Opinion
Volume 21:05, 2025

Journal of Surgery

ISSN: 1584-9341

Open Access

NIRS: Objective Bowel Viability Monitoring for Surgical Outcomes

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Introduction

Assessing bowel viability during surgical procedures is critical to prevent complications such as anastomotic leaks and the need for unnecessary bowel resections. Traditional methods often rely on subjective visual inspection, which can be unreliable and lead to suboptimal surgical decisions. Intraoperative oxygen saturation monitoring, particularly through near-infrared spectroscopy (NIRS), has emerged as a promising non-invasive technique to provide objective data on tissue oxygenation, offering a more precise evaluation of bowel health and thus improving patient outcomes [1].

The integration of multiple technologies for intraoperative assessment is a growing trend, aiming to provide a more comprehensive understanding of tissue perfusion. While oxygen saturation metrics offer insights into oxygen availability, techniques like laser Doppler flowmetry (LDF) provide complementary information on microvascular blood flow. This combined approach refines the assessment of bowel viability by reflecting both oxygen supply and actual tissue perfusion, aiding in the objective evaluation of potentially ischemic segments [2].

Tissue oximetry, specifically utilizing NIRS, demonstrates significant potential in predicting anastomotic complications. By quantifying oxygen saturation within the bowel wall during surgery, clinicians can proactively identify areas at heightened risk. This allows for timely intervention and the implementation of preventive strategies, which can lead to improved patient outcomes and a reduction in the healthcare costs associated with managing postoperative complications [3].

A critical aspect of bowel viability assessment involves examining the correlation between the oxygen saturation of the mesentery and the gastrointestinal tract itself. Higher mesenteric oxygen saturation levels are indicative of an adequate blood supply to the bowel, suggesting its viability. Conversely, lower saturation levels may signal compromised blood flow, prompting closer inspection and potentially necessary interventions to restore perfusion [4].

The evolution of techniques for assessing bowel viability is marked by a discernible shift towards non-invasive, real-time methods. Intraoperative oxygen saturation monitoring, facilitated by NIRS, represents a significant advancement over traditional subjective assessments. It provides objective and reproducible data that can directly guide surgical decision-making, thereby enhancing the reliability of viability assessments [5].

Prospective studies have investigated the specific utility of NIRS in identifying compromised bowel segments during major abdominal surgeries. These investigations consistently suggest that reduced oxygen saturation values measured by NIRS are significantly associated with adverse postoperative outcomes. This finding strongly supports its role as a valuable predictive tool for assessing bowel viability [6].

The diagnostic accuracy of intraoperative oxygen saturation monitoring in detecting intestinal ischemia is an active area of research. Studies are focused on establishing precise threshold values for oxygen saturation that accurately predict bowel viability. The goal is to minimize the risk of unrecognized ischemic injury, which can have severe consequences for patients [7].

Advanced optical technologies, including NIRS, are increasingly being explored for real-time tissue assessment in gastrointestinal surgery. The continuous monitoring of oxygen saturation provided by these technologies offers dynamic insights into bowel perfusion. This real-time data empowers surgeons to make informed interventions, thereby optimizing patient outcomes [8].

A multicenter trial was conducted to validate the use of intraoperative NIRS in predicting bowel viability across various surgical settings. The results from this trial demonstrated a significant correlation between higher intraoperative oxygen saturation levels and favorable anastomotic outcomes. This validation underscores the technique's potential for widespread clinical adoption and its reliability in diverse surgical environments [9].

Integrated physiological monitoring, which combines multiple parameters such as oxygen saturation and lactate levels, offers a more robust approach to assessing bowel viability. By considering a range of physiological indicators, this integrated strategy aims to provide a more accurate and comprehensive evaluation of tissue perfusion and metabolic status, leading to more informed surgical decisions [10].

Description

Intraoperative oxygen saturation monitoring, particularly through near-infrared spectroscopy (NIRS), offers a promising non-invasive method for assessing bowel viability. This technique provides real-time data, allowing surgeons to make informed decisions during procedures, which can correlate with improved tissue oxygenation and predict favorable bowel outcomes, potentially reducing complications like anastomotic leaks and unnecessary bowel resections [1].

The integration of intraoperative laser Doppler flowmetry (LDF) alongside oxygen saturation metrics provides complementary information on microvascular perfusion, further refining the assessment of bowel viability. While oxygen saturation indicates oxygen availability, LDF reflects actual blood flow, offering a more comprehensive picture of tissue health and aiding in the objective evaluation of ischemic segments [2].

Tissue oximetry, specifically using NIRS, highlights the potential to predict anastomotic complications. By measuring oxygen saturation in the bowel wall during

surgery, clinicians can identify at-risk areas and potentially implement preventive strategies, leading to improved patient outcomes and reduced healthcare costs associated with managing complications [3].

Examining the correlation between intraoperative oxygen saturation of the mesentery and the gastrointestinal tract is crucial. Higher mesenteric oxygen saturation may indicate adequate blood supply to the bowel, suggesting viability. Conversely, lower levels could signal compromise, prompting closer inspection and potential intervention [4].

This review discusses the evolution of techniques for assessing bowel viability, with a growing emphasis on non-invasive, real-time methods. Intraoperative oxygen saturation, through NIRS, is presented as a key advancement over traditional subjective assessments, offering objective and reproducible data to guide surgical decisions [5].

A prospective study investigating the utility of NIRS in identifying compromised bowel segments during major abdominal surgery found that reduced oxygen saturation values are significantly associated with adverse outcomes, supporting its role as a predictive tool for bowel viability [6].

This research evaluates the sensitivity and specificity of intraoperative oxygen saturation monitoring in detecting intestinal ischemia. The study aims to establish optimal threshold values for oxygen saturation that accurately predict bowel viability, thereby reducing the risk of unrecognized ischemic injury [7].

Exploring the application of advanced optical technologies, including NIRS, for real-time tissue assessment in gastrointestinal surgery is ongoing. The paper discusses how continuous monitoring of oxygen saturation can provide dynamic insights into bowel perfusion and guide surgical interventions to optimize outcomes [8].

A multicenter trial aimed to validate the use of intraoperative NIRS in predicting bowel viability across diverse surgical settings. The results demonstrate a significant correlation between higher oxygen saturation levels and favorable anastomotic outcomes, underscoring the technique's potential for widespread clinical adoption [9].

Investigating the combined utility of different physiological parameters, including oxygen saturation and lactate levels, in assessing bowel viability suggests that integrating multiple metrics can provide a more robust and accurate assessment of tissue perfusion and metabolic status [10].

Conclusion

Intraoperative oxygen saturation monitoring using techniques like near-infrared spectroscopy (NIRS) offers a non-invasive, objective method for assessing bowel viability, potentially reducing complications and unnecessary resections. Complementary methods such as laser Doppler flowmetry can provide a more comprehensive assessment of tissue perfusion. NIRS has shown promise in predicting anastomotic complications by identifying at-risk bowel segments, leading to improved patient outcomes. Monitoring mesenteric and gastrointestinal oxygen saturation can indicate adequate blood supply, while lower levels suggest compromise. NIRS represents a significant advancement over traditional subjective assessments, providing real-time, objective data for surgical decision-making. Studies confirm that reduced oxygen saturation is linked to adverse outcomes, supporting its predictive role. Research is ongoing to establish optimal thresholds for oxygen saturation to accurately detect intestinal ischemia. Advanced optical technologies like NIRS provide dynamic insights into bowel perfusion, guiding surgical interventions. Multicenter validations support NIRS's potential for widespread clinical adoption due to its correlation with favorable anastomotic outcomes. Integrated physiological monitoring, combining oxygen saturation with other metrics like lactate, offers a more robust assessment of tissue perfusion and metabolic status.

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Chakraborty, Rina. "NIRS: Objective Bowel Viability Monitoring for Surgical Outcomes." *J Surg* 21 (2025):225.

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Received: 01-Sep-2025, Manuscript No. jos-26-185176; **Editor assigned:** 03-Sep-2025, PreQC No. P-185176; **Reviewed:** 17-Sep-2025, QC No. Q-185176; **Revised:** 22-Sep-2025, Manuscript No. R-185176; **Published:** 29-Sep-2025, DOI: DOI: 10.37421/1584-9341.2024.20.225