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Don't intubate women with pneumothorax. Surgery with music and muse

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Abstract

Background: Treatment of women with spontaneous pneumothorax is challenging and multidisciplinary. We performed a retrospective analysis of 10 females with spontaneous pneumothorax to determine the clinical features as well as the effects of treatment and recurrence rates. Our goal was to report that non-intubated video-assisted thoracic surgery is feasible and safe treatment of pneumothorax in women.

Methods: A retrospective review was conducted of the clinical and pathologic data in all 10 patients undergoing treatment at our institution. 4 patients undervent treatment for catamenial pneumothorax. All 10 patients underwent surgical treatment.

Results: The median age was 33 years. The laterality of the pneumothorax was right in 7, left in 3 patients. All patients underwent surgical treatment. Partial resection of the lung was performed in 10 patients and partial resection of the diaphragm with mesh diaphragm augmentation in four. Of these, both resections were performed in four patients. A pathological diagnosis of endometriosis was achieved in only four patients. The observation period was 6 months. No recurrences were observed. 8 patients were operated in the 1st, 1 in

the 2nd, 1 in the 5th episode of pneumothorax. All patients were transferred to the ward 30 minutes and oral food intake was permitted 1 h after surgery.

Conclusions: non-intubated video-assisted thoracic surgery with mesh diaphragm augmentation, atypical lung resection and pleural abrasion could be considered a feasible, safe and effective method of treatment of catamenial pneumothorax. Prolonged follow-up and further clinical investigations are required to confirm the advantages of the proposed approach.

Keywords: Catamenial pneumothorax; diaphragm endometriosis; spontaneous pneumothorax; non-intubated video-assisted thoracic surgery; video-assisted thoracoscopic surgery (VATS).

Background: Treatment of women with spontaneous pneumothorax is challenging and multidisciplinary. We performed a retrospective analysis of 10 females with spontaneous pneumothorax to determine the clinical features as well as the effects of treatment and recurrence rates. Our goal was to report that non-intubated video-assisted thoracic surgery is feasible and safe treatment of pneumothorax in women.

Methods: A retrospective review was conducted of the clinical and pathologic data in all 10 patients undergoing treatment at our institution. 4 patients undervent treatment for catamenial pneumothorax. All 10 patients underwent surgical treatment.

Patients. All 10 patients were females, median age 32,6 ± 13,3 years. 7 patients were admitted with primary spontaneous pneumothorax, 3 patients with recurrent spontaneous pneumothorax (2nd and 5th episode). A previously healthy females presented to the emergency department with a history of shortness of breath (SOB), right or left sided pleuritic chest pain, progressively worsening dyspnea and cough. 2 patients were on 3 day before/after their menstrual cycle has ended. A chest X-ray (CXR) showed pneumothorax.

Thoracoscopy, performed in the 7 intercostal space in posterior axillary line under local anesthesia, has revealed lung collapsed to 1/3 to ½ of the initial volume, small apical blebs and in Case 3,7,8,9 brown spots suspicious for endometriosis on tendinous part of the diaphragm. Depending the clinical signs and degree of pneumothorax on CXR in Case 5, 6 thoracoscopy wasn't performed before operation. After thoracoscopy the patients were explained their supposed diagnosis and the ways of its confirmation and treatment. Before the operation chest and abdomen CT were performed. Small bilateral apical blebs were found on chest CT in all patients.

Case 6

A 37-year-old female, non-smoker, has a child, was presented to the emergency department (ED) with a 2-day history of SOB and right-sided pleuritic chest pain. She complained of insignificant dyspnea and cough. Her vitals showed a blood pressure of 115/70 mm Hg, a heart rate of 88 - 92 beats/min and a respiratory rate of 19 - 21 breaths/min, oxygen saturation of 96 - 97 %. Physical examination was remarkable for decreased breath sound hyper resonance over the right hemithorax. Her labs were unremarkable. CXR showed apical right-sided pneumothorax. The patient told that she previously had 4 pneumothoraxes: 18, 17, 15 and 5 months before. The first three episodes (18-15 months before) were treated with chest drain and chest CT revealed small apical blebs bilaterally. The 4th episode of pneumothorax was diagnosed on CXR as apical after admittance to our hospital 5 months before.

The diagnosis of CP was suspected and the patient was sent to gynecologist who proved the diagnosis of extragenital endometriosis and prescribed Dienogest pills (Visanne, Bayer Schering Pharma Ltd.) for a period of 6 months. Due to normal vitals and not worsening complaints no chest drain was inserted before operation.

Before surgery, the patients were examined by an anesthesiologist. When establishing the physical status and anesthetic risk of surgery, the patient classified as ASA – I and Mallampati grade I, with body mass index <20. Anesthetic protocol was explained to the participants before the informed consent was obtained.

Surgical technique

All patients were operated on the lateral decubitus position, using a combination of intravenous anesthesia with spontaneous ventilation and thoracic epidural anesthesia (TEA). After placement in appropriate position a chest tube was disconnected to perform iatrogenic pneumothorax. In Case 5,6 patients were operated without previous chest drain. A 2-port approach was applied in 7 intercostal space on posterior and anterior axillary lines. In Case 8, 10 a uniportal approach was applied. An utility 3-cm incision was performed anteriorly followed by insertion of SurgiSleeve XS wound protector (Covidien, USA). Next step a chest tube was removed and posterior incision for 12 mm trocar was made in this site for insertion of 10 mm 30° video thoracoscope (Storz, Hopkins II). The lung, diaphragm, thoracic wall and mediastinum were carefully inspected. Apical wedge resection was performed and all macroscopically suspicious areas for endometrial implants on the visceral pleura were resected with universal stapler Endo GIA (Covidien, USA) with purple Tri-Staple loading units and were removed through anterior port. Any pores or fenestrations noted on the surface

of the diaphragm were resected, and sewn with 2-0 Surgipro (Covidien, USA) in Case 3,6,8,9. Then, a Parietex mesh (Covidien, USA) was affixed onto the diaphragm to cover the central tendinous part and any fenestrations. The mesh was introduced through the utilitary incision, then fixed onto the diaphragm using 4 interrupted sutures with 2-0 Surgipro (Covidien, USA). Pleural abrasion was performed from the apex downwards to the diaphragm with tip cleaner. Macroscopically suspicious endometrial deposits on parietal pleura were biopsied for histopathology. After that 18 Fr chest tube was introduced through camera port incision under direct camera visualization and wound protector was removed. Lung was passively reexpanded and placed on suction -20 cm H_2O.

No surgical complications were observed.

Administration of anesthesia

In all cases, anesthetic protocol of non-intubated thoracoscopic operations, as noted above, was performed using combination of intravenous and TEA with spontaneous breathing. In the first group (3 patients – Case 1,2,3), intravenous anesthesia was performed with propofol and fentanyl. In the second group (7 patients- Case 4-10) – using dexmedetomidine, propofol and fentanyl.

The start of anesthesia was the same in both groups. In the operating room, intravenous peripheral catheter was placed in the forearm and a continuous infusion of Sterofundin isotonic solution (B-Braun) was started.

Standard monitoring included electrocardiogram, pulse oximetry, non-invasive blood pressure measurement, measurement of respiratory rate, BIS, and capnography measured with a detector attached to the oxygen mask. During the surgery, oxygen supply was maintained through a non-rebreathing mask (oxygen flow 7 – 10 L/min, FiO_2 0,4 – 0,5).

After established intravenous rehydration, TEA was performed in the sitting position by insertion of an epidural catheter at the T5 – T6 interspace with an 18 G Tuohy needle (B-Braun) via the saline loss of resistance technique and a test dose of 4 ml lidocaine 1% was given and followed by continuous infusion of bupivacaine hydrochloride 0, 25 % – 6 – 8 ml/h. Level of anesthesia achieved T2 – T10 while preserving spontaneous breathing. The patient was positioned in the lateral decubitus position (appropriate for surgery).

The lung was collapsed by iatrogenic pneumothorax through chest drainage which was disconnected before the operation, In Case 5,6 lung collapse was achieved by pneumothorax which wasn’t resolved before operation. We did not premedicate the patients before the operation. But, in case 2, open pneumothorax caused anxiety and discomfort. These patterns have been eliminated by intravenous injection of Midazolam 5 mg. Prepping and draping

were done in a sterile manner. The sites of surgical incisions were locally anesthetized with 20 ml 0, 25 % bupivacaine hydrochloride.

At this time, in the first group, an induction dose of propofol was introduced and maintained further in the form of continuous intravenous infusion in mean dose 8 ± 1,4 mg/kg/h. The sedation was stopped during wound closure. Fentanyl bolus (mean dose 3,1 ± 1,1 μg/kg/h) was given before surgical incisions and pleural abrasion and as required to prevent a cough reflex due to thoracoscopic procedures during surgery. In two patients (Case 1,2) of this group, during surgery, SatO2 became less than 90% due to respiratory depression anesthetic medicine. With the help of short-term lung ventilation with a mask (5-10 breaths), the effects of hypoxia were eliminated. Mean arterial pressure and systolic pressure were at levels 81,4 ± 22,3 and 104 ± 24,1 mmHg, respectively, and controlled only by infusion of crystalloids (18,2 ± 5, 8 ml/kg/h). Capnography parameters were without significant deviations (38 – 52 mmHg). The anesthetic depth is monitored through bispectral index value, and usually kept between 40 and 60.

In the second group, after positioning the patient in the lateral decubitus position, induction infusion of dexmedetomidine was started at a dose of 1 μg/kg for 20 minutes, with further infusion 0,7 μg/kg/h and and stopped at the end of pleural abrasion. Fentanyl and propofol boluses were used as required to prevent a cough reflex and to maintain the depth of anesthesia also 40 – 60 on the BIS monitor. Their doses were lower and amounted to 2 ± 0,8 μg/kg/h and 3,5 ± 1,1 mg/kg/h respectively. In this group, any forms of unstable hemodynamics and respiratory disorders were observed. Mean arterial pressure and systolic pressure were at 81,8 ± 22,7 and 109,6 ± 29,7 mm Hg respectively, they were also controlled by infusion of only crystalloids (~ 15,9 ± 4, 2 ml / kg / h). Oxygen saturation was 95-100%, capnography parameters were also normal, which eliminated the need for assisted ventilation.

Also, in both groups, to reduce coughing induced by pulling on the lung tissue, and to ensure a steady surgical environment, 20 ml of 0,25% bupivacaine hydrochloride was sprayed on the surface of the lung and area of vagus and phrenic nerves under thoracoscopic guidance in the chest cavity. These measures were effective and eliminated the need for blocking the vagus nerve. During wound closure additional infiltration of the sites of incisions where made with 20 ml of 0,25% bupivacaine hydrochloride.

After surgery, the patients of both groups were fully awake and returned directly to the initial department without ICU. The intensity of postoperative pain was assessed as 0-1 score on visual analogue scale. TEA was continued with 0, 25% bupivacaine hydrochloride 4 – 5

ml/h in combination with intramuscular injection of Dexketoprofen 50 mg 2 – 3 time of day. No anesthesia complications were observed.

Postoperative period

The median time of chest drain stay was 3.6±1,95 days . CXR was performed on the day of chest drain removal. Epidural catheter was removed on the day of chest drain removal but not later than 5th day.

On the next day the patients were discharged for out-patient treatment.

Pathohistological examination in all cases revealed bullous disease in lung tissue and endometriosis tissue in diaphragm specimens (CD-10, estrogene receptors positive) in Case 3,6,7,9. In Case 8 endometriosis tissue in diaphragm specimen was not found.

All patients with revealed endometriosis had a gynecologist consultation, who administered Dienogest pills (Visanne, Bayer Schering Pharma Ltd.), for a period of 6 months except Case 7 (due to age of 63)

All patients for a 6-months follow-up period were asymptomatic for recurrence of pneumothorax.

Discussion

The most frequent causes of spontaneous pneumothorax in females are bullous disease, thoracic endometriosis, lymphangioleiomyomatosis. In our observation we have 4 patients with combination of bullous disease and thoracic endometriosis.

Nowadays, endometriosis remains an ill-investigated disease, and its prevalence in the world population reaches 11 % [1]. 12% of them have extragenital forms [2].

Classification of extragenital forms of endometriosis was proposed by Markham (1981) andincluded: digestive, urinary, thoracic, othersiteimplants of endometriosis [3]. Four the ories for pathogenesis of CP have been proposed: Mauertheory (4), Lillingt on theory (5), Rossitheory (6) and Thomastheory (7).

The most favoured theory as to how endometriosis causes a CP is the transdiaphragmatic passage of air. During menses, the absent cervical mucous plug allows air to enter the peritoneum via the uterus and fallopian tubes. Uterine contraction, physical effort or sexual intercourse forces air into the peritoneum which then enters the thorax via diaphragmatic pores or fenestrations. Fenestrations which are mostly right sided can be congenital or acquired. The latter are caused by ectopic endometrial tissue. Diaphragmatic defects have been found in up to 72.5% of patients and are the most probable aetiology [8, 9].

Thoracic endometriosis syndrome (TES) is a clinical manifestation of endometrial tissue growth inside or near the lung [8]. TES includes: catamenial pneumothorax,

catamenialhaemothorax, catamenialhaemoptisis, catamenial chest pain, pulmonary nodules. The diagnosis of TES is set on the clinic and pathohistilogical examination in 2/3 of patients [10]. Nowadays the diagnosis of catamenial pneumothorax is based on the anamnesis of menses, while endometrial or not – on pathohistological examination[11]

The peak of pelvic endometriosis is found at period of 24-29 years, thoracic endometriosis – 5 years later [10]. Catamenial pneumothorax can occur in right, left [12] and both sides [13, 14]. Thoracic endometriosis (TE) can be an independent disease in thoracic cavity[15].

The mean interval between the first pneumothorax and the diagnosis of TE was 18.9±27.0 months [16]. According to the world literature, during the 1st episode of pneumothorax chest drain is inserted. In our department even during the 1st episode of pneumothorax we perform a thoracoscopy under local anaesthesia in order to investigate possible changes of lung, diaphragm, mediastinum and chest wall. That allows us to suspect thoracic endometriosis in some part of cases. Recognized ways of CP treatment include following: observation, aspiration, chest drain/thoracoscopy, VATS/laparoscopy (alternately or simultaneously), thoracotomy, hormonal treatment and combined treatment.

The lung examination for bullae, blebs and air leakage is of high importance, but the diaphragm should also be carefully examined for fenestrations, spots or nodules. In addition, it is critical to examine the parietal pleura, lung, and pericardium in terms of spots and nodules. During VATS diaphragmatic lesions could be found in 38,6%, visceral pleura endometriosis – in 29,6%, bullae – in 23.1% and no pathology – in 8.5% of cases [17].

According to the literature, CP recurrence after surgical treatment alone is 8-40% in 4 years [8, 9, 18, 19, 20 21] , after hormonal treatment alone – 60% in 1 year [8]. Surgery has better results compared to hormonal treatment, so most authors believe that surgical treatment is the gold standard in treatment of CP, not only for its better results but for less recurrences after treatment as well [22]. Some authors suppose that combination of surgical and hormonal treatment may have better results [9, 18, 19, 20, 21]

Nowadays there is no consensus about diaphragm endometriosis treatment in the literature, especially approaches to diaphragmatic fenestrations remain controversial?

In 3 cases reported by *Korom et al.* in 2004, talc pleurodesis was done at the first episode of pneumothorax. At the time of recurrence VATS approach was performed and fenestrations of diaphragm were found, biopsiesed and approach was converted to minithoracotomy and changed part of diaphragm was plicated and double running sutured [14].

Ciriaco et al. (2009) proposed a posterolateral thoracotomy for correction of diaphragmatic deffects. Apical resection and apical pleurectomy were performed in all patients. Chemical basal pleurodesis with talc (1 g) was given to patients with diaphragmatic defects [23].

In a series of 6 patients with endometriosis, reported by*Härkki et al.* (2010), all operations were done through thoracotomy with diaphragm mesh augmentation in 5 and suturing in 1 case, followed by talc pleurodesis in 3 of them. Different hormonal treatment before and after surgery was administered. No CP recurrences were documented for follow-up periods ranging from 5 to 31 months [24].

Ikeda et al. (2012) proposed a method of stapling 2 poliglactin meshes onto S1 and S6 segments and polyglycolate felt (Neoveil sheet) – on diaphragm under VATS. 4 patients with recurrent CP were treated with this technique without any hormonal therapy postoperatively and no recurrence was documented within 5 years after surgery [25].

Nezhat et al. (2012) during treatment of bilateral CP resected diaphragm with Endo GIA stapler from left side through VATS approach, but reoperated via thoracotomy and sewn the hole in diaphragm 2 days later [13].

Attaran et al. (2013) described 3 port VATS technique with apex wedge resection, pleurectomy from apex to diaphragm and GoreTex mesh application onto diaphragm without its resection, followed by hormonal therapy with GnRH for 6-12 months postoperatively [26].

In a case of *Sihoe et al*. (2015), a 10×9 cm defect in right diaphragm was revealed during VATS, which was converted to a combined right limited thoracotomy plus right subcostal laparotomy approaches. A non-absorbable patch (Gore Dualmesh, Gore-Tex, Flagstaff, Ariz, USA) was anchored with continuous 2-0 polypropylene sutures.

Menses are preferred time for the surgical treatment because of enhanced visualization of endometriotic lesions [22, 27].

The minimally invasive approach has shown the same results as in open technique, while decreasing an in-hospital stay and improving a lung function after the surgery.

Nowadays one lung ventilation (OLV) is a gold standart for almost all thoracic procedures but the interest to alternative methods of anaesthesia is constantly growing.

In the early 2000s, the Awake Thoracic Surgery Research Group at the University of Rome Tor Vergata started an investigational programme of thoracic operations performed without general anaesthesia and under spontaneous ventilation. Since that date over 1,000 operations have been successfully carried out [27]. During the period of investigation, strict

anastesiological and surgical indications and contraindications for non-intubated VATS were developed.

Over the last decade the interest in non-intubated VATS procedures has become greater and a lot of thoracic procedures are performed under this way of anaesthesia, which has proved its safety as compared to tracheal intubation.In spite of well-tolerance, complications and adverse effects after intubated general anesthesia and OLV are unavoidable, including intubation-associated respiratory trauma, ventilation-induced lung injury, residual neuromuscular blockade, impaired cardiac performance, and postoperative nausea and vomiting.

Knoll et al. investigated patients after using double lumen tubes and shown that 44% of patient has complained on hoarseness after surgery. [28]

A minimally invasive approach was demonstrated to be superior in shortening the in-hospital stay, alleviating postoperative pain, improving postoperative lung function and reducing overall morbidities after surgery [29]

The use of a combination of intravenous and TEA provides adequate analgesia and sedation while maintaining spontaneous breathing. Dexmedetomidine is a highly specific α2-adrenoceptor agonist with sedative, analgesic, and anxiolytic properties and does not show significant respiratory depression when used at a clinical dosage. In contrast, other sedatives like propofol and fentanyl can cause respiratory depression at clinical dosage. In combination with dexmedetomidine, the doses of propofol and fentanyl become possible to reduce, which prevents ventilation disorders.

NIVATS is a last resort for high risk patients who are not candidates for OLV and we consider that such simple procedures as diaphragm mesh placement and atypical lung resection could be done in less invasive NIVATS approach.

All pathological specimens should undergo immunohistochemical examination (CD 10 markers, progesterone and estrogen receptors) to confirm the diagnosis of endometriosis. [30]

From all mentioned above we can conclude that addressing the diaphragmatic pathology is of paramount importance and multiple approaches can be employed for the fenestrated diaphragm.

Following current trends in minimizing perioperative complications, both surgical and anesthetic, we proposed a NIVATS approach in treatment of thoracic endometriosis with wedge resection of the lung apex and diaphragm resection with Parietex mesh augmentation

and mechanical pleurodesis from apex to diaphragm. It could be done in described feasible and safe technique but further investigations are advisable to discover all the pros and contras.

After the surgery a decision of hormonal treatment should be accepted by gynecologist. Hormonal treatment may consist of oral contraceptive pills, progestines, danazol, gonadotropin-releasing hormone agonists (GnRH – agonists). Choice of drug is based on considerations about costs, side effects and pregnancy wishes of a patient. There is no controlled trials to show superiority of 1 drug over another. Long-term surveillance of these women is mandatory, because recurrence is not an infrequent event.

Multidisciplinary approach dealing with all thoracic pathologies including disease awareness, early diagnosis, diaphragmatic repair, and surgical management of the main chronic systemic disease, followed by early postoperative hormonal treatment may eventually lead to a reduction in the rate of recurrence of catamenial pneumothorax.

Conclusions: non-intubated video-assisted thoracic surgery with mesh diaphragm augmentation, atypical lung resection and pleural abrasion could be considered a feasible, safe and effective method of treatment of catamenial pneumothorax. Prolonged follow-up and further clinical investigations are required to confirm the advantages of the proposed approach.

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