Negative pressure device used in pediatric patients with Hostile abdomen. Case series

K. Serrano Concha[1], H. Morales Mayorga[1], D. Acosta Farina[1,2], L. Mendoza Saldarreaga[1], V. Pólit Guerrero[1,2], J. Oliveros Rivero[1], D. Acosta Bowen[3]

[1]Department of Pediatric Surgery. Hospital de Niños Dr. Roberto Gilbert Elizalde. Guayaquil (Ecuador). [2]Universidad Católica Santiago de Guayaquil (Ecuador). [3]Family Medicine. Mount Sinai Hospital. Chicago (EE.UU.).

ABSTRACT

Introduction. Hostile abdomen is a surgical condition characterized by loss of space between organs and structures in the abdomen. Negative pressure therapy use has been widely described in adults; the case is not the same for pediatric patients. The goal of this study is to present short-term results of negative pressure therapy use in pediatric patients with hostile abdomen due to different etiologies.

Materials and methods. Pediatric hostile abdomen patients (<18 years) who were treated Negative pressure therapy using ABTHERA were identified and retrospectively reviewed.

Results. 7 patients were included in this study. Median age was 16 (range: 9-17 yo). 5 (71.4%) were male and 2 (28.6%) females. 3 (43%) had significant past medical/surgical history (Systemic Lupus Erythematosus, complicated appendectomy and ventriculoperitoneal-shunt). The device was set at a continuous pressure ranging from –50 to –125 mmHg. Pre and post-surgical findings were reported using Bjork's classification. Devices were replaced every 4-7 days (median 5 days). Total amount of replacements was 1-4 (median 3). 5 (71.4%) patients required invasive mechanical ventilation during use of Negative pressure therapy based on clinical status. 4 (57%) patients received enteral nutrition. 1 (14%) patient required re-intervention posterior to definitive closure due to retroperitoneal abscess development. Outcome, evaluated by (oral tolerance, bowel movement and absence of pain), was favorable in all patients.

Conclusion. Negative pressure therapy devices generate favorable results in hostile abdomen in pediatric population but further information is needed to assess pressure settings and device replacement frequency.

KEY WORDS: Abdominal wound closure techniques; Open abdomen techniques; Negative-pressure wound therapy; Pediatrics.

DISPOSITIVO DE PRESIÓN NEGATIVA EMPLEADO EN PACIENTES PEDIÁTRICOS CON ABDOMEN HOSTIL: SERIE DE CASOS

RESUMEN

Introducción. El abdomen hostil es una patología quirúrgica caracterizada por una pérdida de espacio entre los órganos y estructuras del abdomen. La terapia de presión negativa se ha descrito de manera extensa en adultos, pero no así en pacientes pediátricos. El objetivo de este estudio es presentar los resultados a corto plazo de la terapia de presión negativa en pacientes pediátricos con abdomen hostil debido a distintas etiologías.

Material y métodos. Identificación y análisis retrospectivo de los pacientes pediátricos con abdomen hostil (< 18 años) tratados con terapia de presión negativa ABTHERA.

Resultados: Se incluyó a 7 pacientes. La mediana de edad fue de 16 años (rango: 9-17). 5 (71,4%) eran niños y 2 (28,6%) niñas. 3 (43%) presentaban antecedentes médico-quirúrgicos de interés (lupus eritematoso sistémico, apendicectomía complicada y derivación ventriculoperitoneal). El dispositivo se empleó a presión constante, entre –50 y –125 mmHg. Los hallazgos preoperatorios y postoperatorios se notificaron mediante la clasificación de Bjork. Los dispositivos se sustituyeron cada 4-7 días (mediana de 5 días). La cantidad total de reemplazos fue de 1-4 (mediana de 3). 5 (71,4%) pacientes precisaron ventilación mecánica invasiva durante la terapia de presión negativa debido al estado clínico. 4 (57%) pacientes recibieron nutrición enteral. 1 (14%) paciente requirió reintervención posterior al cierre definitivo por el desarrollo de un absceso retroperitoneal. El resultado, evaluado en base a la tolerancia oral, el movimiento intestinal y la ausencia de dolor, fue favorable en todos los pacientes**.**

Conclusión. Los dispositivos de terapia de presión negativa aportan resultados favorables en los pacientes pediátricos con abdomen hostil, aunque se necesita más información para evaluar los ajustes de presión y la frecuencia de reemplazo del dispositivo.

PALABRAS CLAVE: Técnicas de cierre de heridas abdominales, Técnicas de abdomen abierto; Terapia de presión negativa; Pediatría.

INTRODUCTION

Hostile abdomen is a surgical condition characterized by loss of space between organs and structures in the abdomen. Its main causes are severe adhesions and pathologies

DOI: 10.54847/cp.2024.01.16

Corresponding author: Dr. Karen Serrano Concha. Department of Pediatric Surgery. Hospital de niños Dr. Roberto Gilbert Elizalde. Av. Roberto Gilbert y Nicasio Safadi. 090505 Guayaquil, Ecuador.
E-mail address: kaprilu24@hotmail.com

Date of submission: June 2023 *Date of acceptance:* December 2023

Figure 1. 16-year-old patient with closed abdominal trauma due to traffic accident, with jejuno-ileal intestinal perforation with: A) laparostomy device; B) laparostomy device removal results on the 4th day; C) Abthera device placement; D) Abthera device removal results on the 5th day.

who require subsequent re-interventions (generating high morbimortality)[1,2].

Negative pressure therapy (NPT) use has been widely described in adults; the case is not the same for pediatric patients[3].

NPT system for the treatment of the open abdomen works through several different mechanisms. First, the porous dressing may help to isolate the abdominal contents from the abdominal wall and external environment. Second, the negative pressure may actively remove fluid and inflammatory cytokines, helping to reduce oedema, prevent intra-abdominal hypertension and also may help reduce the formation of adhesions between the bowel and anterior peritoneum. Third, the pressure effect is proposed to promote cellular migration and growth of new blood vessels. Fourth, the suction system, using negative pressure, removes fluid and infectious materials from the open abdomen. Finally, it may provide medial tension, which may help to minimize fascial retraction and facilitate the achievement of primary closure[4,5].

The goal of this study is to present short-term results of negative pressure therapy use in pediatric patients with hostile abdomen due to different etiologies (Fig 1).

MATERIALS AND METHODS

A retrospective study was performed. 7 patients diagnosed with hostile abdomen (diverse etiologies) were included. They were treated with NPT using ABTHERA (KCI, San Antonio, TX) in the Hospital, from 09/20 until 05/22.

Pre and post-surgical findings were reported using Bjork's classification (Table 1).

Studied variables were age, gender, past medical/surgical history, interventions before TPN use, surgical findings before and after TPN use (according to Bjork[6] (Table 2), device pressure settings, device replacement frequency (since its first use until abdominal wall is completely closed), invasive mechanical ventilation require-

Table 1. Open abdomen classification according to Bjork (updated 2016)

Scale		*Description*
1	1 A	Clean open abdomen. No adherence between bowel and abdominal wall.
	1 B	Contaminated open abdomen. No adherence/fixity.
	1 C	Enteric leak, no fixation.
2	2 A	Clean open abdomen. Developing adherence/fixity.
	2 B	Contaminated open abdomen. Developing adherence/fixity.
	2 C	Enteric leak, developing fixation.
3	3 A	Clean, frozen abdomen.
	3 B	Contaminated, frozen abdomen.
4	4	Established enteroatmospheric fistula, frozen abdomen.

ment, enteral nutrition, re-intervention, and outcome. Data was gathered using Microsoft Excel 2016 and statistical analysis was performed using SPSS 21.0.0.0.

RESULTS

Seven patients were included in this study. Age range was between 9-17 y/o (median 16). Five (71.4%) were male and two (28.6%) females. Three (43%) had significant past medical/surgical history (systemic lupus erythematosus, complicated appendectomy and VP shunt). The device was set at a continuous pressure ranging from -50 to -125 mmHg. Devices were replaced every 4-7 days (median 5 days). Total amount of replacements was 1-4 (median 3). Five patients (71.4%) required invasive mechanical ventilation during use of NPT, based on clinical status. Four patients (57%) received enteral nutrition. One patient (14%) required re-intervention posterior to definitive closure due to retroperitoneal abscess development. Outcome, evaluated by (oral tolerance, bowel movement and absence of pain), was favorable in all patients (Fig. 2).

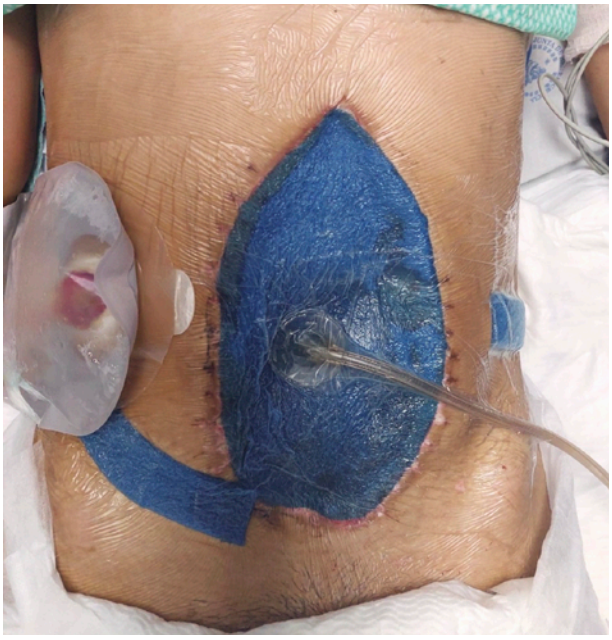

Figure 2. 14-year-old male patient with hostile abdomen secondary to peritonitis due to appendicitis.

DISCUSSION

Hostile abdomen is a surgical condition characterized by loss of space between organs and structures in the abdomen. It is mainly caused by the appearance of severe adherence syndrome after surgery. Any peritoneal lesion unleashes inflammatory cascade, angiogenesis, fibroblastic activity and fibrin/collagen condensation (which forms fibrous bands between organs and tissues; being the most common site between bowel and abdominal wall)[1,6].

Open abdomen management in pediatric patients represents a higher infection risk than adults, due to rapid heat loss and small blood volume. The NPT device (ABTHERA) is easily adaptable to the needs of the abdominal wound in pediatric population[3].

Multiple etiologies have been described for hostile abdomen. In this series it presented most frequent secondary to intestinal perforations (diverse location), in 5 (71.4%) cases. There is no established guideline regarding the exact NPT device replacement frequency in pediatric patients. Recommendations suggest every 5 days, as in our series. In case #VI replacement was delayed due to unstable hemodynamic conditions. Outcome was favorable despite the delay.

In 2009, Bjork created an open abdomen wound classification. Patients were classified according to the complexity of the case. In 2016, and with the backup of the

Table 2. Characteristics of patients who underwent NPT.

Patient	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*
Age (Years)	14	16	16	16	15	17	9
Gender	M	M	F	F	M	M	M
Past Medical/ surgery History	–	–	SLE	– Open appendectomy – Reintervention due to colonic perforation (hemicolectomy and Brooke type Ileostomy)	VPS	–	–
Hostile abdomen ethiology	– Closed abdominal trauma – Duodenal perforation	– Acute abdomen 2dary to Appendicitis	– Acute abdomen 2dary to spontaneous colonic perforation	– Acute abdomen 2dary to ileal perforationA	– Severe adherence syndrome – Jejunum perforation	– SMA syndrome – Intestinal anastomosis dehiscence	– Abdominal penetrating trauma 2dary to firearm lesion – Duodenal perforation – Retroperitoneal hematoma
Initial surgical approach (before NPT)	– Exp laparotomy – Complete omentectomy – Double barrel jejunostomy – Cavity irrigation – Abdominal drain placement – Laparostomy	– Exp laparotomy – Complete omentectomy – Appendectomy – Cavity irrigation – Tubular drain placement x2	– Exp laparoscopy – Exp laparotomy – Tutorization of perforation area – Laparostomy	– Exp laparotomy – Ileum resection – Ileostomy adaptation – Tubular and Penrose drain placement – Laparostomy	– Exp laparotomy – Dehiscence breakdown– 1ary enterorrhaphy –jejunum perforation – Cavity irrigation – Laparostomy	– Exp laparotomy – Piloroplasty – Termino-terminal anastomosis (duodenojejunal)	– Exp laparotomy – Complete omentectomy – Cavity irrigation – Tubular drain placement x2
Abdominal findings pre-NPT (Bjork)	3B	3B	3B	3B	3B	2C	2C
Abdominal findings post-NPT (Bjork)	2A	2A	3A	2A	2A	2A	1A
Frequency of replacement (days)	4	5	4	4	5	7	5
Total amount of replacements	3	1	3	1	2	3	4
Invasive mechanical ventilation requirement	Yes	Yes	No	Yes	No	Yes	Yes
Enteral nutrition requirement	Yes	No	No	No	Yes	Yes	Yes

SLE: systemic lupus erythematosus; VPS: ventriculo-peritoneal shunt; M: male; F: female; SMA: superior mesenteric artery.

(WSACS) The World Society of the Abdominal Compartment Syndrome[7,8], the classification was updated. All our patients evidenced a decrease in class after NPT.

In conclusion, hostile abdomen remains as a complex pathology in pediatric population. Its management has not been standardized, mainly because of worldwide underreport. NPT devices generate favorable results, but further information is needed to assess pressure settings and device replacement frequency. In our series all patients benefited from NPT, evidenced by decrease in Bjork class and no re-intervention requirement posterior to abdominal wall closure.

REFERENCES

1. Zurita Aguirre GK, Ramírez Pulua DA, Ureña Ureña JF, Marín Castro PX. Terapia de presión negativa para el manejo de abdomen catastrófico secundario a íleo biliar. Rev Cub de Cir. 2022; 61: e1085.
2. Salazar-Jiménez M, Alvarado-Duran J, Fermín-Contreras M, Rivero-Yanez F, Lupian-Angulo A, Herrera-Gonzalez A, et al. Íleo biliar, revisión del manejo quirúrgico. México: Cirugia y Cirujanos. 2018; 86: 182-6.
3. Soma J, Ishii D, Miyagi H, Ishii S, Motoki K, Kawabata H, et al. Damage control surgery for grade IV blunt hepatic injury with multiple organ damage in a child: a case report. Surg Case Rep. 2021; 7: 269.
4. Cheng Y, Wang K, Gong J, Liu Z, Gong J, Zeng Z, et al. Negative pressure wound therapy for managing the open abdomen in non-trauma patients. Cochrane Database Syst Rev. 2022; 5: CD013710.
5. Demetriades D. Total management of the open abdomen. Int Wound J. 2012; 9 Suppl 1(Suppl 1): 17-24.
6. Caballero Arevalo AM, Daza Caballero M, Lara Pérez CA. Abdomen hostil: complicación quirúrgica ulterior a 9 intervenciones. Rev Cient Cienc Med. 2018;21:107-112.
7. Björck M, Bruhin A, Cheatham M, Hinck D, Kaplan M, Manca G, et al. Classification--important step to improve management of patients with an open abdomen. World J Surg. 2009; 33: 1154-7.
8. Björck M, Kirkpatrick AW, Cheatham M, Kaplan M, Leppäniemi A, de Waele JJ. Amended classification of the open abdomen. Scand J Surg. 2016; 105: 5-10.