

Trans-Spinal Cord Tumour Ablation: A New Approach Using Minimally Invasive Histotripsy

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Introduction

Clinical Need

- The spine is the **3rd most common site** of metastasis¹
- Up to **70%** of cancer patients develop spinal tumours¹
- **18,000 metastases** diagnosed per year in North America²
- Tumours can cause pain, neurological deficits, paralysis³

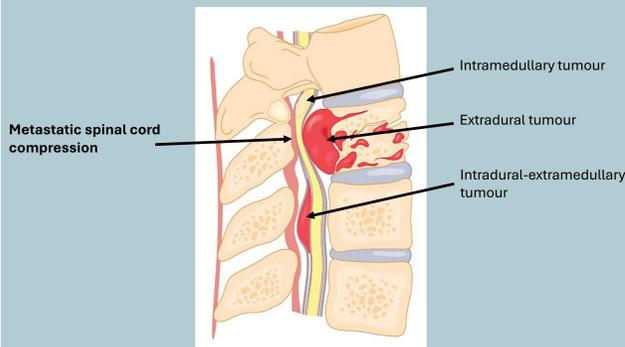


Figure 1. Diagram showing locations of spinal tumours along with metastatic spinal cord compression⁴.

Current Standard: Separation Surgery

- Surgically create a 2–3 mm margin between the tumour and spinal cord⁵
- Deliver targeted radiation therapy to the tumour⁵
- **Challenging + high-risk** as the tumours often lie ventrally (opposite to the access route)⁶

Not all patients can have surgery or enough radiation → treatment gap

Background

- Histotripsy is a non-thermal ablation technique⁶
- Key advantages: tissue selective, non-thermal, and image-guided

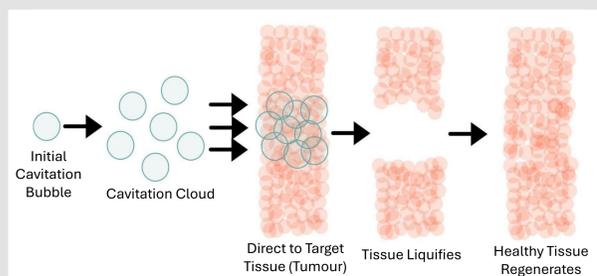


Figure 2. Diagram showing histotripsy process.

Project Objective

To determine the minimum safe distance at which histotripsy can be applied without damaging spinal cord structures

Methods

Histotripsy System

- Custom system developed by *Sound Blade Medical Inc.*
- Fixed focused high-frequency transducer coupled with a 64-element 20 MHz imaging array



Figure 4. SoundBlade Medical histotripsy system.

Treatments

- Ex vivo porcine spinal cord embedded in a tissue mimicking phantom
- Five replicates of each site
- Treated both trans-spinally and laterally
- Spots treated at 240V for 5 seconds
- Each spot separated 2mm longitudinally

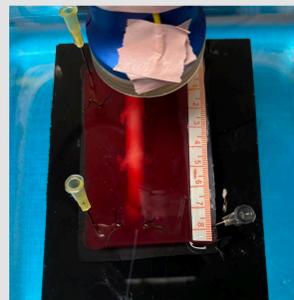


Figure 5. Experimental setup with histotripsy probe and ex vivo spinal cord embedded in phantom material.

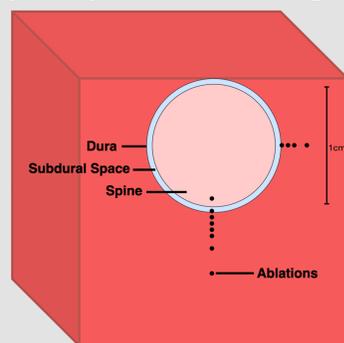
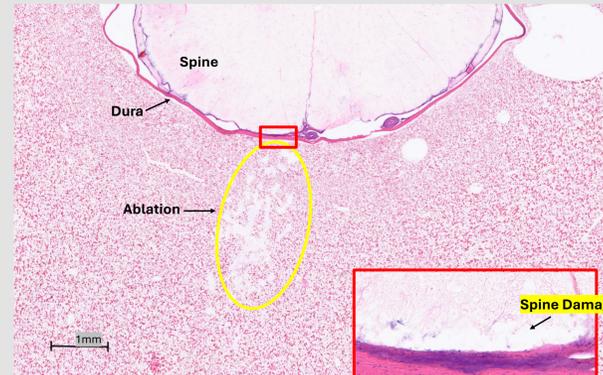
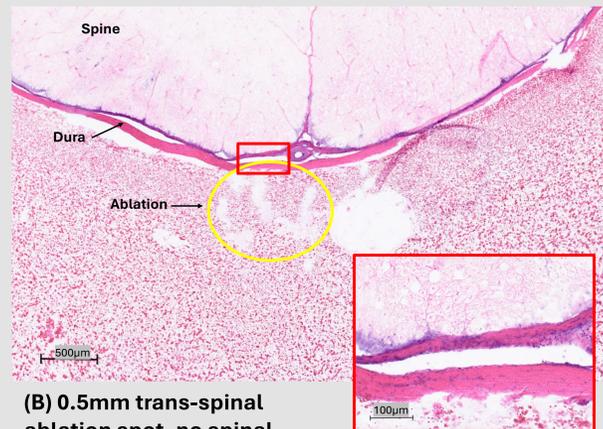


Figure 6. Locations of focused ultrasound ablations on ex vivo pig spinal cord surrounded in red blood cell-agarose phantom tissue.

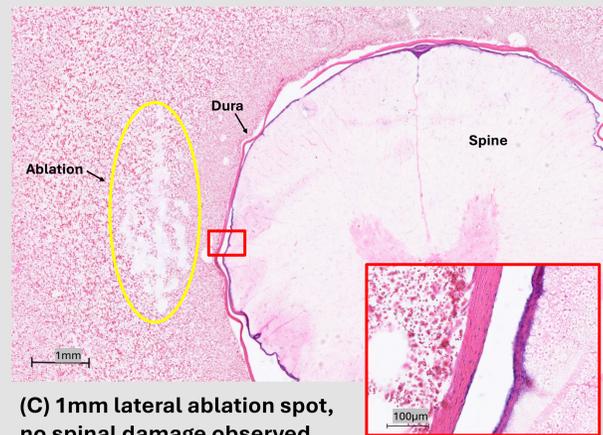
Results



(A) Dural treatment spot, spinal damage observed



(B) 0.5mm trans-spinal ablation spot, no spinal damage observed



(C) 1mm lateral ablation spot, no spinal damage observed

Figure 7. Histological sections of treated spine embedded in red blood cell phantom material showing tissue overview and close-up of potential damage area. (A) 0mm trans-spinal treatment (dural); (B) 0.5mm trans-spinal treatment; (C) 1 mm lateral treatment. Phantom ablations are highlighted.

Minimum Safe Treatment Distance

- 0.5 mm and further: No spinal damage found
- Dural treatment: Spinal damage observed, but no dural damage
- Safety threshold: 0.5mm away from the spine + dura

Conclusion

- Histotripsy enables precise, non-thermal tissue disruption
- Demonstrated ability to treat extremely close (0.5 mm) trans-spinally without dural or spinal damage in ex vivo tissue

Clinical Implications

- Potential alternative to the surgical component of separation surgery
- May allow treatment of tumours adjacent to the spinal cord
- Could expand options for a critical therapeutic gap: patients ineligible for surgery and adequate radiation

Acknowledgements

Special thank you to Hannah Brown (Queens University), Dr. Sean Christie (QEII), everyone at the MicroSonic Lab, Sound Blade Medical Inc., and Oultons Farm, Windsor NS.