

Sequential closure of the abdominal wall for the management of open abdomen. A new surgical technique

Cierre secuencial de la pared abdominal en el manejo del abdomen abierto. Una nueva técnica quirúrgica

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Abstract

Background: The open abdomen is a surgical technique used in the treatment of patients with abdominal sepsis, abdominal trauma, and abdominal hypertension syndrome. **Objective:** The aim was to demonstrate the effectiveness of a new surgical technique designed for the management and closure of the abdominal wall in patients with open abdomen. **Method:** The study of all patients treated with open abdomen in our hospital over a 5-year period. **Results:** It were included 24 patients, 18 men and 6 women. The average age was 41.5 ± 15.9 years. Operative diagnosis was abdominal compartment syndrome in 7 (29%) cases, abdominal sepsis in 9 (38%), and abdominal trauma in 8 (33%). The median of APACHE II score was eight points (range: 5-21), while the assessment of SIRS score had a median of two points (range: 1-4). The median of surgical procedures performed in operating room was two per patient. The median of fascial surgical closures performed in the patient bed was four. A successful closure of the abdominal wall was performed in 21 of 22 live patients (95%). **Conclusions:** The sequential closure of the abdominal wall is an effective technique that offers an alternative to the management of the open abdomen.

Keywords: Open abdomen. Abdominal hypertension. Abdominal wall. Abdominal sepsis. Abdominal trauma.

Resumen

Antecedentes: El abdomen abierto es un método quirúrgico utilizado en el tratamiento de pacientes con sepsis abdominal, en trauma abdominal en casos de cirugía de control de daños y en casos de síndrome de hipertensión abdominal. **Objetivo:** Demostrar la efectividad de una nueva técnica quirúrgica en pacientes con abdomen abierto. **Método:** Estudio de todos los pacientes manejados con abdomen abierto en nuestro hospital en un periodo de 5 años. **Resultados:** Se incluyeron 24 pacientes, 18 hombres y 6 mujeres, con una edad promedio de 41.5 ± 15.9 años. El diagnóstico operatorio fue síndrome compartimental abdominal en 7 (29%) casos, sepsis abdominal en 9 (38%) y trauma abdominal en 8 (33%). La puntuación APACHE II tuvo una mediana de 8 (rango: 5-21) y el SIRS una mediana de 2 (rango: 1-4). La mediana de ingresos a quirófano por paciente fue de dos. La mediana de las aproximaciones aponeuróticas fuera de quirófano fue de cuatro. Se realizó un cierre definitivo de la pared abdominal en 21 de 22 pacientes vivos, considerando cierre exitoso en el 95%. **Conclusiones:** El

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cierre secuencial es una técnica efectiva que ofrece una alternativa en pacientes que requieren manejo con abdomen abierto.

Palabras clave: Abdomen abierto. Hipertensión abdominal. Pared abdominal. Sepsis abdominal. Trauma abdominal.

Introduction

The open abdomen approach is a surgical strategy that has resulted from advances in the operative management of patients with complicated intra-abdominal infection and since, recently, it is used in patients with severe abdominal trauma who require abbreviated or salvage laparotomy, as well as in the prevention and treatment of abdominal hypertension syndrome¹.

Multiple conditions have been described in which infection, peritoneal irritation, presence of blood or compresses within the abdominal cavity, aggressive fluid resuscitation, or closure of a large wall defect will cause visceral and retroperitoneal edema, with a consequent increase in intra-abdominal pressure, which can reach levels that are so dangerous that, in some cases, it causes multiple organ dysfunction. Patients in these conditions have been shown to have a better evolution if they are temporarily treated with open abdomen, which allows better abdominal visceral perfusion and less impact on systemic functioning^{2,3}.

Although the open abdomen surgical approach offers various benefits, it also creates numerous risks of high morbidity for patients, such as hydro-electrolytic disorders, abdominal organs contamination, development of enteroatmospheric fistulae, obstructive adhesions, and abdominal wall giant hernia defects with important esthetic and functional consequences⁴⁻⁶.

At present, there is a marked increase in the use of techniques for open abdomen closure, and new procedures have been devised that, in addition to satisfactorily resolving the acute event, try to avoid the serious complications inherent to long-term management of patients with open abdomen. Sequential closure of the abdominal wall *Cierre Secuencial de la Pared Abdominal* (CSPA) is a technique devised and developed at *Centenario Hospital Miguel Hidalgo*, in which materials and methods used in various techniques are employed for the management and closure of open abdomen, with the particularity that instruments and materials accessible and available at any operating room of a secondary or tertiary care hospital are used.

Methods

A prospective, cross-sectional, descriptive, and analytical study was carried out, which included all adult patients treated with open abdomen at the general surgery department between July 2004 and July 2012. Study variables were age, gender, nutritional status, cause, days of hospital and intensive care unit stay, number of aponeurosis approaches, intra-abdominal pressure during management, acute physiology and chronic health evaluation II (APACHE II) score, and systemic inflammatory response syndrome (SIRS), complications, and mortality.

Surgical technique

The CSPA technique involves the use of a polyethylene interface, which can be a urine collection bag or a plastic bag fixed with polyester cardinal points to the full thickness of the abdominal wall, the purpose of which is to contain the intestinal loops and allow abdominal wall progressive medial sliding. A wide dissection of the aponeurosis border is necessary, separating it from subcutaneous cell tissue, creating sufficient space to place aponeurotic approximation sutures using 1/8" closed drainage tubes (Drenovac®), or long intravenous catheters without removing the steel guidewire. Immediately, the aponeurotic borders are brought together, with some tension being maintained using Kelly clamps or by means of a system of acrylic cubes with adjustment screws, designed at Centenario Hospital Miguel Hidalgo by the authors of the study. In some patients, a sterile compress and an aspiration tube are placed for peritoneal content to be drained.

Through intra-abdominal pressure measurement and patient clinical evolution, the frequency at which apposition has to be adjusted, are determined; adjustments are usually made every 24-48 h. Two to four adjustments are required to achieve aponeurosis edges complete apposition. Adjustments are made at patient bed and final closure of the wall is carried out in the operating room.

When abdominal pressure is lower than 15 mmHg, fasciae have been brought close enough to allow

abdominal wall safe closure, and there is the certainty that there are no intestinal leaks and that intestinal continuity has been restored, sufficient necrotic tissue debridement has been achieved and intra-abdominal infection has been resolved, and abdominal wall definitive closure is decided.

Statistical analysis

Descriptive analysis of each variable was carried out. For qualitative variables, absolute frequencies and percentages were calculated. For quantitative variables, means and standard deviations were estimated, or medians and ranges, according to the type of data distribution.

Results

Twenty-four patients were included, out of whom six were women (25%) and 18 were men (75%). Mean age was 41.5 ± 15.9 years. All patients initially underwent emergency surgery, with pre-operative diagnoses being: acute abdomen in 16 (67%) and abdominal trauma in 8 (33%); in six, it was blunt abdominal trauma, and in one, it was penetrating. Eight patients (33%) were initially managed with open abdomen. The direct cause that motivated management using the “Bogota bag” technique was impossibility of aponeurosis closure without tension; the remaining 16 patients (67%) were re-laparotomized and admitted to the study due to the development of compartment syndrome or abdominal sepsis.

All patients were assessed and included in the study by the authors for the performance of CSPA. In the pre-operative evaluation for installation of the system, patients had an APACHE II score with a median of eight points (range: 5-21) and SIRS score with a median of two (range: 1-4) points. Eight of the 24 patients (33%) were considered undernourished according to the global subjective nutritional assessment scale. The values for biochemical nutritional parameters were the following: median albumin, 2.15 mg/dL (range: 1.03-3.8), and median total lymphocytes, 1820 (range: 730-3,750). Median hemoglobin of patients at admission was 13.9 g/dL (range: 9.2-15.8), and median hematocrit was 39.5% (range: 24-47.6).

The CSPA surgical technique was used in all 24 patients. In 17 cases (71%), aponeuroses edges were brought together using drainage tubes, and in seven patients (29%), intravenous catheters. Average operating room admissions per patient was 2 (range: 1-5).

Median number of aponeurotic approximations at the patient bed was 4 (range: 3-7), always preceded by intra-abdominal pressure measurement.

Intra-abdominal pressure monitoring was strict in all patients: 8 h after the surgical event, median value was 14 cm H₂O (range: 9-21); at 12 h, it was 14 cm H₂O (range: 8-18); at 24 h, it was 10 cm H₂O (range: 6-14); at 48 h, it was 9 cm H₂O (range: 4-14); at 72 h, it was 8 cm H₂O (range: 5-13); immediately before abdominal wall definitive closure, it was 7 cm H₂O (range: 4-11); and 24 h after definitive closure, it was 12 cm H₂O (range: 4-16).

Nine of the 24 patients (38%) were treated at the intensive care unit, with a mean stay in that area of 13.5 ± 6 days. Ten patients (42%) received mechanical ventilatory support for an average of 11 ± 3 days. The number of days of hospital stay were on average 29 ± 14 days.

Abdominal wall definitive closure was considered in 21 patients (88%). The entire procedure was unsuccessful in three cases (13%) since two patients died before abdominal wall definitive closure was performed, and another had the system removed to place a “Bogota bag” due to aponeurosis tearing at several points. Among the acute event survivors, successful closure was achieved in 21 out of 22 patients (95%). Overall, four patients died (17%).

During follow-up, three patients have developed incisional ventral hernia, of 2, 3, and 5 cm; the latter two were electively repaired on an outpatient basis, without major complications.

Discussion

The use of the open abdomen surgical technique is increasing as surgeons are becoming familiar with the procedure, patient selection, the equipment, and instruments that are used, the system operation and possible dysfunctions, as well as the beneficial effects and disadvantages of its use in clinical practice. Open abdomen is currently the standard surgical procedure used for patients undergoing damage control surgery, for decompression in cases of abdominal compartment syndrome and for the management of severe abdominal sepsis. This treatment has saved many lives, but has created that new problems surgeons must deal with, such as loss of fluids and proteins, development of intestinal fistulae, and retraction of the muscular fasciae edge from the muscular wall, with the consequent formation of giant ventral hernias⁷.



Figure 1. Patient with open abdomen and "Bogota bag".

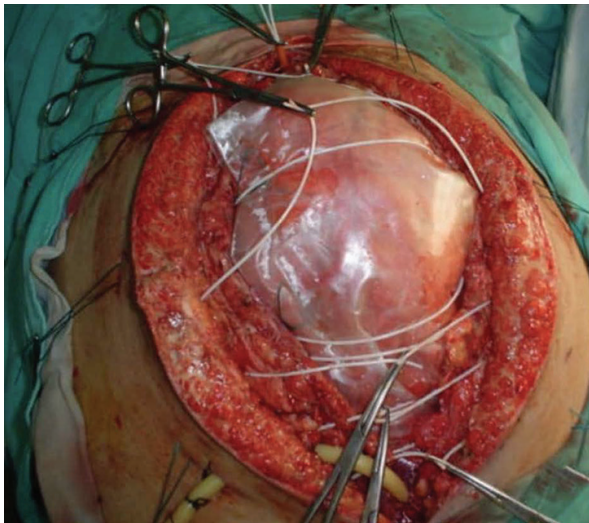


Figure 2. Sequential closure of abdominal wall. The polyethylene interface and fixation of aponeurosis-inserted retraction catheters are shown.

In our hospital, patients who require management with open abdomen to prevent or treat compartment syndrome, for planned re-exploration in cases of peritoneal sepsis or for damage control surgery are common. For many years, the group of surgeons has used the "Bogota bag" technique as standard procedure and, in isolated cases, partially and off-protocol, has tried to apply some of the different methods reported

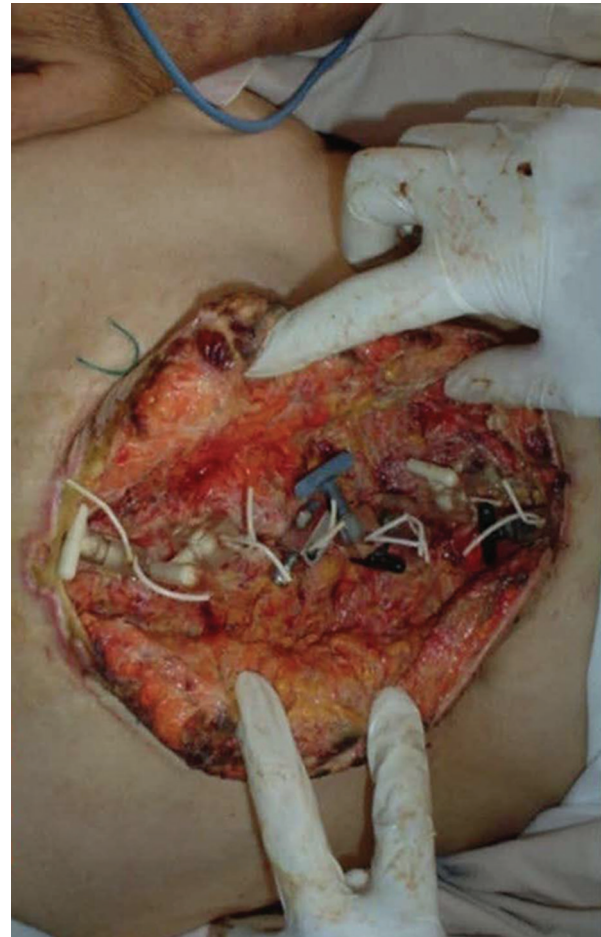


Figure 3. Aponeuroses progressive approximation maintaining traction using acrylic cubes designed at the hospital.

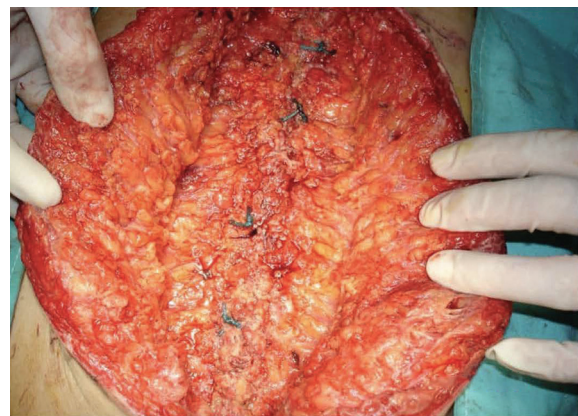


Figure 4. Definitive closure of the wall by suturing the aponeurosis edges.

for abdominal wall closure, which are mostly surgical techniques that involve the use of high-cost materials and instruments, and their use in our institution is



Figure 5. Final result in the abdomen of a patient treated with sequential closure of abdominal wall.

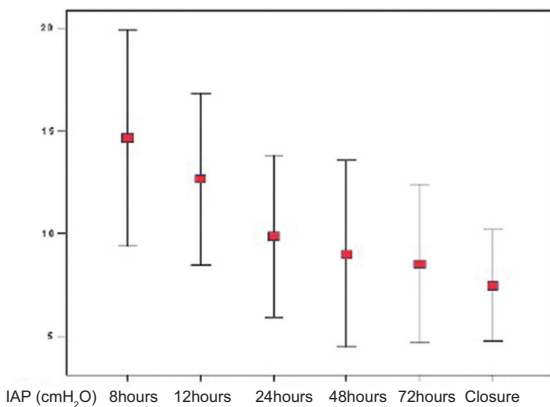


Figure 6. Intra-abdominal pressure (IAP) determination average during the procedure.

therefore very limited and difficult to adopt as standard methods.

Most patients who require this type of management are young adults, economically active and with a long-life expectancy, and abdominal wall cosmetic and functional defects are therefore of high relevance⁸.

In our series of patients, all were young and the cause was of traumatic or infectious origin.

The main indication for open abdomen and CSPA at the time of surgery occurs in patients with acute infectious-type abdominal processes when aponeurotic edges cannot be brought together without tension due to edema and intestinal loops distension; however, it can be used in various circumstances, when the intra-abdominal injury cannot be properly resolved at primary intervention, when the patient is unstable or too ill to perform an extensive operation

and damage control surgery is necessary, when bowel viability is questionable and requires a second intervention (known as second look surgery), when a primary anastomosis is performed in critical circumstances with a high probability of dehiscence, in the event of difficult-to-control bleeding that requires packing or after a prolonged operation with extensive visceral exposure that causes peritoneal edema^{3,6,9}. In abdominal sepsis, the open abdomen technique also provides access to the peritoneal cavity for devitalized tissue debridement, purulent material aspiration, and surgical drainage¹⁰.

Natural evolution of patients who are managed with the “Bogota bag” is toward the development of a planned ventral hernia and large scars caused by secondary intention wound closure. In these patients, in the best case scenario, repair is attempted much later through complex procedures that include the use of large sized prosthetic material, with elevated morbidity and a high failure rate¹¹. As with most progressive closure techniques, abdominal wall components integrity is preserved with CSPA, and performing final closure is possible without the use of permanent prosthetic materials.

At present, we know that the visceral and retroperitoneal edema that occurs in state of shock and tissue reperfusion can increase abdominal cavity pressure to dangerous levels, causing multiple organ dysfunction. Patients in these conditions have been shown to have better evolution if they are treated with an open abdomen approach, which allows better abdominal visceral perfusion¹². In addition, forced closure under conditions of abdominal wall tension have been shown to be likely to cause ischemia, necrosis, propensity to infection, and abdominal wall dehiscence¹³. CSPA benefits include repairing, draining, decompressing, and offering abdominal wall control in those patients who require treatment with open abdomen. The technique has the advantage that the patient can remain in bed, without the need for repeated admissions to the operating room required by other methods. Given that it is a simple and easy-to-apply technique, and because it involves the use of inert materials, it is associated with a low rate of complications¹⁴.

We consider that sequential closure of abdominal wall is an appropriate technique for the management of patients who require treatment with open abdomen. With the obtained results, we can claim that it is a procedure that faithfully meets the most ambitious purposes of abdominal wall progressive closure, and

that it is a safe and efficacious technique that can be reproduced at any secondary or tertiary care hospital.

Conclusions

Sequential closure of abdominal wall is a simple and easy to perform surgical technique, devised and used at *Centenario Hospital Miguel Hidalgo* in a protocol-based and standardized way, which offers an alternative for the management of patients with open abdomen, with encouraging initial results.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this research.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained informed consent from the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

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