adoptability of Orchard Ladders with Short Rung Spacing

Research Team: Victor Duraj, and Tyler Hunter

Preferred Ladder





No one choose the 12" rungs.

No one chose the 72 degree angle.

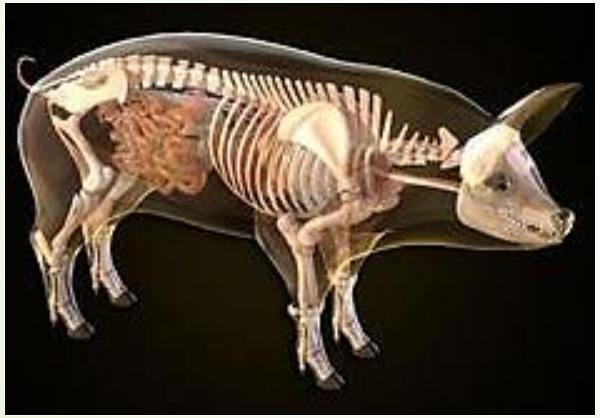
The Relationship between MRI Parameters and Spinal Compressive Loading

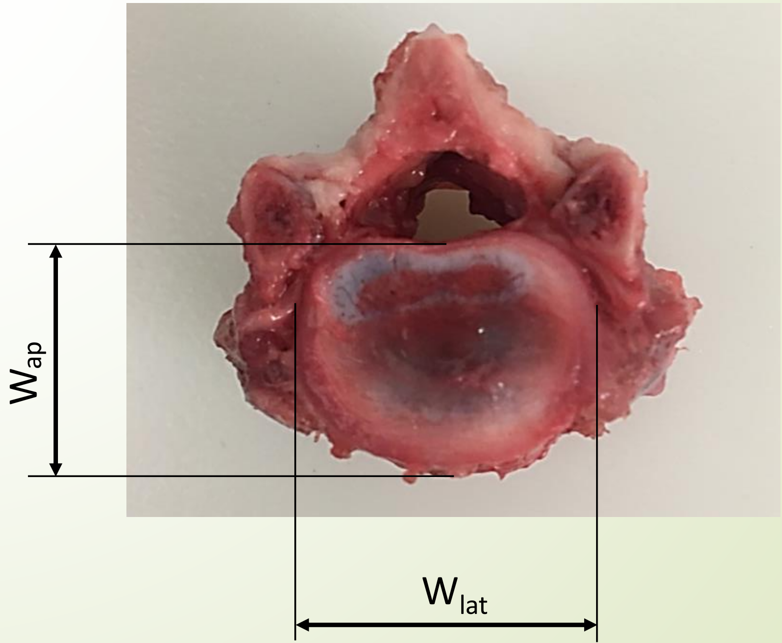
Research Team: Jie (Victor) Zhou and Dr. Jeff Walton

METHODS

➢ Specimens

- In-vitro study, functional spinal units (FSUs) from porcine cervical spines.
- Important similarities to the human lumbar spine.[17, 18, 19, 20]
- Wrapped in PBS-soaked gauze, sealed in plastic bags.
- Frozen at -20° C then thawed for approximately 12 hours before testing.[18, 19]

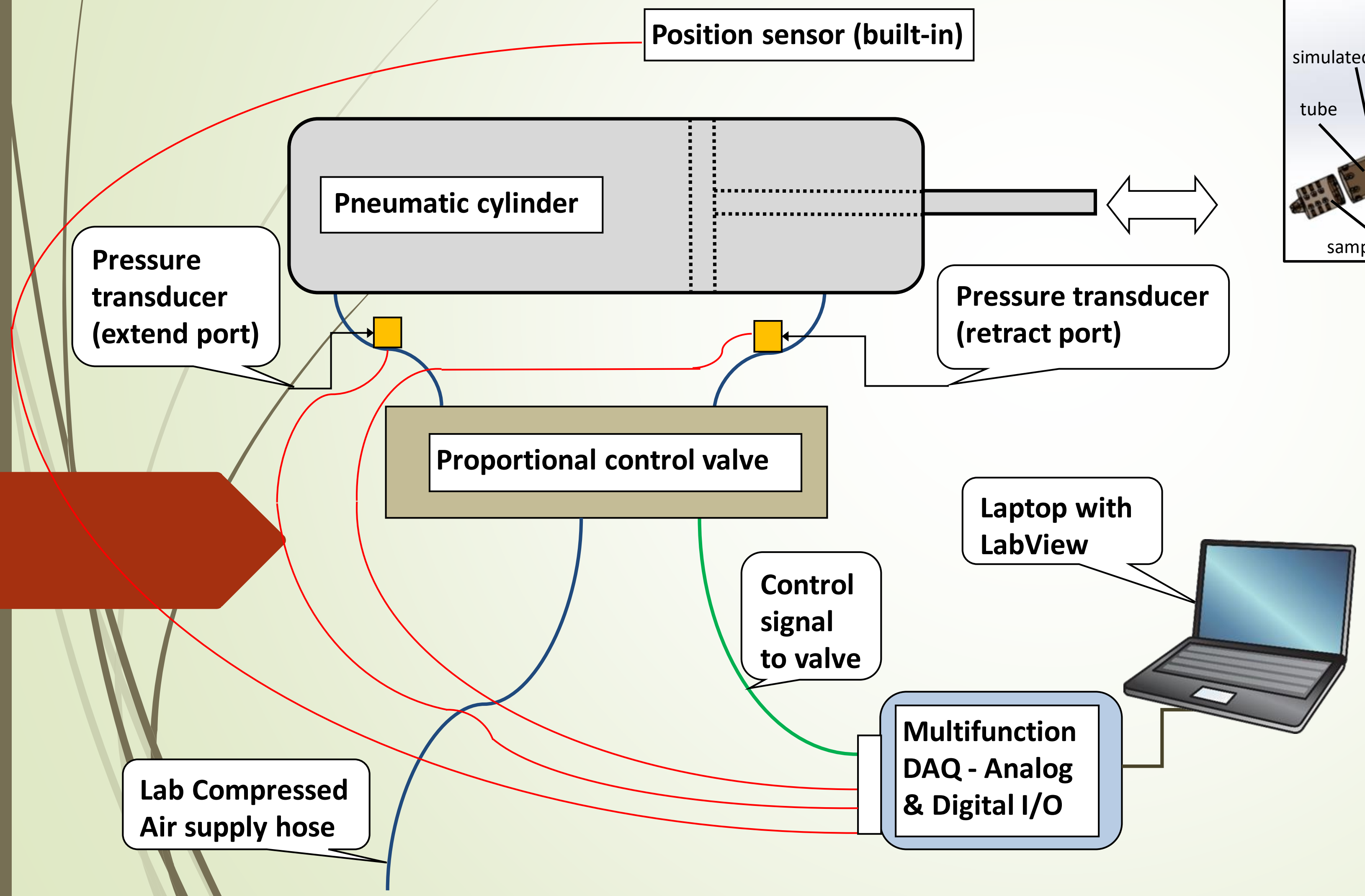


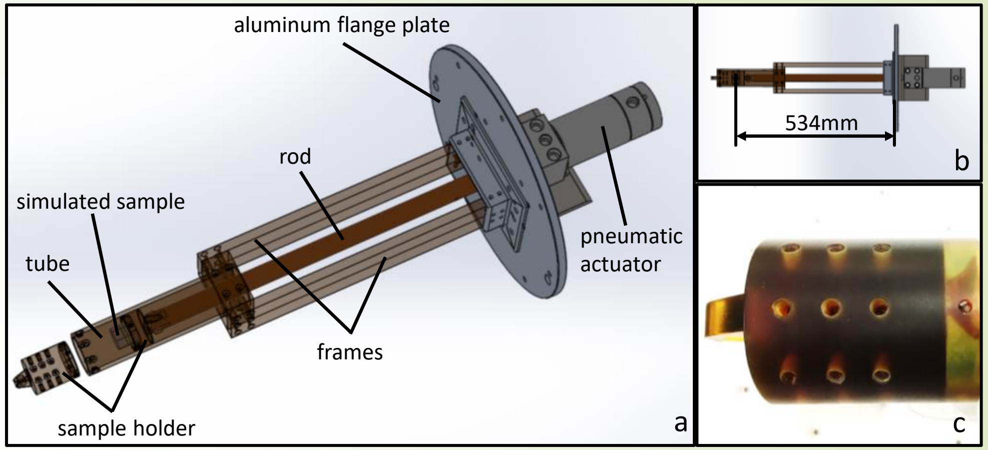


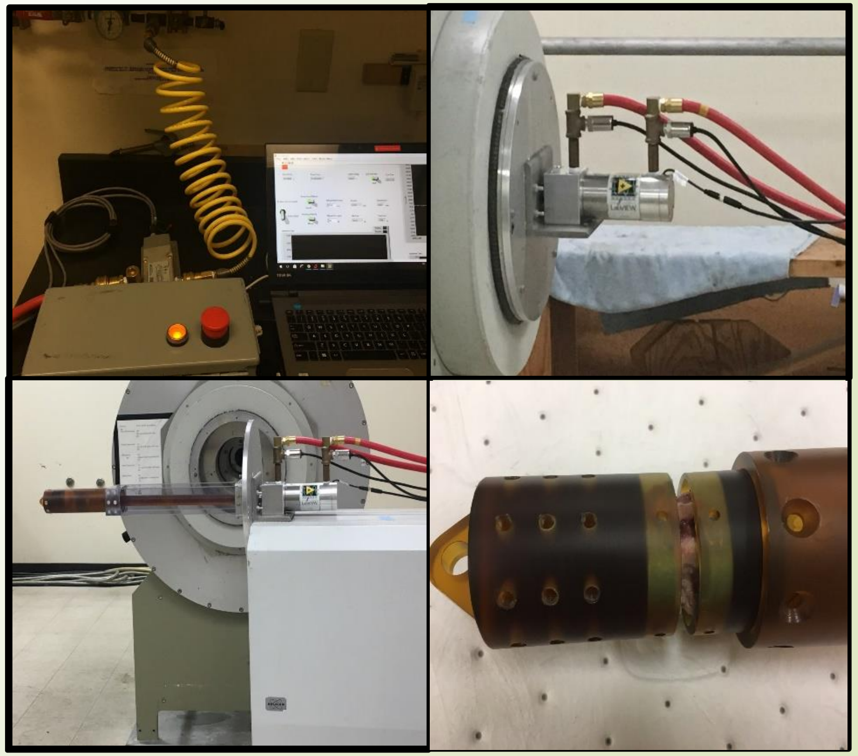
17. Noguchi et al., 2016; 18. Drake et al., 2008;
19. Yingling et al., 1999; 20. Gooyers and Callaghan, 2015;

METHODS

➤ **Computer controlled loading apparatus**

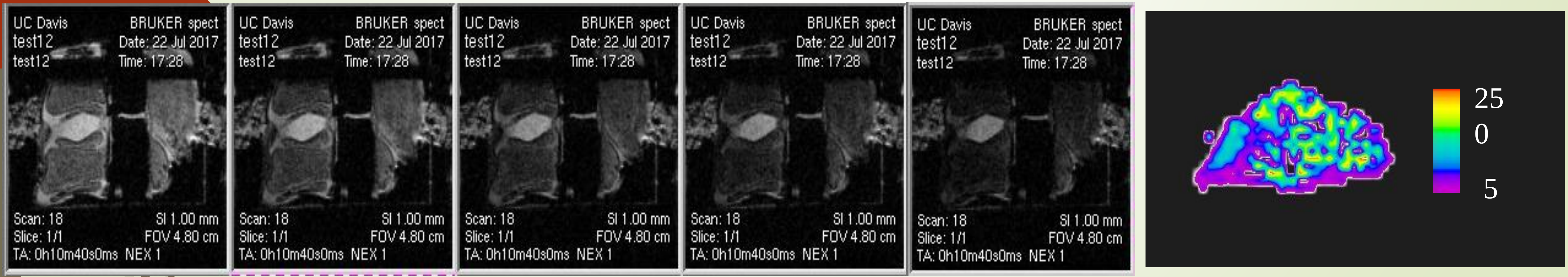






Experimental protocol

- Twenty-two specimens
- A repeated measures experiment design (263.25N for 60 minutes)
- Apparatus setup
- Procedure: Specimen preparation, imaging, compressive loading, imaging.
- Image analyses and parameter calculation
- Statistical analyses (paired t-tests)



RESULTS

	$T_{1\rho}$ (ms)	T_2 (ms)	ADC (mm^2/s)
Baseline	**119.43 (6.22)**	**50.13 (4.70)**	0.002887 (0.000054)
Compressed	**89.03 (5.12)**	**33.10 (3.45)**	0.002790 (0.000084)

- $T_{1\rho}$ significantly and T_2 significantly decreased
- Tension loading (e.g., inversion tables) returned values to baseline)
- Implications as a diagnostic tool and effect of tensile loading as an intervention

Ongoing Study

Quantitative Morphometric and Immunohistochemical Evaluation of the Healing Rat Medial Collateral Ligament and Epiligament

Implications to Work in Stooped Posture and Intervention Effectiveness

Research Team: Amjad Ramahi and Professor Tom Jue

Acknowledgements

- Stavros Vougioukas, Professor, Biological and Agricultural Engineering
- Vicente Munguia, PhD Student, Agricultural Safety and Health Trainee, NIOSH ERC
- Victor Duraj, Associate Development Engineer and PhD Student
- Tyler Hunter, Junior Research Specialist
- Jie Zhou, former PhD student
- Amjad Ramahi, PhD student, Agricultural Safety and Health Trainee, NIOSH ERC
- Funding supported by NIOSH

Questions?

National Institute for Occupational Safety and Health
NIOSH

Western Center for Agricultural Health & Safety

UC AERC Agricultural Ergonomics Research Center

100 YEARS 1915 - 2015
UC DAVIS
BIOLOGICAL AND AGRICULTURAL ENGINEERING