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ORIGINAL ARTICLE

Role of Ultrasound-Based Prenatal Prediction of Pulmonary Function in Congenital Diaphragmatic Hernia: Does It Have Prognostic Significance Postnatally?

Nupur Shah[1] · Sujit Chowdhary[1] · Anita Kaul[1]

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About the Author

Dr. Nupur Shah After pursuing postgraduation in OBGY, she completed her fellowship in Fetal Medicine at Apollo Centre of Fetal Medicine, New Delhi, followed by her training under Prof. Kypros Nicolaides at King's College Hospital, UK. She worked as a Senior fellow in Apollo Hospital, New Delhi, and is now a practising Consultant in Fetal Medicine. She has authored an exemplary research on Cervical Elastography presented in Fetal Medicine Foundation World Congress 2015.

Dr. Nupur Shah, MS OBGY, is a Fellow Fetal Medicine, Department of Fetal Medicine, Apollo Centre of Fetal Medicine, Indraprastha Apollo Hospital; Dr. Sujit Chowdhary is a Consultant Paediatric Surgeon, Indraprastha Apollo Hospital; Dr. Anita Kaul is a Senior Consultant, Department of Fetal Medicine, Apollo Centre of Fetal Medicine, Indraprastha Apollo Hospital.

✉ Nupur Shah
nupurmshah@gmail.com

Sujit Chowdhary
sujitchowdhary@hotmail.com

Anita Kaul
anitagkaul@gmail.com

[1] Department of Fetal Medicine, Apollo Centre of Fetal Medicine, Indraprastha Apollo Hospital, Jasola, New Delhi 110076, India

Abstract

Background and Objectives The incidence of congenital diaphragmatic hernia (CDH) in India is 1 in 1000. About 60 % of these are isolated, and the survival prognosis in them depends upon the quantum of contralateral functional lung. Out of the various pulmonary and extrapulmonary sonological predictors, observed to expected lung–head ratio (O/E LHR) is an efficient gestation-independent predictor of pulmonary function. This study was carried out to see the correlation of this prenatal predictor with the postnatal outcome depending on the pulmonary function.

Methodology This study was carried out at Apollo Center of Fetal Medicine, New Delhi, from January 2009 to December 2015. A total of 14 fetuses with isolated left-sided CDH were included. The contralateral lung area was measured in 2D

transverse view of the thorax at the level of four-chamber view of the heart by tracing method. The obtained value (square mm) was then divided by the expected mean lung area at that gestation and multiplied with 100 to express O/E LHR as percentage. These were then classified as severe (O/E LHR <25 %), moderate (25–45 %) or mild (>45 %) varieties of CDH. The parents to be were counselled for termination or continuation of pregnancy based on severity of CDH and total lung area. The patients were followed up for obstetrical and neonatal outcome till the time of first postoperative visit (diaphragmatic repair).

Results The survival correlation in mild cases was 100 % ($n = 5$ out of 5) and 50 % in moderate cases ($n = 2$ out of 4), and both severe cases were terminated. There was a significant difference ($p < 0.01$) in the survival rate in the mild versus severe cases.

Conclusions The prenatal predictor for postnatal pulmonary function correlates well with the neonatal outcome and hence is an important tool in prenatal counseling and triaging those who require termination of pregnancy versus expectant management. An obstetrician who is a first point of contact to the pregnant women can understand this and use it for counseling and differentiating the patients who need termination with regard to CDH.

Keywords Congenital diaphragmatic hernia · O/E LHR · Tracing method

Introduction

The incidence of Congenital diaphragmatic hernia (CDH) is 1 in 2200 [1, 2]. Left sided is commoner (85 %) than right sided (10–15 %) [3]. The main problem with the congenital diaphragmatic hernia (CDH) is that the herniating viscera lead to pulmonary hypoplasia causing respiratory insufficiency and pulmonary hypertension. Postnatal survival in the western world is reported to be in the range of 60–80 % [4]. In India with the availability of the modern equipments and expertise and with the implementation of universal ultrasound screening, CDH should be picked up in utero. In addition to the diagnosis of CDH, prediction of the pulmonary function postnatally and therefore counseling should be possible. Several pulmonary and extra pulmonary predictors of survival prognosis on ultrasound and MRI have been proposed till date. These include anteroposterior lung diameters, longest perpendicular lung diameters, lung area by tracing method, lung–head ratio, observed to expected lung–head ratio, 3D lung volumes, liver herniation and cardiac function [3]. This study was carried out to correlate the ultrasound-based prenatal prediction of the pulmonary function with the obstetrical and neonatal outcome in the North Indian population. The ultrasound technique used in the study for the prediction of the postnatal pulmonary function was calculation of observed to expected lung–head ratio (O/E LHR) using the contralateral lung tracing [5–7]. Tracing method was used in the study as it has been reported to be better than others in terms of intra-/interobserver agreement and actual area prediction of the lung [5, 6].

Methodology

This study was carried out at Apollo Center of Fetal medicine, New Delhi, from January 2009 to December 2015. Seventeen consecutive fetuses were diagnosed prenatally to be having CDH. Out of which, two fetuses with associated structural anomalies were excluded. There was one with right-sided CDH at 19-weeks gestation which was terminated and fetal autopsy and karyotype carried out (Fig. 1). Fetal autopsy revealed severe pulmonary hypoplasia and liver and bowel herniating in right thorax. The remaining 14 fetuses with isolated left-sided CDH diagnosed in the above time period were included in the study. An amniocentesis was performed for fetal karyotype in all the fetuses to exclude chromosomal abnormalities. The gestational age at presentation was 18–26 weeks. At the time of the first scan at presentation to our center, contralateral lung area was measured in 2D transverse view of the thorax at the level of four-chamber view of the heart. The tracing method was

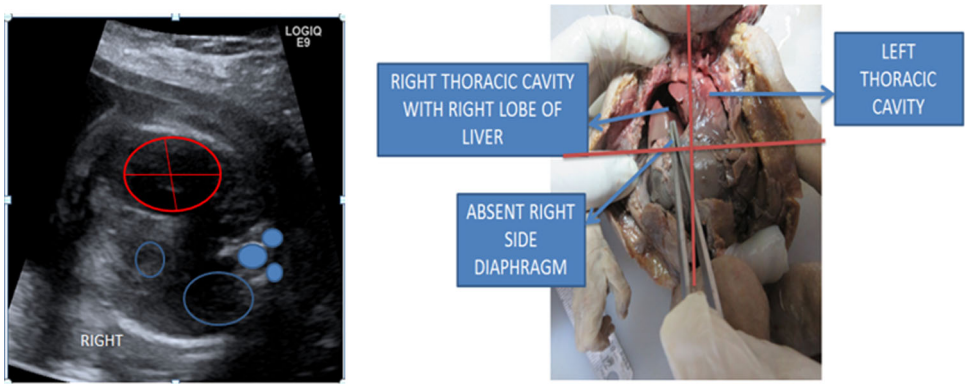

Fig. 1 Prenatal ultrasound image (*left*) and the posttermination fetal autopsy (*right*) in case of right-sided congenital diaphragmatic hernia *The images are taken at our center, Apollo Hospital, Delhi*

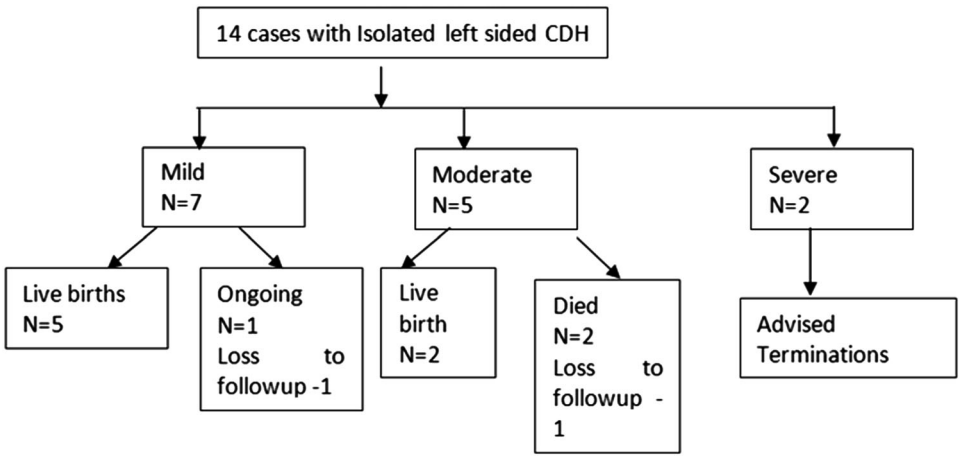

Fig. 2 Flowchart showing distribution and outcome of the fetuses in the current study

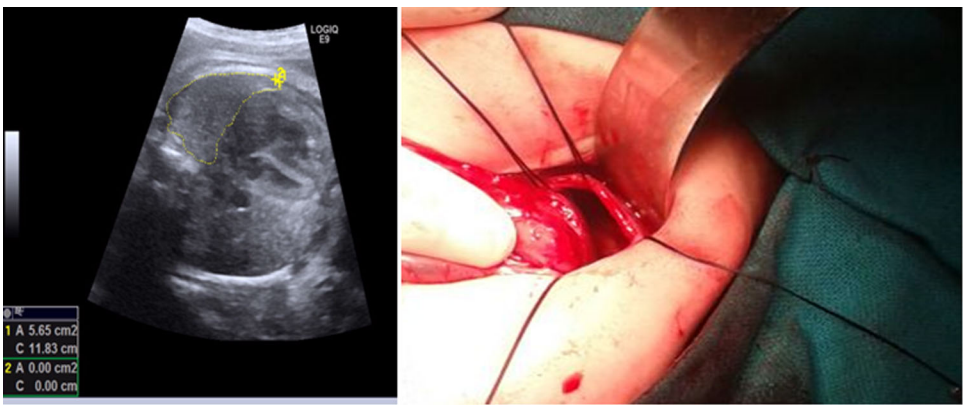

Fig. 3 Contralateral lung tracing in case of 28-week fetus for pulmonary function prediction (*left*) and the postnatal primary diaphragmatic repair (*right*) *The photograph is taken at our center, Apollo Hospital, Delhi*

used for area calculation in square millimeters on Voluson E8 (GE Medical Systems, Milwaukee, WI, USA) ultrasound machine using a convex probe (2–5 MHz). The obtained value was then divided by the expected mean lung area at that gestation and multiplied with 100 to express O/E LHR as percentage. These were then classified as severe (O/E LHR <25 %), moderate (25–45 %) or mild (>45 %) varieties of CDH, and the parents were counseled accordingly. The patients were followed up for obstetrical and neonatal outcome till the time of first postoperative visit (diaphragmatic repair) (Figs. 2, 3).

Results

The mothers included in the study were of the median age 28.4 years. Gestational age at the presentation was between 18 and 28 weeks. Of the 14 having left-sided CDH, two were advised termination of pregnancy based on O/E LHR <25 %. In both these cases, the poor prognosis and severe pulmonary hypoplasia were also supported by the assessment of the lung area [5]. Out of the seven mild cases, five delivered in our hospital. The median gestational age at delivery for live births was 37.3 weeks. They were immediately intubated with artificial ventilation. They were operated by pediatric surgeon for diaphragmatic repair, and the postoperative stay was uneventful. They were well at the first postoperative follow-up visit. One of the seven is ongoing pregnancy, and one is lost to follow-up. Out of the five moderate cases, two had live births and doing well postoperatively, whereas two died postnatally within 48 h because of the lack of ventilator support (delivered elsewhere). One of the moderate cases is lost to follow-up (Table 1).

Table 1 Neonatal and obstetrical outcome in mild, moderate and severe cases of CDH

	Mild (>45 %)	Moderate (25–45 %)	Severe (<25 %)
Live births	5	2	0
Died postnatally	0	2	0
Terminations	0	0	2
Ongoing pregnancy	1	0	0
Loss to follow-up	1	1	0

The survival correlation in mild cases was 100 % ($n = 5$ out of 5) and 50 % in moderate cases ($n = 2$ out of 4), and both severe cases were terminated. There was a significant difference ($p < 0.01$) in the survival rate in the mild versus severe cases.

Discussion

The strategy of the universal screening of the anomalies has led to the early detection of the anomalies like CDH and prompt referral to the Fetal Medicine specialists. There they exclude the abnormal karyotype through amniocentesis and associated structural abnormalities. This is then followed up by prediction of the pulmonary function and counseling of the parents to be, accordingly. The pediatric surgeon consultation is also included in the multidisciplinary counseling which helps parents to understand the postoperative surgery, the related morbidity and the post-op follow-up required. The prenatal prediction of the pulmonary function will help in triaging those who can be allowed to continue the pregnancy (mild and moderate isolated left CDH) vis-à-vis those who require termination of pregnancy (severe left CDH, right-sided CDH, associated structural anomalies, abnormal karyotype). This is especially of great importance in Indian legal setting of terminations before 20 weeks of gestation [8]. With the availability of FETO (fetoscopic tracheal occlusion) [9], there is hope to further improvement in the outcome of the severe left-sided cases and right-sided CDH.

Conclusion

The prenatal sonological prediction of the fetal pulmonary function by tracing method and classifying on basis of O/E LHR significantly helps in counseling and triaging the patients for further obstetrical or neonatal management. This is of great importance for an obstetrician who is the prime contact of the pregnant patient, who can counsel about the prognosis of CDH based on an objective method rather than blanket decision of termination of pregnancy.

Compliance with Ethical Standards

Conflict of interest There are no conflicts of interests to be disclosed.

Ethical Standard The study was approved by the Ethics Committee, Apollo Hospital, New Delhi, and written informed consents were obtained from the patients included.

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