

CORRELATION OF FRACTION OF INSPIRED OXYGEN IN THE INTRAOPERATIVE AND IMMEDIATE POSTOPERATIVE PERIODS WITH THE LOWEST INCIDENCE OF SURGICAL SITE INFECTION: A SYSTEMATIC REVIEW OF THE LITERATURE

CORRELAÇÃO DA FRAÇÃO INSPIRADA DE OXIGÊNIO NO INTRAOPERATÓRIO E PÓS-OPERATÓRIO IMEDIATO COM A MENOR INCIDÊNCIA DE INFECÇÃO DO SÍTIO CIRÚRGICO: UMA REVISÃO SISTEMÁTICA DA LITERATURA

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ABSTRACT

Objectives: Identify the optimal fraction of inspired oxygen (FiO₂) administered in the intraoperative and postoperative periods to reduce the incidence of surgical site infection (SSI). **Methods:** A systematic review was performed in LILACS, PUBMED, and SCIELO databases to answer the guiding question: correlation of FiO₂ in the intraoperative and immediate postoperative periods with the lowest incidence of SSI. **Results:** Three of the six studies included did not prove a relevant improvement in SSI after use of high FiO₂. However, three studies showed a lower incidence of SSI in patients who received high FiO₂ in the intraoperative and postoperative periods. **Conclusion:** A high FiO₂ administered in the intraoperative and postoperative periods was positively correlated with a lower incidence of SSI. However, further research is needed considering the limited number of studies available, the heterogeneity of study populations, and the variety of surgical procedures.

Keywords: Oxygen therapy; Surgical site infection; Intraoperative; FiO₂; Postoperative

RESUMO

Objetivos: Identificar nos artigos revisados a FiO₂ no intraoperatório e pós-operatório ideal para reduzir a incidência de ISC. **Métodos:** Desenvolveu-se uma revisão sistemática da literatura, com busca nas bases de dados: LILACS, PUBMED e SCIELO para responder a seguinte questão norteadora: Correlação da FiO₂ no intraoperatório e pós-operatório imediato com a menor incidência de ISC. **Resultados:** Na avaliação dos 6 artigos estudados, 3 não comprovaram relevante melhoria na ISC após a utilização de altas FiO₂. Porém, 3 estudos evidenciaram menor incidência desta infecção nos pacientes que receberam altas concentração de oxigênio suplementar no intraoperatório e pós-operatório. **Conclusão:** Existe correlação entre o aumento da FiO₂ no intraoperatório e pós-operatório com a menor incidência de ISC. Entretanto, diante da pequena quantidade de estudos disponíveis na literatura, da heterogeneidade das populações e dos procedimentos cirúrgicos conclui-se que são necessárias mais pesquisas.

Palavras-chave: Oxigenoterapia; Infecção de sítio cirúrgico; Intraoperatório; Fração inspirada de oxigênio; Pós-operatório

INTRODUCTION

Surgical site infection (SSI) is caused by surgical incisions or tissue spaces penetrated during or after surgery. This complication may be caused by several factors, increasing hospital length of stay and treatment costs^{1,2}. SSI is the most prevalent among those related to health care and can be prevented. In addition, 14% to 16% of these infections occur in hospitalized patients³.

The administration of high oxygen levels in the perioperative and postoperative periods is associated with a decreased incidence of SSI. Oxygen is a protective factor against pathogens due to the oxidative destruction caused by neutrophils in a mechanism dependent on the partial pressure of tissue oxygen¹.

In 2016, the World Health Organization recommended that all intubated patients receive an oxygen concentration of 80% of the fraction of inspired oxygen (FiO₂) during surgery and the first six hours of the immediate postoperative period. This recommendation sparked debate, and some studies have suggested that a high FiO₂ concentration may increase the risk of adverse effects⁴.

The FiO₂ set at 80% may cause atelectasis, systemic vasoconstriction, pulmonary inflammation. Additionally, free radicals generated by oxygen may oxidize proteins, DNA, or lipids, resulting in cellular oxidative stress⁴.

Thus, the optimal FiO₂ in the intraoperative and immediate postoperative period to prevent SSI without increasing the adverse effects remains under debate. Additionally, few studies on this topic investigated the prevention of surgical complications. This systematic review aimed to identify the optimal intraoperative and postoperative FiO₂ levels to minimize surgical site complications without harming the patient.

METHODS

This systematic review was performed using Latin American and Caribbean Literature in Health Sciences (LILACS), US National Library of Medicine/National Institute of Health (PubMed), and Scientific Electronic Library Online (SciELO) databases to answer the guiding question: correlation of FiO₂ in the intraoperative and immediate postoperative periods with the lowest incidence of SSI.

The study adopted the following inclusion

criteria: (a) articles, dissertations, or theses; (b) free available and full text (original, review, experience report, update, or case study); (c) studies that addressed specific mathematics on FiO₂ with the lowest incidence of SSI; (d) published between 2007 and 2018; and (e) studies available in Portuguese, English, or Spanish. The exclusion criteria encompassed (a) texts that did not answer the guiding question of the research, and (b) duplicates in more than one database⁵. The search terms “oxygen therapy”, “surgical site infection”, “intraoperative”, “FiO₂”, and “postoperative” were used in combination using the Boolean operator AND.

The research was performed by three researchers who independently selected and screened eligible studies. In PubMed, the search terms “oxygen therapy”, “surgical site infection”, and “intraoperative” were used; 11 studies were found, and after reading, 1 was suitable for the review. Using the keywords “oxygen therapy”, “surgical site infection”, and “postoperative”, 27 studies were found, and 4 were suitable for the study. In LILACS, the search terms “FiO₂” and “surgical site” were used; two studies were found, and one was suitable for the study. The search in SciELO did not return results for any of the search terms. The search in SciELO did not return results for any of the search terms.

RESULTS

Given the findings, one study is from 2007, two from 2013, one from 2014, one from 2015, one from 2016, and one from 2018.

Morkane et al. (2018) conducted a retrospective observational study with 378 patients from 29 hospitals with a mean age of 66. The FiO₂ used intraoperatively ranged from 25% to 100%. The results showed that postoperative complications may increase depending on the dose of hyperoxia, potentially increasing morbidity and mortality. Despite the limitations, an FiO₂ of 50% was recognized as the standard used by anesthesiologists in the United Kingdom⁴.

Williams et al. (2013) conducted a randomized controlled study with 160 women. In this study, the correlation between SSI and cesarean sections was assessed based on FiO₂ (30% to 80%) during surgery and two hours after labor. Twenty-two cases of SSI were identified (13.8%). The following covariates were analyzed: ethnicity, marital status, body mass index, maternal parity, and operation

time. The infection rate was associated with three covariates (ethnicity, body mass index, and operation time). FiO_2 did not show any interdependence with the incidence of SSI².

Mejia J et al. (2007) performed a meta-analysis correlating SSI, admission to intensive care unit, mortality, hospital length of stay, first oral food intake in the postoperative period, and time to suture removal. This study found no correlation between FiO_2 and the reduction of SSI in patients who underwent elective abdominal surgery¹.

Schietroma et al. (2016) conducted a prospective randomized study with 81 patients who underwent elective open infraperitoneal surgery for colorectal cancer. An oxygen or air mixture with an FiO_2 of 30% (n = 41) or 80% (n = 40) was administered to the patients and was maintained from the induction of anesthesia until six hours after surgery. Among the patients who received FiO_2 of 30%, 11 (26.8%) had a wound infection, compared with 6 (15%) who received 80%. Thus, FiO_2 80% decreased the risk of SSI by 41% compared with FiO_2 30%, a factor related to the lower incidence of SSI. In addition, the increased FiO_2 reduced the hospital length of stay and the probability of mortality⁶.

Schietroma et al. (2014) conducted a prospective randomized study that correlated FiO_2 perioperative with SSI after surgery for acute sigmoid diverticulitis. They evaluated 85 patients perioperatively; 43 received FiO_2 at 30% and 42 received FiO_2 at 80%. The mean duration of surgery was 195 and 200 minutes for patients who received FiO_2 30% and 80%, respectively. Of the total, 14 patients who received FiO_2 at 30% had SSI, compared with 7 who received FiO_2 at 80%. Thus, the incidence of SSI was lower in patients who received FiO_2 at 80% than in those who received FiO_2 at 30% ($p < 0.05$). The risk of SSI was 43% lower in the group receiving FiO_2 80% (relative risk of 0.68 with 95% confidence interval [0.35 to 0.88])⁷.

Stall et al. (2013) presented a study on oxygen supplementation regarding SSI after open bone fracture fixation. This study evaluated 217 patients, in which one group received FiO_2 at 80% and another FiO_2 at 30% throughout the intraoperative period until two hours postoperatively. The incidence of SSI was 12% in the group that received FiO_2 80% and 16% ($p = 0.31$) in the FiO_2 30% group. High FiO_2 levels showed a correlation with reduced SSI in patients undergoing bone fracture correction surgery.⁸

Table 1. Characteristics of patients in the literature

Author Year	Sample size	Evaluation of the Studied Procedure	p Value	Conclusion
Morkane <i>et al.</i> 2018	378	Intraoperative oxygenation in adult patients undergoing surgery (IOPS): a retrospective observational study across 29 United Kingdom hospitals	0.001	A FiO_2 50% currently represents standard intraoperative practice in the United Kingdom
Williams <i>et al.</i> 2013	339	Randomized controlled trial of the effect of 30% versus 80% fraction of inspired oxygen on cesarean section surgical site infection	0.82	FiO_2 did not show any interdependence with the incidence of SSI
Donado <i>et al.</i> 2007	989	Supplemental oxygen and perioperative surgical site infection: meta-analysis of controlled clinical trials	0.58	High FiO_2 in the management of elective abdominal surgery patients does not reduce SSI
Schietroma <i>et al.</i> 2016	85	High-concentration supplemental perioperative oxygen and surgical site infection following elective colorectal surgery for rectal cancer: a prospective, randomized, double-blind, controlled, single-site trial	< 0.05	FiO_2 of 80% during and after open surgery for acute sigmoid diverticulitis reduces postoperative SSI

DISCUSSION

SSI is a serious surgical complication, as it increases the hospital length of stay. Improving perioperative conditions in the first hours of bacterial contamination is essential to prevent SSI. In this period, tissue oxygen is usually low, which reduces the response to oxidative recovery of neutrophils and decreases collagen formation, neovascularization, and epithelialization. Therefore, a high FiO_2 may reduce the incidence of SSI⁵.

The serious consequences imposed on patients who develop SSI require efforts to create strategies to prevent this infection. One strategy employed is the identification of risk factors, which enables the detection of situations or clinical conditions that predispose patients to SSI development. In this sense, identifying risk factors contributes to adopting interventions that aim to minimize complications⁸.

Therefore, studies were analyzed to correlate the FiO_2 in the intraoperative and immediate postoperative periods with the lowest incidence of SSI. The results showed that few studies investigated the benefits and limitations of protecting the FiO_2 in preventing SSI. Also, the included studies presented heterogeneity in the study populations, different diseases, and surgical procedures.

The results suggest a lack of studies that conclude a correlation between FiO_2 and lower SSI incidence. The literature is heterogeneous, thus presenting different variables that hinder comparisons. However, three of the six studies evaluated did not prove a relevant improvement in SSI after high use of FiO_2 .

The retrospective and observational study by Morkane et al. (2018) found that administering FiO_2 at 80% perioperatively and postoperatively did not achieve a significant change in the prevention of SSI compared with the standard fraction of FiO_2 at 30%⁴. This finding corroborates with the Williams et al. (2013), a randomized clinical trial that concluded no difference in the incidence of SSI in FiO_2 80% and 30%².

In contrast, Schietroma et al. (2014) demonstrated, in a prospective and randomized study, that an FiO_2 of 80% reduced the incidence of SSI in the postoperative period of elective colorectal surgery for rectal cancer⁶. The same author (prospective and randomized study conducted in 2016) also concluded

that SSI was reduced with FiO_2 at 80% in surgery for acute sigmoid diverticulitis⁷. Corroborating with Stall et al. (2013), which found that using high FiO_2 during the perioperative period was safe and tended to reduce SSI in surgeries to fix severe trauma in fractures of the lower extremities⁸.

CONCLUSION

A positive correlation was found between the increased FiO_2 intraoperative and postoperative and a lower incidence of SSI. However, further research is needed, given the limited number of studies, the heterogeneity of the study populations, and the diverse surgical procedures.

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