Does supplemental perioperative oxygen administration reduce the incidence of wound infection in elective colorectal surgery?

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Aim. An association has been proposed between perioperative administration of 80% oxygen and a lower incidence of wound infection after colorectal surgery. The present study was conducted to assess this hypothesis.

Methods. Thirty-eight patients (ASA classification 1 and 2) undergoing elective colorectal cancer surgery were allocated at random to 2 groups. Group 1 consisted of 19 patients who received an admixture of 80% oxygen and 20% nitrogen during anesthesia through an orotracheal tube and during the 2 first hours in the recovery room through a tight facemask with reservoir. Group 2 consisted of 19 patients who received an admixture of 70% nitrous oxide and 30% oxygen during anesthesia, followed by administration of 30% oxygen delivered by a blender through a tight facemask with reservoir in the same manner than group 1, during the first 2 hours in the recovery room. Wound infection was evaluated daily during hospital stay and after 7 days, 2 weeks, and 1 month.

Results. The incidence of wound infection was 12.5% in group 1 and 17.6% in group 2 (p=0.53).

Conclusion. The results of this study showed no reduction in the incidence of wound infection following elective colorectal surgery in patients receiving 80% oxygen during the perioperative period.

Key words: Wound infection - Colon, surgery - Rectum, surgery - Perioperative period - Oxygen.

Wound infection is a serious complication of surgical procedures and is associated with longer hospital stays, higher costs and increased morbidity and mortality.1, 2 Most case of wound infections following abdominal surgery involves colorectal operations.3 Since surgical site infection increases mortality and morbidity rates and clearly affects the clinical outcome of elective surgery,4 all potentially beneficial measures should be assessed in an effort to prevent this serious complication.

The perioperative administration of high concentrations of oxygen has been reported to reduce wound infection rates following colorectal surgery.5 The aim of this study was to reassess the hypothesis that perioperative administration of high concentration of oxygen decreases the incidence of wound infection after elective colorectal surgery.
Materials and methods

The study of approved by the Soroka Medical Center ethics committee.

Informed consent was obtained from all participants after they received a full explanation of the aims of the study during a visit at the preoperative clinic. All patients scheduled to undergo elective colorectal surgery for malignant disease from January 2001 to January 2002 were offered to participate in the study.

Patients with ASA classification 3 and 4, morbid obesity, body mass index (BMI) ≥35, diabetes mellitus, chronic obstructive pulmonary disease, serious malnutrition (serum albumin concentration below 3.3 g/dL, leukocytes count less than 2500/mL, or a loss of 20% or more of body weight), and preoperative immunosuppressive therapy were excluded.

Among 64 patients fulfilling the study criteria, 38 patients agreed to participate in the study and were allocated at random into 2 groups by lottery of closed envelopes.

Group 1 consisted of 19 patients who received an admixture of 80% oxygen and 20% nitrogen during anesthesia through an orotracheal tube and during the 2 first hours in the recovery room through a tight face-mask with reservoir.

Group 2 consisted of 19 patients who received an admixture of 70% nitrous oxide and 30% oxygen during anesthesia, followed by administration of 30% oxygen delivered by a blender (Bird Air-Oxygen Blender, Bird Products Corporation, Palm Springs, CA 92202) through a tight facemask with reservoir in the same manner than group 1 during the first 2 hours in the recovery room.

Extubation was performed, in all patients, at the end of surgery, while still lying down on the operating table.

All patients underwent the same bowel preparation on the day before surgery with intraluminal antibiotics (vancomycin and erythromycin) and bowel cleaning with a standard electrolyte solution.

Prophylactic antibiotic therapy consisted of ampicillin 2 g, garamicin 240 mg, and metronidazole 500 mg administered intra-venously 1 hour before the estimated time of skin incision.

Midazolam 2 mg and fentanyl 0.2 mg were administered intravenously, followed by a slow pentothal injection until the eyelash reflex disappeared. Isoflurane was used for maintenance and its concentration and fentanyl additional doses were adjusted according to the clinical judgment of the attending anesthesiologist. Vecuronium, used for facilitation of tracheal intubation and for intraoperative muscle relaxation, was administered according to train-of-four monitoring.

All patients received 15 mL/kg/h of a crystalloid solution (normal saline or ringer lactate) according to the anesthesiologist’s preference during surgery and blood loss was replaced at a 3:1 ratio of the same solution.

Postoperative fluid management was standardized and all participants received 30 mL/kg/day of a glucose-free crystalloid solution over the first 48 hours following surgery. Adjustments of fluid administration were made, as required, to maintain blood pressure and pulse rate according to the clinical judgment of the attending surgeon, and to keep hourly urinary output in the 0.5 to 1 mL/kg/h range.

The sutures were closed in a standard manner, deep layers with continuous sutures of PDS and polyglycolic acid and skin with DG* APPOSE* ULC staplers.

Postoperative analgesia was provided with PCA adjusted to maintain a VAS ≤4.

The patients were warmed during surgery and in the recovery room by a forced-air cover and warmed fluids, in order to keep body temperature ≥35.5 °C.

During the postoperative period the patients were examined daily by a surgeon who was not a study investigator and was not aware of the patient's group assignment.

Blood replacement was given according to a local protocol in order to achieve hemoglobin level above 10 g% in patients with ischemic heart disease, and 8 g% in patients without coronary disease using leukocytes-free blood only.

All patients were re-evaluated in the ambulatory clinic 7 days, 2 weeks, and 1 month
after discharge from the hospital by a surgeon not involved in the study.

Wound infection was defined as the appearance of erythema with local pain and drainage of fluid or purulent secretion.6

Statistical analyses were conducted with Student’s t test for comparison of continuous variables such as age, BMI, and duration of surgery. The Fisher’s exact test was used to compare discrete variables such as site of surgery, gender distribution, and incidence of wound infection. A p value ≤0.05 was considered significant.

Results

The mean age of patients in group 1 and 2 was 67±10 years (range 49 to 92 years) and 69±9 years (range from 45 to 88 years) respectively (p≥0.05).

The gender distribution was similar with a male/female ratio of 10: 9 in group 1 and 12: 7 in group 2 (p=0.371).

There was no statistically significant difference on BMI between the 2 groups: 25±4 (range 22 to 30) in group 1 and 27±5 in group 2 (range from 21 to 33) (p=0.25).

Eight patients from group 1 and 7 from group 2 underwent right hemicolectomy (p=0.535). Six patients from each group were submitted to left hemicolectomy (p=0.629), in 3 patients from group 1 and 4 from group 2, surgery performed was low anterior resection (p=0.526), and in 2 from each group was abdominal perineal resection (p=0.697).

The duration of surgery was similar among the 2 groups, being 140±40 min in group 1 (ranging from 80 to 210 min) compared to 135±40 min (with a range from 90 to 205 min) in group 2 (p=0.3).

Wound infection was observed in 2 patients of group 1 and among 3 in group 2 (p=0.523). Similarly, other 2 patients in group 1 and 3 in group 2 had anastomotic leaks (p=0.523).

Blood transfusions were not required in the perioperative period among the patients enrolled in the study.

The majority of patients who developed wound infection did so during their hospital stay, but in 1 patient of group 1 the wound infection was detected 15 days after surgery at the postoperative visit to the ambulatory surgery clinic.

Discussion

Surgical site infections are the most common nosocomial infection in surgical patients, accounting for 38% of all such complications.7 They increase morbidity and mortality rates, prolong hospital stay and increase the cost of care.8

The incidence of wound infection after colorectal surgery is one of the highest,9 if not the highest,10 seen in surgical patients. This complication increases the cost of medical care by $ 2 000/case,11 representing an important source of non-budgeted expenses. Thus, much effort has been invested to identify patients at risk and to prevent surgical wound infection after colorectal surgery by the use of prophylactic measures.

Many risks factors have been linked to surgical site infection after colorectal surgery. Ford et al. found an increased incidence of postoperative wound infection associated with the postoperative administration of packed red blood cells.12 However, Vamvakas, in a recent meta-analysis, was unable to detect any influence of blood transfusion on the incidence of wound infection.13 In this regard it should be noted that no patient in the present study received blood transfusions.

Some reports have related intraoperative hypothermia to surgical site infection following colorectal surgery.14, 15 but others have not succeeded in demonstrating this association.16 Despite the lack of clear-cut evidence, we maintained the core temperature of all study patients above 35.5 °C at all times during the operation and the immediate postoperative period.

Because we wanted to assess the effect of perioperative oxygen administration on the incidence of wound infection after colorectal surgery, we excluded all patients considered to already be at risk for surgical site infection. Morbid obesity (BMI ≥35 kg/m²) and chronic obstructive pulmonary disease are
considered independent predictors of the development of wound infection after coronary artery bypass surgery. Although these risk factors have not been confirmed in colorectal surgery, we decided to exclude patients suffering from these conditions because of the theoretical possibility that patients with chronic hypoxemia are more likely to develop postoperative wound infection.

Diabetes mellitus is widely accepted as an important risk factor for surgical site infection, therefore, we excluded patients with either type I or type II diabetes mellitus. Unlike Greif et al., we were unable to demonstrate any beneficial effect of high oxygen concentration administration during the perioperative period on the incidence of wound infections. The 2 studies are different in many respects. We tried to isolate most of the well-recognized risk factors for surgical wound infection, while Greif considered infection, minor procedures, bowel obstruction and malnutrition as exclusion criteria. Our patients underwent mechanical bowel preparation before surgery with intraluminal neomycin and erythromycin and received perioperative prophylactic antibiotic therapy. In Greif’s study bowel preparation was performed without intraluminal antibiotics.

In our protocol, nitrous oxide was used in the control group, during maintenance of anesthesia. In Greif’s research an admixture of oxygen and nitrogen was used after induction. However, exposure to nitrous oxide in clinically used concentrations does not affect immunologic response in surgical patients.

Oxygen was delivered in the recovery room through a tight facemask with multiple one-way flaps on the mask vent ports to allow release of air during exhalation, and closing during inspiration, avoiding room air mixing. A one way valve is placed between the mask and the reservoir bag to prevent exhaled air to enter the bag. The range of oxygen delivered by this device is 90% to 100% at a flow of 10 L/min.

Since there is no standardization of the definition of wound infection, we arbitrarily chose Cole’s definition for diagnosis of this complication.

The incidence of wound infection in the present study is nearly twice than the observed in Greif’s article. We don’t have a good explanation for this difference. However, since the Soroka Medical Center is a training hospital the operations are very often performed by residents. It was previously reported an association between surgical site infection and the individual surgeon. Kingston et al. showed that the incidence of surgical wound infection decreases as the surgeon seniority increases.

All the patients involved in our study underwent surgery due to malignant disease, and cancer is recognized as one of the causes of impediment to wound healing.

The major drawback of our study is the sample size. While Greif’s study included 500 patients we enrolled only 38. The differences between the 2 groups in the present study did not approach statistical significance. However, a type II error cannot be excluded.

In conclusion, perioperative administration of high concentration of oxygen seems not decrease per se the incidence of wound infection. New studies should be conducted to further clarify this issue.

Riassunto

Negli interventi coloretali elettivi la somministrazione supplementare di ossigeno nel periodo perioperatorio può ridurre l’incidenza di infezione della ferita?

Obiettivo. È stata proposta un’associazione tra la somministrazione perioperatoria di ossigeno all’80% e una minore incidenza di infezione della ferita dopo intervento chirurgico colorettale. Questo studio è stato eseguito per valutare tale ipotesi.

Metodi. Trentotto pazienti (stadio I e II secondo la classificazione ASA) che dovevano sottoporsi a intervento chirurgico elettivo per cancro del colon-retto sono stati divisi casualmente in 2 gruppi. Il gruppo 1 era composto da 19 pazienti ai quali era stata somministrata una miscela di ossigeno all’80% e azoto al 20% durante l’anestesia tramite un tubo orotracheale e la stessa miscela era stata somministrata tramite mascherina facciale rigida con reservoir durante le prime 2 ore nella terapia intensiva. Il gruppo 2 consisteva di 19 pazienti a cui era stata somministrata durante l’anestesia una miscela composta al 70% da protossido d’azoto e al 30% di ossigeno, seguita dalla somministrazione del 30% e raggiunto tramite un miscelatore collegato ad una mascherina faccia
Ossigeno.

Parole chiave: Infezioni della ferita chirurgica - Colon, chirurgia - Retto, chirurgia - Periodo perioperatorio - Ossigeno.

References


