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Revisiting outcomes of right congenital diaphragmatic hernia

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ABSTRACT

Background: Studies comparing outcomes of right- and left-sided congenital diaphragmatic hernia (R-CDH and L-CDH) have yielded conflicting results. We hypothesized that R-CDH is associated with higher short-term pulmonary morbidity than L-CDH.

Methods: We reviewed all CDH patients at a tertiary children's hospital over 10 y. In prenatally diagnosed CDH, the observed-to-expected total fetal lung volume and percentage liver herniation (%LH) were calculated using fetal magnetic resonance imaging-based measurements. Outcomes were compared in patients with isolated CDH. Patients were subsequently matched by %LH to compare outcomes.

Results: Of 189 CDH patients, 37 (20.1 %) were R-CDH and 147 (79.9%) were L-CDH. Those with R-CDH were prenatally diagnosed at a significantly lower rate (40.5% *versus* 73.5%; $P < 0.001$) and later gestational age (26.5 ± 7.7 *versus* 22.6 ± 5.65 wk; $P = 0.062$). There was no difference in observed-to-expected total fetal lung volume between those with R-CDH and L-CDH (30.2 ± 11.1% *versus* 33.1 ± 14.2%; $P = 0.471$). Fetuses with R-CDH had a higher %LH than those with L-CDH (37.5 ± 14.1% *versus* 18.6 ± 12.2%; $P < 0.001$). Patients with isolated R-CDH had a higher need for extracorporeal membrane oxygenation than L-CDH (48% *versus* 27%; $P = 0.055$). There was no difference in duration of tracheal intubation, hospital stay, need for supplemental oxygen at 30-d of life or 6-mo mortality between groups. There was no difference in mortality and pulmonary morbidity when patients were matched by %LH.

Conclusions: Compared to those with L-CDH, fetuses with R-CDH are less likely to be diagnosed prenatally and have a higher need for extracorporeal membrane oxygenation.

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The sidedness of the hernia defect was not associated with differences in short-term pulmonary morbidity in this large, contemporary single-institution experience of neonates with CDH.

1. Introduction

Congenital diaphragmatic hernia (CDH) affects approximately one in 2500–3000 live births and is associated with significant mortality and morbidity due to pulmonary hypoplasia and associated pulmonary hypertension [1]. CDH occurs most often on the left with right-sided lesions (R-CDH) occurring in 15%–20% of all CDH cases [2,3]. Improvements in the neonatal management of CDH patients including gentle ventilation and permissive hypercapnia have led to better outcomes with an improvement in survival to approximately 70%–80% [4,5]. Despite these advances, the effect of the sidedness on mortality and morbidity remains unclear.

Historically, R-CDH has been thought to be associated with worse outcomes related to delayed diagnosis, liver herniation, and worsened pulmonary hypoplasia [6]. Current studies on R-CDH have shown mixed results, with some studies suggesting increased mortality in R-CDH compared with left-sided CDH (L-CDH) [7–9], whereas others have shown no differences in mortality. As a result of the improvements in survival of CDH patients, more recent studies have examined the differences in pulmonary morbidity between R- and L-CDH. In some studies, R-CDH is associated with an increased use of extracorporeal membrane oxygenation (ECMO) in the neonatal period and risk of chronic lung disease [10,11]. On the other hand, a recent study examining CDH patients with equal prenatal lung volumes found that there was no difference in pulmonary morbidity between R- and L-CDH [12].

Given the variability in current data, we sought to examine the effect of right-sidedness on outcomes, particularly pulmonary morbidity, in neonates with CDH. Furthermore, we sought to evaluate the effect of the degree of liver herniation on pulmonary outcomes. We hypothesized that neonates with R-CDH have worse short-term pulmonary outcomes than those with L-CDH.

2. Patients and methods

This study was approved (H-26176) by the Institutional Review Board at the Baylor College of Medicine, Houston, TX.

2.1. Patient population

A retrospective review of all patients referred to our pediatric tertiary care center with a diagnosis of CDH between January 2004 and January 2014 was performed. Patients were identified via a database of all patients seen at the Fetal Center with a diagnosis of CDH and a database of neonates with CDH at our institution.

2.2. Magnetic resonance imaging-derived measurements

Fetal lung volumes were obtained by the standard volumetric technique using freehand region of interest measurements as previously described [13]. The observed-to-expected total fetal lung volume (O/E-TFLV) was calculated by dividing the total measured fetal lung volume by the expected fetal lung volume for gestational age as described by Rypens *et al.* [14]. Measurement of liver herniation was obtained as previously described by Lazar *et al.* [15]. The percentage liver herniation (%LH) was calculated as the ratio of herniated liver volume to total liver volume.

2.3. Data collection

Prenatal data including gestational age at diagnosis and initial fetal magnetic resonance imaging and O/E-TFLV were collected from maternal medical records. Infant records were reviewed for clinical data including gestational age at birth and birth weight. Gestational age at diagnosis, initial magnetic resonance imaging, and birth were determined by last menstrual period if known or the first semester ultrasound. Outcomes that were reviewed included the presence of pulmonary hypertension based on the presence of suprasystemic pulmonary pressures, tricuspid regurgitation or right-to-left shunting on postnatal echocardiogram, need for ECMO, length of ECMO run, duration of mechanical ventilation, hospital length of stay, need for supplemental oxygen at 30 d of life, and mortality and need for supplemental oxygen at 6 mo. We compared outcomes between patients with isolated R- and L-CDH. Isolated CDH was defined as CDH without associated major cardiac or structural anomalies requiring surgical or medial management in the immediate perinatal period or associated chromosomal anomalies. A subanalysis of outcomes in patients with equal degrees of liver herniation was performed.

2.4. Statistical analysis

Results are presented as median with interquartile range for continuous variables unless otherwise noted and as percentages for categorical variables. Mann–Whitney *U* tests were performed for nonparametric continuous variables. Chi-square analysis was used to analyze categorical variables. Statistical analysis was performed using IBM SPSS statistical software version 22 (IBM Corporation, Armonk, NY). A *P* value of <0.05 was considered to be statistically significant.

3. Results

3.1. Patients

Of the 189 CDH patients, five had bilateral CDH and were excluded from further analysis. Of the remaining 184 patients, 37 (20.1%) had R-CDH. There was a lower rate of prenatal diagnosis in R-CDH compared with that in L-CDH (40.5% *versus* 73.5%; $P < 0.001$). In addition, those that had a prenatal