THERAPY

Vacuum supported laparostomy – an effective treatment of intraabdominal infection

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Abstract

Background: **Notable experience using the vacuum assisted closure for abdominal wall defects was an assumption for its intra-abdominal application in severely septic patients with intra-abdominal infection. The goal of this study was to evaluate our experience with this new therapeutic technique.**
Methods: **This study is a retrospective analysis and comparison of two groups of patients with severe sepsis and proven intra-abdominal source of infection. Group A consisted of 41 patients, 31 men and 10 women with the age ranging 18–78 years old (mean 49.5), who were treated surgically between 1998 and 2002 using a combination of laparostomy, multiple irrigations and abdominal drainage. Group B consisted of 46 patients, 32 men and 14 women age 18–87 years old (mean 50.8), who were treated between 2002 and 2006 using former techniques with the addition of an intra-abdominal vacuum assisted negative pressure therapy system.**
Results: **In the group A the number of re-laparotomies with debridement of the open abdominal wound in general anesthesia ranged from 5 to 18 over 10 to 35 days (mean 19.4) of hospital stay. In the group B, the number of re-laparotomies decreased to 3–9 and the hospital stay decreased to 7–29 days (mean 14.5). Fifteen patients (36.6 %) in the group A died because of severe sepsis, compared to 11 patients (23.9 %) in the group B.**
Conclusion: **Authors confirmed a significant reduction of morbidity and mortality using the intra-abdominal vacuum assisted system in the treatment of localized intra-abdominal sepsis *(Tab. 2, Ref. 18)*. Full Text (Free, PDF) *www.bmj.sk*.**
Key words: vacuum supported laparostomy, vacuum assisted closure, vacuum sealing, staged lavage, peritonitis, severe sepsis.

Wound negative pressure therapy has been adopted rapidly into surgical practice, the advantages appear to include better control of wound secretions, reduction of wound edema, improved patient comfort, and more rapid healing across many disciplines (1, 2). Intra-abdominal infection, despite many advancements and proposed therapeutic methods, remains a difficult problem for the surgeon to solve as a primary and often lonely manager. Considering the fact that in many cases surgical treatment is replaced by invasive interdisciplinary procedures performed by surgeon, radiologist or gastroenterologist, a generally accepted common title of "source control" has been establishes in literature. The contemporary treatment algorithm can be summarized into four strategies: 1) elimination of the cause of infection, 2) elimination of infected material, necrotic tissue and toxins, 3) active and passive support of body defense mechanisms against infection and 4) immediate diagnosis and treatment of infectious consequences. This topic is frequently mentioned in literature and the number of opinions and techniques available indicate a persistent unfavorable state with a high morbidity, mortality and permanent disability. The mortality in literature varies from 56 % to 18 %, with the decrease of mortality from 30 % to 40 % over the past 30 years (3). Data showing certain optimism comes from the reviews of selected groups of patients (4). Severe intra-abdominal infection implies, in the majority of cases, involvement of the organs of abdominal cavity as well as localized or diffuse involvement of the parietal peritoneum.

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Tab. 1. The causes of intra-abdominal infections and severe sepsis in both groups.

Group A 1998–2002 (n=41)		Group B 2002–2006 (n=46)	
Hemorrhagic-necrotic pancreatitis	16	Hemorrhagic-necrotic pancreatitis	18
Surgery and endoscopy complications	14	Surgery and endoscopy complications	10
Anastomotic leak	4	Anastomotic leak	6
Retroperitoneal phlegmona	3	Intractable small bowel perforation	1
Subphrenic and perihepatal abscess	1	Retroperitoneal phlegmona	6
Perforated peptic ulcer	2	Subphrenic and perihepatal abscess	4
Gynecologic inflammatory disease	1	Peritonitis from postpartum hemorrhage	1
Peritonitis >72 hours in 22 pts	(53.7%)	Peritonitis >72 hours in 26 pts	(56.5%)

The aggressive impact of infectious agents evolves into a progressive systemic dysfunction and terminal multiple organ failure. The surgical strategy lies in all measures aimed to prevent the state so-called incurable triad (peritonitis with severe sepsis, respiratory insufficiency and renal insufficiency). Advanced cases of peritonitis generally arise from hemorrhagic-necrotic pancreatitis, intestinal ischemia and obstruction, gastrointestinal tract perforation or dehiscence of a surgical anastomosis (5). Successful management of intra-abdominal infection requires an immediate surgical intervention with the aim to eliminate the infectious agent. A complex intensive care therapy in the intensive care unit improves chances of successful resolution of the septic state, but for the surgeon, an effective surgical intervention remains the centre of interest. The advanced intra-abdominal infection necessitates repeated surgical interventions for its satisfactory elimination. Classically, intra-abdominal infection was treated with operations, frequently multiple to eliminate the intra-abdominal source of infection. In the last two decades, techniques of laparostomy, continual peritoneal lavage, staged peritoneal lavage and their combinations were added (3, 6). In the last few years according to the very modest literature evidence, there have been some results with the intra-abdominal use of a vacuum suction system located at the site of the source of intra-abdominal infection in trauma patients (7). Our preliminary promising experience has been already was published (8). The goal of this study is to evaluate our good experience using the vacuum assisted system with topical negative pressure in combination with laparostomy for the management of an intra-abdominal source of infection in septic patients and to compare it to combined abovementioned techniques used at surgical departments (6, 9, 10).

Material and methods

We have retrospectively evaluated two groups of patients, treated in our departments, with severe sepsis (7) and proven intra-abdominal source of infection. This study is a comparison of two groups of patients with severe sepsis and proven intra-abdominal source of infection. Group A consisted of 41 patients, 31 men and 10 women with the age ranging 18–78 years old (mean age 49.5), who were treated surgically during the years 1998–2002 using a combination of laparostomy, staged peritoneal lavage of the abdominal cavity and drainage.

Group B consisted of 46 patients, 32 men and 14 women age 18–87 years old (mean age 50.8), who were treated during the years 2002–2006 using abovementioned techniques with an intra-abdominal vacuum assisted negative pressure therapy. The subjects in both groups were patients with severe intra-abdominal infection and unfavorable time interval from the onset of infection to the surgical treatment, which was beyond 48 hours for operational complications and beyond 72 hours for the primary peritonitis. The causes of intra-abdominal infections and severe sepsis in both groups are summarized in Table 1.

In our intensive care units we have applied an accepted classification for peritonitis known as the "Mannheim peritonitis index" (MPI), where a score above 26 indicated severe peritonitis (11). MPI score in the group A ranged from 26 to 37 points and in the group B from 26 to 43 points.

Laparostomies were performed in standard surgical fashion. Staged peritoneal lavage was performed using multiple repeat laparotomies under general anesthesia every 24–48 hours, usually in combination with wide sump drainage. Continual peritoneal lavage of the abdominal cavity was realized using drains. Adhesive impermeable foil with midline zip was used to cover the laparostomy. Additional treatment of the infected intra-abdominal cavity included targeted drainage with the possibility of postoperative lavage through the silicone drains (9). The postoperative lavage was carried out with Ringer solution (with osmolality higher then 290 mOsm/l) in quantities 8–15 liters per day in continual or intermittent manner in four-hour intervals.

Modified intra-abdominal vacuum sealing system used in 46 patients consisted of a sterile fine porous polyurethane sponge (similar to system VAC; KCI Medical Ltd. Wimborne; Dorset. U.K.), and the suction part of the negative pressure drain (Redon, Jackson Pratt) localized in its centre. The size of the sponge was adjusted during the operation according to the size of the intra-abdominal focus. The Redon drain with negative pressure was passed through the abdominal wall away from the laparotomy wound that was closed by temporary retention sutures and hermetic adhesive plastic foil. We know that using of commercial modular negative pressure systems is very successfully, but due to financial burden we tried to develop an equivalent method to provide patients with similar negative-pressure therapy without the significant costs of purchasing or renting the commercial system (12). Our modified system with exchange interval of 48–

Tab. 2. Overview of severe abdominal sepsis therapy.

	Group A (n=41)	Group B (n=46)	Statistics
Mean age (range) (years)	49.5 (18-78)	50.8 (18-87)	
Sex (male/female)	31/10	32/14	
Intra-abdominal vacuum sealing	non	all	
Respiratory support >96h, n (%)	11 (26.8)	12 (26.1)	
Mannheim Peritonitis Index, score	32.33.7	33.54.7	p=0.21 NS
Re-operations (n)	11.43.4	6.71.8	p<0.0001 ES
Treatment (days)	19.46.1	14.56.4	p=0.0017 VS
Mortality, n (%)	15 (36.6)	11 (23.9)	

NS – not significant, ES – extremely significant, VS – very significant

96 hours enabled us to achieve a partially controlled topical negative intra-abdominal pressure (50 to 75 mm of mercury). The contents of the drainage container were daily sent for microbiological evaluation and the gross appearance provided us also with the estimated exchange time for the sponge vacuum suction system. The exchange was accomplished under general anesthesia with additional staged peritoneal lavage of the abdominal cavity.

These polyurethane sponges covered the most affected areas of the abdominal cavity and were mutually connected in all patients. Some sponges were augmented with 2–7 easy flow drains fixed at the low surface of the sponge. The aim of this augmentation was to access distant septic loci of the abdominal cavity. The laparotomy was not closed by suture but also plumbed with a polyurethane sponge and dressed with the original adhesive plastic sheet, included in VAC system package. Vacuum of 50 to 75 mm of mercury was then activated for 4–5 days, when the same procedure was repeated.

All the patients were subjects to microbiological monitoring with directed antibiotic treatment, and in selected cases of immunodeficiency also with immunologic support. Sepsis markers (lactate, C reactive protein – CRP, prokalcitonin – PCT) were monitored continuously enabling estimation of the septic state and the effect of bacterial component. The patients' nutrition was provided by "all in one" total parenteral nutrition system via original 2–3 channel central venous sets with low internal surface adherence (7). Patients were clinically and laboratory monitored according to the ICU standards. Combined nutrition, if possible with "per os" intake, or parenteral nutrition provided every patient according to his current needs with daily nitrogen intake of 16–24 g, energy intake of 6300–11300 kJ (1500–2700 kcal), restricted fluid volumes of 1750 ml to 3000 ml, and glucose/fat ratios from 77/23 to 50/50. The fat emulsion consisted of 10–20 % of triglycerides with medium chain fatty acids. The estimate of the energy expenditure for the patient was calculated daily by well-known Harris–Benedict equation with appropriate increase according to the body activity, temperature and stress factor (13). After managing the intra-abdominal infection, laparostomy closure was dictated by particular conditions of an individual patient with the strict adherence to the standard surgical principles for the suture of risk laparotomy.

Data were compared for statistical differences using the ANOVA and Student t-test. $p<0.05$ was assumed to be significant.

Results

Postoperative complications caused severe intra-abdominal infection according to clinical course and operative reports in group A in 43.9 % of cases and in group B in 34.8 % of cases. The surgical treatment of severe intra-abdominal infection was delayed in 16 cases (39 %) in group A and in group B in 15 cases (32.6 %). These patients were referred late for specialized surgical care or were transferred late from another department or hospital. Ventilation support beyond 96 hours was required in 11 patients (26.8 %) in group A and in 12 patients (26.1 %) in group B. In both groups, the technique of open abdominal laparostomy was used. In group A, the number of re-laparotomies with debridement of the open abdominal wound in general anesthesia ranged from 5 to 18 over 10 to 35 days (mean 19.4 day) of the hospital stay. In group B, the number of re-laparotomies decreased to 3–9 and the hospital stay decreased to 7–29 days (mean 14.5 day). Fifteen patients (mortality 36.6 %) died in group A secondary to the septic state with the symptoms of MODs (multiple organ dysfunctions) and MOF (multiple organ failure) compared to 11 patients (mortality 23.9 %) in group B. Table 2 shows the final results. Of course, we perceive this encouraging data with a little reserve due to small numbers of patients in both groups.

The fact that in the two cases of small bowel fistula we managed to close the fistula using the vacuum assisted closure system after repeated unsuccessful surgical treatments remains unquestionable, what is noticeably in contradiction to surgical doctrine on management of small bowel fistulas.

Discussion

According to the literature (5), 90 % mortality of intra-abdominal infections observed in the early years of the 20th century decreased to about 20 % at the end of 20th century, including cases without severe sepsis and multiple organ dysfunctions.

Optimization of the dominant surgical treatment caused a decrease in mortality to less than 40 %, efficient antimicrobial therapy decreased mortality by 10 % and complex intensive care therapy by another 8–10 %. At present, the mortality for intra-abdominal infection varies around 20 % (3, 5). The control of the source of the intra-abdominal infection is the most critical task, with surgical therapy using laparostomy with staged peritoneal lavage and thorough debridements of the peritoneal cavity being its cornerstone. From 1995 (14), all surgeons know the results of vacuum assisted suction system in the form of vacuum sealing. It is well known at present that the abovementioned system can decrease the time interval to primary definitive closure of the retracted abdominal wall in cases of long standing therapeutic laparostomy. Future development led to the VAC (vacuum assisted closure) with TNP (topical negative pressure) (15). This system allowed the application of regulated intensity of topical negative pressure, which, while applied to an intra-abdominal environment at the topical negative pressure of 75 mmHg proved useful in several ways. The advantages included the stabilization of the position of intra-abdominal organs, control and effective elimination of secretions, intra-abdominal decompression and elimination of compartment syndrome, prevention of secondary contamination of the laparostomy from the environment, reduction in open abdomen fascia separation, and technical simplification for the primary surgical closure of the long-term laparostomy. We have found some literature reports on the treatment of VAC drainage in patients with bowel fistula, which were focused on the stimulation of the proliferation of the fibroblasts (16). Our experiences confirm the published results (17, 18). The definitive conclusions depend on the results of representative patient groups in future projects.

Conclusions

The dominant treatment modality for the patient with intra-abdominal infection with severe sepsis remains repeated surgical treatment with laparostomy, staged peritoneal lavage, directed antimicrobial therapy, and complex intensive care. Based on our preliminary evidence with our modified intra-abdominal vacuum assisted topical negative pressure, we can confirm that the addition of this method in the management of intra-abdominal septic with the appropriate combination of other therapeutic surgical modalities improves the patient's outcome.

The advantages of combination therapy with laparostomy and vacuum sealing, according to our experience, were following: shorten treatment time, prolonged interval between re-operations, examination of secretion, prevention of abdominal compartment syndrome, better respiration comfort, simple nursing, simple laparostomy closure, and cost effectiveness.

References

1. **Scott BG, Feanny MA, Hirshberg A.** Early definitive closure of the open abdomen: a quiet revolution. Scand J Surg 2005; 94 (1): 9—14.

2. **Fabian TC.** Damage control in trauma: laparotomy wound management acute to chronic. Surg Clin North Amer 2007; 87 (1): 73—93.

3. **Holzheimer RG, Dralle H.** Paradigm change in 30 years peritonitis treatment — a review on source control. Eur J Med Res 2001; 6: 161—168.

4. **Schein M.** Surgical management of intra-abdominal infection: is there any evidence. Langenbecks Arch Surg 2002; 387: 1—7.

5. **Barie PS.** Serious intra-abdominal infections. Curr Opin Crit Care 2001; 7: 263—267.

6. **Vokurka J, Wechsler J, Kalac J, Masek M, Vlcek P.** Recurrent intra-abdominal abscesses Bratisl Lek Listy 1995; 96: 265—267.

7. **Kirby JP, Fantus RJ, Ward S, Sanchez O, Walker E, Mellett MM, Maltz SB, Lerner TT.** Novel uses of a negative-pressure wound care system. J Trauma 2002; 53: 117—121.

8. **Olejnik J, Hladik M.** Vacuum sealing in the treatment of severe intra-abdominal infection of septic patient. Lek Obzor 2004; 53: 261—264.

9. **Adam U, Ledwon D, Hopt UT.** Programmed lavage as a basic principle in therapy of diffuse peritonitis. Langenbecks Arch Chir 1997; 382 (Suppl 1): 18—21.

10. **Olejnik J, Mraz P, Vician M, Stranava I.** Laparostomy in the treatment of severe intra-abdominal infections. Rozhl Chir 1999; 78: 166—170.

11. **Fuger R, Rogy M, Herbst F, Schemper M, Schulz F.** Validation study of the Mannheim Peritonitis Index. Chirurg 1988; 59: 598—601.

12. **Bui TD, Huerta S, Gordon IL.** Negative pressure wound therapy with off-the shelf components. Amer J Surg 2006; 192: 235—237.

13. **Frankenfield DC, Muth ER, Rowe WA.** The Harris-Benedict studies of human basal metabolism: history and limitations. J Amer Diet Assoc 1998; 98: 439—445.

14. **Brock WB, Barker DE, Burns RP.** Temporary closure of open abdominal wounds: the vacuum pack. Amer Surg 1995; 61: 30—35.

15. **Tautenhahn J, Burger T, Lippert H.** The present state of vacuum sealing. Chirurg 2004; 75: 492—497.

16. **Rinder H, Wild T.** Fortschritte in der V.A.C.-Therapie bei Laparostoma. Europ Surg 2003; 35 (Suppl 191): 41—42.

17. **Labler L, Keel M, Trentz O.** New application of vacuum assisted closure in the abdominal cavity in case of open abdomen therapy. Zbl Chir 2004; 129 (Suppl 1): S14—19.

18. **Weidenhagen R, Grutzner KU, Kopp R, Spelsberg FW, Jauch KW.** Role of vacuum therapy in the management of the septic abdomen. Zbl Chir 2006; 131 (Suppl 1): S115—119.

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