ORIGINAL ARTICLE

Influence of Upper Abdominal Surgery and Lower Abdominal Surgery on Early Postoperative Hypoxemia in Adults Undergoing Elective Surgery-A Comparative Study

Sridevi M. Mulimani[1], *Srushti M.*[1]

[1]*Department of Anaesthesiology BLDE University's Shri B M Patil Medical College Vijayapura-586103 (Karnataka) India*

Abstract:

Background: Postoperative hypoxemia is common complication in early postoperative period. Upper abdominal surgery significantly impairs the respiratory mechanics for ventilation resulting in hypoxemia. *Aim and Objectives*: To observe the incidence, severity and duration of early postoperative hypoxemia in adults undergoing elective upper and lower abdominal surgeries. *Material and Methods:* This study was conducted in 50 patients of 20- 50 years, posted for various abdominal surgeries, SPO_2 levels were recorded for all the patients when breathing room air, in the recovery room by pulse oximeter. *Results*: In the recovery room, while patients breathed room air, SpO_2 was 91.1% in upper abdominal surgery patients (Group I) then increased gradually but SpO_2 was 94.4% in lower abdominal surgery patients (Group II) and improved over a shorter period than the Group I. SpO_2 returned to >95% in all patients of Group II after 15 minutes of operation. However, in Group I patients SpO_2 levels had reached 95% by 3 h after the operation. *Conclusion:* The degree of arterial desaturation and the incidence of hypoxemia were closely related to the operative sites in the upper abdominal surgery and lower abdominal surgery in the immediate postoperative period. Hence requires close respiratory monitoring and oxygen therapy during the early postoperative period.

Keywords: Elective Surgical Procedure, Hypoxemia, Recovery Room

Introduction:

Hypoxemia is defined as abnormally low partial pressure of oxygen in the arterial blood [1]. Its severity can be classified as mild (PaO_2 60-80mmHg or SpO_2 90-95%), moderate (PaO_2 40-60mm of Hg or SpO_2 75-90%) and severe (PaO_2 <40mm of Hg SpO_2 < 75%). The causes of hypoxemia in post operative period are hypoventilation, ventilation perfusion (v/q) mismatch, and shivering [2].

Hypoxemia is better tolerated in young individuals for certain period; if it is not treated timely it is associated with hazardous complications like acidosis, cardiac arrest and multi organ dysfunction [3]. Symptoms of hypoxemia are air hunger, dizziness, headache, fatigue, nausea and visual impairment. Signs are rapid breathing, cyanosis, and tachycardia hypotension, hypertension and coma [4, 5]. During anaesthesia procedure it can occur at induction, endotracheal intubation, maintenance of anaesthesia, extubation during transport, and in recovery. Mortality and morbidity is high with hypoxemia [6].

In early post operative period hypoxemia is a common complication. There are many factors which influence the occurrence of hypoxemia like co-existing diseases, history of smoking, use of anaesthetic drugs, duration of anaesthesia and surgery [7]. Surgical site is the main component for pulmonary dysfunction. Upper abdominal surgery significantly impairs the respiratory mechanics for ventilation. These changes are of restrictive pattern, decreased forced vital capacity and functional residual capacity. The site of incision and postoperative respiratory dysfunction are most frequent factors for upper abdominal surgery leads to hypoxemia compared to lower abdominal surgeries. This complication is more during transport and in the recovery room. Therefore it is essential to understand the mechanisms involved in postoperative hypoxemia and the available treatment options for prevention of postoperative mortality and morbidity [8-10].

Measurement of arterial oxygen saturation with pulse oximetry provides an early and reliable method of detecting hypoxemia. Hypoxemia can be a preventable complication [8]. This study is performed to compare upper abdominal surgeries to lower abdominal surgeries for incidence, severity and duration of early postoperative hypoxemia in adults undergoing elective surgery.

Material and Methods:

Source of Data

This study was carried out in the department of Anaesthesiology for two months as short term studentship project under Indian Council of Medical Research

Method of collection of data:

Inclusion criteria:

After obtaining informed consent and approval from our ethical committee, 50 patients undergoing elective surgery in the age groups of 20 to 50 years of both sexes and only American Society of Anaesthesiologists Grade I and Grade II, 25 patients in each group were selected for study by using pilot study. Pilot study was done by taking 10 cases of upper abdominal surgery, 10 cases of lower abdominal surgery, using SpO_2 reading after 10 minutes of surgery, assuming α error as 99% (0.001) and β error 99% (0.99). Sample was found 23 in each group using formula $n=(Z_\alpha+Z_\beta)^2 x 2\sigma^2 / d^2$ where d^2= observed difference between two means. Hence 25 patients in both groups were included in the study.

Exclusion criteria:

Patients suffering from cardiovascular, respiratory, endocrine, hepatic, renal, haematological, neurological diseases, pregnancy, history of allergy, predicted obesity - body weight >10% above the ideal and patients with anaemia at the end of surgery due to major blood loss during surgery were excluded from the study.

Preanaesthetic Evaluation:

During preoperative visit, patient's detailed history, general physical examination, assessment of airway and systemic examination were carried out.

Laboratory investigations like Hb%, total count, differential count, ESR, blood sugar, blood urea, urine for albumin, sugar, and ECG were carried out.

Premedication:

All patients were premedicated with injection Glycopyrrolate 0.01mg/kg intravenously and Injection Midazolam 0.02mg/kg intravenously 5minutes before induction.

Induction:

50 patients were allocated to Group I and Group II depending on the site of surgery consisting of 25 each. Group I was upper abdominal surgeries (cholecystectomy, partial gastrectomy, epigastric hernia repair) and Group II was lower abdominal surgeries (abdominal hysterectomy, apendicectomy, gynaec laprotomy).

All the patients were induced with Propofol 2mg/kg intravenously, Injection Pentazocin 0.5mg/kg intravenously and tracheal intubation facilitated by Suxamethonium hydrochloride 1.5mg/kg intravenously. Anaesthesia was maintained with O_2, N_2O, Isoflurane, Vecuronium, or Atracurium for muscle relaxation. During surgery, the lungs were ventilated with Bain's circuit. During surgery, blood loss was measured by swab, drape weighing and from suction bottles. Minimal or moderate blood loss was replaced with lactated Ringer's solution as required. Hemodynamic variables remained stable throughout surgery in all the patients. During anaesthesia and after surgery, SpO_2 was monitored continuously by using pulse oximeter.

Patient's vital parameters like pulse, BP, SpO_2 and ECG were monitored throughout the surgery. At the end of the surgery residual muscle relaxation was reversed with injection Neostigmine 0.05mg/kg and injection Glycopyrrolate 0.01mg/kg intravenously. When protective reflexes had recovered and adequate spontaneous breathing function was re-established or when patients were awake, tracheal extubation was performed in the operating room. The airway was then assessed, and 100% oxygen was administered via a face mask for 3–5 min before patients were transferred to the recovery room. Respiratory status was observed and recorded in the recovery room. Patient was also monitored for postoperative complications. In the recovery room adequacy of ventilation was assessed clinically by observing the expiratory air flow from the nose or mouth and the movement of the thorax with or without auscultation. Hemodynamic parameters and respiratory parameters were monitored post operatively.

Monitoring

SpO_2 levels were recorded for all the patients in supine position when breathing room air shortly after arrival in the recovery room 0, 5, 10, 15, 20, 30, 40, 50, 60, 120, and 180 min. SpO_2 levels classified as mild hypoxemia (90-95%), moderate hypoxemia (85-90%) and severe hypoxemia (<75%). If SpO_2 value decreased to 85%, oxygen was supplied immediately via a disposable plastic face mask with flow of at least 6 L/min for 2 minutes. The patients receiving supplemental oxygen were allowed to breathe room air for at least 3 min before the next recording of SpO_2. Supplemental oxygen was re-administered if hypoxemia occurred with air breathing.

Results:

All the collected data were statistically analyzed using paired't' test and unpaired 't'test.

The values were expressed as Mean± SD and P<0.05 was taken as statistically significant.

The patients in upper abdominal surgery (group I) were compared with lower abdominal surgery (group II) each group consisting of 25 patients.

Table 1: Demographic Data

Variable	Group I (UAS)	Group II (LAS)
n	25	25
Gender (M/F)	14/11	16/9
Age (yrs)	37.2±9.63	37.6±10.9
Weight (Kg)	53.8±7.9	54.68±8.3
Haemoglobin (g/dL)	12.4±1.76	12.8±1.7
Duration of operation (h)	2.4±0.5	2.23±0.5
Transit time (s)	97.3±5	94.7±8.7

UAS: Upper abdominal surgery. LAS: Lower abdominal surgery

There were no significant differences in both the groups in terms of demographic data Table 1. Surgical procedures in all the patients were uneventful, and blood loss was minimal or moderate. In the recovery room, all the patients had clinically adequate ventilation. No patient had airway obstruction and body temperature was normal. Non Steroidal Anti Inflammatory Drugs (NSAIDs) were supplemented as analgesics in immediate postoperative period. No clinical signs of respiratory depression from intra operative administration of pentazocine in both the groups.

Table 2: Incidence of Hypoxemia Observed during Study Period

SpO_2	Group I (UAS) 25 cases	Group II (UAS) 25 cases
<95%	10 (40%)	1 (4%)
>95%	15 (60%)	24 (96%)

UAS: Upper abdominal surgery. LAS: Lower abdominal surgery

In our study 10 (40%) patients in upper abdominal surgery had arterial hypoxemia and 1(4%) patient had arterial hypoxemia in lower abdominal surgery (Table 2). All the patients had normal oxygen saturation preoperatively (Mean SpO_2 >95%). During the transport of patients to recovery room, they are not supplemented with oxygen support. In the recovery room, while patients breathed room air, SpO_2 decreased significantly in the patients of upper abdominal surgery (Group I) then increased gradually but SpO_2 decreased minimally in lower abdominal surgery (Group II) improved over a shorter period than the Group I (Table 3).

During the early postoperative period, the decrease in the SpO_2 and incidences of hypoxemia were closely related to the surgical sites and were most frequent for upper abdominal surgery, less for lower abdominal surgery.

There were significant differences among the two groups in the SpO_2 levels and incidences of

Table 3: Preoperative SpO_2 and Early Post Operative Period SpO_2

Time Interval in minutes	Group I (UAS) SpO_2 Mean ± SD	Group (LAS) SpO_2 Mean ± SD
Pre operative	98.2±1.2	98.5±1
0 (PACU)	91.1±0	94.4±0
5	91.2±0	94.6±0
10	91.3±0	94.9±2
15	91.9±0	95.3±9
20	92.6±0	96.6±0
30	93.0±0	97.2±0
40	93.0±0	98.0±0
50	93.2±0	98.0±0
60	93.8±0	98.1±0
120	94.4±0	98.5±0
180	94.8±0	98.9±0

UAS: Upper abdominal surgery, LAS: Lower abdominal surgery, PACU: Post anaesthesia care unit.

Table 4: Recovery Rates of the SpO_2 during the Early Postoperative Period

Time interval	Group I (UAS) SpO_2 Mean± SD	Paired t test	Group II (LAS) SpO_2 Mean± SD	Paired t test
0 min	91.1±0.(0.176)	t=26.4	94.4±0(0.192)	t=20.88
60 min	93.8±0(0.156)	Significant	98.1±0(0.170)	Significant
0 min	91.1±0(0.176)	t=30.28	94.4±0(0.192)	t=21.88
120 min	94.4±0(0. 129)	Significant	98.5±0(0.165)	Significant
0 min	91.1±0(0.176)	t=26.65	94.4±0(0.192)	t=25.92
180 min	94.8±0(0.129)	Significant	98.9±0(0.168)	Significant

hypoxemia in the early postoperative period. No patient had postoperative complications relating to hypoxemia.

The postoperative recovery of SpO_2 was also significantly different among the two groups (Table 4). SpO_2 returned to >95% in most of cases of Group II after the operation. However in group I patients SpO_2 levels reached 95% by 3 hours after the operation. In addition, the mean SpO_2 levels returned to baseline by 15 min after surgery in Group II.

Discussion:

In our study we revealed that the degree of arterial desaturation and the incidence of hypoxemia (SpO_2<95%) were closely related to the surgical sites in the early postoperative period. We observed that incidence of early postoperative hypoxemia was 40% in upper abdominal surgeries and 4% in lower abdominal surgeries.

In clinical studies, patients who underwent upper abdominal surgery had more severe arterial desaturation when compared with the patients who underwent lower abdominal and peripheral surgery [11, 12].

Xue F [9] studied postoperative hypoxemia in 994 patients, ASA physical status I or II, aged 18-68 years, the results showed that during the early postoperative period, the incidences of hypoxemia were closely related to the operative sites and were greatest for (52%) thoracoabdominal operations, less (38%) for the upper abdominal operation, and least (7%) for the peripheral surgery. These results are consistent with our study results. In a study conducted by Mimica *et al* [8] out of 105 patients, Seventy-five patients in the first group underwent upper abdominal surgery, 30 patients in the second group were submitted to lower abdominal surgery. They concluded that all lower abdominal incisions were found to entail statistically significantly less respiratory disturbances, the upper abdominal incisions observed caused substantial respiratory disturbances including hypoxia, hyperventilation and pulmonary shunt increase.

The incidence of early postoperative hypoxemia in different studies varies considerably because of the differences in patient selection, anesthetic techniques, observation method, and type of surgery. A study on 959 patients showed that 17% of patients had SpO_2<90% and 6.6%, of patients had SpO_2 < 85%. Hypoxemia was not recognized in 82% of the patients in whom an assessment based on clinical grounds was carried out [13].

In our study, the incidence of mild hypoxemia was 40% and no evidences of severe hypoxemia

During early postoperative period, airway tissue edema, secretion accumulation in the pharynx and the tongue falling into the pharynx due to residual anesthetic effect are common. These factors can aggravate alveolar hypoventilation and increase respiratory efficacy. The normal hypoxic drive to ventilation may be abolished by a concentration of Enflurane as low as 0.1 MAC. This concentration may be present in the immediate postoperative period and may cause some early phase respiratory depression. Diffusion hypoxia after nitrous oxide use is unlikely to be a contributing factor because all the patients breathed 100% oxygen for at least 5 min at the end of the operation. Residual effects of neuromuscular blockade could aggravate early postoperative hypoxemia, but routine reversal of residual neuromuscular blockade at the end of surgery makes this unlikely. Except for the influences of anaesthesia on respiratory function described above, patients undergoing upper abdominal and thoracic operations are more at risk of hypoventilation, imbalance of ventilation and perfusion, and atelectasis compared with those undergoing other operations, probably because of more severe mechanical impairment of respiratory function [14-16].

We also controlled the other factors known to interfere with the occurrence of early postoperative hypoxemia and no patients had clinical signs of respiratory depression from the intraoperative administration of anaesthetics. The differences in postoperative SpO_2 levels and hypoxemia observed among groups are likely to be mainly due to the surgical sites. The present results showed no correlation of patient's age with degree of arterial desaturation in the patients undergoing elective surgery of different sites during the early postoperative period. This is in agreement with the results of some previous studies in adult patients however; other studies found that patient's age were closely related to the occurrence of early postoperative hypoxemia

Our data also demonstrated that recovery rate of SpO_2 was faster during the first 60 min. This may be due to the rapid disappearance of the depressant effects of residual anaesthetics [11]. SpO_2 returned to baseline in our patients undergoing lower abdominal surgery by 1h of surgery. Because of the absence of continuing mechanical respiratory abnormality in this category of patients, the effects of residual anaesthetics on respiratory function may be a primary cause of early postoperative hypoxemia. However, SpO_2 levels in upper abdominal surgery recovered only to 94.8±0.6% (corresponds to a PaO_2 of approximately 75 mmHg), 3h after surgery, which were significantly lower than the preoperative levels. Previous studies showed that ventilatory disturbance could remain for several days after upper abdominal or intrathoracic surgery. The present study shows consistently, as like other studies, that the early postoperative period is a time at which patients are most apt to develop severe arterial desaturation, during this time patients should be closely monitored and properly treated, particularly after upper abdominal and thoraco abdominal surgery [17-19].

Pulse oximetry is now a standard of care during anesthesia and in the immediate postoperative period, routine use of oxygen therapy may be an unwarranted expense in healthy patients at low risk of hypoxemia who have adequate oxygen saturation in the recovery room however, in the absence of adequate monitoring of arterial oxygen, oxygen administration should be routinely considered for all the patients after general anesthesia in the immediate postoperative period. In this and other studies oxygen therapy was administered only when SpO_2 was 85% and was sufficient to successfully increase SpO_2 to the desired levels without any hypoxemic consequences [20-23].

Conclusion:

In conclusion, we have confirmed that the severity of arterial desaturation and the incidences and duration of hypoxemia during the early postoperative period are closely related to the surgical sites and that they are the most pronounced for upper abdominal surgery and less for lower abdominal surgery.

These results suggest the need for close respiratory monitoring and oxygen therapy during the early postoperative period, even in healthy adult patients undergoing uncomplicated, elective lower abdominal surgery and particularly in those undergoing elective upper abdominal surgery.

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Author for Correspondence:* *Dr. Sridevi M Mulimani Department of Anaesthesiology*
BLDE University's Shri B M Patil Medical College, Vijayapura 586103 Karnataka
Email: mulimanims@yahoo.co.in Cell: 09449534216