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ORIGINAL RESEARCH ARTICLE

LUNG ULTRASOUND SCORE BEFORE AND AFTER EXTUBATION FOR PREDICTING WEANING OUTCOME

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ABSTRACT

Background: Lung ultrasound (LUS) is an emerging, essential, safe and easily repeatable bedside tool being used for the management of critically ill patients in ICUs. Weaning off the ventilator and decide to extubate require right decision and appropriate timing to avoid extubation failure. The study aimed to perform LUS in planned extubation patients who passed SBT, for the assessment of lungs, before and after extubation.

Methods: A single-centre, observational study at medical ICU of a tertiary level hospital in Nepal was conducted on invasive mechanically ventilated patients. LUS was performed before extubation on those who were planned to extubate and repeat scan done after 24 hours of extubation. LUS scores were calculated at both times. p-value 0.05 was considered statistically significant.

Results: Twenty-eight patients were included after passing spontaneous breathing trial (SBT), one patient had extubation failure. Mean LUS score before and after extubation came to be 16.15 ± 7.00 and 13.15 ± 4.59 respectively with high degree of correlation (Pearson's r = 0.896, P <0.001). The mean difference in LUS scores before and after extubation was significant (Mean difference: 3.00 ± 3.54, t = 4.402, p < 0.001).

Conclusions: Lung ultrasound is very useful additive tool in predicting extubation failure easily and timely. Its use after extubation also helps in early prediction of post-extubation failure by assessing aeration changes and other lung pathology.

INTRODUCTION

Lung ultrasound (LUS) is an important tool in critical care because it is safe, non-invasive, portable and devoid of radiation hazard. Urgent diagnostic and therapeutic decisions by LUS are encouraging due to its morphologic and functional information in real time. These all make LUS as a fast diagnosing tool. It is useful to assess two important factors- lung aeration status and functional status of diaphragm, which are also clues on the probability of successful extubation in mechanically ventilated patients.[1] In intensive care unit (ICU) to predict liberation from mechanical ventilator (MV), mostly rapid shallow breathing index (RSBI) and spontaneous breathing trial (SBT) are used. Thus, assessing patients before and during SBT is very important to predict extubation failure.[2]

Recently, LUS is introduced to assess lung abnormalities patterns. Bouhemad first proposed the LUS score for lung aeration patterns. Later this score is also used to predict weaning outcome. Visualization of multiple and diffuse B-lines >3 per intercostal space is suggestive of increased fluids in the lung. B-line is a well-defined, laser-like, hyper echoic comet-tail artifact arising from the pleural line.[3,4]

The study aimed to perform LUS in planned extubation patients who passed SBT, for the assessment of lungs, before and after extubation in terms of aeration changes, number of B-lines and other pathological LUS signs.

METHODS

This was an observational, cross-sectional, analytical study conducted in medical ICU of Chitwan Medical College Teaching Hospital (CMCTH), Nepal from January to September, 2019 using convenience sample technique.

Patients of both sexes having age ≥16 years of age, under invasive mechanical ventilation for >24 hours and planned for extubation after passing SBT were included in the study while the patient with tracheostomy, neuromuscular diseases were excluded from the study. Approval was taken from Institutional Review Committee of CMCTH (Ref: CMC-IRC/076/077-011). Informed or written consent was taken after explaining about the study.

Patient's identification and details regarding reason of admission, intubation and details of MV parameters were filled as per the proforma after they passed SBT and planned for

extubation then LUS was performed after passing SBT before extubation and after 24 hours of extubation.

Sonosite ultrasonography cardiac probe 5-1 MHz was used to perform LUS. The probe was placed at upper BLUE points, lower BLUE points, posterolateral alveolar and or pleural syndrome (PLAPS) points on both sides as mentioned in the BLUE protocol.[5,6] LUS findings noted in our proforma. Repeat LUS was performed at the points as mentioned above after 24 hours of extubation.

LUS score noted was according to the number of B-lines per intercostal space (ICS) i.e. 0 score for 0 B-line, 1 for 1, 2 for 2, 3 for 3, 4 for 4, 5 for 5, 6 score if confluent B-lines >50% of ICS, 7 score if confluent B-lines >75% of ICS, 8 score if confluent B-lines 100% of ICS. Additional 3 score for consolidation and 1 score for atelectasis or pleural effusion.[7,8]

Patients were kept in the semi-recumbent position throughout the study. Positive end expiratory pressure (PEEP), inspiratory pressure support (IPS) and fraction of inspired oxygen (FiO2), set prior to the examination were not modified throughout the study. Sedation was not modified either. Parameters like tidal Volume (TV), respiratory rate (RR), heart rate (HR) and blood pressure (BP) were recorded.

Data were collected using a structured proforma covering the relevant details and entered in SPSS. Standard descriptive statistics was used, with data expressed as mean ± standard deviation or median (range) as appropriate. Pearson's correlation coefficient was used to assess the relationship between variables. Paired sample t-test was applied to compare the means of LUS scores before and 24-hour after extubation.

RESULTS

Total 28 patients were enrolled in the study. The mean age of the patient was 56.07 ± 20.95 years, among which 57.1% were females. The predominant number of cases were of acute exacerbation of chronic obstructive airway disease in respiratory failure (n=7) and pneumonia with or without comorbidities (n=9). Remaining cases had multiple working diagnoses such as, acute respiratory distress syndrome (n=3), organophosphorus poisoning (n =3), other poisonings (n=2), sepsis with multiorgan dysfunction syndrome (n=2), one case each of decompensated chronic liver disease in hepatic encephalopathy with hepatic hydrothorax and diabetic ketoacidosis with chronic kidney disease stage-IV in pulmonary oedema. There was no agitation or diaphoresis noted in any case during LUS examination.

Median duration of different modes on invasive mechanical ventilation in this study was observed maximum on control mode: 60 hours, followed by continuous positive pressure mode: 39 hours, synchronized mode: 27 hours and least on assist control mode: 11 hours.

Median values of ventilator parameters observed during LUS examination before extubation was within normal range which is shown in Table 1.

Table 1: Ventilator parameters details after SBT and before extubation during LUS examination

Parameters	Median value	Range (minimum–maximum)
Fraction of Inspired Oxygen (%)	30.00	28.00 – 40.00
Positive End Expiratory Pressure (cmH2O)	5.00	5.00 – 6.00
Inspiratory Pressure Support (cmH2O)	8.00	5.00 – 12.00
Tidal Volume (in ml)	425.5	215 – 831
Minute Ventilation (in liters)	8.89	3.80 – 24.00

Average number of B-lines at LUS examination points was more in both PLAPS points, it was slightly more compared with anterior regions BLUE POINTS, shown in Table 2.

Table 2: Average number of B-lines on different LUS examination points

RIGHT*	LEFT*
UBP: 2.0 (1.0 – 8.0)	UBP: 2.0 (1.0 – 8.0)
LBP: 2.0 (1.0 – 5.0)	LBP: 2.0 (1.0 – 8.0)
PLAPS: 3.0 (1.0 – 10.0)	PLAPS: 3.0 (1.0 – 8.0)

*median (minimum-maximum)

We observed mean LUS score before extubation: 16.15 ± 7.00 and mean LUS score after extubation: 13.15 ± 4.59 with high degree of correlation between these 2 scores (Pearson's r = 0.896, p-value <0.001). The mean difference in LUS scores before and after extubation was highly significant (Mean difference: 3.00 ± 3.54, t = 4.402, p-value < 0.001).
There was a single case of failed extubation; a 41yr/F with urosepsis, diabetic ketoacidosis, hypertension and chronic kidney disease. LUS score before extubation was 20 for B-lines bilaterally. After 26 hours of extubation on next day she was unable to maintain oxygen saturation (SpO2-70%) in respiratory distress. After re-intubation again LUS was done and noted increased B-lines at all points, dynamic airbronchogram and shred sign at both PLAPS point. This time her LUS score was 34.

DISCUSSION

Investigation reports (complete blood counts, arterial blood gas, electrolytes), MV parameters (TV, RR, IPS), clinical assessment (for signs of distress, BP, HR) and derived calculations RSBI and SBT are frequently used in practice to predict successful weaning. LUS done prior to extubation helps screening of lung aeration, state of lung water which is a main reason for loss of aeration. Lung derecruitment during SBT leading to post-extubation failure is mainly due to excess lung water

then consolidation. LUS can aid to assess lung water volume overload in a timely manner and non-invasive, quick way to predict post-extubation failure.[9]

LUS finding in our study prior to extubation was normal with no other associated pathological signs. Mean LUS score before and after extubation was highly significant except in one failed extubation case. LUS score was decreased when compared with post-extubation LUS score in successful extubation. One failed extubation case had higher LUS score compared with pre-extubation score. The patient was suffering from chronic kidney disease, which itself is a potential cause for excess lung water and further lung water increased due to lung derecruitment. Similar findings of increased LUS score observed in failed extubation cases by Soummer A et al in Lung Ultrasound Study Group.[10]

In other successful extubation cases low LUS score might be due to use of diuretics also. In this way we found frequent use of LUS to assess aeration and development of new pathological signs which might be helpful for readiness or predicating post-extubation failure.

Probability of re-intubation after successful extubation is 20% and our study had 7%. Since our treating physicians were not blinded and they had background information of LUS findings, which might had influenced in their decision of delaying extubation thus finally resulted in more extubation success.

There are several limitations of our study like small study population, single centred and convenient sampling method.

CONCLUSION

Lung ultrasound can help predicting extubation failure if it can be done even after extubation to assess lung water volume. Further studies are needed in terms of larger population and multi-centre study to precisely revise the use of lung ultrasound before and after extubation in invasive mechanical ventilation cases.

CONFLICT OF INTEREST

None

FINANCIAL DISCLOSURE

None

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