

Lightning strike: a first case of unilateral diaphragmatic paralysis

Timucin Alar,¹ Yildiz Degirmenci,²
Handan Isin Ozisik Karaman²

¹Thorax Surgery Department; ²Neurology Department, Canakkale Onsekiz Mart University, Canakkale, Turkey

Abstract

Lightning injury is the second most common cause of weather-related deaths in the United States. Despite the several neurological complications such as polyneuropathy, myelopathy, spinal cord injury, motor neuron disease due to the lightning-induced injury, there is no documented case of unilateral diaphragmatic paralysis. We describe the case of a patient with a history of lightning strike at childhood period, prior the onset of isolated, diaphragmatic paralysis, unilaterally. Clinical and electrophysiological findings suggest an injury restricted to the phrenic nerve, unilaterally.

Introduction

Lightning injury is a global mortality of 1000 deaths per year, and is the second most common cause of weather-related deaths in the United States.^{1,2,3} Injuries to the lungs and mediastinum after a lightning strike rarely have been described as hemo/pneumothorax and pneumomediastinum.⁴ Review of the lightning-induced injury literature revealed several neurological complications such as polyneuropathy, myelopathy, spinal cord injury, motor neuron disease.⁵⁻⁸ But there is no documented case of unilateral diaphragmatic paralysis. We describe the case of a patient with a

history of lightning strike at childhood period, prior the onset of isolated, diaphragmatic paralysis, unilaterally. Clinical and electrophysiological findings suggest an injury restricted to the phrenic nerve, unilaterally.

Case Report

A healthy 67-year-old male presented to the Thorax Surgery department of our faculty with intermittent dyspnea, hyperhidrosis and painless right epigastric swelling. He had a history of lightning strike at the age of 12 which yield to burn and deterioration of consciousness lasted 1 day. Following this injury, throughout 10 years period, he had tinnitus every day, beginning just at the time of the lightning strike and lasting 5 min. Effort dyspnea that increased with bending and lying down was added to his complaints at the ages of 17-18 years. He did not present to any clinic since February 2009, which he showed up to thorax surgery department of our hospital. After a detailed examination, a chest X-ray and a thorax computed tomography (CT) was performed to the patient. Both chest X-ray and thorax CT revealed elevation at the right diaphragm and the pre-diagnosis was paralysis of the phrenic nerve and congenital eventration (Figures 1 and 2). Despite there was no reciprocal movement diaphragm, neurological assessment was demanded to determine possible phrenic nerve paralysis. The patient had no deterioration in consciousness with intact cranial nerves. He was well nourished and had no muscle wasting with normal strength and deep tendon reflexes. Plantar responses were flexor. He exhibited no abnormal movements. He had a subjective hypoesthesia at the right lower extremity, which may be due to the lymphangitis that he experienced 5 years ago. To assess the phrenic nerve function, nerve conduction study for phrenic nerve was performed using standard techniques, while the patient was lying supine.⁹

We performed electrical stimulation with surface bipolar electrodes applied over the

Correspondence: Yildiz Degirmenci, Neurology Department, Canakkale Onsekiz Mart University Medical Faculty, +9017100, Canakkale, Turkey. Tel. +90.286.263.59.51 - Fax: +90.286.263.59.56. E-mail: ydegir@gmail.com

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phrenic nerve at the neck. Stimulation was given just above the clavicle, between the sternal and clavicular heads of the sternocleidomastoid muscles, and the responses to electrical stimulation were recorded with surface

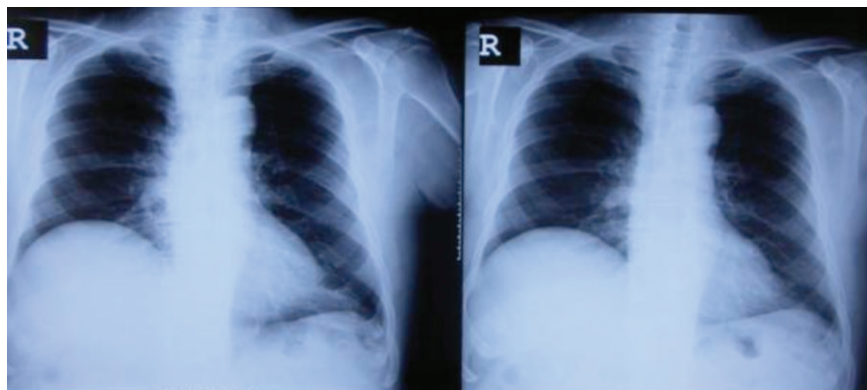


Figure 1. Chest X-ray: Right diaphragm elevation.

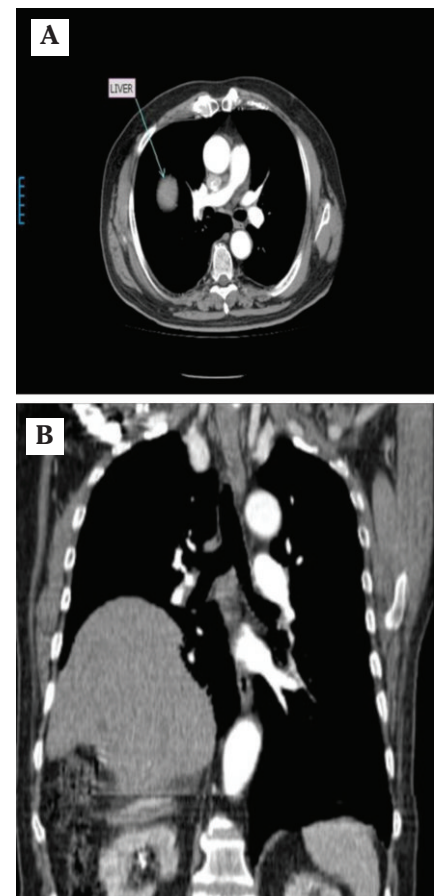


Figure 2. Thorax computed tomography (CT). A) Axial section showing elevation at the right diaphragma. B) Sagittal section showing elevation at the right diaphragma.

electrodes attached over the lateral chest.¹⁰ The phrenic nerve conduction times were compared to reference values in the literature.^{9,10,11} There was no electrophysiological response in the right phrenic nerve (Figure 3A), the left phrenic nerve was normal according to the reference normal values (Figure 3B).⁹⁻¹¹

Discussion

The lightning-related neurologic conditions are divided into four categories. Category I consists of signs and symptoms that are temporary and usually benign. Category II conditions are prolonged or permanent produced by central nervous system lesions such as encephalopathy, myelopathy. A large number of patients are afflicted with neurobehavioral symptoms. Category III contains delayed neurologic syndromes. Category IV encompasses neurologic lesions that are not directly activated by the lightning strike but are the result of trauma secondary to falls or blasts effects.¹²

Despite the acute (hypoxic encephalopathy due to cardiac arrest, isolated facial nerve palsy, transient amnesia, paresthesia, paralysis, dysfunction of the 8th cranial nerve) and chronic (cerebral edema, occlusive or hemorragic lesions, seizures, myelopathy, polyneuropathy, extrapyramidal syndrome) neurological complications following the lightning strike were reported in the literature, there was no diaphragm paralysis found.¹³ However, review of the literature revealed many neurological complications following electrical injuries such as loss of consciousness, acute and/or delayed peripheral neuropathies, memory problems, paresthesia, chronic pain, weakness.^{14,15}

Whereas our patient presented with unilateral diaphragm paralysis following a lightning strike, we had to exclude other reasons which could cause diaphragm paralysis. Unilateral or bilateral diaphragmatic paralysis can occur in the course of several diseases, being usually a serious condition. Chronic diaphragmatic failure is usually due to muscle fatigue in patients with pulmonary disease or to muscle denervation in patients with amyotrophic lateral sclerosis.^{16,17} Occasionally, sub-acute or chronic diaphragmatic failure is the first manifestation of motor neuron disease, hereditary neuropathies, Lambert-Eaton syndrome, or myopathies. Acute respiratory failure occurs typically in patients with the Guillain-Barré syndrome in whom phrenic nerve or nerve root demyelination lead to ineffective contraction of the diaphragm, requiring assisted ventilation until recovery.^{18,19,20} All these entities were reasonably excluded in our patient, who had no other clinical or electrophysiological manifestation of neurological disease except for his unilateral phrenic nerve lesion.

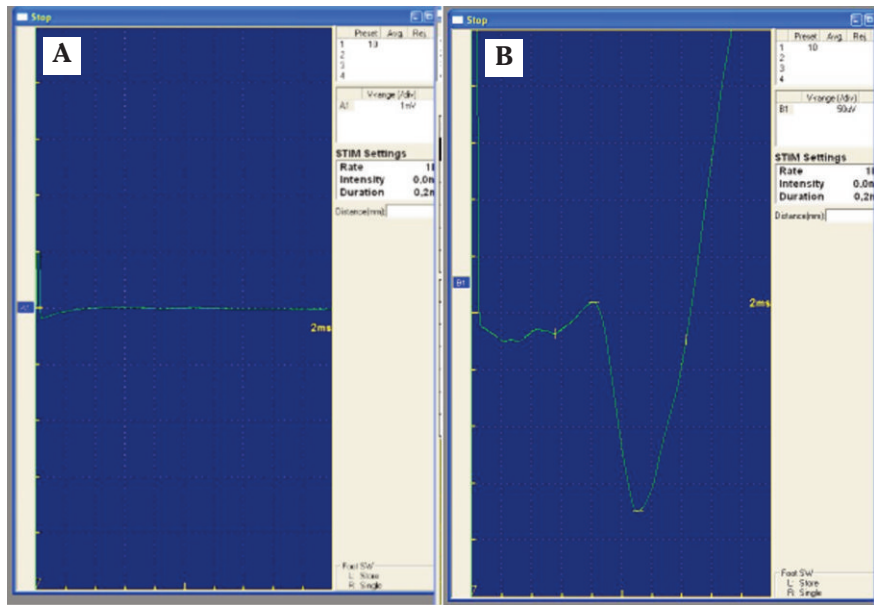


Figure 3. A) Right phrenic nerve motor conduction study revealing no electrophysiological response. B) Left phrenic nerve motor conduction study revealing normal electrophysiological response.

This clinically and electrophysiologically proven unilateral, isolated diaphragmatic paralysis was described in order to emphasize a rare complication of lightning strike.

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