Journal of Pediatric Surgery (2013) **48**, 930–934

ELSEVIER

Journal of Pediatric Surgery

www.elsevier.com/locate/jpedsurg

Abdominal wall closure in neonates after congenital diaphragmatic hernia repair

Damian Maxwell[a,b], **Robert Baird**[b,*], **Pramod Puligandla**[b]

[a]*West Virginia University Charleston Area Medical Center, WV, USA*
[b]*Department of Pediatric Surgery, Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec, Canada H3H1P3*

Received 21 January 2013; accepted 3 February 2013

Key words:
Congenital Diaphragmatic Hernia;
Abdominal compartment syndrome;
Neonate

Abstract

Purpose: Repair of Congenital Diaphragmatic Hernia (CDH) abruptly increases intra-abdominal pressure. This study sought to characterize the incidence and significance of ACS and delayed fascial closure (DFC) after CDH repair.

Methods: We reviewed the CAPSNet database from 2006 to 2011, identifying the subset of patients that developed ACS or required DFC. Prenatal and demographic information, operative and physiologic details, and outcomes were investigated.

Results: Of 349 patients with CDH, 3 (0.8%) were diagnosed with ACS, while 43 patients (12%) had DFC at the time of CDH repair. Patients more often had right-sided defects (26% vs 13%, $p=0.04$) and trended toward requiring a patch repair (41% vs 31.2%, $p=0.23$) and having a liver lobe above the diaphragmatic rim (47% vs 32.7, $p=0.09$).

Patients with ACS or DFC had increased length of stay (47.5 vs 33.9, $p=0.01$), days fasting (8.2 vs 5.8, $p=0.01$), days on parenteral nutrition (23.6 vs 15.5, $p=0.003$), and days on mechanical ventilation (16.3 vs 9.0, $p=0.001$).

Conclusions: While ACS in neonates after CDH repair is rare (<1%), DFC is required relatively commonly (>10%) and is associated with right-sided diaphragmatic hernias. Inability to close abdominal fascia is associated with increased morbidity. Clinicians caring for neonates with CDH should be facile with strategies to manage delayed abdominal fascia closure.

There have been limited improvements in morbidity and mortality for patients with congenital diaphragmatic hernia (CDH) over the past few decades despite improvements in neonatal intensive care [1]. The successful management of neonates with CDH includes a period of stabilization with ventilatory and circulatory support followed by requisite operative repair of the hernia. Recent surgical reports have evaluated multiple aspects of CDH repair including the timing, the necessity and implication of patch closure as well as traditional versus minimally invasive techniques [2,3]. Common to all surgical approaches is the invariable reduction of viscera into the abdominal cavity followed by hernia closure. One of the potential consequences of this manoeuvre is the sudden elevation in intra-abdominal pressure and resultant abdominal compartment syndrome (ACS), a concern recognized but not elaborated upon by standard paediatric surgery textbooks [4,5].

* Corresponding author. Tel.: +1 514 412 4438; fax: 1 514 412 4289.
E-mail address: robert.baird@mail.mcgill.ca (R. Baird).

0022-3468/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jpedsurg.2013.02.008

ACS in children is defined as a sustained intra-abdominal pressure greater than 10–12 mmHg associated with new organ dysfunction/failure and carries with it a significant mortality of up to 60% [6–8]. The pathophysiologic effects of ACS have been well described and can affect multiple organ systems. Increased intra-abdominal pressure displaces the diaphragm upwards contributing to worsening respiratory function. Additionally, intra-abdominal pressure can rise above intravascular pressure leading to decreased splanchnic and renal perfusion thereby resulting in end organ damage [9]. Although ACS has been well studied in adults, there has been little documentation of the phenomena in the neonatal literature. This study aims to identify the incidence, risk factors and outcomes of patients with CDH who developed ACS or required a delayed fascial closure (DFC) after repair of the diaphragmatic hernia.

1. Methods

In this review, we gathered information from the Canadian Association of Pediatric Surgery Network (CAPSNet) database from 2006 to 2011 after approval from the CAPSNet Steering Committee and institutional REB. We identified a total of 353 patients with CDH from the database. The study group was comprised of those infants with documented ACS as well as those for whom the abdominal fascia was not closed at the time of CDH repair. The diagnosis of ACS was left to the discretion of the clinician, and no objective measurements (ventilatory parameters or urinary bladder pressure measurement) were documented. The diagnosis of DFC was self-evident and recorded in the operative details, although the reasoning behind delaying abdominal wall closure was not overtly documented. These patients were compared to the remainder of the CDH cohort. Prenatal information, demographics, pre-operative parameters and intra-operative details as well as outcomes were reviewed. SPSS statistical package version 20 (IBM corporation, NY) was used to analyze the data. The Fisher's Exact test was used to evaluate dichotomous variables and the Student t test was used for continuous data. P values <0.05 were considered statistically significant.

2. Results

Three hundred and fifty-three patients were included for analysis, 141 of which were female patients. The median gestational age was 38 weeks and the mean birthweight was 3059 g. Three patients (0.8%) were diagnosed with ACS while 43 patients (12%) had DFC at the time of CDH repair. ACS and DFC were not predicted by prenatal and demographic variables (Table 1). However, patients with either ACS or a delayed facial closure had more right-sided defects (26% vs. 13%, $p=0.04$). In addition, there was a non-significant increase in requiring patch repairs (41% vs. 31.2%, $p=0.23$) and having a "liver up" position (47% vs. 32.7, $p=0.09$) (Table 2).

Patient outcomes are demonstrated in Table 3. While no difference in mortality was appreciated (13% vs. 21.9%; $p=0.24$), patients with ACS or DFC had increased lengths of stay (47.5 vs. 33.9; $p=0.01$), days fasting (8.2 vs. 5.8; $p=0.01$), days on parenteral nutrition (23.6 vs. 15.5; $p=0.003$) and days on mechanical ventilation (16.3 vs. 9.0; $p=0.001$).

The details regarding the three patients that developed ACS are described in Table 4. The one ACS patient that died was diagnosed by antenatal ultrasound at 27 weeks gestation with a right-sided defect and associated liver herniation. The patient died prior to surgical repair with autopsy findings confirming the right-sided diaphragmatic defect, liver and small bowel herniation into the right hemi-thorax, as well as ipsilateral pulmonary hypoplasia. The diagnosis of ACS made by the attending clinician likely represents secondary ACS from massive resuscitation and subsequent multi-system organ failure as opposed to a direct consequence of visceral reduction.

Table 1 Prenatal and demographic characteristics of study cohort (ACS and DFC) and control cohort.

	ACS + DFC	Remainder of cohort	
Prenatal			
Outborn (N, %)	23 (50%)	186 (61.6%)	$p=0.32$
LHR (Mean, N)	1.27 (n=16)	1.43 (n=47)	$p=0.6$
No prenatal diagnosis (N, %)	14 (30.4%)	94 (31.1%)	$p=0.82$
Demographic			
Gestational age in weeks (Median, range)	38 (31–41)	38 (26–41)	
Birthweight in grams (Mean ± SD)	3036.9 ± 645.8 g	3063.5 ± 650.8 g	
Gender (F:M)	21:24	184:117	

ACS = Abdominal Compartment Syndrome.
DFC = Delayed Facial Closure.
LHR: Lung Head Ratio.