VALIDATION OF NOVEL QUANTIFICATION FEATURE FOR REAL TIME TISSUE PERFUSION ASSESSMENT USING LASER SPECKLE CONTRAST IMAGING (LSCI) BY LASER DOPPLER IMAGING (LDI) IN A PORCINE MODEL

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OBJECTIVE

Tissue perfusion, as defined by blood flow and tissue oxygenation, is a critical determinant of clinical outcome.

LSCI displays real time tissue perfusion with increased spatiotemporal resolution but current colormaps of perfusion lack the objectivity of perfusion quantification. Additionally, LSCI validation to standard clinical benchmarks such as blood pressure and doppler technology has been limited.

We compare a novel LSCI-enabled tissue perfusion quantification feature to LDI in clinically relevant porcine gastric conduit and ileocolic anastomosis models.

We also report the physiological behavior of the ileocolic anastomosis to arterial occlusion.

METHODS

ActivSight™ is an FDA-cleared device that combines LSCI and ICG fluorescence imaging in a laparoscopic form factor.

LSCI displays tissue blood flow in color heatmap. A novel prototype feature can quantify LSCI perfusion in relative perfusion units (RPU) for a given tissue as a percentage relative to reference values of normally perfused/ischemic tissue.

Gastric conduit and ileocolic anastomosis were created in porcine models, and tissue perfusion was compared using both LSCI (ActivSight™) and LDI (Moor Technologies, Wilmington, DE)**(Figure 1A/1B/1C)**.

Perfusion at the ileocolic anastomosis was studied under conditions of arterial occlusion.

Normalized RPU's were calculated from the antimesenteric-mesenteric gradient of the ileocolic anastomosis using perfusion heatmaps generated by LSCI and LDI.

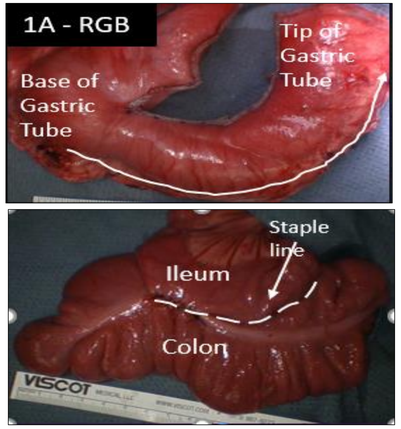


Figure **1A** : RGB image of Gastric Tube (GT) with blood supplied from right gastroepiploic artery only (*top*), Stapled Ileocolic (IC) anastomosis along antimesenteric border (*bottom*).

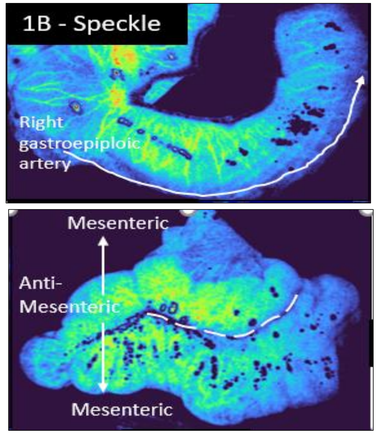


Figure **1B** : Laser Speckle Perfusion Colormap of GT (*top*) + IC anastomosis(*bottom*)

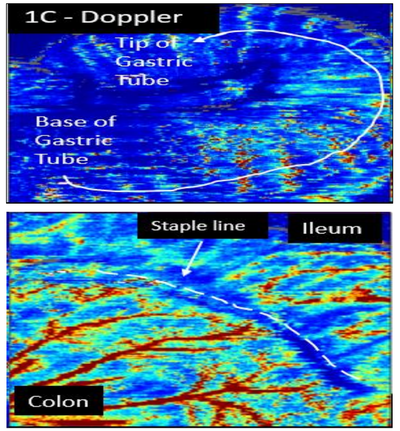
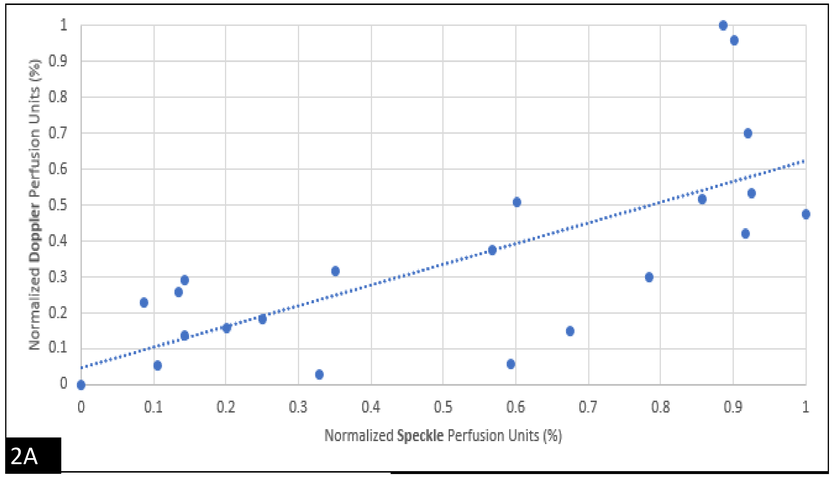


Figure **1C :** Laser Doppler Perfusion Colormap of GT (*top*) + IC anastomosis(*bottom*).



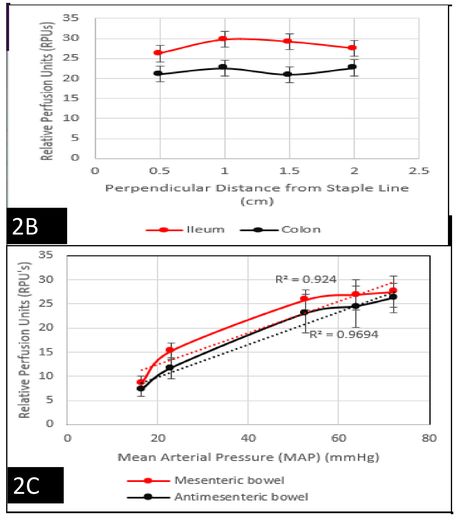


Figure 2A. Correlation between Laser Speckle and Laser Doppler Perfusion Units along Gastric Tube model. X axis shows the normalized speckle perfusion units as a %. Y axis shows the normalized laser doppler perfusion units as a %. **2B.** Relationship of the ileum and the colonic side of the anastomosis in the control setting. X axis shows the perpendicular distance in cm from the staple line outward. Y axis shows the relative perfusion units (RPUs). **2C.** Relationship of mesenteric and antimesenteric bowel RPU's with MAP changes caused by progressive proximal aortic occlusion. X axis shows MAP (mm Hg) and Y axis shows Mean relative perfusion units (RPUs).

RESULTS

LSCI perfusion metrics showed strong correlation (Spearman coefficient 0.76) to that of laser doppler in the gastric conduit model **(Figure 2A)**.

In the ileocolic anastomosis model, LSCI revealed increased perfusion to the ileal side of the anastomosis relative to the colonic side ($p<0.05$) **(Figure 2B).**

With progressive aortic occlusion, both mesenteric and antimesenteric regions of the anastomosis demonstrated corresponding reduction in mean RPU's-with a strong positive linear correlation with MAP (R2 = 0.92/0.96 respectively).

Perfusion measurements on the antimesenteric bowel were significantly lower than corresponding regions on the mesenteric bowel ($p<0.05$) **(Figure 2C).**

CONCLUSION

LSCI technology provides real-time ability to measure tissue perfusion and correlates strongly to perfusion measured by LDI.

LSCI detected significantly lower perfusion at the anastomosis staple line made conventionally along the antimesenteric border compared to mesenteric bowel, especially with physiologic arterial occlusion.

This prototype perfusion quantification feature promises potential clinical utility for more **standardized** and **objective r**eal time perfusion assessment of gastrointestinal anastomoses.