Application of the hydrosurgery system and plasmajet for thoracoscopic pleural cavity debridement in children with fibrinothorax

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Abstract

Aplicarea sistemului de hidrochirurgie și a plasmajetului în debridarea toracoscopică a cavității pleurale la copii cu fibrinotorax

Toracoscopia a devenit o modalitate favorizată în tratamentul empiemului pleural la copii. Cu toate acestea, factorii care afectează rezultatul administrării toracoscopice rămân neclari.
Scopul studiului este de a demonstra eficiența sistemului de hidrochirurgie "Versajet" și a unității de plasmă "Plasmajet" în tratamentul toracoscopic al copiilor cu complicații pleurale ale pneumoniei.
MATERIALE SI METODE. În perioada 2015-2017, la Spitalul de Copii Speransky din Moscova, 377 copii cu pneumonie au fost tratați, la 62 pacienți (16,45%) din 377 am efectuat drenajul cavității pleurale, 14 pacienți cu vârste cuprinse între 1,6 și 15 ani (în medie, 3,2 ± 3,8 ani) cu empiem pleural au fost operați. S-a efectuat decorticarea pulmonară toracoscopică cu sistem de hidrochirurgie (Versajet-2). Sistemul hidrochirurgical este un instrument chirurgical bazat pe impactul jetului de apă de mare viteză asupra țesuturilor necrotice și inflamate, combinând avantajele debridării țesuturilor moi și evacuarea acestora prin pulsarea jetului de apă. Designul tubului de evacuare și apropierea acestuia de jetul lichid creează un vacuum local, care îndepărtează efectiv fibrina și conținutul lichid prin efectul Bernulli. Consimțământul informat a fost obținut de la toți părinții înainte de operare, iar procedura însăși a fost aprobată de comitetul de etică locală.
REZULTATE. Recuperarea și reabilitarea fără particularități au fost în 13 cazuri. La un pacient cu empiem al cavității pleurale pe dreapta și leziune organică severă a sistemului nervos central a perioadei postoperatorii după o toracoscopie convențională complicată de recurența empiemului pleural.Retoracoscopia cu debridarea cavității pleurale de către sistemul de hidrochirurgie efectuată la șase zile după operația inițială, a avut rezultate satisfăcătoare. În cazul hemoragiei intraoperatorii, a fost efectuată coagularea plasmei de argon, obținându-se aerostasie completă la 2 pacienți și hemostază - la 1 pacient. Durata medie de funcționare a fost de 90 de minute (± 15 minute). Drenajul cavității pleurale este eliminat în ziua a 3-a sau a 4-a după operație. Copiii externați în ziua a 10-a (± 1,2 zile). Examinarea cu ultrasunete și cu raze X la patru luni după intervenția chirurgicală a confirmat absența inflamației în parenchimul pulmonar și reexpansarea plină pulmonară la toți pacienții.
CONCLUZIE. Aplicarea sistemului hidrochirurgical în timpul toracoscopiei asigură o debridare sigură și eficientă a cavității pleurale, decorticările plămânului fiind fără deteriorarea severă a parenchimului pulmonar și crearea condițiilor pentru reabilitarea precoce a plămânilor compromiși.

Cuinte cheie: sistem hidrochirurgical, toracoscopie, decorticare, cavitatea pleurală, fibrinotorax

Abstract

Thoracoscopy became a favored modality in pediatric pleural empyema treatment. However, factors affecting outcome of thoracoscopic management remain unclear. The purpose of the study is to demonstrate efficiency of hydrosurgery system "Versajet" and plasma unit "Plasmajet" in thoracoscopic treatment of children with pleural complications of pneumonia.

MATERIALS AND METHODS. During the period of 2015-2017 at the Speransky Children's Hospital in Moscow 377 children with pneumonia were treated, in 62 patients (16.45%) of 377 we perform drainage of pleural cavity, 14 patients from 1.6 to 15 years of age (on average, 3.2 ± 3.8 years old) with pleural empyema were operated. Thoracoscopic lung decortication with hydrosurgery system (Versajet-2) was performed. Hydrosurgery system is a surgical instrument based on impact of high-speed jet of water on necrotic and inflamed tissues, combining the advantages of soft tissues debridement and evacuation them by pulsating water jet. Design of the evacuation tube and its proximity to liquid jet creates a local vacuum, which effectively removes fibrin and liquid contents by Bernulli effect. Informed consent was obtained from all parents before operation, and procedure itself received approval from the local ethics committee.

RESULTS. Recovery and rehabilitation was uneventful in 13 cases. In one patient with empyema of right pleural cavity and severe organic lesion of central nervous system postoperative period after conventional toracoscopy complicated by recurrence of pleural empyema. Rethoracoscopy with debridement of pleural cavity by hydrosurgery system performed six days after initial operation, with satisfactory results. In the event of intraoperative air leak or hemorrhage, application of argon plasma coagulation had been performed achieving complete aerostasis in 2 patients and hemostasis - in 1 patient. Average operation time was 90 minutes (± 15 minutes). Drainage of the pleural cavity removed on the 3rd or 4th day after surgery. Children discharged from the hospital on 10th PO day (± 1.2 days). Ultrasound and X-ray examination four months after surgery confirmed the absence of inflammation in the lung parenchyma and full lung reexpansion in all patients.

CONCLUSION. Application of hydrosurgycal system during thoracoscopy provides safe and effective debridement of pleural cavity, decortications of the lung without severe damage to the lung parenchyma and create conditions for early rehabilitation of compromised lung.

Keywords: hydrosurgycal system, thoracoscopy, decortications, pleural cavity, fibrinothorax

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Introduction

Balance between the resistance of the child's organism, virulence of bacteria and time of appropriate pharmaceutical treatment initiation [6] determines risk of developing pleural empyema during complicated pneumonia course. Independent risk factors for development of empyema include congenital and acquired diseases, such as immunodeficiency, viral infection and organic disease of central nervous system, cancer, Down syndrome, congenital thrombocytopenia, tuberculosis, congenital heart disease, preterm birth, oesophageal disorders and cystic fibrosis [1]. There are three stages in natural course of empyema thoracic: exudative, fibrinopurulent, and organizing stage. These stages developing in continuum if inadequate treatment persist. Two last stages are called complicated parapneumonic effusions and may be a reason to perform surgery for lung reexpantion [4]. Recently, in cases of pneumonia with pleural complications, most surgeons perform thoracoscopic decortication. Success of surgery for this disease depends on the quality of removing fibrinopurulent exudate out of pleural cavity [5]. However, the vacuum aspiration used in thoracoscopy and the mechanical elimination of the pathological contents do not always allow complete debridement of the affected pleural surfaces. In addition, during attempts of full debridment bleeding and bronchopleural fistulas often occur, because of damage to inflamed parenchyma of lung and pleurae, especially if their tight fusion exist [3]. In connection to this, it is relevant to use a hydrosurgical unit for the gentle debridement of affected surfaces and a gas-plasma argon coagulator for provision of intraoperative aerostasis and hemostasis.

Patients and Methods

From 2015 to April 2017, in various departments of the G.N. Speransky Children's Hospital was on treatment 377 children with a diagnosis of acute community-acquired pneumonia. Of these, 64 patients (16.58%) had a complicated course of empyema of the pleural cavity, 40 children from 64 with pleural complications of destructive pneumonia required drainage of the pleural cavity. In 14 (21.8%) of 64 children, intensive therapy was ineffective for 4 days after drainage of the pleural cavity, patients underwent x-ray and ultrasound examination of pleural cavities in dynamics, computed tomography was performed in 5 patients. Detection of the persistence of loculated empyema according to CT and / or ultrasound of pleural cavities was an indication for thoracoscopic sanation of

the pleural cavity. Usually used in this operations vacuum aspiration of content and mechanical extraction of fibrinous-purulent overlays cannot ensure complete debridement of the inflamed surfaces, especially if the disease is long-standing or severe. Attempts to completely debridement are complicated by aspiration of air from the pleural cavity during thoracoscopy, which leads to loss of visualization of the operating field and contamination of the chamber. Elimination of these shortcomings leads to an increase in the operation time. In addition, to ensure the complete removal of nonviable tissues is hampered by the possible sucking up of the aspirator to the affected areas, which usually causes additional bleeding and increases the threat of formation of iatrogenic bronchopleural fistulas. In turn worldwide experience of using hydrosurgical dissection and debridement unit "Versajet 2" in situations that require a delicate attitude to the tissues of the body [2] led us to understand the possibility of its use in children with fibrinothorax.

INTERVENTION - SURGICAL TECHNIQUE

At the preoperative stage, location of maximum accumulation of exudate in the pleural cavity were determined using instrumental methods and later aspirated by pleural puncture. This ensures the creation in the pleural cavity of the necessary space for the safe trocar insertion and introduction of endoscope. Location of the first port depends from degree of lung collapsing and position of diaphragm. After this, removal of exudate residues from the pleural cavity and separation of fibrinous peels between pleura sheets followed by washing out pleural cavity with saline were performed. Then we proceed with elimination of fibrinous-purulent deposits from the visceral and parietal pleura sheets and the decortication of the lung with the tip of the "Versajet" hydrosurgical unit, introduced by the port-free technique (fig. 1). Debridement was performed until the appearance of minimal diapedesis bleeding from the surface of the lung, which indicated sufficient cleaning from purulent-fibrinous peels (fig. 2). In the event of an air leakage or bleeding from the parenchyma or chest wall, we perform coagulation with stream of argon hot plasma by Plasmajet unit to achieve complete intraoperative aerostasis and hemostasis. Operation ends with a classical drainage of the pleural cavity.

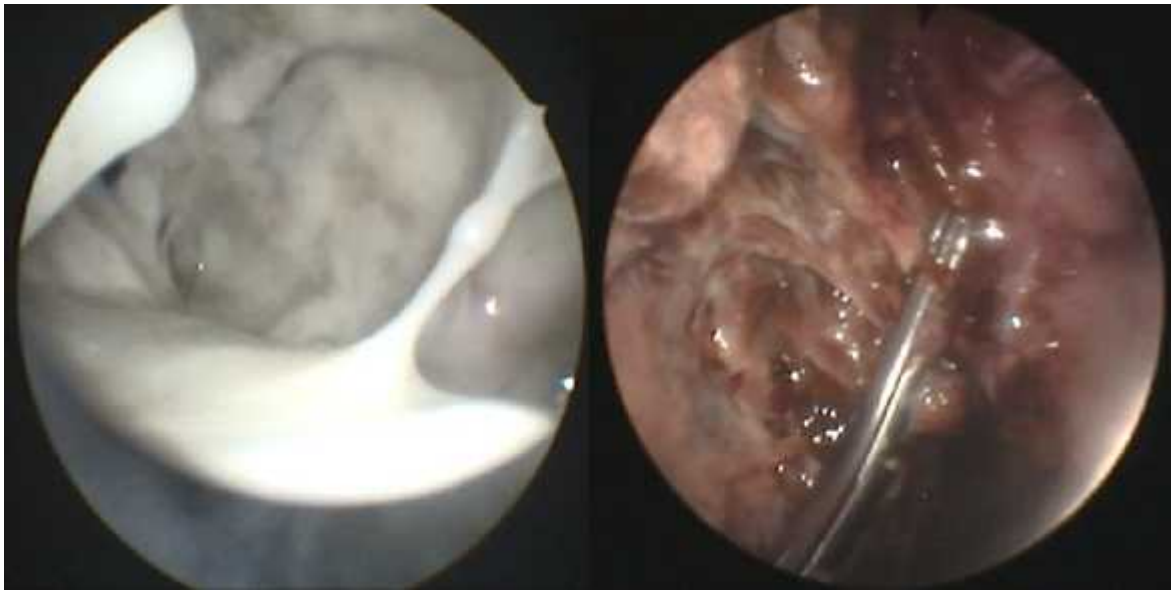

Fig. 1. Insertion of the instrument and the beginning of hydrosurgical debridement of pleural cavity

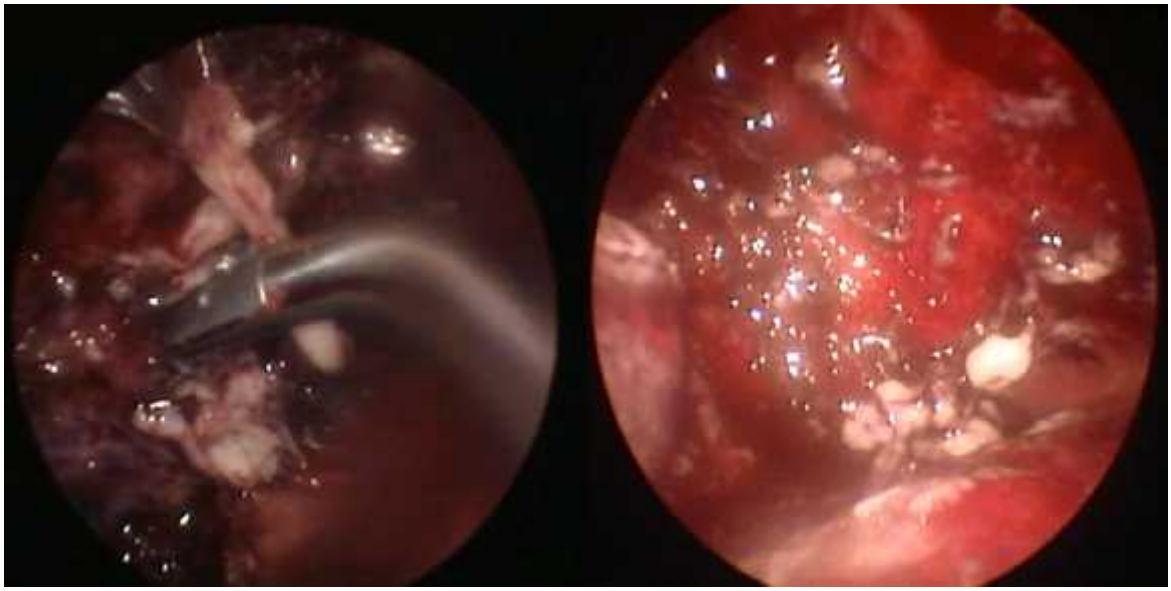

Fig. 2. Complete cleaning of pleura from fibrinopurulent peels

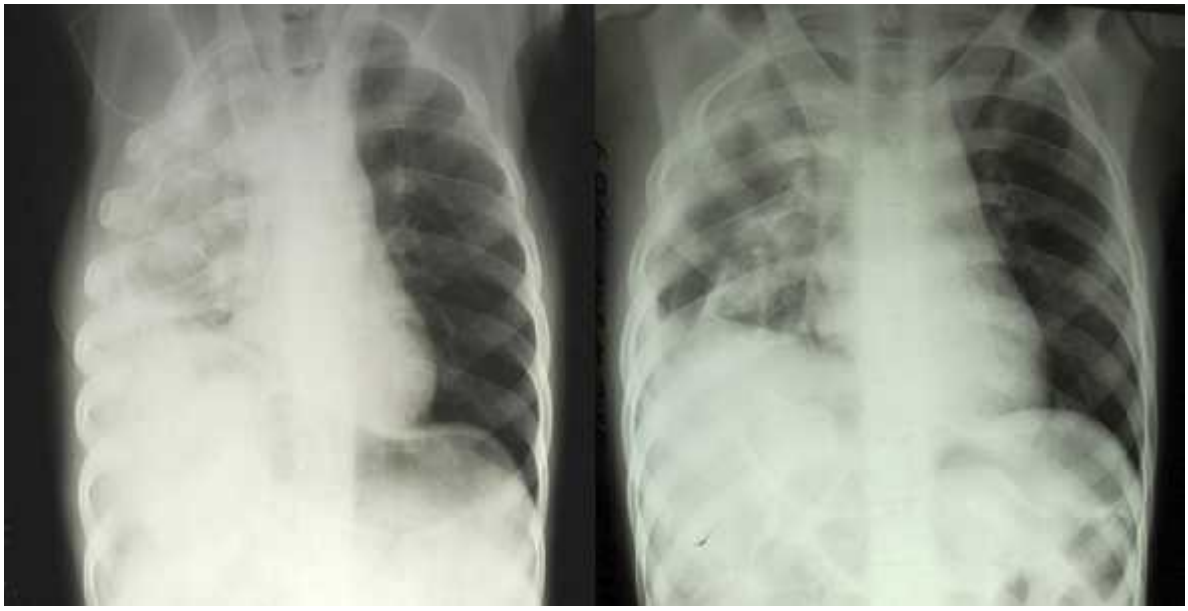

Fig. 3. Postoperative result of hydrosurgical debridement on the 4th postoperative day

Results and Discussion

In all cases, the postoperative period proceeded without complications. Average duration of operation was 90 minutes (± 15 minutes). Drainage from the pleural cavity was removed on 3th day (± 1.1 days) after the operation. PCR analysis of fluid from the pleural cavity showed that in 6 cases Str.pneumoniae was the causative agent, in one - Staph. Aureus, in 7 cases it was not possible to identify the pathogen. After operation, children discharged from the hospital on 10th POD (± 1.2 days), average duration of the hospitalisation was 19 days (± 2 days). Repeated thoracoscopies after hydrosurgical sanation were not performed (Fig. 3). According to chest radiographs and ultrasound of pleural cavities at 3 and 6 months, it was found that all patients lack fibrin overlap and inflammatory changes in the parenchyma of the lungs and pleura

One of the advantages of the hydrosurgical method that it's based on a saline solution that is safe for the patient and does not cause an allergic reaction. High-speed supply of sterile liquid allows perform excision of tissues with one-stage aspirating of detritus and liquid contents, which reduces the time of operation. The advantage of this method lies in the fact that at high values of the power of the apparatus, it is possible to debride dense fibrinous fusion in the pleural cavity. Together with the high accuracy of the liquid flow and the thin depth of cutting of the tissues (1 mm), the water jet device allows selective removal of non-viable tissues, which can reduce the risk of bleeding and damage to the pulmonary parenchyma. Application of argon-plasma coagulation to achieve aero and hemostasis avoids additional manipulations in the pleural cavity and prevents the development of severe complications.

Conclusion

Application of hydrosurgical and plasma scalpel allow us conduct desirable debridement of inflamed surfaces, with the relief of possible complications by aerostasis and hemostasis, what creates favorable conditions for reexpansion of compromised lung and relief of intoxication symptoms for a faster recovery of the patient. However, these statements should be researched in randomized controlled studies.

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