Risk Factors for Abdominal Wound Dehiscence in Neonates: A Retrospective Cohort Study

Shouxing Duan

Shantou University Medical College <https://orcid.org/0000-0002-3539-6741>

Xuan Zhang

shenzhen pingshan District woman and children hospital, southern medical university

Xuewu Jiang

shenzhen pingshan district woman and children hospital, southern medical university

Wenhui Ou

Second Affiliated Hospital of Shantou University Medical College

Maxian Fu

Second Affiliated Hospital of Shantou University Medical College

Kaihong Chen

Second Affiliated Hospital of Shantou University Medical College

Xinquan Xie

Second Affiliated Hospital of Shantou University Medical College

Wenfeng Xiao

Second Affiliated Hospital of Shantou University Medical College

Lian Zheng

The First Affiliated Hospital of Shantou University Medical College

Shuhua Ma

The First Affiliated Hospital of Shantou University Medical College

Jianhong Li (✉ jianhongli2013@163.com)

Second Affiliated Hospital of Shantou University Medical College

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Abstract

Background: Abdominal wound dehiscence (AWD) is a major complication of abdominal surgery, neonates are a group with a high risk of AWD, which has serious consequences or can even result in death. The purpose of this study is to explore the risk factors for neonatal AWD.

Methods: The clinical data for 453 cases of neonatal laparotomy from June 2009 to June 2020 were retrospectively analyzed, among which 27 cases of AWD were found. Nine factors, including gender, age at admission, weight at admission, preterm delivery, level of preoperative anemia, hypoalbuminemia, operation time, incision length, and incision type, were analyzed to explore their correlation with neonatal AWD.

Results: The incidence of neonatal AWD was 6.0% (27/453), of which partial wound dehiscence 4.9% (22/453) and complete wound dehiscence 1.1% (5/453). Anemia, hypoproteinemia, and wound contamination were the main risk factors for neonatal AWD. The AWD-free survival rates for infants with severe anemia and mild to moderate anemia were 83.3% and 91.2%, respectively. The AWD-free survival rates for those with hypoproteinemia, type II and type III incision were 88.0%, 95.1% and 87.1%, respectively.

Conclusion: Neonatal AWD is closely related to anemia, hypoproteinemia, and incision contamination. It is of great significance for the prevention of neonatal AWD to strengthen nutritional support, correct preoperative anemia, and control infection.

Trial registration: Research Registry, researchregistry5350. Registered 01 February 2020 - Retrospectively registered, <https://www.researchregistry.com/browse-the-registry#home/registrationdetails/5e359028eef79c001577fa18/>

Background

With the rapid development of modern neonatal surgery, an increasing number of operations are carried out during the neonatal period, especially abdominal surgeries[1]. Abdominal wound dehiscence (AWD) continues to be a major complication of abdominal surgery, and is accompanied by high morbidity and mortality in neonates [2]. Because of the unique pathophysiological and anatomical characteristics of newborns, the situation of abdominal wound rupture is more complex and the consequences are more serious, as compared to children and adults. The thin abdominal wall of a newborn is more likely to rupture again, with the possibility of causing systemic infection and endangering life [2, 3]. AWD includes both partial and complete wound dehiscence, partial wound dehiscence means when the skin and/or deep tissue is dehiscent, but the fascia layer is intact, no viscera and omentum can be seen; complete wound dehiscence (burst abdomen) is considered present when intestine, omentum or other viscera are seen through the abdominal wound. However, there are few reports describing the risk factors for AWD.

In order to increase our understanding of the factors that influence neonatal AWD, we analyzed the clinical data pertaining to 453 cases of neonatal laparotomy from June 2009 to June 2020, among which there were 27 cases of AWD. The purpose of this study is to explore the risk factors for neonatal AWD, so as to provide a basis for targeted implementation of effective measures to more thoroughly prevent and control wound dehiscence.

Methods

This was a retrospective case-cohort study approved by the Ethics Committee at the Affiliated Hospital of Shantou University Medicine College, and the need for informed consent was waived. All the procedures adhered to the tenets of the Declaration of Helsinki. The study was approved by the institutional review board of the University Medical Center meeting legal requirements (retrospective cohort study).

Patients

We analyzed hospital records from June 2009 to June 2020, and collected 453 cases of neonatal laparotomy. There were 27 cases occurred AWD, among which partially dehiscent was 22 and completely dehiscent was 5. All the 27 patients with AWD were included. Exclusion criteria were as follows: Discharged without treatment; Patient records are incomplete. The 27 infants were 1–28 days old, weighing 1.9–3.5 kg. There were 17 males and 10 females, and 19 term infants and 8 preterm infants. The patient demographics are shown in Table 1.

Table 1
Patient demographics.

Parameter	Datas (number)
Sex	Mals (298); females (155)
Gestational age (week)	38.51 ± 1.59
Age of admission (d)	7.79 ± 8.40 (1–28)
Body weight (kg)	2.80 ± 0.51 (1.9–3.8)
Wound orientation	Horizontal (337) Vertical (116)
AWD types	Partial wound dehiscence (22) Complete wound dehiscence (5)
Etiology	Congenital intestinal atresia/stenosis (117) Intestinal perforation (51) Meconium peritonitis (12) Congenital intestinal malrotation/twist (105) Congenital hypertrophic pyloric stenosis (62) Congenital defects of gastric musculature (12) Mesenteric/omental cyst (16) Neonatal necrotizing enterocolitis with perforation (23) residual diseases of omphalomesenteric duct (55)

Investigation

The clinical data for all children with AWD were compiled and included gender, age at admission, weight at admission, preterm delivery, level of preoperative anemia, hypoalbuminemia, operation time, incision length, and incision type. After data collection, the different clinical data were stratified and statistically analyzed.

Diagnostic Criteria

AWD includes both partial and complete wound dehiscence. The partial wound dehiscence is a condition characterized by the rupturing of a surgical incision along the suture so that the skin and/or deep tissue of an abdominal wound are exposed, but the fascia layer is intact, no viscera and omentum can be seen. The complete wound dehiscence (burst abdomen) is considered present when intestine, omentum or other viscera are seen through the abdominal wound. The preterm infant is 32 weeks ≤ gestational age (GA) < 37 weeks, and the term infant is GA ≥ 37 weeks; the hypoproteinemia standard is albumin < 35 g/L. Newborn anemia is characterized by venous hemoglobin (HB) < 130 g/L or peripheral blood HB ≤ 145 g/L within 2 weeks of birth; after 2 weeks of birth, anemia is characterized by venous blood HB ≤ 115 g/L. Among them, if the infant's age is less than or equal to 2 weeks and the HB is between 100–145 g/L, this condition is classified as mild to moderate anemia; if the HB is less than 100 g/L, it is classified as severe anemia. If the infant's age is more than 2 weeks and HB is between 80–115 g/L, it is classified as mild to moderate anemia; if HB is less than 80 g/L, it is considered to be severe anemia.

Treatment

Postoperatively, abdominal wounds were examined from third postoperative day onwards on daily basis to see the signs of wound infection, dehiscence including redness (erythema), seroma formation, discharge of serosanguinous fluid or pus from one or more sites and subsequently partial or complete wound dehiscence.

Partial wound dehiscence was managed conservatively by laying open the wound, daily wound wash and dressing along with intravenous antibiotics according to culture and sensitivity.

Cases of complete wound dehiscence (burst abdomen) were immediately covered the wound with sterile cotton pads to protect the bulge and fissure once the intestines and/or omentum prolapse were visible. At the same time, the patient was sedated to avoid the increase in abdominal pressure and release more intestinal tubes caused by continued crying. The patients were sent to the operating room for extended suturing under general anesthesia. During surgery, the intestine was washed out, any residual suture in the wound was removed, the subcutaneous tissue was fully expanded, the necrotic tissue was removed, and an entire layer of decompression suture was added. There was a reinforce in the application of antibiotics and local dressing changes after operation, and the suture was removed 2 to 3 weeks later. The AWD in this group occurred 3–8 days after the initial surgery. Table 2 provides the intraoperative findings and treatment of complete wound dehiscence cases.

Table 2
The intraoperative findings and treatment of complete wound dehiscence cases.

Case	Disease	Condition during the first operation	The first operation	Wound orientation	Dehiscence after surgery (d)	Condition during the second operation	The second operation	Length of stay (d)
1	Congenital intestinal atresia	Type II atresia, approximately 40 cm from the flexion ligament	Bowel resection and anastomosis	Horizontal	5	No anastomotic fistula	Debridement and tension suture	29
2	Ileal perforation	An idiopathic perforation was located at approximately 50 cm from the ileocecal area	Bowel repair	Vertical	8	Intestinal repair healed well	Debridement and tension suture	37
3	Meconium peritonitis	Intestinal adhesions were severe during surgery, and fistulization was made 35 cm from the ileocecal area	Enterostomy	Vertical	6	Unexplored abdominal cavity	Debridement and tension suture + stoma replacement	23
4	Congenital intestinal malrotation	Bowel rotation 270° clockwise	Ladd operation and appendectomy	Horizontal	5	The thread that ligated the appendix became untied, and pus was seen in the abdominal cavity, but there was no fistula of the appendix	Abdominal lavage + debridement and tension suture	27
5	Neonatal necrotizing enterocolitis with perforation	Multiple perforations of the colon, and fistulization was made 10 cm from the ileocecal area	Enterostomy	Vertical	7	Unexplored abdominal cavity	Debridement and tension suture + stoma replacement	74

Statistical Analysis

SPSS software 22.0 (IBM, USA) was used for statistical analysis. Categorical variables were summarized as counts and percentages and compared with the use of chi-square test. Overall survival and AWD-free survival were calculated by the Kaplan-Meier method. The level of significance was set at $P < 0.05$.

Results

AWD occurred in 27 of 453 (6.0%) neonates undergoing laparotomy, among which partial wound dehiscence were 4.9% (22/453) and complete wound dehiscence were 1.1% (5/453). The patients with partial wound dehiscence were cured by conservative treatment, the 5 cases with complete dehiscence were cured by debridement and tension suture, and there was no recurrence of dehiscence or death. The patients were followed up for 6 to 12 months, no hernias were observed at the wound site, and the wounds healed well.

Analysis of Risk Factors

After stratified analysis of risk factors, we found that gender, age at admission, weight at admission, preterm delivery, operation time, and incision length were not risk factors for AWD, and the difference was not statistically significant ($P > 0.05$), while the level of preoperative anemia, hypoproteinemia, and incision type were the important risk factors for AWD ($P < 0.05$). The incidence of AWD was higher in patients with anemia, hypoproteinemia, and wound contamination. The correlation analyses of risk factors for neonatal AWD are shown in Table 3.

Table 3
Correlation analysis of risk factors for neonatal AWD.

Factors		Total cases (N = 453)	AWD (N = 27) Rate (%)		Chi-square value	P values
Gender	Male	298	17	63.0	0.101	0.750
	Female	155	10	37.0		
Admission age	< 7 days	283	14	51.9	1.378	0.240
	7–28 days	170	13	48.1		
Admission weight	< 2500 g	113	8	29.6	0.336	0.562
	≥ 2500 g	340	19	70.4		
Preterm delivery	Premature infant	54	4	14.8	0.229	0.632
	Term infant	399	23	85.2		
Preoperative anemia	Severe anemia	30	5	18.5	8.216	0.004
	Mild and moderate anemia	68	6	22.2		
	No anemia	355	16	59.3		
Hypoproteinemia	Preoperative hypoproteinemia	117	14	51.9	10.150	0.001
	No hypoproteinemia	336	13	48.1		
Operation time	< 2 hours	337	19	70.4	0.243	0.622
	≥ 2 hours	116	8	29.6		
Incision length	< 5 cm	155	9	33.3	0.010	0.921
	≥ 5 cm	298	18	66.7		
Incision type	I	106	2	7.4	10.980	0.001
	II	246	12	44.4		
	III	101	13	48.1		

The survival analysis of the study cohort showed that the overall AWD-free survival was 94.7% (Fig. 1). The cumulative risk was significantly higher in patients with preoperative anemia ($P < 0.05$, Fig. 2A), with severe anemia and mild to moderate anemia AWD-free survival of 83.3% and 91.2%, respectively, and there were no significant differences between the two groups ($P = 0.316$). The AWD-free survival significantly decreased in patients with severe anemia compared with those without anemia ($P = 0.093$, Fig. 2B).

The cumulative risk rate for infants with hypoproteinemia was significantly higher ($P < 0.05$, Fig. 3A) as compared to infants without hypoproteinemia. The AWD-free survival rate for patients with hypoproteinemia and patients without hypoproteinemia was 88.0% and 96.1%, respectively, and these were significantly different ($P = 0.001$). The AWD-free survival of patients with hypoproteinemia significantly decreased ($P < 0.05$, Fig. 3B).

For incision type, the cumulative risk rate for patients with a type III incision was significantly higher ($P < 0.05$, Fig. 4A). Patients with a type I incision, type II incision and type III incision had an AWD-free survival rate of 98.1%, 95.1% and 87.1%, respectively. There was no statistical difference between type I and type II incisions ($P = 0.119$). The AWD-free survival of patients with a type III incision significantly decreased ($P = 0.003$, Fig. 4B).

Discussion

With the development of modern medical approaches and anesthesia, there has been a significant increase in the number of neonatal abdomen surgical operations in some developing countries due to recognition and detection of neonatal gastrointestinal malformations [1]. Because of the immature development of organ function in neonates, low immune function and rapid change in disease are more prominent. Newborns are a high-risk group for AWD compared to older children and adults [2, 4].

The incidence of AWD with visceral prolapse in children is 1% – 4% [2, 3]. Wound dehiscence usually occurs within 1 week after surgery, and is the result of multiple factors [5]. However, few studies have reported the risk factors for neonatal AWD. In the current study, 9 factors including gender, age at admission, weight at admission, preterm delivery, level of preoperative anemia, hypoalbuminemia, operation time, incision length, and incision type were analyzed to explore their relationship with neonatal AWD.

In the current study, we found that the incidence of neonatal AWD was 6.0% (27/453), and that AWD occurred 3 to 8 days after surgery, mostly within 7 days. Through the analysis of the above related factors, we found that the level of preoperative anemia, hypoalbuminemia, and the type of incision were the main risk factors for neonatal AWD, but there was no significant correlation with gender, age at admission, weight at admission, premature delivery, operation time, or incision length.

It has been reported that the incidence of wound dehiscence after infection is 5–10 times as high as that after primary healing [6]. It has been noted that infection is an important cause of wound dehiscence. For the group of neonates in the current study, contaminated incisions (type II and III) accounted for 92.6% (25/27), the chance of contamination of the surgical field is higher than in aseptic surgery. The incidence of incision dehiscence increases with the increase of pollution degree. All 5 cases of complete wound dehiscence were underwent the intestinal tract surgery, and all received more than a type II incision. In 2 cases of enterostomy, the stoma was placed at the original wound made during the first surgery, and the intestinal fluid contaminated the wound and caused infection; in 1 case of congenital intestinal malrotation, the second celiac exploration showed that the thread used to ligate the appendix became undone, and pus was found in the abdominal cavity; and in the other 2 patients, the abdominal cavity was polluted by feces. Contamination occurred for the above-mentioned patients, indicating that wound contamination is an important risk factor for AWD. There was a positive correlation between incision type and AWD, and the incidence increased with the aggravation of pollution.

Malnutrition is an important factor affecting postoperative recovery [7, 8]. Albumin is the most commonly used index to evaluate nutritional status, and hypoproteinemia is closely related to the surgical outcome and postoperative complications [8–10]. In our study, we found that the incidence of AWD in patients with preoperative hypoproteinemia was 12%, while the incidence of AWD in patients without preoperative hypoproteinemia was only 3.9%, the former would be 3 times more than the latter. The results indicating that preoperative hypoproteinemia is closely related to AWD because the condition is not conducive to the healing of an abdominal wound. Healing is hindered because hypoproteinemia can reduce the synthesis of collagen and collagenase and the growth of granulation tissue on the wound surface, resulting in poor wound healing [11]. In patients with hypoproteinemia, the colloid osmotic pressure is low, and wound exudation is increased, which provides a medium for the growth and reproduction of bacteria and causes poor wound healing [12]. In addition, hypoproteinemia will lead to the hypofunction of several system organs, especially immune function, causing a decrease in the ability of the wound skin to protect against infection, which can lead to wound infection and dehiscence [13, 14].

Anemia is a common complication before neonatal surgery [15]. The results of this study show that the incidence of AWD in preoperative anemia patients was significantly increased compared with those without anemia, and the incidence of AWD in severe anemia patients was 12.2% higher than those without anemia, indicating that preoperative anemia was significantly related to AWD and was one of the important risk factors for AWD. Anemia in newborns decreases the oxygen-carrying capacity of the blood, which leads to anoxia of the cellular tissue around the wound, hinders the coverage of the wound by collagen, and affects wound healing [16]. In addition, anemia can also lead to low immune function, as red blood cells themselves are a component of the immune system, and participate in maintaining immunity [17]. Neonatal anemia is exacerbated by intraoperative bleeding, resulting in a decrease in postoperative immunity, and in turn, the patient is more prone to poor wound healing.

AWD can be induced in infants by the abdominal distention caused by postoperative enteroparalysis, poor gastrointestinal decompression, and crying [18]. The postoperative recovery of intestinal function was slow in the cases with abdominal distension. Abdominal distention can also directly affect the healing of wounds by aggravating any blood circulation disturbances in the abdominal wall [19]. Other factors such as improper clamping, as well as tearing and rubbing during surgery, and excessive use of an electric scalpel can cause necrosis and liquefaction of the abdominal wall. Failure to carefully recognize the tissue level when closing the abdomen, an abdominal wall that is not tightly closed, the formation of a local invalid cavity, too sparse or too dense needle spacing, and loose suture knots will have adverse effects on the normal recovery of a wound [18, 20, 21].

Vigilance is required to prevent neonatal AWD during the entire perioperative period [22, 23]. Because of the lack of nutritional reserve and the poor tolerance of surgery by neonates, perioperative nutritional support should be strengthened to improve the surgical success rate [24, 25]. The existence of anemia or electrolyte disorders should be corrected before surgery, and for those infants who are not able to accept oral liquid nourishment after surgery, total venous nutrition and albumin should be used to provide positive nitrogen balance [25]. In addition to adequate washing for those who have a severe abdominal cavity infection, effective antibiotics should also be used for control [26]. For those who have fistulization, another incision can be created for stoma replacement to prevent the first wound from being polluted by intestinal fluid. For patients with multiple risk factors, a preventive tension suture can be used [27, 28].

Conclusion

In conclusion, anemia, hypoproteinemia, and wound contamination were the main risk factors for the occurrence of neonatal AWD. Therefore, it is of great significance to strengthen nutritional support, correct preoperative anemia, and effectively control infection for the high-risk population of neonates. At the same time, factors such as cough, abdominal distention, and crying should be minimized or avoided to reduce the inducement of AWD. It should be efficiently and rapidly treated to reduce mortality once AWD occurs.

Abbreviations

AWD: Abdominal wound dehiscence; GA: Gestational age; HB: Hemoglobin

Declarations

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Authors' contributions

Study conception and design: SXD and JHL. Acquisition of the data: WHO, MXF, KHC, XQX, and WFX. Analysis and interpretation of the data: XZ, XWJ, LZ and SHM. Drafting of the manuscript: SXD. Critical revision: LZ, SHM and JHL. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This retrospective study was approved by the Institutional Review Board of Affiliated Hospital of Shantou University Medicine College.

Consent for publication

This article does not contain data on individual persons in any form.

Competing interests

The authors declare that they have no competing interests.

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Figures

Factors	N	Events	AWD-Free
Overall AWD-Free Survival	453	27	94.7%

Figure 1

Kaplan–Meier curve of overall estimated AWD-free survival in the patients.

Figure 2

Kaplan-Meier analysis of cumulative AWD rates (A) and preoperative anemia AWD-free survival (B) according to the level of preoperative anemia.

Figure 3

Kaplan-Meier analysis of cumulative AWD rates (A) and hypoproteinemia AWD-free survival (B) according to hypoproteinemia level.

Figure 4

Kaplan-Meier analysis of cumulative AWD rates (A) and incision type AWD-free survival (B) according to the type of incision.