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# Catamenial Pneumothorax

*Sezai Celik and Ezel Erşen*

## Abstract

Catamenial pneumothorax is a rare condition in which spontaneous pneumothorax is recurrent. The incidence of catamenial pneumothorax has been underestimated for a few number of reasons. Recently, the etiology of catamenial pneumothorax has been more accurately diagnosed because of increased awareness and interest in the disease. Common and effective use of VATS technique contributed to better understanding of the disease. The management of the disease is difficult because of high recurrence rate. Operative and nonoperative interventions should be practiced more to prevent recurrences. Hormonal therapy should be added to treatment in selected cases. In this chapter, we will discuss all aspects of catamenial pneumothorax from diagnosis to treatment.

**Keywords:** pneumothorax, menstruation, catamenial, surgery

## 1. Introduction

Recurrent pneumothorax which is associated with menstruation is named as “catamenial pneumothorax” (CPX). It was first reported by Maurer et al. [1] and was presented to be a form of ectopic endometriosis and the term CPX was stated by Lillington et al. [2].

“Catamenial” is a name from Greek meaning “monthly.” CPX is most commonly associated with endometriosis, but other etiological mechanisms of this disease exist [3–6].

In the literature, CPX is defined to be a recurrent pneumothorax occurring up to 24 h before or within 72 h after the onset of menstruation [4, 6], and on the other hand, not necessarily appearing every month [7]. Symptoms and signs of CPX are mostly unspecific so much clinical suspicion has to be maintained [8]. CPX is a rare entity; however, regarding literature, about one-third of all surgically treated cases of pneumothorax in women are diagnosed to be CPX [9–12].

Therefore, thoracic endometriosis should always be suspected in reproductive-age woman who suffer chest pain from spontaneous pneumothorax.

Thoracic endometriosis syndrome may be associated with other causes than pelvic endometriosis. In the first 24–48 h of menstruation, symptoms begin to appear and are usually seen on the right side of the chest. In 90% of the patients, chest pain is the most common symptom, and in one-third of the patients, shortness of breath is rarely seen, but hemoptysis is also added to the clinical picture [13]. In the light of these findings, the diagnosis of the disease is made clinically.

From 3 to 6% of spontaneous pneumothorax cases are catamenial pneumothorax, about one-third of all surgically treated cases of pneumothorax in affected women.

The mean age of onset is reported to be 32–35 years [3, 4, 12, 14–17]. CPX may also develop as late as at 39 years of age [18, 19]. CPX occurs most often (85–95%) unilaterally, usually occurring on the right side of the chest, but there are cases on which pneumothorax also occurs on the left side or bilaterally [11, 15–21].

## 2. Incidence

CPX is generally considered to be a rare entity, and there is an incidence less than 3–6% among women who suffer from spontaneous pneumothorax. Such a low incidence rate may be a result of decreased disease awareness and underdiagnosis [4, 8–10, 19, 22–29].

Yet, the incidence of catamenial pneumothorax was much higher among women at reproductive age who were referred for surgical treatment because of recurrent spontaneous pneumothorax, ranging between 18 and 33% [9–12, 22].

In a recent study [24, 29, 30], 156 premenopausal women who underwent surgery for spontaneous pneumothorax were reviewed retrospectively, and 31.4% (49/156) of the patients were classified as CPX.

In a retrospective study, Alifano et al. reported thoracic endometriosis in 13 out of 35 (37%) patients who underwent reoperation for recurrent spontaneous pneumothorax [29]. Catamenial pneumothorax was the initial diagnosis in eight cases and idiopathic pneumothorax in four cases [29]. Under/misdiagnosis of thoracic endometriosis can be referred to several causes, including decreased disease awareness, incomplete scanning for the lesions, variations in the size, appearance, and number of the lesions [24, 30].

## 3. Etiology

The etiopathology of catamenial pneumothorax remains unclear, but there are some theories explaining the etiopathogenesis of catamenial pneumothorax. These theories include physiological, migrational, microembolic-metastatic, and the diaphragmatic theory of air passage [17] (**Table 1**).

According to the physiologic hypothesis, high levels of circulating prostaglandin F<sub>2</sub> during menstrual cycle cause vasoconstriction and this induces alveolar rupture and pneumothorax. Pulmonary bullae blebs may be more sensitive to ruptures during hormonal changes. There are no pathognomonic lesions in such cases and this issue supports the physiologic theory [4, 7, 8, 24, 31].

In metastatic or lymphovascular microembolization theory, endometrial tissue spread through the venous and/or the lymphatic system to the lungs, and subsequent catamenial necrosis of endometrial parenchymal site adjacent to visceral pleura causes pneumothorax. If parenchymal endometrial focus is located centrally, hemoptysis may be present as a symptom [3, 4, 7, 8, 22, 24, 30–32]. Endometrial tissue can be detected in the lung parenchyma, at knee, in the brain, and in the eye. This supports the metastatic theory [12].

According to the transgenital-transdiaphragmatic passage of air theory, absence of cervical mucus during menstruation provides air passage from the vagina to the uterus, through the cervix. Then, air enters the peritoneal cavity straight through the fallopian tubes and reaches to the pleural space by diaphragmatic defects [4, 7, 8, 22, 24, 31]. This passage is facilitated by the difference in atmospheric pressures between pleural space and peritoneal space since the atmospheric pressure in the pleural cavity is less than the pressure in the peritoneal cavity.

Physiological hypothesis	High levels of circulating prostaglandin F2 during menstrual cycle cause vasoconstriction, and this induces alveolar rupture and pneumothorax.
Metastatic or lymphovascular microembolization hypothesis	Endometrial tissue spreads through the venous and/or the lymphatic system to the lungs, and subsequent catamenial necrosis of endometrial parenchymal site adjacent to visceral pleura causes pneumothorax
Transgenital-transdiaphragmatic passage of air hypothesis	Absence of cervical mucus during menstruation provides air passage from the vagina to the uterus, through the cervix. Then air enters the peritoneal cavity straight through the fallopian tubes and reaches to the pleural space by diaphragmatic defects.
Migration hypothesis	Following catamenial necrosis of this diaphragmatic endometrial implants results in diaphragmatic perforations. Endometrial tissue then passes through this diaphragmatic perforation and spreads into the thoracic cavity. Ectopic endometrial tissue implants to the visceral pleura and following catamenial necrosis of this tissue causes rupture of the underlying alveoli, and pneumothorax occurs.

*These theories include physiological, migrational, microembolic-metastatic, and the diaphragmatic theory of air passage.*

**Table 1.**  
*The etiopathology of catamenial pneumothorax remains unclear, but there are some theories explaining the etiopathogenesis of catamenial pneumothorax.*

There are few reports in the literature regarding transgenital-transdiaphragmatic passage of air theory. There are rare cases reporting simultaneous [33, 34] or undulating episodes CPX and pneumoperitoneum [35], and also case reports defining radiologic findings of small diaphragmatic defects associated with ipsilateral CPX [21]. But repeated episodes of pneumothorax after hysterectomy, fallopian tube ligation, and diaphragmatic resection provide evidence that all the CPX cases can be explained by this theory [7, 24, 29, 36].

Migration theory is based on retrograde menstruation which causes in pelvic seeding of endometrial tissue and migration of this tissue to the subdiaphragmatic sites through the peritoneal fluid flow. Endometrial tissue is mostly implanted to the right hemidiaphragm because peritoneal circulation prefers a clockwise flow through the right paracolic gutter to right hemidiaphragm and the liver facilitates flow with its piston-like activity. Catamenial necrosis of this diaphragmatic endometrial implants results in diaphragmatic perforations. Endometrial tissue then passes through this diaphragmatic perforation and spreads into the thoracic cavity. Ectopic endometrial tissue implants to the visceral pleura and following catamenial necrosis of this tissue cause rupture of the underlying alveoli, and pneumothorax occurs [3, 4, 7, 8, 22, 24, 30, 31]. Endometrial diaphragmatic implants exist along with diaphragmatic perforations [37], and endometrial tissue can be seen at the edges of the diaphragmatic perforations in many cases of CPX [22]; these findings may support the migration theory in the etiopathology of catamenial pneumothorax.

**4. Clinical manifestations and diagnosis**

The typical clinical manifestations of CPX include spontaneous pneumothorax with or before menses presented with pain, dyspnea, and cough. Scapular and thoracic pain may also be present before or during menstruation. There may also be a history of previous episodes of spontaneous pneumothorax, history of previous uterine surgery, primary or secondary infertility or uterine scratching, pelvic

endometriosis diagnosis, and history of catamenial hemoptysis or catamenial hemothorax [30].

Medical history and occurrence of typical symptoms are crucial for the diagnosis of catamenial pneumothorax, and these findings should be systematically investigated [11]. Although existence of these findings creates high suspicion on catamenial pneumothorax, their absence does not exclude a diagnosis of catamenial pneumothorax [24, 30].

Intermittent presentations out of menstrual bleeding time should not exclude the diagnosis of noncatamenial endometriosis-associated pneumothorax even in the absence of symptoms and pelvic endometriosis [9, 24, 38].

The clinical course of CPX is usually mild or moderate, but sometimes be life-threatening. Widespread thoracic endometriosis after previous operations is reported in the literature as case reports [39]. A young woman who experienced an episode of life-threatening hemopneumothorax who has been treated by urgent tube thoracostomy and thoracotomy was reported by Morcos et al. [39]. Lung wedge resection, parietal pleurectomy, and partial diaphragmatic excision have also been performed in this case.

Patients with CPX are reported to have a mean age of 35 (range 15–54) years at presentation [40].

Catamenial pneumothorax can also have very rare presentations in the literature. Simultaneous occurrence of pneumoperitoneum and catamenial pneumothorax [33, 34], catamenial pneumoperitoneum mimicking acute abdomen in a woman with multiple episodes of pneumothorax [35], pneumothorax, and pneumoperitoneum in a patient with spontaneous diaphragmatic rupture has been reported in the literature [41].

Medical history is the main pathway on the way to the diagnosis of CPX. Synchronicity of the clinical course with menses is the main character of the disease, but on the other hand intraoperative visual inspection and appropriate histological examination of the pathognomonic lesions are crucial for the diagnosis of endometriosis-related pneumothorax. The surgeon needs to be vigilant because it can easily be missed if not cautious [7, 24, 29, 42].

## **5. Imaging diagnostic criteria**

Chest radiogram, computed tomography, and magnetic resonance imaging are the imaging modalities that can be used for the diagnosis of catamenial pneumothorax. Although there are no disease-specific diagnostic criteria, pneumothorax is usually right sided. On the other hand, left-sided or bilateral cases are present. Air-fluid leveling may also occur at chest radiogram, in some cases. Hemopneumothorax may also be a part of clinical course [24, 30]. Loculated fluids can be seen in cases with the history of previous surgery [39].

Only in a few number of cases, small diaphragmatic defects can be detected with careful examination of chest radiogram, which refers to diaphragmatic perforations. Also when a right-sided pneumothorax with a round opacity on the right hemidiaphragm occurs, liver protrusion into a large diaphragm defect is suspected [21, 43]. This type of partial intrathoracic liver herniation at the right hemidiaphragm on chest radiogram and CT [24, 44] has been reported in the literature. There are also reports in the literature regarding diaphragmatic masses on CT [23] and pleural masses on MRI that refers to endometrial implants [45].

CT findings of hemoptysis are nonspecific; they may differ from a focal ground-glass opacity to consolidation because of alveolar filling, similarly in hemoptysis caused by other disease [46]. Especially in nondependent lung parenchyma, these



findings facilitate the location of the site of bleeding. In the early period of the disease, endobronchial clots may be present, which cause atelectasis in some cases. There are also reports revealing band-like opacities referring to linear fibrosis sites, which result from chronic hemorrhage [46].

MRI is another imaging modality that can be used for confirming thoracic endometriosis in some cases. CT has some disadvantages especially in spatial resolution, but MRI has high-contrast resolution and can better characterize hemorrhagic lesions. Representation of diaphragmatic or pleural implants with MRI can help to clarify the diagnosis and management of the patient with catamenial pneumothorax [46].

MRI may also be useful for patients with catamenial hydropneumothorax; small pleural endometriomas characterized by the presence of small cystic hyperintense lesions can be revealed by MRI images of visceral or parietal pleura [46].

Coexisting pneumothorax and pneumoperitoneum are other findings that can be seen on radiography and computed tomography [33, 34].

## 6. Tumor antigens

Increased levels of cancer antigen 125 have been associated with endometriosis. It is not considered a specific marker, but it can play a role in early diagnosis of endometriosis-related pneumothorax [47, 48].

## 7. Characteristic findings of catamenial pneumothorax

Characteristic lesions of the catamenial pneumothorax include single or multiple diaphragmatic spots, perforations, nodules, and visceral or parietal pleural spots and nodules. Pericardial nodules have also been reported in some cases.

These lesions have not been found in all patients with catamenial pneumothorax, but they have been revealed in some cases with noncatamenial pneumothorax. Detection of endometrial tissue is not mandatory in these lesions. On the other hand, endometrial tissue has usually been found in diaphragmatic and pleural nodules, but it is rarely detected at the edges of the diaphragmatic perforations [30].

Visceral and parietal pleural lesions are less frequently detected than diaphragmatic defects, spots, and nodules.

### 7.1 Diaphragmatic lesions

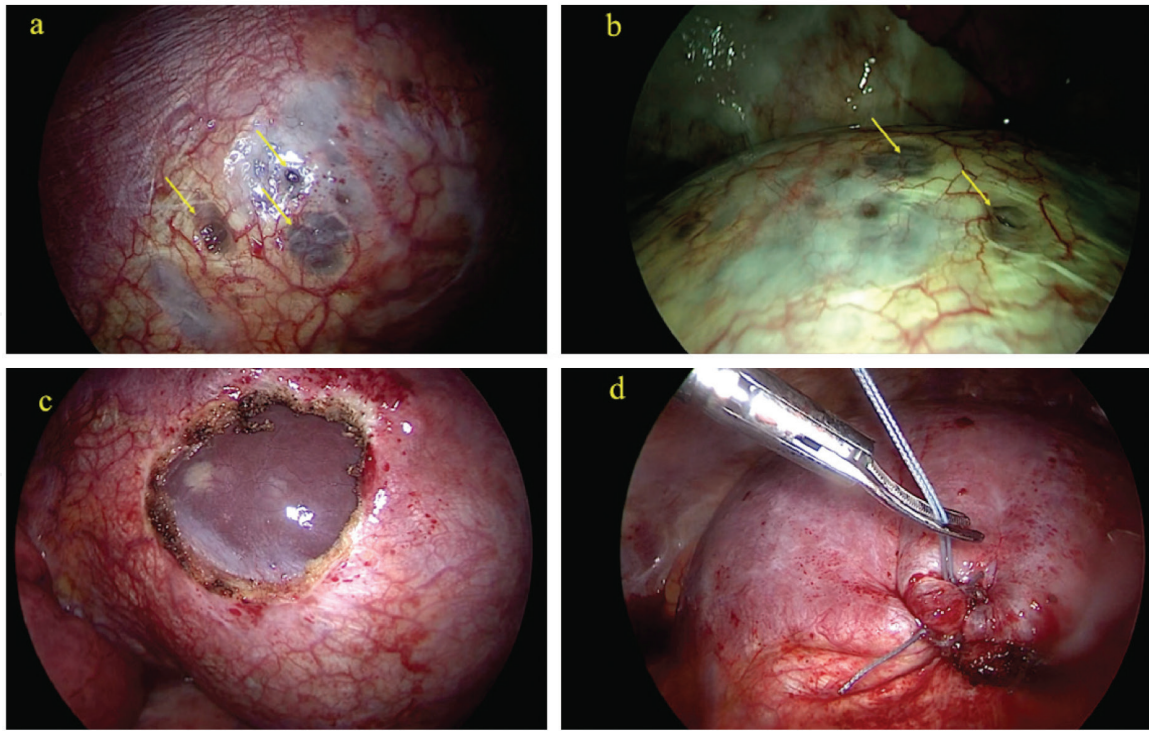
The diaphragmatic lesions usually located at the centrum tendineum and can be single or multiple. They usually settle adjacent to nodules. They can be outlined as perforations, fenestrations, holes, stomata, and pores [24, 30, 49] (**Figure 1a and b**).

They can be tiny holes measuring 1–3 millimeters in diameter [7, 50], or larger defects measuring up to 10 mm [4, 18] or more than 10 mm [8] or represent as undetected holes proven only by diagnostic pneumoperitoneum [42].

Diaphragmatic defects are usually found close to coexisting nodules or spots, and endometrial tissue is sporadically found at the edges of the defects [4, 9, 11, 22]. This situation supports the theory claiming that the diaphragmatic defects represent the breakdown of endometrial implants during menstrual cycle [22, 24].

There are also case reports of larger lacerations that accompany with intrathoracic liver protrusion, but these presentations are very rare.

A patient with catamenial pneumothorax on the right hemithorax was reported by Pryshchepau et al. Liver of the patient was protruded through a large diaphragmatic defect [44].



**Figure 1.** (a) and (b) Thoracoscopic view of diaphragmatic endometriosis. Fenestrations can be seen on the surface of the diaphragm (arrows). (c) The liver is visible after surgical resection. (d) Sutured diaphragm after endometriosis resection. Images are used with the permission of Demetrio Larrain [49].

Visouli et al. also reported five cases of catamenial pneumothorax [24], which contains a case very similar regarding liver protrusion, and they have recommended that these findings should be included in the characteristic findings of catamenial and thoracic endometriosis-related pneumothorax, although this presentation is very rare [24].

Catamenial pneumothorax with a huge diaphragmatic laceration and partial intrathoracic liver herniation was reported by Bobbio et al. [43], and Makhija et al. [51] reported a patient with multiple diaphragmatic fenestrations. The largest lesion was reported to have a diameter of 10 cm.

Spontaneous rupture of the right hemidiaphragm and intrathoracic liver herniation was also reported in the literature [41]. Pneumothorax and pneumoperitoneum was detected in a patient with a history of premenstrual periscapular pain. At the edge of the diaphragmatic defect, a nodule looking like an endometrial implant was found in that patient. Histological examination of the nodule revealed endometriosis with hemosiderin-loaded macrophages. This case is considered as endometriosis-related, but the histological criteria set by the authors was not appropriate [9, 11]. Additionally, previously mentioned cases of large diaphragmatic defects were considered to be limited diaphragmatic ruptures and stated that endometriosis was responsible for these ruptures [43, 44].

## 7.2 Thoracic lesions

Endometrial tissue is usually detected on histopathological examination of the spots or nodules accompanying catamenial pneumothorax so these lesions are considered to be endometrial implants. Diaphragm, visceral, and parietal pleura are the common sites for location. Pericardial implants were also reported by Fonseca et al. [52]. The lesions may be single or multiple and may have varying size. They may have different presentations in color as brown, purple, red, violet, blueberry, black, white, grayish, and grayish-purple [1–20, 51].

Diaphragmatic and thoracic lesions may be present in all cases, but on the other hand, only one or more of them can be seen either [1–21, 39, 53, 54].

In some cases of catamenial pneumothorax, characteristic findings may be absent and blebs and bullae may be the only pathological findings. In some cases, no characteristic thoracic findings may be detected [7, 12, 20, 22–24].

Detection of characteristic lesions during thoracotomy or thoracoscopy depends on thorough and deliberate examination of the thorax, including the diaphragm. This also depends on the stage of the disease and catamenial behavior of the disease and longer-term variation [22, 24, 30, 42].

## 8. Surgical treatment of catamenial pneumothorax

Surgical treatment is the gold standard in treatment of catamenial pneumothorax, not only for its better results but less recurrences after treatment as well. Surgery has better results compared with medical treatment [1–20].

Korom et al. [7] reviewed 195 cases of CPX among 229 cases and reported that 154 cases (78%) were treated surgically. Among surgically treated patients, diaphragmatic repair (38%), pleurodesis (81%), and lung wedge resection (20%) were performed.

There is common consensus in the literature that the appropriate approach to CPX has to be minimally invasive so video-assisted thoracoscopic surgery (VATS) is the choice of treatment. VATS not only provides magnification but complete visualization of diaphragm as well [23].

Video-assisted thoracoscopic surgery (VATS) has been mainly in use since 2000 in the treatment of thoracic diseases with several advantages over conventional thoracotomy. Incision may be extended when extensive diaphragmatic repair is required, and also a muscle-sparing thoracotomy may offer better access in such cases. Thoracotomy may be an option especially in recurrent interventions or in reoperations [4–28, 30].

The lung examination for bullae, bleb, and air leakage is very important, but the diaphragm should also be carefully examined for fenestrations and spots or nodules. In addition, it is critical to examine the parietal pleura, lung, and pericardium in terms of spots and nodules.

Bagan et al. recommended the use of surgical treatment during menstruation. Thus, they stated that endometriotic lesions may be better visualized during menstrual period [22]. Slasky et al. used the pneumoperitoneum method to reveal unseen diaphragmatic fenestrations [42]. Identification of the lesions within the thorax is made easier by the magnification provided by VATS [4–28, 30]. The tissue samples from these lesions make it easy to diagnose thoracic endometriosis [10].

Resection of all visible lesions such as bullae or bleb and also resection of endometriosis-induced thoracic lesions have been recommended by Alifano et al. Limited wedge resection of the diseased lung tissue, limited parietal pleurectomy, and partial diaphragmatic resection were suggested surgical techniques for the elimination of intrathoracic lesions [4].

Excision and wedge resection of bullae and blebs [7, 12, 23, 30], along with pleurodesis or pleurectomy, has been mainly performed in the literature [7, 8, 12, 23, 30, 47]. Pleurodesis was found to be the most common intervention [29]. The majority of pleurodesis performed was mechanical pleurodesis (abrasion or pleurectomy), which has been found to be more successful in comparison to chemical pleurodesis [6].

Addressing the diaphragmatic pathology is of paramount importance. Diaphragmatic plication and/or resection of the diseased area have been reported [7, 12, 23, 24, 30, 49] (**Figure 1c and d**).



Recurrence is the most common complication of CPX, and there are reported recurrence rates of 20–40% [4, 7, 41, 51]. Alifano et al. suggested that diaphragmatic resection with removal of endometrial implants is the preferred method compared to single diaphragmatic plication because plication has an disadvantage of leaving endometrial implants untreated [29, 38]. Still, recurrences may develop even after diaphragmatic resection [29].

Fewer recurrences after diaphragmatic coverage with a polyglactin mesh were reported by Bagan et al. To prevent recurrences, they suggested a systematic diaphragmatic covering, including the normal appearance of diaphragms, treating ocular defects, strengthening the diaphragm, and inducing adhesions to the lung [7].

There are also reports on diaphragmatic coverage with a polyglactin or polypropylene mesh [8], a polytetrafluoroethylene (PTFE) mesh [15], or a bovine pericardial patch [24], which has been reported with good mid-term results.

9. Medical treatment

Hormonal treatment has a supplementary role in the treatment of catamenial pneumothorax. With the administration of hormonal therapy, it is possible to prevent recurrences of catamenial pneumothorax.

A multidisciplinary approach is mandatory for the management of the disease and administration of gonadotrophin-releasing hormone (GnRH) analogue, which results in the lack of menses, and is suggested for all patients with proven catamenial pneumothorax in the early postoperative period for 6–12 months [4, 7, 8, 22, 24, 30, 48]. Patients without documented catamenial character or histologically proven thoracic endometriosis may also benefit from hormonal treatment even in the presence of characteristic lesions [24, 30].

Woman’s plans concerning pregnancy are very crucial, when deciding whether to start hormonal therapy or not. In such therapies, oral contraceptive pills (estrogen-progestogen) are usually used which induce menses every 28 days or they are used continuously without inducing menses. These pills also include progestogens, and they may be administered orally, intramuscularly, or in intrauterine way.

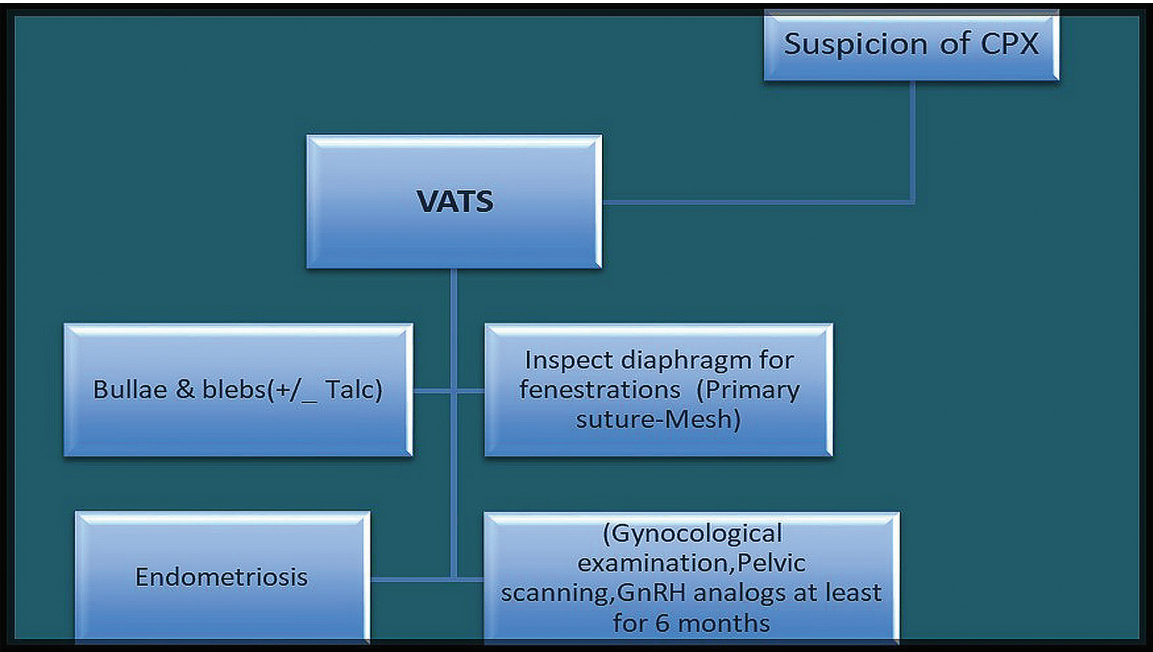


Figure 2.  
Accepted surgical algorithm and treatment in catamenial pneumothorax.

There are also several medications, which are currently in use. Medical treatment is recommended in patients when catamenial pneumothorax is associated with endometriosis [17].

The aim of early GnRH analogue delivery is to prevent cyclic hormonal changes and to suppress the activity of the ectopic endometrium until effective pleurodesis occurs, because time is needed for the formation of effective pleural adhesions [38].

Hormonal treatment is advised for longer periods especially after reoperations for catamenial pneumothorax.

Proven ineffectiveness of the therapy or significant side effects of the drugs are the contraindications of hormonal therapy [29].

There is an accepted surgical algorithm and treatment in catamenial pneumothorax [55], which is described in **Figure 2** in detail.

## 10. Results of treatment

Practically, surgery for catamenial pneumothorax has very low mortality and morbidity. Recurrence is the most common complication of CPX, and there are reported recurrence rates of 20–40% [4, 7, 41, 53].

High recurrence rates are much higher than surgically treated idiopathic pneumothorax [8–10, 22–24, 29].

A low recurrence rate (8.3%), at a mean follow-up of 45.8 months, was reported by Attaran et al., by video thoracoscopic abrasion and pleurectomy, diaphragmatic repair and PTFE mesh coverage for the repair of diaphragmatic defects, and a routine postoperative hormonal treatment [55].

Also Alifano et al. reported that the highest postoperative recurrence rate in 114 women who were operated due to recurrent spontaneous pneumothorax was in the catamenial pneumothorax group (32%), and this was followed by a noncatamenial endometriosis-associated pneumothorax group (27%). They also reported a recurrence rate of 5.3%, at a mean of 32.7 months of follow-up, in patients with noncatamenial nonendometriosis-associated pneumothorax [32].

Incomplete surgical treatment of lesions and lack of additional hormonal treatment in the early postoperative period [23, 24, 38–54] may increase the risk of recurrence [24, 30, 38–56].

## 11. Conclusions

Young women with pneumothorax, especially in the perimenstrual period, should be suspected of catamenial pneumothorax. Failure occurs most frequently when recurrent catamenial pneumothorax occurs.

The lesions of the parietal and visceral pleura should be carefully examined and removed during surgery. Diaphragm reconstruction is required every time when fenestrations are detected in diaphragm.

Hormonal therapy is also recommended because it facilitates the effectiveness of the surgical results.

Multidisciplinary approach with early postoperative hormonal treatment, which deals with all thoracic pathologies including disease awareness, early diagnosis, diaphragmatic repair, and surgical management of the main chronic systemic disease, may eventually lead to a reduction in the rate of recurrence of catamenial pneumothorax [3–13, 15, 23, 24, 30, 32].

Treatment of women of childbearing age is different from men of the same age group. CPX should be excluded in the cohort of women, especially when the

pneumothorax is repeated. Full examination of the diaphragm should be part of the operation. Surgeons who perform VATS should be experienced to resect and repair diaphragms with fenestrations and endometrial deposits, including keyhole laying down of synthetic mesh.

### **Conflict of interest**

There is no conflict of interest.

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