

Special Edition
"Revisiting Physical Diagnosis in
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Case Report

*Corresponding authors

Takeshi Saraya, MD, PhD

Assistant Professor
Department of Respiratory Medicine
Kyorin University School of Medicine
6-20-2 Shinkawa, Mitaka City
Tokyo 181-8611, Japan
Tel. +81 (0) 422 44 0671
Fax: +81 (0) 422 44 0671
E-mail: sara@yd5.so-net.ne.jp

Taro Minami, MD

Assistant Professor of Medicine
Divisions of Pulmonary
Critical Care and Sleep Medicine
Memorial Hospital of Rhode Island
The Warren Alpert Medical School of
Brown University
Pawtucket, RI, USA
Tel. +1-401-729-2635
E-mail: nantaro@gmail.com

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Diaphragm Ultrasonography as a Tool To Assess the Respiratory Issues of a Patient With Amyotrophic Lateral Sclerosis (ALS)

Sunao Mikura, MD¹; Takeshi Saraya, MD, PhD^{1*}; Toru Satoh, MD, PhD²; Hiroki Nunokawa, MD¹; Taro Minami, MD³; Hajime Takizawa, MD, PhD¹

¹Department of Respiratory Medicine, Kyorin University School of Medicine, Tokyo, Japan

²Department of Cardiology, Kyorin University School of Medicine, Tokyo, Japan

³Divisions of Pulmonary, Critical Care and Sleep Medicine, Memorial Hospital of Rhode Island, The Warren Alpert Medical School of Brown University, Pawtucket, RI, USA

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CASE REPORT

A 73-year-old woman with Amyotrophic Lateral Sclerosis (ALS) presented at a university-affiliated community hospital with increasing shortness of breath. She was diagnosed with ALS 2 years prior to this event, and she had lost all mobility except for limited neck flexion, ocular motion, and eyewink. Her ALS status was severe (Functional Rating Scale 7),¹ defined as the need for almost continuous sputum suction and/or need to communicate with a communication board.

On examination, she presented with shortness of breath with tachypnea with a respiratory rate of 30 breaths per minute. She had tachycardia with a heart rate of 120 beats per minute, and she was diaphoretic. Her respiratory muscle weakness seemed to be severe with paradoxical respiration, which is characterized by the chest wall moving in during inspiration and out during expiration together with dyssynchrony between the rib cage and abdomen (Video 1). Ultrasonography of the diaphragm revealed that the thickness of diaphragm (tdi) changed very little during inspiration and expiration along with a thin diaphragm (End-inspiration: 1.2 mm, End-expiration: 1.1 mm). These observations suggested the presence of diaphragm dysfunction (Figure 1).



Video 1: Chest wall moving during inspiration and out during expiration together with dyssynchrony between the rib cage and abdomen.

Note: To best view

1. Kindly open the pdf file in Adobe Reader XI version.
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3. To watch the video kindly install the latest adobe flash player. Click here to download: <http://get.adobe.com/flashplayer/otherversions/>

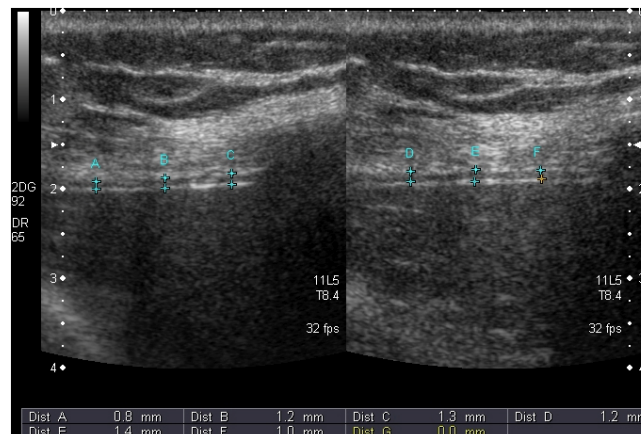


Figure 1: (A) Sonogram of the diaphragm during expiration and (B) inspiration.

	At the initial evaluation (Room air)	One month later (1 L/min via nasal cannula)
pH	7.489	7.443
pCO ₂ (mmHg)	40.5	71.4
pO ₂ (mmHg)	87	68.5
HCO ₃ (mEq/L)	30.5	48.1
A-a DO ₂ (mmHg)	13	13

Table 1: Arterial blood gas analysis at initial evaluation and a 1-month later.

McCool FD and Minami reported² that diaphragmatic dysfunction is probable when tdi at end-expiration is less than 2 mm, and/or change of the thickness (Δ tdi%) is less than 20%. Both of these criteria were met in our case (Figure 1). Hiwatani et al^{3,4} reported that at thickening ratio of the diaphragm, defined by the maximum tdi divided by the minimum tdi, of 1.39 or less in patients with ALS could predict development of hypercapnia (PaCO₂ ≥ 45 mmHg). Indeed, the ratio of diaphragm (max/min) in our case was 1.09, less than the cut-off point of 1.39. The patient subsequently developed hypercapnia with CO₂ narcosis and died from hypercapnic respiratory failure 1 month after the initial examination. Of note, alveolar-arterial oxygen gradient (A-aDO₂) at the initial examination and when she developed hypercapnic respiratory failure, 1 month after the first examination, were almost identical, and both values were within normal limits (13 mmHg) (Table 1). This suggests that respiratory failure was from hypoventilation alone, rather than from other causes, such as shunt, ventilation-perfusion (V/Q) mismatch, or decreased diffusing capacity.

This case illuminates the importance of diaphragm ultrasonography as a tool to evaluate patients with ALS, particularly those with respiratory issues. Diaphragm ultrasonography may help to detect the underlying pathophysiology and predict hypercapnic respiratory failure. In our case, diaphragm ultrasonography revealed a thin diaphragm along with low Δ tdi%, indicating that the paradoxical respiration observed at the initial examination was likely due to diaphragmatic dysfunction. Diaphragm ultrasonography also served to predict the progression to hypercapnic respiratory failure and thus aided in predicting the prognosis for the patient.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONSENT

The authors obtained written informed consent from the patient for submission of this manuscript for publication.

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