

Sandwich Vacuum Bogota versus Conventional Bogota Bag as Temporary Abdominal Closure (TAC) Techniques

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ABSTRACT

Background: Open abdomen (OA) is a concept entailing the deliberate non-closure of the abdominal fascia at the conclusion of surgery to prevent intra-abdominal hypertension or subsequent abdominal compartment syndrome. Several temporary abdominal closure (TAC) techniques have been devised in the management of OA. **Patients and methods:** 31 patients were allocated into 2 groups according to the temporary abdominal closure method. The conventional Bogota bag group consisted of 15 patients; the Sandwich Vacuum Bogota (SVB) group of 16 patients. Statistical analysis was performed to determine whether the addition of a negative pressure system improved the outcome as regards lateral fascial retraction, complication and reapplication rate as well as preservation of skin integrity. **Results:** There was no statistically significant difference in the rate of skin-level approximation between both methods ($p = 0.2$). Yet, at the fascial level, the SVB group demonstrated CT evidence of a statistically significant superior approximation rate ($p = 0.007$). No new fistula occurred but anastomotic leak occurred in a total of 11 patients with no significant difference between both groups. There was also no demonstrable advantage as regards reapplication rate. **Conclusion:** Both TAC techniques are easily available and cost-effective. The addition of a negative pressure system in SVB resulted in a higher fascial approximation rate, easier control of efflux and maintenance of skin integrity.

Key words: Open Abdomen (OA) - Temporary Abdominal Closure (TAC) - Negative Pressure System - Fascial approximation - Skin approximation

INTRODUCTION

Open abdomen (OA) is a concept entailing the deliberate non-closure of the abdominal fascia at the conclusion of surgery to prevent intra-abdominal hypertension or subsequent abdominal compartment syndrome [1-3]. OA is one of the significant advances in recent decades and has become a common procedure in both the traumatic and non-traumatic setting [4]. One of the primary goals of OA treatment is closure of the fascial defect as quickly as is clinically feasible without increasing intra-abdominal pressure during the initial hospitalization.

Several temporary abdominal closure (TAC) techniques have been devised to bridge the period until final abdominal closure can be performed. The addition of a negative pressure system to TAC has been suggested repeatedly with potential advantages in terms of rate of approximation, loss of domain and complications [4-7]. Yet, the management of patients with OA is resource-demanding [4].

The aim of this study is to investigate potential benefits from adding a negative pressure system to the very economic traditional Bogota bag; a

technique we termed Sandwich Vacuum Bogota (SVB).

PATIENTS AND METHODS

This prospective non-randomized comparative study includes 31 non-trauma patients who had an exploratory laparotomy at Kasr Alainy emergency department between May 2016 and April 2017 for various abdominal pathologies associated with significant bowel and tissue edema and bowel distension precluding both primary abdominal closure and also early fascial closure. The consequence was an open abdomen, which is defined as an abdominal wall defect created by deliberately keeping an abdominal incision open at the conclusion of intra-abdominal surgery or by opening (or reopening) the abdomen out of concern for abdominal compartment syndrome.

Early fascial closure defined as closure within 7 days from the initial abdominal surgery was not feasible in our patient cohort due to the severity of their septic abdominal conditions with significant pathophysiological sequelae and metabolic disturbance. Therefore, TAC (Temporary Abdominal Closure) was warranted.

The 31 patients were assigned to two groups. One group comprised 16 patients who had a modification of the conventional Bogota technique which we termed Sandwich Vacuum Bogota (SVB) technique. The other group of 15 patients had the conventional Bogota bag procedure as temporary closure. Group allocation followed surgeon's preference.

Sandwich Vacuum Bogota (SVB) Technique

In SVB, two plasma bags are opened. The first bag is fenestrated by tiny perforations and sutured to the fascial edge using Prolene 1/0 continuous interlocking sutures. A suction drain is inserted through the skin to lie above this first Bogota and connected to 80-100 mmHg of negative pressure. The second bag is sutured to the skin edges using Monocryl 3/0 with interrupted sutures. Its edges are covered with a circular Opsite sheet to create an air-tight vacuum seal. The finished closure of this technique has to be secure, firm, airtight and dry. No dressings are applied above the SVB technique. Any stomas or drain sites were covered with a pouching system of appropriate size. Every effort was exerted to prevent any soiling to minimize infection. The amount and color of the fluid collected in the suction device was monitored and documented.



Figure (1): First Bogota bag sutured to the fascial layer using prolene 1/0 continuous interlocking sutures.



Figure (2): The second Bogota is sutured to skin edges above the suction drain. A circular Opsite sheet is applied for air tightness.

Bogota Bag Technique

In this conventional method, a plasma bag is fenestrated by tiny perforations and the edges are sutured to the fascial edge using Prolene 1/0 continuous interlocking sutures. A dressing is applied over the Bogota and changed twice daily.

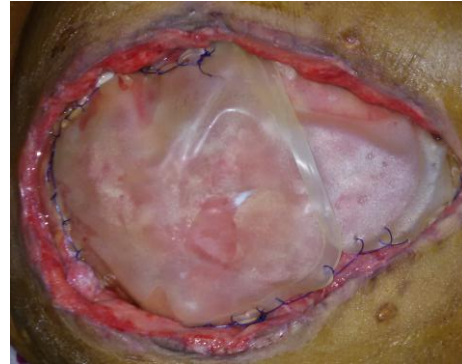


Figure (3): Bogota Bag Technique

Postoperative care & follow up:

Apart from the follow up for the general medical condition of the patients, their wound was examined every day for wound infection, approximation or retraction of skin and fascia, need of reapplication, fistula formation or leakage, granulation tissue formation and surrounding skin integrity.

An abdominal CT to assess the abdominal wall defect in the different layers: skin, fascia and muscles was performed on the 1st postoperative day and repeated after 10-12 days. The CT images of each patient were compared as regards skin and fascial gap by an experienced radiologist. For standardization, by convention the defect was measured at the lower edge of the liver.

Statistical analysis:

The statistical methods that were used in this study included; the range, the mean (\bar{x}), standard deviation (SD), Percentage (%). Statistical analyses were performed using MedCalc version 15.8 (MedCalc software, Ostend, Belgium).

RESULTS

In terms of demographic data, co-morbidities and primary pathology warranting exploratory laparotomy, there was no statistically significant difference between the two treatment arms (**Table 1**).

Table (1): Distribution of age, gender, comorbidities and primary pathology among the 2 techniques

	SVB	Bogota	P value
Age			0.27
Mean (years)	46.8	49.8	
Min (years)	18	35	
Max (years)	66	65	
Gender			0.4
Male	10	12	
Female	6	3	
Comorbidities			0.07
Absent	8	7	
Present	8	8	
Primary Etiology			0.7
GIT perforation	12	12	
Intestinal Obstruction	1	1	
Tubo-ovarian abscess	2	1	
Mesenteric Vascular Occlusion	1	1	

At the level of the skin, comparison between early and late CT images yielded a generally limited skin approximation rate. It was higher in the SVB group with a mean of 12.5% approximation. Yet, the difference between both treatment arms was not statistically significant **Table 2.**

Table (2): Early and late skin level defects and approximation rate

	SVB	Bogota	P value
Day 1 skin gap in cm			
Mean	8.72	8.43	
STDEV	1.2	1.4	
Min	6	6	
Max	11	11	
Day 10-12 skin gap in cm			
Mean	7.66	8	
STDEV	1.8	1.6	
Min	4	5	
Max	11	11	
Skin gap approximation (%)			0.2
Mean	12.5%	6.3%	
STDEV	17.3%	6.7%	
Min	17%	6%	
Max	42%	17%	

On the fascial level, on the other hand, a highly statistically significant difference in the approximation rate between both groups was demonstrated (**Table 3).**

Table (3): Early and late fascial level defects and approximation rate

	SVB	Bogota	P value
Day 1 fascial gap in cm			
Mean	9.2	8.93	
STDEV	1	1.2	
Min	7	6	
Max	11	11	
Day 10-12 fascial gap in cm			
Mean	7.9	8.9	
STDEV	1	1.5	
Min	7	6	
Max	10	11	
Fascial gap approximation (%)			.007
Mean	12.4	.33	
STDEV	15.7	10.5	
Min	-29	-17	
Max	35	19	

Another important factor determining the degree of fascial approximation is the presence of a stoma. **Table 4** shows the significantly limited approximation rate in the presence of a stoma.

Table (4): Percentage of skin and fascial level approximation in the presence or absence of a stoma

	Stoma	No stoma	P value
Skin gap approximation (%)			
Mean	1.1	15.7	.007
STDEV	10.6	12.6	
Fascial gap approximation (%)			
Mean	3.2	13.69	.001
STDEV	12.1	12.02	

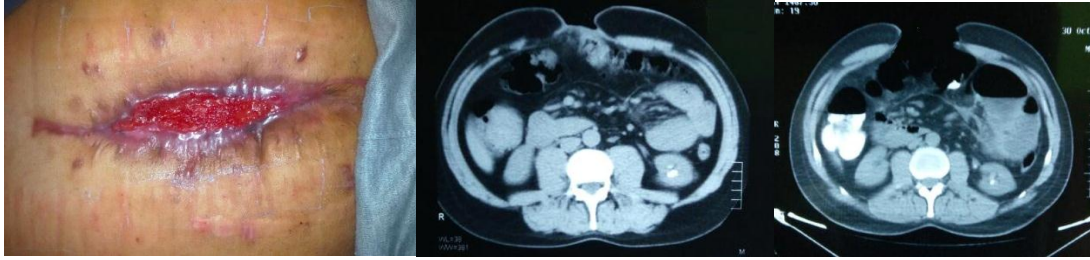


Figure (4): CT image of open abdomen on day 1 (left image) & day 10 (middle image) using SVB. Wound appearance on day 18 (right image).

No new fistula occurred in either group. Leakage from an intestinal anastomosis occurred in both groups, yet, there was no statistically significant difference between both TAC techniques **Table 5**.

As regards the need for reapplication of the Bogota bag, in the SVB group detachment was in the second (Skin) Bogota, which abolished the negative pressure in between the 2 layers and it could simply be reapplied bed side. This occurred in 3 cases. Reapplication in the Bogota bag group was required when detachment from the fascial edges occurred and had to be performed in the operating theatre. Again, this occurred in three patients **Table 5**.

Table (5): Anastomotic leakage and rate of application in both groups

	SVB	Bogota	P value
Anastomotic leakage (Number& Percentage)	6 (37.5%)	5 (35.5%)	0.5
Rate of reapplication (Number& Percentage)	3 (18.8%)	3 (20%)	0.6

DISCUSSION

The concept of open abdomen was originally introduced in the context of trauma as part of damage control surgery. Recently, it has been extended in application to encompass the elective and emergency surgical setting where similar pathophysiological mechanisms may be operating^[8,9].

In trauma, the main objective is control of hemorrhage and contamination. For non-traumatic cases, the basic principle consists of abdominal sepsis control^[10].

Deliberate non-closure of abdominal fascia to prevent intra-abdominal hypertension (IAH) or subsequent abdominal compartment syndrome (ACS) warrants a temporary abdominal closure (TAC) technique^[1,2].

In fact, the outcome in patients with intra-abdominal sepsis with an open abdomen is worse when compared to trauma patients^[11].

In our study, 87% of patients had abdominal sepsis. The other 13% suffered from ischemic bowel and associated bowel edema. No trauma patients were included in our series as most trauma patients could be managed by early fascial closure after damage control. In contrast to trauma victims, many of our patients (51%) also suffered a significant comorbidity adding to the general pathophysiological sequelae of the local inflammatory process. Consequently, the patient cohort of this study presented with severe intra-abdominal septic conditions with significant and prolonged tissue edema and bowel distension rendering early fascial closure non-feasible.

The necessity for prolonged application of a TAC method impacted our choice of TAC technique. In a high flow, resource-limited institution like Kasr Alainy cost containment considerations are of utmost importance. Furthermore, an ideal TAC should be simple and fast, allowing good visibility of intra-abdominal contents, limit contamination, decrease bowel edema and fistula formation, provide visceral, fascial and skin protection and minimize loss of domain^[12].

The diversity of available TAC techniques with their peculiar advantages and disadvantages suggests that there is no established ideal TAC^[13].

As we already had significant previous experience with the use of Bogota bags, which has proven to be an easy, readily available, very cheap and effective method, that has allowed us to bridge many patients over their difficult times with an open abdomen, we chose it as one of the techniques in our study. Plasma bags have the advantage of being relatively robust withstanding lateral tension. They provide a smooth and non-adherent inner surface to be in direct contact with the exposed abdominal contents. Furthermore, they allow direct visualization of possible infection or leakage. Yet, several aspects were problematic during their use. Detachment from the facial edges necessitated repeated reapplication. Inability to quantify and collect the fluid effluent created a continuously moist environment negatively affecting surrounding skin integrity. The need for frequent dressings was a further drawback.

Many of these problems could be solved by the addition of a negative pressure system to the Bogota bag technique. Therefore, we developed a modification of the Bogota bag, the SVB technique, in which we used 2 plasma bags; one sutured to the fascia and the other to the skin providing more support. Most importantly we postulated that the addition of an airtight negative pressure system would prevent muscle contraction and therefore enhance reductions in the gap of the abdominal wall.

Both, the SVB and Bogota groups, were equivalent in terms of age, gender and comorbidities with no statistically significant difference. Also, the indications for an open abdomen in both groups were very much similar. Severe abdominal sepsis with substantial bowel edema and distension made up for the vast majority of our cases. Primary abdominal or early fascial closure was deemed unfeasible in these patients.

Analysis of our results showed that the mean rate of skin approximation was higher in the sandwich vacuum Bogota group (12.5% compared to 6.3%). Yet, it did not reach statistical significance (P value 0.2). On the other hand, the mean rate of fascial approximation was higher in the Sandwich vacuum Bogota group (12.4% compared to 0.3%) as evidenced by CT imaging. The difference was highly statistically significant (P value .007). In fact, in the Bogota group some

patients showed no facial edge approximation or even widening of the gap.

It is worth mentioning that the 4 cases in our study that achieved the highest degree of fascial approximation were the patients who had non-septic intra-abdominal conditions. Two of them were in the SVB limb; the other two in the Bogota limb. Their diagnoses were mesenteric vascular occlusion in two cases, non-perforated malignant obstruction and non-perforated intestinal obstruction in a case of Peutz Jeghers syndrome.

One of the important factors that affected the rate of approximation in our study was the presence of a stoma which may be explained by the reduced area to yield medially due to the passage of the stoma. Additionally, soiling by the stoma content may be associated with a higher infection rate.

We strongly suggest that the use negative pressure therapy is the main reason behind the higher rate of fascial approximation in the sandwich vacuum Bogota group. Furthermore, we believe that the addition of a second layer provided additional abdominal wall support preventing lateral retraction at the level of the fascia.

The benefit of a negative pressure system has repeatedly been reported in the literature [4-7,12,14-19]. Early reports by Brock et al. in 1995 stated that negative pressure therapy (NPT) improves local perfusion and hence delivery of nutrients. Growth of granulation tissue is accelerated in addition to reduced bacterial concentrations in the wound. Resolution of bowel edema is stimulated and the continuous application of mechanical stress to the wound enhances cellular proliferation and angiogenesis^[14]. Several other studies described reverse tissue expansion in the wound in response to negative pressure therapy with subsequent approximation of the musculoaponeurotic edges and stimulation of granulation tissue^[5,15].

Another important aspect was the required postoperative care. We did not need to apply any dressings in the SVB group, while daily dressings had to be performed in the conventional Bogota bag group. This finding keeps in going with the findings of Mouës et al. who stated that frequent and time-consuming dressing changes, intensive nursing, and prolonged treatment prior to definitive wound closure could be significantly reduced by the addition of a negative pressure

system. These effects had a positive impact on the quality of life [15].

A further aspect was the quantification of fluid losses which was measurable only in the SVB group. The control of fluid efflux precluded the application of dressings and therefore helped in maintaining surrounding skin integrity. These findings are in concordance with other studies who found that Bogota bags are neither effective in the removal of abdominal fluids [10].

Various attempts to combine a negative pressure system with an already established TAC method are described in the literature. The Wittmann patch was modified by adding a vacuum dressing and the same benefits of negative pressure therapy are described [20]. Similarly, a combination of a polypropylene mesh and vacuum pack named vacuum-assisted wound closure and mesh mediated fascial traction was described [16].

The fact that several research groups considered combining negative pressure to various other TAC techniques emphasizes the superior outcome associated with a negative pressure system. In fact, according to the International Consensus Conference on Open Abdomen in Trauma, negative pressure wound therapy drains peritoneal fluids, improves nursing care, and prevents retraction of fascial edges, which facilitates wall closure [Grade of recommendation B and Level of Evidence I] [21].

This is very much in concordance with the guidelines of the World Society of Emergency Surgery in 2018 on the open abdomen in trauma and non-trauma patients, which state that negative pressure with continuous fascial traction should be suggested as the preferred technique for temporary abdominal closure (Grade 2B) and that TAC without negative pressure (e.g. Bogota bag) can be applied in low resource settings accepting a lower delayed fascial closure rate and higher intestinal fistula rate (Grade 2A) [22].

To the best of our knowledge the combination of a double-layered Bogota bag with negative pressure wound therapy has not been described in literature before. Given the number of patients with OA that we face and the intensity of resources these patients require, the SVB technique seems to be a cheap and effective TAC, fitting our needs and resources.

CONCLUSION

SVB seems a feasible, safe and cost-effective TAC technique entailing all advantages of a negative pressure system.

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