## **Original Research Article**

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# Role of hyperoxygenation on surgical site wound infection: a randomised case control study

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#### **ABSTRACT**

Background: The aim of this study was to assess the influence of hyperoxygenation on surgical site wound infections.

**Methods:** Using prospective randomized study, conducted from January 2018 to December 2018 at Mamata Medical College and General hospital, Khammam. This study includes 100 patients who were going for elective surgery at various divisions of Department of surgery. Patients were assigned randomly to an oxygen/air mixture with a faction of inspiration (FiO2) of 30% (n=50) and 60% (n=50). Administration was started after induction of anaesthesia and maintained for 3hours after surgery.

**Results:** Surgical site infection was recorded in 5 patients (2 of 50, 10%) in the hyperoxygenation group and 11 patients (11 of 50, 22%) in the control group (p<0.05). Time of hospitalization was  $5\pm3$  days in the hyperoxygenation group and  $9\pm4$  days in the control group (p<0.05).

**Conclusions:** Hyperoxygenation was associated with a reduction in surgical site infection. It also decreases the duration of hospital stay and decreases economic burden.

Keywords: Elective surgery, Hospital stay, Hyperoxygenation, Surgical site infection

## INTRODUCTION

Surgical site infections (SSI) are the third most frequently reported nosocomial infections and comprise one third of total infections in surgical patients.<sup>1</sup>

Several interventions have been investigated as part of an evidence-based approach to reducing surgical site infections: the use, timing, route and dosing of prophylactic antibiotics; the use of WBC-depleted RBC transfusions; the avoidance of hair shaving; the prevention of intraoperative hypothermia; and the use of mechanical bowel preparation. Despite these measures, significant clinical and economic burden of SSIs persists.<sup>2-6</sup>

Oxygen is routinely supplemented at 30% concentrations perioperatively. Supplementing higher concentrations of oxygen in the perioperative period for at least 2 h is one of the methods suggested to overcome perioperative hypoxia. This is vital for healing and critical for prevention of infections by releasing reactive oxygen species.<sup>7,8</sup>

#### **METHODS**

The clinical study was conducted on 100 patients at the Mamata General Hospital, Khammam, Telangana state, India during the period January 2018 to December 2018 by obtaining approval from institutional ethical committee. Adult patients scheduled for elective

surgeries for class I (clean) and class II (clean contaminated) elective general surgeries were taken into the study. After a thorough clinical examination and relevant laboratory investigations of all patients, an informed, valid, written consent was obtained, both for conduct of study as well as administration of spinal anaesthesia. An equal number of patients were classified into 2 groups as the study and control groups (50 each). Both groups were similar in their demographic profiles.

Necessary pre-operative investigations were performed and operated upon. All the patients received a single dose of prophylactic antibiotic, third-generation cephalosporin (ceftriaxone), and a second dose was given whenever surgery extended beyond 2 hours.

Duration of the surgical procedures ranged from 15 min in minor procedures to 3 hours maximum in radical procedures. Major, medium and minor cases were distributed equally to both the groups. Patients with diabetes mellitus, immunosuppression, chronic renal and respiratory diseases and who received chemotherapy or steroids were excluded from the study.

Wound characteristics were evaluated at each visit according to the ASEPSIS wound scoring system. a wound scoring method, ASEPSIS, make assessment of wound sepsis more objective and reproducible by allotting points both for the appearance of the wound in the first week and for the clinical consequences of infection. ASEPSIS scores were between 0 and 70, and a score above 20 was considered to indicate wound infection.

Attending surgeons made hospital discharge decisions. Discharge timing was based on routine surgical considerations, including return of bowel function, control of infections (if any), adequate healing of the incision, and overall recovery during the postoperative period.

After discharge from the hospital, all patients were seen weekly in the clinic by a surgeon not involved in the study for 1 month following discharge from the hospital. The data collected were tabulated and analyzed by using the statistical package for social sciences, Windowsbased version 18.0 (SPSS Inc., Chicago, IL, USA).

#### **RESULTS**

This prospective study was conducted at department of surgery, Mamata medical college. A total of 100 patients were included in the study. Table 1 depicts that different surgeries conducted to patients who underwent clean surgeries. These patients were aged from 15 years to 80 years. Age wise distribution of patients was shown in Table 2. Mean age of patients in hyperoxygenation group was 34.5±15.36 years and 38.2±17.89 years. Different patient characters were shown in table 3. In study group there were 27 males and 23 females. In control group there were 30 males and 20 females. Different patient characters were shown in Table 3. There was no significant difference between the study group and control group regarding age, sex, mean arterial pressure and haemoglobin levels.

Table 1: Type of surgeries.

Types of surgery	Study group (n=50)	Control group (n=50)
Hernia	7	8
Thyroidectomies	6	5
Mastectomy	4	6
Cholecystectomy	6	4
Appendectomies	8	7
Anal fissure	4	5
Hemorrhoidectomy	6	5
Hemicolectomy	2	3
Fibroadenoma	5	6
Dermoid cyst	2	1

Table 2: Age wise distribution of patients.

Age (in years)	Study group (n=50)	Control group (n=50)
>20	4	2
21-30	15	13
31-40	12	15
41-50	4	6
51-60	5	6
61-70	4	4
71-80	6	4

**Table 3: Characteristics of patients.** 

Character	Study group (n=50)	Control group (n=50)
Age (year)	34.5±15.36	38.2±17.89
BMI	25.9±1.02	26.9±1.65
Sex M/F	27/23	30/20
Mean arterial pressure (mm of Hg)	62.35±9.23	64.23±10.26
Mean haemoglobin (g%)	10.6 ±3.2	10.8±2.6

There are eight patients in the hyperoxygenation group were suffered with SSI with less asepsis score compared to control group in which 15 members were infected with moderate asepsis score which is significant. Postoperative hospitalization was significantly decreased in the

hyperoxygenation group. SSI parameters in both groups were shown in Table 4.

Table 4: SSI in two groups.

Character	Study group (n=50)	Control group (n=50)
Surgical site infection (number)	05	11
Asepsis score	15±5	20±5
Postop hospitalization	5±3	9±4
Intraoperative o <sub>2</sub> saturation	98.6	98.2
Postop o <sub>2</sub> saturation	97.5	97.4

#### **DISCUSSION**

Surgical site infection (SSI) is one of the most common postoperative complications and is estimated to account for up to 29% of all hospital infections. <sup>10</sup> An SSI is defined as an infection of a surgical site and leads to prolong hospital admission and increase morbidity and mortality. Therefore, SSIs increase the cost of treatment. <sup>11,12</sup>

The wound healing process involves numerous functions, many of which depend on the presence of oxygen. Collagen production and development influence the strength of the wound which is directly correlated with the partial pressure of oxygen (PO<sub>2</sub>) of the tissue. Synthesis of collagen, crosslinking and the resulting wound strength depend on the normal function of specific enzymes. The functions of these enzymes are directly related to the amount of oxygen present e.g. hydroxylation of proline and lysine by hydroxylase enzymes. <sup>13</sup>

The production of epithelial tissue depends primarily on the degree of hydration and oxygen. Although a moist environment increases wound the rate epithelialization. 13,14 Hyperbaric oxygen treatment increases the proliferation of the fibroblasts and the differentiation and epidermopoiesis the keratinocytes.15

Increasing FIO<sub>2</sub> to improve blood oxygen content and subsequent oxygen delivery to tissues is a plausible mechanism to mitigate SSI and is part of the basis of hyperbaric oxygen therapy use for patients with chronic wounds. <sup>16</sup> Resistance to infection may depend on the partial pressure of oxygen in the wound tissue, and the ability to resist infection may be improved by increasing arterial oxygen tension beyond that required to saturate hemoglobin. <sup>17</sup>

Belda and others in their study showed that SSI occurred in 24.4% of patients who were administered 30% FiO<sub>2</sub> and 14.9 % of patients in the 80%-FiO<sub>2</sub>-administered group.<sup>18</sup> In Grief et al, study, 500 patients undergoing

elective colorectal surgeries of which 250 received 80% oxygen and 250 received 30% oxygen noticed that the study group who received 80% oxygen had 13 surgical wound infections, as compared with 28 of the 250 patients receiving 30% oxygen.<sup>19</sup> Al Niaimi et al, observed that supplemental perioperative oxygenation resulted in a reduced incidence of SSI in a fixed effects model and found to be beneficial in preventing SSI in patients undergoing colorectal surgery.<sup>20</sup>

In a study of colorectal surgeries SSI was recorded in 2 patients (2 of 40, 5%) in the hyperoxygenation group (FiO<sub>2</sub> 80%) and 6 patients (6 of 40, 15%) in the control group (FiO<sub>2</sub> 30%). Time of hospitalization days in the hyperoxygenation group was also significantly decreased.<sup>10</sup>

In colorectal surgeries, tissue oxygen levels are low at the anastomosis site and the skin. Therefore, hyper-oxygenation can increase the tissue oxygen level and the number of oxygen free radicals at those sites and has a protective effect on anastomosis leakage. <sup>21,22</sup>

In this study also, there are five patients in the hyperoxygenation group were suffered with SSI with less asepsis score compared to control group in which 11 members were infected with moderate asepsis score which is significant. Postoperative hospitalization was significantly decreased in hyperoxygenation group. Our results were in accordance to the above studies. In some other studies, hyperoxygenation had no effect on the SSI rate for gastrointestinal (GI) and ovarian surgeries.<sup>23,24</sup>

### **CONCLUSION**

Increased intra-operative FIO<sub>2</sub> was associated with a reduction in surgical site infection. It also decreases the duration of hospital stay and decreases economic burden.

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