

## Treatment of *Staphylococcus aureus* induced abscesses via magnetic resonance guided focused ultrasound

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### Target Audience

Scientists/clinicians seeking novel applications for MR-guided focused ultrasound (MRgFUS) in infectious disease management.

### Purpose

Methicillin-Resistant *S. aureus* (MRSA) produces infections which are not responsive to routine treatments. These highly localized, often inaccessibly located abscesses provide a novel target for the precise, tissue-sparing temperature elevation delivered by MRgFUS.

### Methods

55 female BALB/c mice were subcutaneously injected with 50 $\mu$ L of MRSA suspension, and the resulting abscesses developed for 48 hours prior to treatment. Imaging was done using an Achieva 3T MRI (Philips Healthcare), with treatment on an animal FUS gantry (FUS Instruments, Toronto, Canada) using a 3MHz-transducer (focal length of 50mm and f-number= 0.64). Four ultrasound exposures of 9 seconds were applied to the abscess' centre 2mm under the skin. Planning was done using sagittal and transverse T1-weighted images (GRE, FOV = 120mmX 120mmX48 mm, Voxel size = 0.5mm, slice thickness =2mm, TE/TR= 2.5/4.9ms, flip angle = 35°, acquisition matrix = 120 X 100, reconstruction matrix = 240, 2 NEX). Real-time estimation was done with T1-based water-proton resonance frequency technique using an in-house communication toolkit (matMRI) with thermal on a coronal plane (FOV=80mm, Voxel size = 1mm, slice thickness = 3mm, TE/TR= 16/23ms, flip angle = 19°, acquisition matrix = 68 X 63, reconstruction matrix = 80, ETL=9, 1 NEX). Three experimental groups were considered: moderate temperature (MT) (n=19); at 55°C, high temperature (HT) (n=18); at 65°C, and an untreated control (n=18). Efficacy was determined using plate counting of abscesses on day 1(n=29) or day 4(n=26). Neutrophil recruitment was determined using kinetic spectrophotometric analysis of myeloperoxidase (MPO). For each measure, a two-way ANOVA of log-transformed values was conducted, with post-hoc t-tests at the level of each group.

### Results

A significant reduction in bacterial load with respect to control occurred 4 days following HT treatment ( $p < .05$ ). In both HT ( $p < .003$ ) and MT ( $p < .05$ ) conditions, day four showed a significant reduction in bacterial concentration was over the concentration at day one. No significant reduction in bacterial load was observed for any treatment at day 1. Neutrophil recruitment was equivalent across all conditions and days.

### Discussion

The study indicates HT (65°C) ultrasonication of subcutaneous abscesses is capable of significantly reducing bacterial load four days post-treatment without significantly altering activity of the innate immune system from the elevation due to MRSA infection.

### Conclusion

MRgFUS provides a novel, effective method for treatment of MRSA abscesses without elevating innate immune response.

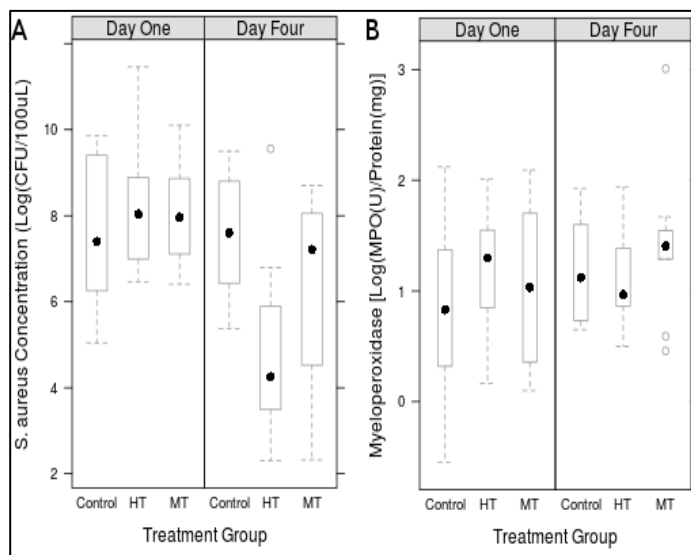


Figure 1. MRSA (A) and MPO (B) concentrations in MRgFUS-treated or control abscesses excised one to four days post-treatment.