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## ORIGINAL RESEARCH

# Impact of surgical treatment in acquired diaphragmatic eventration: experience of a Moroccan center

## *Impact du traitement chirurgical dans l'évènementation diaphragmatique acquise: expérience d'un centre Marocain*

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### ABSTRACT

**Background.** Diaphragmatic eventration (DE) is defined as an abnormal elevation of the hemidiaphragm with abdominal structures migration. We report a retrospective study to emphasize the role of surgical repair.

**Methods.** From January 2006 to December 2018. In group A : 48 cases of asymptomatic DE weren't operated and receive exclusive medical treatment by physical respiratory therapy. In group B: 38 symptomatic patients underwent plication surgery. The change in radiological eventration levels and in restrictive respiratory syndrome parameters (FEV1, FVC) of respiratory function tests performed during pre- and postoperative periods were compared in group B.

**Results.** The thoracic approach of DE can allow a real benefit as reported in the group B . The median duration of chest tube drainage was 2 days. In the same group of patients, 3 of them were complicated by hemothorax (n=2) and pyothorax (n=1) , a secondary surgery was mandatory. Clinical benefit of the surgery was objectified in 29 cases (78%) based on a satisfactory classical questionnaire. In the group A, only 11 patients (22.9%) reported an objective improvement after medical therapy (mainly functional rehabilitation). The difference between the two groups is statistically significant (p=0.025).

**Conclusion.** Diaphragmatic eventration is a rare condition, more frequently diagnosed on the left than on the right side. Surgical treatment have an objective impact on clinical function.

**KEYWORDS:** Eventration; Diaphragm; Surgery; Phrenic nerve; Palsy.

### RÉSUMÉ

**Introduction.** L'évènementation diaphragmatique (DE) est définie comme une élévation anormale de l'hémidiaphragme avec migration des structures abdominales. Nous rapportons une étude rétrospective pour souligner le rôle de la réparation chirurgicale.

**Méthodes.** De janvier 2006 à décembre 2018. Dans le groupe A: 48 cas de DE asymptomatique n'ont pas été opérés et bénéficient d'un traitement médical exclusif par kinésithérapie respiratoire. Dans le groupe B: 38 patients symptomatiques ont subi une chirurgie de plication. L'évolution des niveaux d'événements radiologiques et des paramètres restrictifs du syndrome respiratoire (FEV1, FVC) des tests de la fonction respiratoire effectués pendant les périodes pré et postopératoires a été comparée dans le groupe B.

**Résultats.** L'approche thoracique de l'ED peut permettre un réel bénéfice comme rapporté dans le groupe B. La durée médiane du drainage de la sonde thoracique était de 2 jours. Dans le même groupe de patients, 3 d'entre eux étaient compliqués d'hémithorax (n = 2) et de pyothorax (n = 1), une chirurgie secondaire était obligatoire. Le bénéfice clinique de la chirurgie a été objectivé dans 29 cas (78%) sur la base d'un questionnaire classique satisfaisant. Dans le groupe A, seuls 11 patients (22,9%) ont rapporté une amélioration objective après un traitement médical (principalement une rééducation fonctionnelle). La différence entre les deux groupes est statistiquement significative (p = 0,025).

**Conclusion.** L'évènementation diaphragmatique est une affection rare, plus fréquemment diagnostiquée du côté gauche que du côté droit. Le traitement chirurgical a un impact objectif sur la fonction clinique.

**MOTS CLÉS:** Eventration; Diaphragme; Chirurgie; Nerf phrénique; Paralysie.

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## INTRODUCTION

Different from a diaphragmatic hernia, diaphragmatic eventration (DE) is Defined as an abnormal elevation ,without injury of the hemidiaphragm or part of it, with abdominal structures migration. More frequent in the pediatric population with congenital causes than in adults. The incidence is less than 0.05%.

The most common causes are previous mediastinum surgery, chest trauma, neuromuscular diseases, some viral infection, and malignity. One-sided DE is rarely symptomatic in adults and the radiological diagnosis is the first diagnosing step. Dyspnea can be a common symptom. Respiratory distress can be described in bilateral DE. One of the hard steps in radiological diagnosis is rapid confusion with a diaphragmatic rupture particularly after thoraco-abdominal trauma situation or post-surgery.

Majority of reported studies of surgical treatment have raised discussions about indications of surgery on diaphragm eventration [1-5]. We report a retrospective study to emphasize the role of surgery in this condition within the scope of the existing literature.

## METHODS

From January 2006 to December 2018, 125 cases of diaphragmatic eventration were treated in our unity. Thirty nine cases of them were excluded. Exclusion criteria of patients from our study are patients with poor general state, patients with a cancer, and patients with limited respiratory function (Table 1).

All patients underwent a chest radiograph and CT (Figure 1 and 2A-C), MRI was indicated in few cases (n=4) (Figure 2D). Respiratory functional tests were mandatory for all cases. The patients were divided into two groups based on initial diagnosis. In group

A: 48 cases of asymptomatic DE weren't operated and receive exclusive physical respiratory therapy. In group B: 38 symptomatic patients underwent plication surgery (Figure 3). Patient characteristics are presented in Table 2.

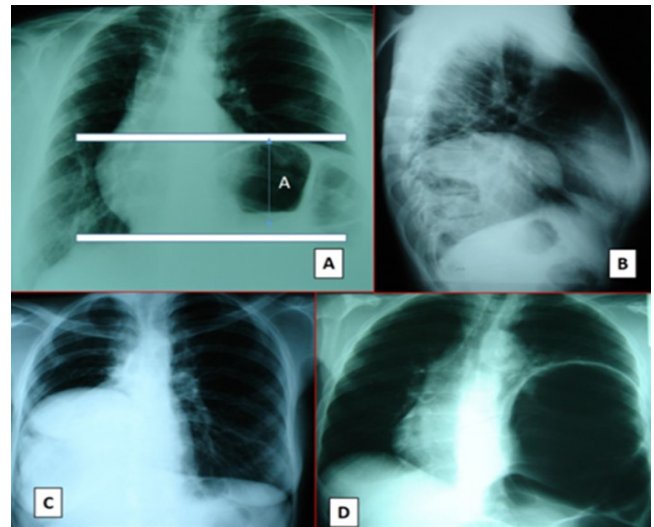


FIGURE 1 (1A-D). Chest radiograph with left diaphragmatic eventration

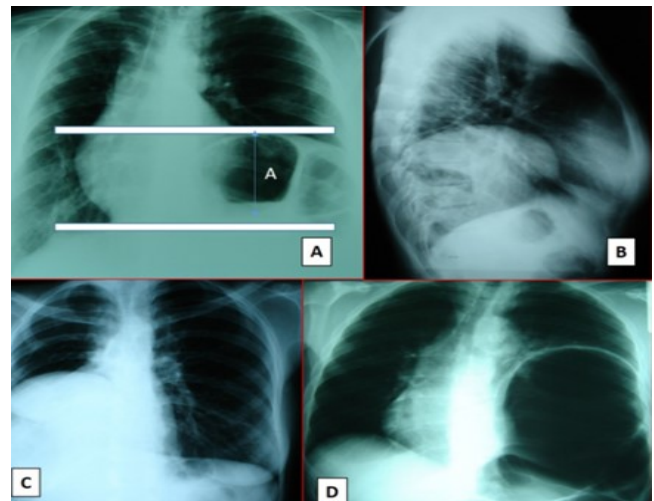


FIGURE 2D. Coronal view of MRI with right diaphragmatic eventration and migration of the liver.

Eligible patients with Diaphragmatic Eventration N= 125	
Included patients n=86	Excluded patients n= 39
chronic progressive dyspnea ± destroyed parenchyma or heart palpitations	Patients with poor general state (n=19)
chronic digestive symptoms	Patients with a history of associated cancer: (n=8)
Patients wanting surgical cure.	Patients who had limited respiratory function (n= 12)

TABLE 1. Inclusion and exclusion criteria.

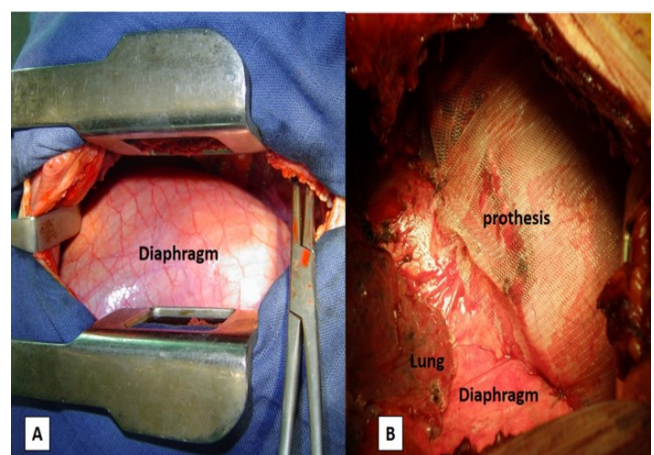


FIGURE 3. Perioperative view of diaphragmatic reparation surgery.

**TABLE 2. Demographic and clinical data of patients with diaphragmatic eventration.**

variables	Group A (n=48)	Group B (n=38)	p value
Sexe male	27	15	0.082
female	21	23	
Age (years)	42.5±5.2	46.8±3.8	0.025
BMI* (KG/m²)	21.8± 2.9	25.8±2.6	<b>0.002</b>
History of smoking			
never	11	21	0.625
Ex	19	11	0.269
Unknown	18	05	<b>0.063</b>
Pack-years	30	10	<b>0.004</b>
Medical past chest surgery	06	00	-
penetrating injury	01		
Comorbidities:			
asthma, COPD	15	06	0.025
diabete	08	03	0.004
eventration Side			
Right	09	07	0.456
left	37	31	0.247
bilateral	02	00	0.350

Respiratory function tests RFT (FEV1, FVC) were performed during pre- and postoperative periods (03 months later) and were compared only in group B. In this way, the effect levels of eventration changes on RFT were assessed.

### Surgery

Surgical treatment of DE was indicated when patients had chronic progressive dyspnea or heart symptoms, chronic digestive symptoms or when patients desired surgical cure.

### Operation procedures

General anesthesia with a double-lumen endotracheal tube to allow selective lung ventilation was prescribed for all operated patients. The patients were placed in the lateral decubitus position. Thoracoscopic approach was attempted in 03 cases and classical posterolateral thoracotomy in most cases. All operated cases underwent diaphragmatic plication surgery through a thoracotomy excepted in three cases, for which a minimally invasive technique was used. The mean argument to perform this classical approach is the delay of diagnosis that is often longer and patients develops serious pleural adhesions.

During thoracotomy, the seventh or eighth intercostal space was chosen to enter and diaphragmatic eventration was observed. We started the procedure on the central tedious part of the diaphragm using seven to nine lines of silk sutures from the postero-medial to anterolateral and by crossing the phrenic nerve fibers. Hanged sutures, and parallel plication were performed with central diaphragmatic repositioning. In some cases the use of reenforcing prosthetic plaques was necessary. In the end of surgery a 28-32Fr chest tube were inserted.

### Postoperative chest tube management

A negative suction was applied immediately after operation and maintained until chest tube removal.

The chest tube was rapidly removed since this extrapulmonary surgical cure.

### Statistical analysis

The data were analyzed using the software Statistical Package for the Social Sciences (IBM SPSS Statistics, version 21.) system. We expressed all values in the text and tables as mean ± SD. Unpaired t-test,  $\chi^2$  test, and Fisher exact test were used for group differences. A p value less than 0.05 was statistically significant.

## RESULTS

Demographic characteristics of group A and B are presented in [Table 2](#). In the post-operative course mortality and morbidity are reported in [Table 3](#). The functional benefit of diaphragmatic surgery is reported in the [table VI](#).

**TABLE 3. Post operative morbidity and mortality.**

Post operative complications	Group B (n=54) (%of the group)
Mortality	0
Pyothorax	2 (3.7%)
Pleural effusion	1 (1.8%)
Recurrence	0
Hemothorax	2 (3.7%)
Morbidity	5 (9.25%)

**TABLE 4. Impact of surgery on the functional respiratory tests.**

variables	Group A	Group B	p value
Pulmonary function test (FEV*)(L, % predicted)	2.1±0.56 78%±25%	Pre	1,5 ± 0.79
		opertaive	60% ± 10%
		Post operative	1,9 ± 0,81 75%± 5%
Vital capacity test	2,99 ± 0,68	Pre	3,35 ± 0,89
		opertaive	
		Post operative	3,87 ± 1,23

The median duration of chest tube drainage was 2 days. In group B, 3 cases underwent a secondary operation for post operative hemothorax (n=2) and pyothorax (n=1). ([Table V](#)). No case of bronchopleural fistula occurred after the three lobectomies.

### Follow-up

Few (n=7) patients were lost to follow-up, and 30 (78.9%) patients had regular follow-up. The end-



point of follow-up was December 2018. The median period of follow-up was 11.5 months (range, 10-31 months; IQR, 10 months). No recurrence was noted after one year of postoperative follow-up. An improvement of the clinical respiratory and digestive symptomatology was noted in 29 cases (78%) based on a satisfactory classical questionnaire. In the group A, only 11 patients (22.9%) reported an objective improvement after medical therapy (mainly functional rehabilitation). The difference between the two groups is statistically significant ( $p=0.025$ ).

## DISCUSSION

Diaphragmatic eventration is a rare condition, between 0.2 % [1,2]. About four men for a woman and it is described in almost 80% of cases on the left side. Clinically, diaphragmatic hernias are most often incidental discovery but large forms with diaphragmatic « hernia » cause more frequently symptomatic. For anatomic reasons (the liver mass), right DE is more associated with respiratory symptoms such as coughing, atelectasis or recurrent pneumonia, and consequently practitioners can easily consider others primary lung disease and misdiagnose the diaphragmatic disorder but left DE are more observable and known to present with post prandial digestive symptoms like pyrosis, gastroesophageal reflux responsible for a disorder of gastric emptying, but clinical compressive cardiac disorders are symmetrically described in both sides and are the results of the mediastinal shift [3-5]. Respiratory failure can result from multifactorial changes in respirator physiology involving atelectasis and ventilation/perfusion dysfunction toward the contralateral lung.

Apart from congenital forms of DE, those of the adult often acquired and result from muscular paralysis due to traumatic phrenic nerve injury or external nerve compression or even from a tumor or inflammatory condition of the phrenic nerve itself or by its cryofixation during of cardiac surgery [6-8]. Sometimes the DE is idiopathic when no classical etiologies were found. Some authors have suggested a degenerative origin of the nerve [9,10]. In our patients, the absence of a history of cervico-thoracic trauma, inflammatory or mediastinal tumoral pathology (excluded patients) and obvious cause on the thoracic imaging and intraoperatively led us to conclude that it is idiopathic even though we did not functionally explore the phrenic nerve. Chest imaging (chest X-ray, CT, MRI) confirms the diagnosis by showing the diaphragmatic ascent without detectable interruption.

## CONFLICT OF INTEREST

*The authors declare no conflict of interests.*

Digestive opacifications are less frequently used. The operative indication is always discussed if there is a functional repercussion as in our patients of group B [11,12].

The thoracic approach is guided by the clinical and radiological data and can reduce the diaphragm surface by a simple plication suture, probably, when needed, reinforced by a prosthesis depending of the muscle quality.

After the plication, the diaphragm placed in a lower position allow more expansion of the hemithorax and improves lung function parameters. Frequently, a decrease is observed in FVC and FEV1, which are among the restrictive-type respiratory failure parameters in the diaphragm function disorder.

Some authors performed celioscopic gastropexy [13,14]. We hard disagree with this selective surgery with aim the digestive part of the question and unrecognized the respirator and cardiac associated symptoms. Video-assisted thoracoscopic repair offers the advantage, to easily achieve diaphragmatic plication according to the various methods currently available, double suture, U-suture or very rarely stapling by endo-GIA [6,7,15].

Most of the studies showed that surgical treatment offer different results based on subjective patient satisfaction. In our study we hope that the present comparative results even with a predominant thoracotomy use, the place of surgery is more indicated. Such what proposed Ozkan et coll [16], we also can propose a new calculation formula of what we call diaphragmatic factor DF toward :

The  $DF = FEV1 (L) / A$ , where A (Figure 1) is the distance between the two diaphragmatic cupola in deep inspiration to detection of the eventration level with digital data, may begin a new approach of multiple discussions about surgical indications. we didn't use this formula in our study because of the retrospective approach and numerous missing chest radiograph in deep inspiration.

## CONCLUSION

Diaphragmatic eventration is a rare condition, more frequent and more expressive on the left than on the right side. It is often related to phrenic nerve palsy in adults. In the absence of an obvious cause, we speak of idiopathic diaphragmatic herniation. Surgical treatment is required to improve functional impact.

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