# Incidence and correlates of Barotrauma in COVID-19 Patients; data from a tertiary care hospital of Karachi.

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***Abstract*-**Barotrauma is one of the major causes of morbidity and mortality amongst covid-19 patients. In our current study, we assessed the incidence of barotrauma in covid-19 patients and its correlation with inflammatory biomarkers and demographic characteristics of patients who were treated in a tertiary care hospital of Karachi. A retrospective cross-sectional study was done using data from patient's medical records from January 2020 to June 2020.Data about patient's characteristics and correlation with barotrauma was analyzed and presented in a descriptive way. A total of 469 patients were included in the study out of which 48 patients suffered from barotrauma. Most common type of barotrauma was pneumothorax effecting 73% of the patients followed by pneumomediastinum. Barotrauma was more common in patients who had high levels of inflammatory markers. Comorbid were also compared with timeline of events and type of barotrauma (using chi-square) and p value was significant <0.05; patients having Diabetes, Hypertension, acute and chronic kidney disease. Patients on mechanical ventilation had a higher mortality rate compared to BI-PAP and CPAP. There is a high incidence of barotrauma in covid-19 ARDS patients. Factors affecting the risk of barotrauma amongst these patients include age, co-morbid conditions and inflammatory markers.

***Index Terms***- barotrauma, BIPAP, CPAP, COVID-19, ventilator

## I. INTRODUCTION

Covid-19 is caused by a newly discovered strain of coronavirus, known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2).(1) It has taken the world by storm and has changed the way people live and interact in their daily lives. It was declared a pandemic by the World Health Organization, on 11th March 2020, just three months after the emergence of the first case in Wuhan, China.(2) Its symptoms include those of respiratory illness, like cough, shortness of breath, and fever, as well as generalized symptoms, for example, fatigue, headache, nausea, gastritis, loss of the sense of smell and taste, etc.(3) The number of Cases in Pakistan alone has exceeded 1.57 million by September 2022, with Sindh accounting for 594k cases. (4)

COVID virus affects all the organ systems of the human body with the most crippling effects on the respiratory system. (5) The virus resides in the mucosal cells of the respiratory tract and replicates which increases the secretions that lead to difficulty in breathing and low oxygen saturation. (6) Covid 19 causes lung complications such as pneumonia, acute respiratory distress syndrome (ARDS), bronchitis, and sepsis. Pneumonia caused by COVID-19 is comparatively more deadly than pneumonia caused by other organisms. (5) People suffering from COVID are at a higher risk of developing ARDS and pulmonary failure which in turn leads to the need for prolonged ventilatory support.

In severe cases of COVID ventilatory support is vital to save a patient's life. (7) Ventilatory support is divided into non-invasive which includes continuous positive airway pressure (CPAP) and bi-level positive airway pressure (BiPAP) and invasive which involves a mechanical ventilator. CPAP and BiPAP are used in the setting when some pulmonary function is preserved and only assistance is needed with respiration while invasive ventilation is used in cases with poor respiratory function. (8, 9)With the prolonged and excessive use of artificial ventilation the risk of barotrauma also increases. Barotrauma refers to alveolar rupture due to the difference in alveolar pressure and pressure in the adjacent interstitial spaces. This causes the air to leak into extra alveolar tissues resulting in conditions such as pneumothorax and pneumomediastinum. (10) Pneumothorax refers to air or gas present in the pleural cavity whereas, Pneumomediastinum is the presence of air or gas within the mediastinum. (11, 12) Barotrauma is very common in our setup hence, the primary aim of this study is to analyze barotrauma in COVID patients; its types, correlation with inflammatory biomarkers, and demographic characteristics of patients who were treated in a tertiary care hospital of Karachi leading journals to complete their grades. In addition, the published research work also provides a big weight age to get admissions in reputed varsity. Now, here we enlist the proven steps to publish the research paper in a journal.

## II. MATERIALS AND METHODS

1) Characteristics of Study:
A retrospective cross-sectional study design was adopted to conduct this study. This study included the retrospective data from patient files and has no identification information used hence it was exempted by the Institutional review board and conducted according to the declaration of Helsinki. OpenEpi was used to calculate sample size with a 5% margin of error and 95% confidence interval and was found to be 154. Data was collected for a period of 6 months (January 2020 to June 2020). A convenient type of sampling technique was utilized for this study. Inclusion criteria include all patients coming

with positive COVID PCR and symptoms, Patients who underwent any type of artificial ventilation, patients who developed barotrauma after use of artificial ventilation.

2) Data Collection tool and procedure:
This was a retrospective cross-sectional study conducted in the Dr. Ziauddin University Hospital, North Nazimabad, Karachi, Pakistan. A non-probability consecutive sampling of 48 subjects was performed. The questionnaire was filled for each case including age, gender, comorbids, Xray findings, inflammatory biomarkers, type and duration of artificial ventilation and barotrauma. Responses were recorded on the questionnaire and then coded for analysis.

3) Data Analysis:
Data was analyzed using Statistical Package for Social Sciences (SPSS) version 25. The mean with standard deviation was calculated for quantitative variables. Chi-Square was used to establish associations between the variables and p-value <0.05 was considered as significant at a 95% confidence interval. Descriptive frequencies were also applied to assess some sociodemographic variables and highlight notable trends.

## III. Results

A total number of 4569 patients were admitted with COVID during the data collection time period among which 469 needed ventilatory support during their admission. Out of 469 patients a total number of 48 patients suffered barotrauma after they were shifted on artificial ventilation due to worsening of covid. Mean age of the participants was 62 years with a standard deviation of 15 years. 59% of the sample population were males while 41% were females. Most common type of barotrauma was pneumothorax effecting 73% of the patients followed by pneumomediastinum as shown in Table 01. Mean duration of hospital stay was 10 +/- 5 days. The mean day for the event (barotrauma) was 6+/- 2 days after incitation of artificial ventilation and majority of patients expired a day after the event.Those who recovered had a longer hospital stay. Comorbids were also compared with timeline of events and type of barotrauma (using chi-square) and p value was significant <0.05; patients having Diabetes, Hypertension, acute and chronic kidney disease developed the barotrauma in 3+/- 1 days as compared with those who doesn't have any comorbids. Moreover, their inflammatory markers (LDH, CRP, Ferritin, Urea and Creatinine) were high thus, they were prone to poor outcome.

When chi square was applied to determine relationship between type of ventilation and type of barotrauma a significant p value of 0.02 was obtained, further subgroup analysis revealed that both C-PAP and BI-PAP has positive association with pneumothorax while Mechanical Ventilator had significant association with both pneumothorax and pneumomediastinum. Furthermore, chi square was also applied to find association between type of ventilation and outcome of barotrauma and a significant p value of 0.01 was obtained and further analysis revealed that patients on mechanical ventilation were more prone to death as compared with other modalities.

**Table 01. Sample Characteristics**

| Variable | Male (n=28) | | Female(n=20) | | Total(n=48) | |
|---|---|---|---|---|---|---|
| | N | % | N | % | n | % |
| ***Type of Barotrauma*** | | | | | | |
| **Pneumothorax** | 19 | 68 | 16 | 80 | 35 | 73 |
| **Pneumomediastinum** | 09 | 32 | 03 | 15 | 12 | 25 |
| **Both** | 00 | 00 | 01 | 05 | 01 | 2 |
| ***Type of Ventilation*** | | | | | | |
| **C-PAP** | 12 | 43 | 05 | 25 | 17 | 35.4 |
| **BI-PAP** | 09 | 32 | 06 | 30 | 15 | 31.3 |
| **Mechanical Ventilator** | 07 | 25 | 09 | 45 | 16 | 33.3 |
| ***Outcome of Barotrauma*** | | | | | | |
| **Death** | 16 | 57 | 11 | 55 | 27 | 56.3 |
| **Recovered** | 12 | 43 | 09 | 45 | 21 | 43.8 |
| ***Comorbids*** | | | | | | |
| **Hypertension** | 17 | 61 | 11 | 55 | 28 | 58.3 |
| **Diabetes Miletus** | 09 | 32 | 09 | 45 | 18 | 37.5 |
| **Ischemic Heart Disease** | 04 | 14 | 03 | 15 | 07 | 14.6 |
| **Chronic Kidney Injury** | 02 | 07 | 03 | 15 | 05 | 10.4 |
| **Acute Kidney Injury** | 03 | 11 | 01 | 05 | 04 | 8.3 |
| **Chronic Obstructive Pulmonary Disease** | 01 | 4 | 01 | 05 | 02 | 4.2 |
| **Asthma** | 01 | 4 | 00 | 00 | 01 | 2.1 |

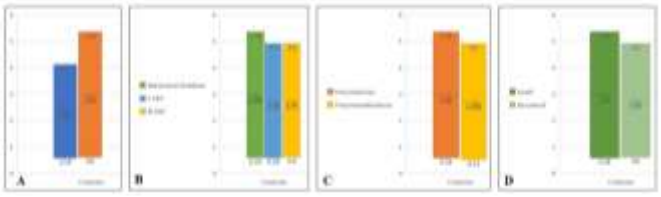

Figure 01. Creatinine levels, A: differentiation in Male (blue) and Female (orange), B: differentiation on the basis of type of ventilation, C: differentiation on the basis of type of barotrauma, D: differentiation on the basis of outcome of barotrauma.

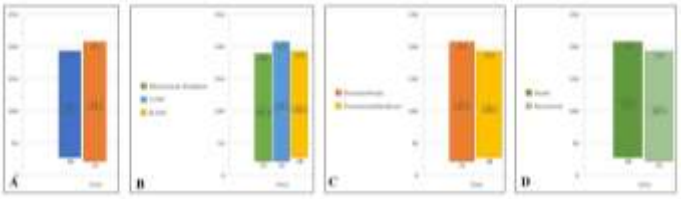

Figure 02. Urea levels, A: differentiation in Male (blue) and Female (orange), B: differentiation on the basis of type of ventilation, C: differentiation on the basis of type of barotrauma, D: differentiation on the basis of outcome of barotrauma.

It was also observed that creatinine was more deranged amongst female, mechanically ventilated patients having pneumothorax and overall average was higher in patients with poor outcome that ultimately leads to death as shown in Figure 01. While urea follows the same trend except for higher mean urea value in patients using CPAP as shown in figure 02.

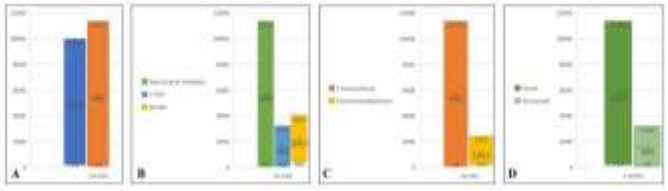

Figure 03. Ferritin levels, A: differentiation in Male (blue) and Female (orange), B: differentiation on the basis of type of ventilation, C: differentiation on the basis of type of barotrauma, D: differentiation on the basis of outcome of barotrauma.

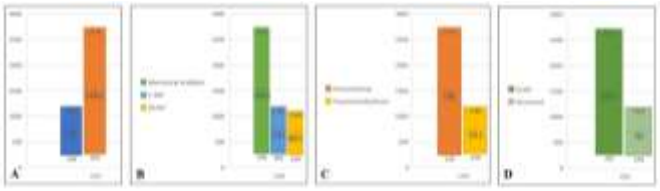

Figure 04. Lactate Dehydrogenase (LDH) levels, A: differentiation in Male (blue) and Female (orange), B: differentiation on the basis of type of ventilation, C: differentiation on the basis o type of barotrauma, D: differentiation on the basis of outcome of barotrauma.

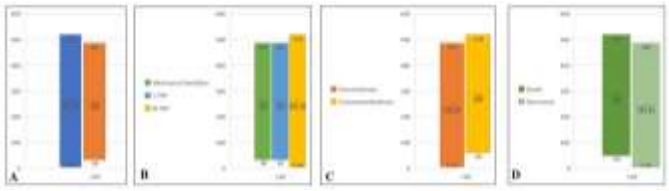

Figure 05. C-Reactive Protein (CRP) levels, A: differentiation in Male (blue) and Female (orange), B: differentiation on the basis of type of ventilation, C: differentiation on the basis o type of barotrauma, D: differentiation on the basis of outcome of barotrauma.

Levels of different inflammatory markers were compared on the basis of gender, type of ventilation, type of barotrauma and outcome of barotrauma as shown in figure 01,02,03,04 an 05.

## IV. DISCUSSION

Findings of the current study suggested that the use of positive pressure and artificial ventilation in covid-19 patients lead to two main types of barotraumas; pneumothorax which was the more common type followed by pneumomediastinum. In our contemporary study, 48 patients out of 469 witnessed the event of barotrauma after artificial ventilation. The main causes of the patient's deterioration and death were pressure changes, co-morbid conditions, and the severity of covid 19. Dhan et al inferred from his systematic review that barotrauma was associated with a longer length of hospital stay, more extended ICU stay, and higher in-hospital mortality. Also, a slightly higher odds of barotrauma was seen in COVID-19 ARDS compared with non-COVID-19 ARDS.(3) Previous studies also indicated that a higher incidence of barotrauma was observed in COVID-19 ARDS than non-COVID-19 ARDS, despite the use of lung-protective ventilation strategy in both groups.(4) Overall, barotrauma related mortality rates were also much higher in cases of covid-19.(5) In contrast to this, another study showed that barotrauma was more likely to occur in younger individuals. (6)

Consistent with previous studies our study also showed that patients having Diabetes hypertension, acute and chronic kidney disease developed the barotrauma relatively faster than those who didn't have any co-morbid conditions. Gazivoda VP et.al also concluded that age and renal dysfunction are the key factors involved in worsening of disease and chances of use of artificial ventilation.(7)

Moreover, levels of inflammatory markers which include LDH and Ferritin which when high, resulted in poor outcome of the patients. Elsaaran H et.al reported similar number of cases of barotrauma and raised WBC and LDH levels as compared with COVID patients without the need of artificial ventilation. (8, 9) Furthermore, some studies have also concluded that barotrauma is more likely to occur in covid-19 patients even if they do not undergo ventilation. A proposed reasoning for this is the release of inflammatory markers which cause alveolar damage. The exact underlying mechanism is not clearly understood yet.(10) Covid-19 pneumonia presents with its unique ventilatory management challenges therefore, training sessions and workshops should be planned for ICU staff to quip them with necessary knowledge and skill set about usage of ventilators in COVID patients in order to limit the cases of barotrauma.

## V. CONCLUSION

Patients with Covid 19 ARDS and prolonged stay in the hospital that requires artificial ventilation has a high incidence of developing barotrauma. Risk factors and co-morbid conditions have to be kept in mind when dealing with covid-19 ARDS related barotrauma. The use of lung protection strategies and better control of ventilator settings can be considered to reduce the risk of barotrauma.

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