Visualizing spinal cord tissue perfusion in real-time

Hofstetter Lab
Neurological Surgery Summer Student Program 2019
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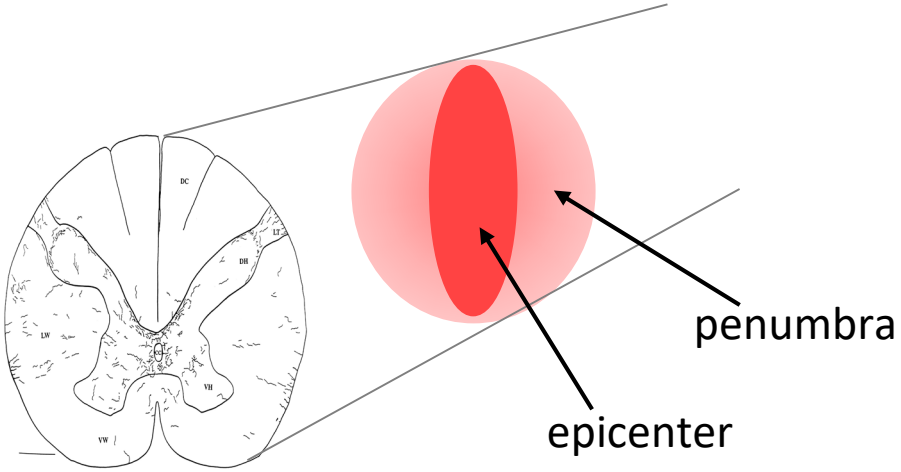
Background

- Traumatic spinal cord injury (tSCI)
  - Motor and sensory deficit caudal to level of injury: bowel, bladder, sexual dysfunction
  - Complete loss of blood flow at injury center
  - Ischemia or hypoperfusion of penumbra → secondary cell death



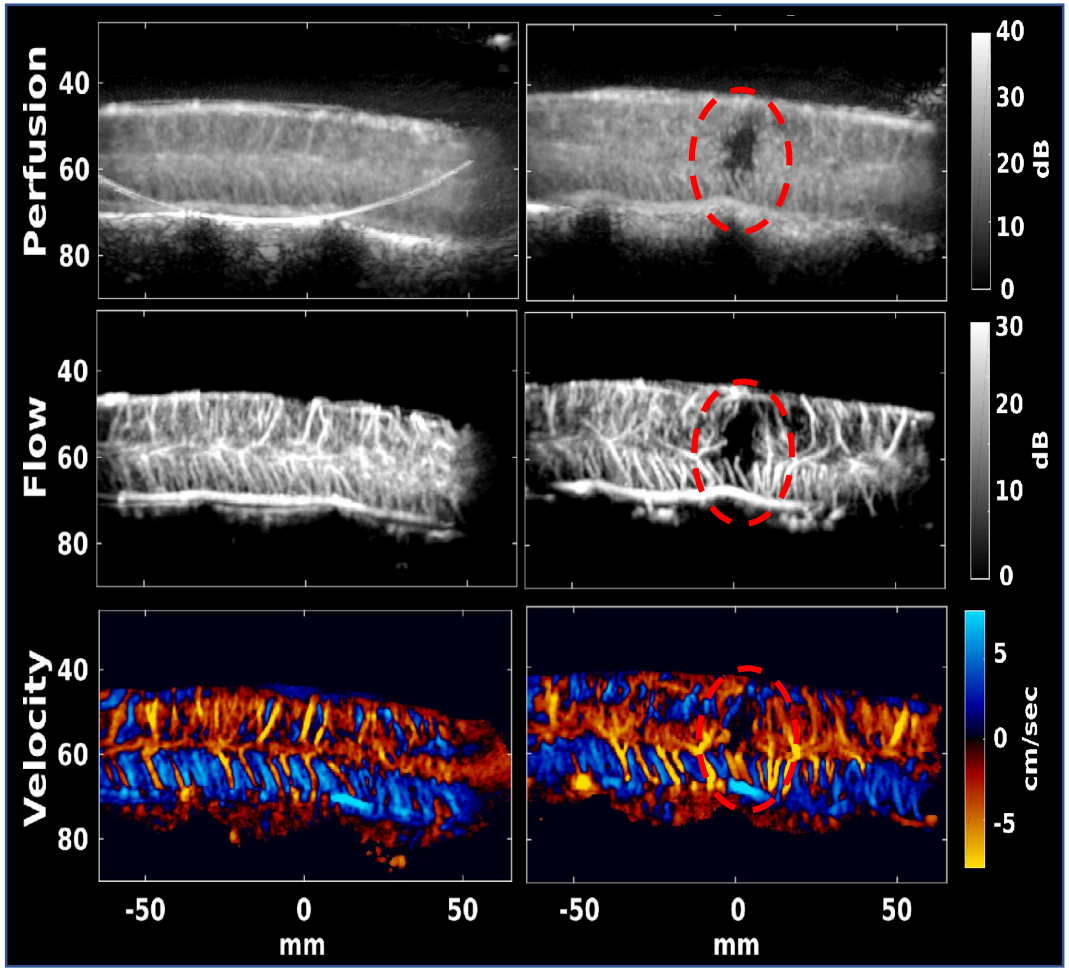
Problem: Lack of non-invasive clinical imaging biomarker for injury severity and to identify the penumbra

Novel Technique

Proposed Solution: ultrafast contrast enhanced ultrasound (CEUS) doppler

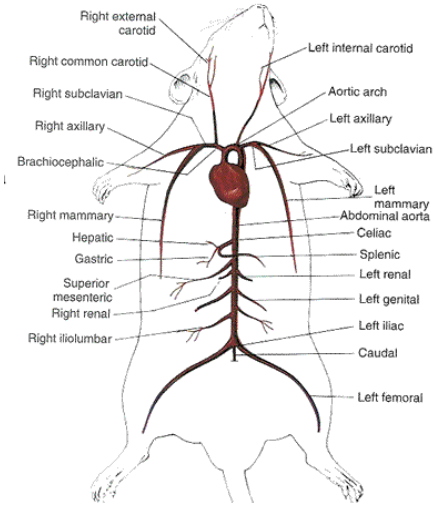
- Local blood perfusion predicts lesion severity and functional deficits

Validate CEUS doppler with golden standard technique (microsphere deposition)

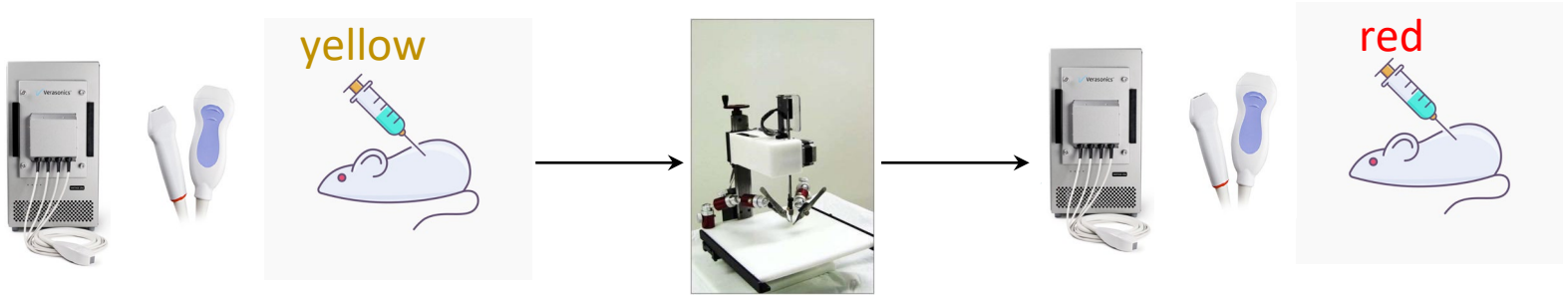


Moderate contusion injury

Experimental Set Up



- Carotid artery catheterization → fluorescent microsphere injection
  - rate: 1 mL for 2 mins
  - red and yellow fluorescent microsphere (15 µm)
- Tail vein catheterization → microbubbles for ultrasound
  - ~ 0.15 mL per injection
- T8-10 laminectomy: 150 kdyn injury at T9

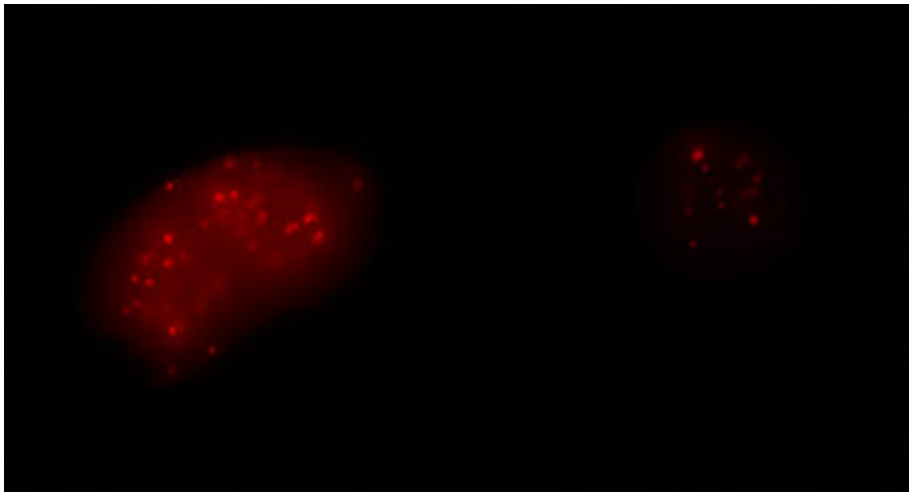


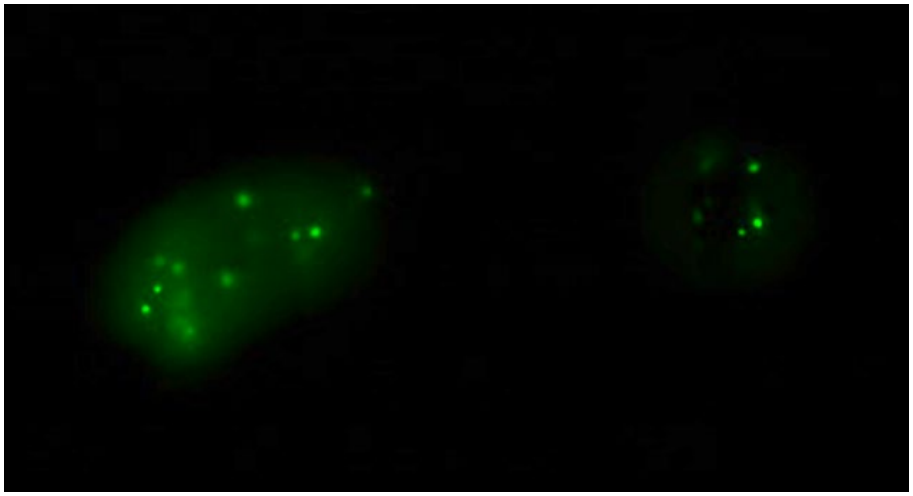
Pre-injury

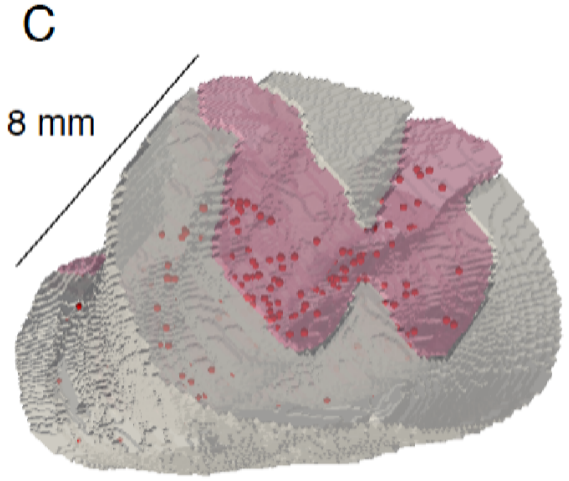
Injury at T9

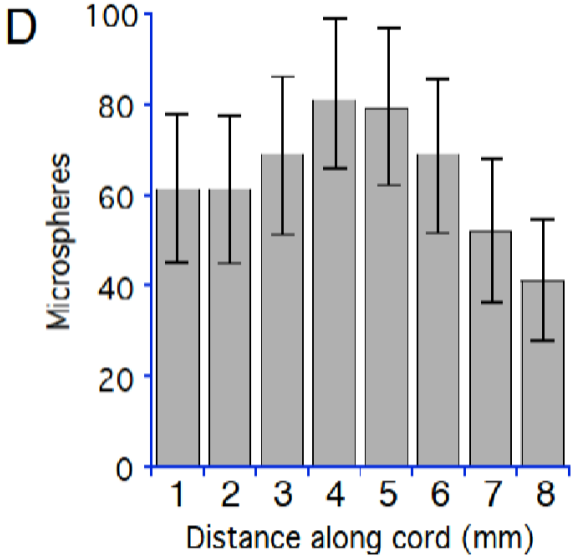
Post-injury

Microsphere Processing



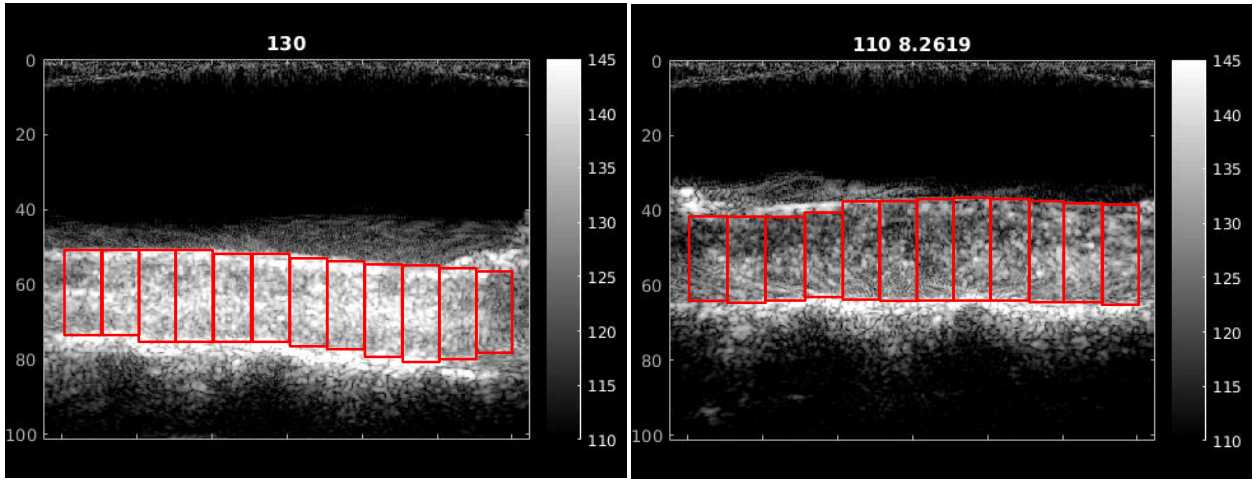






CEUS Image Processing

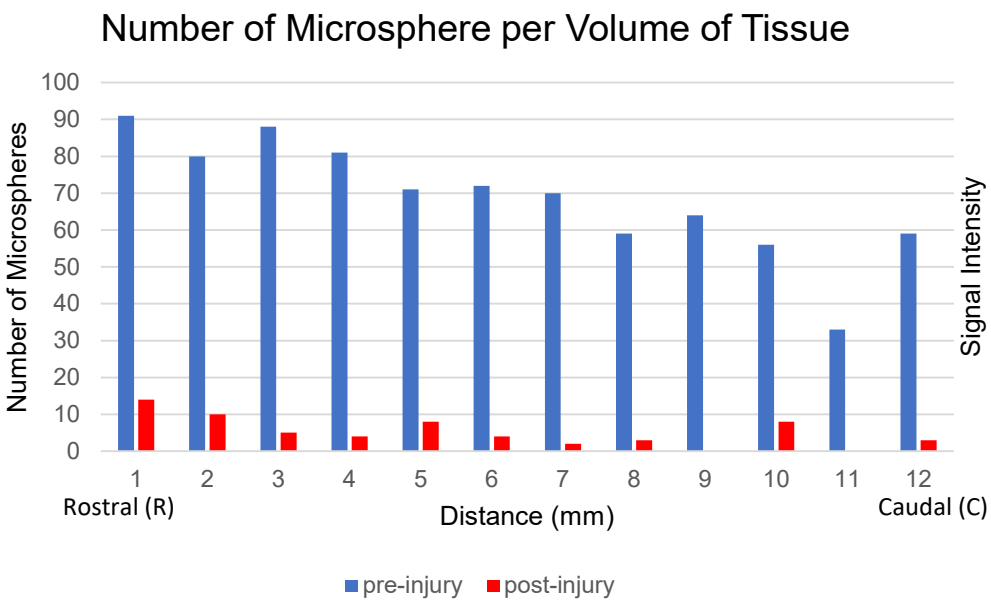
Baseline **Injury**



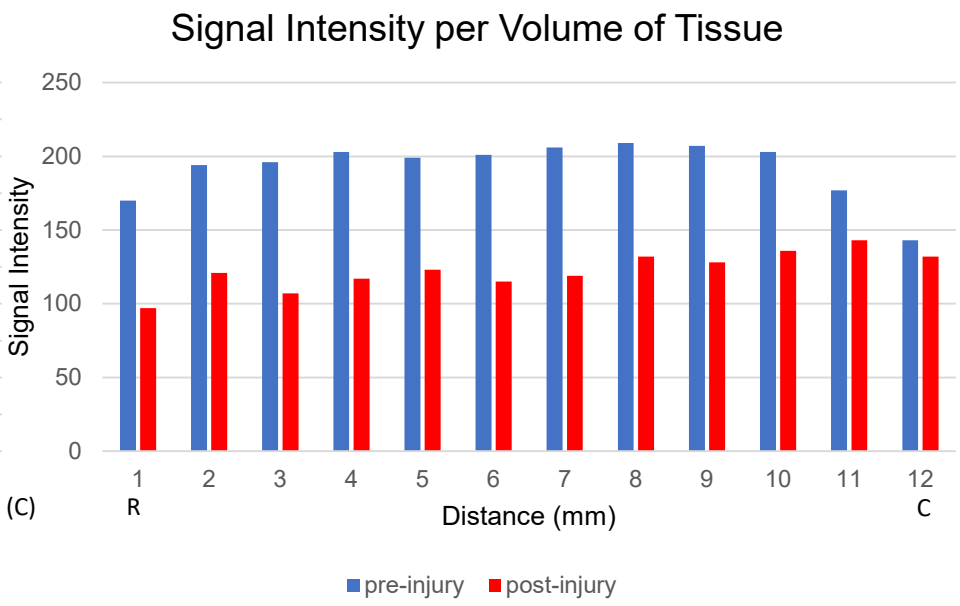
Measure signal intensity every 1 mm segment (total of 12 mm)

Pre-injury vs. Post-injury

Microsphere Deposition

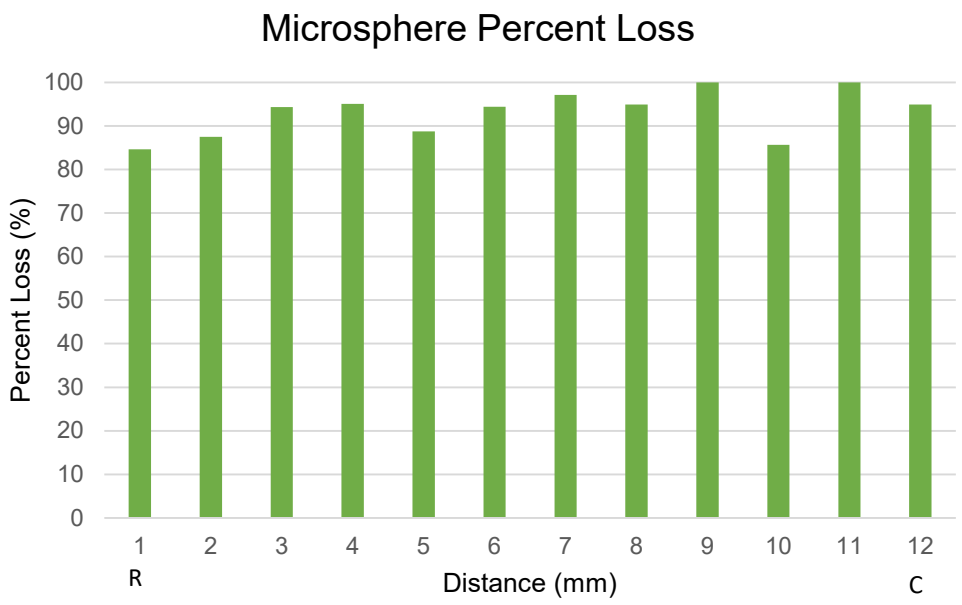


CEUS

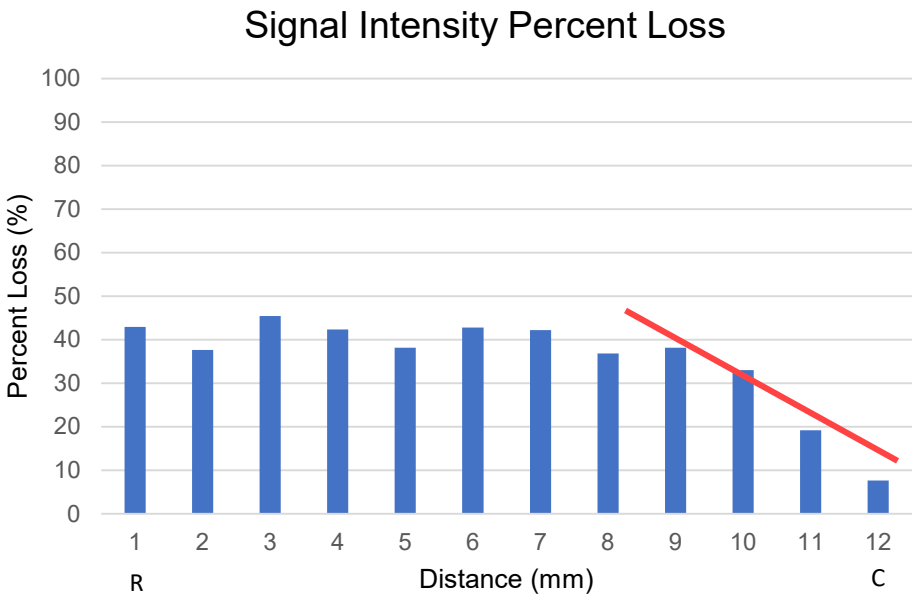


Percent Loss

Microsphere Deposition



CEUS



Discussion

Conclusion

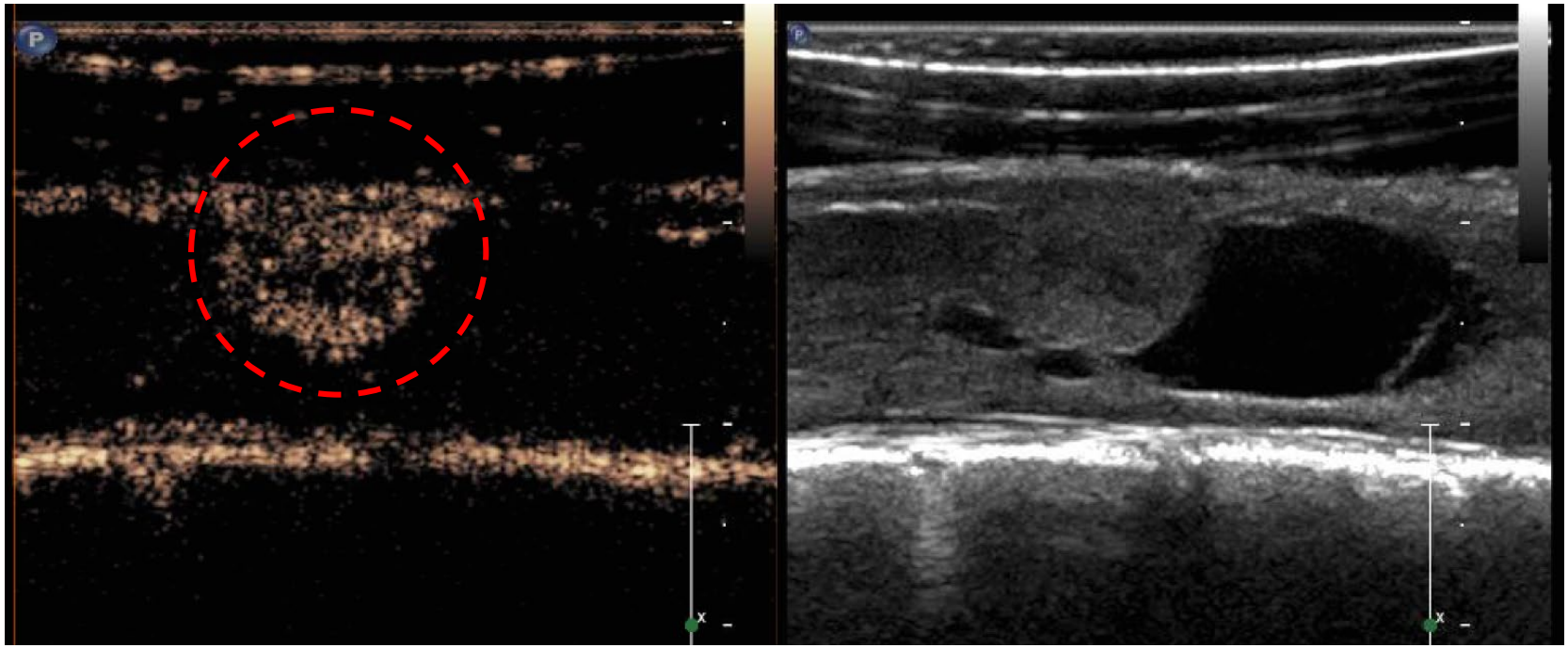
- CEUS has better spatial resolution
- Better temporal resolution
  - Real time visualization of hemodynamic changes
- Intravital imaging
- Intraoperative usage

Ongoing and Future Directions

- Include absolute tissue perfusion
- Hemodynamics of chronic injury
- 3D CEUS parametric maps
- Use as clinical tool to evaluate lesion mapping, severity, and rescue-able zone in real-time

Human CEUS: Spine Tumor

Detecting tumor borders to aid during surgery



Acknowledgement

- **Chair & Program Director:** Richard G. Ellenbogen, MD, FACS
- **Program Executive Advisor:** Sandra Ellenbogen, RN
- **Hofstetter Lab:** Christoph P. Hofstetter, MD, PhD; Zin Khaing, PhD; Matt Bruce, PhD; Lindsay Cates, Jeff Hyde
- **Department Director:** Jana Pettit, MBA
- **Program Administrators:** Christine Mac Donald, PhD; Jim Pridgeon, MHA; Sylvia Zavatchen, MEd
- **Program Coordinator:** Julie Bould
- Jeff Ojemann

- **Funding Agencies**:
  - NIH NINDS Grant: Summer Research Experience in Translational Neuroscience and Neurological Surgery (Grant number: 5R25NS095377-04)
  - Department of Neurological Surgery
  - Royalty Research Funds
  - Institute of Translational Health Sciences
  - Washington Spinal Cord Injury Consortium
  - The Craig Nielsen Foundation
  - DoD CDMRP
  - Raisbeck Foundation

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And we are fun!

Captain Hofstetter