

# Sequential closure of the abdominal wall with continuous fascia traction (using mesh or suture) and negative pressure therapy

## *Fechamento sequencial da parede abdominal com tração fascial contínua (mediada por tela ou sutura) e terapia a vácuo*

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### A B S T R A C T

The last decade was marked by a multiplication in the number of publications on (and usage of) the concept of damage control laparotomy, resulting in a growing number of patients left with an open abdomen (or peritoneostomy). Gigantic hernias are among the dreaded consequences of damage control and the impossibility of closing the abdomen during the initial hospital admission. To minimize this sequela, the literature has proposed many different strategies. In order to explore this topic, the "Evidence-based Telemedicine – Trauma & Acute Care Surgery" (EBT -TACS) conducted a literature review and critically appraised the most relevant articles on the topic. No commercially available systems for the closure of peritoneostomies were analyzed, except for negative pressure therapy. Three relevant and recently published studies on the sequential closure of the abdominal wall (with mesh or sutures) plus negative pressure therapy were appraised. For this appraisal 2 retrospective and one prospective study were included. The EBT-TACS meeting was attended by representatives of 6 Universities and following recommendations were generated: (1) the association of negative pressure therapy and continuous fascia traction with mesh or suture and adjusted periodically appears to be a viable surgical strategy to treat peritoneostomies. (2) the primary dynamic abdominal closure with sutures or mesh appears to be more efficient and economically sound than leaving the patient with a gigantic hernia to undergo complex repair at a later date. New studies including larger number of patients classified according to their different presentations and diseases are needed to better define the best surgical treatment for patients with peritoneostomies.

**Key words:** Open abdomen; peritonostomy; dynamic abdominal closure; fascia traction; negative pressure therapy; ventral hernia.

### INTRODUCTION

Historically, surgical principles invariably were based on restoring the normal anatomy by primarily and definitively repairing defects at single-stage surgical interventions. In the last decade, there was a multiplication of publications, particularly in trauma, emphasizing the importance of restoring the physiology in surgical patients.

This greater attention to physiologic derangements led to the principle of "damage control surgery", where the abdomen is left open (laparostomy or peritoneostomy) in abbreviated surgeries with the intent to restore normal physiology before definitive repair of injuries<sup>1</sup>.

Nowadays, the concept of damage control surgery is well-established either for trauma or non-trauma patients<sup>1-3</sup>. It emphasizes the restoration of the physiologic

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stress delaying definite repair, which if attempted primarily and definitively, would lead to further deterioration of physiology; and thus the impossibility of improving patient's condition. The main indications for peritoneostomy include inability of closing the abdominal wall, documented intra-abdominal hypertension, abdominal compartment syndrome, need for abdominal drainage due to severe infection, and need for relaparotomies. Although leading to increased survival rates, damage control surgery is accompanied by challenging complications associated with the open abdomen. Ideally, abdominal closure should be performed expediently but without compromising the patient's physiology<sup>1</sup>.

The need to manage a growing number of open abdomens has resulted in multiple different approaches with the intent to definitively perform abdominal closure in a timely fashion. These approaches are aimed at minimizing the development of giant ventral hernias<sup>4,5</sup>.

The studies on abdominal closure following damage control surgery involve multiple different dynamic techniques for primary abdominal closure. Due to the financial constraints and need for rationalized expenditures in health care systems, the Evidence-based Telemedicine – Trauma & acute Care Surgery (EBT-TACS) group opted for not including commercial systems available for abdominal closure, except for the vacuum (or negative-pressure) system. We performed a critical appraisal of the most relevant studies recently published on primary abdominal closure using dynamic and mesh-mediated suture. Recommendations were generated based on this appraisal of existing evidence on the topic<sup>5-8</sup>.

## ESTUDY 1

"Multicentre prospective study of fascial closure rate after open abdomen with vacuum and mesh-mediated fascial traction"<sup>6</sup>

### Rationale

A preliminary study demonstrated the efficacy of partial abdominal closure with vacuum and mesh-mediated fascial traction. With the goal to evaluate the rate of abdominal closure associated with that technique a multicentre prospective study was conducted. This study also aimed to identify complications and predictors of failure in closing the fascia associated with the technique.

### Question

What are the fascial closure rates, complications and predictors of failure in obtaining fascial closure associated with the vacuum and mesh-mediated fascial traction technique?

### Main findings

In the intention-to-treat analysis, abdominal closure was achieved in 76% of the cases, while in the per-protocol analysis, the abdominal closure rate was 89%. Intestinal fistula rate, the most fearful complication, was 7.2% in this study. However, the authors could not clearly determine whether this complication rate was directly due to the technique studied. On the other hand, the presence of fistula was the only variable independently associated with the inability of closing the abdomen in the binary logistic regression analysis.

In a multivariate analysis, vacuum utilization for a period more than 14 days was independently associated with failure of fascia closure.

It was also noted a marked reduction in intra-abdominal pressure in patients with abdominal compartment syndrome. Multiple organs failure, measured using the SOFA score, was not altered by the use of the technique and the authors do not recommend use this score for evaluating the patient physiologic status. The in-hospital mortality was 29,3%.

### Strengths

- Prospective study allowing obtaining accurate data on studied variables and, due to its multicenter design, also allowing generalizing study findings;
- Exclusion criteria and classification of comorbidities (vascular, surgical disease and trauma) well-defined, which facilitates understanding and applicability of study findings to clinical settings;
- Surgical technique well-described, including information on height and weight of recipients of mesh and fascia traction allowing replication in future comparisons;
- Study outcomes (rates of abdominal closure and complications) easily interpretable and transportable to clinical settings.

### Limitations

- There was no control group for a comparative analysis;
- Subjective exclusion criterion (anticipated usage of vacuum for at least 5 days) of little clinical value;
- Rates of abdominal closure and mortality reported together for various clinical conditions. The lack of subgroup analysis does not allow verification of potential benefit in particular clinical conditions. However, the small sample would limit the effect estimates in subgroups;
- The vacuum pressure was not determined a priori for different clinical conditions, being decided at the surgeon's discretion instead;
- No criteria were determined for timing of closure, which might influence secondary analyses of morbidity and mortality;
- Despite considering abdominal compartment syndrome of extreme importance, only 46 out of 151 patients

had their intra-abdominal pressure measured with no reported criteria for its indication;

- There was no information on the management of patients who developed enteroatmospheric fistulas and their implications for the maintenance of the mesh and fascia traction;

- Although it was reported that there was no continuity of care by surgeons, which might reflect real life, technical errors cannot be ignored and may compromise study outcomes;

- Even though complications were reported, no causality can be definitively established;

- The study did not perform analysis of patients who expired after fascial closure. The evaluation of these deaths could have provided important information on limitations and contraindications of the intervention.

## STUDY 2

“One hundred percent fascial approximation can be achieved in the postinjury open abdomen with a sequential closure protocol”<sup>7</sup>

### Rationale

When utilizing only the vacuum-assisted method (VAC), the majority of studies reports variable rates of abdominal closure. This method in isolation is unable to reduce time to abdomen closure and its associated morbidity, the need for using biological meshes, and the need for complex abdominal reconstruction. The authors aimed at demonstrating that following a predefined protocol of sutures associated with VAC every 48 hours it is possible to accomplish 100% abdominal closure rates during a study period of five years.

### Question

Does the use of a rigid vacuum-assisted protocol for abdominal closure followed by sequential fascial sutures reduce rates of complex abdominal reconstructions in patients who did not have their abdomen closed by day 3 after initial surgery?

### Main findings

- Out of 51 patients, 29 patients who were operated accordingly to the study protocol had their abdomen closed on average 6.8 days;

- Out of 22 patients who did not follow the study protocol, only 12 (55%) achieved abdominal closure;

- Out of the 22 patients not following the protocol, 16 were excluded due to non-compliance with the 48 hour time interval between surgeries. Three fourth of these 16 patients had their abdomen closed at the third operation;

- 75% of the patients were followed up by an average of 8 months;

- Enteric injuries occurred in 48% of the patients in the study protocol group versus 59% in the non-protocol group. Mortality was 4% in each group.

### Strengths

- Study included a control group that utilized VAC in isolation (defined based on previous studies) in order to compare with VAC associated with fascial sutures;

- The study design included patients who did not have their abdomen closed after second surgery, which represents a very pragmatic criterion;

- Physiologic variables are comparable or even worse in the intervention group as compared with the control population;

### Limitations

- Retrospective study including a limited cohort (trauma patients who did not have the abdomen closed after second laparotomy) without control group;

- The costs involved with using the quantity of the sponges in the VAC system might be questionable due to the more recent and efficient systems for absorption of peritoneal edema available;

- The authors describe that don't reoperate the patient unless arise criteria worsening. It can promote the formation of undrained abdominal collections.

## STUDY 3

“Vacuum and mesh-mediated fascial traction for primary closure of the open abdomen in critically ill surgical patients”<sup>8</sup>

### Rationale

The failure of primarily closing the abdomen leads to increased complications such as enteroatmospheric fistulas, and poor quality of life due to the development of giant ventral hernias. Preliminary evidence suggests higher rates of abdominal wall closure with the utilization of continuous fascial traction for the open abdomen. Therefore, this study was conducted with the intent to evaluate the efficacy of vacuum and mesh-mediated fascial traction for primary closure of the open abdomen

### Question

Does the utilization of vacuum and mesh-mediated fascial traction for temporary abdominal closure improve the rate of primary abdominal closure as compared to methods not using continuous fascial traction?

### Main findings

- The vacuum and mesh-mediated fascial traction method accomplished higher rates of primary abdominal closure, and consequently lower rates of giant incisional hernias;

- The underlying diagnosis and indication for peritoneostomy were independent predictors of primary abdominal closure and development of ventral hernia;
- Time to fascial closure was shorter in the vacuum and mesh-mediated group as compared to the control group;
- In severe acute pancreatitis, peritonitis and ruptured abdominal aortic aneurysm, the rate of abdominal closure was only 53%, which was lower than in other pathologies. The rates of closure were higher in patients who had the abdomen left open prophylactically or for the management of intra-abdominal hypertension, which is recognized by the authors as a potential source of selection bias.

### Strengths

- Although the study had a retrospective design, it included a control group allowing a comparative analysis to be performed;
- The study included an adjusted analysis accounting for potential confounders and biases related to the study outcomes;
- The authors reported confidence intervals for point estimates, which helps to interpret study findings and determining the precision of estimates. This is important when deciding whether study results are valid.

### Limitations

- Even though a logistic regression analysis is performed, the authors did not provide information on the quality of the model (i.e.: discriminatory power, calibration and fitness of the logistic regression model constructed);
- The sample size of the study cohort is small resulting in less precision of estimates, which is reflected by wide confidence intervals;
- The study was conducted over a long period of 6 years, which might have suffered from changes in practice occurring over time.

## CONCLUSIONS

A large number of damage control laparotomies is performed every day worldwide. While damage control principles are responsible for a reduction in mortality of severely ill surgical patients, it has also led to a growing

number of patients left with the abdomen open (or peritonestomies). The surgical management of these patients is complex and was the goal of this critical appraisal of 3 recent studies on the topic.

The most relevant conclusions reached include:

1. Ideally, the abdomen should be closed within the shortest period of time possible after the original surgery.
2. The abdomen that is left open for more than 14 days will possibly never be closed during the initial hospitalization; and the patient will have a gigantic hernia that will require complex repair at a later date.
3. The open abdomen is the cause of a multitude of complications. Enteric fistulae is the most feared complication, occurring in approximately 7% of the patients, and associated with failure of closing the abdomen and high mortality.
4. Many factors are associated with failure in closure of the abdomen that was purposefully left open. The most important factors include the primary cause leading the surgeon to opt for the peritoneostomy (sepsis, pancreatitis, aortic aneurysm rupture, trauma etc.).
5. The 3 studies appraised suggest that continuous traction on the fascia (with sutures or mesh) together with negative pressure therapy, are associated with high success rates in closing the abdominal wall. One study suggested a success rate between 76 and 89%, while another 100% when the surgeon follows a well-defined protocol of re-operations and continuous fascial traction.

### Recommendations

1. Vacuum and mesh-mediated together with continuous fascial traction (periodically adjusted) seems to result in higher rates of abdominal closure following damage control surgeries.
2. The sequential closure of the abdominal wall with continuous fascia traction (using mesh or suture) and negative pressure therapy seems to be more cost-effective and efficient than planned late giant ventral hernia reconstructions. O fechamento sequencial abdominal primário com terapia a vácuo, sutura e tração fascial mediada por tela parece ser mais econômico e eficiente do que a deixar o paciente com uma hérnia abdominal gigante e planejar uma reconstrução complexa muito tempo mais tarde. Surgeons should aim to definitively close the abdominal wall in a timely fashion.

## R E S U M O

*Na última década multiplicaram-se as publicações e a utilização da cirurgia de controle de danos, resultando num número crescente de pacientes deixados com o abdome aberto (ou peritoneostomia). Uma das consequências nefastas do abdome aberto são as hérnias ventrais gigantes que resultam da impossibilidade de se fechar o abdome durante a internação hospitalar do paciente. Para minimizar esta seqüela têm surgido na literatura diferentes tipos de abordagem. Para abordar este tópico, a reunião de revista "Telemedicina Baseada em Evidência - Cirurgia do Trauma e Emergência" (TBE-CiTE) optou por não analisar sistemas comerciais de fechamento abdominal dinâmico, com exceção da terapia de pressão negativa ou vácuo. O grupo fez uma avaliação crítica dirigida*

de três artigos mais relevantes publicados recentemente sobre fechamento sequencial da parede abdominal (com tela ou sutura) mais vácuo. Nesta avaliação foram incluídos dois estudos retrospectivos mais um estudo prospectivo. Baseados na análise crítica desses 3 estudos mais a discussão que contou com a participação de representantes de 6 Universidades e realizada via telemedicina, são feitas as seguintes recomendações: (1) a associação de terapia de pressão negativa com tração fascial constante mediada por tela ou sutura, ajustada periodicamente, parece ser uma ótima estratégia cirúrgica para o tratamento de peritoneostomias. (2) O fechamento abdominal primário dinâmico com sutura e mediada por tela parece ser mais econômico e eficiente do que deixar o paciente com uma hérnia gigante e planejar uma reconstrução complexa tardiamente. Novos estudos com grupos maiores de pacientes separados de acordo com as diferentes apresentações e doenças são necessários para definir qual o melhor método cirúrgico para o tratamento de peritoneostomias.

**Descritores:** Abdome aberto; peritonostomia; fechamento abdominal primário dinâmico; tração mediada da fásica; terapia de pressão negativa (Vácuo); hérnia incisional.

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