

## Open Abdomen: Indications, Management and Closure

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### 1. Abstract

Open abdomen (OA) management is a surgical modality of intentionally leaving the abdominal wall edges un-approximated. It has been indicated in multiple medical and surgical conditions like trauma management, intra-abdominal sepsis and vascular emergencies. The target of leaving the abdomen open is to reduce morbidity and mortality by reducing the risk of intra-abdominal hypertension. After the patient has been resuscitated and the initial management has been performed in order to stabilize the patient, further plans and surgical procedures are performed.

### 2. Introduction

Open abdomen (OA) approach is a surgical modality of intentionally leaving the abdominal wall edges un-approximated in order to prevent intra-abdominal hypertension (IAH) / abdominal compartment syndrome (ACS), and to allow easy access for abdominal re-exploration with minimal damage to the abdominal wall [1]. Although open abdomen is proven to be effective in reducing mortality and immediate postoperative complications for certain patients, its use remains controversial due to other possible consequences and complications [2]. In this review article we will be discussing the indications for open abdomen management strategy, managing patients with OA and closure criteria.

### 3. Indications

Leaving the abdomen open is a technique that has been proven to be effective in patients with severe injuries and critical illnesses like in trauma. Despite the benefits of leaving the abdomen open in some cases, absolute indications are required as the procedure itself carries a high morbidity and mortality.

#### 3.1. Damage control management

Damage control management (DCM) is a protocol used to man-

age patients with severe injuries and physiological derangement. It includes damage control resuscitation (DCR) and damage control surgery (DCS). Parameters used to assess the need for open abdomen in damage control in order to prevent intra-abdominal hypertension includes: Persistent hypotension with a systolic blood pressure of  $\leq 70$  mmHg, acidosis ( $\text{pH} \leq 7.2$ ), Lactate  $\geq 5$  mmol/L, hypothermia (core temperature  $< 34^\circ\text{C}$ ), blood loss  $> 4$  L or transfusion of  $> 10$  unites of packed red blood cells, and coagulopathy ( $\text{INR/PT} > 1.5$  times normal) [4] [Table 1].

Following the damage control surgery, the patient is expected to be in the Intensive Care Unit, managed by multidisciplinary team and is expected to undergo a definitive procedure within 72 hours from the initial laparotomy [4,5].

**Table 1:** Risk factors for abdominal hypertension/compartment syndrome

SPB	$\leq 70$ mmHg
pH	$\text{pH} \leq 7.2$
Lactate	$\geq 5$ mmol/L
Core temperature	$< 34^\circ\text{C}$
Blood loss	$> 4$ L or transfusion of $> 10$ unites of PRBC
Coagulopathy	$\text{INR/PT} > 1.5$ times normal

#### 3.2. Prevention of abdominal compartment syndrome

Another major indication is the prevention of intra-abdominal hypertension (IAH), which is defined as a state of sustained intra-abdominal pressure greater than 12 mmHg and can be graded according to severity and may progress further to the development of abdominal compartment syndrome. Abdominal compartment

syndrome (ACS) refers to the progression of a steady-state pressure within the abdominal cavity to a higher pressure of more than 20 mmHg with associated organ dysfunction or IAP more than 25 mmHg with or without end organ damage [2]. Studies have shown that there are many risk factors for abdominal compartment syndrome such as, damage control surgery, injuries that require packing and planned reoperation, extreme retroperitoneal and visceral swelling, obesity, aggressive fluid resuscitation and loss of abdominal wall tissue. All those factors are, therefore, are strong indicators of the necessity for open abdomen in trauma cases [4].

### 3.3. Severe abdominal sepsis

A number of published papers have shown that open abdomen is an option for patients with intra- abdominal sepsis or septic shock. The main goal in the management of sepsis is source control of the infection [2]. Laparotomy is indicated in this case to control the source of sepsis, debride necrotic tissue and repair intestinal injuries [2]. Previous studies have shown a reduction in mortality rate in the application of damage control surgery for surgical abdominal sepsis patients [2]. A retrospective study has shown a reduction in stoma rate creation (83% vs 47%) in patients who had laparotomies with a left open abdomen followed by a re-look laparotomy within 24 -48 hours due to generalized peritonitis secondary to perforated diverticulitis [3].

### 3.4. Vascular emergency

Open abdomen has been considered in vascular emergencies such as ruptured abdominal aortic aneurysms (AAA) [4]. Recent publications have shown that patients with ruptured AAA are at risk of developing IAH and ACS due to massive fluid resuscitation, reperfusion injuries and hematoma formation [2]. There are a number of factors that increase the risk of ACS in patients who undergo open abdominal surgery for vascular emergencies. These include preoperative systolic blood pressure <90 mmHg for >18 minutes, preoperative cardiac arrest, hypothermia <33, severe acidosis status (base deficit >13) and massive intraoperative resuscitation (>3.5L/h) [2] [Table 2].

**Table 2:** Risk factors for abdominal hypertension / compartment syndrome in patients with vascular diseases

Pre-operative SBP <90 mmHg for >18 minutes
Pre-operative cardiac arrest
Hypothermia < 33° Celsius
Severe acidosis (base deficit >13)
Massive intra-operative resuscitation (>3.5L/h)

A retrospective study showed the comparison between open versus closed initial management of ruptured AAA in two separate time periods (1989- 2000) and (2000-2005) respectively [2]. Although, there was no significant difference in 24-hours mortality

rate between the two groups (2% open vs 10% close, p=0.13), it was found that patients who underwent open abdomen often have other high- risk characteristics such as, preoperative hypotension, and estimated blood loss (EBL) > 6 L or > 12 L [2]. Once these high-risk characteristics were managed, a significant reduction in 24-hours mortality rate was achieved (0% vs 21%, p=0.03) [2].

## 4. Management of open abdomen

### 4.1. Temporary Abdominal Closure (TAC)

Leaving the abdomen open with a temporary cover is a common method. Simple packing is one of the methods used in cases of severe abdominal sepsis. The abdomen is usually packed with wet gauze which is often changed while the patient is admitted at the ICU. This is done in order to allow continuous drainage, which results in better control of the intra-abdominal sepsis. Bogota bag is another example that can be used to prevent abdominal compartment syndrome. A sterile plastic bag is sutured around the open abdomen to help maintain the sterility of the abdominal cavity [7].

### 4.2. Negative pressure wound therapy (NPWT)

A vacuum-mediated dressing encompasses a spongy bowel protection layer along with an adhesive bandage having a minute opening for draining, which is connected to continuous suction. Evidence-based analysis reveals that NPWT in the management of open abdomen reduced the postoperative mortality rate and length of stay in the intensive care unit as compared to control patients without NPWT [8]. One of the important merits in NPWT is that the vacuum device allows irrigation and reduces the inflammatory cytokines levels and thus prevents the sepsis in open abdomen [9]. The local practice at our center is by the use of green towel closure technique. In this technique, sterile surgical green gauze and towels are used, covered with opsite and are tucked and packed in all compartments of the abdomen, two suction tubes are then placed within the abdominal cavity, and a tegaderm is applied over the mentioned for complete coverage.

### 4.3. Mesh bridging

This technique involves placement of rapidly absorbable mesh of biological or synthetic origin at the graft interposition between the fascial edges. It mediates the intestinal coverage and enhances the granulation for skin grafting and reconstruction later on [10]. In CLOSE-UP study, open abdomen subjects managed with Biomesh showed less ICU admission, requirement of mechanical ventilation and reoperation in comparison to patients treated with other methods of temporary abdominal closure [11].

### 4.4. Abdominal Re-approximation Anchor (ABRA)

In this method, plastic tubes are placed into the abdominal wall away from the fascial edges and held in place with an adhesive button. Thus, performing temporary retention suture might tighten the abdominal wall to decrease the domain loss in open abdomen. The main merit of ABRA is that it elicits fascial tension and also preserves the fascial edges for delayed primary closure. A retro-

spective study conducted to study the efficacy of ABRA device for open abdomen closure reveals that the complete fascial apposition was achieved in 83% of the patients during the entire study duration [12].

## 5. Other Methods

Use of Wittman patch in the event of delayed closure and trans-abdominal wall traction (TAWT) systems displayed abdominal closure rates. These procedures mediate the closure by enhancing the abdominal wall sequential isometric contraction through Velcro sheets sewn to the fascia in the case of Wittman patch and by trans-fascial sutures done over plastic skin bolster in the case of TAWT. In addition, chemical component separation using botulinum toxin increases the possibility of primary fascial closure [13].

### 5.1. Closure of open abdomen

Myofascial closure (MFC), fascial closure and definitive fascial closure (DFC) are terms that describe the closing of the open abdomen (OA) for trauma and non-trauma patients. The process of closing the abdomen aims mainly to reduce the morbidity and mortality [14]. The two-staged closing procedure within 2-3 weeks increases the risk of complications such as enterocutaneous fistula and hernia formation. Therefore, the trend is to close fascial layers within initial hospitalization [15]. Failure of primary abdominal closure is accounted as one of complications of OA technique [16]. Temporary abdominal closure methods as described above are used when absolutely necessary, however, Definitive reconstruction is achieved with mesh, components separation, and autologous tissue transfer [18]. The primary fascial closure is achieved in 79% of patients who underwent OA. While the range of re-look procedure is between 2 to 25 with a mean of 4.5 reoperations, the percentage of achieved fascial closure drops from 93% of patients with maximum of 4 relook operation to 32% of patients with at least 5 re-operations [16]. The initial performed OA rate was 71% of patients in which fascial closure was performed and 54% in those with non-fascial closure OA. The second and third relook operation in patients with fascial closure were ( $2.7 \pm 2.5$  and  $5.6 \pm 3.7$  days) respectively, while they were ( $4.2 \pm 6.6$  and  $8.5 \pm 8.6$  days) in those with non-fascial closure. The rate of peritonitis and large bowel resection increases when fascial closure is performed by 47% and 54%, respectively. However, failure to achieve fascial closure increases the in-hospital mortality rate by 44% and pancreatitis rate by 9% [15]. The primary fascial closure successfully achieved in 75.4% of patients with NPWT with mean period of 6 days while it is 93.8% in patients with mBVP after mean period of 6.5 days. Although, the entero-cutaneous fistula formed in 2.6% of both techniques, the mortality rate is significantly higher in patients with mBVP [19]. The abdominal closure rate is 80-100% after using VAMCM with a range period from 9-32 days and in-hospital survival rate of 57-100% [17]. In Comparison among three OA dressing systems, ABThera is significantly superior to

both V.A.C. Abdominal Dressing System. However, Barker's vacuum packing technique is significantly the most inferior among those systems [20]. PFC is achieved faster with a period of 16.9 days in patient with VAC technique in comparison to 20.5 days' period when using the Bogota bag. The mortality in patient with Bogota bag is 17.5% in comparison to 12% in patients with VAC technique [21]. ABRA device can be used separately or in conjunction of VAC technique. It is applied mostly after day 18 and for approximately 53 days [22]. The use of Wittmann patch closure device have statistically higher rate of achieving PFC and DFC by 90% and 100%, respectively. However, the rate of achieving PFC when using ABThera covering device is 81% and that of DFC is 44%. Furthermore, the incidence of complications is found to be higher with ABThera device [23]. The risk of closure failure increases significantly with the increase in the duration of OA and total number of re-look procedures. This risk increases by 20% for each subsequent day, after the first 24 hours [14]. The achievement of fascial closure is unlikely if it is performed after 5 days' duration of OA or after the second re-look procedure [14] [24]. It is more likely to be achieved when initial OA is performed and when the second and third re-looks are performed early. The risk of failure significantly increases after the 4th reoperation [16]. A high primary abdominal closure rate can be achieved using VAWCM technique in non-trauma elderly patients after prolonged OA therapy period [17]. Although, the Bogota bag and vacuum-pack are cheaper and are available in most centres in comparison to the use VAC. Nonetheless the use of VAC has proved to being more efficient and shows the highest rate of primary abdominal closure [25].

## References

1. Coccolini F, Roberts D, Ansaloni L, Ivatury R, Gamberini E, Catena F, et al. The open abdomen in trauma and non-trauma patients: WSES guidelines. *World J Emerg Surg.* 2018; 13: 7.
2. Chabot E, Nirula R. Open abdomen critical care management principles: resuscitation, fluid balance, nutrition, and ventilator management. *Trauma surgery & acute care open.* 2017; 2(1): e000063.
3. Diaz JJ Jr, Cullinane DC, Dutton WD, Jerome R, Bagdonas R, Bilaniuk JW, et al. The management of the open abdomen in trauma and emergency general surgery: part 1-damage control. *J Trauma.* 2010; 68(6): 1425-1438.
4. Coccolini F, Biffi W, Catena F, Ceresoli M, Chiara O, Cimbanassi S, et al. The open abdomen, indications, management and definitive closure. *World J Emerg Surg.* 2015; 10(1): 32.
5. Guillen B, Cassaro S. *Traumatic Open Abdomen.* Book.
6. Demetriades D. Total management of the open abdomen. *Int Wound J.* 2012; Suppl 1: 17-24.
7. Huang Q, Li J, Lau W. Techniques for Abdominal Wall Closure after Damage Control Laparotomy: From Temporary Abdominal Closure to Early/Delayed Fascial Closure A Review. *Gastroenterol Res Pract.* 2016.

8. Cirocchi R, Birindelli A, Biffl WL, Mutafchiyski V, Popivanov G, Chiara O, et al. What is the effectiveness of the negative pressure wound therapy (NPWT) in patients treated with open abdomen technique? A systematic review and meta-analysis. *J Trauma Acute Care Surg.* 2016; 81(3): 575-584.
9. Hu P, Uhlich R, Gleason F, Kerby J, Bosarge P. Impact of initial temporary abdominal closure in damage control surgery: a retrospective analysis. *World J Emerg Surg.* 2018; 13(1): 43.
10. Como JJ, Gunter OL, Diaz JJ, Ho VP, Miller PR. Use of posterior component separation and transversus abdominis release in trauma and emergency general surgery patients: a case report and review of the literature. *Trauma Surg Acute Care Open.* 2019; 4(1): e000268.
11. De Vries FEE, Claessen JJM, Atema JJ, Van Ruler O, Boermeester MA, Van Acker GJD, et al. Immediate Closure of Abdominal Cavity with Biologic Mesh versus Temporary Abdominal Closure of Open Abdomen in Non-Trauma Emergency Patients (CLOSE-UP Study). *Surg Infect (Larchmt).* 2020; 21(8): 694-703.
12. Haddock C, Konkin DE, Blair NP. Management of the open abdomen with the Abdominal Reapproximation Anchor dynamic fascial closure system. *Am J Surg.* 2013; 205(5): 528-533.
13. Zielinski MD, Goussous N, Schiller HJ, Jenkins D. Chemical components separation with botulinum toxin A: a novel technique to improve primary fascial closure rates of the open abdomen. *Hernia.* 2013; 17(1): 101-107.
14. Granger S, Fallon J, Hopkins J, Pullyblank A. An open and closed case : timing of closure following laparostomy. *Ann R Coll Surg Engl.* 2022; 102(7) : 519-524.
15. Lambertz A, Mihatsch C. Fascial closure after open abdomen: initial indication and early revisions are decisive factors a retrospective cohort study. *Int J Surg.* 2015; 13: 12-16.
16. Richard F, Stephen A. The number of operations negatively influences fascia closure in open abdomen management. *Am J Surg.* 2012; 204(6): 996-998.
17. Stefan A, Martin B, Ulf P. Vacuum-assisted wound closure and mesh-mediated fascial traction for open abdomen therapy - a systematic review. *Anaesthesiol Intensive Ther.* 2017; 49(2): 139-145.
18. Turza K, Campbell C. Options for closure of the infected abdomen. 2012; 13(6): 343-351.
19. Giulia M, Niccolo A. Negative Pressure Wound Therapy versus modified Barker Vacuum Pack as temporary abdominal closure technique for Open Abdomen management : a four-year experience. *BMC Surg.* 2017; 17(1): 86.
20. Delgado A, Sammons A. In vitro pressure manifolding distribution evaluation of ABThera<sup>(TM)</sup> Active Abdominal Therapy System, V.A.C.<sup>(®)</sup> Abdominal Dressing System, and Barker's vacuum packing technique conducted under dynamic conditions. 2016; 4: 2050312115624988.
21. Rencuzogullari A, Dalci K. Comparison of early surgical alternatives in the management of open abdomen: a randomized controlled study. *Ulus Travma Acil Cerrahi Derg.* 2015; 21(3): 168-174.
22. Nemecek H, Christie B. Wittmann Patch: Superior Closure for the Open Abdomen. *Am Surg.* 2020; 86(8): 981-984.
23. Salman A, Yetisir F. Use of dynamic wound closure system in conjunction with vacuum-assisted closure therapy in delayed closure of open abdomen. *Hernia.* 2014; 18(1): 99-104.
24. Adam C, Scott J. Treatments and other prognostic factors in the management of the open abdomen: A systematic review. *J Trauma Acute Care Surg.* 2017; 82(2): 407-418.
25. Ribeiro M, Barros E. Comparative study of abdominal cavity temporary closure techniques for damage control. 2016; 43(5): 368-373.