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Utility of POCUS in the Diagnosis of Drowning-related Noncardiogenic Pulmonary Edema: A Case Report

Boğulmaya Bağlı Kardiyojenik Olmayan Akciğer Ödeminin Tanısında POCUS'un Faydası: Olgu Sunumu

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Abstract

Respiratory complications such as noncardiogenic pulmonary edema, acute respiratory distress syndrome and pneumonia are frequently seen in drowning. No additional disease was noted in the history of a 37-year-old male patient who was brought to the emergency department with cardiopulmonary arrest after drowning at sea. Spontaneous circulation returned following 12 minutes of cardiopulmonary resuscitation. Bedside point-of-care ultrasound (POCUS) revealed multiple and confluent B lines, an irregularity on the pleural line, disappearance in the A-lines, and subpleural hypoechoic areas predominantly in the 2nd, 3rd, 4th and 6th zones of the right lung and the 3rd, 4th and 6th zones of the left lung. The ventilator mode and settings were adjusted according to the POCUS findings, being a safe option in emergency departments for the diagnosis of noncardiogenic pulmonary edema due to drowning and for the management of such patients.

Keywords: *Drowning, Point-of-care ultrasonography, POCUS, Pulmonary edema.*

Öz

Boğulma sonucu, nonkardiyojenik pulmoner ödem, akut solunum sıkıntısı sendromu ve pnömoni gibi solunum komplikasyonları sıklıkla görülmektedir. Denizde boğulma sonucu kardiyopulmoner arrest olarak acil servise getirilen 37 yaşındaki erkek hastanın özgeçmişinde ek hastalık yoktu. Kardiyopulmoner resüsitasyonun 12. dakikasında spontan dolaşım geri döndü. Yatak başı yapılan nokta bakım ultrasonunda (POCUS) sağ akciğer 2. 3. 4. 5. 6 zonda ve sol akciğerde 3. 4. 5. 6. zonda ağırlıklı olmak üzere multiple ve confluent B çizgileri, plevral çizgide düzensizlik, A çizgilerinde kaybolma, subplevral hypoecoik alan görüldü. POCUS bulgularına göre ventilatör modu ve ayarları düzenlendi. POCUS acil servislerde, boğulmaya bağlı nonkardiyojenik pulmoner ödemin tanısında ve bu hastaların yönetiminde güvenle kullanılabilir.

Anahtar Kelimeler: *Boğulma, Nokta bakım ultrasonu, POCUS, Pulmoner ödem.*

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Drowning is defined as respiratory distress resulting from immersion/submersion in liquid, and is the third most common cause of accidental death in all age groups worldwide (1). Respiratory complications such as noncardiogenic pulmonary edema, acute respiratory distress syndrome (ARDS) and pneumonia are frequently observed in drowning cases, and a chest X-ray is recommended in all such cases for diagnosis. A chest computed tomography (CT) may reveal the severity of the disease, and radiological follow-up may be required in such cases, depending on the severity of the lung damage (1,2).

Ultrasonography (US) is a widely used imaging approach in intensive care units and emergency departments as a portable radiation-free option. Studies of ultrasonography have increased with the increase in the provision of training in point-of-care ultrasound (POCUS). Lung diseases such as thoracic trauma, pulmonary edema, ARDS and pneumonia can be visualized with POCUS. Studies have reported POCUS to be a reliable diagnostic tool, accelerating the time to diagnosis in patients with respiratory distress, and to be supportive of disease management and follow-up (2–6).

This case report compares the POCUS and CT images of a patient who developed noncardiogenic pulmonary edema as a result of drowning in water.

CASES

The 37-year-old male patient in the present study, who had no medical history, developed cardiopulmonary arrest as a result of drowning at sea. It was learned that the patient had been given cardiopulmonary resuscitation (CPR) for 10 minutes at the scene, and that CPR was continued until his arrival at the emergency department. The initial examination in the emergency department revealed no spontaneous breathing, no pulse, dilated pupils and no light reaction. CPR was continued in the emergency department and the patient was monitored. Pulseless electrical activity was observed on the monitor. The location of the intubation tube was confirmed by auscultation. There were diffuse rales in either lung. The aspiration of the endotracheal tube revealed constantly clear fluid. Arterial blood gas: pH: 6.74, pCO_2: 122mmHg, pO_2: 40mmHg, lactate: 11 mmol/L and BE: -18mmol/L. Spontaneous circulation returned (ROSC) at the 12th minute of CPR. After ROSC, the patient's heart rate was 138/min and blood pressure were 90/60mmHg. In arterial blood gas, pH: 7.08, pCO_2: 46mmHg, pO2: 101mmHg, lactate: 9.4mmol/L and BE: -15mmol/L. ECG revealed sinus tachycardia and right axis deviation.

The patient was placed on positive inotropic therapy and provided with positive-pressure mechanical ventilator support. POCUS was performed for the evaluation of the lungs, revealing In POCUS, multiple and confluent B lines, irregularity on the pleural line, the disappearance of A-lines and a subpleural hypoecoic area, predominantly in the 2nd, 3rd, 4th, 5th and 6th zones of the right lung, and the 3rd, 4th, 5th and 6th zones of the left lung (Figure 1, 2, 3, 4). The zones of the findings were marked on the POCUS study form, and the ventilator mode and settings were adjusted based on the POCUS findings. The pressure-controlled mode was selected, and ventilation was started with high PEEP. CT images revealed diffuse ground glass opacities in both lungs. The patient was transferred to the intensive care unit.

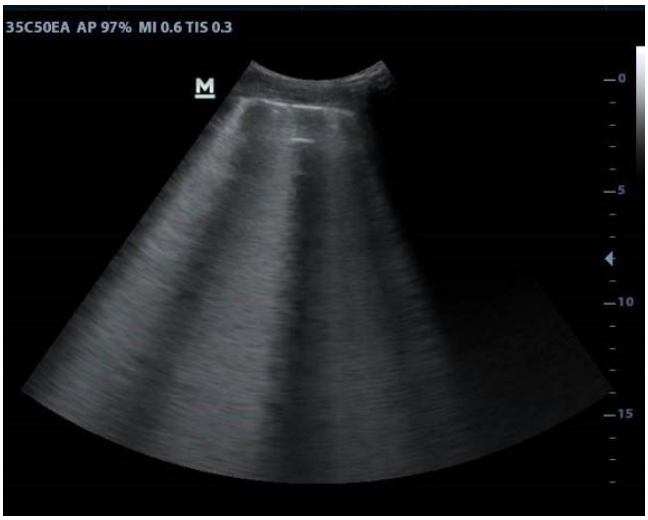

Figure 1: Confluent B lines in the 5th zone of the left lung

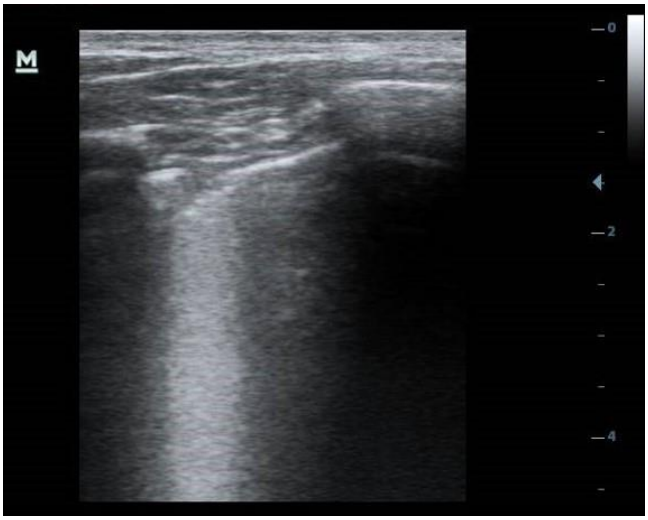

Figure 2: Irregularity on the pleural line and the disappearance of A-lines

Table 1: Point-of-care ultrasonography form

Thorax Zones				R3	R2	R1		L1	L2	L3			
	R6	R5	R4								L4	L5	L6
Normal lung signs													
A Line						+		+					
Lung sliding						+		+					
Seashore						+		+					
Lung pulse													
Pathological lung signs													
Multiple or Confluent B Line	+	+	+	+	+				+	+	+	+	+
Pleural line abnormalities	+	+	+	+	+				+	+	+	+	+
Alveolar syndrome and consolidation findings													
Subpleural hypoechoic zone	+	+		+						+		+	+
Hepatization													
Air bronchograms													
Shred sign													
Pneumothorax Signs													
Stratosphere (barcode) sign													
Lung point													
Pleural Syndrome Signs													
Quad sign													
Sinusoidal sign													

Point-of-care ultrasonography

POCUS was performed with the patient in a supine position, using 7.5 MHz linear and 3.5 MHz convex ultrasound probes (Mindray DP-30, Germany). The thorax was evaluated from the anterolateral aspect, while the hemithorax was evaluated by tracing the midsternal line and determining the right and left sides, and each hemithorax was divided into six zones on the longitudinal plane formed by the midclavicular, anterior axillary and posterior axillary lines, and the transverse plane based on a line at the nipple level. The zones were numbered from the sternum to the lateral, and each area was visualized in the longitudinal and transverse planes with linear and convex probes (4). With the linear probe, all areas were evaluated in B mode and M mode. Normal lung signs were first evaluated, followed by pathological lung signs, and the findings of each zone were noted on a POCUS form (Table 1). The POCUS was completed in 5 minutes.

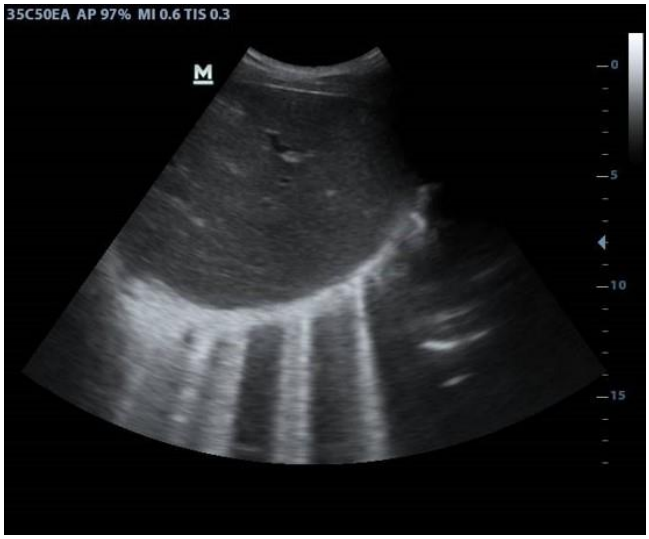

Figure 3: B lines in the 6th zone of the right lung (at the diaphragm level)

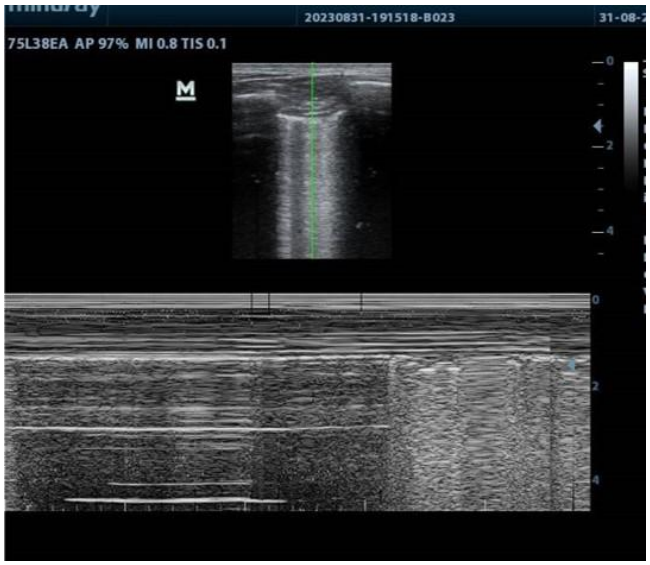

Figure 4: Viewing the zone with confluent B lines in M mode

DISCUSSION

Pulmonary edema refers to an abnormal accumulation of extravascular fluid in lung parenchyma. Pulmonary edema may occur due to both cardiogenic and non-cardiogenic causes (7), although cardiogenic and non-cardiogenic pulmonary edema may have very similar appearances in the US. B lines have been identified as a sonographic sign of interstitial-alveolar syndrome on lung US. The POCUS images of our case, who developed cardiopulmonary arrest due to drowning, were evaluated systemically for each zone, and revealed multiple and confluent B lines in the bilateral lungs, an irregularity on the pleural line, the disappearance of A-lines and a subpleural hypoecoic area. These findings are important as they indicate severe alveolar edema. The thorax CT images of the patient contained widespread ground-glass opacities in the bilateral lungs. These findings are among the most common radiographic findings seen in cases of drowning (8,9). Neither US nor CT images can distinguish between cardiogenic and noncardiogenic pulmonary edema, and so it is important to evaluate the images together with clinical findings. Clinically, the drowning cause of our patient's cardiopulmonary arrest and the continuous discharge of clear fluid upon aspiration of the endotracheal tube supported our diagnosis of non-cardiogenic pulmonary edema. Studies have reported that the number of B lines correlates well with the degree of extravascular lung water. Visualized confluent B lines are actually very close (⩽3 mm) B lines and correspond to ground glass opacities on a CT scan, and are a result of the alveoli being completely filled with fluid. For this reason, the number and profile of B lines are used in the diagnosis of pulmonary edema and for monitoring response to treatment (10,11). Confluent B lines were highly evident in the POCUS images of our case, especially in the lateral zones, and this was attributed to the increased accumulation of water in these areas due to the effect of gravity in the patient in the supine position.

In our case, the diagnosis was made rapidly based on an evaluation of the POCUS images and clinical findings together. Simultaneously, the width of the damaged area was determined by marking the pathological lung areas on the POCUS form. In our case, the extent and severity of lung damage were determined by the involvement of the 2nd, 3rd, 4th, 5th and 6th zones in the right lung, and the 3rd, 4th, 5th and 6th zones in the left lung, along with the appearance of multiple and confluent B lines in these areas. Our patient's ventilator mode and parameters were adjusted according to the POCUS findings. The pressure-controlled mode was selected, and ventilation was started with high PEEP.

CONCLUSION

The findings of non-cardiogenic pulmonary edema due to drowning noted on POCUS images are similar to those in cases with cardiogenic pulmonary edema, and it is, therefore, necessary to evaluate the POCUS findings together with clinical findings for an accurate diagnosis. POCUS can be used safely in emergency settings for the diagnosis and management of noncardiogenic pulmonary edema due to drowning.

CONFLICTS OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

Concept - İ.E.A., N.K.; Planning and Design - İ.E.A., N.K.; Supervision - N.K., İ.E.A.; Funding - İ.E.A.; Materials - İ.E.A.; Data Collection and/or Processing - N.K..; Analysis and/or Interpretation - İ.E.A., N.K.; Literature Review - N.K.; Writing - İ.E.A., N.K.; Critical Review - N.K.

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