To evaluate the role of high concentration oxygen therapy in preventing surgical site Infection: a prospective comparative study

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Abstract

Background: Oxygen therapy has important role in perioperative care. During bacterial infection, neutrophils act as the main defense by oxidative killing of the micro-organisms which require molecular oxygen. This study was planned in order to observe whether increased concentration of perioperative oxygen therapy would result in reduction of surgical site infection or not.

Methods: A total of 60 adult patients undergoing emergency laparotomy were included in the study. They were divided into two groups(n=30), one groups received80% supplemental inspired oxygen, the other groups received no supplemental oxygen after the surgery. Both the groups were compared postoperatively in regards to wound infection, wound dehiscence, burst abdomen, sepsis, ICU stay and mortality. Chi- square test and Means were used for statistical analysis.

Results: Both the groups were comparable in terms of demographic data. There was no significant difference in the two groups in terms of postoperative complications and mortality(p value >0.05).

Conclusions: Supplemental oxygen does not prevent or reduce the incidence of SSIs post-surgically.

Keywords: SSI, oxygen, infection, surgery.

Introduction

Despite the advances in medical field in terms of surgical technique, equipment's and sterilization,surgical site infection (SSI) is still among the most common health care associated infections contributing about 17% of all hospital acquired infections(1). It contributes to significant patient morbidity and mortality(2).

The term Surgical site infection was coined in 1992 and led to replacement of the term surgical wound infection. The most accepted definition of SSI is, "all infections that occur within 30 days from the date of surgical procedure or within one year in case if an implant has been placed and affecting the incision of the deep tissue at the site of operation (3,4). They are also defined as infections anatomically associated with a surgical procedure performed in an operating room and not present prior to the operation. Wound site infection rate is much more in emergency operative procedures than elective surgeries.

The cause of SSI is multifactorial depending on the overall well-being of the patient, including nutritional, immunological, hemodynamic status, appropriate prophylactic antibiotics, and fair operative technique. Additional factors that may influence SSI include operative time, core body temperature, blood transfusions in proximity to surgery, postoperative pain, and tissue oxidative tension.

The use of high fractions of oxygen in SSI has always been a topic of discussion. The factors favoring the use of high concentration oxygen to reduce SSI is usually based on two notions. The first concept is based upon the assumption that surgical incision might not be adequately perfused, and high concentration of oxygen might be beneficial in improving oxygenation of compromised tissue. Low oxygen tension also reduces induction of collagen formation, neovascularization and epithelialization. Second notion is that overall host defense systems might be further improved by higher oxygen partial pressures, particularly by enhancing neutrophil oxidative killing(5).

Neutrophils are the first inflammatory leukocytes infiltrating into wounds where they play important role in protecting wound tissue from various pathogens. The most important mechanism by which neutrophils destroy invading pathogen is through generation of antimicrobial oxidant species, such as hypochlorous acid (HOCl), which is dependent on the availability of oxygen (6). Thus, oxidative killing by neutrophils isthe primary defense against surgical pathogens and is the function of tissue oxygen partial pressure. Therefore, interventions that increase tissue oxygen may reduce infection risk.

Optimization of tissue oxygen can be done by administering high concentration of oxygen perioperatively. However, whether the use of high concentration of oxygen can reduce the incidence of SSI is still controversial. Two relatively large randomized trials (7,8)showed that increased oxygen concentration may decrease the SSI risk but a large latest metanalysis didn't find any benefit in terms of decrease in SSI, hospital stay and mortality.(9)

In light of already work done, this study was planned in order to observe whether increased concentration of perioperative oxygen therapy would result in reduction of surgical site infection or not in our setup.

Material and methods:-

This comparative prospective study was conducted in the Department of GeneralSurgeryafter approval from institutional ethical committee at tertiary care hospital from March 2020 to September 2021. The informed consent was taken from all patients.

Study Population included patients above 18 years of age of either genderundergoing exploratory laparotomy in emergency and maintaining arterial haemoglobin oxygen saturation ≥ 94% post operatively on room air.Patients with preoperative arterial hemoglobin oxygen saturation below 90% without supplemental oxygen as assessed by pulse oximetry, diabetics, immunocompromised,with chronic obstructive pulmonary disease, SBP< 90mmHg and BMI ≥ 30 were excluded from the study.

Keeping in view the availability and feasibility of participants, a non- random convenient sampling technique was adopted. So, consecutively a total of 60 patients were considered for the study. A computer-generated random table was used for the allocation of participants in 2 groups. All the patients undergo emergency laparotomy under standard general anaesthesia using 40% oxygen intraoperatively and received antibiotics within an hour before the surgical incision.

Sixty patients were divided into groups A and B. Group A included 30 patients who were given 80% oxygen and the group B included 30 patients, who were not given any supplemental oxygen and werekept on room air postoperatively for 2 hours.

All the patients were put on antibiotics (Inj. Piperacillin and tazobactam 1.5 gm 8 hourly along with ofloxacin and ornidazole 100ml 12 hourly) postoperatively. In both groups FiO_2 was increased if hypoxia was detected or suspected to ensure arterial saturation (SpO_2) more than 94%.

Both the groups were followed up for surgical site infection and other postoperative complications till 30 days.

After completion of the study, the results were compiled and statistically analyzed. The person involved in the analysis of the data so collected was unaware of the group allocation. Blinding was open at the end of the study. Data was entered in MS Excel and analysis was done using SPSS 26.0 version statistical program for Microsoft Windows. Continuous variables were presented as mean & standard deviation (SD) while categorical variables were presented as percent. The quantitative variables were compared using the unpaired student t- test. To compare paired quantitative variables paired t- test was done. The categorical data were compared using the Chi-square test. P value of <0.05 was considered statistically significant and <0.001 as highly significant.

Results

A total of 60 adult patients undergoing emergency laparotomy were included in the study.Both the groups were comparable in terms of demographic variables (table 1).

Variables	**GroupA(n =30)**	**GroupB(n=30)**	**P value**
Age	49±16.23	47± 7.833	0.55
Gender(male/	24:6	22:8	0.196

female)			
BMI	25.06±2.04	25.06±1.85	0.987
ASA GRADE (I/II)	17/13	19/11	0.598
Duration of surgery in minutes	93.16±6.70	92.20±5.62	0.517

Table 1- Demographic variables

Indication of laparotomy	**Group A**	**Group B**
Intestinal perforation	**14**	**17**
Intestinal obstruction	**16**	**13**
Total	**30**	**30**

Table 2- Indication of laparotomy in both the groups

Postoperative complications as encountered in both groups are tabulated in table 3.In the present study, wound infection was observed in 12(40%) patients in group A and 13(43%) patients in group B(p-value was 0.793). Wound dehiscence was observed in 10(33%) patients in group A and in 11(37%) patients in the group B. (p- value - 0.0787).

We observed that 5(17%) patients in group A while 8(27%) patients in group B were found to have burst abdomen. Various stoma related complications like stoma prolapse, retraction and peristomal skin excoriation were studied in both the groups. Stoma related complications in group A were seen in 8(27%) patients and in 9(30%) patients in group B (p-value 0.053). Sepsis was seen in 4(13%) patients in group A as compared to 5(17%) patients in group B (p- value 0.718). In the present study, 6(20%) patients in group A and 8(27%) patients in group B were admitted to ICU postoperatively. (p-value 0.542)

In our study we observed other complications like abdominal abscess, pleural effusion and metabolic complications in both the groups. In group A, 1(3.3%) patient developed abdominal abscess and 1(3.3%) patient developed metabolic complications. No patient had pleural effusion in group A. On the other hand, in group B, 2(6.6%) patients developed abdominal abscess, 2(6.6%) patients had pleural effusion and 1(3.3%) patient developed metabolic complications. In total, 2(6.6%) patients from group A and 5(15.7%) patients in group B had the above complications. The p-value was 0.337, which was insignificant.

The mean hospital stay for group A was 15.066± 6.389 days and for group B was 18.133 ± 6.786 days. (The p-value - 0.297) . In the present study, 2 (7%) patients in group A and 4 (13%) patients in group B had mortality during the post-operative period.

Complications	**Group A (n=30)**	**Group B (n=30)**	**P value**
Wound infection	12	13	0.793
Wound Dehiscence	10	11	0.787
Burst Abdomen	5	8	0.347
Stoma related complications	8	9	0.053
Sepsis	4	5	0.718
ICU care needed	6	8	0.542
Other complications	2	5	0.337
Mortality	2	4	0.389
Total duration of stay in the hospital (in days)	15.066 ± 6.389	18.133 ± 6.786	0.078

Table 3- Postoperative complications and duration of hospital stay.

DISCUSSION

SSIs represent a pervasive problem for surgical patients and surgeons all over the world.

They are frequently responsible for severe morbidity, higher health care cost and greater risk of mortality (3). Even when the patients recover, many find that their overall quality of life is significantly impaired over the long term.India also shows SSI prevalence rate of nearly 4.2%-6.0%, which varies with the surgical procedure (10).

Oxygen therapy is indicated in the wide spectrum of clinical conditions for its definitive, supplementary, and palliative role. To prevent surgical site infection, it is essential to optimize perioperative conditions in the first hours following bacterial contamination. Even WHO has recommended the oxygen therapy to prevent SSI (11).

But increased perioperative oxygen therapy is also linked with few adverse events like absorption atelectasis (12),shifting of carbon dioxide dissociation curve, worsening of ventilation perfusion mismatch by counteracting hypoxic vasoconstriction effect (13)and reduced cardiac output (14). Moreover, in resource poor countries unindicated use of oxygen can add on to the financial burden on the health services. We have witnessed the acute shortage of oxygen in COVID times. So perioperative use of oxygen needs to be evaluated.

In our study, we evaluated the role of high concentration oxygen therapy in preventing SSI by imparting high Fio2(80%) in one group and no oxygen therapy in other group postoperatively for 2 hours.Both the groups were comparable in terms of age, gender, BMI, Type of surgery and duration of surgery(table 1 and 2). However, we couldn’t demonstrate any difference in postoperative complications and total duration of hospital stay between the two groups (table 3).

A study was conducted by Pryor KO to compare theSSI following use of 80% or 30% oxygen. They used the same concentration intraoperatively as well as postoperatively for 2 hours. They also couldn’t demonstrate the efficacy of increased oxygen concentrations to prevent SSI. In present study intraoperative oxygen concentration was same for both the groups and only one group received 80% oxygen other group was kept on room air. [15]
Schietroma M conducted a trial to demonstrate usefulness of oxygen therapy to reduce SSI after perforated pectic ulcer and showed that oxygen therapy reduces the incidence of SSI. However, they used the higher concentration intraoperatively as well as 6 hours postoperatively. We used only postoperatively that too only for 2 hours which might be responsible for the results

obtained. [16]

Results in the present study were inconcordance with the study performed by Kurz A et al, who performed a large trial in designated operation theatre site and alternate between 30% and 80% and demonstrated that overall observed incidence of the composite outcome was 10.8% (314/2896) in the 80% oxygen group and 11.0% (314/2853) in the 30% group and hence stated that supplemental oxygen does not prevent major infection and healing-related complications after major intestinal surgery (17).

Hence in present study we couldn't demonstrate any benefit of high flow oxygen therapy to prevent or decrease SSI and thus routine use of high flow oxygen therapy just to reduce SSI should be discouraged.

However, this study has some inherit limitations, it is a single centered small group study. We didn't differentiate between various type of abdominal surgery, didn't categorize patient according to the duration of onset of symptoms and surgery and didn't exclude patients with malignancy. This information could have added to the significance of results. More large population multi centric studies can be attempted in same setting to confirm the findings of present study.

Conclusion

Supplemental postoperative inspired oxygen had no significant effect, neither on wound healing nor on the prevention of SSIs following various surgical procedures.

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