

# POTENTIAL TOOLS FOR DELAYING DEGRADATION OF BRAIN TISSUE PROPERTIES IN PMHS TESTING

Yun-Seok Kang<sup>1</sup>

Alaine Wetli<sup>1,2</sup>, Ann Mallory<sup>2</sup>, Heather Rhule<sup>3</sup>, Kevin Moorhouse<sup>3</sup>

<sup>1</sup>The Ohio State University, Injury Biomechanics Research Center

<sup>2</sup>Transportation Research Center Inc.

<sup>3</sup>National Highway Traffic Safety Administration



# Background

- Traumatic brain injuries (TBI) [Center for Disease Control and Prevention]
  - Account for 33% of all injury related deaths
  - 50,000 deaths due to TBI in 2014
- Previous brain research using PMHS
  - Stalnaker et al. (1977), Nusholtz et al. (1984), Trosseille et al. (1992), Hardy et al. (1997), Hardy et al. (2001), Hardy et al. (2007), Al-Bsharat et al. (1999), Mallory (2014), Giudice et al. (2017)

**Giudice et al. (2017): 60 hrs**

**Mallory (2014): 59 and 86 hrs**

**Hardy (2007): 120 – 240 hrs**

# Background

- Brain Tissue Degradation



43 hrs



216 hrs

Increase of H<sup>+</sup> ions and bacteria break down post mortem brain tissue

# Background

- How to delay degradation of brain tissue properties?
  - Antibiotics
    - Medical applications
    - Sterilization
    - Used in previous studies to preserve post mortem human tissue [Csonge et al., 1995, Potier, 2010]
    - Inhibit bacteria by attacking the cell wall or multiplication process of the bacteria

# Background

- How to delay degradation of brain tissue properties?
  - Sodium Bicarbonate
    - Medical uses [Davis 2010; Velissaris et al., 2015]
    - Strong base
    - Counteracts the increase in H<sup>+</sup> ions once blood and oxygen supply is cut off

**Objective: evaluate the effect of antibiotics and sodium bicarbonate on delaying degradation of post mortem brain tissue properties**

# Solutions

Artificial Cerebrospinal  
Fluid (aCSF)

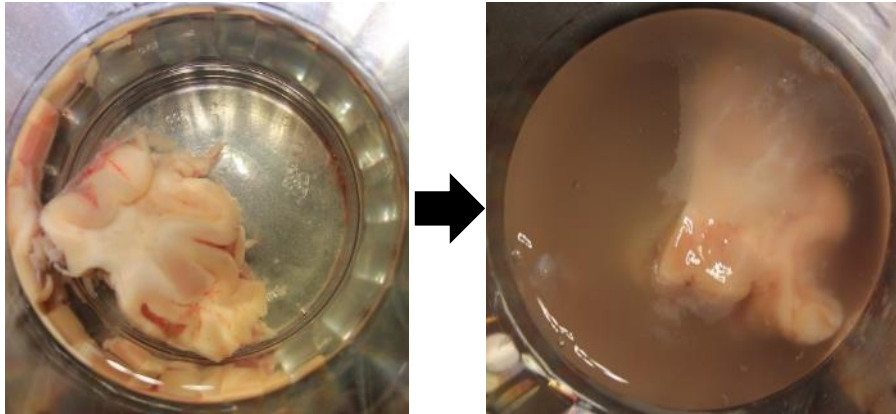
Antibiotics:  
Amphotericin,  
Ceftazidime, and  
Ampicillin in aCSF  
[Csonge et al., 1995]

Sodium Bicarbonate:  
Sodium bicarbonate in  
aCSF  
[Velissaris et al., 2015]

Both: Sodium  
bicarbonate and  
antibiotics in aCSF

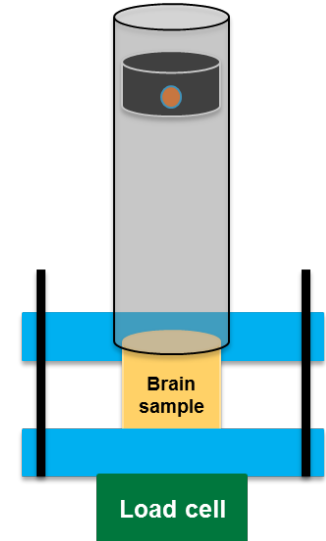
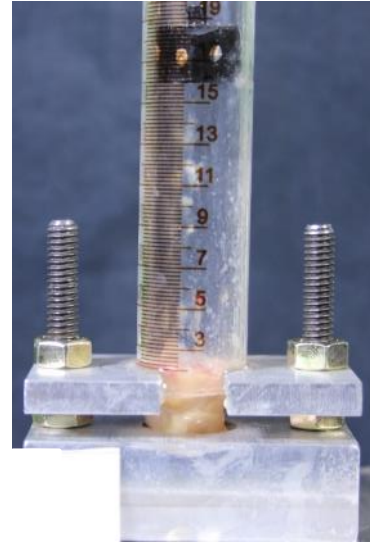
# Methods – Evaluation of Solutions

## Qualitative analysis (PMHS1)



## Quantitative analysis (PMHS2)

### Compression test



## PMHS1 - Qualitative analysis

PMHS information	
Sex	Male
Age	67
Cause of death	Pneumonia
Post mortem time	58 hrs



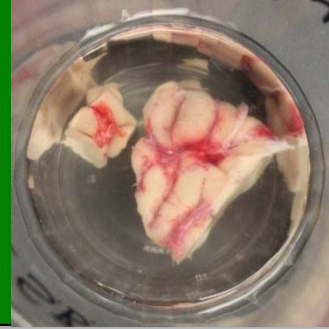


# PMHS1 – Qualitative Analysis

aCSF



Antibiotics



Post  
Mortem  
58 hrs

Sodium Bicarbonate



Both



# PMHS1 – Qualitative Analysis

aCSF



Antibiotics

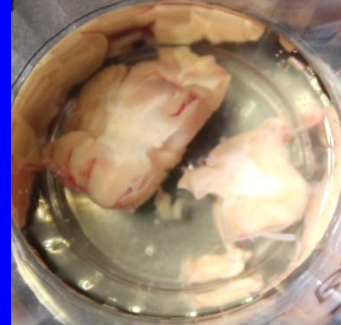


Post  
Mortem  
83 hrs

Sodium Bicarbonate



Both

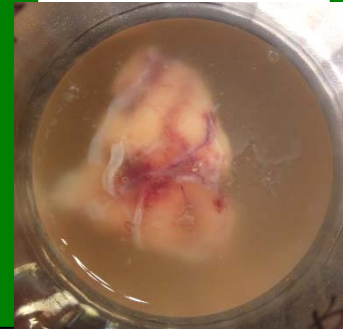


# PMHS1 – Qualitative Analysis

aCSF



Antibiotics



Post  
Mortem  
109 hrs

Sodium Bicarbonate



Both



# PMHS1 – Qualitative Analysis

aCSF



Antibiotics



**Post  
Mortem  
152 hrs**

Sodium Bicarbonate



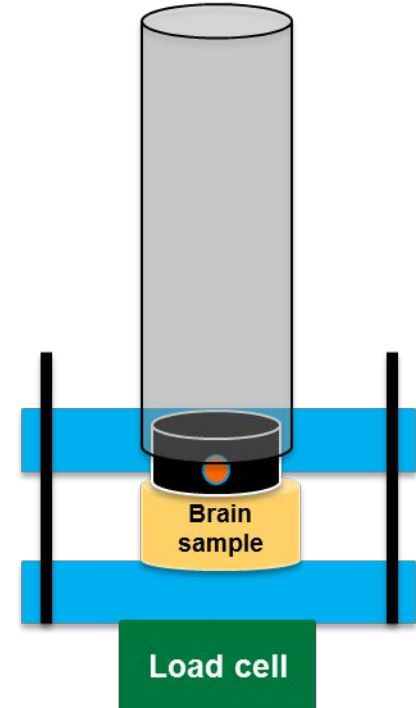
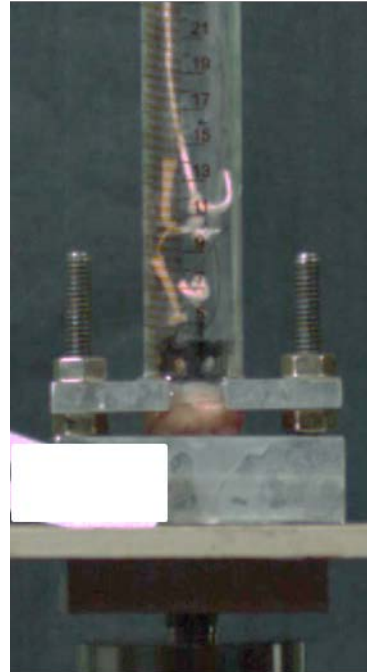
Both



## PMHS2 - Quantitative analysis

### PMHS information

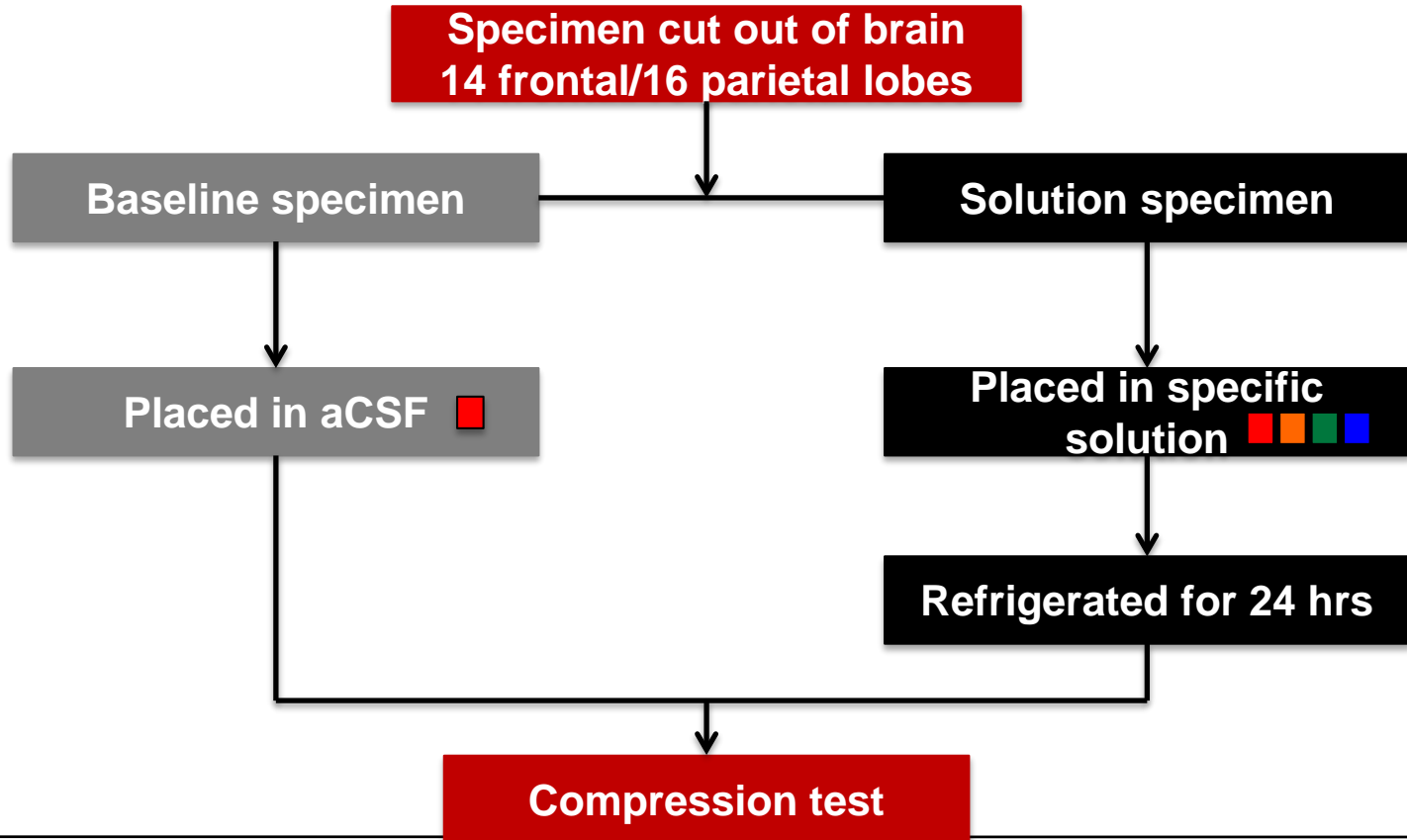
Sex	Male
Age	80
Cause of death	Diastolic Heart Failure
Post mortem time	32 hrs



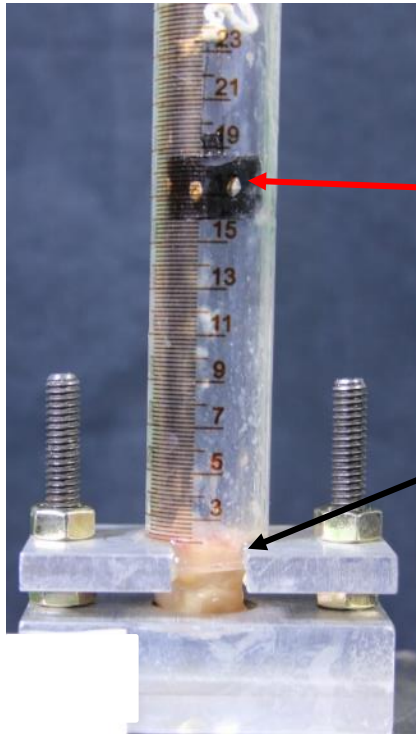
# PMHS2 – Brain Tissue Sample



# PMHS2 - Procedure

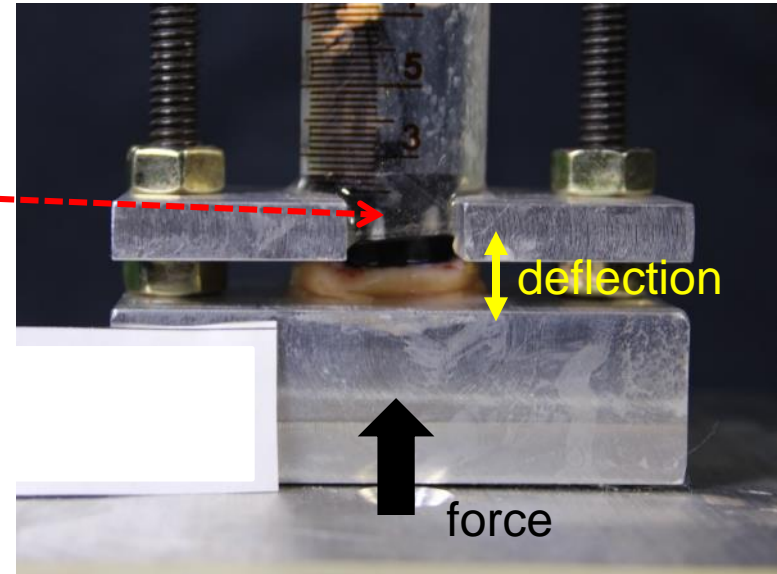


# PMHS2 – Compression Test



Impactor  
(20 gram)

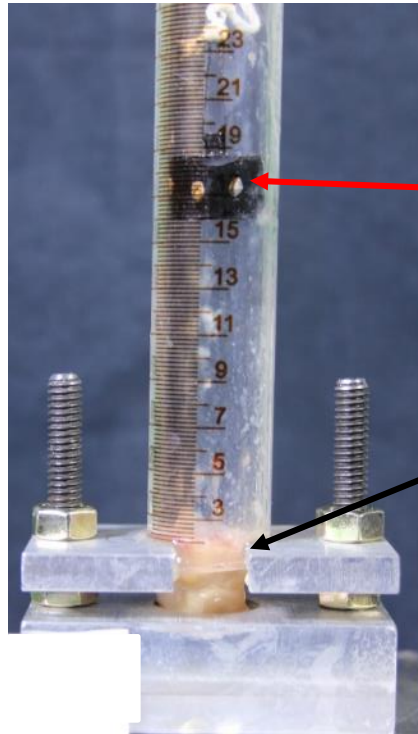
D: 16 mm  
H: 25 mm



Quantify force and deflection  
→ **stiffness**

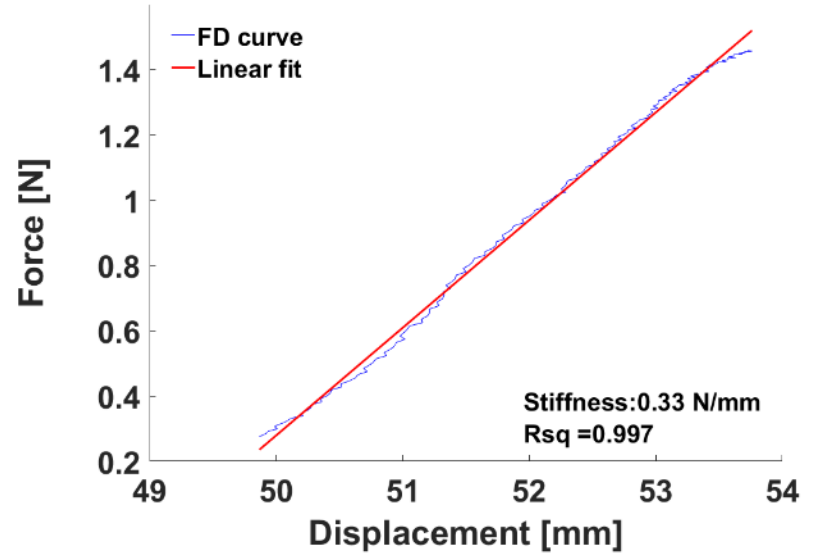


# PMHS2 – Compression Test



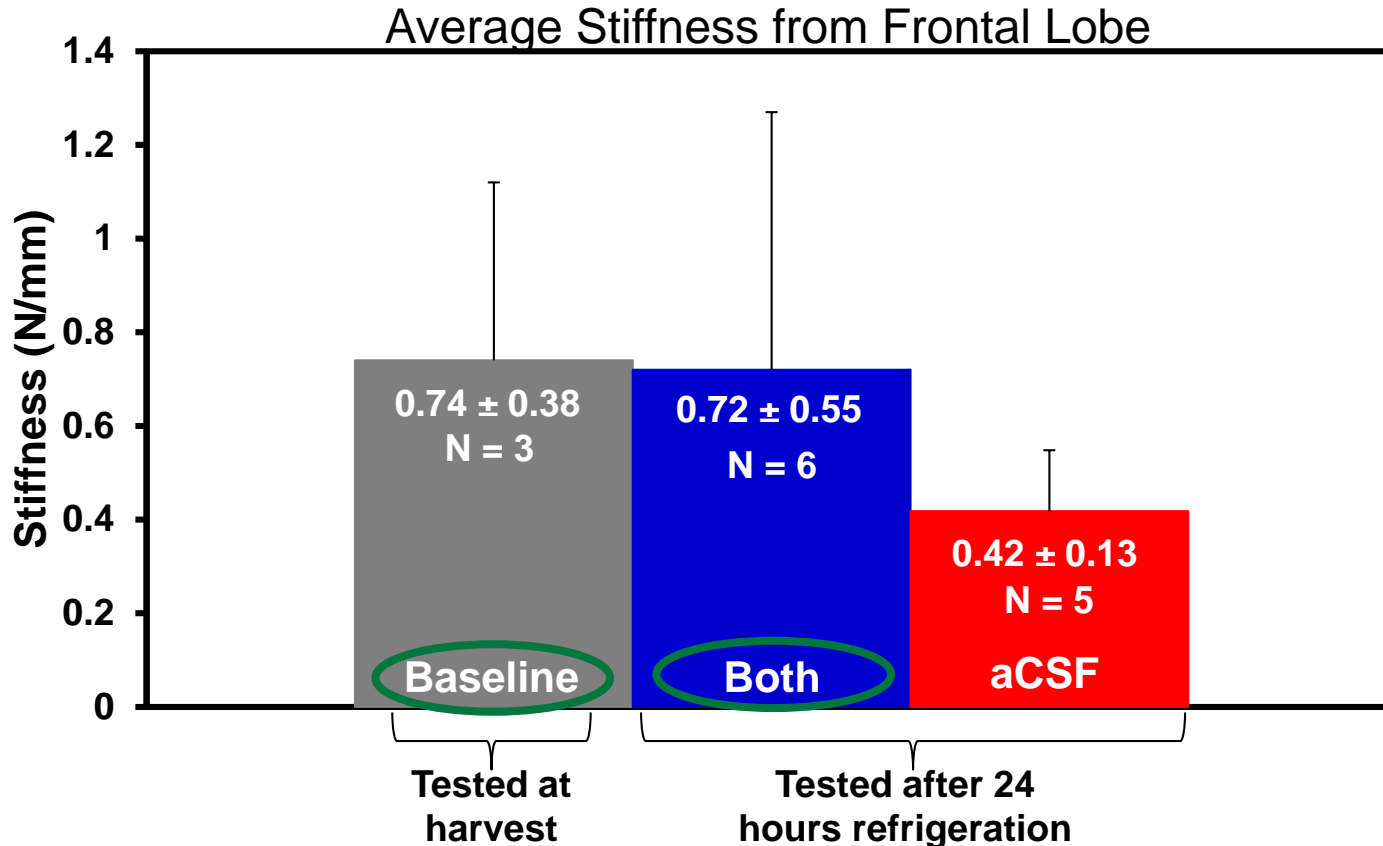
Impactor  
(20 gram)

D: 16 mm  
H: 25 mm

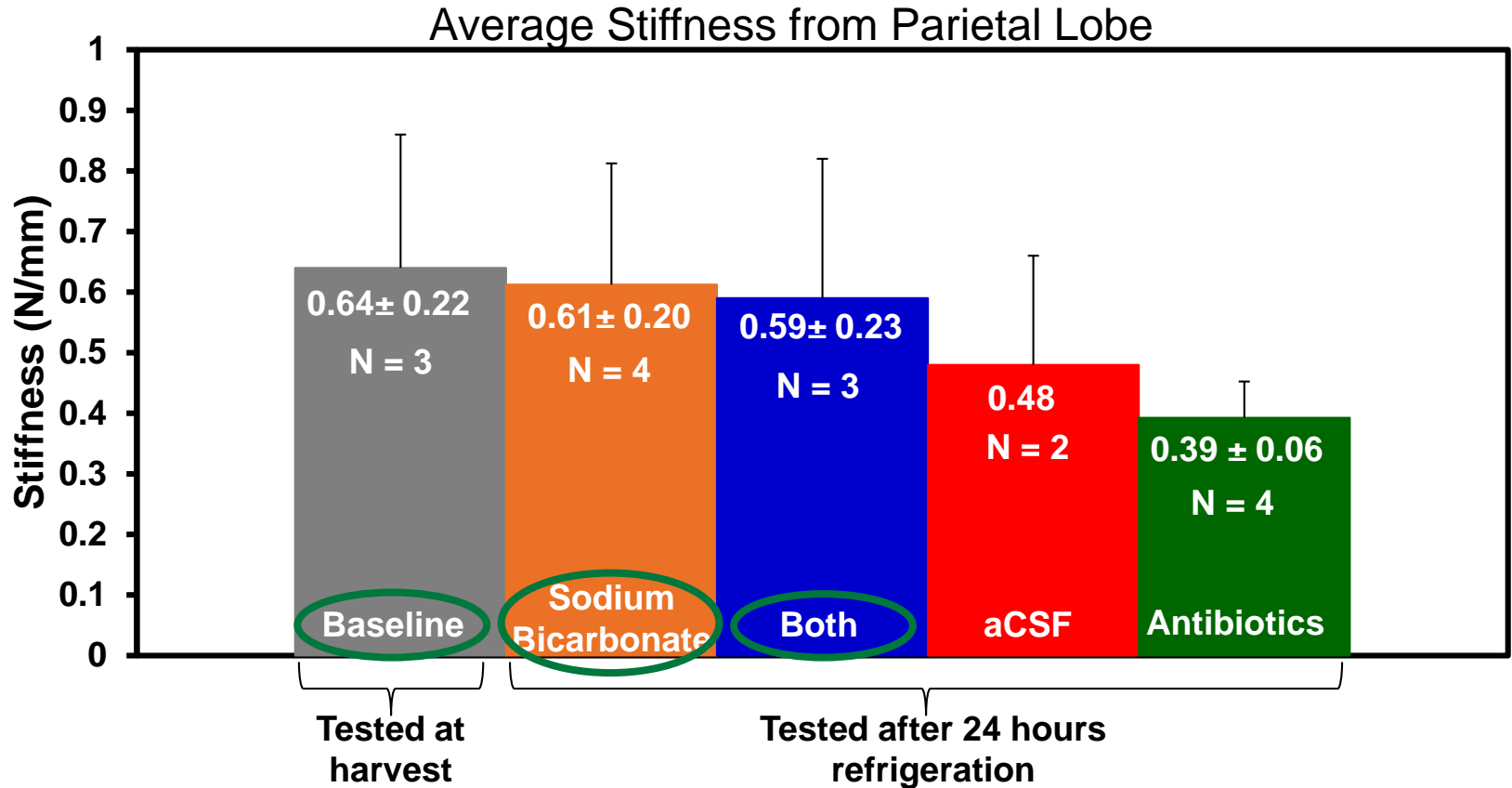


Quantify force and deflection  
→ **stiffness**

# Results – Quantitative Analysis





# Results – Quantitative Analysis



# Conclusion

- Sodium bicarbonate identified as potential new tool to help delay degradation
- The combination of sodium bicarbonate and antibiotics solution showed ability to delay degradation of post mortem brain tissue properties

# Acknowledgements

- IBRC members 
  - Bernie Cook
  - Mandy Agnew, PhD
  - John Bolte, PhD
- TRC 
  - Colton Thomas

# Thank you for your attention!

- Name: Yun-Seok Kang
- Company: Injury Biomechanics Research Center at The Ohio State University
- Address: 333 West 10<sup>th</sup> Ave, Columbus, OH 43210
- Phone: 614-366-7584
- Email: [yunseok.kang@osumc.edu](mailto:yunseok.kang@osumc.edu)