**SAS Journal of Medicine**
Abbreviated Key Title: SAS J Med
ISSN 2454-5112
Journal homepage: https://saspublishers.com

OPEN ACCESS

**Radiology**

# Diagnostic Strategy in Idiopathic Diaphragmatic Paralysis

H. Bouqourou[1*], S. Taddart[1], A. EL Hajjami[1], Y. Bouktib[1], B. Boutakioute[1], M. Ouali EL Idrissi[1], N. Cherif Idrissi Ganouni[1]

[1]Department of Radiology, CHU Mohammed VI, University of CaddiAyyad, Marrakech

**DOI:** https://doi.org/10.36347/sasjm.2024.v10i09.009 | **Received:** 26.07.2024 | **Accepted:** 31.08.2024 | **Published:** 06.09.2024

***Corresponding author:** H. Bouqourou
Department of Radiology, CHU Mohammed VI, University of CaddiAyyad, Marrakech

**Abstract** **Case Report**

Unilateral diaphragmatic paralysis is a medical condition characterized by the impairment of either the right or left hemidiaphragm, resulting in an inability to contract effectively during inspiration. This condition may arise due to intrinsic diaphragmatic muscle dysfunction or a disruption in the neural input from the phrenic nerve to the affected hemidiaphragm. The etiology is diverse, with clinical manifestations varying from an absence of symptoms to severe respiratory compromise. This case study aims to review the assessment and management of unilateral diaphragmatic paralysis, highlighting the role of dynamic imaging techniques, such as diaphragmatic ultrasound, in the diagnosis, evaluation, and ongoing monitoring of patients with this condition.

**Keywords**: Diaphragm, Diaphragmatic Dysfunction, Diaphragmatic Paralysis, Diaphragmatic Ultrasound.



## INTRODUCTION

The diaphragm is widely recognized as the most vital respiratory muscle, serving as a key barrier that separates the thoracic and abdominal cavities. Innervated by the phrenic nerve, which originates from the C3-C5 nerve roots, the diaphragm plays a crucial role in breathing. Upon contraction, the diaphragm moves downward, generating negative intrathoracic pressure. This action facilitates lung expansion and enables passive airflow into the lungs, thereby promoting gas exchange [1-3]. Any disruption to diaphragmatic innervation, muscle contractility, or its mechanical linkage to the chest wall can lead to diaphragmatic dysfunction.

Diaphragm paralysis can be unilateral or bilateral, with unilateral paralysis being more prevalent. Unilateral diaphragmatic paralysis occurs when one side of the diaphragm, either right or left, loses its contractile capability, impairing the inspiratory process. This condition can result from either intrinsic muscular issues or a loss of innervation from the phrenic nerve to the affected hemidiaphragm.

We present the case of a 73-year-old male with unilateral diaphragmatic paralysis, manifested by exertional dyspnea.

## CASE REPORT

A 73-year-old male with a medical history of type 2 diabetes managed with oral antidiabetic agents and arterial hypertension under pharmacological treatment presented with chronic exertional dyspnea, exercise intolerance, and daytime fatigue. Clinical examination revealed tachycardia with a heart rate of 105 bpm, while the remainder of the cardiovascular and pleuropulmonary assessment was unremarkable. Electrocardiography demonstrated sinus tachycardia, and transthoracic echocardiography revealed no abnormalities. Initial chest evaluation was conducted with a thoracic X-ray (Figure 1) that revealed an elevation of the right hemidiaphragm. A subsequent thoracic CT scan confirmed this finding, with no additional abnormalities detected (Figure 1). Based on the clinical and radiological evidence, unilateral diaphragmatic paralysis was highly suspected. To further evaluate diaphragmatic function, a diaphragmatic ultrasound was performed for dynamic assessment (Figures 3, 4). The ultrasound focused on diaphragm excursion and diaphragmatic thickness fraction, both of which indicated diaphragmatic dysfunction.

Spirometry was also conducted, revealing a mild restrictive ventilatory pattern consistent with the diagnosis. As part of the etiological investigation, a series of tests were performed, including cervical MRI, thyroid function tests, and Borrelia burgdorferi serology,

all of which returned normal results. Consequently, the paralysis was deemed to be of idiopathic origin.

No therapeutic interventions were deemed necessary, as the condition did not significantly impact the patient's quality of life.

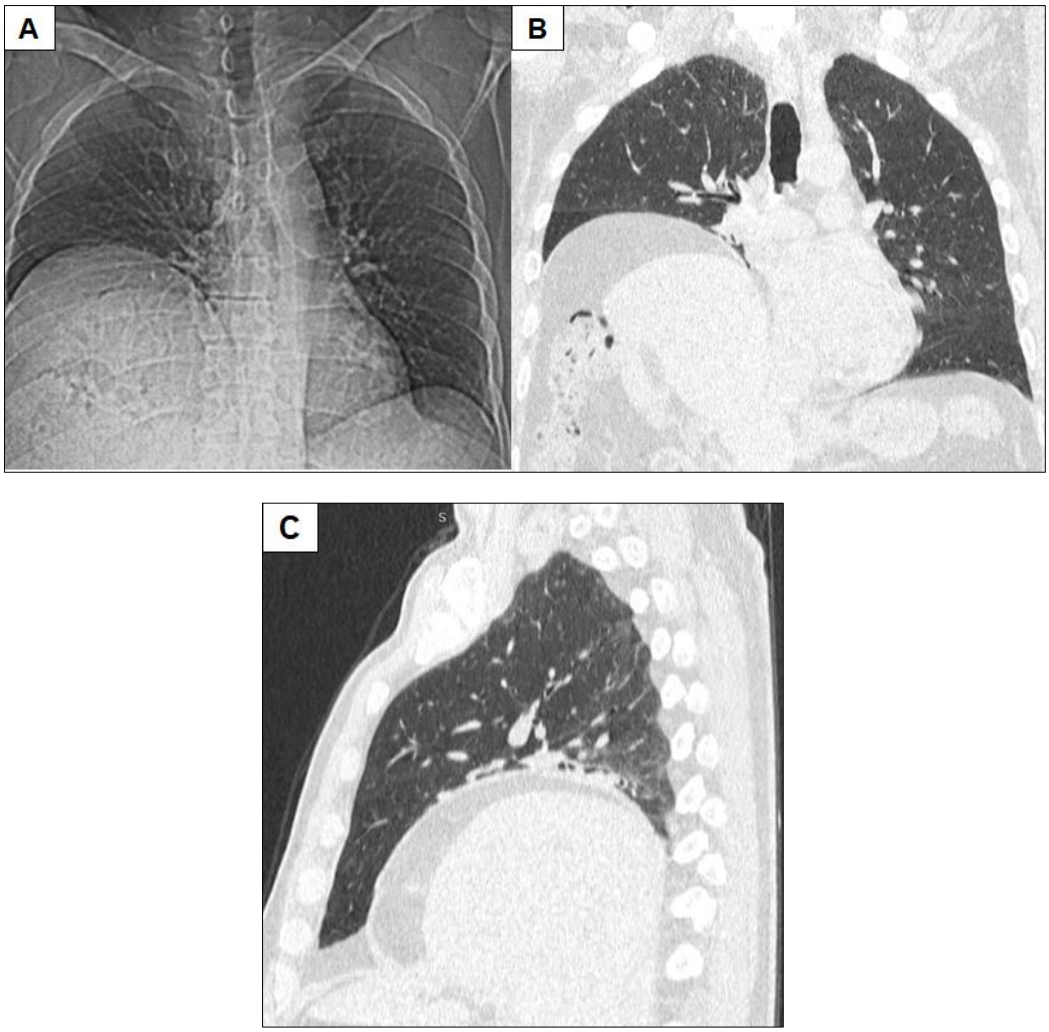


**Figure 1: Chest x-ray (A), coronal (B) and sagittal (C) thoracic CT scan images showing an elevation of the right diaphragmatic dome**

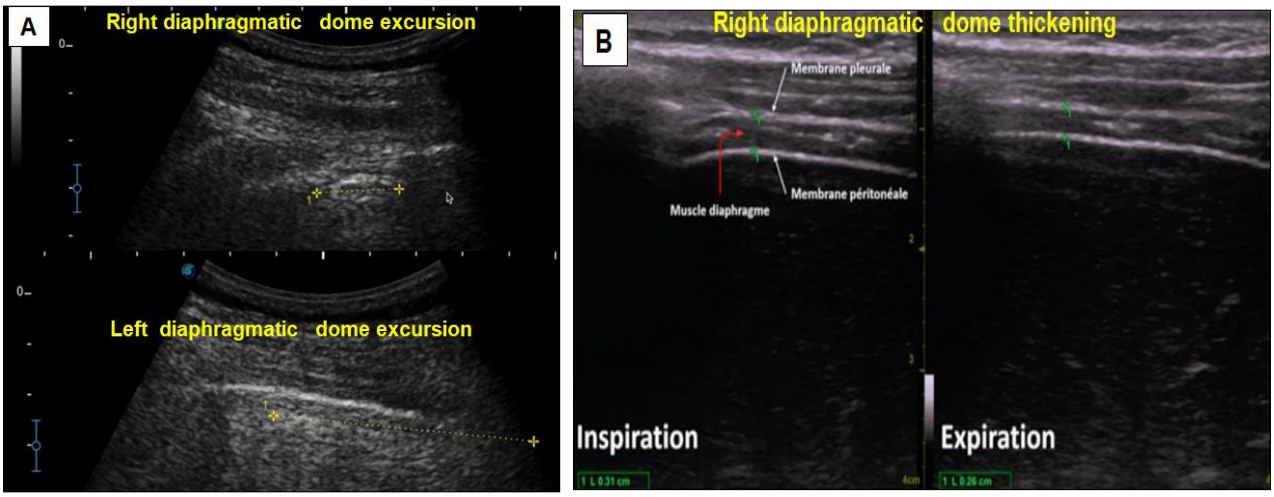


**Figure 2: Diaphragmatic ultrasound images shomwing a diaphragmatic excursion of less than 10mm on the right (A) and a 19% thickening fraction (B) (thickening fraction= (inspiration thickness- expiration thickness)/ (inspiration thickness-expiration thickness) x 100) both parameters indicate right diapghragmatic paralysis.**

## DISCUSSION

The term "diaphragmatic dysfunction" broadly refers to both diaphragmatic weakness and paralysis. Diaphragmatic weakness involves a partial loss of muscle strength, impairing the diaphragm's ability to generate sufficient pressure for effective ventilation, whereas paralysis indicates a complete loss of this function. Depending on the etiology, diaphragmatic dysfunction can be unilateral or bilateral, and either temporary or permanent. The severity of paralysis varies with the underlying cause [4, 5]. In some instances, it may be reversible without long-term deficits, while in others, it may result in permanent impairment.

The causes of unilateral diaphragmatic paralysis can be categorized into different etiologies such as traumatic causes that are considered the most common cause of diaphragm weakness. Direct trauma, either blunt trauma or during a surgical procedure, has the potential to injure the phrenic nerve leading to hemidiaphragm weakness or paralysis [6, 7]. In the other hand, compression of the phrenic nerve, whether in the form of cervical spondylosis or from an adjacent tumor or malformation can lead to a decreased ability to function properly [10]. Neurogical conditions that cause nerve damage or demyelination may also lead to diaphragm paralysis or weakness [8, 9]. Some viruses including herpes zoster, Zika, poliovirus, and other viral infections such as lyme diasease have been linked to unilateral diaphragmatic paralysis [11]. Iatrogenic causes were also reported in patients taht received nerve blocks, the local spread of anesthetic can affect the phrenic nerve cause unilateral diaphragmatic paralysis. Finally, nearly 70% of the causes of both unilateral and bilateral diaphragmatic paralysis and weakness have been considered idiopathic.

Unilateral diaphragmatic dysfunction is often asymptomatic, leading to incidental diagnosis when an elevated hemidiaphragm is detected on a chest X-ray performed for unrelated reasons. Symptoms tend to be more pronounced in patients who are obese or have concurrent cardiac or pulmonary conditions [5]. The most common symptoms include exertional dyspnea and orthopnea, with possible manifestations of nocturnal hypoventilation and gastroesophageal reflux. Physical examination findings are generally non-specific, but may reveal diminished breath sounds at the base of the affected hemithorax.

Diaphragmatic dysfunction may be suspected during the evaluation of unexplained dyspnea or discovered incidentally through imaging tests conducted for other purposes. Diagnosis typically involves both static and dynamic imaging modalities, such as radiography, fluoroscopy, and chest ultrasound.

### Radiography

Many cases of unilateral diaphragmatic paralysis are asymptomatic, leading to some cases being found incidentally by chest radiographs by showing an elevation of the diaphragm Although the presence of a diaphragmatic elevation is not necessarily a sign of dysfunction, its absence makes diaphragmatic dysfunction unlikely [12].

### Fluoroscopy (Snif Test)

For many years, fluoroscopic evaluation has been the gold standard for diagnosing diaphragmatic paralysis. This imaging technique allows continuous visualization of the diaphragm throughout the normal respiratory cycle and during forced inspiratory maneuvers. In cases of unilateral diaphragmatic paralysis, the affected hemidiaphragm will either exhibit no movement or demonstrate paradoxical upward movement into the thoracic cavity during sniffing or deep inspiration, a positive test observed in over 90% of cases.

### Diaphragmatic Ultrasound

Ultrasound is a non-invasive, rapid, simple, and well-tolerated test that offers both quantitative and qualitative assessment of diaphragmatic movement, with a linear correlation between diaphragmatic excursion and inspired volume. Unlike fluoroscopy, ultrasound does not involve exposure to ionizing radiation, and it does not require intense patient cooperation. The two primary indices used to diagnose diaphragmatic paralysis are a diaphragmatic excursion of less than 10 mm during tidal breathing and a diaphragm thickening fraction (TF) of less than 20%. The TF is calculated as [(thickness at end-inspiration − thickness at end-expiration) / thickness at end-expiration] × 100. [13].

### CT Scan and MRI

CT scan and MRI can be beneficial to determine the etiology of the paralysis, and to exclude any possibility of compression from tumors or other thoracic and cervical etiology.

### Pulmonary Function Tests

In cases of unilateral diaphragmatic paralysis, a reduction of approximately 50% in forced vital capacity is typically observed, while other pulmonary volumes may remain unchanged as long as the paralysis is unilateral. [10].

Therapeutic management of diaphragmatic paralysis is largely determined by its underlying etiology. However, unilateral diaphragmatic paralysis is often asymptomatic and frequently discovered incidentally. In such cases, no intervention is generally necessary, as the condition does not adversely affect the patient’s quality of life. The prognosis for these patients is generally favorable, provided there are no concurrent cardiopulmonary conditions.

On the other hand, several therapeutic options are available for cases that do require intervention, including surgical diaphragmatic plication,

diaphragmatic pacemaker implantation, ventilatory support, and phrenic nerve repair through microsurgery [14,15].

## CONCLUSION

Diaphragmatic paralysis can have significant clinical implications. A comprehensive evaluation is essential to determine its etiology and to address its impact on sleep architecture and exercise capacity. Ultrasound is a valuable and straightforward tool for routinely assessing diaphragmatic function, aiding clinicians in making informed therapeutic decisions. Management of diaphragmatic dysfunction should be conducted in specialized centers equipped with expertise in diaphragmatic ultrasonography, phrenic nerve stimulation, pacemaker implantation, and surgical techniques such as diaphragmatic plication.

## REFRENCES


1. Shane, M. O'Toole., Jeremy, K. Treasure Island (FL): StatPearls Publishing; 2024 Jan ; Unilateral Diaphragmatic Paralysis.
2. Sankari, A., Minic, Z., Farshi, P., Shanidze, M., Mansour, W., Liu, F., ... & Goshgarian, H. G. (2019). Sleep disordered breathing induced by cervical spinal cord injury and effect of adenosine A1 receptors modulation in rats. *Journal of Applied Physiology*, *127*(6), 1668-1676.
3. Zimmer, M. B., & Goshgarian, H. G. (2007). Spinal cord injury in neonates alters respiratory motor output via supraspinal mechanisms. *Experimental neurology*, *206*(1), 137-145.
4. Gibson, G. J. (1989). Diaphragmatic paresis: pathophysiology, clinical features, and investigation. *Thorax*, *44*(11), 960.
5. Ricoya, J., Rodríguez-Núnez, N., Álvarez-Dobano, J. M., Toubes, M. E., Riveiroa, V., & Valdés, L. (2019). *Diaphragmatic dysfunction*, *Pulmonology*, *25*(4), 223-235.
6. Canbaz, S., Turgut, N., Halici, U., Balci, K., Ege, T., & Duran, E. (2004). Electrophysiological evaluation of phrenic nerve injury during cardiac surgery–a prospective, controlled, clinical study. *BMC surgery*, *4*, 1-5.
7. Castillo, E. D., Benguria, S. T., Fernández, K. I., & Iriarte, B. E. (2019). Unilateral diaphragmatic paralysis after laparoscopic cholecystectomy. *Revista Española de Anestesiología y Reanimación (English Edition)*, *66*(6), 342-345.
8. McEnery, T., Walsh, R., Burke, C., McGowan, A., Faul, J., & Cormican, L. (2017). Phrenic nerve palsy secondary to parsonage–turner syndrome: a diagnosis commonly overlooked. *Lung*, *195*, 173-177.
9. Van Alfen, N., Doorduin, J., Van Rosmalen, M. H., Van Eijk, J. J., Heijdra, Y., Boon, A. J., ... & Groothuis, J. T. (2018). Phrenic neuropathy and diaphragm dysfunction in neuralgic amyotrophy. *Neurology*, *91*(9), e843-e849.
10. Kokatnur, L., Vashisht, R., & Rudrappa, M. (2023). StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL), 31, Diaphragm Disorders.
11. Rajapakse, N. S., Ellsworth, K., Liesman, R. M., Ho, M. L., Henry, N., Theel, E. S., ... & Meneses, J. (2018). Unilateral phrenic nerve palsy in infants with congenital Zika syndrome. *Emerging infectious diseases*, *24*(8), 1422.
12. Chetta, A., Rehman, A. K., Moxham, J., Carr, D. H., & Polkey, M. I. (2005). Chest radiography cannot predict diaphragm function. *Respiratory medicine*, *99*(1), 39-44.
13. Gottesman, E., & McCool, F. D. (1997). Ultrasound evaluation of the paralyzed diaphragm. *American journal of respiratory and critical care medicine*, *155*(5), 1570-1574.
14. Freeman, R. K., Van Woerkom, J., Vyverberg, A., & Ascioti, A. J. (2009). Long-term follow-up of the functional and physiologic results of diaphragm plication in adults with unilateral diaphragm paralysis. *The Annals of thoracic surgery*, *88*(4), 1112-1117.
15. Groth, S. S., Rueth, N. M., Kast, T., D'Cunha, J., Kelly, R. F., Maddaus, M. A., & Andrade, R. S. (2010). Laparoscopic diaphragmatic plication for diaphragmatic paralysis and eventration: an objective evaluation of short-term and midterm results. *The Journal of thoracic and cardiovascular surgery*, *139*(6), 1452-1456.