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Incidence of perioperative respiratory complications in patients undergoing elective open upper abdominal surgery under general anaesthesia: Smokers versus non-smokers - An observational study

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ABSTRACT

Background: Smoking has various deleterious effects and peri-operative complications. Pulmonary complications following abdominal surgery are frequent and associated with increased morbidity and mortality and length of hospital stay. **Aims and Objectives:** Hence, this study was done to observe the incidence of various respiratory and cardiovascular complications in the perioperative period in patients undergoing elective open upper abdominal surgery under general anaesthesia among smokers versus non-smokers. The various complications which are studied are as follows - Arterial desaturation, Severe coughing, Laryngospasm, Bronchospasm, Recurrent apnea, Variations in Mean Arterial Blood Pressure and Heart rates. **Materials and Methods:** Male patients ASA-I, II or III, aged 20–60 years undergoing elective open upper abdominal surgery under general anaesthesia were selected. They were divided into two groups (during pre-anaesthetic checkup) - smokers (>10 cigarette/day for the past 1 year and continued smoking till admission), non-smokers (who never smoked). General anaesthesia was given according to standard protocol. **Results:** The smokers had higher incidence of laryngospasm as well as bronchospasm but they were not statistically significant. Smokers had low baseline SpO_2; greater fall in SpO_2 just after extubation, before sending to PACU and on day 1 which were statistically significant. Smokers had raised MAP just after extubation, on day 1 and day 2 which were statistically significant. **Conclusion:** Smokers had increased incidences of respiratory and hemodynamic complications than non-smokers.

Key words: GA; Haemodynamic complications; Non-smokers; Open upper abdominal surgery; Respiratory complications; Smoker

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INTRODUCTION

Perioperative respiratory complications are a major concern of elective open upper abdominal surgery under G.A., and smoking is known to increase the frequency of complications.[1-4] Despite this, the recommendations to stop smoking before elective surgery are rarely followed.

Smoking impairs mucus transport, pulmonary macrophage function, increases bronchial reactivity, reduces the closing capacity of the lung and increases arterial carbon monoxide

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levels. These adverse effects can explain the increased susceptibility to pulmonary complications. Smoking also alters the immune system.[5]

Carbon monoxide reduces oxygen transport and metabolism. Cyanide inhibits mitochondrial oxidative metabolism. These adverse events can explain the increased susceptibility to various pulmonary complications among smokers. As well as the causes of stormy induction of anaesthesia. Hence non-smokers are expected to have smoother perioperative period.[6,7]

Smoking cessation therapy appears to be more efficient when introduced before a surgical procedure and hence, the preoperative period might represent a golden moment for smoking cessation. Also longer period of preoperative smoking cessation is more beneficial.[8,9] Still there would be a significant proportion of patients who would not be interested in smoking cessation as they have no interest in giving up smoking rather their smoking increases due to preoperative tension for the forthcoming procedure.

Again previous smokers have been found to suffer from relapse rates of >50%,[10] and this may indicate that a significant percentage of this group would revert back to smoking during the follow-up period.

We have undertaken this study to observe the perioperative complications among smokers versus non-smokers undergoing elective open upper abdominal surgery under general anaesthesia.

Aims and objectives

1. To compare perioperative respiratory complications among smokers versus non-smokers undergoing elective open upper abdominal surgery under general anaesthesia,
2. To compare their haemodynamic effects and
3. To compare level of analgesia using Visual analogue scale (VAS) score.

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary Medical College and Hospital from January 2018 to June 2019 on 20–60-years-old male patients, posted for elective open upper abdominal surgery (except cardiothoracic surgeries) under general anaesthesia. ASA status I, II, III were included in the study.

Sample size/design

$Z\alpha$ is a constant, set by convention according to the accepted alpha error. Here, it is 1.96 Similarly $Z\beta$ is 0.84. Now from previously published study we get[4],

P1 percentage of non-smokers having respiratory complications = 11% or 0.11

P2 percentage of smokers having respiratory complications = 20% or 0.20

And P = (P1+P2)/2=0.155

Now sample size $N = \{Z\alpha \sqrt{P(1-P)} + Z\beta\sqrt{P1(1-P1)+P2(1-P2)}\}^2/(P1-P2)^2$

Now putting the values we get N=160

The study was initiated after obtaining approval of the institutional ethics committee. The allocation was open level. Patients with ASA IV status, patients with psychoactive medication, COPD not being controlled by regular medication, comorbidities such as diabetes, hypertension, coronary artery disease and obstructive sleep apnoea and alcoholic patients were excluded from the study. Patients with anticipated difficult intubation were also excluded.

During pre-anaesthetic check up smoking history was taken along with the number of cigarettes smoked per day as well as the duration. Patients were instructed to stop smoking immedialy. Patients with pulmonary changes were optimized before surgery. Optimization was done by 1) Maintaining proper hydration, 2) Nebulization, 3) Antibiotic levofloxacin (500–750) mg OD, 4) Chest physiotherapy – palpation, percussion, vibration, deep breathing, coughing and postural drainage.

The patients were divided into two groups - 1) smokers (>10 cigarettes/day for the past 1 year), 2) non-smokers (who never smoked). Lung function tests (mainly spirometry) were done to detect preoperative respiratory problems. Pre-operative evaluation was done taking proper history, physical examinations, and routine pre-operative investigations (Hb, blood sugar, serum urea, creatinine, chest X-ray, ecg).

All patients were premedicated with Tab Alprazolam 0.5 mg oral, the night before surgery, Tab. Pantoprazole (40 mg) oral at 6 A.M. and a minimum fasting state of 8 h before anaesthesia was ensured. In the theater, peripheral line was established. Intravenous crystalloid infusion was started and standard ASA monitors were attached. All patients were pre-oxygenated for 3 min with 100% oxygen. Premedications given with injection Midazolam 0.03 mg/kg, Fentanyl 2 mcg/kg intravenously. Induction of anesthesia was done by Propofol 2 mg/kg and confirmed with loss of response to verbal commands followed by checking for bag-mask ventilation.

Intravenous suxamethonium 1.5 mg/kg was used for neuromuscular blockade. After one minute of bag-mask

ventilation with 100%, oxygen patient was intubated with appropriate size endotracheal tube. Position was checked by bilateral chest auscultation and $EtCO_2$. Anaesthesia was maintained by nitrous oxide: oxygen (2:1) and sevoflurane. Loading dose of Atracurium was administered followed by intermittent boluses depending on need.

Haemodynamic and variation in oxygen saturation level monitoring was done every 5 min and was recorded.

At the end of surgery nitrous oxide was discontinued and residual neuromuscular blockade was reversed by Neostigmine 0.05 mg/kg and Glycopyrolate 0.005 mg/kg. Patient was extubated after fulfilling extubation criteria.

The various parameters that were observed during the whole perioperative period are-

- Arterial desaturation: pulse oximetry (SpO_2) <92% for more than 1 min.
- Laryngospasm: audible stridor or airway obstruction not relieved by airway manipulations.
- Bronchospasm: audible wheeze or unexplained increase in airway pressure.
- Mean arterial pressure (MAP).
- Heart rate (HR) and
- Level of analgesia using VAS score.

All the patients after operation were sent to Post Anaesthesia Care Unit (PACU) and observed for 48 h for any complications.

Statistical analysis

For statistical analysis, data were entered into a Microsoft Excel spreadsheet and then analyzed by SPSS (version 25.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sided sample t-tests were used for a difference in mean involved in independent samples or unpaired samples. Paired t-tests were used as form of blocking and which had greater power than unpaired tests. A Chi-square test (χ^2 test) was used for statistical hypothesis test. "Chi-squared test" is often used as short for Pearson's Chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate. P≤0.05 was considered for statistically significant.

RESULTS

Demographical variable like age, weight,height and BMI were comparable in both the groups with no statistical difference which is shown in Table 1.

Difference of mean just after extubation MAP versus smoker and nonsmoker was statistically significant (P=0.0001). Difference of mean day 1 MAP versus smoker and nonsmoker was not statistically significant (P=0.3314). Difference of mean day 2 MAP versus smoker and nonsmoker was statistically significant (P=0.0006) shown in Table 2 and Figure 1.

Difference of mean just after intubation HR versus smoker and nonsmoker was statistically significant (P=0.0021). Difference of mean 1 h intra-op HR versus smoker and nonsmoker was not statistically significant (P=0.1910). Difference of mean just after extubation HR versus smoker and nonsmoker was statistically significant (P=0.0001).Others value were statistically not significant shown in Table 3 and Figure 2.

Difference of mean baseline SpO_2 versus smoker and nonsmoker was statistically significant (P=0.0040),but the difference of mean value was not that clinically significant. Difference of mean just after extubation SpO_2 versus smoker and nonsmoker was statistically significant (P=0.0049). Difference of mean before sending to ward SpO_2 versus smoker and nonsmoker was statistically significant (P≤0.0001) shown in Table 4 and Figure 3.

Difference of mean VAS Score Day 1 morning versus smoker and nonsmoker was not statistically significant (P=0.5478). Difference of mean VAS Score Day 2 morning versus smoker and nonsmoker was not statistically significant (P=0.3034) shown in Table 5 and Figure 4.

In nonsmoker, 3 (1.9%) patients had Arterial desaturation. In smoker, 12 (7.5%) patients had Arterial desaturation. Association of Arterial desaturation (SpO_2<92%) versus smoker and nonsmoker was statistically significant (P=0.0344).

In nonsmoker, 160 (100.0%) patients had no Bronchospasm. In smoker, 3(1.9%) patients had Bronchospasm. Association of Bronchospasm versus smoker and nonsmoker was not statistically significant (P=0.245) shown in Table 6.

DISCUSSION

In our study we found –

- The smokers had higher incidence of laryngospasm as well as bronchospasm but they were not statistically significant.

Table 1: Distribution of means age versus smoker and nonsmoker

Demographical variable of two groups:			
Variable	**Nonsmoker (160) Mean±SD**	**Smoker (160) Mean±SD**	**P-value**
Age	46.906±9.944	46.675±10.144	0.837
Height (cm)	165.050±6.310	165.918±6.644	1.994
weight	65.43±5.47	65.994±5.762	0.3710
BMI	24.046±2.082	24.0063±2.216	0.868

Table 2: Distribution of mean MAP at different time interval : Smoker and Nonsmoker

	Number	Mean	SD	Minimum	Maximum	Median	P-value
Baseline MAP							
Non Smoker	160	80.1688	8.6644	65.0000	96.0000	81.0000	0.2719
Smoker	160	81.1938	7.9823	67.0000	97.0000	80.0000	
During induction MAP							
Non Smoker	160	78.4750	8.2041	64.0000	92.0000	79.5000	0.2392
Smoker	160	79.5375	7.9130	66.0000	94.0000	80.0000	
Just after intubation MAP							
Non Smoker	160	75.1813	8.9638	58.0000	94.0000	75.5000	0.5260
Smoker	160	75.8438	9.6905	55.0000	96.0000	77.0000	
30 min intra-op MAP							
Non Smoker	160	75.8250	8.0263	63.0000	90.0000	76.0000	0.4769
Smoker	160	76.5063	9.0561	60.0000	100.0000	77.0000	
1 h intra-op MAP							
Non Smoker	160	76.5250	7.2224	65.0000	90.0000	76.0000	0.8151
Smoker	160	76.3125	8.9296	65.0000	99.0000	73.0000	
Just after extubation MAP							
Non Smoker	160	83.2563	7.8141	69.0000	100.0000	82.5000	0.0001
Smoker	160	86.7688	7.8044	70.0000	103.0000	88.0000	
Before sending to ward MAP							
Non Smoker	160	80.3750	7.3534	67.0000	92.0000	80.0000	0.3314
Smoker	160	81.1438	6.7701	65.0000	94.0000	80.0000	
Day 1 MAP							
Non Smoker	160	80.0688	7.3091	66.0000	94.0000	81.0000	0.0013
Smoker	160	82.6563	6.9735	68.0000	95.0000	81.0000	
Day 2 MAP							
Non Smoker	160	80.1313	7.2399	66.0000	93.0000	82.0000	0.0006
Smoker	160	82.9000	7.1315	70.0000	95.0000	82.0000	

MAP: Mean arterial pressure

Table 3: Distribution of mean HR at different time interval: Smoker and Nonsmoker

	Number	Mean	SD	Minimum	Maximum	Median	P-value
Baseline HR							
Non Smoker	160	85.3000	9.7360	68.0000	110.0000	85.0000	0.7967
Smoker	160	85.5875	10.2081	65.0000	107.0000	85.0000	
During induction HR							
Non Smoker	160	83.2375	8.5344	68.0000	103.0000	83.0000	0.7084
Smoker	160	82.8813	8.4915	66.0000	100.0000	84.0000	
Just after intubation HR							
Non Smoker	160	96.1188	10.3221	77.0000	123.0000	93.0000	0.0021
Smoker	160	100.0813	12.4071	74.0000	130.0000	99.0000	
30 min intra-op HR							
Non Smoker	160	78.0500	9.8401	56.0000	100.0000	78.0000	0.3267
Smoker	160	79.2625	12.1238	60.0000	129.0000	80.0000	
1 h intra-op HR							
Non Smoker	160	77.1750	8.5492	61.0000	96.0000	75.0000	0.1910
Smoker	160	78.5750	10.4656	62.0000	111.0000	76.0000	
Just after extubation HR							
Non Smoker	160	97.5813	12.7745	77.0000	133.0000	95.0000	0.0001
Smoker	160	103.1250	12.9054	85.0000	136.0000	100.0000	
Before sending to ward HR							
Non Smoker	160	85.9188	6.7320	70.0000	102.0000	86.0000	0.7366
Smoker	160	85.6750	6.2107	68.0000	98.0000	86.0000	
Day 1 morning HR							
Non Smoker	160	89.2313	5.2894	74.0000	98.0000	88.0000	0.1527
Smoker	160	88.3063	6.2172	70.0000	102.0000	89.0000	
Day 2 morning HR							
Non Smoker	160	87.8875	5.0232	75.0000	98.0000	88.0000	0.6523
Smoker	160	88.1938	6.9685	72.0000	105.0000	88.0000	

HR: Heart rate

Table 4: Distribution of mean SpO_2: Smoker and Nonsmoker

	Number	Mean	SD	Minimum	Maximum	Median	P-value
Baseline SpO_2							
Non Smoker	160	99.7000	0.5355	98.0000	100.0000	100.0000	0.0040
Smoker	160	99.4750	0.8238	97.0000	100.0000	100.0000	
During induction SpO_2							
Non Smoker	160	99.8125	0.4371	98.0000	100.0000	100.0000	0.6912
Smoker	160	99.7938	0.4059	99.0000	100.0000	100.0000	
Just after intubation SpO_2							
Non Smoker	160	99.5313	1.1098	94.0000	100.0000	100.0000	0.3258
Smoker	160	99.4063	1.1617	94.0000	100.0000	100.0000	
30 min intra-op SpO_2							
Non Smoker	160	99.9250	0.2642	99.0000	100.0000	100.0000	0.0936
Smoker	160	99.3813	4.0807	70.0000	100.0000	100.0000	
1 h intra-op SpO_2							
Non Smoker	160	99.9438	0.2311	99.0000	100.0000	100.0000	0.4023
Smoker	160	99.8875	0.8164	94.0000	100.0000	100.0000	
Just after extubation SpO_2							
Non Smoker	160	98.3313	2.5740	84.0000	100.0000	99.0000	0.0049
Smoker	160	97.1250	4.7248	75.0000	100.0000	99.0000	
Before sending to ward SpO_2							
Non Smoker	160	99.5438	0.9170	95.0000	100.0000	100.0000	<0.0001
Smoker	160	98.3063	1.8360	92.0000	100.0000	99.0000	
Day 1 morning SpO_2							
Non Smoker	160	99.3875	0.8087	97.0000	100.0000	100.0000	0.0278
Smoker	160	99.0938	1.4743	94.0000	100.0000	100.0000	
Day 2 morning SpO_2							
Non Smoker	160	99.5813	0.6865	98.0000	100.0000	100.0000	0.0529
Smoker	160	99.3688	1.2007	95.0000	100.0000	100.0000	

Table 5: Distribution of mean VAS score day 1 and 2 morning : Smoker and Nonsmoker

	Number	Mean	SD	Minimum	Maximum	Median	P-value
VAS Score Day 1 morning							
Non Smoker	160	4.2625	1.3388	2.0000	8.0000	4.0000	0.5478
Smoker	160	4.3563	1.4465	2.0000	8.0000	5.0000	
VAS Score Day 2 morning							
Non Smoke	160	4.4188	1.3984	1.0000	8.0000	5.0000	0.3034
Smoker	160	4.5875	1.5271	1.0000	8.0000	5.0000	

VAS: Visual analogue scale

Table 6: Distribution of laryngospasm; arterial desaturation and bronchospasm between Smoker and Nonsmoker

Variable	Non smoker	smoker	Chi-square value	P-value
Laryngospasm				
No	157	154	0.457	0.49
Yes	3	6		
Arterial desaturation				
No	157	148	4.476	0.034
Yes	3	12		
Bronchospasm				
No	160	157	1.346	0.245
Yes	0	3		

- Smokers had low baseline SpO_2; fall in SpO_2 just after extubation, before sending to PACU and on day 1 which were statistically significant.
- Smokers had more arterial desaturation (SpO_2<92%) than non-smokers which was statistically significant.
- Smokers had raised MAP just after extubation, on day 1 and day 2 which were statistically significant.
- Smokers had incidences of raised HRs just after intubation and just after extubation which were also statistically significant.
- Postoperative VAS scores among smokers and non-smokers were statistically not significant.

Myles et al.,[4] found that smokers had increased incidences of respiratory complications (i.e. laryngospasm, bronchospasm or fall in SpO_2) Our study confirms to the study of Myles et al. We have found the incidence of laryngospasm and bronchospasm was higher among smokers group though not statistically significant. But higher fall of SpO_2 was significantly lower in smoker group during baseline, just after extubation, before sending to ward and on day 1. These effects are probably due to effects of general anaesthesia and more ventilation perfusion mismatch in smokers.[4] This fall in SpO_2 was also supported by the study of Dennis et al.,[10] Graybill et al.,[11] also found that the smokers had higher incidences of respiratory complications compared to non-smokers. Chandrashekar et al.,[12] stated smokers had increased incidences of haemodynamic complications compared to non-smokers. We have got similar results.

Rodrigo[13] found that smokers had overall raised blood pressure, HR and systemic vascular resistance as compared to non-smokers. Our study conforms to the studies of Chandrashekar

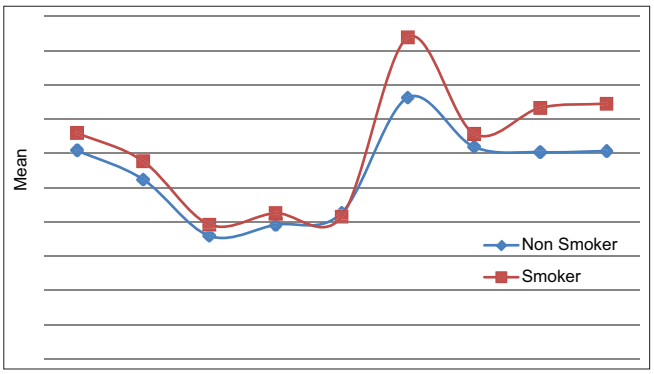

Figure 1: Changes of mean arterial pressure at various time points between the two groups

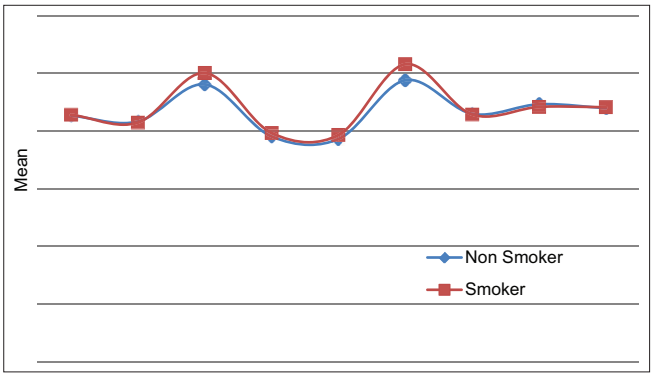

Figure 2: Difference of mean BP at various time points

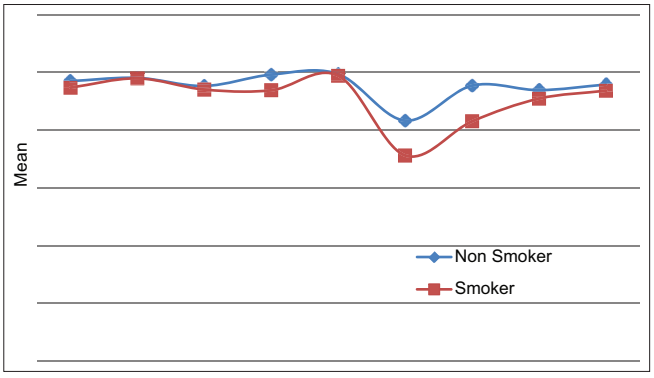

Figure 3: Difference of SpO_2 between two groups

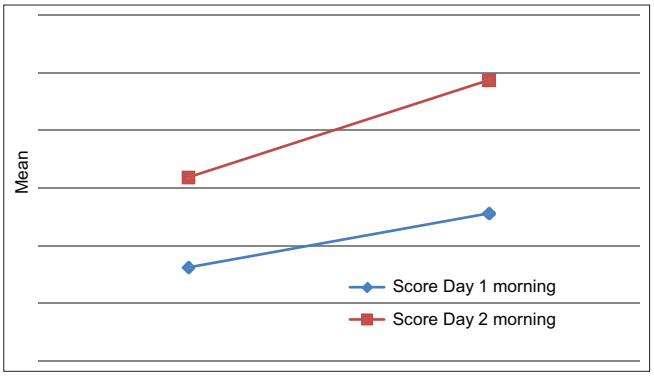

Figure 4: Difference of visual analogue scale between two groups

et al.,[12] and Rodrigo.[13] We found that MAP was significantly raised among smokers than non-smokers just after intubation and extubation, on day 1 and day 2 as compared to non-smokers. The smokers were also found to have significantly raised HRs just after intubation and extubation as compared to non-smokers. These might be because of the higher levels of nicotine in blood among smokers than non-smokers. Our study was also supported by the study of Miskovic and Lump[14] who also showed that smokers suffered from high blood pressure. Chiang et al.,[15] stated that smokers suffered from higher pain intensity and required more the study of Dennis et al.,[10] Graybill et al.,[11] also found that the smokers had higher incidences of respiratory complications compared to non-smokers.

Chandrashekar et al.,[12] stated smokers had increased incidences of haemodynamic complications compared to non-smokers. We have got similar results. Rodrigo[13] found that smokers had overall raised blood pressure, HR and systemic vascular resistance as compared to non-smokers. Our study conforms to the studies of Chandrashekar et al.,[12] and Rodrigo.[13] We found that MAP was significantly raised among smokers than non-smokers just after intubation and extubation, on day 1 and day 2 as compared to non-smokers. The smokers were also found to have significantly raised HRs just after intubation and extubation as compared to non-smokers. This might be because of the higher levels of nicotine in blood among smokers than non-smokers. Our study was also supported by the study of Miskovic and Lump[14] who also showed that smokers suffered from high blood pressure. Upadhyay et al.,[16] Chiang et al.,[15] stated that smokers suffered from higher pain intensity and required more opiate analgesics during the first 72 h postoperatively as compared to non-smokers. But in our study, we assessed the level of analgesia using VAS score for 48 h postoperatively which was statistically non-significant between smokers and non-smokers. This might be because of the analgesic coverage provided post-operatively. Chiang et al.,[15] also found that there were more number of male smokers whose average age were less than the female smokers. For excluding gender bias we selected only male patients. In our study, the mean age, height, weight and BMI among smokers and non-smokers were statistically non-significant.

Smoking perioperatively increases the chances of the development of various pulmonary complications. Cessation of smoking any time before surgery is beneficial. Patients can be motivated by assurance, nicotine gum or patch, inhaler or various pharmacotherapy such as bupropion.

Limitations of the study

The notable shortcomings of this study are:

1. Breath CO analyzer or Urine Cotinine level cannot be done to confirm or refute a history of smoking.
2. The study has been done in a single center.
3. The study was carried out in a tertiary care hospital and open label, so hospital bias and confounding bias cannot be ruled out.

4. Some of the patients possibly on different medications, which were not given by patients for properly during study and evaluation.
5. Non-smokers having passive smoke inhalation were not taken into account.

CONCLUSION

In our study, we found that smokers had increased incidences of respiratory and haemodynamic complications than non-smokers.

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