Clinics in Surgery

Surgical Practice
Published: 01 Apr, 2024

Utility of Rigorous Preoperative Testing for Unilateral Diaphragmatic Dysfunction

*Kim RS[1] and Khaitan PG[1,2]**

[1]Department of General Surgery, Georgetown University School of Medicine, Medstar Washington Hospital Center, USA

[2]Department of Surgery, Division of Thoracic Surgery, Sheikh Shakhbout Medical City, Abu Dhabi, UAE

Is a CXR and/or a CT scan enough to plicate the diaphragm in a symptomatic patient? An elevated hemidiaphragm is indicative of either a paretic/paralyzed diaphragm or eventration of diaphragm. While central paralysis can affect the entire hemidiaphragm, an eventration is suggestive of thinning of only a small segment of the hemidiaphragm. Regardless of the underlying etiology, management remains the same. Signs and symptoms may include difficulty breathing (at rest or on exertion), chronic atelectasis, recurrent pneumonia, and/or fatigue limiting one's quality of life. Once diagnosed on CXR or CT scan in a symptomatic patient, generally surgery is recommended with a few exceptions. For example, patients with certain neuromuscular disorders (e.g. amyotrophic lateral sclerosis or muscular dystrophy) may not benefit from plication and require pacing instead [1].

The etiology of unilateral diaphragm paralysis can be considered in three broad categories: Iatrogenic secondary to a surgical procedure or nerve block, inflammatory disease or infiltrative process, or idiopathic. Infiltrative causes resulting in phrenic nerve dysfunction include lymphoma or lymphadenopathy encasing the nerve, thymoma, or other hilar infiltrative pathologies or malignancies. Neuropathies, demyelinating disorders and cervical spinal cord injury can also result in diaphragmatic paralysis. Of these, the most common cause of unilateral diaphragm paralysis is either post-procedural (50-60%) or idiopathic (20%) [1]. Specifically, coronary artery bypass grafting is frequently associated with lesions of phrenic nerves resulting in postoperative diaphragmatic paralysis due to harvesting of internal mammary artery and/or cardiac cooling process [1]. Occasionally, a central line placement in the internal jugular vein can lead to an injury to the ipsilateral phrenic nerve. Typically, these patients are observed and placed under pulmonary rehabilitation for a period of at least 6 months to a year prior to considering any surgical intervention to allow recovery of the nerve [2,3]. However, if the patient's clinical picture deteriorates compromising their quality of life, early surgical intervention is reasonable.

Conventional teaching has included a battery of preoperative tests including (but not limited to) chest X-ray, CT scan or MRI of the chest, Pulmonary Function Tests (PFTs), diaphragmatic fluoroscopic sniff test or ultrasound, Electromyography (EMG), transdiaphragmatic pressure measurements, sleep study and lab tests to test for underlying thyroid disease or Lyme disease [4]. PFTs are usually performed first line to quantify the physiologic impact of diaphragmatic weakness. Unilateral diaphragm weakness is usually associated with a mild decrease in vital capacity, approximately 75% of predicted value with changes based on patient position (i.e. decrease when supine). Functional residual capacity and total lung capacity are usually preserved. Fluoroscopy is a dynamic evaluation of the diaphragmatic movement to evaluate possible unilateral diaphragmatic weakness. The sniff test consists of assessing the motion of the diaphragm while instructing the patient to take short inspiratory efforts through the nostrils. Normally, descent of the diaphragm will be seen bilaterally. However, in patients with unilateral paralysis, a paradoxical upward motion of the abnormal hemidiaphragm is observed. Despite its relative ease, there are several drawbacks of fluoroscopy. First, this test is dependent on patient effort and with variation in interpretation (often without a reference to compare against), the test is very subjective in nature. An intubated patient, for example, will be unable to elicit any positive findings of unilateral paralysis. Although historically sniff testing has been used to determine whether there is diaphragm paralysis *vs.* eventration, this screening methodology has long been shown to lack specificity, have significant inter and intra-observer variability, with 6% of normal patients exhibiting paradoxical motion on fluoroscopy [5]. Another more commonly accepted functional test of the hemidiaphragm is the sonographic examination of the muscle at the zone of apposition where it abuts the lower rib cage. Here the

OPEN ACCESS

Correspondence:
Puja Gaur Khaitan, Department of Surgery, Division of Thoracic Surgery, Sheikh Shakhbout Medical City, Khalifa University, Abu Dhabi, UAE; Tel: +971-2314-6615;

Received Date: *11 Mar 2024*
Accepted Date: *26 Mar 2024*
Published Date: *01 Apr 2024*

Citation:
Kim RS, Khaitan PG. Utility of Rigorous Preoperative Testing for Unilateral Diaphragmatic Dysfunction. Clin Surg. 2024; 9: 3693.

thickening of the diaphragm reflects diaphragmatic shortening, and lack of thickening with inspiration is considered diagnostic of paralysis. While the test allows for a quantitative and qualitative assessment of diaphragmatic movement, it is highly reproducible [5]. While all these tests are available and can be educational, they result in unwanted costs and undue delays that ultimately may not alter the management. A few high-powered studies comparing these two methodologies have demonstrated the advantage of ultrasound over fluoroscopy in its ability to identify abnormal hemidiaphragmatic movement with more sensitivity [5]; all cases of fluoroscopic abnormality were also found to be abnormal on ultrasound but not necessarily *vice-versa*.

Diaphragmatic plication is the main surgical treatment offered to patients with hemidiaphragm dysfunction, whereby the flaccid hemidiaphragm is oversewn and thus made taut via thoracic or abdominal approach [6]. Plication has been generally shown to be effective, safe, and with few complications. Various surgical approaches have been described in the literature including open, thoracoscopic, or robotic using either a running sutured, interrupted, barbed *vs.* non-barbed sutures, pledgeted, plicated *vs.* stapled, with or without mesh reinforcement. The effects of plication have been not only seen in postoperative scans, but in improved pulmonary function tests, including increase up to 20% in vital capacity, forced expiratory volume in 1 sec, and total lung capacity. Such increase in lung volume in the operated side results from immobilization of the diaphragm which decreases its paradoxical motion. Interestingly, improvements have been seen in tidal volumes of both hemidiaphragms after repair, postulated to be related to overall improvement in expansion of the rib cage, as well as exercise capacity and daily quality of life [7-9]. However, symptomatic improvement does not necessarily translate into improved PFTs, and one has to wonder if the central dogmatic teaching of rigorous (and expensive) preoperative testing of the diaphragmatic function and PFTs are indeed warranted and impacts surgical decision?

We, the authors, therefore propose a more conservative workup including just a CXR and a CT scan of the chest for patients with unilateral diaphragmatic elevation without a neuromuscular disorder causing symptoms prior to diaphragmatic plication. While making the workup more economic, an abbreviated workup will also avoid unnecessary delay in surgery.

Keywords: Hemidiaphragm paralysis; Eventration; Diaphragmatic placation.

References

1. McCool FD, Tzelepis GE. Dysfunction of the diaphragm. N Engl J Med. 2012;366(10):932-42.
2. Summerhill EM, El-Sameed YA, Glidden TJ, McCool FD. Monitoring recovery from diaphragm paralysis with ultrasound. Chest. 2008;133(3):737-43.
3. Gayan-Ramirez G, Gosselin N, Troosters T, Bruyninckx F, Gosselink R, Decramer M. Functional recovery of diaphragm paralysis: A long-term follow-up study. Respir Med. 2008;102(5):690-8.
4. Patel DC, Berry MF, Bhandari P, Backhus LM, Raees S, Trope W, et al. Paradoxical motion on sniff test predicts greater improvement following diaphragm plication. Ann Thorac Surg. 2021;111(6):1820-6.
5. Houston JG, Fleet M, Cowan MD, McMillan NC. Comparison of ultrasound with fluoroscopy in the assessment of suspected hemidiaphragmatic movement abnormality. Clin Radiol. 1995;50(2):95-8.
6. Shields TW. Diaphragmatic function, diaphragmatic paralysis, and eventration of the diaphragm. In: Shields TW, Locicero J, Ponn R, Rusch VW, editors. General Thoracic Surgery, VI. Philadelphia: Lippincott Williams & Wilkins; 2005:740-745.
7. Freeman RK, Van Woerkom J, Vyverberg A, Ascioti AJ. Long-term follow-up of the functional and physiologic results of diaphragm plication in adults with unilateral diaphragm paralysis. Ann Thorac Surg. 2009;88(4):1112-7.
8. Elshafie G, Acosta J, Aliverti A, Bradley A, Kumar P, Rajesh P, et al. Chest wall mechanics before and after diaphragm plication. J Cardiothorac Surg. 2016;11:25.
9. Celik S, Celik M, Aydemir B, Tunckaya C, Okay T, Dogusoy I. Long-term results of diaphragmatic plication in adults with unilateral diaphragm paralysis. J Cardiothorac Surg. 2010;5:111.