

Bogota Bag and Negative-Pressure Wound Therapy (NPWT) Experience in Children

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Abstract

Introduction: As the war that took place in Syria caused many tragedies, it also brought children with open abdominal wounds which are not very common in pediatric surgery practice. In this study, we present the results of ten children treated with BB and NPWT for open-abdomen.

Materials and Methods: We retrospectively reviewed the hospital records of ten children who were treated with BB and NPWT in our clinic between February 2016 and June 2018.

Results: Ten of the patients had sustained firearm injuries during the war in Syria. There were four girls and six boys. The average age was 8.1 years (2-14 years). Five patients received BB in emergency conditions followed by NPWT. Five patients received NPWT only. Abdomen could be closed in all 10 patients who treated with combined BB and/or NPWT. Enteroatmospheric fistula developed in one patient and ventral hernia developed in one patient. No mortality occurred in our patients.

Conclusion: BB and NPWT techniques can be applied fast and easy and have a high success rate in children with an open abdomen.

Keywords

- Open abdomen
- Bogota bag
- Negative pressure
- Wound therapy
- Children

Introduction

As the war that took place in Syria caused many tragedies, it also brought children with open

abdominal wounds which are not very common in pediatric surgery practice **Figure 1** (Patient 10).



Figure 1: A pediatric patient with open abdominal wound due to war trauma

Laparostomy has been recommended since 1979 in cases with hemodynamic instability, open abdomen that cannot be closed anatomically with primary repair, compartment syndrome, intraabdominal drainage due to severe infection, the need for re-laparotomy, abdominal sepsis and for damage control.¹ However, in children, laparostomy is rarely required and performed.^{2,3} So far, several methods such as Bogota bag (BB), vacuum-assisted closure, skin closure alone with various types of sutures, abdominal re-approximation anchor system (ABRA), mesh closure, Wittmann patch, Barker's vacuum pack, and commercial negative-pressure wound therapy (NPWT) have been described for the management of open abdomen.^{1,4,5} The Bogota bag (BB) was first described in an adult patient

in 1984, where it was used to close the abdomen during the third surgical operation.⁴ NPWT has been used in adults for almost 20 years.^{1,5} In this study, we present the results of ten children treated with BB and NPWT for open-abdomen. Our patients have been injured by firearms during the war in Syria.

Materials and Methods

We retrospectively reviewed the hospital records of ten children who were treated with BB and NPWT in our ward between February 2016 and June 2018. Patients' age, gender and BB and NPWT application durations were determined. Patients who received BB and NPWT (ABThera™ (ABT) system developed by KCI, San Antonio, USA)

since their abdomen could not be closed primarily and/or they had abdominal sepsis were included in the study. Patients were classified as open abdomen

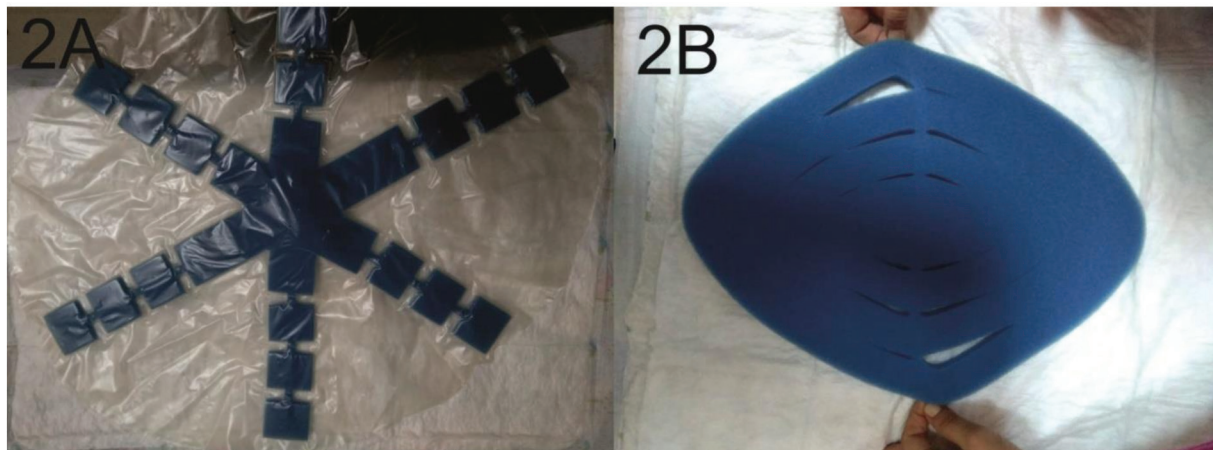
according to the classification system proposed by the World Society of Abdominal Compartment Syndrome (WSACS) **Table 1.**⁶

Table 1: Open abdomen classification

Grade 1A	Clean OA without adherence between bowel and abdominal wall or fixity of the abdominal wall (lateralization of the abdominal wall).
Grade 1B	Contaminated OA without adherence /fixity
Grade 2A	Clean OA developing adherence /fixity
Grade 2B	Contaminated OA developing adherence /fixity
Grade 3	OA complicated by fistula formation
Grade 4	Frozen OA with adherent bowel, unable to close surgically, with or without fistula

Follow-up and treatment of patients were conducted under intensive care conditions by 3 pediatric surgeons. For NPWT treatment, the

polyurethane foam was trimmed appropriately to cover the defect and placed on the open abdomen **Figure 2A-2B.**



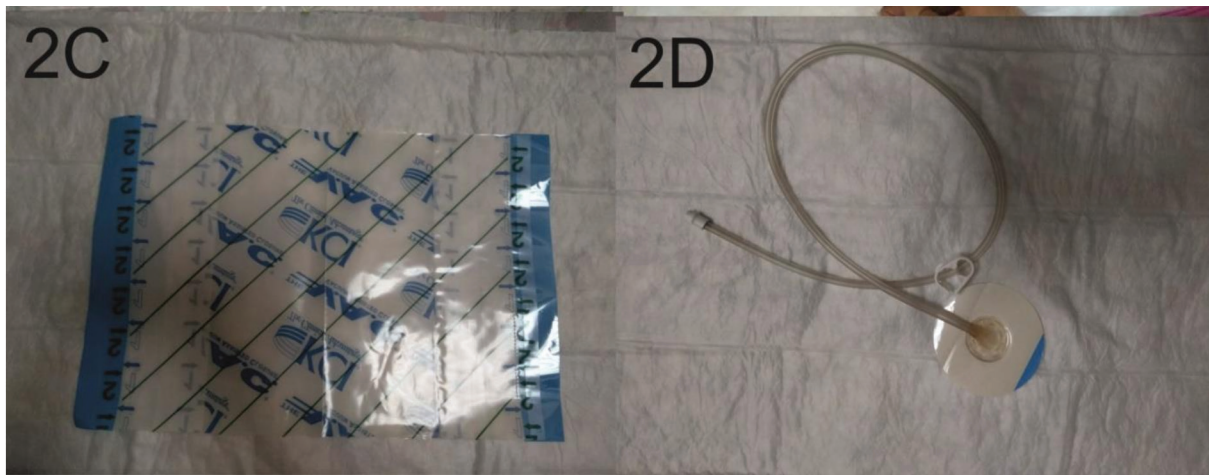


Figure 2: NPWT (negative-pressure wound therapy) devices

Then, the foam and surrounding wound was covered with a transparent film to form an airtight seal and the skin was covered **Figure 2C**. Before attaching the apparatus providing negative pressure to NPWT pump, it was cut in a 1 cm diameter and glued **Figure 2D**. Negative pressure was constantly kept at -80-100 mmHg. During the treatment period, NPWT systems that had air leakage or provided inappropriate negative pressure were changed in the operating room (it was changed 3-5 times in total). Patients who received NPWT for wound care or other reasons (orthopedics, cardiac, plastic surgery operations, burns, etc.) and those older than 16 years of age were excluded from the study. The ethics committee approved the study

which was conducted according to the Helsinki Declaration. Informed consent was obtained from the patients, their parents or next-of-kin who were with the patient.

Results

Ten of the patients had sustained firearm injuries during the war in Syria. They had received initial damage control surgeries in Syria and thereafter they were transferred to our hospital for follow-up and treatment. There were four girls and six boys. The average age was 8.1 years (2-14 years). Five patients received BB **Figure 3** in emergency conditions followed by NPWT. Five patients received NPWT only **Figure 4A-4B-4C-4D**

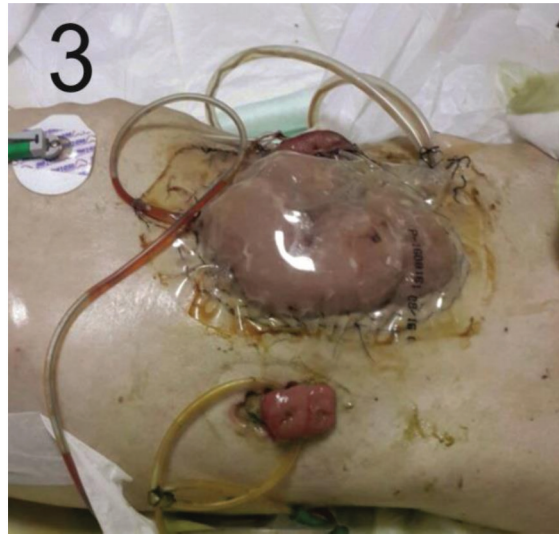


Figure 3: A patient with BB

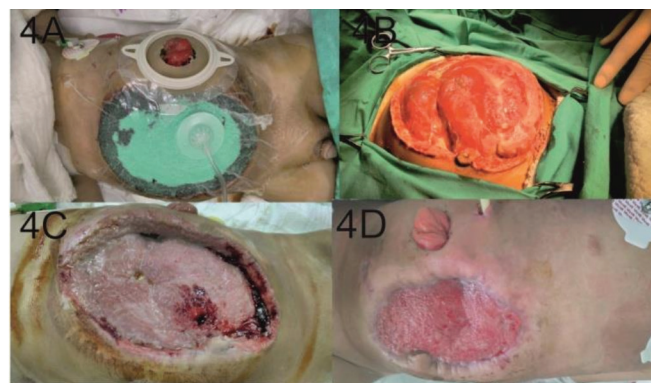


Figure 4: Patient with NPWT at different stage of recovery

Mean BB duration was 8.4 days (2-2-2-7-29 days) and mean NPWT duration was 20 days (7-9-10-12-19-22-25-26-30-40 days). Diameters of abdominal defect decreased and granulation tissue developed at the end of the treatment in all patients. In two patients, the defect was closed primarily with granulation tissue and a graft/flap was not needed. In one patient, a fasciocutaneous flap was applied over the granulation tissue. In the

remaining 7 patients, split thickness skin grafting was performed over the granulation tissue. All of the patients were healed. Complications developed in two patients. As a complication, entero-atmospheric fistulas developed in one patient and ventral hernia developed in another. No mortality occurred in our patients. The primary diagnosis and information of the patients are summarized in **Table 2**.

Table 2: The primary diagnosis and information of the patients

Patients	Age (year)/ Sex	Primer Diagnosis	First Operation	Second Operation	Third Operation	Time of BB/day	Time of NPWT /day	Results
1	7 Y/M	Firearm injury	Damage control surgery (DCS) in Syria	Laparotomy	-	-	10	Graft/ Cure
2	7 Y/F	Firearm injury	DCS in Syria	Enterostomy	Evisceration	2	25	Cure
3	6 Y/M	Firearm injury	(DCS in Syria) (Stomach and intestine repare)	Colostomy	Compartment syndrome	7	40 (Gastrostomy in 30 days)	Graft/ Cure
4	2,5 Y/F	Firearm injury	DCS in Syria	? (in Syria)	faeces drainage from the incision	-	7	Fasyocutane flep/ Cure
5	14 Y/F	Firearm injury	(DCS in Syria) Colostomy	Colostomy revision	-	-	30	Graft/ Cure
6	14 Y/ M	Firearm injury	DCS in Syria	Laparotomy	Laparotomy (Two anastomoses were repaired again)	29	9	Graft/ Cure
7	13 Y/F	Firearm injury	Colostomy (in Syria)	Repair of intestine	-	2	22	Graft/ Cure
8	2 Y/M	Firearm injury	DCS in Syria	? (in Syria)	-	-	12	Cure

9	7	Firearm injury	(DCS in Syria) (Bladder and intestine reaire)	(in Syria) (Bladder reaire)	-	-	19	Cure
10	9	Firearm injury	DCS in Syria	Laparotomy (Two bowel anastomoses and uretero ureteric anastomosis was performed)	-	2	26	Graft/ cure
	Y/F							
	Y/M							

Discussion

The first method to close an open abdomen was described by Ogilvie during the World War II in 1940 [5]. Laparostomy has been used increasingly, especially in adult patients, over the last 30 years, resulting in a significant reduction in mortality.^{6,7} Laparostomy is frequently used in adults if the abdomen cannot be closed primarily, the development of compartment syndrome is expected, damage surgery is used, the patient has had critical trauma, diffuse peritonitis, wound dehiscence, mesenteric ischemia, intraabdominal sepsis or necrotizing pancreatitis.^{8,9} On the other hand, it is rarely used in children and frequent indications for laparostomy in this age group include rapidly growing stage 4S neuroblastoma, abdominal wall malformations (gastroschisis, omphalocele), necrotizing enterocolitis, vascular malformations, severe constipation, and after cardiac, orthopedic, plastic surgery.^{2,3,10,11} However, there was no literature on the management of open abdomen after firearm injuries in children. We performed BB and NPWT in children since they had severe tissue defect that could not be closed primarily and/or abdominal sepsis in eight patients and wound infection and evisceration in two patients.

The optimal temporary abdominal closure technique should protect the abdominal content, enable adequate drainage, prevent evisceration, decrease intra-abdominal pressure, protect the fascia before a subsequent operation, control infection and inflammation.^{8,10} We have used BB and NPWT, which we thought would provide these conditions, in our patients. A polyvinylchloride-containing plastic bag was used when BB was first described,

but polypropylene, polytetrafluoroethylene (PTFE) grafts, composite materials, and biological materials were used in the subsequent years.⁴ BB was our first choice in patients with bowel repair because NPWT might be risky for intestinal anastomosis security. We preferred sterile saline bags because of their wide availability, low cost and short application time **Figure 3**. Since BB is transparent, it provides easy visualization. It does not have a size problem and can be directly sutured to the wall of the abdomen or to the edge of the fascia.^{8, 12} NPWT which is reported to have higher rates of abdominal closure compared to BB and other methods, improves wound healing by increasing blood perfusion, angiogenesis, cellular division rate and proliferation through induction of vascular endothelial growth factor (VEGF) and angiopoietin-2.^{1, 10, 13} NPWT also began to dominate other methods because of its advantages such as flexibility, not adhering to tissue, lower allergenicity, not causing an inflammatory response, hypothermia prevention, being relatively easy to learn and preservation of fascia.^{4, 14} However, the downsides of NPWT include the development of an enteroatmospheric fistula. Compared to NPWT, BB has the advantages of being cheaper and available in all hospitals and therefore it can be preferred in the first place. NPWT is not readily available in hospitals and requires preparation. Therefore, we used BB in the acute period in our patients because it's widely available, cheap, and does not require preparation. But in the later period, we replaced BB with NPWT and continued the treatment with NPWT.

Although still controversial, it has been reported in experimental studies that intermittent vacuum

therapy is more effective than continuous vacuum therapy in terms of granulation tissue formation.¹⁵ We preferred continuous vacuum therapy in our patients because the fluids often were peritoneal fluids, sometimes included intestinal content and required serious drainage (200-500 cc daily drainage).

The application of NPWT is controversial in terms of anastomosis safety in cases with gastrointestinal repair and enterocutaneous fistula.¹² One of our patients had undergone jejunojejunal and gastrojejunal anastomosis after firearm injury in Syria (patient 6). After the patient's referral to our department, we detected during a second laparotomy that both anastomoses had separated almost completely. We repaired both anastomoses and delayed the transition from BB to NPWT to 29th day due to the concerns of negative effects of NPWT on anastomosis. In this patient, granulation tissue was developed after the treatment and the abdomen was closed with a graft.

In patients treated with NPWT, the rate of open abdomen closure varies according to the primary diagnosis. The NPWT success rate may be as low as 22% in cases with pancreatitis and as high as 92% in those with trauma.^{16, 17} A success rate of 40% was reported for BB.^{1, 12, 15} Despite all developments in treatment modalities, the open abdomen is still a serious clinical condition and the rate of mortality and morbidity (enteroatmospheric fistula, ventral hernia, etc.) is still high.¹⁸ The mortality rate was reported between 20% and 60% in patients with an open abdomen, and the mortality rate was reported as 65% in patients using BB alone.⁸ In our study, abdomen could be closed in all 10 patients who

were treated with combined BB and/or NPWT. No mortality occurred in our patients. The rate of enteroatmospheric fistula has also been reported in the literature between 14-25%, which is similar to our findings.¹³

Conclusion

BB technique can be preferred in children in the first place because it is cheap, easy to apply and does not require preparation. However, since these patients usually require long follow-up and BB applications alone has a low success rate and high mortality rate, BB should be replaced with NPWT at the continuation of the treatment. Since NPWT can be applied fast and easily and has a high success rate, it can be used safely in children with

an open abdomen. Retrospective design and the low number of patients are accepted as limitations of our study.

Ethical Consideration

Ethical Code Number of this study is “28/12/2017-176”.

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Not applicable

Conflict of interests

There is no conflict of interests.

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