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Successful video-assisted thoracic surgery for pleural empyema

Sėkmingas minimaliai invazinis chirurginis pleuros empiemos gydymas

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Background / Objective

Few thoracic conditions present such a considerable challenge as does pleural empyema. The disease is known since Hippocrates' time, nonetheless it is still associated with the rising incidence all over the world. Minimally invasive procedures become more and more popular in many fields of surgery as well as in patients with pleural empyema. However, video-assisted thoracoscopy cannot replace open surgery in all empyema cases. In this report, we would like to present our thoracoscopic technique and preliminary experience in treating patients with pleural empyema.

Patients and methods

During the period from January 2011 till September 2013, thoracoscopic empyemectomy was performed in 49 patients. All patients were operated on under general anaesthesia using single lung ventilation. All procedures were performed through two or three ports. Conversion to thoracotomy was performed when it was impossible to make successfully thoracoscopic empyemectomy.

Results

A video-assisted thoracoscopic operation was successful in 36 (73.5%) patients, whereas in 13 (26.5 %) cases a conversion was required. Pleural space adhesions and inability to remove completely the peel from the underlying lung were the main reasons for conversion. Ten (20%) patients had postoperative complications such as recurrence of disease, prolonged air leak, or wound infection.

Conclusions

Minimally invasive surgery is a safe and effective treating of patients with pleural empyema. However, we should search for preoperative factors of identifying the right persons who could be cured successfully by video-assisted thoracoscopic surgery.

Key words: pleural empyema, pyothorax, video-assisted thoracic surgery, empyemectomy, debridement, decortication

Įvadas / tikslas

Pleuros empiema – viena iš seniausiai žinomų krūtinės ligų ir iki šiol yra susijusi su didėjančiu sergamumu visame pasaulyje. Kaip ir daugelyje chirurgijos sričių, gydant pūlinėmis pleuros ligomis sergančius ligonius populiarėja minimaliai invazinės chirurginės procedūros. Tačiau torakoskopinė operacija vis dar negali pakeisti atvirosios visais empiemų atvejais. Šiame straipsnyje supažindiname su mūsų atliekamų torakoskopinių pleuros empiemos operacijų metodika ir aptariame pradinę patirtį.

Ligoniai ir metodai

Nuo 2011 m. sausio iki 2013 m. rugsėjo torakoskopiškai buvo operuoti 49 ligoniai, sergantys pleuros empiema. Visi pacientai operuoti sukėlus bendrinę nejautrą, naudojant vieno plaučio ventiliaciją. Visos torakoskopinės operacijos buvo padarytos per dvi arba tris angas krūtinėje. Tais atvejais, kai sėkmingai atlikti torakoskopiniu būdu empiemektomijos nepavykdavo, būdavo pereinama į atvirąją (torakotominę) operaciją.

Rezultatai

Sėkmingai videotorakoskopinė operacija buvo atlikta 36 (73,5 %) ligoniams, o 13 (26,5 %) atvejų prireikė konversijos į atvirą operaciją. Pleuros ertmės sąaugos ir negalėjimas iki galo pašalinti ant plaučio paviršiaus susidariusio jį kaustančio šarvo buvo pagrindinės konversijų priežastys. Dešimt (20 %) ligonių patyrė tokių pooperacinių komplikacijų kaip ligos atkrytis, ilgesnį laiką besiskiriantis pro drenus oras, žaizdos infekcija.

Išvados

Pleuros empiemos atveju minimaliai invazinė chirurgija yra saugi ir pakankamai efektyvi. Tačiau turėtume ieškoti tam tikrų veiksnių, kurie padėtų atrinkti asmenis, tinkamus sėkmingai torakoskopinei pleuros empiemos operacijai.

Reikšminiai žodžiai: pleuros empiema, piotoraksas, videoasistuojamoji krūtinės chirurgija, empiemektomija, dekortikacija

Background

Pleural empyema, the accumulation of pus within the pleural cavity (purulent effusion), is known since the times of Hippocrates [1]. Despite the evolution of medicine and being recognized over two millennia, pleural infection is still increasing in incidence in many countries and is associated with a substantial morbidity and mortality in patients of all ages [2–7].

Infection in the pleural cavity is usually a secondary process. Its cause may include direct or indirect spread of infection (from the lung, mediastinum, abdomen), chest trauma or a iatrogenic cause secondary to any kind of intervention or surgical procedure to the chest [2, 4]. So, the ideal management of empyema should primarily be its prevention [4]. Pathophysiologically, empyema evolves through three stages of development, which include accumulation of fluid (exudative, stage I), loculation of pleural fluid, formation of adhesions (fibrinopurulent, stage II) and formation of inelastic pleural peels (organizational, stage III) [4, 8]. There is no definitive diagnostic test to identify the transition of an empyema from stage to stage, especially from stage II to stage III [4].

The majority of patients with pleural empyema are not cured by medical therapy and usually require surgical intervention [6, 9, 10]. The aim of the surgery is to eliminate the infected material from the pleural space and to achieve the expansion of the underlying lung [11]. The current management of empyema is still based on the local empirical practice as there is no consensus on an optimal regimen [4, 10, 12]. There is a lack of adequate research data regarding the treatment of pleural infections [5, 7, 8, 12]. Patient history, choice and condition still often direct the appropriate surgical management [4, 12]. The precise role of video-assisted thoracic surgery (VATS) in the treatment of pleural empyema remains controversial [5, 9], but in the era when minimally invasive techniques become more and more common, thoracoscopic surgery for pleural empyema is getting more and more popular, even in advanced cases. Although there are some basic principles of what should be done during operation, the way and methods to perform it sometimes vary depending on the center or surgeon experience, equipment, patient status.

What could be the advantages of thoracoscopic surgery for pleural empyema? In the literature, you can find that the VATS approach offers equivalent outcomes in terms of the resolution of the disease as compared with open surgery. It decreases the length of hospital stay, postoperative complications, patient morbidity and mortality, postoperative discomfort, has better cosmetics and a higher patient satisfaction [9, 10, 13]. However, thoracoscopy has also some disadvantages. There are possible complications, such as bleeding, air leakage, residual pleural space, wound infection. It is also related to up to the 58.5 % rate of conversion to an open surgery [6, 10]. Conversion by itself leads to a longer operating time and hospital stay. Thoracoscopic surgery may also fail, be incomplete, requiring an additional invasive treatment later [9]. All these factors may significantly increase the general treatment cost and patient morbidity.

We have started using the VATS technique for empyema patients in 2006. In this report, we would like to describe our VATS technique and preliminary experience in the management of patients with pleural empyema.

Methods

In this study, we included patients with pleural empyema independently of chronicity (stages II and III) treated at the department of General Thoracic Surgery, Vilnius University Hospital, from January 2011 to September 2013, in whom VATS empyemectomy was attempted to perform. Empyema was defined with at least one of the following features: purulent or opaque fluid, positive pleural fluid culture, loculations at CT scan or specific findings in the pleural fluid (pH < 7.3, glucose $<$ 2.22 mmol/l, LDH > 1000 IU/l, protein >10 g/l, WBC $>500/\mu$l). We excluded patients with bronchopleural fistula, empyema necessitatis, mediastinitis, pulmonary or pleural malignancy, or previous thoracic surgery.

The aims of the surgery are: (1) to evacuate purulent debris from the pleural space, and (2) to achieve total lung reexpansion.

All surgical procedures have been performed under a general anesthesia. All patients were managed with a double-lumen endotracheal tube for single lung ventilation and were placed on the lateral decubitus position. A small antidecubitus mattress was placed below the dependent hemithorax to obtain a slight splitting of the intercostal spaces.

Usually, two trocars 12 mm in diameter were used. However in some cases it was impossible to remove all debris and to make a complete decortication through two ports. In these cases, an additional trocar 10 mm in diameter was used. A 30^{o} camera was preferred to allow an easier exploration of the pleural cavity and a better visualization of infected material collections (Figure 1). The initial port was performed in the sixth or seventh intercostal space in the mid-axillary line, independently of the location of empyema cavities. After digital exploration, the first 12 mm thoracoscopic trocar was placed. If no free pleural space had been found, firstly the lung around the initial port was blindly dissected from the chest wall using the index finger and a peanut pusher (Figure 2-A) trying to move it gently and as close to the thoracic wall as possible. Then, after the camera had been introduced through the first port, the remaining one or two ports were made according to the empyema cavities location under thoracoscopic vision to avoid injury to the underlying lung parenchyma. Fluid, loculations, septa, all solid debris and adherent peel from the pleura were removed using an endoscopic aspirator-irrigator (Figure 2-B), a special thick and rigid aspirator 10 mm in diameter (Figure 2-C), spoon-like forceps (Figure 2-D), a curette and a spoon (Figure 2-E). The lung was completely mobilized from the apex to the diaphragm. If the lung was not seen to reexpand completely, then additional decortication of the lung (removing the cortex from the lung) was performed using a small peanut dissector and a ring clamp (Figure 2-F) or thoracoscopic forceps. Material for microbiological analysis and pieces of the parietal pleura for histological examination were collected in all patients.

After the decortication had been accomplished, the pleural space was irrigated with an antiseptic solution, and an assessment of lung reexpansion and air leak was made. At the end of the procedure, usually two 32 French gauge size chest tubes were placed. Neither suction nor irrigation via chest tubes was used directly postoperatively.

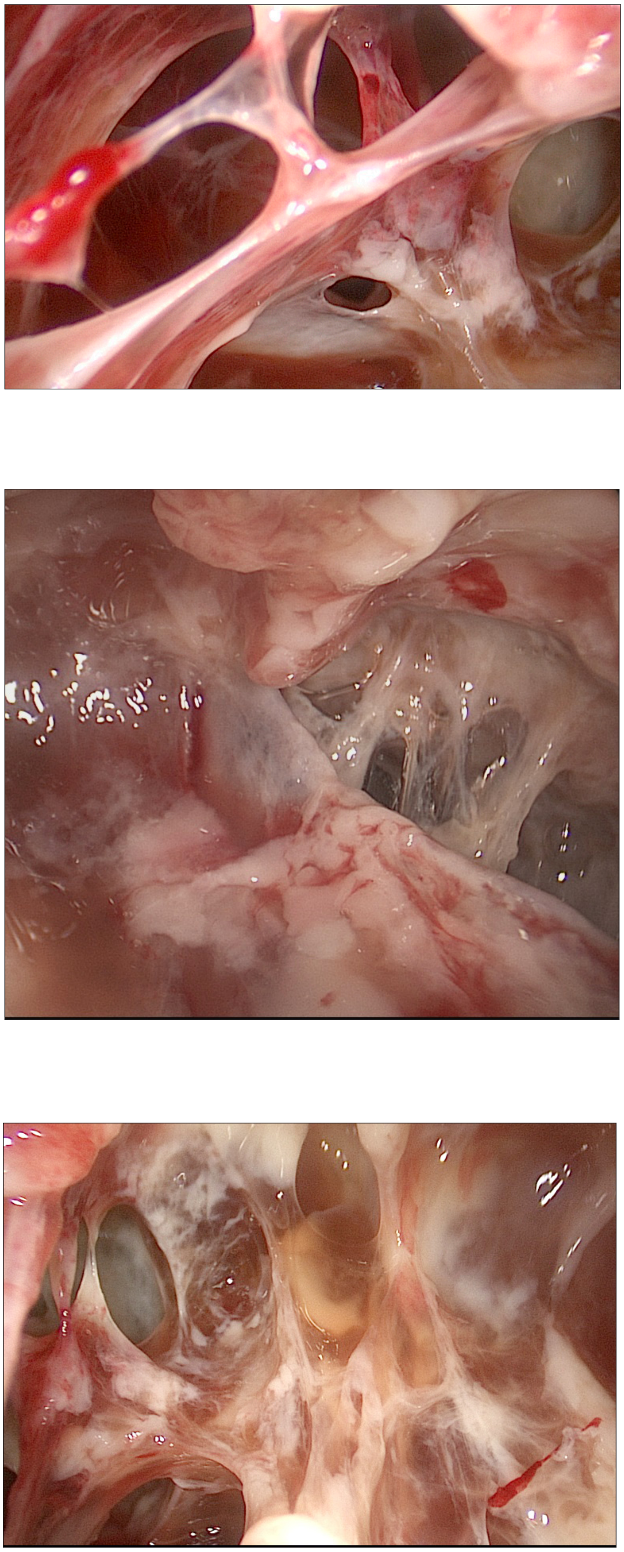

Figure 1. Purulent material in the pleural cavity

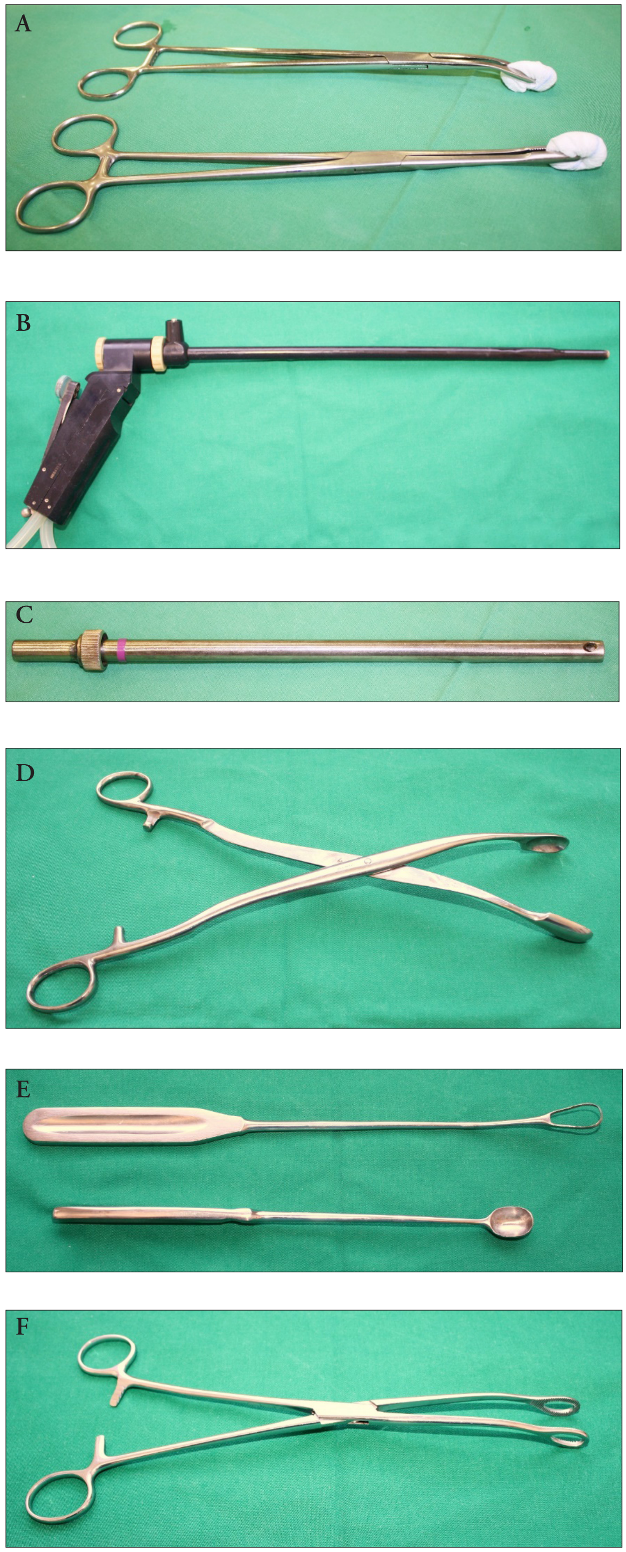

Figure 2. Instruments we use for VATS empyemectomy (A – peanut pusher, B – endoscopic aspirator-irrigator, C – rigid powerful aspirator, D – spoon-like forceps, E – curette and spoon, F – ring clamp)

Conversion to thoracotomy was considered when it was impossible to enter the pleural cavity safely due to adhesions or to remove completely all debris from the underlying pulmonary surface. Intraoperative complications, such as significant bleeding or a severe pulmonary leakage, could be additional reasons for conversion.

Subsequently, analgesics were administered after the operation on demand. An intensive respiratory rehabilitation program was started since the first postoperative morning. Antibiotics (Cefuroxime and Metronidazole) were given empirically if there were no established bacteriological agent or according to the microorganism and its sensitivity. Chest tubes were removed when there was no air leak and the drainage output was less than 200 ml per 24 h.

Continuous variables in this study are expressed as a mean and standard deviation if there was a normal distribution of variables, or as a median and quartile range (QR) in other cases.

Results

During the period between January 2011 and September 2013, we had 49 consecutive cases of VATS performed for pleural empyema. There were 44 males and five females, the mean age 52 ± 16 years (range, 22–87). Pleural empyema was usually associated with pneumonia – 44 (90 %) patients, posttraumatic – 4 (8 %) or due to subdiaphragmatic abscess – 1 (2 %).

The operation was successfully performed in 36 (73.5 %) cases, whereas in 13 (26.5 %) cases conversion to thoracotomy was required. Obliterated pleural space by very dense adhesions (in eight patients) and inability to achieve total lung reexpansion (in four patients) were the main reasons for conversion. The last patient was converted to an open approach for severe obesity, when the standard trocars were too short to reach the pleural space.

The pleural fluid culture was positive in 11 (22 %) patients. The sterility of the pleural fluid may reflect the chronicity of the process as well as may be associated with the prior antibacterial treatment. The mean duration of symptoms before referral to surgery was 20 ± 16 days. The majority of patients (84 %) had been previously treated with antibiotics at another hospital or department. The mean duration of hospital stay was 14 ± 8 days (range, 6–42). The mean operating time was 79 ± 26 minutes, and the median postoperative hospital stay was 7 days (QR 6–10). Chest tubes remained in place with a median indwelling time of 5 (QR 3–6) days. Ten patients (20 %) had postoperative complications. Four of them had the recurrence of disease (clinical symptoms and a significant amount of effusion in the chest cavity remained) and needed additional procedures (three underwent thoracotomy, one was successfully treated by thoracocentesis). Three patients had a prolonged air leak (more than 5 days), and they were successfully cured using permanent aspiration via chest tubes. Three patients had wound infection. One patient died postoperatively. The cause of death (hepatic cirrhosis) was not associated with pleural empyema.

Discussion

"If empyema does not rupture, death will occur", stated Hippocrates even two thousand years ago [14]. Despite this old truth, pleural empyema remains a challenging entity for thoracic surgeons [8]. All experts agree with some fundamental principles of managing empyema: control of the infection (antibiotics), complete evacuation of the infected material, and refilling the pleural space [5, 8, 14–16]. However, the best treatment option for each patient differs and varies based on the condition of his empyema and on the institutional or physician's experience [5, 8, 17, 18].

The surgical management of thoracic empyema has progressed over the past decade [4, 19]. However, there is still a question: when, for what patient and what kind of operation to perform? There is a lack of adequate studies regarding the role of thoracoscopy in managing pleural infections [2, 5]. Thoracoscopy in the management of pleural empyema initially was used only for diagnostic purposes, but reduced postoperative morbidity and more pleasing aesthetics generated a greater interest to the procedure [2, 4]. Complex, multiloculated empyemas previously had been managed solely by open surgery [4, 13, 19]. However, recent studies have shown that VATS could be an equally effective but a less invasive approach, even in advanced cases [2, 4, 9, 10, 14, 20]. Thoracoscopic surgery could probably replace open surgery for empyema, but actually not in all cases. Successful treatment depends on how precisely we can evaluate the patient's empyema by taking into account the duration of the illness, the extent of the process, the type of responsible organisms, the presence of bronchopleural fistula, the thickness or calcification of pleura, etc. [8]. The earlier empyema we treat, the better success rate we could achieve [8, 21, 22].

In our study, we used VATS for the management of pleural empyema in all patients whatever the duration of the disease. We have found that it is quite a safe procedure, although related with 26.5 % of conversions and with a higher recurrence rate than it could be after thoracotomy (comparing successfully performed VATS with VATS converted to thoracotomy). On the other hand, VATS offers a lower postoperative morbidity, shorter postoperative stay, and reduces treatment cost. Some data analyzing the cost of empyema management have shown that tube thoracostomy is cheaper than VATS which is cheaper than open surgery (if the only approach is used successfully). But if one of the approaches fails, then you have to turn to another, and in this situation the treatment cost and hospital stay usually exceed the cost and the hospital stay in any of single approaches [2, 16, 23]. It would be useful to know in advance what patient with pleural empyema fits for VATS and what should be scheduled directly to an open operation. So, conversion is always a worse choice than an exact minimally invasive or open procedure.

Usually, most thoracoscopic procedures are performed under general anesthesia. When performing VATS, it is necessary to have a space (in the pleural cavity) for a safe manipulation with the camera and instruments. To achieve this, a single lung ventilation is needed. We performed all operations under general anesthesia, using a double lumen endotracheal tube for a single lung ventilation as it is done in the majority of centers [13, 17–19, 22, 24–26]. However, reports by Tacconi et al. and by Tassi et al. mention that VATS for empyema could be done successfully even in awake patients under loco-regional anesthesia and spontaneous breathing [15, 18]. Bishay et al. suggest the use of carbon dioxide insufflation at a low flow and pressure to make a better space for the operation [17].

Thoracoscopy for empyema is usually performed through two to four incisions in the chest [3, 15, 17–19, 20, 24, 26, 27]. But there are few centers who are trying to make a single-port VATS for empyema [25] and even for bilateral empyema [28]. The trocars used are usually 10–12 mm in diameter [20, 24, 27]. We use two 12-mm and if needed, an additional 10-mm trocars. The number and location of ports is dictated by the preoperative CT scan and intraoperative findings [15, 24, 27]. There is a debate about where to place the first port. Is it better to put it directly into the empyema cavity, or is it better to start in the unaffected pleural space area? Wurnig et al. [19] and Waller et al. [13] recommend to position the first port so that the empyema is not touched, whereas Tassi et al. [18] and Martinez-Ferro [25] suggest to put the first port directly into the empyema cavity. We think that there is no difference where to start the VATS procedure regarding empyema location. We usually perform the first port in the sixth or seventh intercostal space in the mid-axillary line (Figure 3). This incision could be extended for thoracotomy if a conversion is needed. Everybody agree that the rest ports should be placed under the thoracoscopic vision to avoid an injury of the underlying lung parenchyma.

Once you have successfully entered the pleural space using a thoracoscope, you have to do the same things

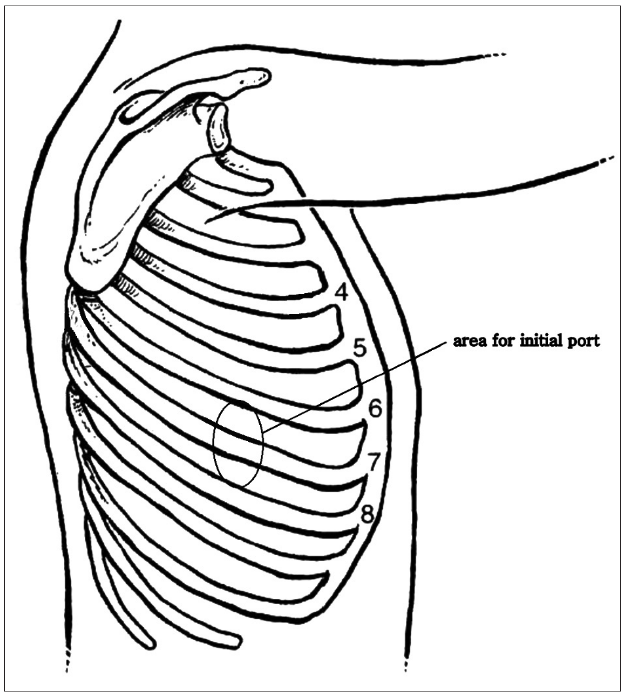

Figure 3. Area where the initial port for VATS empyemectomy is made

with the empyema as you would do it during thoracotomy. This means that under the endoscopic vision you have to release the whole lung, to break all loculi, to remove all purulent material (solid and liquid) from the pleural cavity, to remove the adherent peel from the underlying lung and parietal pleura. Eventually, to wash out the pleural space with a saline or antiseptic solution and insert chest tubes [11, 19, 22, 24, 26]. To perform thoracoscopic empyemectomy, usually you need to use only a few instruments: the camera, the aspirator, a ring clamp, a peanut pusher, and endoscopic forceps [24]. Chan et al. in VATS empyemectomy use only conventional instruments [20]. We use an endoscopic suction–irrigation cannula and another more powerful thick and a rigid aspirator to destroy and to remove at the same time all fibrin septa, the adherent peel and other solid material as well as some conventional instruments (peanut pusher, currete or spoon, ring clamp, special spoon-like forceps). Some authors describe special devices such as endoshavers, ultrasonic devices that allow easier to destroy and to remove solid purulent material and to peel it from the pleura [6, 29].

There is still an open discussion concerning the possibility to perform a true VATS decortication or only debridement. Some authors advocate that it is possible to perform the same decortication by VATS as by thoracotomy [13, 24]. Others disagree, arguing that decortication under thoracoscopy is not truly technically identical one as under thoracotomy [7, 8, 19]. The definition "debridement" means evacuation of necrotic material form the cavity. The original concept of "decortication" is peeling off the organized coat of the visceral pleura from the underlying lung [7]. This is a technically demanding procedure (lengthy, with a risk of mortality, a substantial blood loss and prolonged air leak) and used to be performed under thoracotomy [7, 8, 11]. Successful empyemectomy means evacuation of necrotic material from the space and decortication, which is mandatory for the reexpansion of the underlying lung. The procedure under thoracoscopy intends the evacuation of necrotic material and the breakdown of loculations rather than peeling off the organized pleura, so it may be termed VATS debridement [7, 8]. There are some data showing that debridement or decortication do not associate with any difference in surgically treating the empyema [11, 14]. Probably, that is why surgeons have been moving towards VATS debridement as the management of empyema [11, 19]. In our study, we have found that in earlier cases of empyema it is enough to make a debridement only, because the underlying lung is not yet trapped by a thick and rigid coat. In advanced cases, when you can enter the pleural cavity successfully, the decortication of the underlying lung is mandatory. However, this may be done by VATS not in all cases.

At the end of the operation, usually one to three large-bore (at least 28 French gauge size) chest tubes are placed [15, 17–19, 20, 22, 24–26]. We prefer to leave two 32 French gauge chest tubes, one placed anteriorly to the apex and the other towards the posterior sinus. Cardillo et al. and Waller et al. suggest the use sealants if there is a significant air leak or bleeding during the operation [13, 24]. We have never used any additional material during the operation. Kho et al. advice to connect aspiration through the chest tubes at once [11]. Wurnig et al. recommend to irrigate pleural space via chest tubes postoperatively [19]. We think these maneuvers are not necessary, unless on the second postoperative day the air leak continues or the lung is partially collapsed on the chest X-ray.

Conversion to thoracotomy is considered if it is impossible to enter the pleural cavity due to firm adhesions, completely dissect the peel from the underlying lung surfaces, or in cases of severe bleeding or air leakage [13, 15, 17, 19, 22, 24, 26]. The first two were the main reason for conversion in our study. The success rate on the thoracoscopic management of empyema is variable, with conversion rates of 0% to 58.5% being reported [6, 7, 10, 13–15, 17–20, 22, 24–26]. The conversion rate in our study, according to the fact that we have included advanced (stage III) cases of empyema, is 26.5 %. Some recent studies have identified that a delayed referral to surgery or a longer anamnesis lead to a higher conversion rate [2, 7, 14, 17, 21, 22].

The complication rate after VATS empyemectomy varies from 9 % to 22 % [10, 16, 19, 20, 24]. Prolonged air leak, bleeding, recurrence of the disease, renal insufficiency, wound dehiscence due to the infection, residual pleural space are the most common complications [10, 18–20, 24]. In our series, the complication rate was 20 % (in 10 out of 49 patients): recurrence of disease (four patients), prolonged air leak (three), and wound infection (three). One patient died because of the reason not associated with pleural empyema. Postoperative mortality varies from 0 % to 3 % [13, 17, 18, 24].

Video-assisted thoracic surgery is safe and may reach the same goals as open surgery in treating patients with pleural empyema sometimes even in advanced cases. However, we should search for the preoperative factors identifying the right persons who could be cured successfully by using a minimally invasive approach.

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