Stomach and Small Bowel Disorders

*Novel/Experimental Endoscopy*

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**Introduction:** Defective intestinal barrier function and increased intestinal permeability (IP) are key features of prevalent GI conditions such as celiac disease, inflammatory bowel disease, and environmental enteric dysfunction and have been associated with systemic diseases including type 1 diabetes, autoimmune hepatitis, and systemic lupus erythematosus. The gold standard for assessing IP is the dual-sugar test that can have low specificity, provides no specific information on etiology, is challenging to implement when pristine urine samples cannot be collected (e.g. infants), and cannot account for spatially heterogeneous disease. We have developed a minimally invasive trans-nasal device that measures voltage locally across the intestinal wall (intestinal potential difference: IPD), which presumably is altered with changes in IP and/or intestinal ion channel function. Here, we report the first demonstration of the IPD probe in living swine.

**Material and Methods:** The IPD probe is a 1.2-mm-diameter device that can be introduced transnasally. The probe contains an electrode, a perfusion port, and an optical fiber. Fluid is injected via the port to provide ionic contact between the electrode and the intestinal mucosa. The optical fiber carries light to obtain non-scanning (M-mode) optical coherence tomography (OCT) images at the probe’s tip to determine when it is in contact with mucosa. A reference probe is inserted subcutaneously or implemented via a skin patch; the IPD is the voltage measured across the two. The probe is inserted into the duodenum using OCT image guidance to confirm anatomical placement. After probe situation in the duodenum, fluid is perfused via the port and the probe brought in contact with the mucosa as confirmed with OCT. IPD is then measured. To validate this probe, IPD was measured in 3 swine under baseline conditions (Ringers, 60 seconds) and after perfusion with an ion channel modulator (45 mM glucose, 60 seconds) (MGH IACUC# 2016N000215). 5 IPD values per swine were obtained, with each value determined by averaging filtered voltage traces (Savitzky-Golay, order 3) over 15 seconds with the probe in contact with the mucosa. While the device is designed for transnasal placement, in these initial experiments, it was endoscopically placed in the duodenum (Pentax EG2990K).

**Results:** The mean baseline IPD across the 3 swine was -13.1±2.8 mV, consistent with values reported in literature. The change in IPD with glucose perfusion was -10.5±2.4 mV (p<0.01), due to the glucose mediated active Na transport across mucosa.

**Conclusion:** Real-time IPD measurement of the duodenal mucosa in swine *in vivo* suggests useful applications of this device for localized real-time IP and/or intestinal ion channel function assessment in unsedated patients.
Fig. 1 (A) is the endoscopy image of the duodenum showing the IPD probe in the duodenum. The M-mode OCT image at the left top corner of the image shows increased signal intensity near the center depicting that the probe is in contact with mucosa while the plot on the right top corner shows a plot of the PD values. 1(B) shows the PD values with the probe in contact and not in contact with the mucosa. 1(C) shows a change in the IPD value after perfusion with 45 mM glucose solution showing an increase in the IPD value by as much as -10.5 mV.