Purpose: To demonstrate the feasibility of thermoacoustic (TA) imaging to detect microvasculature surrounding tumors embedded 6+ centimeters deep.

Methods:
Ex vivo imaging of porcine kidneys in a custom TA testbed demonstrates 6cm depth penetration. Chilled glycine solution serves as acoustic couplant. Submicrosecond radiofrequency pulses with carrier frequency 108 MHz and peak power of 40kW generate TA pressures. Step-and-shoot volumetric scanning is performed by rotating and translating the kidney while the transducer remains stationary. Translation increment is 3.6mm between slices. Focused single-element videoscan transducers with center frequencies of 1 MHz and 2.25 MHz collect signals, which are amplified by a 54dB preamp. Lightly filtered single-slice sinograms are backprojected in-plane to reconstruct images.

TA signal generated by vials of blood product and pure anticoagulant are compared with TA signal from pure water. Vials are manually positioned, diminishing repeatability of these experiments, so multiple realizations of each are presented.

Results:
Reconstructions of the kidneys clearly track progression of calyces from one slice to the next. In vivo, calyces are filled with urine, which can have widely varying electrical conductivity. TA signal strength is directly proportional to electrical conductivity but is also a function of other tissue parameters: bulk modulus, thermal expansion coefficient, and specific heat capacity. In our testbed, the calyces fill with glycine, which has low conductivity, causing signal dropout in the calyces.

TA pressures generated by both blood product and pure anticoagulant generate orders of magnitude stronger signal than pure water.

Conclusions:
We demonstrate whole organ TA imaging is possible with 108 MHz RF irradiation. Furthermore, at 108 MHz, blood is highly conductive and generates strong signal, supporting the hypothesis that TA may be able to detect microvasculature surrounding aggressive tumors.

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