Intraoperative hyperspectral imaging enables real-time quantitative visualisation of tissue oxygenation during surgery

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UNMET CLINICAL NEED

There is a need for new technologies to provide tissue oxygenation assessments intraoperatively without disruption of the surgical workflow.

Background

- **Inadequate tissue perfusion** can result in reduced viability, impaired healing, and ischemic injury.
- **Standard intraoperative color imaging techniques only provide limited visualization** of borderline ischemia, which can lead to postoperative complications, such as anastomotic leakage.



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

Methods

- **Hyperspectral imaging (HSI)** uses light split into >15 bands, collecting more comprehensive spectral information than standard color imaging.
- This spectral information enables calculation of the relative concentrations of oxy- and deoxy-hemoglobin, as validated in liquid tissue phantoms, thus enabling non-invasive **measurement of superficial tissue oxygenation.**
- A **compact hand-held minimally invasive HSI laparoscope** was developed (Hypersnap Surgical System) and assessed in a porcine model.
- Small bowel loops were externalised, and vessels of the mesentery clamped to create regions of ischemia **(Figures 1 and 2).**

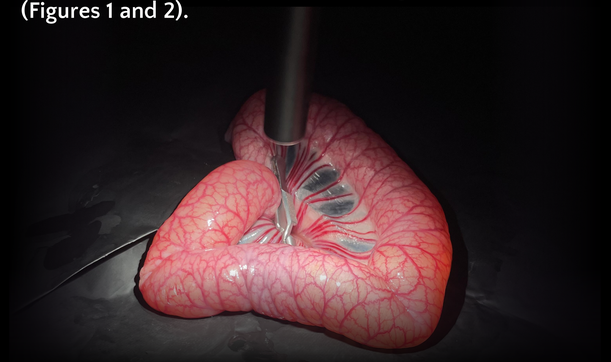


Figure 2. An externalised small bowel loop with a clamped section of the mesentery inducing a hypoperfused area.

Results

- **Dynamic HSI and color imaging** were **continuously accessible** in a side-by-side view **in real time.**

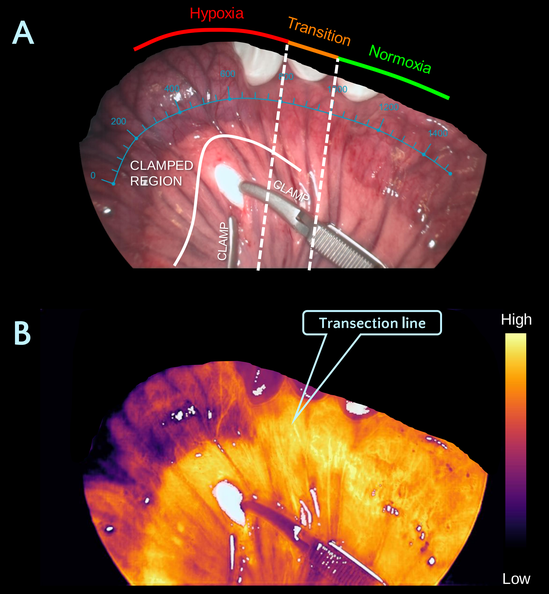


Figure 3. (A) Colour image of small bowel loop acquired with the Hypersnap Surgical System. The surgeon denotes normoxic, transition and ischemic zones with three fingers. **(B)** Corresponding StO_2 image.

- **Quantitative measurement of superficial tissue oxygenation** with HSI enabled discrimination between different states of perfusion in real time and without disruption of the surgical workflow.

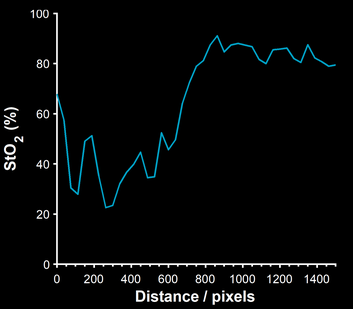


Figure 4. Quantitative tissue oxygenation along the length of the bowel loop (i.e., along the blue line in **Figure 3A**).

Conclusions

The validation of intraoperative optical tissue oxygenation measurements lays the foundation for **clinical studies using HSI guidance in minimally invasive surgery.** HSI has the potential to prevent complications by intraoperative recognition of critical perfusion levels.