RESEARCH ARTICLE

Assessing Impaired Oxygenation through Evaluating Cough Frequency and Duration at Extubation in the Post-anesthesia Phase

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Background: Atelectasis is one of the most common postoperative respiratory complications following general anesthesia. It occurs mainly in 85% to 90% of patients who undergo general anesthesia. Postoperative atelectasis occurs due to diaphragmatic dysfunction, impaired surfactant activity, coughing at the end of anesthesia, and disturbance in (A-a) GO_2 (alveolar-arterial oxygen partial pressure gradient). The aim of this study was to evaluate the effect and duration of coughing on impaired oxygenation and atelectasis after emergence from general anesthesia under mechanical ventilation in post-anesthetic care unit.

Methods: In this prospective study, 97 patients undergoing general anesthesia and mechanical ventilation were enrolled. Quantitative and qualitative demographic data were collected through questionnaires. Arterial blood samples were taken 30 minutes before the end of the surgery and one hour after the completion of operation to measure the alveolar -arterial gradient. Data analysis was performed using SPSS-16 software, t-test and qui square test. P value <0.05 was considered statistically significant.

Results: The number of coughs before extubation or after extubation and increased duration of coughing could result in significantly increased arterial alveolar gradient.

Conclusion: Increased frequency of coughing during emergence from anesthesia and extubation results in increased Arterial - alveolar oxygen partial pressure gradient (A-a) GO_2 and also the prevalence of atelectasis in post-anesthesia care unit.

Keywords: Cough; Extubation; Oxygenation; Arterial-alveolar oxygen pressure gradient (A-a) GO_2

Pulmonary complications are among the important concerns affecting patients undergoing varied surgeries at the end of the operation. The most common postoperative pulmonary complication following general anesthesia is atelectasis which leads to impaired gas exchang [1]. Atelectasis occurs mainly in 85% to 90% of patients undergoing general anesthesia [2]. During general anesthesia and spontaneous ventilation, impaired pulmonary gas exchange leads to shunt and changes in ventilation/perfusion ratios and causes further pulmonary complications including pneumonia and acute lung injury [3] which in turn contribute to increased mortality rate and prolonged ICU stay [1,4]. Previous studies conducted on the formation of atelectasis before, during and after induction of anesthesia have shown that addition of continuous positive airway pressure (CPAP) following positive end expiratory pressure (PEEP) increases [5-6] prevalence of atelectasis in the post-anesthetia care unit (PACU) [7]. Another possible cause of atelectasis at the end of anesthesia is coughing in pre-intubation [8]. Coughing has been reported with an incidence of 40% during extubation [9] and awake extubation in adults; this might increase to 70% or higher in children [10]. Coughing on the tracheal tube at the time of extubation leads to further reduction in FRC and results in worsening of atelectasis and oxygenation in PACU [11]. We hypothesized that abnormal coughing, commonly seen at the time of extubation, may be a factor contributing to the impairment of gas exchange and oxygenation in PACU. Therefore, this observational study was designed to evaluate the relation between the frequency and duration of coughing and impaired oxygenation/atelectasis after emergence from general anesthesia under mechanical ventilation in post-anesthetic care unit.

Methods

This observational study was conducted from 2013 through 2014 at Imam Reza Teaching Hospital, Tabriz, Iran. After approval of ethics committee (27/12/96-5.4.12400) informed written consent was obtained from all patients scheduled for elective surgical procedures. The sample size was estimated in accordance with Cochran's formula (p=q=%5, d=0/1). Patients with respiratory diseases, requiring higher FiO_2 and postoperative ventilation, were excluded. Quantitative and qualitative data were collected

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using questionnaires. During induction of anesthesia, patients were ventilated manually via a face mask with 100% oxygen. In all patients, general anesthesia was induced using same drugs (midazolam, fentanyl, propofol and muscle relaxant for tracheal intubation) based on the routine of our hospital. Patients underwent mechanical ventilation by (FiO_2 = 40%) without positive end expiratory pressure (PEEP), respiratory rate (10 /min) and tidal volume 10 mL/ kg. Atelectasis was assessed by the impairment of gas exchange and the alveolar-arterial O_2 pressure difference. So 30 minutes before and one hour after surgery, arterial blood samples were sent to measure (A-a) G to indicate the degree of impairment of the lungs' ability for oxygenation. Extubation was performed using positive pressure breathing technique. A positive pressure breath was given simultaneously with deflation of endotracheal cuff and tube was withdrawn without suctioning the trachea. Coughing usually occurs at extubation which results in discharge of secretions. Another person who was not involved in patient's anesthesia recorded cough frequency and duration before and after extubation. Patients were monitored with regards to vital signs and oxygenation up to an hour after surgery in PACU, and they received 6 liters per minute of humidified oxygen through facemask with FiO_2 of 40%. Data analysis was performed using SPSS 16 software, t-test for quantitative demographic information and chi-square test for qualitative information. P value≤0.05 was considered statistically significant.

Results

Of 100 patients who were enrolled in this study, 97 continued the study while 3 patients were excluded from the study due to changes in the respiratory and ventilatory patterns throughout the postoperative period. Patient's characteristics and quantitative variables are shown in (Table 1) and qualitative parameters in (Table 2). There was statistically significant association between BMI and physical status (based on ASA) and mean of (A-a) G (P=0.0). There was no significant difference between (A-a) GO_2 and arterial oxygen levels in post-anesthesia care unit in patients who had coughing before or after extubation in comparison with non-coughing patients. The increased number of coughs before or after extubation and increased duration of coughing significantly increased arterial-alveolar oxygen pressure gradient (P=0.0). The mean (A-a) G (alveolar-arterial oxygen partial pressure) after extubation increased significantly in comparison with its mean before extubation (P=0.002). The mean arterial oxygen pressure in PACU increased compared with pre-extubation values which was not statistically significant.

Discussion

There are very few clinical studies on the effect of cough on atelectasis and impairment of gas exchange. Atelectasis is a common post-anesthesia complication. It reduces the oxygenation of blood due to pulmonary tissue collapse [7,12]. Lang et al. and Hedenstierna et al. studies showed that atelectasis in obese people was more frequent than in lean subjects. In 90% of the cases, atelectasis does not correlate with age [13-14]. Our study also showed that age had no significant effect on gradient increase; nevertheless, BMI and physical status based on ASA had a significant relation with high gradient. The presence of underlying diseases or type of surgery and duration of surgery did not significantly affect reduction of PaO_2 or increasing of arterial - alveolar oxygen gradient. The mean duration of surgery in our patients was longer than one hour and with increasing the duration of operation, increasing of arterial - alveolar gradient also augmented; however, this difference was not statistically significant. Studies in this regard showed that surgery of the upper extremity and duration of surgery are frequently cited as a major risk factor for (A-a) GO_2 disorders [13]. In this study, the mean (A-a) GO_2 increased after extubation while PaO2 decreased. This deterioration of oxygenation state after extubation (increased (A-a) GO_2 or decreased PaO_2) was not due to changes in inspiratory oxygen levels. Patients before extubation and in PACU received the same oxygen levels after the anesthesia. Studies have shown that (A-a) GO_2 is indicative of atelectasis, and at the end of anesthesia, it increases which is due to intrapulmonary shunts or decreased perfusion ventilation ratio. Hence, it may be affected by FiO_2; when FiO_2 is higher than 1.0, atelectasis occurs within 5 minutes. Other studies have shown that ventilation of the lungs with pure oxygen results in reduced alveolar stability and rapid lobar atelectasis [14]. In our study, there was no significant effect on (A-a) GO_2 before and after extubation, but the frequency and duration of cough had a significant effect on (A-a) GO_2. A study by Bickler and colleagues showed that, during general anesthesia, cough in response to the tracheal tube significantly reduced functional residual capacity [15-16]. Also, in the study of Lumb et al. on 84 patients, they showed that there is a significant relation between cough during extubation and impairment of oxygenation in PACU [17]. In the present study, the patients' oxygenation deteriorated after anesthesia and the mean (A-a) GO_2 significantly increased from 7.5 kpa to 13.9 kpa in PACU. Nevertheless, the frequency and score of coughs had a significant effect on the (A-a) GO_2. In summary, cough is a major cause of impaired oxygenation that may be formation of atelectasis.

Table 1- Demographic data of patients

Parameters	mean (SD)
Age (yr)	47.1±16.6
Weight (kg)	74.7±10.8
Operation Time	169.1±5.7
BMI; kg/m2	25.31±3.1
Cough count pre-intubation	1.25±2.2
Cough count after-intubation	1.9±2.9
(A-a) GO_2 pre-extubation	92.8±5.3
(A-a) GO_2 after-extubation	111.2±7.16*
PaO2 pre-extubation	114.29±7.6
PaO2 after-extubation	111.57±3.33
Cough duration; s	4.9±6*

Table 2- Results for the variables potentially affecting change in (A-a) GO_2 and PaO_2. Values are number or mean (SD)

	Change in (A-a) DO2; kPa	p-value	Change Pao2(mmHg)	p-value
Age				
18-40	99.74±51.14	0.0511	117.59±26.00	0.0257
40-60	118±76.00		111.13±27.00	
Upper 60	114.92±93.00		103±26.14	
Type				
upper abdominal	97.54±42.45	0.0557	108.51±25.62	0.0207
lower abdominal	84.17±31.08		110.19±23.16	
head and neck surgery	94.73±93.40		121±31.80	
ASA classification				
I	97.81±55.05	0.001	120.37±30.12	0.098
II	115.54±79.00		106.63±40.32	
III	164.27±10.12		103.55±27.02	
Cough before extubation				
Yes	99.94±56.05	0.0373	108.8±34.00	0.503
No	92.84±32.00		112±22.81	
Cough after extubation				
Yes	97.81±55.05	0.0272	110.34±24.02	0.752
No	115.54±79.00		112.11±28.01	
Duration of surgery				
<2h	108.19±71.09	0.0749	122.02±30.00	0.91
>2h	113.11±73.10		110.18±34.01	
lung disease				
Yes	111.88±74.20	0.0805	102.86±28.00	0.27
No	105.54±50.20		115.77±33.10	

Conclusion

Increased frequency of coughs during emergence from anesthesia and extubation results in increased Arterial-alveolar oxygen pressure gradient and also atelectasis in the post-anesthesia care unit.

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