Vacuum Assisted Closure Therapy in Children with Complicated Abdominal Wounds, with or without Viscero-Cutaneous Fistulae

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Abstract

Background: Management of complicated abdominal wounds is challenging in children. Vacuum-assisted closure proved to be beneficial. We aimed to report the outcome of VAC over 5 years’ practice in complicated abdominal wounds with or without viscero-cutaneous fistulae.

Methods: Retrospective review of children managed by VAC over 5 years, from January 2017 to December 2022. Included patients had complicated abdominal wounds. Customized VAC devices with continuous negative pressure were used for all patients. The applied pressure was tailored according to the patient's age and the wound condition.

Results: Nineteen patients were included, their ages ranged from 3 months to 15 years. Peritonitis was the main pathology in 12 patients, abdominal wall infection in 4, and a combination of both in 3. VAC was applied over closed wounds in 10 patients and over open wounds in 9; 6 of them had cutaneous fistulae. The median duration of VAC application over closed wounds was 7.5 days, while it was 10 days in open wounds. VAC promoted healing in closed and narrow-gapped wounds, while it was successfully used as a bridging therapy in 4 patients with wide-gapped wounds. Patients with viscero-cutaneous fistulae were successfully managed without further surgical intervention. VAC was complicated by fascial dehiscence with evisceration and incisional hernia in two patients.

Conclusion: VAC could be beneficial to complicated abdominal wounds in pediatric age. It was helpful in managing small viscero-cutaneous fistulae.

Introduction

Complicated abdominal wounds are not uncommon in pediatric age. Various pathologies, including abdominal trauma, congenital abdominal wall defects, and abdominal wall necrosis, can cause these severe wounds. Open wounds are challenging and harder to manage. The fragile tissues in younger children, the small thickness of the abdominal wall, and the involvement of large areas relative to the abdominal wall's total surface area contribute to the complexity of these cases [1].

There are different approaches to managing complicated wounds; each has advantages and disadvantages. Since its introduction to animal models in 1997, negative pressure wound therapy (NPWT) has fundamentally changed the management of such wounds [2]. This management form has evolved over centuries until the recent vacuum-assisted closure (VAC) system [3]. It is an advanced therapeutic tool that delivers continuous, intermittent, or dynamically controlled negative (sub-atmospheric) pressure distributed equally across the wound area. It can offer protection against infection, eliminate exudate, reduce edema, improve vascularity, and enhance granulation formation [4].

To our knowledge, the first report describing the use of VAC in pediatric patients was published in 2000 [5]. Since then, it has been increasingly used in the pediatric age as a valuable therapeutic tool in the
management of complex wounds [6]. In the current study, we aimed to report the outcome of VAC over a period of 5 years’ practice in complicated abdominal wounds with or without viscero-cutaneous fistulae.

**Patients And Methods**

Medical records of pediatric patients managed by VAC over five years, from January 2017 to December 2022, were retrospectively reviewed. Patients included had complicated abdominal wounds, either open or closed. Exclusion criteria included neonates and patients who needed VAC to manage wounds in areas other than the abdominal wall.

Complicated abdominal wounds were defined as:

- The presence of exposed bowel or intestinal stoma in the bed of the wound.
- The presence of viscero-cutaneous fistulae, either enteric or urinary.
- The presence of an infected mesh in the bed of the wound.
- Gapped wounds that could not be approximated due to tissue loss, infection and necrosis, edema and friable tissues, or combinations.
- Dehisced and/or infected wounds, even if secondary sutured.

Patients’ demographics, initial pathology, pre-VAC wound status, VAC application duration, dressing frequency, and outcome were among the data reviewed.

Customized VAC devices were used for all patients. The black foam (reticulated polyurethane granufoam) was used directly over partially dehisced or closed wounds if there was no exposed bowel, fistula, or stoma. Atraumatic, non-adhesive contact layer was used as a protective layer between the bed of the wound and the black foam in complete wound dehiscence and wounds with exposed bowel, stoma, and/or fistulae. Moreover, the atraumatic, non-adhesive layer was used to protect the granulation tissue when it became healthy.

Continuous negative pressure was applied to all patients. The applied pressure was tailored according to the patient’s age and the presence of a bowel, stoma, and/or fistulae in the bed of the wound.

- Infants younger than 6 months old: 75 mm Hg.
- Infants ≥ 6 months: 100 mm Hg.
- Children: 125 mm Hg.
- Patients with bowel, stoma, and/or fistulae in the wound bed, irrespective of their ages: 50 mm Hg.

Depending on the necessary negative pressure, central wall-mounted or peripheral suction units were utilized.

The study protocol was approved by the Research Ethics Committee (FWA 000017585) and gained approval number (FMASU R250/2022).
Results

During the study period, 19 patients fulfilled the inclusion criteria and were enrolled in the study (Table 1). They were 14 males and 5 females. Their ages ranged from 3 months to 15 years (median: 14 months, IQR: 115 months). The primary cause of the complicated abdominal wounds was peritonitis (12 patients), skin and subcutaneous infection (4 patients), or a combination of both (3 patients). All patients were followed up inside the hospital; 11 were admitted in the PICU, while 8 were admitted to the ward.

Frequency of dressings and duration of VAC:

Sixteen patients had their dressings performed bedside under light sedation or regular analgesics. Two patients with infected mesh and one patient with corrosive spillage over his abdomen needed debridement of necrotic tissue under general anesthesia in the operative theater. Patients with a high amount of exudate needed dressings every other day. Aside from that, the dressing was applied every three days. VAC was initiated later (5 to 10 days after surgery) in patients with exposed bowel, cutaneous fistula, intestinal leakage, or stoma, while it was applied earlier (same day to 2 days after the surgical procedure) in other patients. All patients received VAC for a total of 196 days (median: 10 days, IQR: 7 days). In patients with close wounds, the total duration was 87 days (median: 7.5 days, IQR: 7.5 days), while it was 109 days (median: 10 days, IQR: 10.5 days) in cases with open wounds.

VAC over closed wounds:

The application of VAC was over closed wounds in 10 patients. Before the application of VAC, wounds of 9 patients were complicated by fascial dehiscence with evisceration. Due to his poor general health, VAC was applied after bedside skin closure to a patient with a recurrent fascial dehiscence with evisceration. In these patients, neither intestinal fistulae nor stomas were present within the wound. VAC was discontinued when the exudate became clear, its amount was minimal, and the edema subsided.

VAC over open wounds:

VAC was applied over open wounds in 9 patients. Complete wound dehiscence was present in 5 patients, while 4 patients had partial dehiscence. Wound dehiscence occurred after failed secondary closure in 2 patients. Six patients had viscero-cutaneous fistulae, one had loop ileostomy within the boundaries of the wound, and one patient had intact exposed bowel in the bed of the wound. In each case, atraumatic, non-adhesive tulle was applied. VAC was used as a bridging therapy for surgical wound closure in 4 patients with wide-gapped wounds with significant tissue loss. VAC therapy was discontinued in these patients when there was healthy granulation tissue, and the edges of the wound could be approximated and sutured safely without tension, while in other patients, VAC was used to induce healing by secondary intention.

VAC in patients with viscero-cutaneous fistulae:
Four patients developed enterocutaneous fistulae as a complication of major gastrointestinal surgery due to different pathologies. Two patients had colo-cutaneous fistulae; one patient underwent abdominal assisted trans-anal Swenson, while Duhamel's operation was performed to the other patient for Hirschsprung's disease. Controlled fecal fistula was evident on postoperative day six in the first patient and postoperative day seven in the second patient when VAC therapy was started. The fistulous discharge decreased gradually until it stopped completely after 10 and 6 days, respectively. Two cases had controlled enterocutaneous small bowel fistulae. Both cases presented multiple small intestinal perforations. In one case, perforations occurred after adhesiolysis of the small intestine due to an extensive adhesive intestinal obstruction, while in the other case, they occurred after a gunshot. VAC was applied for 21 and 14 days, respectively, without the need for re-exploration. A fifth case had a biliary enteric fistula after choledochal cyst excision and hepaticoduodenostomy. It was controlled using a VAC for seven days. All patients were kept nothing per os (NPO) on total parenteral nutrition, and VAC dressing was performed every other day. One patient underwent sigmoid cystoplasty, which was complicated by a urinary leak six days after surgery. VAC was applied on day eight postoperative. Complete cessation of the urinary leak was achieved 13 days later.

Complications:

Five patients presented with peri-wound skin dermatitis, necessitating topical treatment and the use of non-adhesive dressing. One patient (patient 13) experienced fascial dehiscence with evisceration over the VAC, which was successfully closed with tension sutures. One patient was found to have an incisional hernia (patient 14). There were no mortalities. No cases of foam retention were encountered.

Discussion

The current series included patients with complicated abdominal wounds, either open or closed. Complicated intestinal surgery was the major causative factor of such complicated wounds. Cutaneous and subcutaneous necrosis of the abdominal wall, either septic or chemical, was another significant causative agent. The presence of an intestinal stoma in close proximity to the wound increased the difficulty of treatment, as intestinal stomal output could aggravate wound dehiscence by promoting infection and chemical irritation [7]. All patients were managed by NPWT, either primarily after surgery or secondarily after the failure of surgical control.

McCord et al. [8] did not find a correlation between the applied pressure and the percent of wound closure. They recommended using less negative pressure in children younger than four years and those with exposed viscera or delicate structures. In the current study, a graded pressure was used according to age; up to 100 mm Hg in infants and 125 mm Hg in children. As recommended by other studies [8,9] the exerted pressure was as low as 50 mm Hg in patients with exposed viscera, irrespective of age. This low VAC pressure had no negative impact on the exposed bowel. Wall-mounted suction was utilized to generate low pressures, while proprietary suction devices were employed to create higher negative pressures.
Different modalities of negative pressure were employed in wound management. In their controlled study, Malmsjö et al. [10] demonstrated that intermittent and variable negative pressure has a more significant impact on granulation tissue formation, wound contraction, and the entire healing process. Variable negative pressure could maintain negative pressure throughout therapy and be superior to intermittent pressure in pain tolerance [11]. In the current report, the use of continuous negative pressure was well tolerated by the included patients.

Despite the wide range of age in the current series, pain during VAC dressing was controlled bedside using regular analgesics. Occasionally, intensive care unit (ICU) patients who required minimal debridement were sedated at the bedside. General anesthesia was restricted to patients who needed extensive surgical debridement performed in the operating room. Although our aim in widely gapped wounds was to use VAC to facilitate subsequent surgical closure, i.e., bridging therapy, it was advantageous in minimizing repeated surgical interventions and hence the need for general anesthesia in those critically ill patients.

We believe active wound monitoring is of utmost importance as it will guide the management plan. The frequency of dressing should depend on the condition of the wound. Conversely, we observed that the use of VAC decreased the nursing burdens as it abolished the multiple daily dressings needed for such complicated wounds.

Santosa et al. [12] reviewed a cohort of 1563 pediatric cases primarily treated by outpatient NPWT, mostly due to nonsurgical indications. They reported the feasibility and low complication rate of using outpatient NPWT without the need for sedation or anesthesia. In contrast to their cohort, all included patients in the current series had complicated abdominal surgery that necessitated inpatient management. In properly selected cases, outpatient NPWT, aided by portable VAC devices, may have a positive impact on the child's psychology, decrease the total cost, and limit nosocomial infection.

Successful nonsurgical closure of enterocutaneous fistula using VAC therapy was reported in adult patients [13]. However, this was not frequently mentioned in pediatric cases. Pauniaho et al. [7] reported successful management of enterocutaneous fistula with VAC in three cases (one neonate and two children). Due to the continuous exposure of the wound to the intestinal contents, continuous pressure was preferred over intermittent pressure. Five patients (one biliary enteric, two jejunoileal, and two colonic) in the present series had controlled cutaneous fistulae. In a range of 6 to 21 days, all the wounds healed spontaneously as a result of VAC therapy and parenteral nutritional support without the need for additional interventions. In addition to the known benefits of the VAC, spontaneous fistulous closure in the current report may be attributed to the small size of the fistulae, the low output, the use of low negative pressure, and the nutritional support.

VAC was successful in facilitating spontaneous closure of the urinary fistula after sigmoid cystoplasty. Therapy was continued for 13 days and aided by bladder drainage. A similar case was reported in the literature involving a 15-year-old boy that was closed non-surgically using a VAC device for two days [14].
Complications were encountered in 7 cases. Peri-wound dermatitis was present in 5 cases. It was considered a minor complication. It was attributed to the adhesive dressing and had been managed topically. There was fascial dehiscence with evisceration on top of VAC in one case, while an incisional hernia was encountered in another.

Our study is limited by its retrospective nature and inhomogeneous, small number of patients. Controlled prospective studies are required to highlight the role of VAC in children with complicated abdominal wounds associated with viscero-cutaneous fistulae.

Conclusion

VAC could be beneficial in complicated abdominal wounds, either closed or open, in the pediatric age. It was helpful in managing small viscero-cutaneous fistulae, irrespective of their origins, aided by adequate medical control.

Abbreviations

VAC: Vacuum assisted closure.

NPWT: Negative pressure wound therapy.

NPO: Nothing per os.

ICU: Intensive care unit.

References


Tables

Table 1
<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Wound status</th>
<th>Start of VAC (Days after surgery or wound closure)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12 years</td>
<td>Adhesive intestinal obstruction with gangrenous bowel</td>
<td>Complete dehiscence with loop ileostomy and enteric fistulae</td>
<td>8 days</td>
<td>21 days</td>
</tr>
<tr>
<td>2</td>
<td>15 years</td>
<td>Leakage after sigmoid-cystoplasty</td>
<td>Complete dehiscence with urinary fistula</td>
<td>8 days</td>
<td>13 days</td>
</tr>
<tr>
<td>3</td>
<td>8 months</td>
<td>Leakage after abdominal assisted trans-anal Swenson</td>
<td>Partial dehiscence with enteric fistula</td>
<td>6 days</td>
<td>10 days</td>
</tr>
<tr>
<td>4</td>
<td>4 years</td>
<td>Strangulated sigmoid volvulus</td>
<td>Complete dehiscence with intestinal loops at its bed</td>
<td>Day 5</td>
<td>7 days</td>
</tr>
<tr>
<td>5</td>
<td>2 years</td>
<td>Corrosive injury (ingestion and spill over)</td>
<td>Complete dehiscence</td>
<td>Same day</td>
<td>10 days</td>
</tr>
<tr>
<td>6</td>
<td>6 months</td>
<td>Leakage after Duhamel’s operation</td>
<td>Partial dehiscence with enteric fistula</td>
<td>Day 7</td>
<td>6 days</td>
</tr>
<tr>
<td>7</td>
<td>14 months</td>
<td>Corrosive ingestion</td>
<td>Closed infected wound</td>
<td>Day 2</td>
<td>12 days</td>
</tr>
<tr>
<td>8</td>
<td>6 months</td>
<td>Leakage after hepatico-duodenostomy (choledochal cyst)</td>
<td>Partial dehiscence with biliary enteric fistula</td>
<td>Day 5</td>
<td>7 days</td>
</tr>
<tr>
<td>9</td>
<td>5 months</td>
<td>Intussusception (extended right hemicolectomy)</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>5 days</td>
</tr>
<tr>
<td>10</td>
<td>4 months</td>
<td>Cecal perforation (Hirschsprung's disease)</td>
<td>Closed infected wound</td>
<td>Day 1</td>
<td>3 days</td>
</tr>
<tr>
<td>11</td>
<td>10 years</td>
<td>Infected S.C mesh after repair of incisional hernia</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>12 days</td>
</tr>
<tr>
<td>12</td>
<td>13 years</td>
<td>Perforated Meckel's diverticulum</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>7 days</td>
</tr>
<tr>
<td>13</td>
<td>3 months</td>
<td>Closure of ileostomy (Previous NEC)</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>14 days</td>
</tr>
<tr>
<td>14</td>
<td>8 months</td>
<td>Intussusception (Right hemicolectomy)</td>
<td>Closed infected wound</td>
<td>Day 2</td>
<td>8 days</td>
</tr>
<tr>
<td>15</td>
<td>5 months</td>
<td>Post NEC stricture</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>7 days</td>
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<tr>
<td>16</td>
<td>3 months</td>
<td>Strangulated inguinal hernia</td>
<td>Closed infected wound</td>
<td>Same day</td>
<td>14 days</td>
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<td>17</td>
<td>9 years</td>
<td>Gun shot with periumbilical inlet</td>
<td>Complete dehiscence with enteric fistulae</td>
<td>Day 10</td>
<td>14 days</td>
</tr>
<tr>
<td>18</td>
<td>10 years</td>
<td>Right lumbar stab wound</td>
<td>Closed infected wound</td>
<td>Day 1</td>
<td>5 days</td>
</tr>
<tr>
<td>19</td>
<td>3 years</td>
<td>Infected mesh after repair of ventral hernia (exomphalos major)</td>
<td>Partial dehiscence</td>
<td>Same day</td>
<td>21 days</td>
</tr>
</tbody>
</table>