# A0014 Intraoperative monitoring of tissue ischemia by fluorescence lifetime optical probe for laparoscopic urological surgery

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**Introduction & Objectives:** The mechanisms of the ischemic pathology are deeply connected with cell metabolism, ROS production and damaged mitochondrial function. The introduction of real-time feedback for surgeons and anesthesiologists about the cellular signs of ischemia may become a game-changing technology for organ-preserving surgery for renal tumours and transplantology. This work aimed to study how the tissue ischemia assessed by parameters of tissue autofluorescence can be monitored intraoperatively and used to optimise the operative procedure.

**Materials & Methods:** In this study, we used a bespoke multimodal measurement system for the intraoperative monitoring of the autofluorescence lifetime parameters. The system is built with the use of UV (375 nm) picosecond laser, sterilisable fibre optic probe, time-correlated single-photon counting (TCSPC) subsystem. The patients operated on for kidney tumours were split into two groups: control and patients administered with intravenous antihypoxic infusion of 15% sodium fumarate. During minimally invasive surgical interventions, the kidney artery occlusion with warm ischemia was used to minimise blood loss. By the system, the fluorescence lifetimes were monitored on the surface of renal parenchyma before and during occlusion was applied and for 20 minutes after the recovery of the blood supply to the kidney.

**Results:** The infusion of a 15% sodium fumarate solution caused a pronounced nephroprotective effect, expressed in a decrease in the level of neutrophil gelatinase-associated lipocalin (NGAL) protein in plasma. The measurements in the control group demonstrated reproducible statistically significant changes in the long fluorescence lifetime $\tau_2$. The parameter increased during ischemia and then plummeted during the reperfusion stage. With the measured lifetimes, we have estimated the corresponding changes in the cellular NADPH/NADH ratio in the area of interest. The population of short lifetime component $\alpha_1$, used as an assessment of NAD(P)H not bound to protein, also increased during ischemia and dropped when the occlusion was released. In the group of patients where 15% sodium fumarate was administrated prior to renal occlusion, no statistically significant changes in the mentioned parameters were observed. The results suggest that sodium fumarate assists in maintaining cellular energy production and antioxidant protection during both ischemia and reperfusion and has a pronounced nephroprotective effect in patients with organ-preserving interventions in conditions of warm ischemia.

**Conclusions:** The demonstrated sensitivity of the applied system to the tissue changes during ischemia and reperfusion stages suggests further development of the intraoperative fluorescence lifetime monitoring technique. Nevertheless, more clinical studies are necessary before the detailed application routines are shaped and the technique achieves widespread use.