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ORIGINAL ARTICLE

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The outcome of newborns with abdominal wall defects according to the method of abdominal closure: the experience of a single center

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Abstract Recent reports suggest that the technique of abdominal closure in neonates with anterior abdominal wall defects (AWD) correlates with the outcome. The aim of this study is to analyze factors related to mortality and morbidity, according to the technique of abdominal closure of these neonates. Retrospective analysis of charts from 76 consecutive neonates with AWD treated in a single institution. They were divided according to the type of abdominal wall closure: group I: primary closure, group II: silo followed by primary closure and group III: silo followed by polypropylene mesh. Outcome was analyzed separately for neonates with gastroschisis and omphalocele. There were 13 deaths (17.1%). Mortality for neonates with isolated defects was 9.6%. Mortality rate was similar in all groups for either neonates with gastroschisis or omphalocele. Postoperative complications were not significantly different among groups except for a prolonged time of hospitalization in group III. Mortality rate is not correlated with the type of abdominal closure. Neonates with primary closure or with other methods of abdominal wall closure had similar rate of postoperative complications. Neonates with mesh closure of the abdomen have prolonged hospitalization. The use of a polypropylene mesh is a good alternative for neonates whose primary closure or closure after silo placement is not possible.

Keywords Abdominal wall defects · Abdominal wall closure · Polypropylene patch · Mortality · Postoperative complication

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Introduction

As in many other countries, the rate of admissions of neonates with abdominal wall defects (AWD) has been increasing in our Neonatal Intensive Care Unit. The widespread use of prenatal diagnostic ultrasound and increased intra-uterus referrals are possible explanations for this fact.

Overall survival in children with AWD and no other major congenital defect is reported to be over 90% [1]. The high survival rates reflect improvements in perinatal attention and advances in neonatal intensive care. Recent reports suggest that the type of abdominal closure has a direct correlation with the outcome of these children, more specifically regarding the period of time to achieve full enteral feedings as well as hospital stay [2–4].

The aim of this publication is to report our experience as a single center on the treatment of these neonates, and to analyze factors related to mortality and morbidity according to the type of abdominal closure.

Materials and methods

We analyzed retrospectively children treated in our institution for AWD (onphalocele and gastroschisis) from January 1998 to March 2005. There were inborn patients and patients referred from other obstetric centers.

Data were retrospectively collected from patients charts and included: presence or absence of antenatal sonografic diagnostic, birth weight, type of closure, postoperative complications, and time to resume enteral nutrition and period of hospital stay. Data regarding gestational age, apgar index, chromosomal studies, and mode of delivery were not available in cases referred from other institutions.

Initially, all infants were considered for primary wall closure. After a period of hemodynamic and respiratory stabilization the children were sent to the

operating room, receiving general anesthesia and monitorization. A nasogastric and a rectal tube were inserted and irrigation of the bowel with saline was performed when dilated loops were present. Intra-abdominal pressure monitoring via a bladder catheter was used. The decision to perform or not the primary closure was based on the intravesical pressure and also on hemodynamic and ventilatory parameters. Infants presenting intravesical pressure above 20 mmHg, discoloration of lower limbs, decrease on main arterial pressure, dessaturation on pulse oximentry or needed an increase of 5 mmHg on inspiratory pressure for adequate ventilation during primary closure were considered for staged closure. Ward reduction without anesthesia was not considered for infants with gastrochisis in this series.

Infants were divided into three groups according to the type of abdominal closure:

(a) Group I: Primary closure of fascia and skin. Bowel was reduced to the abdominal cavity without extending the abdominal defect. Primary suture of fascia with interrupted 3-0 or 4-0 prolene was attempted in cases of omphalocele. In infants with gastroschisis, reduction of the bowel without extension of the defect followed by an umbilicoplasty, as described by Sandler et al. [5], was the procedure of choice.
(b) Group II: Silo creation, followed by primary closure: In neonates in whom primary closure was not possible, the skin was dissected free from the fascia around the defect to an extent of 3 cm. The defect was extended longitudinally. A sterile plastic saline bag was sutured to the abdominal fascia with interrupted 3-0 prolene. The abdominal content was placed loosely inside the bag and squeezed gently every day to accommodate to the abdominal cavity. After 5–7 days, the silo was removed and the abdomen was closed primarily, including fascia and skin.
(c) Group III: Closure with polypropylene mesh: In infants in whom a primary closure after a silo was not possible, a polypropylene patch (JHS Laboratories, Curitiba, BR) was sutured to the fascia. The patch was placed above the liver when possible, avoiding direct contact with the bowel. In other cases the patch was placed loosely in contact with bowel. Patches remained partially or totally exposed as no sufficient skin was available.

After surgery, infants were sent on mechanical ventilation to the neonatal intensive care unit (NCIU), for hemodynamic and respiratory care. Parenteral nutrition was initiated in the second postoperative day.

All infants received ampicillin and gentamicin for antibiotic prophylaxis. In infants presenting evidence of cellulitis or abnormal secretion at the wound site, antibiotics were changed according to cultures and antibiogram.

Wound care was by an attending pediatric surgeon. Group I patients had regular daily dressing changes, group II patients had silo squeezed and dressed twice a day in the neonatal ICU with the patients on ventilator and under intravenous sedation. Group III patients had closed dressings with normal saline solution-soaked gauzes. The dressings were changed and the patch was mechanically cleaned with neutral soap when saturated, as much as necessary, until granulation tissue under the mesh was formed (Fig. 1). When full feedings were reestablished, the infant was discharged with home care. The ambulatory follow up of these children was made once a week. The mesh was trimmed as it was progressively and spontaneously detaching from the wound (Fig. 2), with progression of underneath epithelialization. In all children, the mesh could be totally removed after a few months, leaving a firm, epithelialized scar (Fig. 3).

Postoperative complications were noted. Data were quoted as media and ranges. Kruskal–Wallis analysis and Fisher's exact test were used for statistical analysis and significance considered for $P < 0.05$.

Results

Seventy-six neonates with anterior AWD were treated. Fifty-nine cases were inborn, and 17 cases were referred from others institutions. There were 43 neonates with gastroschisis and 33 with omphalocele. Weights ranged from 1,200 to 3,800 g (mean 2,580 g).

Sixty neonates had prenatal ultrasound diagnosis, 53 of them were followed by our Fetal Medicine Service.

There were 54 patients in group I, 12 infants in group II and 10 patients in group III. Associated malformations are shown in Table 1. There was a uniform distribution of patients according to gender and birth weigh in all groups.

Fig. 1 Abdominal closure with a polypropylene patch in a neonate with omphalocele on the 7th postoperative day

Fig. 2 Same neonate on the 35th postoperative day, in an ambulatory follow-up. Notice the granulation tissue and no signs of infection

There were 13 deaths during the neonatal period, six patients in group I, three in group II and four in group III: Eight neonates had omphalocele. In three of them, death was due to severe cardiac defects, one due to renal agenesis and anuria one in consequence of respiratory distress and three infants due to sepsis. Five neonates had gastroschisis and died from central line sepsis (3) and necrotizing enterocolitis (2). No statistical differences were seen regarding mortality among groups ($P < 0.05$). The mortality for patients with isolated defects (without other malformations) was 9.6%. Mortality was similar among groups when neonates with severe associated malformations were excluded ($P < 0.05$)

Postoperative complications are listed on Table 2 for patients with gastroschisis and in Table 3 for patients with omphalocele. The incidence of postoperative complications was not significantly different among groups. None of the neonates required removal of the patch because of uncontrolled infection or cellulitis.

Fig. 3 Late aspect of the wound in another patient, showing a firm scar with almost complete epithelialization after the patch was removed

Table 1 Associated malformations and deaths

	Gastroschisis	Omphalocele
Intestinal atresia	3 (1)	
CDH	–	1
Bilateral hydronephrosis	–	1 (1)
Severe cardiac defect	–	3 (3)
Pericardial hernia	–	1
Beckwith–Wiedemann syndrome		2

Values are given as *N* (deaths)
CDH congenital diaphragmatic hernia

Postoperative time to resume enteral feedings was significantly increased among groups for neonates with omphalocele but not for neonates with gastroschisis ($P > 0.05$).

Total time of hospitalization was significantly higher for patients with omphalocele and gastroschisis who did not achieve primary closure at the first operation ($P > 0.05$).

Discussion

The current recommendations in cases with an intrauterine diagnostic of AWD are: close follow up, delivery in a center with availability of high risk obstetrics, neonatology and pediatric surgery services, delivery at or just before term, before onset of labor with confirmation of lung maturity [6].

The real impact of these recommendations on the mortality and morbidity for these neonates is difficult to be evaluated since in these centers, the intensive care of high risk neonates have dramatically improved in the last decade. Mortality is reported to be related to the association with others malformations and prematurity. The surgeons' attention had changed towards the evaluation of safety and efficacy among several methods of closure of the defect. Considering the wide anatomic variability in these infants, correction of the defect right after delivery, with low morbidity, and leaving a good cosmetic appearance or a scar-free abdomen can be considered just for a selected group of patients [7]. For infants with large and complex defects, low birth weight and associated malformation, survival is the major concern.

Proposed methods of determining feasibility of primary abdominal closure include monitoring intravesical or intragastric pressure, central venous pressure, gastric tonometry, calculated splanchnic perfusion pressure and clinical, (hemodynamic and respiratory) parameters [8–11]. Complications related to a possible abdominal compartmental syndrome still occur, despite meticulous measurement and the clinical experience of surgeons. Necrotizing enterocolitis, bowel obstruction, prolonged ileus and temporary ventilatory dependence were

Table 2 Postoperative outcome for gastroschisis

	GI (n = 32)	GII (n = 8)	GIII (n = 3)	P value
Necrotizing enterocolitis	2	–	–	0.66
Enteric fistula	–	–	1	0.96
Small bowel obstruction	1	–	–	0.66
SVC thrombosis	2	–	–	0.66
Time to resume enteral feedings (days) (mean ± SD)	16.8 ± 17.0	19.0 ± 0.55	31 ± 0.39	0.28
Cellulitis	2	–	1	0.65
Cholestasis	3	–	–	0.68
Sepsis	2	1	2	0.77
In hospital period (days) (mean ± SD)	26.0 ± 21.2	41.4 ± 8.48	48.33 ± 21.35	< 0.001

Values are given as n unless when specified

Table 3 Postoperative outcome for omphalocele

	GI (n = 22)	GII (n = 4)	GIII (n = 7)	P value
Time to resume enteral feedings (days) (mean ± SD)	5.0 ± 2.8	10.9 ± 3.2	13.5 ± 0.5	0.008
Sepsis	2	1	2	0.62
In hospital period (days) (mean ± SD)	21.7 ± 6.1	23.3 ± 7.0	26.4 ± 16.5	0.038
PPHN	0	0	1	0.77

Values are given as n unless when specified

examples of these complications that occurred also in some of our infants [8].

The use of prosthetic and biocompatible material is described as an alternative method of closure of AWD [8, 12, 13]. Polyester, polyethylene and polytetrafluoroethylene (PTFE) patches have been used for the correction of abdominal hernias, eventrations and evisceration in adults [13–15]. Nevertheless, when local infection is present, PTFE patches need frequently to be removed while polyethylene patches provide adequate drainage for the wound [16–18]. Infants with gastroschisis and omphalocele treated with silo have potentially contaminated wounds. For this reason, polyethylene or polyester patches seems to be more suitable for those patients.

The use of a polypropylene mesh is not recommended when it is placed in direct contact with bowel because of the risk of erosion and perforation [15, 19–21]. We observed this complication in one patient. The neonate had a gastroschisis initially treated with a Silo. It was removed after 5 days and replaced by a polypropylene mesh. After 7 days an enteric fistula was diagnosed. The neonate died of sepsis in the 45th day. In our series, when the patch was placed above the liver no complications were observed. Also, in all other cases the patch was placed after a plastic silo. These infants had, besides the peel, a thick fibrin layer covering the bowel. That fibrin coat probably provided an extra protection against erosion.

A tissue graft developed from a bioabsorbable tissue scaffold of porcine submucosal small intestine extracellular matrix, referred to as "SIS_ECM mesh" (Surgisis™, Cook Surgical, Bloomington Ind.) has been reported in adults for correction of large abdominal defects [22]. In neonates, it has been reported as an alternative to prosthetic material to correct diaphragmatic defects or AWD [13, 23]. In all of these situations, the patch is internally placed or covered by skin. The use of Surgisis in large and exposed defects has never been reported. The use of these biological patches in substitution of polypropylene patches under the same protocol is now under investigation in our service.

Another concern about the use of mesh is regarding the increased rate of local or systemic infection, particularly when it is totally or partially exposed [24]. This was not observed in our casuistic, since patients in group I and group III had similar rates of sepsis and cellulitis and did not interfere in the outcome of these infants. The presence of a trained team for wound care at home could allow us to discharge these infants as soon as they reach full enteral feedings, avoiding unnecessary hospital stay.

According to recent publications, infants with primary abdominal closure may experience a less prolonged ileus time and can achieve full enteral feedings earlier [2–4, 7]. We did not observe a difference in time for resuming enteral feedings among the groups in neonates with gastroschisis, but a prolonged hospitalization period was seen in neonates whose primary closure was not possible; this is in accordance with other studies [25–29].

The presence of associated anomalies was a decisive factor influencing mortality and morbidity in our series, as reported elsewhere [28]. Two infants with omphalocele died in consequence of severe cardiac malformations and another that survived in the neonatal period, died in consequence of severe pulmonary hypertension secondary to a cardiac defect.

In conclusion, in our institution the mortality rate of infants with AWD is not correlated with the type of abdominal closure. Infants with primary closure have similar rate of complications relative to those who had

other types of abdominal closure, except for a shorter hospital stay. The use of polyethylene patch is a good alternative for infants in whom primary closure could not be achieved.

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