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Experience of endoscopic correction of congenital diaphragmatocele in newborns

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***Study aim:** analysis of surgical treatment of congenital diaphragmatocele on the basis of epy multi-profile republican hospital #1 of the National center of medicine. **Study participants and methods.** The article gives analysis of treatment results for 8 newborns (6 girls and 2 boys) with false diaphragmatoceles. The average age at the moment of operation was 3 days. In 6 cases the malformation was revealed antenatally during ultrasound investigation within a prescribed period, in 3 cases – within the first antenatal hours. **Results.** All patients were operated thoroscopically, average operation time – 60 minutes. No intraoperative complications, hemorrhage or conversion. Average time of post-operative artificial pulmonary ventilation – 5.6 days, of pleural draining – 4.7 days. Results were being evaluated from 6 months to 2 years after operation. An excellent direct and long-term functional and cosmetic result was achieved with all patients. **Conclusions.** Thoroscopic plastic surgery of defects at false congenital diaphragmatocele introduced in clinical practice is a sufficiently safe procedure for newborns. Excellent visualization of all stages of intervention, lack of technical difficulties with bringing organs down and plastic surgery of the diaphragm itself and quick recovery in the nearest post-operative period are indubitable advantages of endosurgical intervention.*

Keywords: newborns, congenital diaphragmatocele, endosurgery.

INTRODUCTION

According to different world neonatal centers, the congenital diaphragmatocele rate in newborns is 1:2,500-5,000 [1–7]; including the stillborn into the statistics, the real disease rate is ca. 1:2,000 births [2, 3]. Shift of organs from abdominal cavity to chest through the back left dehiscence is revealed in almost 90% of cases. Herniation causes respiratory failure, which is considerably aggravated by pulmonary hypoplasia not only on the affected side, but also on the collateral side. Ca. 36% of children with congenital diaphragmatocele die right after birth of respiratory failure despite the conducted resuscitation measures [1, 2, 4, 8]. Pulmonary hypoplasia and hypertension are the main death causes in patients with diaphragmatocele [1, 2, 4, 8, 9].

Congenital diaphragmatocele treatment results have been being considerably improved for the last 10 years. It became possible due to the introduction of new anesthetic, resuscitation and surgical strategies. Strategy of delayed surgical treatment of Bochdalek defects after the patient has reached respiratory stabilization is now widespread. Early operation tactics in such children is rejected at most clinics [6, 7, 10] as post-operative mortality in this case is 80% and higher; this is caused by decompensation of life support systems [2]. The use of high-frequency oscillatory artificial pulmonary ventilation and extracorporeal membrane oxygenation is prospective in treating newborns with respiratory failure [1, 4, 6, 7, 9–12].

Surgical treatment of congenital diaphragmatocele has undergone considerable changes, especially in the recent decade. Standard operations of closure or synthetic patching to correct posterolateral diaphragmatic defects are traditionally conducted using laparotomy. Introduction of endosurgical interventions in pediatric surgery causes considerable interest of many scientists in different countries [6, 8, 10, 12, 13]. The number of publications dedicated to this area of surgery is increasing every year. One of the relevant issues of modern pediatric endosurgery is the correction of diaphragmatocele in children.

Indications to endoscopic operations at diaphragmatocele expand intensively, to a large scale due to better visualization of thoracic cavity organs during surgical intervention, good functional and cosmetic results, more favorable course of early post-operative period and quick rehabilitation of patients after operative interventions. Endoscopic operations in the group of newborns are a difficult task for surgeons and anesthesiologists, because intensity of respiratory and cardiovascular disorders plays the crucial role in these children.

Selection of one of the methods is determined by the balance of efficacy and safety factors; together, they provide maintenance of the patient's required life quality level.

Study aim: efficacy analysis of surgical treatment of congenital diaphragmatocele on the basis of a multi-profile republican hospital #1 of the National center of medicine.

PATIENTS AND METHODS

In 2010-2012 the pediatric center's surgical department housed 9 newborn children with congenital diaphragmatocele. The first thoracoscopic plastic surgery of a diaphragmatic defect was conducted in March 2010. Since then, thoracoscopic plastic surgery of a diaphragm had been scheduled for all newborns with diaphragmatocele admitted in the clinic. As of today, 8 patients have been operated. In 6 cases, the defect was revealed antenatally by ultrasound investigation within the prescribed period, in 3 cases – in the first postnatal hours. Preoperative examination included examination, plan chest radiography, abdominal echography, neurosonography and echocardiography. In all cases, preoperative preparation in the form of high-frequency pulmonary ventilation lasted for 3 days; it was aimed at fighting pulmonary hypertension and the developed persistent fetal blood flow. Operative intervention was conducted under a standard endotracheal anesthetic using endovideocomplex and the "Karl Storz" kit in the patient's right lateral decubitus.

Operative technique. 3 3.5mm trocars for a telescope and manipulators were used at plastic surgery of a diaphragm. Trocars were placed in the 4th intercostal space in the posterior axillary line and in the 6th intercostal space in the anterior axillary and scapular lines. Low CO₂ pressure in pleural cavity (5mm Hg) with 1 l/minute flow rate was used to prevent hypercapnia and minimal hemodynamic disorders during a thoracoscopic operation. The primary entry into the left pleural cavity was conducted by the 3.5mm trocar thoracocentesis in the 4th intercostal space in the line posterior axillary line.

Operative intervention would continue if there was no aggravation of the main monitoring parameters. Pleural cavity was examined after carbon dioxide insufflation and lung collapse (pic. 1).



Pic. 1. Intestinal loops in the left pleural cavity

Trocars for manipulators were introduced. Intestinal loops and parenchymatous organs were dipped into abdominal cavity under the positive CO₂ pressure and with help of manipulators. Diaphragmatic cupola defect, its dimensions and the presence of “parietal” muscular embankment were appraised (pic. 2).



Pic. 2. Appraisal of diaphragm defect and possibility of local flaps grafting

The defect was closed by separate interrupted (5 cases) or uninterrupted (2 cases) suture (Ethibond 2/0 Ethicon, Mersilen 2/0) with intracorporeal formation of a knot; pleural cavity was drained through the trocar mouth (pic. 3). Dermal wounds were adapted using adhesive “DERMABOND” (pic. 4).



Pic. 3. Defect closure by interrupted suture



Pic. 4. Termination of thoracoscopic plastic surgery. Adaptation of dermal wounds by a biological skin adhesive

In the immediate postoperative period children remained on the prolonged artificial pulmonary ventilation in the conditions of a resuscitation unit for newborns. Patients received sedation and were prescribed muscle relaxants. Time of shift to spontaneous respiration and enteral stress depended on the respiratory function's stabilization and gastrointestinal tract's passage recovery; usually, they did not take longer than 5 days after operation.

RESULTS AND DISCUSSION

Thoracoscopic plastic surgery was conducted to 8 patients (6 girls and 2 boys) with false diaphragmatoceles. All children were newborn. The average age by the moment of operation was 3 days. The average body weight of the newborns was 3,200g. In all cases the defect was left-side and posterolateral with the average dimensions of 3.5x2.0cm. The left pleural cavity in all newborns contained small and large intestinal loops, in 4 cases – also spleen and left kidney. The average operation time was 60±10 minutes. No hemorrhage or intraoperative complications were registered. No cases of conversion were registered. The average postoperative artificial pulmonary ventilation lasted for 5.6 days, the pleural drainage – for 4.7 days. Enteral stress would start on the 2nd-3rd day. No anesthesia was used. The average duration of postoperative hospitalization was 15.4 days.

The children were examined in catamnesis, all patients develop age-adequately, functional condition of a diaphragm is satisfactory. No relapses of false diaphragmatocele were registered in our patients. Good functional and cosmetic result was reached in all children. 1 newborn with the left diaphragmatic cupola aplasia, agenesis of the left and hypoplasia of the right lung was not operated. He died on the first day of life in the setting of progressing cardiorespiratory failure. Malformation was revealed antenatally; perinatal council appraised prognosis in that case as unfavorable, but the family decided to prolong pregnancy.

On the basis of the data from the conducted operations, we may conclude that thoracoscopic plastic surgery of a Bochdalek defect is possible in an absolute majority of cases. Thoracoscopy provides excellent visualization of the diaphragmatic cupola's defect, which is the most important condition for suturing manipulation.

Laparotomy is the traditional access for correcting false diaphragmatoceles; however, it does not resolve particular difficulties in bringing intestinal loops and parenchymatous organs down from the pleural cavity. Sometimes even wide laparotomy cannot provide the required quality of operative access, which may lead to traumatization of hollow

organs and hemorrhage from parenchymatous organs. One of the ways of resolving this issue is the additional dissection of the diaphragm in the area of the defect. Diaphragmatic suturing is also significantly complicated by the wound-adjacent intestinal loops, stomach and spleen.

With the development of endosurgery, correction of false diaphragmatoceles became a safe procedure for infants and newborns. According to the combined statistics, rate of conversions now is relatively low. Thoracoscopy allows visualizing organs, which have relocated to the pleural cavity, and atraumatically setting them in the abdominal cavity.

We have not encountered technical difficulties in relocating organs. Carbon dioxide insufflation into the pleural cavity favors their relocation. Pressure in the pleural cavity (5mm Hg) allows collapsing a lung and creating optimal conditions for diaphragmatic manipulations in the absolute majority of cases. Also, it is exactly this pressure that has been determined as safe for newborns, as it does not cause hemodynamic disorders.

As unobstructed access to the diaphragm is possible, defect's suturing does not pose any technical difficulties. After the diaphragmatic defect has been appraised, it is sutured by nonabsorbable suture Mersilen, Ethibond (Ethicon) 2/0 or 3/0. We have not noticed any fundamental difference between the use of interrupted or uninterrupted suture, or any serious difference in time spent for the procedure.

Moreover, thoracoscopic access is preferable due to no dissection of a big number of muscles, as this may disturb respiratory function in the postoperative period. As peritoneum is not damaged, there is no postoperative gastrointestinal tract's paresis and peritoneal commissures do not develop. The prolonged artificial pulmonary ventilation is short (5.6 days) as there is no operative chest trauma, postoperative pain syndrome and disturbed respiratory biomechanics.

CONCLUSION

1. Thoracoscopic plastic surgery of a defect caused by false diaphragmatocele introduced into clinical practice is a sufficiently safe procedure for newborns.
2. Sufficient visualization of all intervention stages, lack of technical difficulties in relocating organs and diaphragmatic plastic surgery itself, quick recovery in the immediate postoperative period are indisputable advantages of endosurgical intervention.
3. Outcome of such interventions depends on the experience of doctors taking part in treating this extremely difficult category of patients and the development of neonatal anesthesiology-resuscitation service at the particular medical institution.

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