Air leak in post COVID-19 patients: Incidence, ICU course and outcomes

Fuga aérea en pacientes post COVID-19: incidencia, evolución en UCI y resultados

Dear Editor,

COVID-19 not only leads to acute respiratory compromise, but may also lead to prolonged or recurrent symptoms which may persist for months. Up to one-third of COVID-19 patients may have persistent symptoms even after 9 months after recovery.[1] Most symptoms were mild, but multi-organ involvement may also occur and patients may rarely develop life-threatening complications.[1]

Air leak (AL) is an under-recognized and under-reported complication of COVID-19. In mechanically ventilated patients with COVID-19 related acute respiratory distress syndrome (ARDS), the incidence of AL has been reported to be seven times higher than that for non-COVID-19 ARDS along with higher mortality rate.[2] In addition, AL may also occur in spontaneously breathing COVID-19 patients who are not on any positive pressure ventilation (PPV).[3] However, there is a dearth of data regarding the true incidence, intensive care unit (ICU) course and outcomes of post-COVID-19 patients who develop AL.

This retrospective observational study was conducted in medical ICUs of tertiary care private hospital and was approved by the institute's ethical committee. The inclusion criteria were patients above 18 years, recent history of COVID-19 (less than 30 days), admitted in ICU with documented AL (pneumothorax, subcutaneous emphysema, pneumomediastinum, pneumoperitoneum, pneumopericardium). Patients with active COVID-19 infection and those with post-procedure (iatrogenic) AL, were excluded. All post-COVID-19 patients admitted from May 2020 to July 2021 were screened for any documented AL, and those with positive findings were included. Data regarding the baseline parameters, oxygen support, type of AL, interventions, need for organ support, and hospital mortality, were collected. The outcome measures were incidence of AL, need for invasive mechanical ventilation (IMV), days in ICU, days in hospital and hospital mortality.

Quantitative data were compared by Student's t-test (unpaired) and qualitative data were tested by chi-square or Fisher's exact test, as appropriate. A p value < 0.05 was considered significant. Univariate and multivariate analysis was done to evaluate the risk factors associated with hospital mortality, and odds ratio (OR) with 95% confidence interval (CI) was calculated.

Out of 639 post-COVID-19 patients admitted, 78 (12.2%) had documented AL and were included. Overall, the incidence of pneumothorax was 57 (73.1%), 35 (44.9%) pneumomediastinum, 20 (25.6%) surgical emphysema, 2 (2.6%) pneumopericardium, and 1 (1.3%) pneumoperitoneum. Only three patients had a documented history of smoking and five had some underlying lung disease like asthma (2), COPD (2) or pulmonary tuberculosis (1 patient). 41% were not on any PPV at the time they developed AL. The mean days since COVID-19 positive was 24.17 ± 13.1 (range 10–60 days).

Most of the patients, 58 (74.4%), developed respiratory symptoms like breathlessness, increasing oxygen requirement, desaturation, chest pain or cough at the time of AL. Eight (13.8%) patients also had swelling over chest or neck as an initial symptom. 23 patients on ventilatory support showed worsening of ventilatory parameters but only three patients presented with shock. However, 15 (19.2%) patients did not exhibit any sign or symptom and the diagnosis was made incidentally on radiographic imaging. Fifty patients required intercoastal drain insertion out of which only 3 required pleurodesis, and 1 patient each required decortication and thoracotomy.

All cause hospital mortality rate was 65.4%. On comparing factors among survivors and non-survivors, five factors were found significant in the univariate analysis (Table 1). In the multivariate analysis, need for IMV (OR: 52.6, 95%CI: 2.1–1325.1, $p = 0.016$) and vasopressors (OR: 48.8, 95%CI: 2.9–815.5, $p = 0.007$) were associated with increased hospital mortality.

The true incidence of AL in COVID-19 patients is unknown. Smaller studies have reported an incidence ranging from 1.1 to 28.6% in COVID-19 patients.[4,5] We had a high incidence of AL and all-cause mortality. This could be explained by the fact that we included critically ill patients admitted to ICUs who would have been categorized as severe or critical COVID-19.

The exact pathophysiology for AL with COVID-19 is unclear. Half of patients developing AL have been shown to be breathing spontaneously and not requiring any PPV.[3] In addition, majority have shown to be having no pre-existing risk factors.[3] Hence, pathogenesis beyond pulmonary barotrauma is suspected. Other postulated mechanisms include patient self-inflicted lung injury induced inflammation and cytokine imbalance, pulmonary fibrosis, pulmonary cavitation and Mecklin effect causing a large pressure gradient between marginal alveoli and surrounding structures leading to AL.[3]

Post-COVID-19 syndrome is the persistence of symptoms after confirmed SARS-CoV-2 infection and has been differently defined.[1] The most commonly reported sequalae, in these patients, are dyspnea and venous thromboembolism but rarely AL may complicate their clinical course.[6] As a significant proportion of patients maybe asymptomatic, a close observation and high index of suspicion is required to make an early diagnosis. This may have implications in patient management as these patients may require close monitoring for any signs of deterioration and cautious use of PPV.

Mortality associated with COVID-19 patients admitted in ICUs remain high, up to 40.5%.[7] Mortality rates may be higher in patients who develop complications or require IMV.[8] Overall prognosis of patients with AL is guarded. Development of AL has been associated with a higher need for IMV, longer ICU stay, and higher mortality.[2,5] Mortality rate of 60% was reported in a study which predominantly had patients with pneumomediastinum, which was 15 times higher than that observed in patients with no AL.[5] Another case series reported an even higher mortality rate of 86.7% in COVID-19 patients with AL.[9] Need for IMV and presence of shock have been reported to be associated with higher mortality rates in COVID-19 patients admitted to ICUs.[9] In addition, COVID-19 patients who develop AL while on IMV have been shown to have high mortality rates of 92.3%.[10]

Table 1 Comparison of patient characteristics between survivors and non-survivors.

Parameter	Overall (*n* = 78)	Survivors (*n* = 27)	Non-survivors (*n* = 51)	*p* value
Age	57.83 ± 13.1	54.70 ± 12.6	59.49 ± 13.3	0.396
Gender	Males: 59 (75.6%) Females: 19 (24.4%)	Males: 21 (77.8%) Females: 6 (22.2%)	Males: 38 (74.5%) Females: 13 (25.5%)	0.749
Diabetics	27 (34.6%)	11 (40.1%)	16 (31.4%)	0.408
Hypertensives	33 (42.3%)	10 (37%)	23 (45.1%)	0.493
History of lung disease	5 (6.4%)	3 (11.1%)	2 (3.9%)	0.217
Smokers	3 (3.8%)	2 (7.4%)	1 (2%)	0.384
Admission SOFA score	3.94 ± 2.2	2.93 ± 1.3	4.47 ± 2.4	0.002*
Days since COVID diagnosis	24.17 ± 13.1	25.59 ± 15.4	23.41 ± 11.7	0.343
Side involved*	Right: 29 Left: 18 Bilateral: 16	Right: 8 Left: 8 Bilateral: 3	Right: 21 Left: 10 Bilateral: 13	0.244
Presence of pneumothorax	57 (73.1%)	17 (63%)	40 (78.4%)	0.143
Type of oxygen support	No oxygen: 2 Face mask: 12 NRBM: 14 HFNC: 4 NIV: 23 IMV: 23	No oxygen: 1 Face mask: 9 NRBM: 10 HFNC: 2 NIV: 4 IMV: 1	No oxygen: 1 Face mask: 3 NRBM: 4 HFNC: 2 NIV: 19 IMV: 22	
Use of PPV (at the time of development of air leak)	46 (59%)	5 (18.5%)	41 (80.4%)	<0.001*
Diagnostic modality	Clinical: 3 CXR: 46 CT: 28 USG: 1	Clinical: 1 CXR: 16 CT: 10 USG: 0	Clinical: 2 CXR: 30 CT: 18 USG: 1	
Intervention done	50 (64.1%)	14 (51.9%)	36 (70.6%)	0.101
Need for increase in respiratory support	49 (62.8%)	7 (25.9%)	42 (82.4%)	<0.001*
Need for IMV	52 (66.7%)	3 (11.1%)	49 (96.1%)	<0.001*
Days on IMV	8.62 ± 10.9	4.67 ± 3.8	8.86 ± 11.1	0.439
Need for RRT	3 (3.8%)	0	3 (5.9%)	0.309
Days on RRT	7.67 ± 6.4	0	7.67 ± 6.4	
Need for vasopressors	50 (64.1%)	2 (7%)	48 (94.1%)	<0.001*
Days on vasopressors	5.02 ± 5.5	2	5.15 ± 5.6	0.228
Days in ICU	17.05 ± 13	17.04 ± 13.7	17.06 ± 12.7	0.410
Days in hospital	23.91 ± 17	29.22 ± 20.1	21.10 ± 14	0.021*

SOFA – sequential organ failure assessment, PPV – positive pressure ventilation, IMV – invasive mechanical ventilation, RRT – renal replacement therapy, ICU – intensive care unit.
* Total is less than 100% as some patients had only pneumomediastinum.

As far as we know, this is the first such study conducted in post-COVID-19 patients. We have relatively large cohort size from a single tertiary care center. Being a retrospective study, it was prone to missing data and information bias and as many AL are asymptomatic, we might have underdiagnosed AL. Also, we did not include patients with active COVID-19, which could also have affected the incidence of AL.

To conclude, a significant proportion of patients may develop AL in the post-COVID-19 period leading to high morbidity and mortality. High index of suspicion is warranted for an early diagnosis as many patients may be asymptomatic and this complication may also occur much later in the disease course. Need for organ support, in the form of IMV and vasopressors, was associated with increased mortality.

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Conflict of interest

None.

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Gastric residual volume management in pediatric intensive care units in Spain and Latin America

Manejo del volumen gástrico residual en las unidades de cuidados intensivos pediátricos de España y Latinoamérica

Dear Editor:

The measurement of residual gastric volume (RGV) is often used as a marker of digestive intolerance in critically ill patients.[1] However, the most recent evidence available reveals that this practice does not reduce pneumonia[2] and leads to unnecessary interruptions of enteral nutrition (EN).[3,4] For this reason, it is ill-advised in some of the most recent clinical practice guidelines that do not recommend it on a routine basis in critically ill patients.[4]

To understand the management of RGV in Spanish and Latin American pediatric intensive care units (PICU) and check their compliance to the new recommendations established, we conducted a multicenter, prospective study through an electronic survey that was submitted to the different scientific societies. The final survey included 16 questions divided into the following sections: location and type of pediatric intensive care unit (PICU), personnel dedicated to the management of nutrition, route of administration of EN, measurement and management of RGV, and use of prokinetic drugs.

Statistical analysis was conducted using the SPSS 25 statistical software package (SPSS Inc, Chicago, IL, United States). Categorical variables were expressed as frequency and percentage and compared using the chi-square test. P values $\leq .05$ were considered statistically significant.

A total of 21 PICUs from 5 different countries participated, 76.2% of which were Spanish PICUs and 23.8% Latin American PICUs; 18 (85.7%) were pediatric intensive care units only and 3 of them (14.3%) were mixed care units (pediatric and neonatal).

Two of the PICUs (9.5%) had between 1 and 5 beds, 12 (57.1%) between 6 and 10 beds while 7 PICUs (33.4%) had >10 beds. Only 38.1% of all PICUs said they had somebody in charge of handling nutrition; the participation of this person was much more common in PICUs > 10 beds (71.4% vs 21.4%; $P = .026$).

Mixed teams were responsible for the management of nutrition in 62.5% of all PICUs and they included an intensivist plus a gastroenterologist, and less commonly a gastroenterologist plus a nutritionist. In the remaining 37.5%, the person responsible for EN was an intensivist (25%) or a gastroenterologist (12.5%).

The most common route of administration of EN was continuous nasogastric tube (47.7%), then discontinuous nasogastric tube (38%) followed by transpyloric tube (14.3%). The process of selecting the route of administration of EN had nothing to do with the number of beds.

Most PICUs (71.4%) measured gastric remains without any significant differences being reported between Spanish and Latin American PICUs or among the PICUs that had someone