# Is Extubation with Positive Pressure Safer than Extubation with Negative Pressure?

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**ABSTRACT**

**Objective:** To compare the frequency of respiratory complications with two different methods of extubation i-e negative pressure extubation versus extubation with positive pressure.

**Study Design:** Quasi Experimental Study.

**Place and Duration:** This Study was conducted in CMH Peshawar, from 1st November 2022 till 30th October 2023.

**Methodology:** A total of 200 patients planned for any surgery involving general anesthesia and tracheal intubation were chosen for this study and were divided into two equal groups. Extubation was done when the patients were fully awake. In group N (Negative Pressure), endotracheal tube was removed in a single smooth motion while applying suction to the endotracheal tube. On the other hand, in group P (Positive pressure), extubation was done by applying positive pressure of 15-20 $cmH_2O$. Patients were observed for post-extubation complications for 10 minutes after the extubation.

**Results:** In group N, only 6 (6%) had cough; whereas in group P, 12 (12%) patients had cough and this difference was statistically not significant (p-value=0.138). Breath holding was seen in 7 patients in both groups (p-value=1.0). Laryngospasm was seen in 7 patients in group N, and 3 patients in group P and the difference was not statistically significant (p-Value=0.194). Desaturation was seen more in group N than in group P but results were statistically insignificant (p-value=0.155). No patient required the re-intubation in either group.

**Conclusion:** Tracheal extubation at the end of general anesthesia with positive pressure is equally effective as compared to the extubation done with negative pressure.

**Keywords:** Airway complications, Extubation techniques, Laryngospasm, negative pressure extubation, Positive pressure extubation, tracheal extubation.

**How to Cite This:**

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## INTRODUCTION

General anesthesia usually requires endotracheal intubation during the surgical procedures. Though seemingly very simple procedure but intubation of trachea caries many risks which include trauma to the airway, laryngospasm, bronchospasm, hypoxia, hemodynamic stability, failure to intubate and ventilate leading to death.[1-3] Similarly, extubation at the conclusion of surgical procedures and anesthesia is associated with various complications including coughing, bucking, laryngospasm, bronchospasm, trauma to the airway, aspiration, hemodynamic instability hypoxia, re-intubation.[4-6] Incidence of these complications varies widely ranging from 13 percent to as high as 66 percent.[7]

Various strategies have been employed to reduce the incidence of airway complications which are associated with extubation of trachea at the end of surgical procedures. Most commonly used technique for extubation i.e negative pressure extubation, involves application of suction catheter on endotracheal tube and removing it with a single smooth motion while continuously applying the suction over endotracheal tube. Various researchers have also tried the deep extubation technique which involves extubation of trachea when patient is in deeply anesthetized and his airway reflexes are blunted.[8] Though this technique showed promising results but it is associated with increased risk of aspiration. Very few researchers have tried extubation with positive pressure, a technique in which oropharynx is thoroughly suctioned and then endotracheal tube is removed with a single smooth motion while apply continuous positive pressure instead of applying suction and creating negative pressure.[9]

Some researchers have argued that airflow passing between the larynx and the endotracheal tube helps expel accumulated

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subglottic secretions upwards towards the oropharynx, from where they can be easily suctioned once they reach the oral cavity Some researchers have showed concern that continuous positive pressure during extubation may push the secretions into the distal airways which may result in coughing, laryngospasm and bronchospasm. Rationale of this study was to evaluate the safety of extubation with positive pressure and compare its results with the conventional extubation technique done with negative pressure. Therefore, this study was planned with an objective to compare the frequency of respiratory complications with two different methods of extubation i.e negative pressure extubation versus extubation with positive pressure.

## METHODOLOGY

This Quasi Experimental study was done in Anesthesia Department Combined Military Hospital Peshawar Pakistan, from 1st November 2022 till 30th October 2023. Ethical Review Board was taken before conducting the study (Reference Letter No. A23/ERC/43 dated 7th September 2022). All patients or attendants of unconscious or younger ages who were willing and signed the consent to participate in this study were selected. Patients of either sex with age ranging from 3 to 70 years belonging to American Society of Anesthesiologists (ASA) status I, II and III scheduled for any elective and emergency surgery involving general anesthesia and endotracheal intubation were recruited for this study after signing the consent to participate in this study.[10] Patients with history of bronchial asthma, COPD, recent respiratory infections were excluded from this study. Patients with more than two intubation attempts were also excluded. A total of 200 patients were selected for this study and were divided into two equal groups randomly with the help of computer generated random number table. Sample size calculation was done with the help of online sample size calculator (10) with confidence level of 95%, power of 80% with population proportion P1 of 64% and population proportion P2 of 77%.[11] Sample size came out to be 190 but it was round off to be 200.

All patients were extubated fully awake. In both groups thorough oropharyngeal suction was done prior to extubation. In group N (Negative pressure), endotracheal tube was removed in a single smooth motion while applying suction to the endotracheal tube. On the other hand, in group P (Positive pressure), extubation was done by applying positive pressure of 15-20 $cmH_2O$ depending the age of the patient. Patients were given 100% oxygen immediately after extubation. Patients were observed for post-extubation complications for 10 minutes after the extubation. These included persistent coughing (coughing continuing for more than 60 seconds), breath holding for more than 15 seconds, desaturation ($SPO_2$ less than 90%), laryngospasm and need for re-intubation. To reduce the bias in data collection, extubation and post-extubation period was observed and data was collected by a non-author resident anesthesiologist with at least two years of experience.

Data was collected on a proforma specially designed for this study. Demographic data including gender, age and body mass index was noted for each patient. American society of anesthesiology (ASA) status of the patient, surgery type and duration of surgery were also noted.

**Data Analysis:** Statistical Package for Social Sciences (SPSS) v. 24 for was used to compute the data. Continuous variables were presented as mean and standard deviation, whereas qualitative variables were presented as frequency and percentage. Both groups were compared using independent sample t-test (Age, BMI) and chi-square test (gender, frequency of complications). P-value of 0.05 or less was taken as significant.

## RESULTS

A total of 200 patients were selected for this study. Selected patients had an age range between 3 to 78 years. In group N, age range was from 3 to 74 years with mean of 30.06±16.3 years. In group P, age range was from 5 to 78 years with mean of 34.17±18.77 years. In group N, 52 were male and 48 were female with male to female ratio of 1.08:1. In group P, out hundred 41 patients were male and 59 were female with male to female ratio of 0.69:1. In group N, mean BMI was 23.83±3.72 $kg/m^2$, whereas in group P, it was 24.34±3.63 $kg/m^2$. Detailed comparison of demographic characteristics is shown in table-I.

**Table I: Comparison of Demographic Characteristics between Negative and Positive Pressure Extubation Groups. (N=200)**

| Characteristic | | Group N (n=100) | Group P (n=100) | p-Value |
|---|---|---|---|---|
| Age (Years) | | 30.06±16.3 | 34.17±18.77 | 0.1 |
| BMI ($kg/m^2$) | | 23.83±3.72 | 24.34±3.63 | 0.32 |
| Gender n (%) | Male | 52 (52%) | 41 (41%) | 0.12 |
| | Female | 48 (48%) | 59 (59%) | |

**Table II. Comparison of Surgical Procedures Performed in Both Groups (Negative vs Positive Pressure). (N=200)**

| Surgery | Group N (n=100) | Group P (n=100) | Total (n=200) |
|---|---|---|---|
| Laparoscopic Cholecystectomy | 16 (16%) | 28 (28%) | 44 (22%) |
| Appendicectomy | 19 (19%) | 16 (16%) | 35 (17.5%) |
| Tonsillectomy | 20 (20%) | 12 (12%) | 32 (16%) |
| Turbinoplasty | 6 (6%) | 10 (10%) | 16 (8%) |
| Septoplasty | 7 (7%) | 5 (5%) | 12 (6%) |
| Functional Endoscopic Sinus Surgery | 5 (5%) | 6 (6%) | 11 (5.5%) |
| Total Abdominal Hysterectomy | 5 (5%) | 3 (3%) | 8 (4%) |
| Rhinoplasty | 4 (4%) | 2 (2%) | 6 (3%) |
| Dacryocystorhinostomy | 2 (2%) | 4 (4%) | 6 (3%) |
| Thyroidectomy | 4 (4%) | 2 (2%) | 6 (3%) |
| Laparotomy | 5 (5%) | 0 (0%) | 5 (2.5%) |
| LSCS | 2 (2%) | 2 (2%) | 4 (2%) |
| Tympanoplasty | 0 (0%) | 4 (4%) | 4 (2%) |
| PUH | 2 (2%) | 2 (2%) | 4 (2%) |
| Diagnostic Lap | 0 (0%) | 3 (3%) | 3 (1.5%) |
| Myringotomy | 2 (2%) | 0 (0%) | 2 (1%) |
| Circumcision | 1 (1%) | 0 (0%) | 1 (0.5%) |
| Herniotomy | 0 (0%) | 1 (1%) | 1 (0.5%) |
| **Total** | **100 (100%)** | **100 (100%)** | **200 (100%)** |


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In group N, 60 patients were labelled as American Society of Anesthesiology (ASA) physical status 1, 38 were ASA 2 and 2 were ASA 3. Whereas in group P, 56 patients were ASA 1, 41 patients were ASA 2 and 3 patients were ASA 3. Both groups were comparable in terms of ASA physical status with p-value of 0.798. In group N, mean duration of surgery was 79.01±52.12 minutes while in group P it was 74.78±33.58 minutes. Difference between both groups in terms of duration of surgery was insignificant with a p-value of 0.549. Details of the surgeries performed in both groups is shown in table II.

In group N, out of 100 patients, only six had cough; whereas in group P, 12 patients had cough but the difference was not statistically significant. Breath holding was seen in 7 patients in both groups. Laryngospasm was seen in 7 patients in group N, and 3 patients in group P but the difference was not statistically significant. Desaturation was seen more in group N than in group P but results were not statistically significant. No patient required the re-intubation in either group. Detailed comparison of complications is shown in table III.

**Table III. Comparison of complications (N=200)**

| Complication | Group N (n=100) | Group P (n=100) | p-value |
|---|---|---|---|
| Cough | 6 (12%) | 12 (24%) | 0.138 |
| Breath Holding | 7 (14%) | 7 (14%) | 1.0 |
| Laryngospasm | 7 (14%) | 3 (6%) | 0.194 |
| Desaturation (n%) | 2 (4%) | 0 (0%) | 0.155 |
| Re-intubation | 0 (0%) | 0 (0%) | -- |

## DISCUSSION

The major finding of our study was that both the extubation techniques i.e. extubation with negative pressure and extubation with positive pressure are equally effective with no significant statistical difference in terms of respiratory complications. This proves that the positive pressure extubation technique is as safe as the extubation with negative pressure. Our results are comparable to various international studies conducted by various authors[12-14]. However, in a systematic review conducted by Shimada K et al demonstrated that extubation with positive pressure is associated with lower risk of complications as compared to extubation with negative pressure. These results are contradictory to our results.[15]

In this study, we observed that more patients in positive pressure had post extubation cough as compared to negative pressure group but the difference not statistically significant. In another similar study, it was observed that incidence of post-extubation cough was lesser in positive pressure group as compared to negative pressure group[11].

In our study, we observed that 2% patients desaturated after extubation with negative pressure and no patient desaturated with positive pressure technique but this difference was not statistically significant (p-value 0.155). In a study done by Yousefshahi F et al found out that positive pressure extubation helps improve respiratory parameters and attenuates the oxygenation complications and thus amplifies oxygenation after extubation.[16] This could be due to the fact that negative pressure sucks out the oxygen reserve from the lungs while extubation whereas positive pressure extubation insufflates the lungs with 100 percent oxygen. In another similar study, L'Hermite J. et al. compared the two techniques in terms of onset of desaturation.[17] They found out that positive pressure extubation did not delay the onset of desaturation as compared to the extubation with negative pressure in patients who underwent general anesthesia. These results are contradictory to our results.

In a systematic review conducted Lee Y et al included 7 studies that compared the extubation with positive versus negative pressure.[18] They observed that all the studies but one concluded that there was a lower risk of airway complications including airway obstruction, desaturation, aspiration, atelectasis and re-intubation with positive pressure technique as compared to the negative pressure technique. Similarly in a local study conducted by Khan KA et al concluded that negative pressure extubation increases the requirement of suctioning and supplemental oxygen in immediate post extubation period of 3 minutes.[19]

In our study, we found out that no patient required re-intubation in either group. In a similar study conducted by Andreu MF et al. found out patients extubated with negative pressure were more likely to require re-intubation as compared to those who were extubated with positive pressure.[20] This proves that extubation with positive pressure is not inferior or may be even superior to negative pressure extubation.

The strength of our study is that we included a reasonably large sample size wide range of patients in terms of age, type and duration of surgery and both genders. One possible limitation of our study is that this was a single center study. It is recommended that a multicenter study should be conducted with even a larger sample size to reach to a better conclusion.

## CONCLUSION

It is concluded in our study that extubation of trachea at the end of general anesthesia with positive pressure is equally effective as compared to the extubation done with negative pressure.

## AUTHOR'S CONTRIBUTION

**Hussain A:** Conceived Idea, Designed Research Methodology, Literature Search, Literature Review, Data Interpretation, Statistical Analysis and Manuscript Writing

**Munir S:** Conceived Idea, Designed Research Methodology, Literature Search, Data Collection and Literature Review

**Chaudhry AH:** Data Collection, Literature Review, Data Interpretation and Statistical Analysis

**Wahid F:** Data Collection, Data Interpretation, Statistical Analysis, Manuscript final reading and approval

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