

Best Approach and Benefit of Plication for Paralyzed Diaphragm



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KEYWORDS

• Diaphragm plication • Paralysis • Eventration • Laparoscopy • Thoracoscopy

KEY POINTS

- Diaphragmatic plication is a safe procedure and should be performed for patients with symptomatic diaphragmatic paralysis or eventration.
- The diagnosis of symptomatic diaphragmatic paralysis or eventration is mostly clinical.
- Preoperatively, all patients should have a chest radiograph, pulmonary function tests, and a respiratory quality-of-life questionnaire.
- Although pulmonary function tests are often abnormal in symptomatic patients, these changes are inconsistent and do not correlate with the severity of dyspnea.
- Surgical approaches for plication include open transthoracic, thoracoscopic (with and without mini-thoracotomy), robotic assisted (abdominal or thoracic), open transabdominal, and laparoscopic.

INTRODUCTION

Diaphragmatic Eventration and Diaphragmatic Paralysis

Diaphragmatic eventration is defined as thinning of the diaphragm secondary to a congenital deficiency in its muscular structure; the normal attachments to the sternum, ribs, and dorsolumbar spine are maintained.¹ It is postulated that it occurs embryologically secondary to an abnormal migration of myoblasts from the upper cervical somites into 22 of the 4 embryologic structures that contribute to diaphragm development: the septum transversum (beginning at 4 weeks of gestation) and the pleuroperitoneal membrane (at 8–12 weeks of gestation).^{2,3} Clinically, diaphragmatic eventration can be impossible to differentiate from acquired paralysis. Diaphragmatic eventration is rare (incidence <0.05%), more common in male individuals, and more often affects the left

hemidiaphragm.^{4–6} Most adult patients who have diaphragmatic eventration are asymptomatic and generally present with an elevated hemidiaphragm discovered incidentally on a chest radiograph.^{4,7} Symptomatic patients who have diaphragmatic eventration usually present until adulthood because of weight gain or change in lung or chest-wall compliance.⁷

In contrast to true diaphragmatic eventration, diaphragmatic paresis or paralysis is a more common acquired condition. In adults, this condition arises more frequently on the left side. It can result from a number of abnormalities that affect the neuromuscular axis between the cervical spinal cord and the diaphragm.⁸ Common causes are idiopathic, iatrogenic phrenic nerve trauma from surgery (eg, cardiac, noncardiac thoracic, and cervical surgeries), tumor invasion of the phrenic nerve (eg, lung and mediastinal tumors), trauma, and rarely, infectious processes.^{8–14}

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PATHOPHYSIOLOGY AND CLINICAL PRESENTATION

Normal diaphragm function exerts caudal movement of the diaphragm during inspiration, resulting in expansion of the rib cage, which generates negative intrathoracic pressure and results in lung expansion.¹⁵ In patients with eventration or paralysis, diaphragmatic movement can be diminished, absent, or even paradoxical. As a result, ventilation and perfusion to the basal portion of the lung ipsilateral to the paralyzed or eventrated diaphragm are impaired, the latter possibly caused by regional vasoconstriction induced by alveolar hypoxia¹⁶; ventilation/perfusion mismatch and loss of chest-wall compliance are among the factors that contribute to dyspnea. Some symptomatic patients develop mild hypoxemia and attempt to compensate by hyperventilating, which can result in mild respiratory alkalosis.^{6,17} Others may manifest orthopnea caused by cranial displacement of the affected hemidiaphragm by the abdominal viscera in the supine position, leading to further reductions in lung volumes.¹⁷ A few patients (especially those with left hemidiaphragm eventration) can develop nonspecific gastrointestinal symptoms, such as epigastric pain, bloating, heartburn, regurgitation, belching, nausea, constipation, and weight loss, as the abdominal viscera migrate into the thoracic cavity.^{3,7}

DIAGNOSIS AND PREOPERATIVE EVALUATION

Most adults with paralysis or eventration are asymptomatic. Most cases are discovered incidentally on a chest radiograph, showing hemidiaphragm elevation.^{4,7}

The diagnosis of symptomatic diaphragmatic eventration or paralysis is mostly clinical, and is based on a focused history and physical examination and a chest radiograph. Dyspnea secondary to eventration or paralysis is predominantly a diagnosis of exclusion. These patients must be evaluated for other primary causes of dyspnea, and if found, corrected or improved if possible (eg, morbid obesity, primary lung disease, heart failure). In patients with dyspnea or orthopnea, a history consistent with hemidiaphragm paralysis (eg, onset of dyspnea after cardiac surgery), and an elevated hemidiaphragm on a standard full-inspiration posteroanterior and lateral chest radiograph, additional diagnostic studies are rarely necessary.

Symptom Evaluation

It is essential to determine the start, duration, and progression of dyspnea and/or orthopnea.

Patients who have diaphragm paralysis can often recall with precision when their dyspnea started or worsened (eg, after cardiac surgery); patients who have eventration may not be able to determine a specific starting point. All patients who have dyspnea secondary to diaphragmatic eventration or paralysis should fill out a standardized respiratory questionnaire to evaluate the severity of their symptoms and to assess their response to treatment.

Objective Respiratory and Quality of Life Evaluation

We use the St George's Respiratory Questionnaire (SGRQ),¹⁸ which is a validated questionnaire that measures health impairment from respiratory disease and quantifies changes in health after therapy. This questionnaire is formed by 2 parts: The first part is a symptoms score that assesses the patient's perception of the frequency and severity of his or her respiratory symptoms. The second part is an activity score, which assesses the degree of impairment of daily physical activities by a respiratory disease, and an effect score, which determines psychosocial dysfunction resulting from respiratory disease. Total scores range from 0 to 100 (normal: 0–6); higher scores translate to worse health impairment. A clinically significant improvement after surgery is defined as a reduction of 4 or more points after an intervention. Other respiratory questionnaires and scales exist, such as the Chronic Respiratory Disease Questionnaire, the Manchester respiratory activities of daily living questionnaire Medical and the Research Council Dyspnea Scale.^{19–21} They can be used to objectively measure response to treatments and impact on well-being and quality of life.

Physical Examination

The 2 characteristic findings that may be present on a physical examination in these patients are (1) paradoxical inward movement of the lower costal margin during inspiration (Hoover sign),²² and (2) abdominal paradox (the rib cage and abdomen move out of phase with each other).^{15,23}

Other nonspecific respiratory signs include increased anteroposterior diameter of the chest, diminished maximal excursion of the diaphragm on percussion, and diminished breath sounds on the affected side, mostly at the base.^{3,15} If an eventrated diaphragm is exceptionally redundant, a flopping sound may be heard on auscultation.²⁴

Pulmonary Function Tests

Standard pulmonary function tests (PFTs) are an unreliable tool to evaluate diaphragm function

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