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Original Article

Effects of Perioperative Hyperoxygenation on Surgical Site Infection in Patients with Acute Appendicitis

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Abstract

Introduction: Surgical wound infection is nightmare for any surgeon following elective and emergency operations. In recent studies, the possibility of reducing surgical site infection (SSI) by perioperative hyperoxygenation has been raised. Hypoxia at the level of local wound site retards proper healing. Proper oxygenation of the tissue through microcirculation is vital for the healing process and resistance to infection. The data obtained from the related randomized, controlled trials for the benefits of perioperative hyperoxygenation to reduce SSI remain controversial. To overcome this problem, we have performed a randomized, controlled trial in a patient population with a single diagnosis (acute appendicitis), using standard surgical approach (open appendicectomy).

Key words: Hyperoxygenation, Surgical site infection, Acute appendicitis

INTRODUCTION

Surgical wound infection is nightmare for any surgeon. The surgical team takes all the precautions before, during and after the surgery to avoid and control the surgical wound infections. In spite of our efforts surgical site infection (SSI) constitutes a noteworthy problem in emergency and planned surgeries. Among nosocomial infection surgical wound infection is the most common. The cause of surgical wound infection is multifactorial depending on the overall well-being of the patient, types of surgery, surgical skill, and use of other preventive measures like prophylactic antibiotics. Other factors which may influence SSI include operative time, core body temperature, post-operative pain, and tissue hypoxia.[1]

Hypoxia at the level of local wound site retards proper healing. Proper oxygenation of the tissue through microcirculation is vital for the healing process and resistance to infection.[2] In recent studies, the likelihood of surgical wound infection by perioperative hyperoxygenation has been raised, but the data obtained from the related randomized, controlled trials remain controversial. In three studies, perioperative inhalation of an oxygen-enriched (80%) mixture led to a significant reduction of surgical wound infection following miscellaneous or only lower gastrointestinal tract surgery. However, in another three randomized, controlled studies concerning various gastrointestinal tract, colorectal, or gynecological operations, perioperative hyperoxygenation was not associated with an improved rate of wound infection. However, in meta-analyses gathering almost all of the participating subjects cumulative results favor the use of hyperoxygenation for surgical wound infection reduction.

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MATERIALS AND METHODS

This was a prospective case–control study conducted at BLDEU's Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapur, from October 2015 to August 2017 and included 180 patients with acute appendicitis and in each group, 90 patients were allotted. A total of 180 patients who underwent open surgery for acute appendicitis, pre-operative intravenous antibiotics were given to all patients. In the control group, 90 patients

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received oxygen from the room air, while in the study group, the fraction of inspired oxygen (FIO_2) reached 80% with the use of nonrebreathing mask in the rest 90 patients and continued for 2 h in the recovery room following completion of the operation in the study group with high-flow oxygen (10 L/min) through a nonrebreathing mask, while control group received oxygen from room air. We used the ASEPSIS system score to assess the degree of healing and infection of the surgical wound. The results of the two groups were compared and analyzed.

RESULTS

From October 2015 to June 2017, a total of 180 patients of having confirmed diagnosis of acute appendicitis are included in this study. To have uniformity in both the groups, we excluded all the patients having diabetes and immunocompromised status. We also excluded the patients having clinical evidence and imaging study confirming the diagnosis of perforated or gangrenous appendicitis. Superficial infective skin disease can influence the result, so excluded from the study. All the patients included in the study underwent open appendicectomy surgery by McBurney's approach. A total of 180 patients were alternately alienated between the study group (90 patients, FIO_2 of 0.80) and control group (90 patients, FIO_2 of 0.30). Our institute serves the relatively low and middle socioeconomic group of people. All the patients included in the study were having almost similar socioeconomic status.

Out of 180 patients included in this study, 80 (44.45%) patients were female and 100 (55.55%) patients were male. In the control group out of 90 patients, 47 (52.2%) patients were female and 43 (47.8%) patients were male. In the study group, 33 (36.7%) patients were female and 57 (63.3%) patients were male. There is no significant difference in sex-wise distribution of patients in both the group.

In total group range of the age was from 9 to 72 years with mean age of 28.9 ± 11.9 years. In the control group range of the age was from 9 to 62 years, with a mean age of 27.8 ± 11.2 years. In the study group range of the age was from 9 to 72 years, with a mean age of 30.0 ± 12.5 years statistically there were no significant differences in age.

There were no major differences between the groups in medical history and clinical presentation. Parameters such as smoking history, obesity, timing of perioperative antibiotic administration, and abdominal shaving (in the operating room) as well as laboratory results were similar in both groups. Intraoperative hemodynamic parameters and intraoperative findings were not statistically different either.

In our study, we noticed a marked difference in requirement of antibiotic in the control group (98.9%) as compared to the study group (1.1%) making it significant. In study group, 5 (5.6%) patients had SSI ranging from minimal to moderate degree as per the ASEPSIS score. In the control group, 17 (18.9%) patients had SSI ranging from minor to severe degree as per the ASEPSIS score.

All the open appendicectomy surgery was done by different surgeons. We noted operative time from making of an incision to the complete skin closure. Operative time in the study group was 37.6 ± 4.5 min and in control group 37.8 ± 6.2 min. There is no significant difference in operative time in both the groups.

Average stay in the hospital also differs in both the group. Control group has an average stay of 7.6 ± 2 days while the study group has 6.4 ± 2.4 days. Stay in hospital is statistically lower in the study group (*P* significance 0.001).

The total cost of the disposable nonrebreathing mask and antibiotics in the study group is Rs. 39,240, means Rs 436 per patient. Control group has a total cost of 86,580 means Rs 962 per head. Cost of treatment in the study group is significantly lower than the control group.

As per asepsis scoring method erythema was noted on the 2nd post-operative day in 13 out of 90 patients (14.4%) in control group while only 1 out of 90 patients (1.1%) in the study group had developed erythema. 9 patients had serous discharge on the 2nd post-operative day, 9 patient had on the 3rd post-operative day, and 3 patient had on the 4th post-operative day. 5 patients had purulent discharge on the 5th post-operative day. Pus culture was taken for sensitivity study and antibiotics were modified accordingly. In the control group, 17 patients (18.9%) required additional antibiotics while in study group only 1 patient (1.1%) required additional antibiotics. This is significantly lower in the study group as compared to control group.

Analysis

SSI is a major complication of abdominal surgery, associated with prolonged hospitalization, increased costs, and excess mortality. In recent years, randomized trials have identified a number of preventive measures that can substantially reduce the risk of SSI. These include appropriate perioperative antibiotic prophylaxis, maintenance of perioperative normothermia, and control of hyperglycemia.[3,4] Achieving high oxygen tension at the site of surgery has been proposed as a means of reducing the risk of SSI, based on data that oxygen can enhance the oxidative processes in white cells, thus facilitating bacterial killing.[3,5] A number of preclinical studies have shown

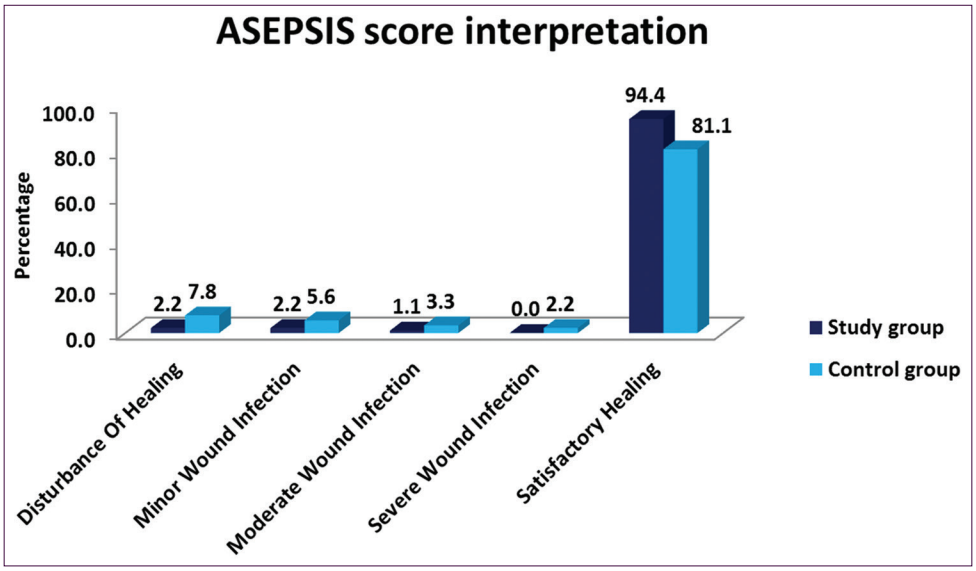

Chart 1: ASEPSIS score between study and control groups

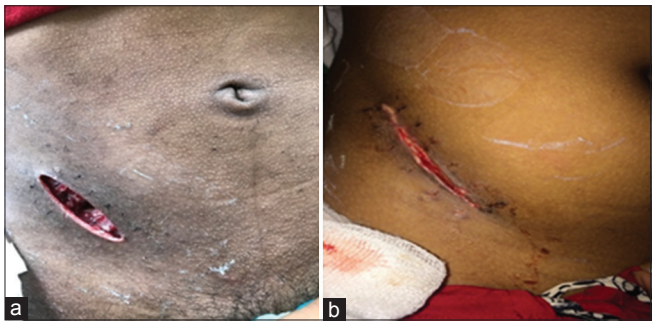

Figure 1: (a-b) Asepsis in control group

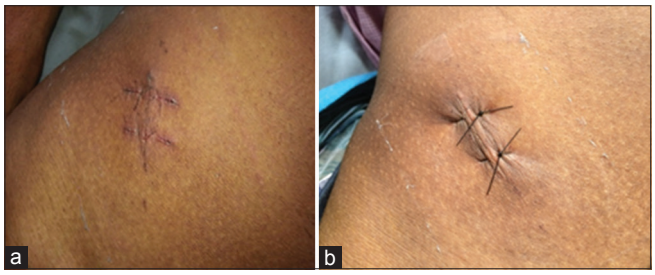

Figure 2: (a-b) Healing in study group

that the provision of high tissue oxygen concentrations promotes local wound healing in animal models. Recent studies in humans have found that administration of supplemental oxygen in the perioperative period to patients undergoing colorectal surgery may reduce the risk of SSI.[6] However, not all studies have found this benefit, and one paradoxically found an increased risk of SSI with supplemental perioperative oxygenation administration.[7] Recent evidence-based reviews and editorials have recommended the use of supplemental perioperative oxygenation for the prevention of SSI,[1] but no meta-analysis has systematically quantified the magnitude of the effect.

Table 1: Asepsis score between study and control groups

ASEPSIS score interpretation	Study group	Control group	*P* value
	n (%)	*n* %	
Disturbance of healing	2 (2.2)	7 (7.8)	0.093
Minor wound infection	2 (2.2)	5 (5.6)	
Moderate wound infection	1 (1.1)	3 (3.3)	
Severe wound infection	0 (0.0)	2 (2.2)	
Satisfactory healing	85 (94.4)	73 (81.1)	
Total	90 (100.0)	90 (100.0)	

We studied the role of perioperative hyperoxygenation in patients undergoing open appendicectomy by McBurney's incision at BLDE Hospital [Figures 1 and 2] We attempted to minimize heterogeneity in the included studies by including only patients that were undergoing open appendicectomy by McBurney's incision. Our hospital is located in remote district place, Bijapur. Peoples residing in 50 km radius are taking treatment. The population is mainly from low and middle socioeconomy class. It has served in our study of having homogenous mass in both the groups. Our hospital provides almost free medical service to the surrounding population.

Analysis of all the collected data statistically confirmed that there is no significant difference in age, sex, class, and clinical presentation. The homogenous population is the important factor in our study.

Analysis of our results demonstrated statistically decreased rate of surgical wound site infection following administration of perioperative hyperoxygenation in a patient undergoing open appendicectomy. Our result correlates with many studies such as Bickel *et al.*, Qadan *et al.*, and Schietroma *et al.* favoring perioperative hyperoxygenation are

beneficial to prevent SSI. Significant point in our study is homogenicity inpatient population with the same type of surgery as compared to the other literature.[1,3,4]

Prolonged operative time is one of the factors which predispose the surgical wound to the infection. As per guideline from NNIS operative time in both the group was <75 percentile. This eliminates the factor of prolonged surgery time in our study.

We used the ASEPSIS scoring method, and it is one of the easy and reliable systems to judge the SSI [Table 1]. Moreover, we included the patients of acute appendicitis operated by McBurney's incision, so it's easy to judge and compare the same right lower abdomen incision in all the patients. In our studies, we used single dose of pre-operative antibiotics in the study group as compared to 3 days antibiotics in the control group. In spite of that just providing perioperative hyperoxygenation SSI could be reduced to a significant level, avoiding unnecessary usage of antibiotics. As such, we are all worried about the development of drug resistance due to unnecessary usage of antibiotics. Recent report by the WHO on antibacterial agents in clinical development shows serious lack of newer antibiotics to combat the growing threat of antimicrobial resistance. The WHO also remark that antimicrobial resistance is global health emergency and will seriously jeopardize the progress in modern medicine. Our study justifies the use of perioperative hyperoxygenation to avoid unnecessary use of antibiotics and at the same time reducing the cost to the patient [Chart 1].

Hospital atmosphere is one of the common places to spread cross infection and thereby developing drug resistance. Our study demonstrated that the study group has significantly lower hospital stay as compared to the control group. Just providing perioperative hyperoxygenation can reduce the post-operative stay; resultant decrease in the chances of cross infection and decrease in financial burden to our charitable hospital. Moreover, early discharge in the study group makes the beds free for other waiting patients.

As per our protocol, we used maximum FIO_2 of 80% to provide hyperoxygenation. There was no reported adverse event showing a significant difference in pulmonary complications or other adverse effects.[8,9]

Limitation of this study is that open appendicectomy surgeries were done by different surgeons. Although approach and incision are the same, there may be difference in intraoperative tissue handling skill. It could not be eliminated in this study. However, it remained the same for both the groups.

CONCLUSION

The use of perioperative hyperoxygenation is advantageous in operations for acute appendicitis. As this is the most common emergent operation in general surgery, decreasing the rate of SSI carries significant clinical and economical gains in the form of judicious use of antibiotics, shorter hospital stay, and cost-effectiveness. In addition, as our study was conducted in a relatively homogeneous study population, our results support the beneficial effects of supplemental oxygen in clean-contaminated surgery in general.

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