Archives of Disease in Childhood 1993; **69:** 68–70

Congenital diaphragmatic hernia: influence of associated malformations on survival

Yechiel Sweed, Prem Puri

Abstract

The medical records of 116 consecutive cases of congenital diaphragmatic hernia (CHD) among 368 772 live births at the three maternity hospitals in Dublin were examined and the incidence of associated malformations and their impact on survival analysed. The patients were divided into two groups: group I included 64 (55%) patients who died during resuscitation and stabilisation before surgery at a mean age of 11·2 hours and group II included 52 (45%) patients who were operated upon. All patients in group I underwent detailed postmortem examination as did the 45% patients who died in group II. The mean (SD) gestational age for group I patients (36·1 (4·5) weeks) was significantly lower than the mean gestational age of group II patients (39·0 (2·4) weeks). Similarly, the mean birth weight of group I patients (2415 (906) g) was significantly lower than that of group II patients (3140 (563) g). Of the newborns who died before surgery, 40 (62·5%) patients had 79 associated malformations. The major associated anomalies were: cardiac (n=16), neural tube defects (n=15), skeletal (n=8), chromosomal (n=5), urinary tract (n=6), gastrointestinal (n=3), omphalocele (n=4), craniofacial (n=5), pulmonary (n=2), and syndromes (n=2). Sixteen (40%) of these patients were found to have multiple anomalies. Of the 52 patients who were operated upon, only four (7·7%) had associated malformations. Our data shows that associated malformations in neonates with CDH is a major factor influencing outcome in this congenital malformation.

(*Arch Dis Child* 1993; **69:** 68–70)

Neonates with congenital diaphragmatic hernia (CDH) continue to have a high mortality despite recent advances in prenatal diagnosis, maternal transport, neonatal resuscitation, and intensive care.[1–4] The high mortality in these infants has been attributed to respiratory insufficiency secondary to pulmonary hypoplasia and pulmonary hypertension caused by herniation of viscera into the chest during critical stages of pulmonary development.[5–7]

The prenatal diagnosis of CDH is now well established and the widespread use of maternal ultrasonography has resulted in the identification of a large group of fetuses with CDH who die in utero, or soon after birth, and never present to the paediatric surgeon.[1] Several studies have shown that prenatally diagnosed CDH is associated with a mortality of over 80% despite maximum conventional treatment.[1 8 9] Recently, attempts have been made to correct CDH in utero as a solution to the problem of high mortality from this condition.[10 11]

Previous reports have noted that the incidence of associated malformations in infants with CDH is extremely low.[12 13] This information was based on studies involving patients with CDH seen at the referral centre and does not include stillborns or liveborns who died before transfer to the referral centre. Recent studies, however, have shown that a significant number of infants with CDH have major associated anomalies.[14–16] We have previously reported that the frequency and severity of non-pulmonary anomalies in patients with CDH depend on whether the patients are stillborn or liveborn.[14 17] Almost 100% of stillborns with CDH have major associated anomalies and neural tube defects are the predominant associated defects in stillborns.[17] Cardiac and chromosomal abnormalities predominated in liveborn infants with CDH.

In the present study we examined the medical records of 116 consecutive liveborn infants with CDH, analysing the incidence of associated malformations and their impact on survival.

Patients and methods

Between January 1973 and December 1990 there were 116 consecutive cases of CDH diagnosed during the first 24 hours of life among 368 772 livebirths at the three maternity hospitals in Dublin (National Maternity Hospital, Rotunda Hospital, and Coombe Hospital). The patients were divided into two groups: group I included 64 (55%) patients who died during resuscitation and stabilisation before surgery at a mean age of 11·2 hours and group II included 52 (45%) patients who were operated upon. Of the 52 patients who underwent surgery, 27 (52%) survived. The medical records of all these patients were examined to obtain information regarding sex distribution, gestational age, birth weight, side of hernia, age at diagnosis, presence and type of associated malformations and the final outcome. All patients in group I underwent detailed postmortem examination as did the 45% of patients who died in group II.

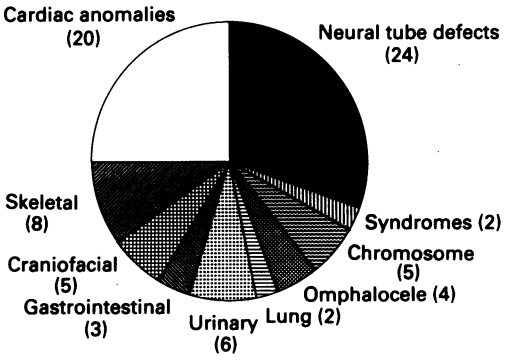
Results

The sex distribution, gestational age, birth weight, site of abdominal defect, and age at

Children's Research Centre, Our Lady's Hospital for Sick Children, Crumlin, Dublin 12, Ireland
Yechiel Sweed
Prem Puri

Correspondence to:
Mr Puri.

Accepted 9 March 1993



Incidence of associated malformations in group I patients (40 patients, 79 anomalies).

diagnosis in group I and group II patients are shown in table 1. Ninety of the diaphragmatic hernias were left sided and 25 right sided, a left to right ratio of 3·6:1. Bilateral CDH was present in one case.

There was a significant difference in the incidence of associated malformations in the two groups of patients. In group I, 40 (63%) patients had 79 associated malformations whereas only four (7·7%) patients had associated anomalies in group II patients.

The figure shows the various associated malformations in the 40 patients in group I. There were 20 cardiac anomalies among 16 patients. Ventral septal defects (n=5), tetralogy of Fallor (n=4), transposition of great vessels (n=2) and hypoplastic left ventricle (n=2) were the most common cardiac defects. There were 24 neural tube defects among 15 patients consisting of hydrocephalus in eight, myelomeningocele in seven, inencephaly in three, microcephaly in three, anencephaly in two, and encephalocele in one.

Sixteen (40%) of these patients were found to have multiple associated anomalies. Analysing the severity of these anomalies, it was observed that 90% were major malformations and 10% were minor.

Table 2 shows comparison of birth weight, gestational age, and age at diagnosis in group I patients with or without associated malformation. The mean (SD) birth weight (2302 (879) g) was significantly lower ($p<0·01$) in 40 patients with associated malformations compared with that (2600 (937) g) in 24 patients who did not have associated malformations. However, the mean gestational age and mean age at diagnosis was not significantly different in the above two groups of patients.

Table 1 The sex distribution, gestational age, birth weight, site of anatomical defect, and age at diagnosis in group I and II patients

Group	Sex		Mean (SD) gestational age (weeks)	Mean (SD) birth weight (g)	Side of CDH			Mean (SD) age at diagnosis (hours)
	M	F			Right	Left	Bilateral	
I	35	29	36·1 (4·5)*	2415 (906)**	15	48	1	0·49 (0·4)
II	22	30	39·0 (2·4)	3410 (563)	10	42	–	1·78 (3·3)

*p value <0·01 group I *v* group II mean gestational age.
**p value <0·01 group I *v* group II mean birth weight.

Table 2 Comparison of birth weight, gestational age, and age at diagnosis in group I patients with and without associated malformations

	Mean (SD) birth weight (g)	Mean (SD) gestational age (weeks)	Mean (SD) age at diagnosis (hours)
Patients with associated malformations (n=40)	2302 (879)	36·0 (4·5)	0·5 (0·2)
Patients without associated malformations (n=24)	2600 (937)	36·4 (4·7)	0·5 (0·5)

Discussion

A unique feature of this study is that it documents findings in the 116 consecutive cases of CDH born in the three maternity hospitals in Dublin who had respiratory distress at or soon after birth and required resuscitation and stabilisation. More than half (55%) of these patients died during resuscitation and stabilisation prior to surgery. The vast majority of these patients died at maternity hospitals and did not come to the attention of referral centres.

The results of this study demonstrate that infants with CDH who die during resuscitation and stabilisation have a significantly higher incidence of other major associated anomalies compared with those patients who were operated upon. Almost two thirds of the patients in group I had associated malformations with 90% being major associated malformations. Moreover, 40% of patients with associated malformation in group I were found to have multiple associated anomalies. The increased mortality of infants with complex malformations is not unexpected, for many of the anomalies are lethal in themselves, without the complications of diaphragmatic hernia.

Most previous studies reporting incidence of associated malformations in CDH have reviewed cases seen at the referral centre and do not include a large number of infants with CDH who die before transport to the referral centre.[15 16] It is conceivable, therefore, that a significant number of infants with associated malformations were not identified in previous reports. Our study which examined in detail 116 consecutive cases of CDH in the maternity hospitals provides an accurate incidence of associated malformations in liveborns with CDH. All patients in group I and nearly half of the patients who died in group II underwent a postmortem examination which made accurate documentation of frequency and type of associated malformations much easier.

Prematurity was a frequent occurrence in babies with CDH who died during resuscitation and stabilisation. Mean gestational age as well as mean birth weights in group I patients were significantly lower than those in group II patients. Furthermore, the birth weights of patients with associated malformation in group I were significantly lower than those patients without associated malformation. Generally, low birthweight infants have a much higher mortality compared with full sized infants. The presence of additional major anomalies in a low birthweight infant with CDH will result in the mortality rate being even higher.

In recent years two management strategies have emerged in the care of high risk CDH patients that offer some hope of improving overall survival: extracorporeal membrane oxygenation and delayed surgical repair. Although

these strategies have improved survival somewhat, mortality rates of over 50% are still seen despite aggressive neonatal care of these patients.[3] Our data show that associated malformations in high risk neonates with CDH is a major factor influencing outcome in this congenital condition in addition to pulmonary hypoplasia and pulmonary hypertension.

1 Adzick NS, Harrison MR, Glick PL, *et al.* Diaphragmatic hernia in the fetus: prenatal diagnosis and outcome in 94 cases. *J Pediatr Surg* 1985; **20:** 357–61.

2 Langham MR Jr, Krummel TM, Bartlett RH, *et al.* Mortality with extracorporeal membrane oxygenation following repair of congenital diaphragmatic hernia in 93 infants. *J Pediatr Surg* 1987; **22:** 1150–4.

3 Wilson JM, Lund DP, Lillehei CW, *et al.* Delayed repair and postoperative ECMO does not improve survival in high-risk congenital diaphragmatic hernia. *J Pediatr Surg* 1992; **27:** 368–75.

4 Bohn DI, James I, Filler RM, *et al.* The relationship between $PaCO_2$ and ventilation parameters in predicting survival in congenital diaphragmatic hernia. *J Pediatr Surg* 1984; **19:** 666–70.

5 Harrison MR, Jester JA, Ross NA. Correction of congenital diaphragmatic hernia in utero: I. The model: intrathoracic balloon produced fetal pulmonary hypoplasia. *Surgery* 1980; **88:** 174–82.

6 Adzick NS, Outwater KM, Harrison MR, *et al.* Correction of congenital diaphragmatic hernia in utero: IV. An early gestational fetal lamb model for pulmonary vascular morphometric analysis. *J Pediatr Surg* 1985; **20:** 673–80.

7 Geggel RL, Murphy JD, Langleben D, *et al.* Congenital diaphragmatic hernia: arterial structural changes and persistent pulmonary hypertension after surgical repair. *J Pediatr Surg* 1985; **107:** 457–64.

8 Benacrarraf BR, Adzick NS. Fetal diaphragmatic hernia: ultrasound diagnosis and clinical outcome in 19 cases. *Am J Obstet Gynecol* 1987; **156:** 573–6.

9 Adzick NS, Vacanti JP, Lillehei CW, *et al.* Fetal diaphragmatic hernia: ultrasound diagnosis and clinical outcome in 38 cases from a single medical centre. *J Pediatr Surg* 1989; **24:** 654–8.

10 Harrison MR, Langer JC, Adzick NS, *et al.* Correction of congenital diaphragmatic hernia in utero: V. Initial clinical experience. *J Pediatr Surg* 1990; **25:** 45–57.

11 Harrison MR, Adzick NS, Longaker MT, *et al.* Successful repair in utero of a fetal diaphragmatic hernia after removal of herniated viscera from the left thorax. *N Engl J Med* 1990; **322:** 1582–4.

12 Harrison MR, Bjordal RI, Langmark F, *et al.* Congenital diaphragmatic hernia: the hidden mortality. *J Pediatr Surg* 1978; **13:** 227–30.

13 Adelman S, Benson CD. Bochdalek hernias in infants: factors determining mortality. *J Pediatr Surg* 1976; **11:** 569–73.

14 Puri P, Gorman F. Lethal nonpulmonary anomalies associated with congenital diaphragmatic hernia: implications for early intrauterine surgery. *J Pediatr Surg* 1984; **19:** 29–32.

15 Benjamin DR, Juul S, Siebert JR. Congenital posterolateral diaphragmatic hernia: associated malformations. *J Pediatr Surg* 1988; **23:** 899–903.

16 Cunniff C, Jones KL, Jones MC. Patterns of malformation in children with congenital diaphragmatic defects. *J Pediatr* 1990; **116:** 258–61.

17 Puri P. Epidemiology of congenital diaphragmatic hernia. In: Puri P, ed. *Congenital diaphragmatic hernia.* Basle: Karger, 1989: 22–7.