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B-Line Artifact as a Diagnostic Tool in Various Conditions at the Emergency Department

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Abstract

BACKGROUND: B-line artifacts (BLAs) play an important role in identifying lung pathology. They may indicate different diseases. However, the diagnostic study of BLA as applied to emergency patients has not been well studied.

AIM: The aim of this study was to determine the diagnostic accuracy of BLA in various conditions.

METHODS: This was a retrospective observational study of emergency patients who had received lung ultrasound at Srinagarind Hospital's Emergency Department throughout January 2020–December 2020. Ultrasound artifacts were recorded. Ultrasonography findings were correlated with final diagnosis. Sensitivity and specificity were also calculated.

RESULTS: A total of 105 patients were evaluated. The most prevalent condition which BLA found in this study was pulmonary edema (44.12%) with 88.24% sensitivity and 46.48% specificity. BLA also indicated pneumonia with 66.67% sensitivity and 35.71% specificity. Diffuse BLA indicated pulmonary edema with 70% sensitivity and 70.42% specificity. Focal BLA indicated pneumonia with 28.57% sensitivity and 76.19% specificity.

CONCLUSIONS: The sensitivity of BLA for pulmonary edema and pneumonia diagnosis in this study was of moderate to good sensitivity, but low specificity. BLA may become crucial in the diagnosis of lung pathology in the emergency department.

Introduction

Lung ultrasound (LUS) is an important tool amid the care of patients at the emergency department [1], [2], [3]. Nowadays, LUS is more widely used, especially in critically ill patients [4], [5]. LUS is based on the analysis of ultrasound artifacts. Of the many artifacts, B-line artifact (BLA) is caused by a reverberation phenomenon. Moreover, it is the crucial lung artifact applied in critically ill patients [4]. The characteristic of BLA [6] is as follows: (1) It arises from the pleural line, (2) it is hyperechoic, similar to the pleural line, (3) it is well-defined, similar in appearance to a laser, (4) the sign erases the normal A-lines and extends outward without fading to the bottom of the display screen, and (5) the sign moves with lung sliding. BLA is applied in numerous diseases such as pulmonary edema, congestive heart failure, lung contusions, pneumonia, and acute respiratory distress syndrome [7], [8], [9], [10], [11], [12]. In addition, some literatures showed that BLA has been applied amid connective tissue diseases [13], [14], [15]. While they have been reported on in lung pathology, single focal BLA can also be observed in healthy populations [7].

The previous ultrasound studies [7], [8], [9], [10], [11], [12], [13], [14], [15] have examined selected groups of patients such as those exhibiting acute respiratory distress, dyspnea, or critically ill patients with LUS examination. With the introduction of LUS and training of emergency medicine residents, LUS has been increasingly used in the emergency departments in Thailand. Ultrasound findings through BLA in undifferentiated patients in the emergency department have never been documented. The clinical question addressed in this study was the following: For patients presenting themselves at the emergency department with variable conditions, which disease BLA can be used to confirm a diagnosis accurately?

Methods

Study design

This was a retrospective, single-centered, observational study at a tertiary university hospital in Thailand. Ethical approval was provided by the Khon Kaen University Ethics Committee for Human Research and registered with the Thai Clinical Trials Registry (HE641156).

Sample size

We included all patients who had received LUS and had had ultrasound video clips and images recorded in the ultrasound machine at the emergency department throughout January 2020–December 2020. Patients with no ultrasound documents were excluded from the study. The sample size for the analysis of the estimated sample size in the diagnostic test was determined. Prevalence was 0.26 [16]. The standard normal value was 1.96. Power analysis was determined using an alpha of 0.05. Sens was 0.923 [16] and absolute precision was 0.01. This resulted in an estimated desired effect sample size of at least 105 subjects.

Study protocol

The study was performed throughout January 2020–December 2020. We collected data from patients who visited the emergency department. Ultrasound was performed by emergency medicine residents and the attending physician. Ultrasound artifacts including A line and B line were recorded. LUS artifacts were correlated with the final diagnosis made by the treating physicians. This study was conducted with the standard ultrasound machine (Mindray M9) which we used at the emergency department. The images were obtained in B mode. In terms of transducers, the examination of transducer selection depended on the preferences of the physician performing LUS. In this study, we used curvilinear, phased array and linear transducers. The primary outcome of this study aimed to determine the diagnostic accuracy of BLA in various conditions.

Statistical analysis

Continuous type variables in the data were summarized as mean and standard deviation or median and range as appropriate. Categorical variables were summarized as counts and percentages. Sensitivity and specificity were calculated. All statistical analyses were performed using the software Stata version 10.1 (Stata Corp, College Drive, TX, USA). Statistical significance was defined as a two-sided p = 0.05 or less.

Results

Among 105 patients, 52.38% were female. Median patient age was 64.38 years. The greatest indications of LUS scans were of respiratory symptoms (50.47%). BLA was discovered in 68 patients (64.76%); diffuse BLA was found in 42 patients (61.76%) and focal BLA was discovered in 26 patients (38.23%). This study included two cardiac arrest patients which one patient receiving diffuse BLA and another patient receiving focal BLA (Table 1).

Table 1: Patients' characteristics

Patient characteristics (n=105)	
Sex	
Female, n (%)	55 (52.38)
Age	
Mean ± SD	64.38 ± 15.44
LUS artifacts	
A line, n (%)	37 (35.24)
B line, n (%)	68 (64.76)
Area of BLAs (n=68)	
Diffuse, n (%)	42 (61.76)
Focal, n (%)	26 (38.24)

BLAs: B-line artifacts, LUS: Lung ultrasound.

BLA revealed various conditions in this study including pulmonary edema (44.12%), pneumonia (20.5%), septic shock (10.29%), lung metastasis (4.41%), interstitial lung disease (ILD) (systemic sclerosis, systematic lupus erythematous, and PCP infection) (2.94%), and pulmonary embolism (2.94%).

Besides that, BLA specified pulmonary edema with 88.24% sensitivity and 46.48% specificity. BLA indicated pneumonia with 66.67% sensitivity and 35.71% specificity. Diffuse BLA specified pulmonary edema with 70% sensitivity and 70.42% specificity. Focal BLA indicated pneumonia with 28.57% sensitivity and 76.19% specificity (Table 2).

Table 2: Sensitivity and specificity of BLA categorized by diseases

BLA observed in final diagnosis	Sensitivity (%)	Specificity (%)
Pulmonary edema (n=34)	88.24	46.48
Pneumonia (n=21)	66.67	35.71
Septic shock (n=3)	100	62.24
Lung metastasis (n=3)	100	36.27
ILD (n=5)	40	66
Pulmonary embolism (n=2)	100	64.28

BLA: B-line artifact, ILD: Interstitial lung disease.

Discussion

The present study described 105 patients who underwent LUS at the emergency department. Our study found BLA in 64.76% of patients. Hence, BLA indicated pulmonary edema with 88.24% sensitivity in consistence with other studies [5]; however, rather low specificity was established (46.48%). The study of Lichtenstein and Mezière [5] revealed the discovery of multiple anterior diffuse B lines, with lung sliding indicating pulmonary edema with 97% sensitivity and 95% specificity. From

a meta-analysis study [17], diffuse BLA for diagnosis of pulmonary edema was more accurate than initial clinical work-up, chest X-ray, and natriuretic peptides [18].

In terms of pneumonia, we discovered diffuse BLA in >50% of pneumonia cases. In accordance with Patel *et al*. [16], they found bilateral BLA (more than two B lines) in two or more zones out of a six-zone examination with or without pleural line and subpleural abnormalities which were suggestive of this diagnosis. Our study showed 66.67% sensitivity and 35.71% specificity which was a lower rate than in other studies [5]. These results displayed anterior diffuse B lines with abolished lung sliding which indicated pneumonia with 89% sensitivity and 94% specificity.

In terms of septic shock, most physicians in this study employed LUS to assess fluid responsiveness. We established that most septic shock patients in this study had fluid overload from LUS that showed diffuse BLA. However, due to this method of data collection, we are unable to establish whether the volume of fluid resuscitation was associated with BLA in LUS or not.

ILD is a major pulmonary manifestation of connective tissue disease. Our study demonstrated 100% sensitivity of BLA to detect ILD from systemic sclerosis, systematic lupus erythematous, and PCP infection. In accordance with a study by Barskova *et al*. [4], they reported that LUS diagnostic sensitivity and specificity were 100% and 55%, respectively. Moreover, negative predictive value and positive predictive value were 100% and 78%. Numerous B line in LUS was associated with high-resolution computed tomography findings in connective tissue disease.

The strengths of this study were as follows: (1) We identified the sensitivity and specificity of BLA for diagnosis in various conditions in Thai emergency patients and (2) the findings from this study demonstrated the impact of using POCUS at the emergency department. Limitations of the study were as follows [19], [20], [21], [22], [23]: (1) It could not assess certain conditions at the emergency department such as fluid responsiveness which was mentioned above, and (2) in this study, the data collected from various types of transducer may have influenced BLA image quality.

Conclusions

BLA was applied to observe pulmonary edema and pneumonia with moderate to good sensitivity in emergency patients. BLA may become crucial in directing the diagnostic process. Further research is warranted to clarify technical adjustments as well as different transducers and machine factors which influence BLA visualization.

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