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Comparative Analysis of Bronchospasm in Patients with Normal and Difficult Airway during General Anesthesia

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ABSTRACT

Background: Background: Bronchospasm, a significant tightening of the muscles around the airways, poses diagnostic challenges as its main symptom, wheezing, has various causes. Notably, severe bronchospasm may present without wheezing due to minimal air movement, necessitating comprehensive diagnostic approaches beyond simple auscultation. **Objectives:** The study aimed to determine the frequency of bronchospasm among patients with normal and difficult airways under general anesthesia and to assess the effectiveness of treatment strategies. **Materials and Methods:** This retrospective observational study reviewed data from December 2021 to August 2022, involving 100 patients undergoing surgeries under general anesthesia at Shifa International Hospital Islamabad, New Age Medical Center, and Liaquat Memorial Hospital Kohat. Patients were divided based on airway status into normal and difficult airway groups to compare the incidence of bronchospasm and treatment outcomes. **Results:** The study found a higher prevalence of bronchospasm in patients with difficult airways, where 44.10% (19 out of 43) experienced bronchospasm, unlike the normal airway group, which had no cases. Treatment predominantly involved administering 100% oxygen, deepening anesthesia, and using salbutamol inhalers. **Conclusion:** The correlation between difficult airways and an increased rate of bronchospasm under general anesthesia is clear, emphasizing the need for vigilant monitoring and specialized care. These findings suggest the importance of preparedness in anesthesia practice to manage bronchospasm effectively, ensuring patient safety and optimal care outcomes.

Keywords: Bronchospasm, Wheezing, General Anesthesia, Auscultation, Desaturation.

INTRODUCTION

Bronchospasm and wheezing are distinct terms, with bronchospasm being one of the potential causes of wheezing [1]. It's important to rule out other causes before confirming a bronchospasm diagnosis, as severe cases may not always produce audible wheezing. Failure to secure the airway during anaesthesia can lead to decreased oxygen levels, posing significant risks [2]. Additionally, severe perioperative bronchospasm can lead to life-threatening events and irreversible brain damage, requiring swift diagnosis and immediate treatment crucial for life [3].

The supraglottic airway device (SAD) such as laryngeal mask airway (LMA) is recommended to oxygenate a patient with a difficult airway in the guidelines of both the 'American Society of Anaesthesiologists (ASA) and the 'Difficult Airway Society'[4, 5]. For the

management of such patients, oxygenation, steroids, bronchodilators should be given to the patient. Bronchospasm may be of different degrees from mild to severe and the patient should be managed accordingly. Obstruction to gas flow is caused by bronchospasm, and this is the respiratory obstruction's consequences that usually attract the anaesthesiologist's attention [6]. The bronchospasm becomes worse due to intubation, but the intubation becomes necessary. The pre-operative visit of the patient for the assessment of airway enables the anaesthesiologist to manage the alternative strategy for the risk of the patient's difficult airway intubation [7]. Bronchial spasm and wheezing is strongly predisposed by the asthmatic tendency.

Anaesthesiologists faces some different serious challenges during general anaesthesia in patients with Apert syndrome because of some anatomical abnormalities. Challenges associated with airway management in the patients of Apert syndrome are difficulties such as bronchospasm, wheezing, and even difficulty in intravenous access. The clinicians should be aware and able to overcome these challenges and other complications occurs in these patients during airway management. Apert syndrome, also called acrocephalosyndactyly (this syndrome is autosomal dominant inherited and is characterized by craniosynostosis and fusion of the digits) is a genetic syndrome characterized by anomalies of the skull, face, and limbs [8].

Gene mutations are responsible for causing the early fusion of the skull, hand and feet bones. This syndrome is associated with mutations in Fibroblast Growth Factor 2 which causes anatomic abnormalities [9]. The prevalence rate of Apert syndrome is 1:100,000, and is the second most form of craniosynostosis syndrome (A birth defect in which the bones in a baby's skull join together too early). Associated abnormalities are heart defects, polycystic kidney and pyloric stenosis [10]. For the early diagnosis of Apert syndrome some suggestive findings should be suspected in some individuals, such as craniosynostosis, characteristic dysmorphic facial manifestations, and syndactyly of the hands and feet with bone involvement [11].

The asthma which is a chronic inflammatory disease of the airways, in which recurrent episodes of wheezing occurs. Due to the occurrence of asthma, the risk of intraoperative bronchospasm increases and hence a large number of patients with asthma are presenting for anaesthesia care. In this disease some inflammatory mediators increase like eosinophils and leukotriene's which results in inflammation, exaggerated smooth muscle reactivity and constriction [12]. The signs and symptoms in such patients includes intermittent and reversible airway obstruction with cough, dyspnoea (shortness of breath), wheezing, bronchospasm, chest tightness and in some conditions blueness of the body parts such as lips and peripheries also occurs due to reduced oxygen supply. The treatment strategy for these patients includes immediate acting or long term control medications such as using bronchodilators, anti-inflammatory medications including corticosteroids, leukotriene modifiers, and other biologic agents. The number of patients of asthma in the whole world is 300 million and the prevalence in the United States is 6.7% [13]. So as a result of asthma and different other respiratory complications as described previously, intraoperative bronchospasm occurs and this is acute life threatening adverse event.

Some differential diagnosis for bronchospasm is inadequate anaesthesia, mucous plugging in the airway pulmonary aspiration is the differential diagnosis for bronchospasm, so correct diagnosis is necessary. Intraoperative risk factors should be minimized such as airway irritation, tube misplacement, aspiration and pulmonary edema. Though the incidence of perioperative severe bronchospasm in severe asthmatics is rare, but it can be life threatening when it can occurs [14]. The prevalence rate of severe bronchospasm Peri-operatively in all general anaesthesiologic procedures has been reported to be 0.17-4.2%, which is carried out in asthmatic patients [15]. The incidence rate of intraoperative bronchospasm is 1.7 per 1000 patients [16] which is revealed by retrospective analysis, with a proven increased number of occurrences in such patients who have the presence of irritable airway pathology, and the ASA close claim study also accounts the similar percentage [17].

There are some conditions which are considered to be at risk for intraoperative bronchospasm. These conditions includes, exposure to tobacco smoke, recent upper respiratory tract viral infections, for bronchial asthma exacerbation recent hospital admission and atopy history. Absolutely airway instrumentation is a strong stimulus due to which the bronchoconstriction in patients with irritable airways can triggers [18]. Another report about the bronchospasm is that it is a contributory factor in 23% of moderate and 5% of severe adverse reactions induced by radio contrast media (RCM) [19].

The obesity is considered a clear evidence-based risk factor independently for difficult intubation and as compared to normal patients, at the time of induction of general anaesthesia, the obese patients can cause faster oxygen desaturation and hypoxemia, that's why the intra operative rate of morbidity and mortality can significantly increases [20]. Due to these reasons the elected surgical obese patients requires a complete preoperative upper airway examination to specifically target the overall indices at the time of physical examination which may give us the prediction about difficult intubation [21-24].

In some patients who lacks the allergic or bronchial asthmatic history, in such patients the mechanical irritation of the upper airway that occurs at the time of endotracheal intubation can sometimes leads to bronchospasm and the exaggerated airway

pressures of the respiratory system[25], but these adverse events may be reversible with the use of inhaled bronchodilators[26]. There are so many causes of pre-and intra-operative bronchospasm in the above discussion, but these all are the causes other than the bronchospasm in patients with normal and difficult airway during general anaesthesia and the current study focusses about this issue. According to the study on different published research articles it is find that the researchers searched on different topics in which the bronchospasm during general anaesthesia occurs. The only research gap which is find out is the 'comparative analysis of bronchospasm in patients with normal and difficult airway during general anaesthesia' over which a reliable study has done in this research article. The primary aims and objectives of this research study encompass two key aspects. Firstly, it seeks to establish the prevalence of bronchospasm in patients undergoing general anaesthesia, distinguishing between those with normal airways and those with difficult airways. Secondly, the study aims to evaluate the effectiveness of various treatment approaches in managing bronchospasm in these patients.

MATERIALS AND METHODS

It was an observational study and data was collected retrospectively. The population size included 100 patients of either gender undergoing general anaesthesia for different surgeries. Patients were divided into two groups i.e. patients with normal airway and patients with difficult airway. Frequency of bronchospasm was calculated among the two groups. Moreover treatment strategies for management of bronchospasm among both groups were studied. The data was collected from Shifa international hospital Islamabad, New Age Medical Center and Liaquat Memorial Hospital Kohat. The data was collected on a pre-structured Performa [27].

2.1. STATISTICAL ANALYSIS

Frequency and percentages were calculated and data was compared using one way ANOVA through SPSS version 22.

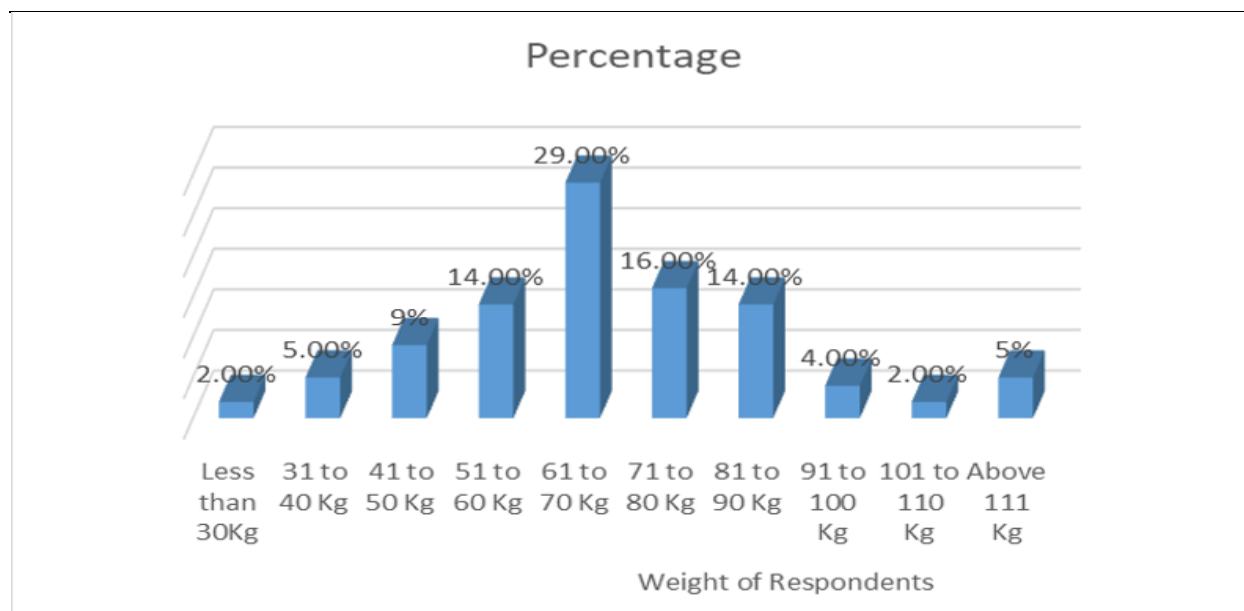
RESULTS

This research study examined a diverse population in terms of age, gender, education, and marital status. The total sample size of population was 100. Among the respondents, the age groups were categorized into eight categories. The youngest group (11-20 years) constituted 6% of the total participants, while those aged 21-30 represented 15%. The 31-40 age bracket had 21% of participants, and 41-50 accounted for 20%. Similarly, participants aged 51-60 and 61-70 both made up 20% of the sample. The older age groups (71-80 and 81-90 years) comprised 6% and 2% respectively. In terms of gender, 46% were male and 54% were female. Regarding education, the categories included postgraduates (5%), graduates (29%), individuals with intermediate education (11%), those with matric-level education (28%), individuals below matric (3%), and uneducated participants (24%). Finally, marital status was divided into single (16%) and married (84%) respondents.

Figure 1 displays ten weight categories within the research population. The first category encompasses individuals weighing between 21 to 30kg, representing only 1% of the total participants. Moving on to the second category (31 to 40kg), 5% of the individuals fell into this bracket. The third category (41 to 50kg) accounted for 9% of the total. Participants weighing 51 to 60kg constituted the fourth category, making up 14% of the sample. The fifth category (61 to 70kg) was the largest, comprising 29% of participants. Category six (71 to 80kg) included 16% of individuals. Moving up, category seven (81 to 90kg) represented 14% of the total. Category eight (91 to 100kg) encompassed 4% of individuals. The ninth category (101 to 110kg) was the smallest, with only 2% of participants. Lastly, the tenth category, consisting of individuals weighing above 111kg, made up 5% of the total participants.

Table 1. Demographic Analysis (N=100)

		Frequency	Percent
Age	11 to 20 years	6	6
	21 to 30 years	15	15
	31 to 40 years	21	21
	41 to 50 years	20	20
	51 to 60 years	20	20
	61 to 70 years	10	10
	71 to 80 years	6	6
	81 to 90 years	2	2
Gender	Male	46	46.0
	Female	54	54.0
Education	Post-Graduation	5	5.0
	Graduation Intermediate	11	11.0
		29	29.0
	Matriculation	28	28.0
	Under Matric	3	3.0
	Uneducated	24	24.0
Marital status	Single	16	16.0
	Married	84	84.0

**Figure 1.** Distribution of Participants on Base of Weight.

In figure 2, the prevalence rate of bronchospasm during general anesthesia in the total population of the study is shown'. According to this research study, in 81 patients out of hundred patients the bronchospasm has not occurred during general anesthesia, and in the remaining 19 patients, the bronchospasm has occurred. The number of the patients who had not suffered from bronchospasm during general anesthesia is 81%, and on the other hand, the ratio of the patients who had suffered from bronchospasm during general anesthesia is 19%.

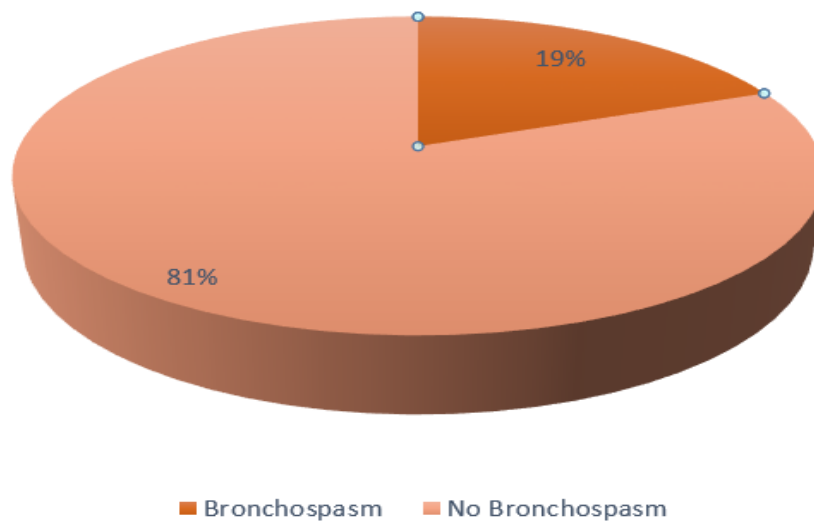


Figure 2. Prevalence of Bronchospasm.

The table 2 shows the prevalence of bronchospasm in the research population of this study. There are total 100 participants in this study. Out of 100 participants, there were 57 patients with normal airway, and there was no bronchospasm in these patients. On the other hand, there are total 43 patients with difficult airway which includes, 19 patients with bronchospasm and 24 patients with no bronchospasm during general anaesthesia. The overall ratio of the patients who does not suffered from bronchospasm is 81.

Table 2. Prevalence of Bronchospasm in Patients with Normal and Difficult Airway.

	Prevalence of Bronchospasm		Total
	Bronchospasm	No Bronchospasm	
Normal Airway	0	57	57
Difficult Airway	19	24	43
Total	19	81	100

The hypothesis tests that, bronchospasm occurs in relation to airway of different groups. Participants were divided into two groups (Normal airway and difficult airway). The one way ANOVA results suggests that, the bronchospasm occurs in relation to airway of different groups, scores of bronchospasm in different groups differs significantly. So there is a significant difference between the bronchospasm and airway across the groups, because in the ANOVA table the significance level is $< .001$ ($df= 1, 98$, $Ms= 7.621$, 0.172 , $f= 44.223$, $sig 0.000$).

The figure 3 shows the variance of bronchospasm in two groups. There is negative relation between the patients of normal airway and bronchospasm ratio. Its means that when the number of patients with normal airway increases, the bronchospasm ratio will be decreases, or when the number of the patients with normal airway decreases, the bronchospasm ratio will be increases. On the other hand, there is positive relation between the patients of difficult airway and bronchospasm ratio. Its means that, when the number of patients with difficult airway increases, the bronchospasm ratio will be increases, or when the number of patients with difficult airway decreases, the bronchospasm ratio will be decreases.

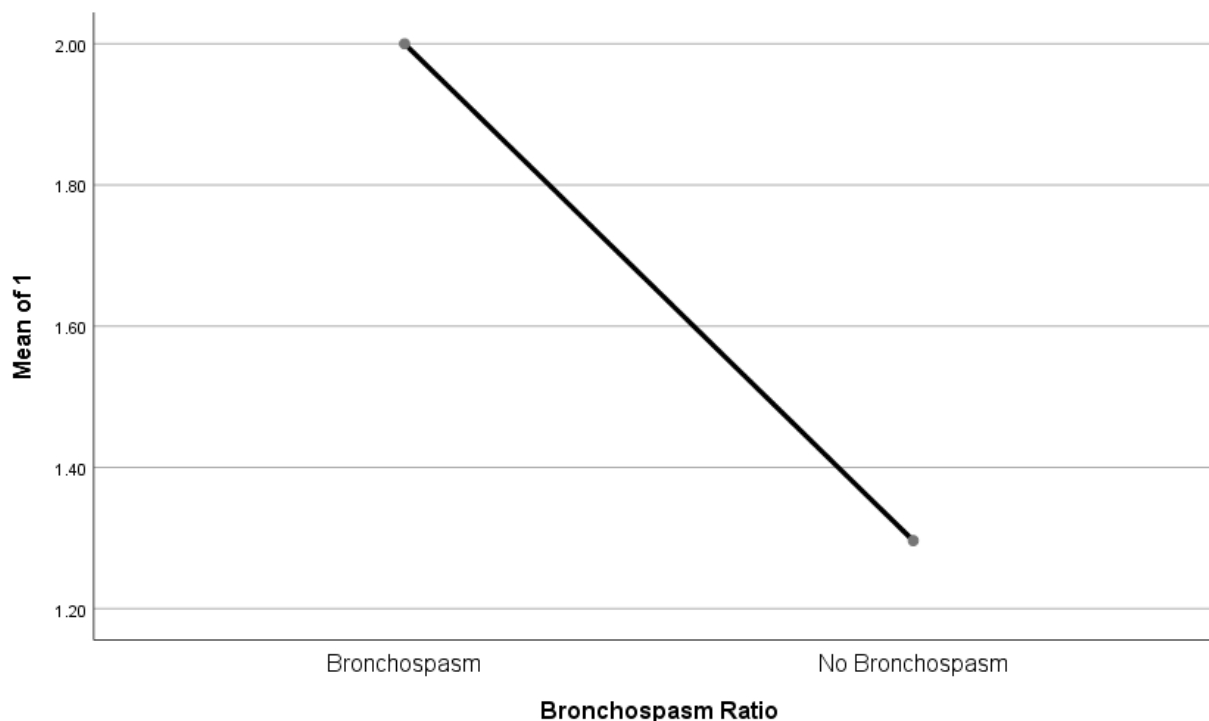


Figure 3. Variance of Bronchospasm in Two Groups.

Table 3. Association of Airway with Bronchospasm.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.621	1	7.621	44.223	0.000
Within Groups	16.889	98	0.172		
Total	24.510	99			

The following figure 4 shows the bronchospasm ratio in patients with difficult airway. The number of total patients with difficult airway is 43. In all these patients with difficult airway, only 19 patients were suffered from bronchospasm during general anesthesia. The prevalence rate of bronchospasm in all patients with difficult airway was 44.10%. When the bronchospasm has occurred in the above mentioned patients, the treatment strategy was approximately same in all hospitals from where the data was collected. According to our assessment, the anesthesiologists gave 100% oxygen to the patient, they deepened the anesthesia and they gave the salbutamol in inhalational form as the salbutamol is a fast acting bronchodilator.

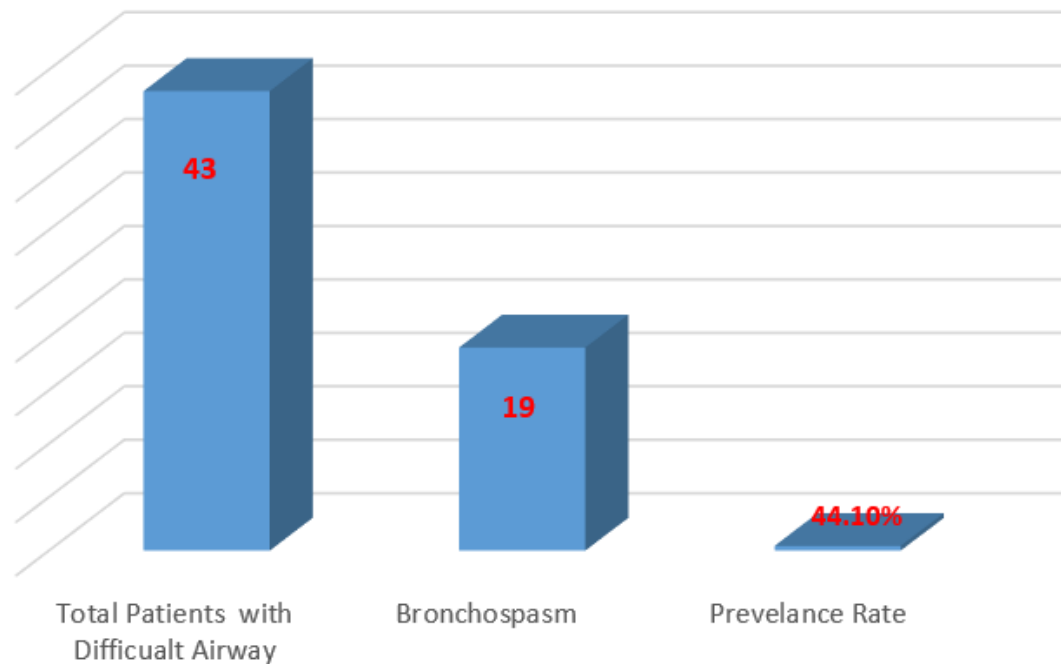


Figure 4. Bronchospasm in Patients with Difficult Airway.

DISCUSSION

In According to this study, the prevalence rate of bronchospasm is higher in patients with difficult airway compared to patients with normal airway under general anesthesia. Out of 100 patients of this research study, there were 43 patients with difficult airway in which 19 patients were suffering from bronchospasm under general anesthesia, and 24 patients were not suffered. The remaining 57 patients were with normal airway, and no any patient was suffered from bronchospasm during general anesthesia. The number of total patients in this research study, who were not suffered from bronchospasm under general anesthesia is 81. The overall prevalence rate of bronchospasm in patients with difficult airway under general anesthesia was 44.10%.

Obese people are more likely to experience bronchospasm than non-obese patients, when undergoing elective laparoscopic surgery. The bronchospasm is observed a clinically related issue in patients who undergoes bariatric laparoscopic surgery with obesity. As the rise of obesity is directly associated with difficult airway. The findings indicated that, obese patients had increased prevalence of bronchospasm (6 of 50, 12%), which was substantially more than the prevalence in non-obese patients (0 of 50, 0%, $P = 0.027$)[28]. The reason of higher incidence of bronchospasm in obese patients is unclear. In relation to patients without bronchospasm, patients with bronchospasm indicated considerably higher airway pressure and PaCO₂ levels. Increase in airway pressures, PaCO₂ between groups observed in the study are consistent with the literature on obese awake patients, and this is indicated by them that, undergoing laparoscopic surgery the obese patients are in a "pre-bronchospasm state" and are consequently susceptible to bronchospasm.

The airway management in the patients of apert syndrome (caused by mutations in a gene known as fibroblast growth factor 2) is related with some difficult challenges such as bronchospasm, wheezing and even difficulty in IV access. Because of the abnormalities of the airway, the anesthesia related issues in these patients was the anticipation of difficulty in intubation and ventilation. A lot of secretions is produced by patients with apert syndrome which might irritate their airways more and increases their risk of bronchospasm [8]. The craniofacial anatomic abnormalities are frequently related to airway obstruction due to reduced airway caliber or complete airway obstruction. The patients with morbid obesity have a high relative risk of difficult intubation. According to the initial hypothesis of this study, nothing is totally indicatable by any one specific method and that the anesthesia providers may face the possibility in obese patients for difficult intubation. According to the second hypothesis of this study, either difficulty in intubation can leads to bronchospasm due to manipulation or using specific equipments. The results of this article shows no such relation. This is the fact that overall obese patients who presented with bronchospasm (6 out of 50, a

very high rate compared to general population) these patients were in the easy intubation group and indicates that induction to anesthesia may accelerate different mechanisms in obese patients[20]. These mechanisms may be attributed to chronic lung inflammation, which in addition with mechanical irritation during at the time of intubation can progress to bronchial hyperactivity and consequent bronchospasm[29]. Nevertheless, this study indicates that difficult intubation does not enhance the likelihood of bronchospasm. Because, studies concerning about bronchospasm at the time of intubation makes large references to the other causes (any allergic reaction or mechanical irritation) of bronchospasm during general anesthesia, but no any difference or any comparison has been drawn yet by any one between simple and difficult intubation, and more especially to the issue that weather, the ratio of bronchospasm is increased due to difficulty in intubation [30, 31].

In relation to the above discussion (literature review), this current study shows different results as described previously. In the above discussion, the study is about the bronchospasm in obese and non-obese patients undergoing elective laparoscopic surgery, difficult airway management in apert syndrome and about that do difficult airway techniques predispose obese patients to bronchospasm etc. In these studies there is a relation of bronchospasm with other different variables as mentioned above. In its extension the current study is about the 'comparative analysis of bronchospasm in patients with normal and difficult airway under general anesthesia' and there is a huge difference among the results. The results of the current study indicates that there is no any data about this topic, for the first time this research is done to provide data about this issue.

Limitation of the study

This is recommended that, the population of this study was 100 patients and the study was done about two variables, (Normal and difficult airway). So to extend the current issue, the researchers are recommended to increase the sample size or population of their study, to research about any other aspects other than the airway or to increase the area of their study because the current study was done in a limited geographic area.

Conclusion

The study was done about the 'comparative analysis of bronchospasm in patients with normal and difficult airway during general anesthesia'. According to the current findings, 19 patients with difficult airway were suffered from bronchospasm during general anesthesia. The study also confirms that, the airway is significantly correlated with the bronchospasm ratio. In patients with normal airway, there is 0% prevalence rate of bronchospasm, and in patients with difficult airway there is 44.10%. As a whole the prevalence rate of bronchospasm in patients with difficult airway was significantly higher as compared to patients with normal airway, because according to the current study there was 0% prevalence of bronchospasm in patients with normal airway.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

AUTHOR CONTRIBUTION

All the Authors contributed equally in planning and the collection of data, drafting manuscript and analyzing data to be qualified for Authorships.

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