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Congenital diaphragmatic hernia: an evaluation of risk factors for failure of thoracoscopic primary repair in neonates☆,☆☆

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Abstract

Purpose: Publications aiming to prove the feasibility and safety of thoracoscopic CDH-repair in neonates grow in numbers. Some teams use selection criteria, but none have proven statistical evidence. The aim of this study is to detect risk factors for failure of thoracoscopic primary closure of CDH in neonates.

Methods: In 8 centers performing minimal access surgery (MAS), complete prenatal, postnatal, and operative data were evaluated for a retrospective study concerning patients with thoracoscopic congenital diaphragmatic hernia (CDH) repair. Most of the selection criteria and risk factors mentioned in the literature were analyzed. Two groups were defined: Group A — neonates who tolerated thoracoscopic primary repair, and Group B — neonates who required conversion or presented with major complications

Abbreviations: CDH, congenital diaphragmatic hernia; $EtCO_2$, end tidal CO_2; HFOV, high frequency oscillatory ventilation; iNO, inhaled nitric oxide; LHR, lung over head ratio; $LHR^{obs}/_{exp}$, LHR observed over LHR expected for the gestational age; MAP, mean airway pressure; MAS, minimal access surgery; NICU, neonatal intensive care unit; OI, oxygenation index; PDA, patent ductus arteriosus; PEEP, positive end-expiratory pressure; PIP, peak inspiratory pressure; PPHN, persistent pulmonary hypertension of the newborn; SD, standard deviation; WGA, weeks of gestational age.

☆ With the approval of the French CDH Study Group.

☆☆ The authors have nothing to disclose.

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after thoracoscopic repair. Univariate and multivariate logistic regressions were used to compare these two groups.

Results: From 2006 to 2010, thoracoscopy was performed in 40 neonates: Group A consisting of 28 neonates, and Group B 9 patients. Three patients were excluded because of insufficient data or major associated malformations. Significant statistical differences were found in Group B for postnatal $PaCO_2$ >60 mmHg, need of iNO during postnatal stabilization, intrathoracic position of the stomach, pulmonary hypertension signs on the postnatal cardiac ultrasound, and preoperative OI >3.0. On multivariate analysis, only an OI >3.0 was significantly associated with conversion or major post-operative complication of thoracoscopic primary repair.

Conclusion: CDH can be safely repaired in the neonatal period by thoracoscopy. The limiting factor for thoracoscopic CDH repair is PPHN. The best preoperative indicator for PPHN is OI. Prospective studies are nonetheless necessary to prove the effectiveness of using these risk factors as selection criteria to help design surgical management protocols for neonates presenting CDH.

Minimal access surgery (MAS) is commonly accepted for the treatment of late presenting congenital diaphragmatic hernia (CDH) since 1995 [1–3]. The first attempts of MAS repairs in neonates were published in 2003 [4]. Since then, more than 250 newborns were treated with MAS [4–21]. Even though the first attempts of MAS closure of CDH were done through laparoscopy [4], thoracoscopy is currently commonly used in the neonatal period as this approach allows better exposure of the diaphragmatic rims after replacement of the viscera into the abdominal cavity with less necessity of continuous CO_2 insufflation [16].

A great number of recent publications suggest that thoracoscopic CDH repair is feasible and safe [1–23], reducing postoperative pain and the physiological disturbances of surgery [15,22,23]. Nonetheless, there are still pediatric medico-surgical teams reluctant to use this approach as it requires a capnothorax increasing the thoracic and abdominal pressures through the defect, and as the insufflated CO_2 has to be eliminated through hypoplastic lungs [17,23,24]. Therefore some investigators have sought to establish selection criteria and/or searched for risk factors for adverse outcomes after thoracoscopic repair [6,12,14,15,17,19,20,25], but none of them have reached consensus: Only a few papers evaluate selection criteria through prospective studies [6,12,20], but most describe potential risk factors for thoracoscopic failure [14,15,17,19,25].

The aim of this study is to retrospectively identify risk factors for failure or adverse outcomes after thoracoscopic primary closure of CDH in neonates.

1. Patients and methods

A retrospective multicenter study was undertaken with the approval of the French CDH Study Group (Centre de référence des hernies de la coupole diaphragmatique).

In the neonatal period, eight centers in France and Luxemburg perform thoracoscopic CDH repair. In all centers, thoracoscopic CDH repair is done by a senior surgeon, trained in pediatric MAS. From January 2006 to December 2010, all neonates who underwent thoracoscopy for CDH with the intention to treat were included. Patients were identified and collected through individual hospital health records. Chart reviews were conducted by one author, who traveled to each center where the chart review was conducted. The complete prenatal, postnatal, operative and postoperative data were evaluated. Patients with associated major malformations, incomplete charts or operated after the 7th day of life (as most of these patients presented a fortuitous diagnosis of CDH without cardiopulmonary implications) were excluded. The selection criteria and potential risk factors evaluated were based on previous studies [6,12,14,15,17,19,20,24] (see Table 1).

For each patient, we analyzed whether a prenatal diagnosis was done or not, the gestational age at diagnosis, as well as the prenatal predictors like the LHR, the $LHR^{obs}/_{exp}$ or the liver herniation [26–28]. As this last criterion is difficult to evaluate prenatally, only patients presenting a shift of the umbilical vein and/or of the hepatic vessels were considered to have an intra-thoracic liver [29].

In the immediate postnatal period, we analyzed for each newborn the place of birth (outborn/inborn), weight, gestational age, Apgar scores at 1 and 5 min and the need for ventilatory support immediately after delivery. From the admission-forms in the neonatal intensive care unit (NICU), we collected the $PaCO_2$ and post-ductal SpO_2 levels, the required FiO_2 to maintain a preductal SpO_2 >90%, the need and time of initiation of conventional mechanical ventilation, HFOV, iNO, vasoactive drugs as well as their durations, the need and time of instillation of exogenous surfactant. The first chest radiograph was analyzed to specify the side of the CDH and the stomach's position (intra-thoracic/intra-abdominal). The results from echocardiographic assessment performed within the first 24 h of life were analyzed to specify whether a PDA was present and the signs of PPHN: right-to-left PDA, left-to-right deformation of the interventricular septum, importance of the tricuspid valve insufficiency.

In the preoperative period, we analyzed the age at surgery, the ventilatory parameters (ventilation mode, PIP,