

# NEGATIVE PRESSURE WOUND THERAPY JOURNAL

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# Deferred anastomosis in severe secondary peritonitis using a temporary intestinal shunt – case series

Ignacio Rey-Simó, Alejandra García-Novoa, Jessica Correa-Marín, Alden Pool Gómez-Alfárez

## CASE REPORT

**Abstract—Introduction:** As part of the damage control surgery concept applied to the treatment of sepsis due to severe secondary peritonitis following intestinal perforation and/or in high-risk patients we describe the novel "temporary intestinal shunt" (TIS) technique with delayed intestinal anastomosis, as an alternative to primary anastomosis or enterostomy.

**Material and Methods:** We present three patients in whom urgent laparotomy was performed due to intestinal perforation, with intestinal resection and TIS.

### Case reports:

- 1) **Case 1:** A 39-year-old male presented with acute myeloid leukemia M3 and generalized peritonitis, sigmoid colon perforation and secondary jejunal loop involvement. In view of these findings, we performed 10 cm jejunal resection with TIS placement, sigmoid colon resection, and negative pressure therapy (NPT). Reoperation after 48 hours showed no evidence of peritonitis, so a manual jejuno-jejunal anastomosis and terminal colostomy were performed.
- 2) **Case 2:** A 65-year-old woman treated with corticosteroids presented with a pneumoperitoneum secondary to a road traffic accident. Urgent laparotomy revealed a 2 cm jejunal perforation. Resection of the jejunal segment and TIS with NPT was performed. Exploration of the peritoneal cavity 96 hours later showed clinical improvement and a jejunio-ileal anastomosis was performed.
- 3) **Case 3:** A 73-year-old male was admitted due to intestinal subocclusion. Clinical deterioration occurred rapidly and we performed an urgent laparotomy diagnosing jejunal perforation secondary to torsion and ischemia of the affected loop, and generalized peritonitis. Intestinal resection and TIS with NPT placement were thus decided. Anastomosis and closure of the abdominal appendage were deferred until 96 hours after the first surgery.

**Conclusion:** Although the evidence we present is limited, we believe TIS to be an additional tool in damage control surgery. This staged management strategy allows definitive reconstruction with the patient in a more favorable physiological condition.

**Keywords—**temporary intestinal shunt, deferred anastomosis, severe secondary peritonitis, sepsis, negative pressure wound therapy

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## INTRODUCTION

SEVERE sepsis secondary to intrabdominal infection has a bad prognosis with mortality rate that could exceed 30%,<sup>1-3</sup> particularly in patients with intestinal perforation.<sup>4</sup> The treatment of severe sepsis includes source control, restoration of gastrointestinal function, systemic antimicrobial therapy and support of organ function. A great percentage of these patients will need more than one intervention to control the source of infection. Various strategies have been proposed as abbreviated laparotomy, planned reoperation and recently, damage control surgery (DCS), in which an early temporizing operation is performed, leaving the abdomen open, followed by a planned reoperation with the definitive repair. The damage control approach allows abbreviated surgery for temporary control of the source of insult by the means of the "open abdomen" technique. Leaving the abdomen open allows for the patient to be transferred to an ICU for the restoration of homeostasis followed by a return to the operation theatre 1 – 2 days later, when hemodynamic parameters have improved (pH, blood pressure, diuresis), for new surgical management with the definitive repair of organ defects.<sup>5, 6</sup>

Any intestinal anastomosis has a certain risk of leakage, and although in small bowel anastomosis it is lower than in the colon, they can appear in 0.3% to 5.5% of cases, increasing the mortality up to three times.<sup>7</sup> Peritonitis, hypoxemia, metabolic acidosis and edema secondary to shock are intestinal leakage symptoms, particularly in an immunologically compromised patient.<sup>8</sup>

As part of the concept of DCS<sup>9, 10</sup> applied to the treatment of sepsis in the course of severe secondary peritonitis due to intestinal perforation in a high-risk patient (immunosuppressed, malnourished, elderly, SIRS, etc.), we describe a novel technique of "temporal intestinal shunt" (TIS) with delayed intestinal anastomosis as an alternative to the primary anastomosis or enterostomy creation.

## MATERIAL AND METHODS

We present 3 patients operated at Coruña Hospital by the same surgeon. Urgent laparotomy was performed in all cases due to intestinal perforation followed by intestinal resection and TIS. In all cases, the decision of a delayed anastomosis was taken into account during the surgical procedure, assessing the patient's overall conditions (pH, diuresis, and the need

Table I  
CLINICAL CHARACTERISTICS OF THE PATIENTS

	Case 1	Case 2	Case 3
Age (years)	39	65	73
Sex	Male	Female	Male
Disease history	Acute myeloid leukemia	Rheumatoid arthritis	None
Need for vasopressors in operating room	No	Yes	No
Intraoperative pH	7.16	7.30	7.28
Intraoperative lactic acid	4	5	3
No. laparotomies	2	3	3
ICU stay (days)	20	7	4
Hospital stay (days)	47	34	15
Abdominal complications	No	Acute cholecystitis and death	No

for vasopressors), associated comorbidities and the severity of peritonitis.

### Surgical technique

The DCS was performed by resecting the affected small intestine segment. Subsequently, we inserted a fragment of a chest tube (24 to 28 fr), joining both intestinal strands, and sutured it with two silk ligatures. We then supplied a posterior laparostomy with negative pressure therapy (NPT). To perform negative pressure therapy, we used the VIVANO® System (PAUL HARTMANN AG).

This kit contained:

- 1) an organ protection layer to cover abdominal content;
- 2) two pieces of pre-shaped foam and
- 3) the suction connection device.<sup>11</sup>

We provided a standard continuous pressure aspiration therapy between -80 and -120 mmHg. Subsequently, the aspiration system was replaced every 24 – 48 hours. When the patient improved an intestinal anastomosis was performed. This allowed us to conduct the surgery when local peritoneal or systemic conditions were more favorable (Fig. 1). If during the surgical review peritonitis persisted, another round of NPT was performed with the VIVANO® Tec Pro system for an additional 24 – 48 hours (according to the surgeon's critical evaluation).

### CASE SERIES

**Case 1:** A 39-year-old male was admitted to the hematology department for the treatment of acute myeloid leukemia in stadium M3. He presented with total medullary aplasia, abdominal pain, fever, and generalized peritonism. An urgent abdominal computed tomography scan (CTS) showed perforated sigmoid diverticulitis. Urgent surgical laparotomy revealed generalized peritonitis, sigmoid perforation and secondary affection of jejunal loop. The patient remained hemodynamically stable during surgery with metabolic acidosis (pH = 7.16). Therefore, 10 cm jejunal resection with TIS placement, sigmoid colon resection and NPT with VIVANO® were performed. After 48 hours no evidence of peritonitis was observed and manual jejunio-jejunal anastomosis with a terminal colostomy (Hartmann) and definitive closure of the abdominal wall was performed. After slow recuperation secondary to the patient's concomitant myeloid leukemia the

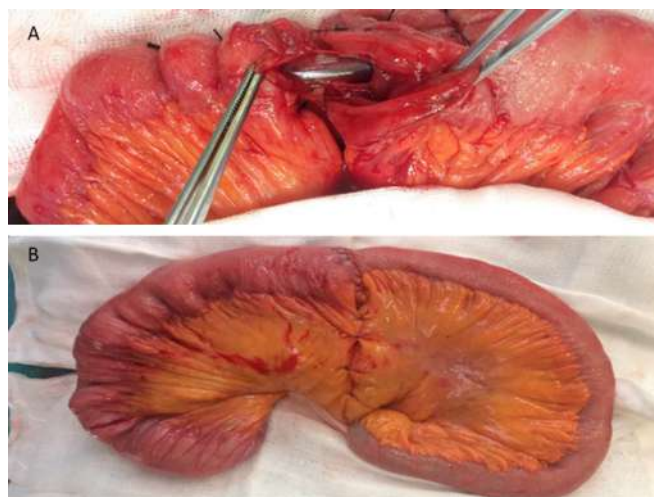


Figure 1. A. "Intestinal shunt" with thoracostomy tube n° 28. B. Final intestinal anastomosis

patient could be discharged after 2 months of hospitalization and successful introduction of early oral feeding.

**Case 2:** A 65-year-old woman treated with corticosteroids for rheumatoid arthritis suffered a road traffic accident. She presented in the emergency room 48 hours later with vomiting and abdominal pain. CTS demonstrated pneumoperitoneum requiring an urgent laparotomy. In the operating room, we saw a 2 cm jejunal perforation and repaired it surgically. On the fifth postoperative day, the patient developed fever (> 38°C) and hypotension requiring vasopressors. Another laparotomy was performed showing evidence of diffuse peritonitis and intestinal leakage between suture points. We performed the resection of the jejunal segment followed by TIS with NPT. The cavity was revised after 48 hours with signs of active peritonitis and vacuum therapy was prolonged. After another 48 hours, a significant clinical improvement without peritonitis was observed what allowed us to perform a jejunio-ileal anastomosis. Initially, we observed a satisfactory evolution with the tolerance of the oral route nutrition but 8 days later clinical course was complicated by acute cholecystitis. Despite performing an urgent cholecystectomy, patient's general condition remained severe. 6 days after the last surgical intervention the patient died.

**Case 3:** A 73-year-old male was admitted to the General

Surgery Ward with a partial small bowel obstruction. Three days after admission his clinical status deteriorated. Increasing abdominal pain and peritonism urged us to perform a laparotomy. We saw jejunal perforation secondary to a jejunal flange that was responsible for the torsion and ischemia of the affected loop and generalized peritonitis. During the intervention, the patient had significant hypotension and metabolic acidosis (pH = 7.28), so that we decided to perform an intestinal resection and TIS with NPT. After 48 hours abdominal revision revealed persistent peritonitis so that the anastomosis and closure of the abdominal appendage were deferred for another 48 hours. This time the patient remained in the ICU with NPT. Successful evolution afterwards allowed us to discharge the patient in 10th postoperative day.

## DISCUSSION

Late-diagnosed perforations or anastomotic leakages in the small intestine are often catastrophic. Their incidence is higher in immunocompromised (due to corticosteroids or malignancy), malnourished, septic patients. Such lesions present with diffuse peritonitis and septic shock, dramatically increasing morbidity and mortality (60 – 100%).<sup>12</sup> For this reason, the classical approach would be to avoid anastomosis and perform derivative enterostomata. More recently, in cases of septic shock secondary to intestinal perforation, the clinical guidelines of the World Society of Emergency Surgery<sup>13–16</sup> propose to apply the concept proposed by Stawicki *et al.*<sup>17</sup> of DCS and NPT.

DCS was initially designed for trauma patients. However, definitive surgery in a patient with severe alteration of their physiology may present adverse results, regardless of the origin of the damage. For this reason, rapid surgical management for the hemorrhage or contamination, without further major tissue injury, followed by early transfer to the intensive care unit (ICU) for resuscitation and physiological correction (acidosis, coagulopathy, and hypothermia) before performing the definitive surgery is now accepted for sepsis secondary to peritonitis.<sup>18</sup> This staged management allows subsequent reconstruction of the lesions in a more favorable physiological condition.

The literature suggests DCS with affected bowel resection leaving both ends closed with mechanical sutures. There are two problems with this approach. Firstly it requires discontinuation of the intestinal transit. Secondly, it increases the possibility of intestinal leakage, which can worsen the peritonitis. In this context, our team has modified the technique using the TIS, which allows the physiological intestinal transit and decreases the pressures in the proximal cap that is often responsible for the leakage of intestinal contents through the staples and increasing the edema of the proximal end, putting the safety of the deferred anastomosis at risk.

It is evident that the appropriate selection of patients is necessary to perform this staged surgery.<sup>6</sup> The overuse of this procedure in patients who do not need it may increase the number of unnecessary surgeries, prolong the stay in the ICU and increase the risk of developing an enterocutaneous fistula. However, there is no sufficient data to establish

the criteria to select patients that might have an indication to perform damage control with TIS surgery. However, in patients with generalized peritonitis and septic shock requiring vasopressors, patients with coagulopathy or acidosis, or those patients with risk factors (e.g. immunocompromised), an anastomosis would probably fail owing to the severe physiological compromise. So, in this extreme situation, it seems logical that deferring the anastomosis may result in a better outcome.

The use of a laparostomy with NPT improves the perioperative mortality rate even in non-trauma patients with abdominal symptoms. It reduces the risk of compartment syndrome, increases abdominal perfusion, decreasing the risk of renal, cardiac or pulmonary failure.<sup>19</sup> However, it is important not to prolong the final closure of the wall, longer duration of open abdomen management and the greater number of serial abdominal explorations increase the risk of complications. Khan *et al.*<sup>18</sup> determined that closure before the seventh day decreases postoperative morbidity, although it increases the risk of respiratory failure. Therefore, our team proposes the TIS with NPT to optimize the patient's general condition while trying not to prolong the open abdomen over 96 hours.

## CONCLUSION

In conclusion, although the evidence we present is scarce, we believe TIS is an additional tool in damage control surgery. In the cases presented above, this technique allowed performing a delayed anastomosis, without the necessity of an enterostomy formation. Further studies will be necessary to confirm the effectiveness of this technical proposal, as well as to establish its clinical indications.

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# Novel, self-made and cost-effective technique for closed-incision negative pressure wound therapy

Dominik A. Walczak, Maciej Grajek, Marcin Zeman, Tomasz Pałka, Mathias Kalkum, Mirosław Dobrut, Piotr Drozdowski, Rafał Ulczok, Karolina Donocik, Adam Maciejewski, Łukasz Krakowczyk

## TOOLS AND TECHNIQUES

**Abstract—Background:** It has been suggested that applying the negative pressure wound therapy (NPWT) to a closed surgical incision may hasten the healing of the incision and decrease the incidence of wound healing complications. The goal of this study is to present the new idea of a simple, self-made, low-cost wound vacuum dressing for closed-incision NPWT that may become an alternative to currently manufactured medical industry products.

**Method:** We designed a simple dressing for closed-incision NPWT from gauze pads, polyurethane adhesive film, stoma paste, and a drain tube. Negative pressure was created using a standard 50 ml syringe connected to the drain. First, the dressing was applied to the wound model and on the healthy volunteer. Finally, the dressing was applied to 10 patients after low anterior rectal resection. The vacuum dressing was left in place for 3 days, then changed and placed once more for the next 3 days.

**Results:** We did not observe any adverse effects associated with the dressing. All postoperative wounds healed properly. 18 out of 20 dressings were still air-tight 72h post-placement.

**Conclusions:** This simple, self-made dressing for NPWT is safe and effective and may decrease the wound infection rate. However future studies are needed to confirm that hypothesis.

**Keywords—**NPWT; vacuum-assisted closure; surgical site infection; closed incision negative-pressure wound therapy

## INTRODUCTION

NEGATIVE Pressure Wound Therapy (NPWT) is an accepted way of treating chronic wounds or supporting skin grafts. However, there is an emerging body of literature describing a novel application of NPWT to surgical incisions healing by primary intention. It has been suggested that applying NPWT to a closed surgical incision may hasten the healing of the incision and decrease the incidence of complications, such as infection or wound dehiscence.<sup>1</sup> However, these systems are quite expensive, making their usage limited in developing countries.

This paper presents a novel method of simple, self-made, low-cost wound vacuum dressing that may become an alternative to commercially available medical products.

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Equipment necessary for dressing application:

- 1) 10 x 10 cm gauze pads
- 2) dressing impregnated with paraffin wax (e.g., Grasolind, Jelonet)
- 3) drape (polyurethane adhesive film – e.g., Hydrofilm, PAUL HARTMANN AG, Germany)
- 4) 50 ml syringe with a luer lock
- 5) stoma paste
- 6) drain – intravenous extension set with a clamp and a luer access split-septum
- 7) peripheral venous catheter (PVC) film dressing

## DRESSING APPLICATION TECHNIQUE

The dressing should be applied at the end of the surgical procedure.

- 1) Dry the peri-wound skin.
- 2) Cut 5 cm wide strips of ointment dressing (e.g., Grasolind, etc.) and place it over the wound (half the size of the gauze pad)
- 3) Fold the gauze pads once and cover the wound, then similarly create the second layer.
- 4) Measure and trim the drape to cover the gauze with an additional border of 2 – 3 cm
- 5) Apply the drape over the gauze, including about 2 – 3 cm of the surrounding skin (Fig. 1).
- 6) Create a small aperture (0.5 – 1 cm in diameter) in the drape at the upper pole of the dressing. Create a space between two layers of folded gauze pads.
- 7) Insert the drain into created space.
- 8) Cover the aperture in the drape (where the drain enters the dressing) with the stoma paste.
- 9) Adhere 2 PVC film dressings over the aperture and around the drain to provide airtightness (Fig. 2).
- 10) Evacuate residual air with a syringe to create negative pressure.

The vacuum dressing was left in place for 72 hours. The wound exudate was collected in the gauze (Fig. 3). Initially, the dressing was applied to the wound model and on the healthy volunteer to measure the negative pressure by a liquid column depending on the size of the wound and the amount of air which was removed with a syringe (Fig. 4) (Tab. I). A self-made liquid column manometer filled with distilled water was used to measure the pressure. Experimental assays were





Figure 1. Dressing applied to the wound after low anterior rectal resection. Black arrow — stoma paste covering the aperture were drain (i.e., intravenous extension set) enters the dressing; red arrow — drain between the two layers of a gauze pad.



Figure 2. Two PVC film dressings adhered together over the orifice and around the drain to provide airtightness.



Figure 3. The vacuum dressing after 72 hours.



Figure 4. Dressing applied to the wound model with a liquid column to measure negative pressure.

Table I

THE TABLE SHOWS THE APPROXIMATE AMOUNT OF AIR THAT SHOULD BE REMOVED WITH A SYRINGE TO ACHIEVE A CERTAIN NEGATIVE PRESSURE (MEAN VALUES OF FIVE TRIAL RUNS FOR EACH DRESSING LENGTH ON A HEALTHY VOLUNTEER ).

Negative pressure Dressing length	40 mmHg	70 mmHg	100 mmHg
15 cm	40 ml	50 ml	60 ml
25 cm	45 ml	62 ml	75 ml

performed at room temperature ( $\sim 21 - 24$  °C). The values in centimeters of  $H_2O$  were transformed to millimeters of mercury (mmHg) with the on-line calculator.<sup>2</sup>

Subsequently, the dressing was applied to 10 patients after a lower anterior rectal resection. This pilot study was approved by the Bioethics Committee at the Oncology Center, Gliwice, Poland. All patients have given their written informed consent to participate in the study and receive this type of dressing. The negative pressure of approximately -80 to -100 mmHg was created with a standard 50 ml syringe connected to the drain. The vacuum dressing was left in place for 3 days, then changed and placed one more time for the next 3 days. We did not observe any adverse effects due to the dressing application. All postoperative wounds healed properly. 18 out of 20 dressings were airtight after 72 hours post-application. The individual in Fig. 1 has given his written informed consent to publish the photographs.

## DISCUSSION

A similar self-made and cost-effective technique for closed-incision NPWT was initially described by Oliver Muensterer and Richard Keijzer, who used vacuum dressing after a single incision pediatric laparoscopic appendectomy.<sup>3</sup> Gauze (5x5 cm) used in their study was folded two times and covered with a bioocclusive dressing. The air was evacuated with 22-G needle on a 10 ml syringe which was passed subcutaneously from outside the dressing into the gauze. The authors applied a dressing and measured the negative

pressure by a liquid column. Over five runs, the negative pressure ranged from -34 mmHg to -44 mmHg. We previously described the use of this technique in larger wounds (i.e. after open appendectomy or ileostomy reversal). However, the size of the wound was still a limit.<sup>4</sup> Hypothetically, larger wounds could be covered with the technique proposed by Muensterer and Keijzer, but more than one subcutaneous injection should be performed to evacuate excess air and generate adequate negative pressure. It should be emphasized that every additional injection is connected with a higher risk of complications like hematoma formation. Moreover, this type of dressing could be applied only on an anesthetized patient.

The technique we present in the current paper may be used on a wound of every size and almost in any location. Application is painless so it could be reapplied after 3 days or when the dressing depressurizes. With this method, we are able to create negative pressure lower than -100 mmHg (similar to the level produced by commercially available, pump-activated vacuum dressings). Finally, the dressing is cost-effective as its total prize depends on the type and amount of materials used however it should not exceed 10\$. The cost of commercially available negative pressure wound

therapy products is usually twenty times higher.

#### CONCLUSIONS

This simple, self-made dressing for closed-incision Negative Pressure Therapy is a safe and cost-effective alternative for commercially available NPWT systems. However future studies are necessary to confirm its noninferiority to other forms of NPWT.

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# IMPROVING MEDICAL CARE

by supporting the use on new technologies in medicine



clinical trials and observational studies



medical registries



mobile and web applications



innovative medical devices



telemedical and patient-oriented outcomes using mobile technologies



## PROJECTS

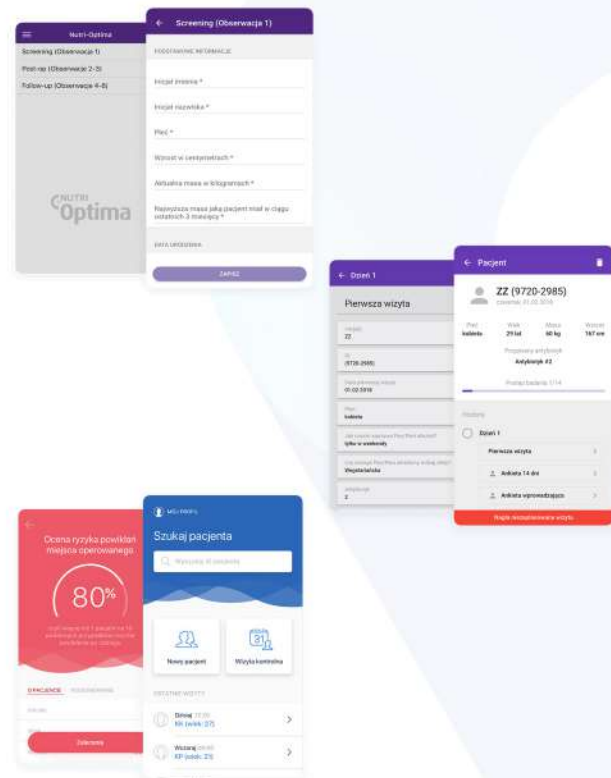
Application designed for conducting a clinical trial in the field of pre- and postoperative nutrition. Medigent Foundation created in cooperation with Nutricia mobile application processing data in this area. The application is available on all platforms.



Application designed for conducting and evaluating a clinical trial on a group of patients testing new medical solutions. The application has been improved with a system which monitors daily quality of patient's life and data analysis.



Medical application for risk assessment of postoperative complications. The solution gives doctors a tool that supports their clinical decisions. Application enables to quickly and accurately estimate the real risk of postoperative complications of the patient. An additional advantage of the application is the ability to automatically generate printable reports, which significantly improves the work of doctors.



Foundation currently supports work on two IoT medical devices that will soon support home and hospital patient care.



## PARTNERS

