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Laparostomy in Critically Ill Patients

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Abstract

Laparostomy consists in the surgical opening of the anterior abdominal wall which is deliberately left open with exposure of the intra-abdominal viscera.
It is used in severely ill or injured patients to facilitate healing or prevent complications, including the development of abdominal compartmental syndrome (ACS).
Authors here present current indications for laparostomy/Open abdomen in trauma and non trauma patients; classification of Open Abdomen (OA); physiologic alterations associated with OA and demanding local care to avoid complications; techniques for temporary and definite closure of the abdominal wall; and optimal time of closure.
Laparostomy can be technically demanding, with considerable morbidity and it is resource-expensive, with frequent visits to the operating room and requires surgeons with experience in the field and material valuable means.
Keywords: Laparostomy; Open Abdomen; Closure

Introduction

The concept of Open Abdomen (OA) dates back to 1897 and was first described by Andrew McCosh in a series of patients he operated with diffuse peritonitis [1].
Ogilvie, a military surgeon, in 1940 reported two clinical cases in which patients were in laparostomy [2].
By then, OA was a technique used to treat intra-abdominal sepsis, where infusion and frequent dressing changes helped in clearing the infection [1,3].
OA consists in the surgical opening of the anterior abdominal wall, which is deliberately left open, with exposure of the intra-abdominal viscera.
Temporary abdominal wall closure (TAC) is the method used to protect intra-abdominal contents during the time the fascial edges of rectus abdominus muscles are separated.
Currently, laparostomy is used in severely ill or injured patients, such as severe trauma, abdominal sepsis or severe acute pancreatitis, to facilitate healing or prevent complications, including the development of abdominal compartmental syndrome (ACS). Laparostomy can be technically demanding, with considerable morbidity and it is resource-expensive, with frequent visits to the operating room and requiring human and material valuable means. Its complexity demands a judicious decision.
The aim of this paper is to summarize the approach to the patient with OA, with emphasis on the techniques used in TAC.

Methods

An extensive bibliographic search was carried out in digital databases, scientific journals and smith & nephew's manual of negative pressure dressings.
The words searched were laparostomy, open abdomen and abdominal wall closure. Articles written from 1912 to 2020 written in English and Spanish were considered.
45 articles were selected because they were the most relevant for the review in question.

Indications to OA

We can divide the current indications to laparostomy in trauma and non trauma patients.

1) Trauma patients

In trauma patients temporary abdominal wall closure can be used in the context of damage control surgery (DCS). This concept has dramatically changed surgical practice in these patients, although DCS has its value in the non trauma patient as well. It is used to minimize operative time and intervention, in the unstable patients. DCS minimizes hypothermia, metabolic acidosis and coagulopathy, allowing the patient to return to the operating room in a few hours after stability has been achieved (maximum 48 hours). The first approach to these patients should only be hemorrhage and contamination control and abdominal wall closure, to prevent heat and moisture loss and protect the viscera. This can be done with a TAC.

Trauma patients will frequently develop intra-abdominal hipertension (IAH), which is multifactorial due not only to physiological changes associated with aggressive fluid resuscitation but also to massive bleeding, tissue edema secondary to insults - like ischaemia and sepsis - paralytic ileus, etc. ACS establishes when sustained intra-abdominal pressure is ≥ 20*mmHg* and new organ dysfunction installs, worsening previous present organ dysfunction, in a vicious cycle that will only be broken with surgical decompression [4,9].

Laparostomy should be considered:

In a DCS scenario: hemodynamic instability with persistent hypotension, acidosis, hypothermia and coagulopathy.

When reassessment is advisable after bleeding and contamination control, to look for further abdominal injuries, reevaluate bowel perfusion or restore bowel continuity.

When development ACS is a possibility or when it has already installed.

2) Non trauma patients

In patients with intraabdominal sepsis, laparostomy can be appropriate when ACS has installed and also when patients benefit from an abbreviated laparotomy due to physiological instability, such as in acute mesenteric ischemia where reassessment of ischemic organs is needed or a deferred anastomosis is planned. Planned re-laparotomy strategy in patients with severe peritonitis did not reveal any differences on death or major peritonitis-related morbidity.

Hence, there is no evidence that leaving the abdomen open after abdominal sepsis when the fascia can be immediately closed is beneficial for the patient unless reassessment is needed for a specific procedure (such as an anastomosis).

In patients with severe acute pancreatitis (SAP), the development of ACS is one of the few current indications to immediate surgical treatment, as in hemorrhagic events or perforation. Infected pancreatic necrosis should be treated in a step up approach [10,11].

Like in trauma, all medical measures to prevent ACS should be accomplished before surgical decompression.

Laparostomy should be considered in cases of:

- Severe peritonitis and septic shock if intra-abdominal reassessment is planned.
- Extensive visceral edema with the concern for development of ACS.
- SAP when development of IAH or ACS is a possibility.
- ACS – after decompressive laparotomy.
- Hemorrhagic vascular catastrophes such as ruptured abdominal aortic aneurysm, to prevent or treat ACS; or following surgical management of acute mesenteric ischemic insults [4,12,13].

In most of the cases described above, there is always the question of whether to use temporary or definitive abdominal wound closure. We know that the chances of leaving a patient in laparostomy depends on the initial medical condition. In trauma patients after DCS up to 70% of patients can have their abdominal wall definitely closed after first surgery, while in cases of abdominal sepsis fascial closure rates are much smaller. The choice always depends on surgeon good judgement.

Classification of OA

There are a number of conditions that can result in OA, leading to very heterogeneous patient populations, which makes it difficult to compare results and conclusions.

The Bjork classification was developed in 2009 and revised later in order to standardized nomenclature and facilitate comparison between clinical studies [14,16]. Table 1 describes the initial classification and the amended classification published in 2016.

OA classification system		
	2009	2016
1A	Clean OA without adherence between abdominal wall or fixity	Clean OA without adherence between abdominal wall or fixity
1B	Contaminated OA without aderence/fixity	Contaminated OA without aderence/fixity
1C		Enteric leak, no fixation
2A	Clean OA developing adherence/fixity	Clean OA developing adherence/fixity
2B	Contaminated OA developing aderence/fixity	Contaminated OA developing aderence/fixity
2C		Enteric leak, developing fixation
3A	OA complicated by fistula formation	Clean, frozen abdómen
3B		Contaminated, frozen abdomen
4	Frozen OA with adherent/fixed bowel; unable to close surgically; with or without fistula	Established entheroatmospheric fistula, frozen abdomen

Table 1: OA Classification

Particularities of the patient in laparostomy

Physiological alterations

The patient with an OA is a complex patient who must be managed in a multidisciplinary approach in an intensive care unit (ICU).
A major concern in these patients is fluid and electrolytes balance. Insensible fluid losses are increased in OA patients [17].
Fluid replacement should be performed with continuous monitoring. The correction of fluid balance should be done in line with adequate urine output, patient weight and continuous cardiac monitoring. Cardiac output should be maintained at low/normal values, in order to avoid fluid overload and vasopressor use. A restrictive fluid management strategy should be implemented to avoid IAH. In these patients measure of pulmonary artery occlusion pressure or central venous pressure can potentially lead to wrong decisions because intra-abdominal or intra-thoracic pressures may be increased.[7,18]
Protein loss from exposed viscera is also important. Critically ill patients are usually in a catabolic state. Catabolism increase relates to proteolysis, protein malnutrition, dysfunction of the immune system, particularly at the digestive system level [2]. There is also a continuous protein loss. The fluid secreted by the peritoneum is rich in protein and for every liter of fluid removed 2g of protein is lost. Calculations for nitrogen balance should include these losses and they should be replaced on the basis of an appropriate nutritional plan [19].
Early enteral nutrition (EN) should be started as soon as the functional gastrointestinal (GI) tract allows. When it is started within the first 24–48hours it improves wound healing and fascial closure rate, decreases catabolism, reduces pneumonia and fistula rate, preserves functional and structural integrity of the GI tract, and finally reduces length of hospital stay and costs [21,22].
Compared to total parenteral nutrition (TPN), the reduction of infections from the use of EN is consistent across almost all critical care patient populations. However, if necessary, it should be supplemented with TPN to meet the nutritional needs [9,17,18,22].
Along with volume resuscitation and nutrition, correction of coagulopathy and acidosis is important to restore normal physiology. Body temperature should be kept in mind while in resuscitating these patients, as the OA patient has heat losses that are not quantifiable.[6] Hypothermia leads to tissue hypoperfusion, cardiac depression and decreased tissue oxygen delivery; this can lead to aggravation/development of acidosis and changes in the coagulation cascade.
One should always be aware of the possibility of recurrence of ACS, hence, all patients at risk should have serial monitoring of intra-abdominal pressure. If there is IAH, measures should be implemented to reduce it, such as GI decompression, prokinetics, patient positioning, avoidance of constrictive dressings, percutaneous decompression when needed, adequate mechanical ventilation, analgesia, sedation and neuromuscular blockade and balanced resuscitation [18].

Complications

Patients with an OA are at an increased risk for complications, particularly infectious, due to prolonged inflammatory status and acquired immunocompromised status [5,7].
Antibiotics are usually necessary. Intra-operative cultures should be performed to allow de-escalation of antibiotic therapy. Empirical antifungal therapy should be considered, particularly after multiple surgeries or when suspected of hospital acquired infection.[23]
One of the most feared complications is the development of entheroatmospheric fistula (EAF). Their incidence depends on the underlying condition for OA, but it can be as high as 20% and may occur early in the first week [24,25]. They have a multifactorial etiology, and usually develop as a consequence of disruption of an anastomosis or due to bowel lesion during manipulation, use of high resuscitation volumes, presence of intra-abdominal infectious complications, exposure of bowel to materials used for temporary abdominal closure and preceding bowel ischemia [25].
EAF have no overlying soft tissue and no real fistula tract, making spontaneous healing difficult. Also, they promote physiological changes that make OA patient management even more demanding.
Morbidity rates of EAF are high and are directly related to their pathophysiological consequences, which already happen in OA but augment considerably when an EAF is present: severe fluid and electrolyte losses, acid–base homeostasis derangement, hypercatabolism and vitamin deficiencies. TPN should be started as soon as possible, having also the benefit of decreasing the fistula output; EN should be considered once the GI tract is viable [25].
Isolation of the enteric effluent is essential for proper wound healing and prevent infectious complications. Spillage of enteric contents on the adjacent OA surface serves as a factor of continuous impairment of the healing process which worsens local wound sepsis and is considered a source of major morbidity. Definitive management of EAF should be delayed until the patient has recovered, and usually requires surgical intervention [26,27].
Patients with EAF have a mortality rate as high as 40%, with 3 x time rise in the length of stay in ICU, increased hospital stay and total hospital cost.[4] Preemptive measures to prevent frozen abdomen and EAF are imperative: early wall closure, bowel protection with no direct application of synthetic prosthesis or negative pressure wound therapy (NPWT) on the viscera [18,25,26,28,29].
Loss of domain and development of large incisional hernias are complications that can affect half of the patients with OA. Studies on the use of NPWT report decreased size of the incisional hernia resulting from TAC especially when this technique is used in combination with fascial traction [16]. Adjuncts to prevent incisional hernias have been described, such as component separation technique, mesh reinforcement and use of botulinum toxin type A, however the literature is scarce on this matter and most recommendations come from extrapolation from other high-risk groups.[5,16] The most efficient way to reduce incisional hernia formation is to close abdominal wall as soon as possible, ideally before the fifth day of laparostomy. Afterwards, the chance of complications is four times higher [30].

Temporary closure of abdominal wall

After deciding to leave a patients with OA, the surgeon has several techniques that allow temporary abdominal closure (TAC). The main objective should be protection of the underlying viscera and at the same time preventing fascial retraction. The ideal dress for TAC should maintain a physiological environment, actively draining fluid and maintaining abdominal domain while preserving abdominal wall tissues. It should also prevent adhesion formation and EAF, provide simple and safe reassessments and should facilitate primary closure, while being readily available e cheap [5,18].

The first and easiest method to cover and protect the laparostomy wound was the application of the "Bogota bag". This method consists of suturing a sterile irrigation bag to the fascia or to the skin, leaving fascial edges intact. It permits to relieve intraabdominal pressure, preventing evisceration and it is cheap and easy to apply. However, it is a so called "non-traction technique", meaning that it permits fascial retraction, with loss of domain and making definitive closure harder and development of larger incisional hernias more frequent. Furthermore, it does not provide effective removal of intraperitoneal infected fluid, which is a limitation when dealing with intraabdominal sepsis [5,18,31].

Other technique developed for TAC was the Wittmann patch, described for the first time in 1993, in which two Velcro sheets were sutured to fascial edges and in the middle they overlapped, allowing for easy access to abdominal cavity and a stepwise reaproximation of the fascia [15].

This prevented fascial retraction, however it did not allow effective fluid drainage, which limited its use in sepsis. Along with this, the suture to fascial edges might cause fascial necrosis, precluding definitive closure.

Some institutions still use absorbable or non-absorbable synthetic meshes in laparostomy. They were designed for patients that will have longer-term closure needs. The meshes are sutured to the fascial edges and can be reduced in size to allow fascial approximation. To grant fluid drainage, vacuum assisted abdominal dressings can be used in conjunction with meshes, though with more difficulty, they can improve fascia closure rates [5,7,16,17].

None of these techniques properly remove peritoneal fluids, unless combined with vacuum techniques, and they are fallible due to changes in patient positioning, such as in ICU, during pulmonary recruitment maneuvers. However, their use can be acceptable in low resource hospitals, favoring its use in trauma patients when comparing to patients with intra-abdominal sepsis [18].

In 1995, a vacuum pack was described using a polyethylene sheet put in between the bowel and the parietal peritoneum, which prevented the bowel from adhering to abdominal wall. Later, in 2001 the introduction of a vacuum-assisted instrument, changed the concept of wound treatment in OA [16,32]. Although there is no consensus on the ideal technique for TAC, negative pressure wound therapy (NPWT) fulfills all the principles of intended temporary closure and anticipates a definitive closure compared to the other methods used. The possibility to drain infected fluid makes it stand out in the treatment of sepsis, fulfilling all prerequisites for source control, allowing primary wall closure in a shorter period of time [8,18,33,34].

Negative pressure wound therapy

The first technique described with vacuum therapy was simple: a fenestrated polyethylene sheet that did not adhere to the bowel and was used over it, then moisty surgical gauze covered the sheet and two silicone drains over the towels, to isolate the wound, a transparent adhesive drape was placed over it. The drains are connected to continuous wall suction and the wound is revised each 24-48 hours. Since then NPWT has been implemented under several commercial systems.

The general principle is the same for all: first, a non-adherent contact layer is placed over the viscera, and stays also in contact with the wound bed itself because it is believed to prevent the growth of granulation tissue inside the wound filling material. Then, it is used a dressing that is in direct contact with the wound bed and is called "the wound contact material". This layer is usually the filling of the wound (polyurethane foam of open pore structure or a moistened gauze) with little adherence. These fillers exert a mechanical effect on the wound. The tissue surface of the wound is stimulated by the structure of the dressing and causes the cells to divide, rebuild and strengthen the tissue; the function of wound filling is to promote negative pressure on the wound bed [5,25,26,31,33,34].

The suction generated by the negative pressure actively drains the wound exudate. This decreases various wound healing inhibitors, such as proteolytic enzymes and metalloproteinases. The usual recommendation is to change dressings every 48 hours. [9,33] If replaced in shorter periods, they challenge the physiological reserve of the patient, and in longer periods they are associated with increased risk of adhesion formation and iatrogenic injury.

Other negative pressure tools were developed where the protective visceral layer was made of polyurethane foam enveloped in a polyethylene sheet with small fenestrations that was tucked between the bowel and the peritoneum. Then, two layers of foam were placed over this, the last layer of foam was settled between fascial edges and in the end an adhesive drape covered the wound. Next, a small hole is made in the adhesive drape and a pad that is connected to a negative pressure tool unit is placed over it.

Based in these principles, other commercial systems have been launched to date: the Barker technique, Vacuum Assisted Closure ® (KCI), the ABThera ® (KCI) and the Renasys ® (Smith and Nephew) [9,33].

NPWT has revolutionized the management of OA decreasing the likelihood of adhesions and EAF, actively draining bacteria-rich fluid and decreasing bacterial load in the wound. Furthermore, favors angiogenesis and promotes the formation of granulation tissue. It preserves the peritoneal space and allows the mobilization and advancement of the abdominal wall, allowing early primary fascia closure, thus altering the natural history of surgical wound closure in these patients increasing the window of opportunity for deferred primary closure for a longer period of time [7,18,29,33,35].

Continuous pressure technique is the most effective, but it is also possible to use intermittent or variable pressure. The optimal pressure that stimulates cell proliferation and maximizes tissue expansion is -125mmHg, however it should be individualized on a case by case basis. The standard on the OA is -80mmHg [5,25,26,31,33,34].

There are several NPWT allies that prevent abdominal wall retraction and anticipate primary abdominal wall closure. They should however, be used with caution to minimize manipulation and tension of the aponeurosis that may result in its destruction. These include vessel loops, retention sutures at the end of the operative wound, relaxation incisions in the aponeurosis or skin grafts [7].

One should be aware that in the presence of postoperative complications, such as hemorrhage or leakage of enteric content through the surgical wound, negative pressure should be suspended in order to reassess the abdomen and try to solve the problem (or contain the effluent in cases of EAF).

What says the literature about NPWT?

NPWT proved to be a safe method depending on the population studied, but usually significantly inferior to the other methods. Also, although some small studies had suggested that the use of NPWT could increase the rate of EAF, an international cohort study published in 2019, with initial results of the International Register of Open Abdomen project, that included 649 adult patients with OA did not relate the use of NPWT with increasing rates of EAF. Further, it proved that the duration of OA was by itself a risk factor for the development of EAF [36,37].

In terms of efficacy, in a systematic review of the literature that included 4303 patients, where different methods of TAC were studied and compared, the investigators concluded that the methods with the best primary delayed closure rates were the Wittmann patch and vacuum assisted closure (VAC) with 78% and 58% closure rates, respectively. However, in the presence of sepsis, VAC had the highest delayed primary closure [36]. One must highlight that the new generation of VAC were not included in this study and also that there was a great deal of heterogeneity between studies population. Again, a non-randomised comparative study of 578 patients treated by NPWT or other temporary abdominal closure techniques reported closure rates of 45% and 61% respectively; however one must have in mind that techniques of TAP without vaccum are usually used in trauma context and not in patients with sepsis, which can explain these results. Also, the necessity of prosthetic replacement of the abdominal wall was not significantly different between NPWT and other methods of TAC (14% and 11%, respectively) [38]. The use of adjuvants to help sequential fascial closure in NPWT, dramatically improved the rates of primary closure that can be over 90% even in patients with sepsis [39].

Definitive wound closure

After OA and TAC, one must think how to achieve a rapid closure of abdominal wall – this is the primary objective in an OA patient in order to prevent morbidity associated with it. When it is possible to close the fascia directly, it is called “delayed fascial closure”. However when it is not possible to close and the fascia has retracted with loss of domain, then the wound has to close by “secondary healing”, over a mesh.

Optimal time of closure

Prolonged OA has several complications, including delayed extubation, increased risk of frozen abdomen, EAF and increase of other long term complications [18,37].

The patient with OA should first be managed in ICU and in Operation Room (OR). To decide on closure, it is imperative that physiology optimization and intra-abdominal source control was achieved, with no concern regarding organ viability and no further surgical re-exploration needed. Then definitive closure should be tried, always being cautious with the possibility of ACS.

Primary closure should be performed by the seventh postoperative day. It reduces complications and mortality regardless of the temporary closure technique used [5,13,25,26,31,33,34].

During the first week of OA, after control of the injure mechanism, distention and edema decrease in line with the systemic inflammatory response, however, the fascia retracts and multiple adhesions develop between bowel loops and also to the parietal peritoneum. In the second week, granulation tissue formed on the fused loop, transforms into a frozen extremely hostile abdomen for re-intervention. If the opportunity window is lost, the closure should be deferred [7].

Factors that delay abdominal wall closure

As mentioned, definitive closure should be attempted always in order to decrease the failure rate at primary closure, which increases by 1.1% per 24hours, as well as complications related to TAC [17].

The likelihood of delayed fascial closure is related to the underlying etiology: it is significantly higher in trauma than in abdominal sepsis. Loftus et al studied 224 patients with OA, and found that, in the patients that survived, fascial closure in abdominal sepsis was achieved in 76% of patients, compared with 90% in trauma patients [40]. Other factors that negatively affect primary or delayed fascial closure include the number of surgical procedures and the length of laparostomy, persistent sepsis, presence of EAF and Injury Severity Score greater than 15 [25,26,31,41].

Techniques for definitive closure

Once closure of an OA is possible without tension, it must be accomplished as soon as possible. In most cases fascial closure is possible within the first days. In the cases that is not possible due to bowel edema or ongoing sepsis, then progressive closure should be attempted.

Techniques used to definitively close are mostly divided into non-mesh and mesh mediated. In the presence of large fascial defects, definitive reconstruction has been described using synthetic or biologic meshes or autologous tissue transfer with component separation. When there is concern about infection, then biological materials, such as biological prostheses (Alloderm®, Lifecell®) should be preferred; they can be protected with skin grafts or flap. Other techniques include the use of acellular dermis matrix, component separation techniques or myocutaneous flaps [17].

Another scenario is when one choses a planned hernia approach, with skin coverage of the defect, with skin graft or with direct skin closure and subsequent delayed abdominal wall reconstruction. Usually this strategy is adopted when [18].

- Impossible to re-approximate the retracted abdominal wall
- Considerable tissue loss
- Risk of ACS
- Presence of complicated abdominal due to infection or EAF

The skin is grafted over the exposed bowel and after 12 months it can be removed from the bowel without damage and the defect (incisional hernia) corrected.

Meshes: synthetic versus biologic materials

Synthetic meshes can be either permanent or absorbable. Historically, synthetic meshes have its use contraindicated in the case of contaminated field as they are supposed to raise the risk of infection with subsequent removal of mesh [18]. Synthetic non absorbable meshes use materials such as polypropylene, polyester and polytetrafluoruroethylene (PTFE) products. These are commonly used in an attempt to minimize hernia in complex reconstruction of the abdominal wall and associated to the risk of enterocutaneous fistulae (ECF) and recurrent herniation that may develop years after. Risk factors for of ECF include prior bowel desiccation and adherence of bowel to mesh and fascial edges [42]. Composite mesh, that uses polypropylene and ePTFE, have the theoretical advantage of fibroblastic ingrowth of the polypropylene and decreased adhesion formation of the ePTFE, decreasing the risk of ECF. In general, non absorbable synthetic meshes are not recommended in closing an OA [18].

Synthetic fully absorbable meshes (biosynthetic) such as DEXON (Covidien, Mansfield, MA) that contains polyglycolic acid, and VICRYL (Ethicon, Inc., Somerville, NJ) a copolymer of glycolide and lactide, loose mechanical strength and are resorbed fairly quickly, making their use less than ideal with high hernia recurrence rates. New synthetic absorbable materials are being developed so that they are resorbed slower, with lower rates of incisional hernia, and less infection rates. These include GORE BIO-A (W.L. Gore and Associates, Inc., Flagstaff, AZ) copolymer of polyglycolide: trimethylene carbonate, TIGR Matrix (Novus Scientifc) and PHASIX Mesh (C. R. Bard, Inc./Davol Inc., Warwick, RI), that include poly-4-hydroxybutyrate in their structure [43].

Biologic materials derive from collagen-rich tissues and includes extracellular matrix from animal or human tissue. The more commonly used biologic meshes are human acellular dermal matrix, porcine small intestine submucosa, porcine dermis, and bovine pericardium [44]. Biologic material is chemically decellularized and serves as supporting scaffold for cellular repopulation and neovascularization. These acellular scaffolds may also be additionally cross-linked which inhibits collagen degradation by blocking collagenase-binding sites, thereby allowing the mesh to maintain its structure for a longer period with slower incorporation into the adjacent tissue.

Biologic material lack antigenic response, are associated with minimal adhesions, promote vascular ingrowth which in turn allows the host immune system to fight infection, as opposed to synthetic meshes where no true ingrowth occurs. Disadvantages include febrile reaction, seroma and/or erythema over the mesh that lasts for 48 to 72 hours. Non-cross-linked biologic meshes are associated with higher rates of hernia recurrence and and they should be used only in a sublay position. If fascia cannot be closed, then the surgeon should use cross-linked biologic meshes. In cases that closure of skin is not possible, then NPWT can be used to facilitate tissue granulation and, eventually, skin closure [18]. Most surgeons would prefer to use biologic meshes in the definitive closure of an OA when contamination is an issue [5,18]. However, both biologic and absorbable synthetic meshes are incorporated into native tissue and theoretically both resist infection and thought to reduce the frequency of potential complications. There is not strong evidence against the use of biosynthetic over biological meshes for de closure of OA even if there is contamination. Contaminated field rises the rates of surgical site infection and hernia recurrence, but studies do not compare biosynthetic and biological meshes, the latter being used more commonly in this scenario. When meshes are needed to bridge the fascia, then biosynthetic meshes should be preferred, although cross linked biological meshes are also an option [18,44,45].

Skin closure

After closing/bridging the fascia, one should always try to close the skin, especially when there is prosthetic material. This will decrease the risk of infection and fistula formation. Coverage can be achieved with direct skin closure, skin grafting or flaps. Direct skin closure is the ideal scenario but might not be possible in all. Skin grafting is mostly used after application of NPWT and later application of skin grafting on granulation tissue. It obliges the surgeon to continued local wound care and of donor site. Skin graft lost is always a possibility, particularly if local conditions are not ideal [5].

Skin flaps are used when fascial closure is either not possible or, in the surgeon´s judgment would predispose to ACS. Local flaps should be enough in most cases. However, when coverage cannot be accomplished distant flaps can be used. Disadvantages of this technique include the creation of an additional wound (donor site) and complication associated with flap use (epidermolysis or necrosis of the skin flap). Surgeon must weight local and patient conditions in order to decide which technique he favors most for each patient.

Component Separation

Component separation technique consists on trying to reconstruct the midline defect with advancement of muscle and fascia; it can be used also to cover a mesh. Necrosis of the overlying skin can happen and sometimes requires skin grafts or prolonged local wound care. Multiple modifications of this technique exist, including incising the posterior rectus sheath, transposing the posterior rectus sheath, and the “open-book” variation to allow further mobilization. This technique avoids complications associated with mesh placement [5].

Conclusion

Laparostomy can be used in trauma and non-trauma patients, when the surgeon feels that it is advantageous for the patient. The OA is challenging as it carries physiologic alterations and demanding local care to avoid complications. The primary outcome is early definitive closure of the abdomen. There are various techniques for temporary and definitive abdominal closure, and advances in them have improved results in the past years. However, the diversity of means that can be used as well as the unique condition of each patient make therapeutic guidance demanding and should be preferably provided by one or two surgeons with experience in the field.

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