

# ENTEROATMOSPHERIC FISTULAS - THE CHALLENGE OF THE OPEN ABDOMEN

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## ABSTRACT

**INTRODUCTION:** In the past two decades, the open abdomen (OA) technique has gained wide popularity as an effective approach in the cases with severe peritonitis, abdominal compartment syndrome and critical trauma. However, it is still associated with high complication rate. Enteroatmospheric fistulas are the most devastating complication. Despite the numerous techniques described in the literature, their management remains a challenging task.

**MATERIAL AND METHODS:** The present study analyses the frequency of enteroatmospheric fistulas in two cohorts managed by open abdomen and discussed the results from their treatment in the V.A.C. group. The first cohort includes 69 consecutive patients temporarily closed by V.A.C. abdominal dressing, whereas the other one encompasses 83 patients treated by mesh-foil laparostomy. The fistula effluent was isolated by 10 ml syringe barrel according to the technique of Verhaalen.

**RESULTS:** Overall, 5/69 (7.2%) fistulas were identified. All were high output (>500 ml) small bowel fistulas. One patient died before fistula closure (25%, 1/5). A controlled enterocutaneous fistula was achieved in 2 patients and spontaneous closure in one. In one case an extensive small bowel resection due to intractable ileus was performed. The mean ICU and hospital stay in the fistula group were 15.2 (7-28) and 55.6 (32-84) days versus 8.2 (2-30) and 16.7 (3-84) respectively.

**CONCLUSION:** The enteroatmospheric fistulas are the most dangerous complication of the open abdomen. The best treatment is their isolation combined with V.A.C. at the early stages and resection with primary anastomosis after 3-12 months.

**Keywords:** *enteroatmospheric fistulas, V.A.C., treatment*

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## INTRODUCTION

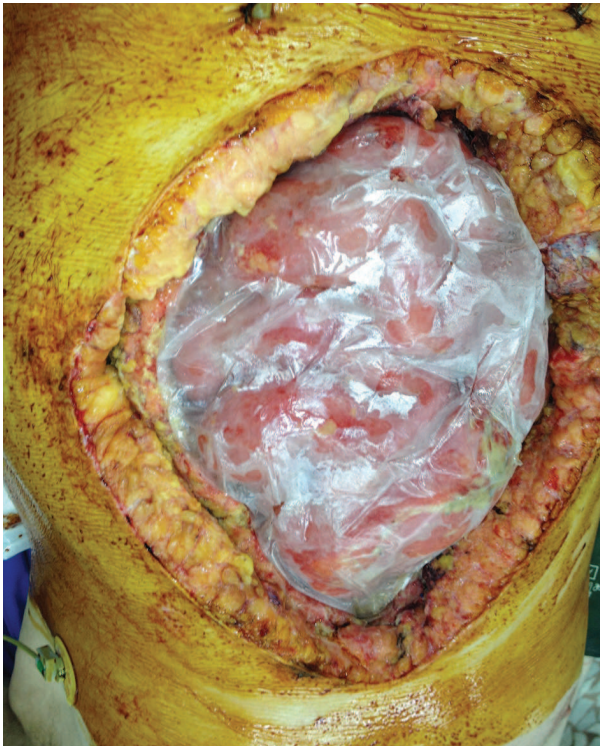
In the last three decades, the open abdomen (OA) has been largely recognized as an effective technique for treatment of severe peritonitis, abdominal compartment syndrome and as a part of damage control surgery. On the other hand, it remains a great challenge due to the high complication rates. The enteroatmospheric fistulas (EAFs) are the most devastating complication of the OA, described by some au-

thors as “the nemesis of OA” (35). They are associated with continuous contamination of the abdominal cavity, development of new fistulas and tend to exhaust the hospital resources due to prolonged ICU and overall hospital stay (2,43). In contrast to the enterocutaneous fistula, EAF have no fistula tract and their spontaneous closure is almost impossible. Despite the numerous methods described in the literature, the results are still contradictory.

### MATERIAL AND METHODS

The present study analyses the frequency of EAFs in two cohorts managed by OA and the results from their treatment in the V.A.C group. The first cohort includes 69 consecutive patients temporarily closed by V.A.C. abdominal dressing, whereas the other one encompasses 83 patients treated by mesh-foil laparostomy (MFL). The causes for OA were neglected severe secondary peritonitis with a massive contamination of the abdominal cavity, inability to close abdomen due to severe bowel edema and damage control surgery. All patients were treated during a 7-year period (2007-2013).

#### *Surgical technique*



*Fig. 1. V.A.C. abdominal dressing*

**V.A.C.® Abdominal Dressing System (KCI, San Antonio)** includes sutureless placement of 3 layers into the wound. The first is a perforated polyethylene sheet, which envelop the whole abdominal content to the both lateral channels. The second layer consists of black polyurethane foam (Granu Foam®), which allows equal distribution of the negative pressure through the wound. Finally, the wound is covered with an impervious adhesive drape. Through a small hole on it, a track pad connector is connected to a source of negative pressure. In all patients a continuous negative pressure of 125 mmHg was applied (Figs. 1, 2).

**Mesh-Foil laparostomy (MFL)** is an original method, developed and widely used in our hospital for treating before the implementation of the Negative Pressure Wound Therapy. It consists of outer layer, which is a prosthetic mesh (polycapromide, Ampoxen®) impregnated with 5-Nitrox. The inner layer consists of a polyethylene sheet with multiple small openings. The two layers are sewn to the fascial edges and covered with sterile gauzes without a negative pressure (Fig. 3).



*Fig. 2. V.A.C. abdominal dressing*

The fistula effluent was isolated by 10 ml syringe barrel, placed over the fistula orifice in 4 of our cases. Over the polyethylene sheet, a black foam and an adhesive drape were placed with a holes matched to the size of the barrel (Fig. 4). After application of a negative pressure of 125 mmHg, an ostomy bag was placed over its external orifice (Fig. 5). The dressings were changed every 48 hours. One case was temporarily managed via “floating stoma” (Figs. 6, 7).



*Fig. 3. Mesh-Foil laparostomy*

## RESULTS

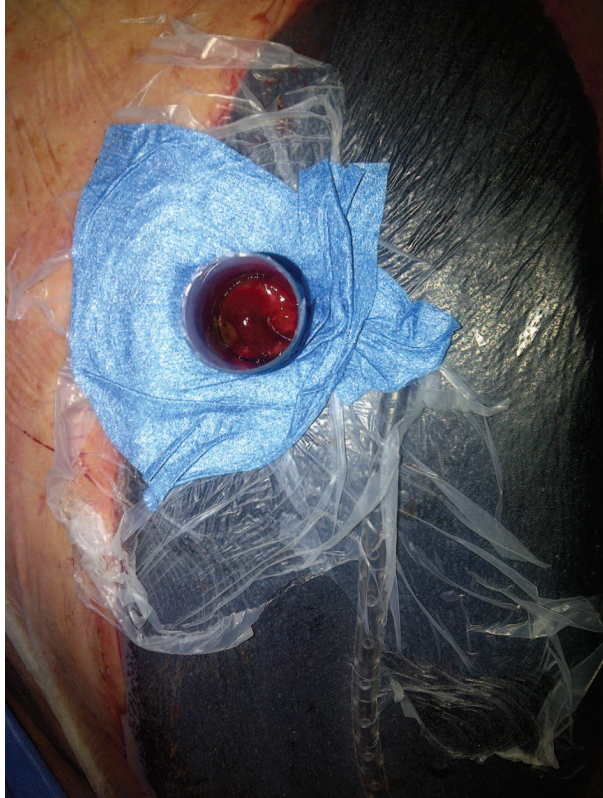
Overall, 5/69 (7.2%) EAFs were identified in the V.A.C. group vs. 16/83 (19.3%) in the MFL group. All of the EAFs in the V.A.C. group were small bowel fistulas with a high output according to Berry's classification (> 500 ml) (3). Two cases were transferred from other hospitals. The primary cause was anastomotic insufficiency in 2 cases and perforation of the

small bowel after debridement with multiple serosal lacerations in 3. One patient died (20%, 1/5). The characteristic of the cases with and without EAF are shown in Table 1.

## DISCUSSION

Although the OA has gained wide popularity, surgeons should be aware of its inherent complications. The EAFs are the most devastating complication. In a comprehensive analysis, Fisher et al., found EAFs in 8.4% (32/380) of the cases with OA vs. 0.6% (11/1844) after definitive abdominal closure (13). The review of 18 series with overall 1395 patients managed by OA and V.A.C. revealed a mean rate of EAFs 6.1% (Table 2), (4,8,14,17,19,20,26-29,31,32,36-38,42,45,47), which is comparable to 7.2% in our series.

As it is shown in Table 1, EAFs are associated with significantly prolonged ICU and overall hospital stay. As in our series, Texeira et al, found prolongation of ICU and LOS with 21 and 66 days, respectively, which was associated with increase of the hospital costs from 126 996 to 539 309\$ (43). EAFs were



*Figs. 4, 5. Isolation of EAF by a syringe barrel [Verhaalen]*

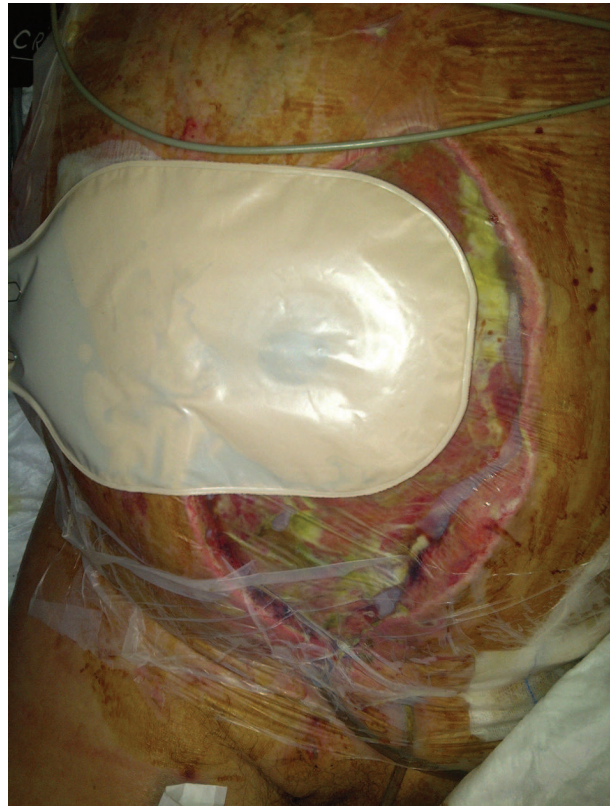
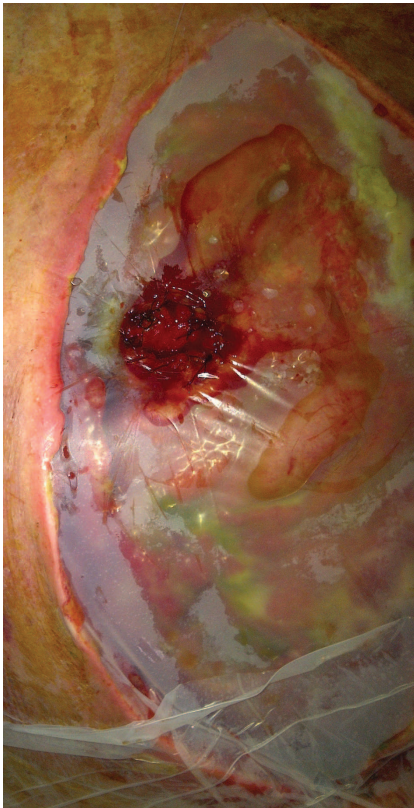


Fig. 6, 7. "Floating stoma" [Subramanian]

associated with a higher mortality (14% vs. 6%) (13), than the cases without and reach 42% in other series (2). Additionally they lead to a significantly lower rate of primary fascial closure (19).

Our data and the review of the literature do not support the hypothesis for the causative role of the negative pressure (7,13,34,35,39,40).



Fig. 8. Nipple V.A.C [Di Saverio]

The risk factors for EAFs are presence of anastomoses on the background of septic abdomen or multiorgan failure (MOF), use of jejunal tube for enteral feeding in OA, lack of gentle surgical technique during the re-explorations with iatrogenic serosal lacerations, which were noted in 3 of our cases. Other important factors are development of adhesions between bowels and the fascial edges, a contact of the bowels to the materials used for temporary abdominal closure, especially non-absorbable meshes, OA lasting over 9 days and performing of frequent re-explorations (2,5,27,35).

The above-mentioned results clearly demonstrate that the prevention of EAFs is of paramount importance. The early abdominal closure (<9 day) significantly diminishes their frequency. On the background of overall frequency of 11.5% (32/279), Miller et al., found that 70% (24/32) of EAFs were in the group of secondary fascial closure (24/69, 34.8%) (27). Management of the patients with OA by an experienced team is obligatory (35,39). Other preventative measures include omental covering of the anastomoses or their placement deep in the abdomi-

*Table 1. Comparison between cases with and without EAFs in the VAC group*

TAC	N (%)	APACHE	MPI	Mortality, %	ICU stay	LOS (days)
VAC	69	19.8	25.5	30 (21/69)	8.2 (2-30)	16.7 (3-84)
EAFs	5/69 (7.2)	20.4	26	20 (1/5)	15.2 (7-28)	55.6 (32-84)

*Table 2. The frequency of EAFs in the literature*

Study	Year	N	EAF % (n)
Miller	2002	148	0.7 (1)
Garner	2003	14	0
Stonerock	2003	15	0
Suliburk	2003	35	5.7 (2)
Stone	2004	48	4.2 (2)
Miller	2004	53	1.9 (1)
Miller	2005	344	9.3 (32)
Labler	2005	18	0
Oetting	2006	36	11(4)
Perez	2007	37	2.7 (1)
Peterson*	2003	7	0
Wondberg	2008	30	6.7 (2)
Teixeira	2008	93	15 (14)
Bee	2008	31	22.6 (7)
Verdam*	2011	18	18.8 (3)
Kafka-Ritsch*	2012	160	3 (5)
Cheatam	2013	178	2.2 (7)
Hougaard	2014	115	3.5 (4)
Overall		1395	6.1 (85)

nal cavity, gentle surgical technique and prevention of adhesions between the bowels and the abdominal wall. Management of the patients with OA by a team with experience in this area is of a particular importance.

The general measures include control of the sepsis, parenteral nutrition, maintenance of the fluid and electrolyte balance and meticulous skin care.

The use of Somatostatin is controversial and its routine application is not recommended (2).

The mainstay of the treatment of EAFs at the early stage of OA is the isolation of the fistula, thus minimizing the contamination of the abdominal cavity. Although the resection, exteriorization or proximal diversion is the best option, it is often not possible due to the edematous and vulnerable bowel wall and the shortened of the mesentery.

There are several techniques described in the literature. Subramanian et al., described the so-called "floating stoma" with successful outcome in 3 cases. They covered the bowels with a plastic silo from intravenous bag, similarly to Bogota bag. Next, they cut a hole matched to the fistula opening, which was sutured directly to the plastic bag with continuous polypropylene suture. Finally, they put an ostomy bag over the bag (41). This method was temporarily used in 1 of our patients (Figs. 6, 7).

In 2006, Goverman et al. described a successful application of "fistula-VAC" in 5 cases. They put a single sheet of Xeroform dressing over the bowels with a hole for the fistula opening. Next, black foam with a hole matched to the fistula orifice was placed over it, followed by placement of polyurethane drape and negative pressure of 75 mmHg. Finally, they cut the drape around the fistula and attached an ostomy bag (16). Instead of Xeroform dressing, Byrnes and al. used split-thickness skin graft (6). Al Khoury modified this technique through a Malecot catheter put into the fistula's orifice (1).

In most of our cases we applied the so-called "ring/silo" method described by Verhaalen et al. (46). The ring is constructed from circular foam covered with V.A.C.' adhesive drape and fixed over the fistula by stoma paste. Another option is a roll of tape or syringe barrel matched to the fistula. We used a 10 ml syringe placed over the fistula orifice (Fig 5, 6). Black foam and an adhesive drape are placed with a hole matched to the size of the barrel. In this way we achieved spontaneous closure in 1 and a controlled

fistula in 2 cases. All of them were discharged with large ventral hernias. One patient died due to refractory sepsis. Currently, there are original silicone fistula adapters with different sizes, which are soft and easy to use with a minimal risk for additional injury of the bowel wall (PPM Fisteladapter™, Phametra, Herne/Ruhrstadt, Germany).

Di Saverio et al. successfully applied the slightly modified “nipple V.A.C.”, described by Layton (9,21). Similarly, they used a silicone baby nipple placed over fistula opening, which was fixed with Stomadhesive® (Convatec, USA), but through the top of the nipple they placed 10F Foley catheters to facilitate the draining of the enteric content. This technique was temporarily used in one of our patients due to frequent displacement of the nipple with insufficient control of the fistula effluent (Fig. 8).

Wright reported a case treated by modified vacuum pack and continuous lavage with saline and 2 dressing changes per a day. He placed two tube drains toward the fistula and isolated the abdominal cavity with moistened gauze compresses to the level of the skin, followed by adhesive drape (48). Ramsay and Galo attempted to transform EAF into enterocutaneous fistula through a Foley catheter put into the fistula, which was taken out through a tunnel in the healthy tissues of the abdominal wall (33). Recently, Ozer et al. reported a successful closure in 1 patient by using of a novel “silicone fistula plug” technique (30). They used a circular silicone plug inserted in the fistula, which was suspended for an aluminium bridge over the abdominal wall. Through a careful tension they sealed the fistula inside the bowel opening with subsequent V.A.C. dressing. In small and superficial EAFs without visible mucosa, suture with subsequent coverage of the suture line with fibrin glue, acellular dermal matrix or autologous split skin graft may be successful without any additional risks (15, 44). Jamsidi et al. reported 5/7 EAFs closed in this way (71.4%) (18).

At the late stage of OA, when the bowels are fixed and covered with granulation tissue, a method of choice is the resection of the affected bowel segment with subsequent anastomosis and reconstruction of the abdominal wall (12,22). However, there is no consensus about the appropriate timing of this operation. The proponents of early operation report-

ed a mortality rate 7-21% and complications in 17% of their cases (10). Marinis et al. advocate early intervention using lateral approach to the fistula trough incision in a healthy tissue near the granulation bed (24).

Other authors advocate a waiting period of 4-6 weeks due to the high mortality within this time frame (11,25). Most authors prefer operation after an interval of 3-12 months (12, 23). The reconstruction after 12 months is associated with increased complication rate from 7.4% to 25% (12).

## CONCLUSION

The EAFs represent the most devastating complication of the open abdomen and are associated with a high mortality, prolonged ICU and overall hospital stay, increased hospital costs and lower rate of primary fascial closure. Their treatment is difficult and requires combined efforts of a multidisciplinary team. Therefore, their prevention should be of a paramount importance. Important preventative measures are the early definitive closure of the abdomen, gentle surgical technique and management of the OA from one and the same experienced surgical team. The mainstay of the treatment is the fistula isolation, combined with V.A.C. therapy at the early stages of OA. A resection with primary anastomosis and abdominal wall reconstruction after 3-12 months is warranted at the later stage of OA.

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