A hyperspectral laparoscope for quantitative intraoperative visualisation of bowel oxygenation

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UNMET CLINICAL NEED

There is a need for new technologies to provide real-time label-free quantitative tissue oxygenation assessments intraoperatively.

Background

- Adequate blood supply is essential to avoid anastomotic leaks (AL), but borderline ischemia is often invisible during surgery,
- Recent RCTs show that **intraoperative perfusion assessment can reduce AL rates,** but current methods rely on fluorescent dyes and lack continuous, quantitative monitoring.
- **Hyperspectral imaging (HSI)** has the potential to address this clinical gap with **label-free, real-time and continuous assessment of superficial tissue oxygenation (StO_2),**

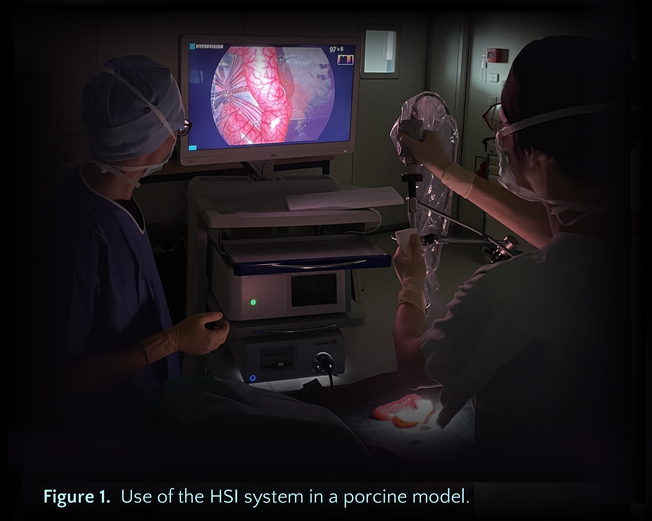


Figure 1. Use of the HSI system in a porcine model.

Methods

- A compact hand-held hyperspectral imaging (HSI) system (HYPERSNAP® Surgical System, Hypervision Surgical Ltd.) was evaluated in an *in vivo* porcine model (n=3).
- The system provides **high-resolution colour images and continuous quantitative StO_2 maps in real-time** via a 10mm laparoscope.
- Ischemic bowel segments were created by selective clamping of vessels, enabling the HSI system to image **healthy, transition, and ischemic zones (Figure 2)**.

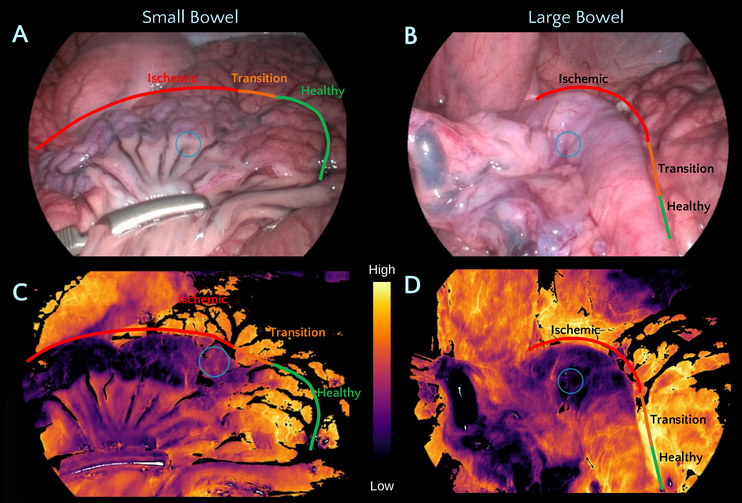


Figure 2. Colour image of A) small bowel and B) large bowel alongside StO_2 maps of C) small bowel and D) large bowel acquired with the HYPERSNAP® Surgical System. Clamped sections of the mesentery induced a hypoperfused area.

Results

- **The HSI system detected StO_2 drops** of 39–86 percentage points during bowel clamping, with measurements **aligning with healthy, transition, and ischemic zones (Figure 3)**.
- After release of clamping, a recovery with reperfusion of the target bowel segments was observed.

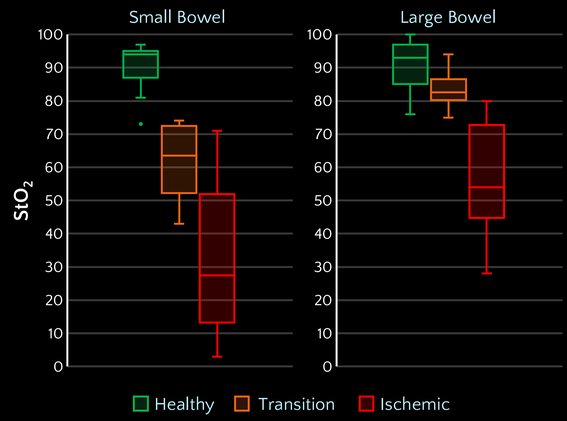


Figure 3. Superficial tissue oxygenation measurements made with the hyperspectral imaging system in healthy, transition and ischemic sections of A) small and B) large bowel. These labels were determined by the primary surgeon, based on the location of the clamped vessels.

- **The HSI system detected post-occlusive reactive hyperaemia (Figure 4)**, with previously hypo-perfused regions showing significantly higher StO_2 (86.0±2.9%; n=5) than non-clamped segments (71.6±4.4%; n=5; p=0.0003, t-test).

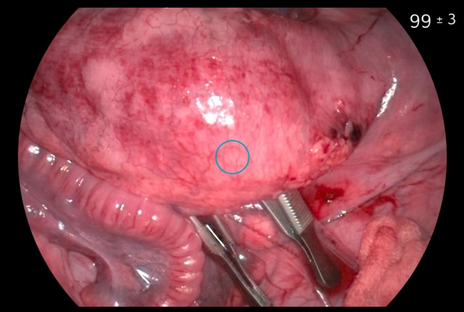


Figure 4. Reactive hyperaemia of the descending colon (StO_2 value of 99±3% within blue circle).

Conclusions

HSI has the potential to reduce post-operative ischemic complications by providing **label-free quantitative tissue oxygenation assessment at live video rate, anytime during surgery.** Successful preclinical *in vivo* validation on small and large bowel, lays the foundation for first-in-human trials.