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Contents

Monthly Volume 15 Number 7 July 27, 2023

REVIEW

- 1262 Pathophysiological consequences and treatment strategy of obstructive jaundice
Liu JJ, Sun YM, Xu Y, Mei HW, Guo W, Li ZL

MINIREVIEWS

- 1277 Carbon footprints in minimally invasive surgery: Good patient outcomes, but costly for the environment
Chan KS, Lo HY, Shelat VG

ORIGINAL ARTICLE

Basic Study

- 1286 Primary animal experiment to test the feasibility of a novel Y-Z magnetic hepatic portal blocking band
Zhang MM, Li CG, Xu SQ, Mao JQ, Ren YX, Zhang YH, Ma J, Shi AH, Lyu Y, Yan XP
- 1294 Magnetic compression anastomosis for reconstruction of digestive tract after total gastrectomy in beagle model
Zhang MM, Li CG, Xu SQ, Mao JQ, Zhang YH, Shi AH, Li Y, Lyu Y, Yan XP
- 1304 Differences in metabolic improvement after metabolic surgery are linked to the gut microbiota in non-obese diabetic rats
Luo X, Tan C, Tao F, Xu CY, Zheng ZH, Pang Q, He XA, Cao JQ, Duan JY
- 1317 Intervention effects and related mechanisms of glycyrrhizic acid on zebrafish with Hirschsprung-associated enterocolitis
Liu MK, Chen YJ, Chen F, Lin ZX, Zhu ZC, Lin Y, Fang YF, Wu DM
- 1331 Histological study of the structural layers around the esophagus in the lower mediastinum
Saito T, Muro S, Fujiwara H, Umebayashi Y, Sato Y, Tokunaga M, Akita K, Kinugasa Y

Case Control Study

- 1340 Liver transplantation for combined hepatocellular carcinoma and cholangiocarcinoma: A multicenter study
Kim J, Joo DJ, Hwang S, Lee JM, Ryu JH, Nah YW, Kim DS, Kim DJ, You YK, Yu HC
- 1354 Optimal choice of stapler and digestive tract reconstruction method after distal gastrectomy for gastric cancer: A prospective case-control study
Wu Z, Zhou ZG, Li LY, Gao WJ, Yu T

Retrospective Cohort Study

- 1363 Impact of perioperative blood transfusion on oncological outcomes in ampullary carcinoma patients underwent pancreaticoduodenectomy
Fei H, Zhang XJ, Sun CY, Li Z, Li ZF, Guo CG, Zhao DB

Retrospective Study

- 1375** Nomogram based on clinical characteristics for predicting overall survival in gastric cancer patients with preoperative anemia
Long Y, Zhou XL, Zhang CL, Wang YN, Pan WS
- 1388** Major complications after ultrasound-guided liver biopsy: An annual audit of a Chinese tertiary-care teaching hospital
Chai WL, Lu DL, Sun ZX, Cheng C, Deng Z, Jin XY, Zhang TL, Gao Q, Pan YW, Zhao QY, Jiang TA
- 1397** Different percutaneous transhepatic biliary stent placements and catheter drainage in the treatment of middle and low malignant biliary obstruction
Yang YB, Yan ZY, Jiao Y, Yang WH, Cui Q, Chen SP
- 1405** Utilization of deep neuromuscular blockade combined with reduced abdominal pressure in laparoscopic radical gastrectomy for gastric cancer: An academic perspective
Zhang YW, Li Y, Huang WB, Wang J, Qian XE, Yang Y, Huang CS
- 1416** Efficacy of peritoneal drainage in very-low-birth-weight neonates with Bell's stage II necrotizing enterocolitis: A single-center retrospective study
Shen Y, Lin Y, Fang YF, Wu DM, He YB
- 1423** Emergency exploratory laparotomy and radical gastrectomy in patients with gastric cancer combined with acute upper gastrointestinal bleeding
Kuang F, Wang J, Wang BQ
- 1434** Correlation of serum albumin level on postoperative day 2 with hospital length of stay in patients undergoing emergency surgery for perforated peptic ulcer
Xie D, Lu PL, Xu W, You JY, Bi XG, Xian Y

Clinical Trials Study

- 1442** Laboratory scoring system to predict hepatic indocyanine green clearance ability during fluorescence imaging-guided laparoscopic hepatectomy
Chen ZR, Zeng QT, Shi N, Han HW, Chen ZH, Zou YP, Zhang YP, Wu F, Xu LQ, Jin HS

Observational Study

- 1454** Incidence, characteristics and risk factors for alveolar recruitment maneuver-related hypotension in patients undergoing laparoscopic colorectal cancer resection
Zhang NR, Zheng ZN, Wang K, Li H
- 1465** New classification system for radical rectal cancer surgery based on membrane anatomy
Jiang HH, Ni ZZ, Chang Y, Li AJ, Wang WC, Lv L, Peng J, Pan ZH, Liu HL, Lin MB

Randomized Controlled Trial

- 1474** Transcutaneous electrical acupoint stimulation in adult patients receiving gastrectomy/colorectal resection: A randomized controlled trial
Hou YT, Pan YY, Wan L, Zhao WS, Luo Y, Yan Q, Zhang Y, Zhang WX, Mo YC, Huang LP, Dai QX, Jia DY, Yang AM, An HY, Wu AS, Tian M, Fang JQ, Wang JL, Feng Y

SYSTEMATIC REVIEWS

- 1485 Combined and intraoperative risk modelling for oesophagectomy: A systematic review
Grantham JP, Hii A, Shenfine J
- 1501 Spleen-preserving distal pancreatectomy from multi-port to reduced-port surgery approach
Hsieh CL, Tsai TS, Peng CM, Cheng TC, Liu YJ
- 1512 Resection of isolated liver oligometastatic disease in pancreatic ductal adenocarcinoma: Is there a survival benefit? A systematic review
Halle-Smith JM, Powell-Brett S, Roberts K, Chatzizacharias NA

META-ANALYSIS

- 1522 Outcome of split liver transplantation *vs* living donor liver transplantation: A systematic review and meta-analysis
Garzali IU, Akbulut S, Aloun A, Naffa M, Aksoy F

CASE REPORT

- 1532 Idiopathic hypereosinophilic syndrome with hepatic sinusoidal obstruction syndrome: A case report and literature review
Xu XT, Wang BH, Wang Q, Guo YJ, Zhang YN, Chen XL, Fang YF, Wang K, Guo WH, Wen ZZ
- 1542 Reoperation for heterochronic intraductal papillary mucinous neoplasm of the pancreas after bile duct neoplasm resection: A case report
Xiao G, Xia T, Mou YP, Zhou YC
- 1549 Successful resection of colonic metastasis of lung cancer after colonic stent placement: A case report and review of the literature
Nakayama Y, Yamaguchi M, Inoue K, Hamaguchi S, Tajima Y

ABOUT COVER

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Retrospective Study

Efficacy of peritoneal drainage in very-low-birth-weight neonates with Bell's stage II necrotizing enterocolitis: A single-center retrospective study

Yong Shen, Yu Lin, Yi-Fan Fang, Dian-Ming Wu, Yuan-Bin He

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Abstract

BACKGROUND

Currently, pediatric surgeons are challenged by a lack of consensus on the optimal management strategy (conservative or surgical) for children with Bell's stage II necrotizing enterocolitis (NEC).

AIM

To evaluate the clinical efficacy of peritoneal drainage in very-low-birth-weight (VLBW) neonates with modified Bell's stage II NEC.

METHODS

This was a retrospective analysis of 102 NEC (modified Bell's stage II) neonates born with VLBW who were treated at the Fujian Children's Hospital (Fujian Branch of Shanghai Children's Medical Center) between January 2017 and January 2020; these included 24 cases in the peritoneal drainage group, 36 cases in the exploratory laparotomy group, and 42 cases in the conservative treatment group.

RESULTS

The general characteristics were comparable in the three groups ($P > 0.05$). Compared with conservative treatment, peritoneal drainage was associated with significantly shorter fasting time, abdominal distension relief time, fecal occult blood (OB) negative conversion time, and reduced hospital length of stay (HLOS) ($P < 0.05$ for all). Despite some advantages of peritoneal drainage over conservative treatment in terms of cure, conversion to laparotomy, intestinal perforation,

intestinal stenosis, and abdominal abscess rates, the differences were not statistically significant ($P > 0.05$). Compared to exploratory laparotomy, the fecal OB negative conversion time was significantly shorter in the peritoneal drainage group ($P < 0.05$); similarly, the exploratory laparotomy group showed longer fasting time, abdominal distension relief time, HLOS, and higher complication rate compared to peritoneal drainage group, but the between-group differences were not statistically significant ($P > 0.05$).

CONCLUSION

Peritoneal drainage, an easy-to-operate procedure, can improve the clinical symptoms of VLBW neonates with Bell's stage II NEC and help reduce the HLOS.

Key Words: Stage II necrotizing enterocolitis; Enterocolitis; Very-low-birth-weight; Peritoneal drainage; Hospital length of stay

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Core Tip: Peritoneal drainage, a procedure simple to operate and easy to popularize, can reduce abdominal pressure and monitor intraperitoneal conditions, which is expected to be a third treatment option for very-low-birth-weight neonates with modified Bell's stage II necrotizing enterocolitis. This study validated the efficacy of peritoneal drainage from the perspectives of clinical symptom improvement, prognosis and neonatal complications.

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INTRODUCTION

Neonatal necrotizing enterocolitis (NEC) is a gastrointestinal (GI) emergency in newborns, especially in premature and low birth weight infants. The reported incidence of NEC in very-low-birth-weight (VLBW) infants is approximately 10% and the case fatality rate is as high as 20%-30%[1]. Although the case fatality rate has decreased in recent years with the improvement of treatment, NEC remains a major cause of death in the neonatal period, especially in VLBW infants. Children with Bell's stage I NEC are typically treated conservatively, while timely exploratory laparotomy is recommended for those with grade III NEC. However, there is no clear consensus on the optimal treatment strategy (conservative or surgical) for children with Bell's stage II NEC, posing a challenge for pediatric surgeons. This is because conservative treatment may be ineffective for grade III NEC, leading to further deterioration of the condition; on the other hand, surgical exploration may find no obvious intestinal necrosis requiring surgical intervention, causing an unnecessary surgical blow to the child and prolonging the hospital length of stay (HLOS)[2]. While being easy to operate and popularize, peritoneal drainage with catheters can reduce abdominal pressure and facilitate the monitoring of intra-abdominal conditions, which can be a third treatment option. In this study, we retrospectively reviewed 102 cases of Bell's stage II NEC admitted between January 2017 and January 2020. The objective of this study is to evaluate the effectiveness of peritoneal drainage for Bell's stage II NEC in neonates born with VLBW.

MATERIALS AND METHODS

Research participants

VLBW (birth weight < 1500 g) neonates with Bell's stage II NEC who were admitted to the neonatology department of Fujian Children's Hospital (Fujian Branch of Shanghai Children's Medical Center) between January 1, 2017 and January 1, 2020 were selected as the study subjects.

Inclusion criteria: (1) Grade II NEC diagnosed according to the modified Bell's staging criteria; and (2) The choice of the treatment was made by the family members of the children after they were thoroughly counselled about the illness and the advantages and disadvantages of each of the three available treatment methods.

Exclusion criteria: (1) Presence of major congenital anomalies that affect surgical considerations or primary outcome measures; (2) Other serious internal diseases; (3) Previous history of NEC; (4) Previous laparotomy or drainage tube placement; (5) Treatment refusal by children's legal guardians; and (6) Presence of intestinal necrosis during exploratory laparotomy that requires corresponding necrotic intestinal resection and anastomosis or fistulostomy.

Research methods

In this retrospective cohort study, VLBW children with Bell's stage II NEC were categorized into conservative treatment group, exploratory laparotomy group, or peritoneal drainage group depending upon the treatment modality received.

NEC diagnosis

The NEC diagnosis was made strictly following the NEC diagnostic criteria and the modified Bell's staging criteria for NEC[3].

Routine treatment

Fasting, GI decompression, intravenous nutrition therapy, blood transfusion, and anti-infection were carried out, and targeted antibiotics were administered based on each child's infection.

Conservative treatment

Conservative treatment, including fasting, GI decompression and intravenous nutrition to maintain water-electrolyte balance, improving GI microcirculation, correcting acidosis, anti-infection, and blood transfusion, was performed.

Peritoneal drainage

For peritoneal drainage, an incision was made at the McBurney's point in the right lower abdomen, or approximately 0.5 cm away from the reverse McBurney point, where a large amount of abdominal effusion was indicated by color Doppler ultrasound. Following the skin incision, an 8F trocar included in the peritoneal dialysis kit was used for puncture, which entered the abdominal cavity upon penetration. The needle core was then withdrawn and the catheter was inserted into the abdominal cavity for approximately 7-8 cm. After incision closure and fixation of catheter to the abdominal wall, a sterile bag was attached to the catheter. This was followed by rinsing of the abdominal cavity with normal saline, 20 mL at a time, twice daily.

Exploratory laparotomy

After general anesthesia, a transverse incision was made in the upper abdomen to explore the abdomen layer by layer. The operation mode was determined according to the child's weight, general condition, and lesion location and extent. In the absence of any obvious intestinal necrosis, the abdominal cavity was flushed and a drainage tube was placed before abdomen closure. In the presence of intestinal necrosis, a corresponding necrotic intestinal resection and anastomosis or fistulostomy was performed.

Data acquisition

Data pertaining to the following variables were retrieved from the electronic medical records: (1) General information: Sex, birth weight, and Apgar score; (2) Improvement of clinical symptoms: Fasting time, abdominal distension relief time, and fecal Occult blood (OB) negative conversion time; (3) Prognosis: HLOS, conversion to laparotomy, and cure rate; and (4) Neonatal complications: Incidence of intestinal perforation, intestinal stenosis, and peritoneal abscess.

Statistical analysis

Statistical analysis was conducted using R 4.0 statistical software. Continuous variables were presented as mean \pm SD, and the variance analysis and the Bonferroni test were employed for inter-group and pairwise comparisons, respectively. Categorical variables, represented by frequencies and percentages [n (%)], were compared between groups using the χ^2 test or Fisher's exact probability test, and pair-wise comparisons performed by the Bonferroni method. P values < 0.05 were considered indicative of statistical significance.

RESULTS

General information

During the study period, 102 cases of VLBW newborns with Bell's stage II NEC were treated at the neonatal surgery department at our hospital, including 42 cases in the conservative treatment group, 36 in the exploratory laparotomy group, and 24 in the peritoneal drainage group. The two groups showed no significant differences in terms of sex distribution, birth weight, or 1-min or 5-min Apgar scores ($P > 0.05$; Table 1).

Clinical symptoms

The mean fasting time in the conservative treatment, peritoneal drainage, and exploratory laparotomy groups were 12.36 ± 3.01 d, 7.08 ± 1.72 d, and 7.11 ± 1.60 d, respectively. The mean abdominal distension relief time in the three groups was 7.19 ± 1.88 d, 4.21 ± 1.10 d, and 3.94 ± 1.07 d, respectively, while the mean fecal OB negative conversion time was 8.36 ± 1.46 d, 4.58 ± 0.97 d, and 5.42 ± 1.13 d, respectively. All three parameters were significantly shorter in the peritoneal drainage group compared to the conservative treatment group ($P < 0.05$). Moreover, compared with exploratory laparotomy, peritoneal drainage was associated with significantly shorter fecal OB negative conversion time ($P < 0.05$); however, the fasting time and abdominal distension relief time were not significantly different between the exploratory laparotomy and peritoneal drainage groups (Table 2).

Table 1 General information

Groups	n	Sex, n (%)		Birth weight	1-min Apgar score	5-min Apgar score
		Male	Female			
Conservative treatment	42	26 (61.9)	16 (38.1)	2.11 ± 1.00	8.05 ± 1.15	9.29 ± 0.71
Peritoneal drainage group	24	13 (54.17)	11 (45.83)	2.05 ± 0.88	7.88 ± 1.15	9.00 ± 0.83
Exploratory laparotomy group	36	28 (77.78)	8 (22.22)	1.98 ± 0.84	8.19 ± 1.21	9.08 ± 0.77
t value		4.01		0.13	1.02	2.24
P value		0.134		0.936	0.601	0.326

Table 2 Comparison of improvement of clinical symptoms

Groups	Fasting time (d)	Abdominal distension relief time (d)	Time for fecal occult blood negative conversion (d)
Conservative treatment	12.36 ± 3.01	7.19 ± 1.88	8.36 ± 1.46
Peritoneal drainage group	7.08 ± 1.72 ^a	4.21 ± 1.10 ^a	4.58 ± 0.97 ^a
Exploratory laparotomy group	7.11 ± 1.60 ^a	3.94 ± 1.07 ^a	5.42 ± 1.13 ^{a,b}
t value	61.00	54.85	65.84
P value	< 0.001	< 0.001	< 0.001

^aP < 0.05 vs conservative treatment.^bP < 0.05 vs peritoneal drainage group.

Prognosis

As presented in Table 3, the laparotomy conversion rate in the conservative treatment and peritoneal drainage groups was 16.67% and 8.33%, respectively, with no significant difference ($P > 0.05$). The mean HLOS in the conservative treatment, peritoneal drainage, and exploratory laparotomy groups was 29.26 ± 5.18 d, 23.58 ± 3.67 d, and 23.94 ± 3.02 d, respectively. The HLOS was comparable in the peritoneal drainage and exploratory laparotomy groups ($P > 0.05$) that was shorter than that in the conservative treatment group ($P < 0.05$). The cure rates in the conservative treatment, peritoneal drainage and exploratory laparotomy groups were 83.33%, 91.67%, and 91.67%, respectively. The cure rate was identical in the peritoneal drainage and exploratory laparotomy groups, higher than that in the conservative treatment group, but without statistical significance ($P > 0.05$).

Neonatal complications

The incidence of intestinal perforation in the conservative treatment, peritoneal drainage and laparotomy groups was 21.43%, 8.33%, and 8.33%, respectively. The incidence of intestinal stenosis was 14.29%, 4.17%, and 2.78%, respectively, and the incidence of abdominal abscess was 11.9%, 4.17%, and 2.78%, respectively. Compared to conservative treatment group, fewer patients in the peritoneal drainage group developed intestinal perforation, intestinal stenosis, and abdominal abscess, but the between-group difference was not statistically significant ($P > 0.05$). The incidence rates of intestinal stenosis and abdominal abscess in the peritoneal drainage and exploratory laparotomy groups were lower than those in the conservative treatment, but the differences were not statistically significant ($P > 0.05$) (Table 4).

DISCUSSION

Neonatal NEC is a common GI condition during the neonatal period and a common cause of neonatal death. In intensive care units, the incidence of NEC ranges from 2%-5%, with an incidence of 4.5%-8.7% in VLBW infants and a case fatality rate of 20%-30%[4]. Primarily, NEC can be treated medically or surgically, depending on the severity of the disease, which is often classified by the Bell's staging system[5]. Conservative treatment, mainly refers to fasting, GI decompression, intravenous nutrition, and antibiotic therapy, and is usually recommended for children with Bell's stage I NEC. Patients with Bell's stage III NEC are typically treated by surgery as a life-saving intervention. However, the choice of optimal treatment strategy for children with Bell's stage II NEC, especially for VLBW infants, is challenging[6].

For VLBW children with Bell's stage II NEC, some authors support conservative treatment while others advocate early exploratory laparotomy. In 1977, Ein *et al*[7] proposed that peritoneal drainage should be performed rather than laparotomy, noting a better prognosis observed on follow-up. Lessin *et al*[8] argued that peritoneal drainage can be a reliable choice for NEC treatment in VLBW infants, and that there was no need for surgical treatment in those who failed to respond to this therapy. Murcia Pascual *et al*[9] suggested that peritoneal drainage is an effective treatment for NEC

Table 3 Patient prognosis in three groups

Groups	Hospital length of stay (d)	Cure, n (%)	Conversion to laparotomy n (%)
Conservative treatment	29.26 ± 5.18	35 (83.33)	7 (16.67)
Peritoneal drainage group	23.58 ± 3.67 ^a	22 (91.67)	2 (8.33)
Exploratory laparotomy group	23.94 ± 3.02 ^a	33 (91.67)	0 (0.00) ^a
<i>t</i> value	26.25	-	-
<i>P</i> value	< 0.001	0.533	0.023

^a*P* < 0.05 *vs* conservative treatment.**Table 4 Complications in three groups of neonates, n (%)**

Groups	Intestinal perforation	Intestinal stenosis	Peritoneal abscess
Conservative treatment	9 (21.43)	6 (14.29)	5 (11.9)
Peritoneal drainage group	2 (8.33)	1 (4.17)	1 (4.17)
Exploratory laparotomy group	3 (8.33)	1 (2.78)	1 (2.78)
<i>P</i> value	0.203	0.183	0.328

The Fisher's exact probability test is used.

children born with VLBW. In recent years, many experts have used peritoneal drainage as an independent treatment for children with Bell's stage II NEC, especially those born with VLBW, with good results achieved[10]. However, other scholars have proposed that peritoneal drainage alone may increase the occurrence of complications such as intestinal stenosis and even reduce the survival of children[11-13].

We hold that VLBW children with Bell's stage II NEC suffer from obvious abdominal distension, which increases the intra-abdominal pressure leading to impairment of GI barrier function and migration of bacteria and endotoxins[14], triggering sepsis and multi-organ function impairment. Moreover, severe intra-abdominal pressure is liable to induce intestinal ischemia[15], exacerbating intestinal inflammatory responses and increasing the risk of complications such as intestinal perforation and intestinal stenosis. Effective peritoneal drainage can rapidly reduce intra-abdominal pressure, thereby improving pulmonary function and venous return while enhancing intestinal circulation. Besides, proper saline irrigation can promote the discharge of bacteria and their metabolites from the abdominal cavity to a certain extent, thus reducing the occurrence of intestinal necrosis and intestinal stenosis. Our findings also suggest that peritoneal drainage is more effective than conservative treatment in terms of reducing fasting time, abdominal distension relief time, fecal OB negative conversion time, and HLOS; in addition, it has similar therapeutic benefits to exploratory laparotomy with the advantage of being simpler to perform and reduced hospitalization costs. Rao *et al*[12] reported that peritoneal drainage can avoid conversion to laparotomy in nearly half of preterm LBW infants with perforated NEC or spontaneous intestinal perforation, confirming a lower laparotomy conversion rate in infants in the peritoneal drainage group, similar to our findings. However, a meta-analysis by Loyola-Nieto *et al*[16] showed no significant advantage of peritoneal drainage over laparotomy in terms of HLOS for perforated NEC in LBW premature infants. The inconsistency between our findings and the meta-analysis may be attributable to the small sample size of this study. In terms of cure rates and incidence of complications, no significant differences were determined between peritoneal drainage and exploratory laparotomy, which were higher but not statistically different from the conservative treatment. This may be related to the relatively small number of patients or to the inherent limitations of a single-center study. Ahle *et al*[17] found no significant difference in terms of complication rate and mortality between peritoneal drainage and exploratory laparotomy for spontaneous intestinal perforation, suggesting comparable safety profile and prognostic effects of the two treatment modalities, consistent with our findings. In addition, Sharma *et al*[18] reported that exploratory laparotomy was clinically superior to peritoneal drainage in VLBW infants in terms of timely recognition of intestinal perforation and reduced risk of complications such as severe thrombocytopenia or neutropenia.

All in all, for VLBW neonates with Bell's stage II NEC, peritoneal drainage therapy can reduce intra-abdominal pressure and abdominal infection, relieve clinical symptoms, and shorten the HLOS. In addition, due to the relatively simple operation of peritoneal drainage, it is easier to be applied in underdeveloped settings. Moreover, this procedure mitigates the impact of surgery and anesthesia on children, with advantages over direct laparotomy in terms of long-term prognostic benefits. However, the single-center scope of the study, the retrospective study design, and the relatively small sample size are some of the study limitations which may have introduced an element of bias. Larger multi-center studies are required to obtain more robust evidence.

CONCLUSION

Peritoneal drainage may help improve the clinical symptoms of VLBW neonates with Bell's stage II NEC and shorten the HLOS. Owing to the simple procedure, it is worth popularizing in clinical practice.

ARTICLE HIGHLIGHTS

Research background

For very-low-birth-weight (VLBW) neonates with modified Bell's stage II necrotizing enterocolitis (NEC), the controversy over the choice of treatment (conservative or surgical) is also a challenge for pediatric surgeons.

Research motivation

To find an effective treatment scheme with clinical promotion and application value for VLBW newborns with modified Bell's stage II NEC.

Research objectives

To investigate the clinical efficacy of peritoneal drainage in the treatment of VLBW newborns with modified Bell's stage II NEC.

Research methods

A total of 102 VLBW newborns with modified Bell's stage II NEC were included, including 24 in the peritoneal drainage group, 36 in the exploratory laparotomy group, and 42 in the conservative treatment group. The efficacy of the three groups was comparatively analyzed.

Research results

Compared with conservative treatment, the time of fasting, abdominal distension relief, negative conversion of fecal occult blood (OB) and hospital length of stay (HLOS) of peritoneal drainage were significantly shorter. Although peritoneal drainage showed some advantages over conservative treatment in the rates of cure and conversion to laparotomy, as well as the incidences of intestinal perforation, intestinal stenosis and abdominal abscess, the advantages were not significant. Taking exploratory laparotomy as the control, the time of fecal OB negative conversion in the peritoneal drainage group was statistically shortened. In addition, laparotomy exploration and peritoneal drainage were not statistically different in fasting time, abdominal distension relief time, HLOS, and complication rate.

Research conclusions

Peritoneal drainage is a simple-to-operate procedure that can improve the clinical symptoms of VLBW newborns with modified Bell's stage II NEC and reduce HLOS, which is worthy of clinical generalization.

Research perspectives

Peritoneal drainage is relatively simpler and easier to use in economically underdeveloped areas. In addition, it reduces the impact of surgery and anesthesia on children, and is superior to direct laparotomy in terms of long-term prognostic benefits, with high clinical application value. However, as a single-centered retrospective clinical analysis with a relatively small number of cases, this study may still have certain limitations.

FOOTNOTES

Author contributions: Shen Y and Lin Y contributed equally to this work and are co-first authors; Shen Y and Lin Y designed the research study; Shen Y, Lin Y, Fang YF and Wu DM contributed reagents and analytic tools; Shen Y, Lin Y and He YB analyzed the data; Shen Y and Lin Y wrote the manuscript; and all authors have read and approved the final manuscript.

Institutional review board statement: The study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Medical Ethics Committee of Fujian Children's Hospital (registration number: 2022ETKLR08021).

Informed consent statement: This is a retrospective study, and since the analysis used anonymous clinical data approved by the Ethics Committee of Fujian Children's Hospital, the need for informed consent from subjects or guardians was waived.

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