Title: Non-Contact Impedance Measurement to Assess Kidney Degradation in Real-Time

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Abstract
In the U.S., 117,919 people (27.8.2025) are on the waitlist for an organ transplant. Roughly 13 people die daily while waiting for a kidney. A major reason for the transplant shortage is that U.S. physicians easily reject possibly nonoptimal transplants. There is an official goal to reduce unused kidneys from 25% to 5%. We aim to develop a new, objective, non-contact real-time method to assess transplant degradation from procurement to transplantation to give physicians confidence to utilize the still usable borderline organs. Our intended medical device measures electrical properties of the tissue with essentially an electrical coil close to the organ (pat. pending). The measurement is based on the decreasing impedance of the degrading tissue. To the best of our knowledge, no comparable objective non-contact real-time measurement has been performed prior to our work. For proof-of-concept, six porcine kidneys for 1-72 h post-procurement were measured with our non-contact sensors along with clinically relevant reference measurements. The measurements included impedance measurements as well as lactate and adenosine triphosphate (ATP) measurements and histology. We noticed that the coil impedance depended highly on the frequency and temperature. However, at mid frequency range (kHz to MHz), coil impedance exhibited clear tissue aging effects. As expected, ATP dropped postmortem. No significant rise in the lactate levels was observed. With our sensors, we were able to successfully detect kidney tissue aging post-mortem.