

HIGH-FiO₂ ADMINISTRATION REDUCES SURGICAL SITE INFECTIONS IN EMERGENCY APPENDECTOMY: A RANDOMIZED CONTROLLED STUDY

General surgery

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ABSTRACT

Background: Surgical site infections (SSIs) are among the most common postoperative complications in emergency abdominal surgery, contributing to prolonged hospital stay, increased healthcare costs, and morbidity. Oxygen plays a crucial role in wound healing and bacterial killing by neutrophils. This study aims to evaluate the effect of perioperative hyperoxygenation on reducing SSIs in patients undergoing surgery for acute appendicitis. **Methods:** A prospective randomized study was conducted in the Department of General Surgery at Sri Siddhartha Medical College, Tumkur, between March 2023 and August 2024. A total of 155 patients diagnosed with acute appendicitis and undergoing open appendectomy were included. Patients were divided into two groups: Group A (control, n=80) received 30% inspired oxygen intraoperatively, and Group B (study, n=75) received 80% inspired oxygen during induction, maintenance, and the first six postoperative hours. Postoperative wound evaluation was performed using the CDC criteria for SSI on postoperative days 3, 5, and 7, and during follow-up at 1 month. **Results:** The incidence of SSI was 10% in the control group and 4% in the hyperoxygenation group. The mean postoperative hospital stay was 6.7 days in the control group compared to 5.2 days in the study group. These findings demonstrate that perioperative hyperoxygenation significantly reduces the rate of SSIs and the duration of hospital stay among patients with acute appendicitis. **Conclusion:** Perioperative administration of high inspired oxygen concentration (80%) reduces surgical site infections and hospital stay in patients undergoing surgery for acute appendicitis. This simple, low-cost intervention can be integrated into standard perioperative protocols to improve postoperative outcomes.

KEYWORDS

Hyperoxygenation, Surgical site infection, Appendicitis, Wound healing, Postoperative care

INTRODUCTION

Surgical site infections (SSIs) continue to represent one of the most frequent and costly postoperative complications worldwide, accounting for nearly 20% of all healthcare-associated infections. The incidence of SSI varies from 2% to 20% depending on the surgical type, duration, and patient comorbidities. In developing countries, the burden is even greater due to limited resources, delayed presentation, and variability in perioperative care. Acute appendicitis remains one of the most common emergency surgical conditions, and though appendectomy is a routine procedure, it carries a significant risk of SSI, especially in perforated or gangrenous cases.

Adequate tissue oxygenation is a key determinant of surgical wound healing. Oxygen facilitates collagen synthesis, angiogenesis, and fibroblast proliferation-essential components of tissue repair. Moreover, neutrophil-mediated bacterial killing relies on oxygen-dependent oxidative mechanisms, particularly the production of reactive oxygen species (ROS). Insufficient oxygen delivery to the wound impairs these processes, increasing the likelihood of infection and delayed healing.

Perioperative hyperoxygenation-administering high inspired oxygen concentration (FiO₂ 80%) during surgery and early postoperative period-has emerged as a simple, cost-effective adjunct to reduce SSI risk. Multiple studies, including randomized controlled trials, have demonstrated that higher perioperative oxygen tension enhances wound perfusion and lowers infection rates in colorectal and abdominal surgeries. However, the practice remains debated due to concerns about potential oxidative tissue injury and lack of universal protocol.

Given these uncertainties, this study was undertaken to assess the impact of perioperative hyperoxygenation on SSI rates and postoperative outcomes in patients undergoing open appendectomy for acute appendicitis. We hypothesized that maintaining high inspired oxygen concentration during and after surgery would reduce SSI incidence and shorten hospital stay.

MATERIALS AND METHODS

This prospective randomized controlled trial was conducted in the Department of General Surgery, Sri Siddhartha Medical College, Tumkur, from March 2023 to August 2024 after obtaining institutional ethical committee approval. Informed written consent was obtained from all participants. A total of 155 patients diagnosed clinically and radiologically with acute appendicitis and undergoing open appendectomy were enrolled.

Patients were randomly assigned to two groups using a computer-generated randomization sequence:

Group A (Control, n=80): Received standard anesthesia with 30% inspired oxygen concentration.

Group B (Hyperoxygenation, n=75): Received 80% inspired oxygen during induction, maintenance, and up to six hours postoperatively via face mask.

All patients underwent open appendectomy under general anesthesia. Standard perioperative antibiotic prophylaxis with intravenous ceftriaxone and metronidazole was administered 30 minutes before incision. Operative findings were documented, and appendectomy was performed via a right lower quadrant incision. Peritoneal lavage was done where indicated, and skin closure was performed with nylon interrupted sutures.

Intraoperative monitoring included pulse oximetry, ECG, and non-invasive blood pressure. Postoperative monitoring comprised wound inspection on days 3, 5, and 7, and at follow-up visits after two weeks and one month. SSI was defined according to the Centers for Disease Control and Prevention (CDC) criteria as infection occurring within 30 days of surgery involving skin, subcutaneous tissue, or deeper structures.

Data were recorded on patient demographics, intraoperative findings, duration of hospital stay, and incidence of SSI. Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean $\pm$ standard deviation and compared using the Student's t-test, while categorical data were compared using the chi-square test. A p-value < 0.05 was considered statistically significant.

Inclusion Criteria

- Patients aged 18–60 years
- Diagnosed with acute appendicitis and undergoing open appendectomy
- ASA Grade I and II patients
- Patients providing informed consent

Exclusion Criteria

- Patients with diabetes mellitus, COPD, or ischemic heart disease
- Immunocompromised patients
- Patients on long-term corticosteroids
- Pregnant women
- Patients requiring laparoscopic appendectomy

Follow-up

Patients were monitored daily for the first seven postoperative days and assessed for wound erythema, discharge, or dehiscence. Subsequent follow-up visits were conducted at 2 weeks and 1 month postoperatively. Surgical site infections were classified according to the Centers for Disease Control and Prevention (CDC) criteria into superficial, deep, or organ-space infections.

RESULTS

The study included 155 patients, with 80 in the control group and 75 in the hyperoxygenation group. The overall demographic characteristics, such as age and sex distribution, were comparable between groups. The incidence of SSI was significantly lower in the hyperoxygenation group (4%) than in the control group (10%). The mean hospital stay was also shorter in the hyperoxygenation group (5.2 days) compared to the control group (6.7 days).

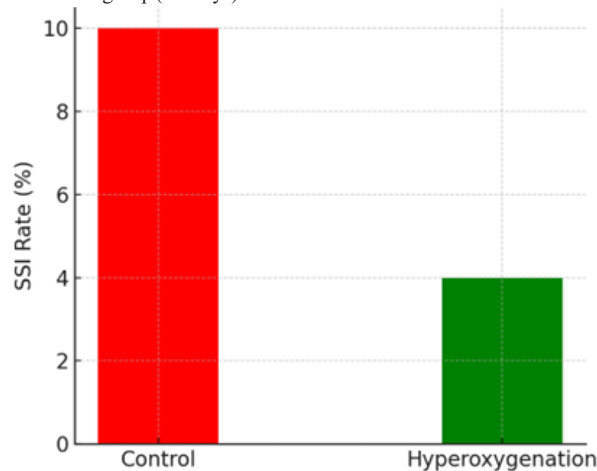


Figure 1. Comparison of surgical site infection (SSI) rates between the control and hyperoxygenation groups.

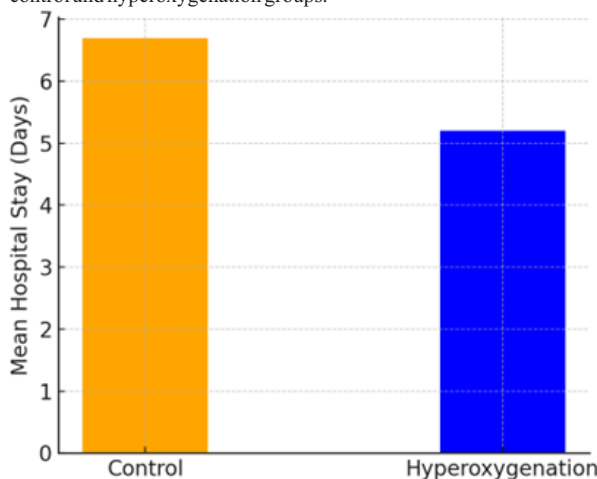


Figure 2. Comparison of mean hospital stay between the control and hyperoxygenation groups.

DISCUSSION

The present study demonstrates that perioperative hyperoxygenation significantly decreases the rate of SSI and shortens hospital stay in patients undergoing open appendectomy for acute appendicitis. The SSI rate reduced from 10% in the control group to 4% in the hyperoxygenation group, and mean hospital stay decreased by approximately 1.5 days. These findings highlight the beneficial effect of maintaining high tissue oxygen tension during the perioperative period.

Oxygen plays a crucial role in multiple cellular mechanisms that facilitate wound healing. Adequate oxygen supply enhances fibroblast proliferation, collagen deposition, and angiogenesis. More importantly, neutrophils require oxygen for oxidative killing of bacteria via the production of superoxide radicals and hydrogen peroxide. Hypoxic tissues, conversely, exhibit reduced bactericidal efficiency, favoring infection. Thus, maintaining sufficient oxygen

tension during and after surgery is critical in contaminated abdominal surgeries such as appendectomy.

Our findings are consistent with previous literature. Belda et al. (2021) reported a significant reduction in SSI rates with 80% FiO₂ compared to 30% in colorectal surgery patients. Hovaguimian et al. (2020), in a meta-analysis of 30 randomized controlled trials, found that supplemental oxygen lowered SSI risk without causing pulmonary complications. Similarly, Schietroma et al. (2022) demonstrated improved tissue oxygenation and fewer SSIs in abdominal surgery patients receiving 80% oxygen intraoperatively.

While hyperoxygenation offers substantial benefits, potential concerns include oxidative stress and absorption atelectasis. However, these risks are minimal when exposure duration is short, as in this study, and outweighed by infection prevention benefits. The intervention is simple, non-invasive, and cost-effective, requiring no additional equipment beyond standard anesthesia delivery systems.

Limitations of our study include a modest sample size, single-center design, and limited follow-up period. Moreover, wound cultures were not routinely obtained, and oxygenation parameters such as PaO₂ were not directly measured. Future multicenter studies with larger cohorts and longer follow-up are warranted to establish standardized guidelines for perioperative hyperoxygenation use.

Despite these limitations, our results strongly suggest that administering high inspired oxygen concentration (80%) during the perioperative period can serve as a valuable adjunct to conventional SSI prevention strategies. Incorporating this protocol into standard perioperative care could significantly enhance postoperative recovery and reduce healthcare costs.

High inspired oxygen levels enhance oxidative killing by neutrophils, improve fibroblast function, and promote angiogenesis, all of which are essential for tissue repair. In our study, the SSI rate dropped from 10% in the control group to 4% in the hyperoxygenation group. These findings support incorporating perioperative hyperoxygenation into surgical protocols, especially for contaminated or clean-contaminated cases.

Several recent studies have supported the use of perioperative hyperoxygenation. Belda et al. (2021) reported a reduction in SSIs from 11% to 5% with 80% FiO₂ in colorectal surgery. Similarly, Hovaguimian et al. (2020) conducted a meta-analysis confirming the benefit of higher oxygen concentration in reducing SSI incidence without major adverse effects. While our study was limited to appendectomy cases, the results reinforce the potential of this approach in general abdominal surgery.

Limitations of this study include its single-center design and relatively small sample size. The follow-up period of one month may not capture late-onset wound infections. Nonetheless, the study provides strong preliminary evidence supporting the routine use of hyperoxygenation during the perioperative period.

CONCLUSION

Perioperative hyperoxygenation at 80% inspired oxygen concentration is an effective, safe, and economical method to reduce postoperative SSIs and hospital stay in patients with acute appendicitis. Integrating this practice into standard anesthesia protocols could lead to improved outcomes in emergency abdominal surgeries.

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