

The open abdomen - still a challenge for the surgeons. Which is the best technique for temporary abdominal closure? A focus on negative pressure wound therapy

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"The prevention of open abdomen is better than any techniques for temporary closure"

S. Shah

"Although in surgery the art and science are balanced, the management of open abdomen is more art than science"

T. Fabian

Brief overview

The open abdomen (OA) is not a new idea. In 1897 Andrew McCosh describe its use in diffuse peritonitis, in 1894 Körte used it in necrotic pancreatitis. In 1940 the military surgeon W.H. Ogilvie reported two cases in which he left abdomen open. In the middle of XX century Gross and Schuster used it in the treatment of large omphalocele in children. Nowadays, there is consensus about the indication for OA – severe diffuse peritonitis with insufficient control of the primary source of infection, damage control surgery in trauma, abdominal compartment syndrome, need for second look.

Various technique for temporary abdominal closure (TAC) have been described which clearly indicates that the ideal technique is not yet available. These are open packing, skin closure with towel clips, Bogota bag, mesh, mesh-zipper, mesh-foil (Figure 1), palisade dorso-ventral drainage (Figure 2), Wittmann patch, negative pressure wound therapy. During the years TAC[®] evolved from a passive dressing to active approach with negative pressure. In 1986 M. Schein published in BJS the so-called "sandwich technique" which is the first use of negative pressure in open abdomen (1). After 1994 negative pressure wound therapy (NPWT, home-made or commercial vacuum assisted closure) have gained tremendous popularity. Along with traditional home made Barker's vacuum pack several commercial products have been released into the practice: V.A.C.[®] (KCI), Vivano[®] (Hartmann), Renasys[®] (Smith & Nephew). Actually, the pioneers from Wake Forest University in North Carolina replaced the gauze with polyurethane foam in 1996.

Despite the growing body of literature high level of evidence about open abdomen management are still lacking (2). This is may be due to the inherent difficulties to perform randomized controlled trial in emergency setting. The following advantages in comparison to passive dressings has been claimed: increased primary fascial closure, lower rate of adhesions, diminished bacterial count, better qualitative and quantitative analysis of the fluid, increased survival and significantly easier nursing. The critical analysis, however, revealed significantly more complicated situation. Recent systematic review and meta-analysis of only comparative

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studies (NPWT vs non-NPWT) reported significant benefit only regarding mortality and length of ICU stay and no difference about PFC and complications (incl. EAFs) (2).

In this light, several problems regarding remains to be elucidated as follows.

Enteroatmospheric fistulas

The major concern is the increased risk for enteroatmospheric fistulas (EAFs).

A recent systematic review found no difference of EAFs rate in comparison to non-NPWT (2). Scientific evidence clearly showed that significant risk factor for EAFs is not negative pressure itself but the presence of large bowel resection, massive fluid resuscitation, frequent re-explorations (4), prolonged duration of OA (5), multiorgan failure (6), use of meshes (7) and the adhesions between fascial edges and bowels which can be easily overcome with use of non-adherent folio between bowels and abdominal wall (8). A recent international project headed by prof. T. Banasiewicz from Poland confirmed the low incidence of EAFs in NPWT (unpublished data).

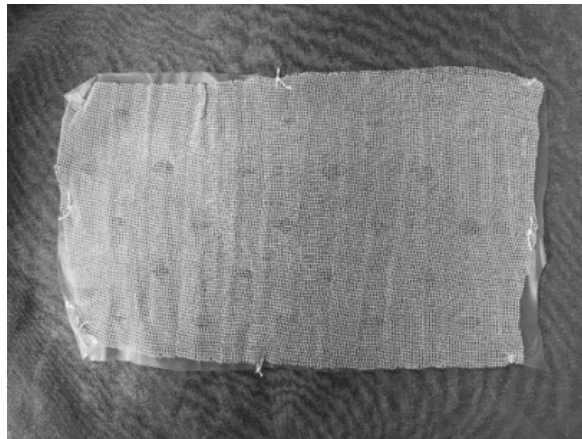


Figure 1 - Mesh-foil laparostomy.

Level and type of negative pressure

There is insufficient data in the literature regarding the role of the different levels and type of pressure (continuous or intermittent), and the effect of instillation therapy in OA as well. Recent, but not yet published review from Poland showed that the most commonly used pressure is -125 mmHg (reports largely differ from 20 mmHg to 200 mmHg) with continuous pressure used from most of the authors (T. Banasiewicz, unpublished).

Primary fascial closure

PFC is the most commonly primary outcome measure because it is reported to significantly reduce complication and mortality rates in the cases with early PFC, irrespectively of the technique for TAC (9). Although most systematic reviews reported preponderance of NPWT, the most recent meta-analysis of only comparative studies reported similar PFC rate in NPWT vs non-NPWT with significant heterogeneity between included studies (2). Peterson

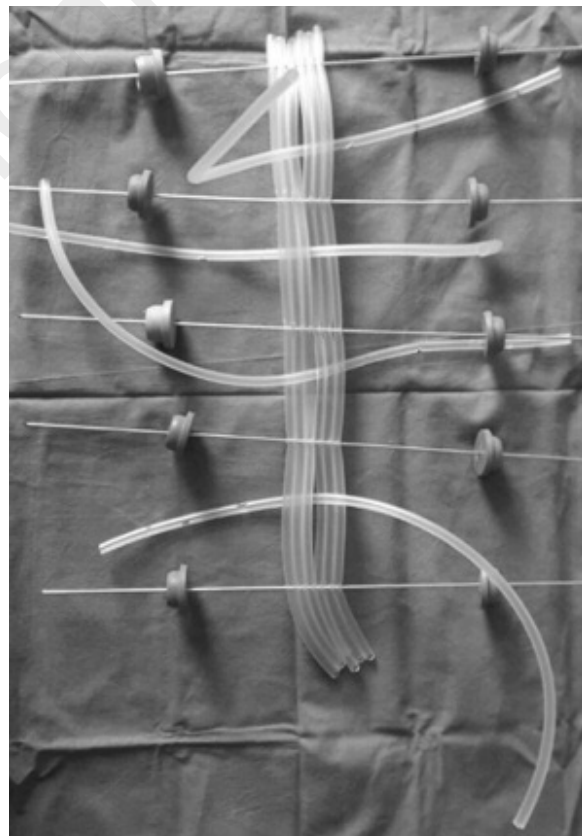


Figure 2 - Pallisade dorsoventral drainage.

et al. applied for a first time mesh mediated traction reporting 100% PFC (10). In a small RCT Pilakos et al. firstly demonstrated the benefit of this technique (11). The subsequent experience unambiguously demonstrates that higher PFC rates could be achieved only in combination with dynamic fascial closure, especially when OA is expected to be applied for more than 8 days (7, 12).

On the other hand, PFC depends on several other factors. It is lower in DP than in non-septic patients (13). Other important negative determinants are necrotizing fasciitis, EAFs (14) wound dehiscence (15) longer duration and advanced stage of OA (5, 16).

Mortality

Mortality is a complex outcome metric and depends on several factors, predominantly on the co-morbidity and the severity of the condition led to OA. Therefore, it is very difficult to measure accurately the influence of the type of TAC. Higher rate in diffuse peritonitis was reported (17). Ateama et al. failed to demonstrate benefit of one or another technique in diffuse peritonitis, although dynamic retention sutures and NPWT + DFC were associated with the lowest mortality (7). According to other authors NPWT seems to be associated with reduced mortality (2, 3). However, significant difference between techniques with negative pressure was reported. A prospective comparative study found significantly lower mortality rate in ABThera® vs. Barker's VP in diffuse peritonitis (16). The randomized trial of Kirkpatrick et al. comparing commercial ABThera® and VP failed to prove that the higher survival rate in ABThera® is due to "an improvement in peritoneal fluid drainage, fascial closure rates, or markers of systemic inflammation" both in trauma and peritonitis (18). The preliminary data from the International Register of Open Abdomen (IROA) showed different mortality rates between different TAC according to etiology for OA. The authors reported lowest mortality rate in NPWT vs. Barker's VP, Wittmann patch and highest rate in Bogota bag in diffuse peritonitis subgroup (3). In the trauma subgroup the lowest mortality rate was observed in Bogota bag followed by NPWT and Barker's vacuum pack.

Bacterial clearance

In our opinion, the antibacterial effect of NPWT is a common misconception. Although Morykwas et al. initially found lower bacterial load, the subsequent publications showed contradictory results (19). Weed et al. reported even increase in 43% of the cases (20), others reported decrease of non-fermentative Gram negative, but selective increase of *S. aureus* (21). An increased bacterial count in all foams was reported, although it was lower in black vs. white foam at 125 mmHg (22). The systematic review of Patmo et al. reported "no conclusions on changes in the bacterial load and type of bacteria can be drawn. There is no clear answer to the question whether VAC can be safely used on any wound without causing or worsening wound infection" (23).

Cost

The cost is an important part of the contemporary health care. For the patient with PFC, Bee et al. reported 474\$ in resorbable mesh, 17\$ for Barker's VP and 1070\$ for V.A.C.® (24). On the other hand, however, the cost analysis of Banasiewicz et al. clearly demonstrates the economical effectiveness of NPWT (25). The authors reported diminished total cost with 5661 euro and 17381 euro per saved life in comparison to the standard treatment or decrease with 64%. Moreover, they found significant decrease with 3292 euro and 4932 euro when NPWT was applied in the first five days after diagnosis/admission, respectively.

Bulgarian experience

Our Institution serves as a tertiary center for most complicated cases in Bulgaria and has a long tradition with the open abdomen management dating from 1979. The open abdomen with planned re-laparotomies was introduced in 1987 and led to decrease of the mortality to 17% in diffuse peritonitis (26). The first authors used a specifically designed polycapropamid mesh impregnated with 5-Nitrox (Ampoxen[®], Medica S.A. Sandanski, Bulgaria) put directly on the bowels. Due to high rate of fistulas Losanoff and Kjossev made an original modification called mesh-foil laparostomy (MFL) (Figure 1) (27, 28). They added additional inner layer consisting of polyethylene foil with multiple small openings thus protecting the bowels. This novel technique significantly reduced the fistula rates and authors reported 100% PFC in 50 patients with severe neglected diffuse peritonitis and 24% mortality. Few years later they additionally improve the technique adding a large synthetic sheet enveloping all viscera to reduce the rate of adhesions (29). The same authors introduced also the pallisade dorsoventral drainage into Bulgarian practice (Figure 2) (30). NPWT was introduced into our practice by prof. Mutafchiyski in 2007. In a comparative study the authors reported 73% PFC in NPWT group vs. 53% in MFL group using mesh-mediated traction (Figures 3, 4) (31). Regarding ABT-hera[®] our experience suggest better results in diffuse peritonitis with significantly better evacuation of the intra-abdominal fluid (Figures 5, 6). In necrotizing fasciitis and wound dehiscence, however, the results are not so good - PFC was achieved in only 43% (9/21) (unpublished data). A possible explanation is the influence of the co-morbidity and the severity of infection. This finding is in accordance to the literature (32) but mesh-mediated traction could significantly increase the rate of PFC in such conditions (33).

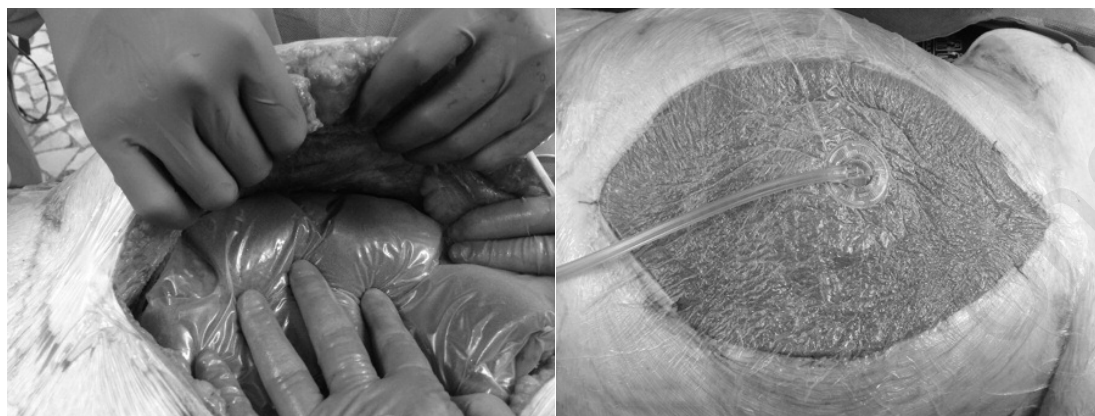
Conclusion

Surprisingly, despite the enormous experience high quality data are still lacking and may probably be OA management is still more art than science? It is wittily depicted from our team like “last waltz of the surgeon with the patient facing the death”?

Instead conclusion we would like to cite Dr Matthew Walsh from Cleveland Clinic who said in Basel this year “guidelines are not religion – be thoughtful surgeon”. The critical review of the literature on OA management is mandatory. It is also worthwhile to follow the advise of M. Schein “data and theory are everywhere – the sources are numerous but what you really need is wisdom to enable you to apply correctly the knowledge you already have and constantly gather” (Schein’s common sense Emergency Abdominal Surgery, Springer, 2005, p.5).



Figures 3, 4 - NPWT with mesh-mediated traction.



Figures 5, 6 - ABThera® in diffuse peritonitis.

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