

What Surgeons Miss in Perfusion-Ischemia Assessment of White Light Imaging: A Novel Color Gradient Technique

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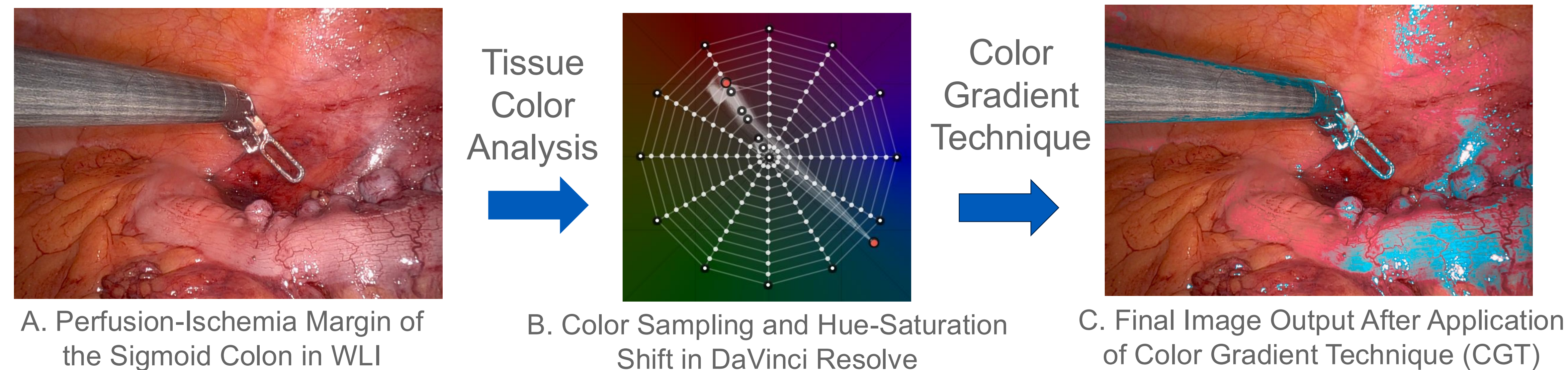
Objective of the Technology

- Accurate detection of the perfusion-ischemia margin (PIM) in white light imaging (WLI) relies on subjective surgeon visual perception of subtle red and blue hue differences in oxygenated and de-oxygenated tissue
- We hypothesize that Color Gradient Technique (CGT) enhancement of naturally occurring color differences in WLI can detect and display the PIM signal-to-background ratio (SBR) comparable to ICG-NIRF in left-sided colorectal surgery

Description of the Technology

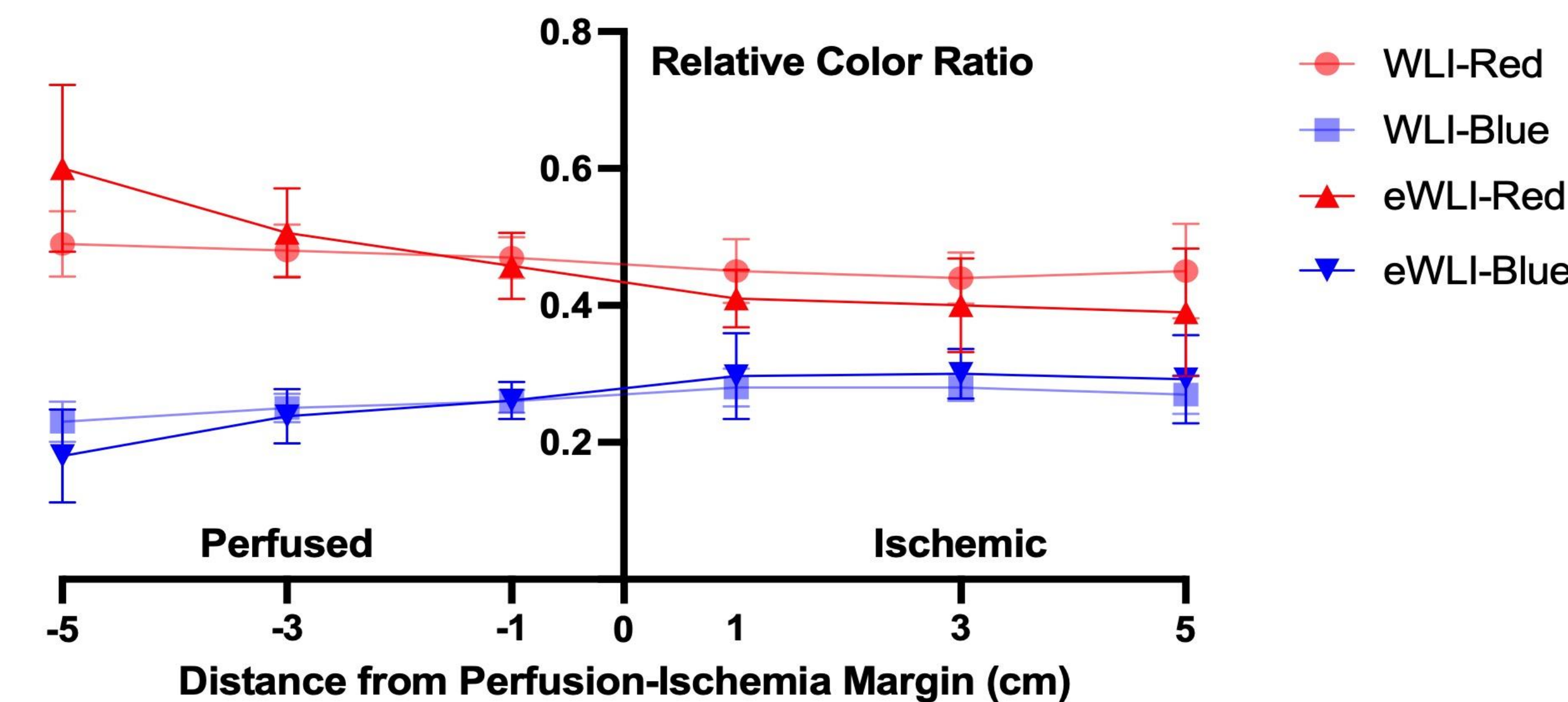
- Robotic and laparoscopic assisted sigmoidectomy and lower anterior resection surgical videos were prospectively collected from September 2025 to February 2026 (n=15)
- Intra-operatively surgeons were instructed to identify the colonic PIM after devascularization in WLI and ICG-NIRF modalities
- Pixel-level color differences between perfused and ischemic colon were quantified in ImageJ
- We generated color enhanced WLI (e-WLI) using a three-step technique in DaVinci Resolve (*Blackmagic Designs*): (1) white balance, (2) increased contrast magnitude, and most importantly (3) hue-saturation shift to accentuate the naturally occurring color difference
- We quantitatively analyzed the visual impact of e-WLI by measuring red and blue color intensity and calculating the ischemic (signal) to perfused (background) ratio difference

Methodology Overview



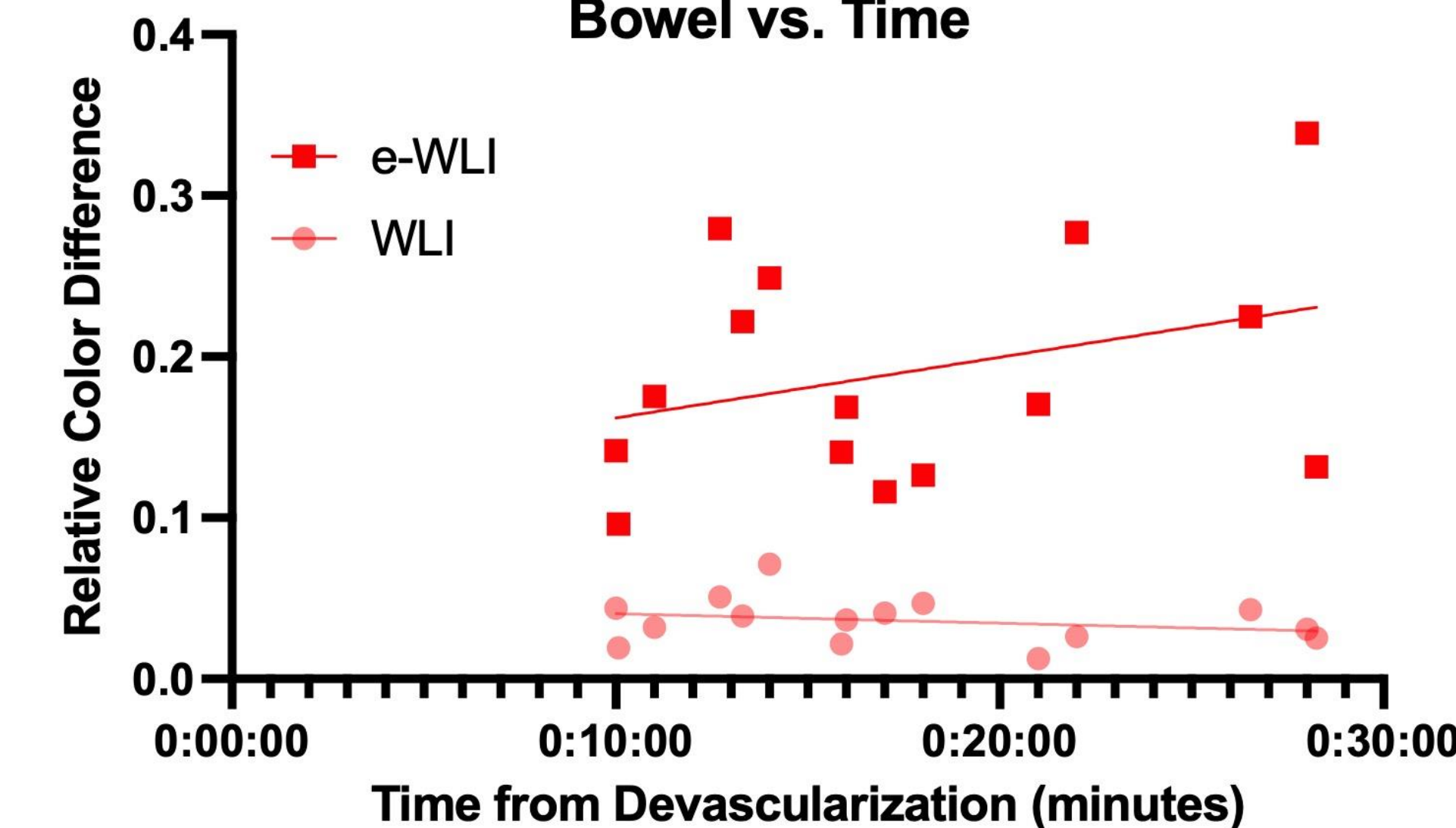
Results

A. e-WLI vs. WLI Relative Color Ratio over Distance from Perfusion Ischemic Margin (PIM)

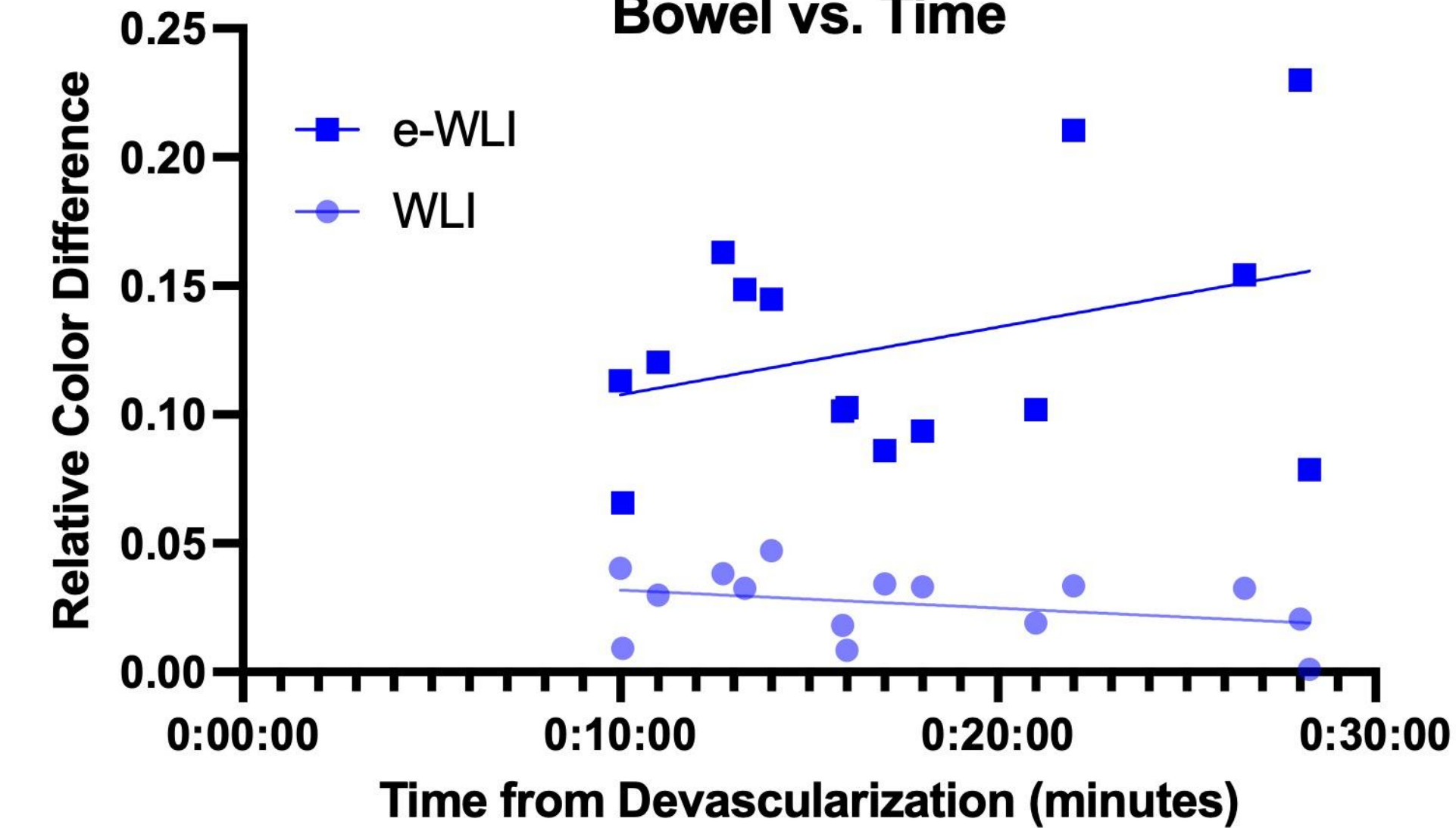


- Panel A demonstrates the change in relative color composition of perfused and ischemic bowel over distance in WLI and e-WLI
- Panels B and C demonstrate the consistent superior color enhancement of e-WLI compared to WLI at various timepoints of PIM assessment after devascularization

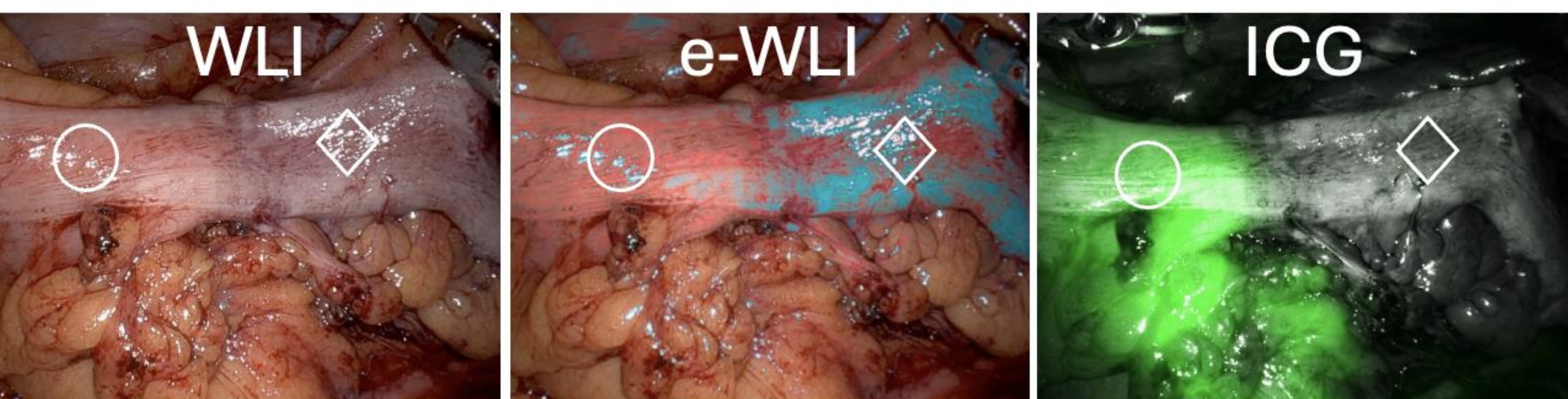
B. Red Color Difference in Ischemic to Perfused Bowel vs. Time



C. Blue Color Difference in Ischemic to Perfused Bowel vs. Time



Signal-To-Background Ratio Improvement



◇ **Signal: Ischemic** ○ **Background: Perfused**

Imaging Modality	Signal to Background Difference (Δ SBR)	p-Value
White Light Imaging (WLI)	0.41 +/- 0.27	-
Enhanced WLI (e-WLI)	1.45 +/- 0.95	p < 0.001 vs. WLI
Indocyanine Green (ICG)	2.46 +/- 1.38	p < 0.001 vs. WLI p = 0.10 vs. e-WLI

Conclusions

- Detectable baseline color differences exist between perfused and ischemic colon in white light imaging (WLI) however their interpretation is hindered by a limited SBR difference
- We demonstrate the development of a novel CGT e-WLI capable of enhancing the perfusion-ischemia margin signal to background ratio 3.5-fold greater than baseline WLI (p < 0.01) and comparable to ICG-NIRF (p = 0.10)
- The visually perceptible CGT differences are validated by the consistent color enhancement over WLI across both distance from the PIM and time after devascularization