Professional paper
Stručni članak

ISSN 1848-817X
Coden: MEJAD6 52 (2022) 4

Congenital Diaphragmatic (Bochdalek) Hernia of the Fetus: A Report of Two Autopsy Cases

Kongenitalna dijafragmalna (Bochdalekova) hernija fetusa: Izvješće o dva slučaja obdukcije

Vladimir Bartoš, Olga Kačerikova*

Summary

Congenital diaphragmatic hernia (CDH) is a developmental malformation characterized by a defect in the diaphragm that allows abdominal viscera to move into the chest cavity. A routine ultrasound screening performed during pregnancy detects over half of all cases. This paper describes two women who were prenatally diagnosed to have a fetus with isolated posterolateral CDH. Both mothers underwent medical abortion. In the first case, a postmortem examination of the fetus revealed a large right-sided CDH, in which a part of the liver and small intestine were propagated into the chest. In the second one, a huge left-sided CDH was identified, in which the entire stomach, a large proportion of the small intestine and part of the left lobe of the liver were pushed up into the thoracic cavity. CDH is a diagnostically challenging birth defect with a marked variation in severity and corresponding survival. In utero-diagnosed cases usually represent more severe and prognostically unfavorable conditions than those that were postnatally diagnosed. Early prenatal detection of CDH may help improve the clinical outcome as the mother can be referred to a specialist center before the onset of labor for optimal perinatal management. A legal medical abortion should be the last option after all the others have been exhausted.

Key words: congenital diaphragmatic hernia, prenatal ultrasonography, malformation, abortion

Sažetak

Kongenitalna dijafragmalna hernija (CDH) je razvojna malformacija koju karakterizira defekt dijafragme koji omogućuje pomicanje trbušnih organa u prsnu šupljinu. Rutinski ultrazvučni pregled tijekom trudnoće otkriva više od polovine svih slučajeva. Ovaj rad opisuje dvije žene kojima je prenatalno dijagnosticiran fetus s izoliranom posterolateralnom CDH. Obje su majke podvrgnute medicinskom pobačaju. U prvom slučaju, obdukcija fetusa otkrila je veliki desni CDH, u kojem je dio jetre i tankoga crijeva propagiran u prsni koš. U drugom je identificiran golemi lijevostrani CDH, u kojem su cijeli želudac, veliki dio tankog crijeva i dio lijevog režnja jetre gurnuti u prsnu šupljinu. CDH je dijagnostički izazovna urođena mana s izrazitom varijacijom u težini i odgovarajućem preživljenju. Utero dijagnosticirani slučajevi obično predstavljaju teža i prognostički nepovoljnija stanja od onih koji su dijagnosticirani postnatalno. Rano prenatalno otkrivanje CDH-a može pomoći u poboljšanju kliničkog ishoda budući da se majka može uputiti u specijalistički centar prije početka poroda radi optimalnog perinatalnog zbrinjavanja. Legalni medicinski pobačaj trebao bi biti posljednja opcija nakon što su sve ostale iscrpljene.

Ključne riječi: kongenitalna dijafragmalna hernija, prenatalni ultrazvuk, malformacije, pobačaj

Med Jad 2022;52(4): 285-290

*__Martin Biopsy Center, Ltd., Martin, Slovakia__ (Vladimir Bartoš, MD, PhD, MPH); __Faculty Hospital Žilina,__ Department of gynecology and obstetrics (Olga Kačerikova, MD)

Corresponding address/*Adresa za dopisivanje:* Dr. Vladimir Bartoš, PhD., Martin Biopsy Center, Ltd, Prieložtek 1, Martin, 036 01, Slovakia E-mail: vladim.bartos@gmail.com

Received */Primljeno* 2022-09-28; Revised */Ispravljeno/* 2022-11-25; Accepted/*Prihvaćeno* 2022-12-07

Introduction

Congenital diaphragmatic hernia (CDH) is a developmental malformation characterized by a defect in the diaphragm that allows abdominal viscera to move into the chest cavity.[1-3] Depending on the amount of abdominal contents included, this structural defect may significantly affect the normal embryonic and fetal development of the lungs. The prolonged mechanical compression may result in severe pulmonary hypoplasia and persistent pulmonary hypertension which are the leading cause of neonatal death. CDHs are classified according to the location of the defect in the diaphragm. [1-3] Posterolateral (Bochdalek) hernias are the most common form (70–75%) with the majority occurring on the left side (85%) and less frequently on the right side (13%) or even bilaterally (2%).[1] Non-posterolateral hernias, i.e. anterior (Morgagni) hernia (23–28%) and central hernia (2–7%) are the other rare types.[1] A diagnosis of CDH can be made in utero or after birth. In European regions, CDHs are increasingly diagnosed prenatally, but a routine ultrasound screening performed during pregnancy detects only 59% of all cases. [4] This mostly depends on the severity and the timing of the herniation. A certain proportion of utero-diagnosed CDH cases result in a legal termination of pregnancy. Herein, we report on two cases with an emphasis on prenatal imaging and autopsy findings of aborted fetuses.

Case reports

The first patient was a 37-year-old woman (gravida 6, para 4, spontaneous abortion 1) who was referred to an outpatient obstetric imaging center for a routine second trimester screening (at 21+1 weeks) of her sixth pregnancy. The ultrasound showed a living fetus with an irregular echogenic mass in the right thoracic cavity at the same plane as the heart. It seemed to be the bowel loops that had herniated into the chest. The heart was strongly displaced to the left (Figure 1). Amniotic fluid volume was adequate. A right-sided CDH was suspected and the patient was scheduled for a targeted imaging investigation at a specialized obstetric institution.

The 3D ultrasound scan confirmed an incomplete defect of the diaphragm with intestines protruding into the chest and compressing the right lung. The shift of the heart and mediastinum to the left was once again documented. The extent of the anomaly constituted a legal indication for medical termination of pregnancy and the mother decided on it. The medical abortion (at the 23rd weeks' gestation) resulted in a dead male fetus, crown-rump length of 18 cm, weight 470 grams. The autopsy of the formalin-fixed fetus revealed a huge defect in the right posterolateral portion of the diaphragm. Approximately one-third of the liver and a large portion of the small intestine were propagated into the chest cavity (Figure 2). The right lung was smaller in size (with a sagittal diameter of 24 mm, compared to 38 mm found in the left lung) and the heart was severely deviated to the left. The stomach was situated in the abdomen at its normal position. Other morphological anomalies were not detected. The gross findings corresponded with the prenatally diagnosed isolated right-sided CDH of Bochdalek.

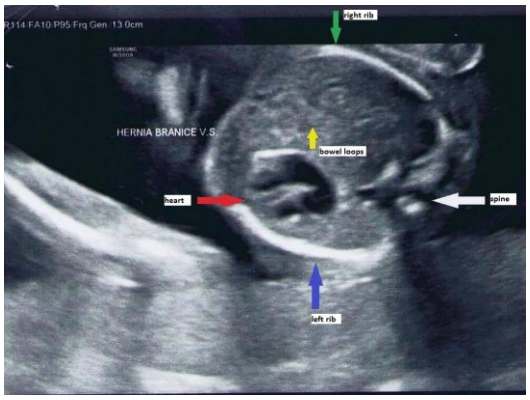

Figure 1 Right-sided CDH. Transverse US scan of the fetal chest shows herniated bowel loops.
Slika 1. Desnostrani CDH. Transverzalni ultrazvuk prsnog koša fetusa pokazuje hernirane petlje crijeva.

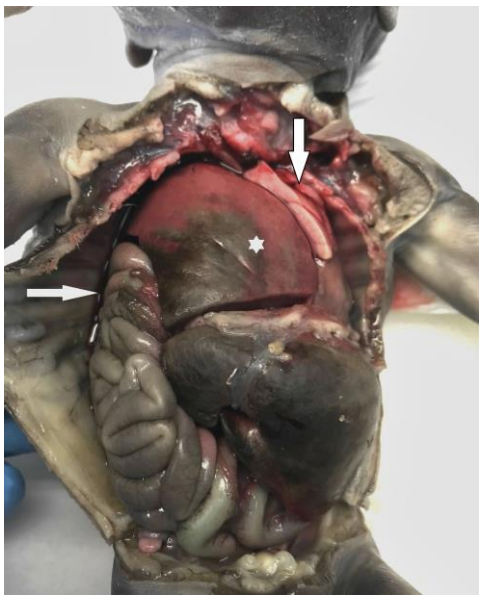

Figure 2 Right-sided CDH. Detail on partial agenesis of the diaphragm allowing the intestine (left horizontal white arrow) and liver (white asterisk) to

move up into the chest. Compressed right lung (right vertical white arrow) is shifted to the left.
Slika 2. Desnostrani CDH. Detalj o djelomičnoj agenezi dijafragme koja omogućuje crijevu (lijeva vodoravna bijela strelica) i jetri (bijela zvjezdica) da se pomaknu prema gore u prsa. Komprimirano desno plućno krilo (desna okomita bijela strelica) pomaknuto je ulijevo.

The second patient was a 29-year-old woman (gravida 3, para 1, spontaneous abortion 1) who underwent a routine antenatal ultrasound examination at 21+3 weeks of her third pregnancy. On ultrasonography, a single vital fetus was seen showing a large anechoic fluid-filled bubble structure in the left thorax with the heart displaced to the right (Figure 3). Primarily, a left-sided CDH was considered. The amount of amniotic fluid was normal. The patient was referred to a specialist obstetric centre where a partial absence of the diaphragm with a herniation of the stomach into the thoracic cavity were proven. Fetal cardiac dextroposition was also visible.

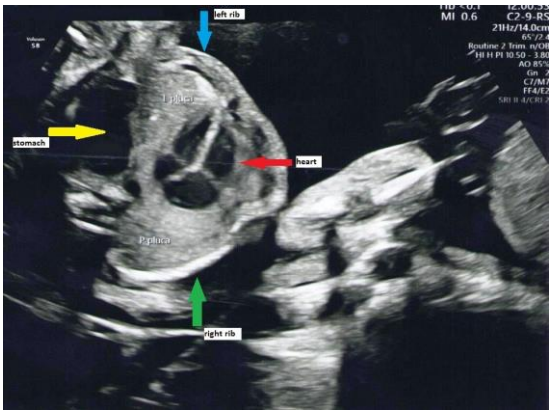

Figure 3 Left-sided CDH. Transverse US image of the fetal thorax displays the herniated stomach at the level of the four-chamber heart view.
Slika 3. Lijevi CDH. Transverzalna UZ snimka prsnog koša fetusa prikazuje hernirani želudac u razini prikaza srca s četiri komore.

Information about the diagnosis and prognosis was given to the family. The defect met the criteria for medical termination of pregnancy, but the mother was first offered an option of undergoing a FETO (in utero fetal endoscopic tracheal occlusion) abroad. After repeated clinical counseling and considering the overall benefits, she finally gave her consent to terminate the pregnancy. The medical abortion was induced at the 23th week of gestation and resulted in a dead female fetus (crown-rump length 20 cm, weight 530 g.). In accordance with previous prenatal imaging, the postmortem examination demonstrated an isolated left-sided Bochdalek's CDH. A huge defect in the left posterolateral part of the diaphragm was found through which the entire stomach, a large proportion of small intestine and a part of the left lobe of the liver were pushed up into the thoracic cavity (Figure 4). A sagittal diameter of the left lung and right lung was 34 mm and 39 mm, respectively. No other somatic malformations were present.

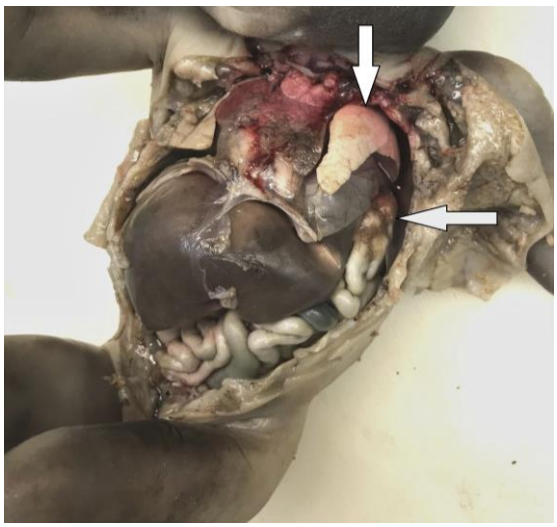

Figure 4 Left-sided CDH. The left part of the thoracic cavity contains the stomach, bowel loops (horizontal white arrow) and a part of the liver lobe. Left lung (vertical white arrow) is pushed up by the stomach.
Slika 4. Lijevi CDH. Lijevi dio prsne šupljine sadrži želudac, crijevne petlje (vodoravna bijela strelica) i dio jetrenog režnja. Lijevo plućno krilo (okomita bijela strelica) gurnulo je želudac prema gore.

Discussion

The incidence of CDH has been estimated at 1/3,000–5,000 live births, however, if the stillbirths and medical terminations of pregnancy (hidden mortality) are included, it reaches 1 in 2,000 cases.[5,6] In developed countries, approximately one third of all proven cases constitute aborted fetuses and intrauterine deaths, which obscure the true incidence and mortality rate (Table 1).[4,6-11]

Table 1 Proportions of diagnosed CDH cases in given studies.[4,6-11]
Tablica 1. Udjeli dijagnosticiranih slučajeva CDH u danim studijama.

Region *Regija*	Total number *Sveukupno*	Medical termination *Medicinski prekid*	Abortion / Stillbirths *Pobačaj Mrtvorođenče*	Born alive *Živorođeno*	Mortality rate in born alive *Stopa smrtnosti živorođenih*	Reference *Referenca*
Europe*	187	39 (20.9%)	15 (8%)	133 (71.1%)	N	4
Scotland	130	46 (35%)	15 (12%)	69 (53%)	N	6
UK	185	44 (24%)	12 (6%)	129 (70%)	58 (45%)	7
Australia	116	38 (33%)	8 (6%)	71 (61%)	34 (47.9%)	8
UK	201	14 (7%)	38 (18.9%)	149 (74.1%)	75 (50.3%)	9
France	501	96 (19%)	18 (4%)	387 (77%)	152 (39.3%)	10
Australia	242	23 (10%)	19 (8%)	200 (82%)	111 (55.5%)	11

*Twenty European regions from 12 European countries were included (N – not reported/not possible to evaluate)
**Uključeno je dvadeset europskih regija iz 12 europskih zemalja (N – nije prijavljeno/nije moguće ocijeniti)*

The vast majority of CDHs occur sporadically, without any identifiable familial link.[2,3] They are usually presented as an isolated finding (isolated CDH) but may be associated with other somatic or chromosomal anomalies (non-isolated CDH).[1-3] Additional morphologic malformations are detected in 25 - 57% and chromosomal defects are found in 10 - 30% of the cases.[2] Both CDHs in the analysed fetuses were sporadic and probably an isolated form of disease, because no related disorder has been recorded in the family, and no associated fetal structural malformations have been detected at autopsy. The benefit of our work is that we had the opportunity to compare the sonographic and necroptic findings. In our country, it is not customary to send aborted fetuses with confirmed congenital anomalies for postmortem investigation. In both our cases the autopsy confirmed a liver herniation, which was not previously reported sonographically. This points out that the postmortem examination has an important role for exact clinicopathological correlations. Since amniocentesis was not carried out, it is not possible to comment on a potential chromosomal pathology. Nevertheless, global literature data rather suggest that such a finding is less likely. In a Belgian study,[12] all isolated CDHs (n=27) showed no chromosomal abnormality. In contrast, of the 15 patients with non-isolated CDH, four (26.7%) presented with chromosomal anomaly. This indicates that in CDH with additional somatic malformations, fetal karyotyping should strongly be considered, while in isolated CDH, the risk for a chromosomal pathology is low and fetal karyotyping is not always necessary.[13] Anyway, the exclusion of a genetic cause by amniocentesis or chorionic villus sampling may be important for prediction of the recurrence risk. In isolated non-familial cases, the recurrence risk is low (< 2%), while in syndromic CDH patients, the recurrence risk may range from 1% to 50%, depending on specific etiology.[14]

In Europe, the overall prenatal detection rate of CDH is 59% with significant differences between isolated and non-isolated CDH (51% vs. 72%).[4] In developing countries, such as India or Singapoure,[15,16] it is only 25%, probably due to inadequate facilities and poorer clinicians' experiences. The prenatal ultrasound diagnosis is made by identifying either direct signs, such as the presence of abdominal organs within the thoracic cavity, or indirect signs, such as abnormal cardiac axis, mediastinal shift, or polyhydramnions.[1-3] Left-sided CDH is usually characterized by the presence of a heterogeneous mass adjacent to the heart which may be the stomach filled with fluid or intestines. In this location, the fluid-filled viscera may show peristalsis and are quite easily distinguished from the more echogenic fetal lung.[1,2,5] In contrast, isolated right-sided CDH is much more difficult to diagnose by ultrasound when the liver is the only organ that has shifted into the chest. That is because the hepatic parenchyma and the fetal lung have very similar echogenicity.[1,2,5] Indirect signs such as a deviation of the cardiac axis or mediastinum become very important in such cases.[2] Large CDHs may cause polyhydramnios due to compression of the esophagus with a subsequent increase in amniotic fluid levels.[2] We did not confirm it, but polyhydramnios usually starts to develop from the beginning of the third semester of pregnancy.[13] Given the wide spectrum of severity in CDH, predicting prognosis from prenatal findings is

crucial for appropriate antenatal workup and management. Major fetal predictors of the outcomes in CDH include the presence of associated morphologic anomalies, the extent of lung hypoplasia, and the position of the liver.[1-3,13] However, no single prenatal ultrasound marker has been shown to be absolutely predictive of the postnatal outcome. As expected, prognosis of isolated CDH is generally better than CDH complicated by multiple anomalies.[1] If CDH is associated with a chromosomal defect, the long-term prognosis depends on the type of genetic abnormality and coexisting abnormalities (in particular heart and CNS defects).[3] For isolated cases of CDH, the most commonly accepted prognostic parameter is the assessment of the amount of the lung tissue in the fetal chest.[3,13] Prenatal evaluation of lung size using ultrasound is considered a surrogate marker of pulmonary hypoplasia. The two most accepted and validated predictors are the lung-to-head ratio (LHR) and the observed/expected LHR (o/e LHR).[3,13] In extreme/severe lung hypoplasia (LHR < 1; o/e LHR < 25 %), moderate lung hypoplasia (LHR 1-1.5; o/e LHR 26 - 45 %), and mild lung hypoplasia (LHR > 1.5; o/e LHR > 45%), the neonatal mortality is reported to be 85 - 100%, 40 - 70%, and 0%, respectively.[13] Another important predictive marker of postnatal survival is the presence of liver herniation (liver-up), being associated with worse prognosis.[1,3,17,18] In one study,[17] liver herniation was highly predictive of survival (45% in liver-up vs. 93% in liver-down cases) and the need for extracorporeal membrane oxygenation after birth (80% in liver-up vs. 25% in liver-down cases). A systemic literature review[18] revealed that the survival decreased from 74% to 45% with liver herniation. The presence of herniated stomach within the thorax also contributes to a worse prognosis.[2,3]

Once a mother had been diagnosed with a fetus with CDH, she should be referred to a tertiary center with experience in prenatal and postnatal management of this condition.[14] A multidisciplinary team will discuss with her on the predicted prognosis, antenatal options available, and any postnatal therapeutic interventions that may be required.[14] Based on the given situation, the mother can choose between: expectant management with prenatal referral for elective delivery, termination of pregnancy, or, in selected patients, fetal intervention.[14] A fetoscopic endotracheal occlusion is currently a therapeutic option that increases the survival of the child after birth. Although the perinatal mortality of babies with CDH generally remains high,[1-3] some authors[19] stress that the improved survival rate after corrective surgery must be emphasized when giving information to mothers regarding abortion of fetuses with a prenatally diagnosed CDH. A legal medical abortion should be the last option after all the others have been exhausted.

CDH is a diagnostically challenging congenital abnormality with a large variation in severity and corresponding survival. More than half of the cases are revealed in utero. They usually represent more severe and prognostically unfavorable conditions than in cases of postnatal diagnosis. Early prenatal detection of CDH may help improve the clinical outcome as the mother can be referred to a specialist center before the onset of labor for optimal perinatal management.

References

1. Chandrasekharan PK, Rawat M, Madappa R, Rothstein DH, Lakshminrusimha S. Congenital diaphragmatic hernia – a review. Matern Health Neonatol Perinatol. 2017;3:6.
2. Graham G, Devine PC. Antenatal diagnosis of congenital diaphragmatic hernia. Semin Perinatol 2005;29:69-76.
3. Kosiński P, Wielgoś M. Congenital diaphragmatic hernia: pathogenesis, prenatal diagnosis and management - literature review. Ginekol Pol. 2017;88:24-30.
4. Garne E, Haeusler M, Barisic I, Gjergja R, Stoll C, Clement M. Congenital diaphragmatic hernia: evaluation of prenatal diagnosis in 20 European regions. Ultrasound Obstet Gynecol 2002;19:329-33.
5. Doné E, Gucciardo L, Van Mieghem T, et al. Prenatal diagnosis, prediction of outcome and in utero therapy of isolated congenital diaphragmatic hernia. Prenat Diagn. 2008;28:581-91.
6. Brownlee EM, Howatson AG, Davis CF, Sabharwal AJ. The hidden mortality of congenital diaphragmatic hernia: a 20-year review. J Pediatr Surg. 2009;44:317-20.
7. Stege G, Fenton A, Jaffray B. Nihilism in the 1990s: the true mortality of congenital diaphragmatic hernia. Pediatrics 2003;112:532-5.
8. Colvin J, Bower C, Dickinson JE, Sokol J. Outcomes of congenital diaphragmatic hernia: a population-based study in Western Australia. Pediatrics 2005;116:e356-63.
9. Dillon E, Renwick M, Wright C. Congenital diaphragmatic herniation: antenatal detection and outcome. Br J Radiol 2000;73:360-5.
10. Gallot D, Boda C, Ughetto S, et al. Prenatal detection and outcome of congenital diaphragmatic hernia: a French registry-based study. Ultrasound Obstet Gynecol 2007; 29:276-83.
11. Levison J, Halliday R, Holland AJ, et al. A population-based study of congenital diaphragmatic

hernia outcome in New South Wales and the Australian Capital Territory, Australia, 1992-2001. J Pediatr Surg 2006;41:1049-53.
12. Witters I, Legius E, Moerman P, et al. Associated malformations and chromosomal anomalies in 42 cases of prenatally diagnosed diaphragmatic hernia. Am J Med Genet 2001**;**103:278-82.
13. Straňák Z, Kučerová I, Urbánková I, et al. Současné možnosti prenatální diagnostiky kongenitální diafragmatické hernie. Ceska Gynekol 2009;74:183-7.
14. Russo FM, Debeer A, De Coppi P, et al. What should we tell parents ? Congenital diaphragmatic hernia. Prenat Diagn 2022;42:398-407.
15. Rattan KN, Dalal P, Singh J. Clinical profile and outcome of neonates with congenital diaphragmatic hernia: A 16-year experience from a developing country. Proc Singapore Healthc 2019;28:74-8.
16. Bhat YR, Kumar V, Rao A. Congenital diaphragmatic hernia in a developing country. Singapore Med J 2008**;**49:715-8.
17. Hedrick HL, Danzer E, Merchant AM, et al. Liver position and lung-to-head ratio for prediction of extracorporeal membrane oxygenation and survival in isolated left congenital diaphragmatic hernia. Am J Obstet Gynecol. 2007;197:422.e1-4.
18. Mullassery D, Ba'ath ME, Jesudason EC, Losty PD. Value of liver herniation in prediction of outcome in fetal congenital diaphragmatic hernia: a systematic review and meta-analysis. Ultrasound Obstet Gynecol 2010;35:609–14.
19. Gudbjartsson T, Gunnarsdottir A, Topan CZ, Larssons LT, Rosmundsson Th, Dagbjartsson A. Congenital diaphragmatic hernia: improved surgical results should influence abortion decision making. Scand J Surg 2008;97:71-6.