The Effects of Pulse-Focused Ultrasound on the Injured Kidney

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BACKGROUND

- There is currently no treatment available for the reversal of Acute Kidney Injury (AKI) upon its presentation, yet AKI is often a precursor or exacerbator for the onset of chronic diseases such as Chronic Kidney Disease (CKD) or Diabetes.
- Current standard approach treatments for AKI are mostly homeostatically supportive by maintaining blood volume or balancing electrolyte concentrations via dialysis or intravenous fluid administration.
- Pulse Focused Ultrasound (pFUS) offers a novel, noninvasive solution to this disparity with fewer monetary or labor costs compared to other treatments.

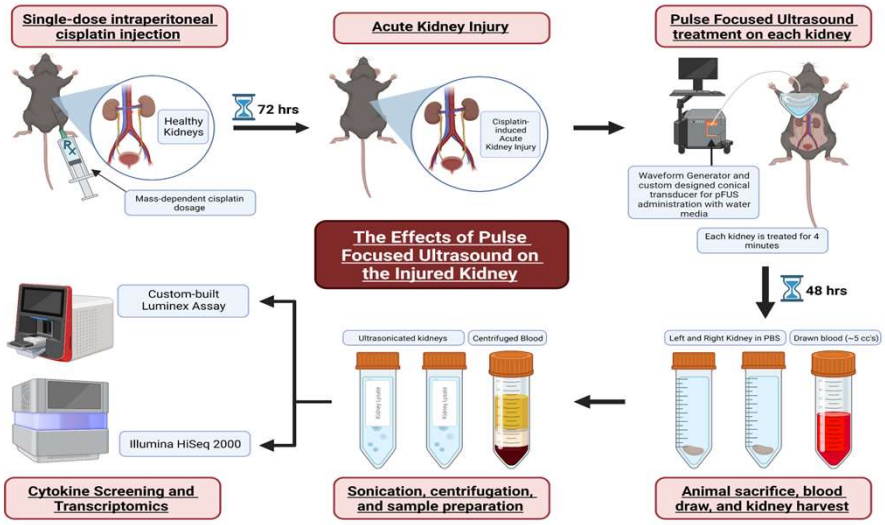
HYPOTHESIS

Our novel pFUS treatment is an efficient therapeutic capable of reversing AKI

MATERIALS & METHODS

- Isolate the therapeutic capacity of pFUS through a cisplatin-induced AKI experiment, with differential rest periods between AKI and pFUS treatment
- Use Custom-built Luminex Assay and Illumina HiSeq 2000 to measure the cellular response to pFUS via transcriptomics and proteomics

RESULTS



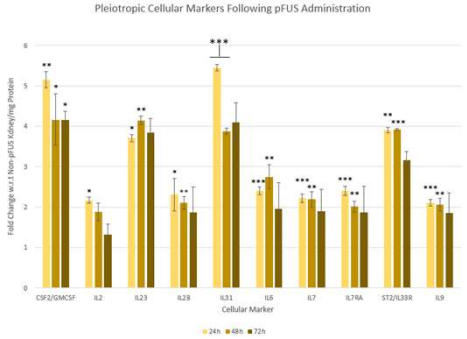


Fig. 1: Pleiotropic Cellular Markers Following pFUS Administration. Cellular Markers that could be anti or pro-inflammatory depending on cellular context were measured by ac custom-built Luminex screening assay.. Results are expressed as fold changes relative to healthy controls and are shown as normalized fold change ± SEM. *, p<0.05 vs. Healthy, Black6 mice. N=2 separate experiments, enclosures, and unpaired data. **, p<0.005 vs. Healthy, Black6 mice, same parameters. ***, p<0.0005 vs. Healthy, Black6 mice, same parameters.

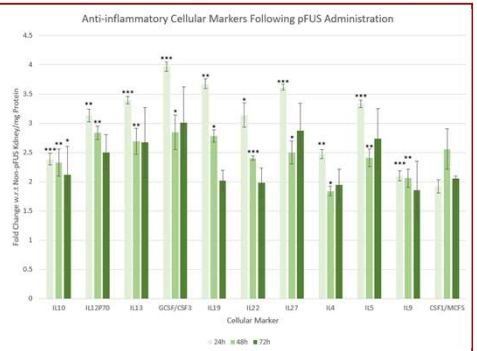


Fig. 2: Anti-inflammatory Cellular Markers Following pFUS Administration. Cellular markers known to be anti-inflammatory were measured by ac custom-built Luminex screening assay. Results are expressed as fold changes relative to healthy controls and are shown as normalized fold change ± SEM. *, p<0.05 vs. Healthy, Black6 mice. N=2 separate experiments, enclosures, and unpaired data. **, p<0.005 vs. Healthy, Black6 mice, same parameters. ***, p<0.0005 vs. Healthy, Black6 mice, same parameters

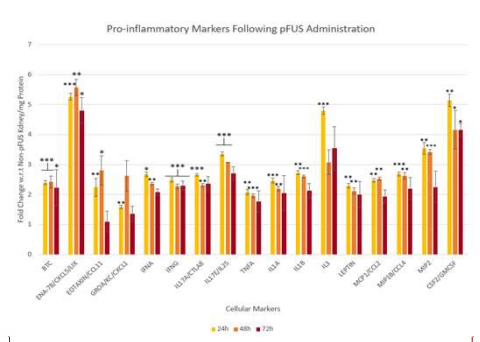


Fig. 3: Pro-inflammatory Cellular Markers Following pFUS Administration. Cellular markers known to be pro-inflammatory were measured by a custom-built Luminex screening assay. Results are expressed as fold changes relative to healthy controls and are shown as normalized fold change ± SEM. Significance was mapped through the same notation as prior figures.

CONCLUSIONS

- Our pFUS treatment is shown to visibly produce a healthier kidney following visual examination and proteomics assays.
- We validated our visual evaluations of the pFUS vs healthy kidneys with a Luminex protein screening assay that revealed a uniform multifold increase in cytokines and cellular homing factors. This suggests a therapeutic effect and a transient local increase in chemoattractants (i.e., cytokines) for the pFUS subjected organ.

Future directions

- Further measure efficacy following receipt of transcriptomics data
- Measure therapeutic effect with CKD model or comorbidity with diabetes model
- Widen applications with stem cell/ extracellular vesicle treatment in addition to pFUS

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