

## Original Article

# ABDOMINAL DECOMPRESSION FOR ABDOMINAL COMPARTMENT SYNDROME IN CRITICALLY ILL PATIENTS: A RETROSPECTIVE STUDY

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## ABSTRACT

**Background.** The abdominal compartment syndrome (ACS) refers to organ dysfunction that may occur as a result of increased intra-abdominal pressure (IAP). Successful management may require abdominal decompression and temporary abdominal closure (TAC). The aim of this study was to analyze the characteristics of patients requiring abdominal decompression, to describe the methods used for TAC, and to study the outcome of these patients.

**Methods.** A series of critically ill patients who required abdominal decompression for ACS between January 2000 and March 2007 were reviewed retrospectively. Age, gender, severity of organ dysfunction before decompression and the cause of ACS as well as the type of abdominal closure system and length of ICU-stay were recorded. Definitive abdominal closure and in-hospital mortality were the main outcome parameters.

**Results.** Eighteen patients with primary ACS and 6 with secondary ACS required decompressive laparotomy. Patients' ages ranged from 18 to 89 years (mean 50.7). The median preoperative IAP was 26mmHg, and IAP decreased to 13mmHg after decompressive laparotomy. Organ function, as quantified by the SOFA scoring system, improved significantly after the intervention. Eight patients had immediate primary fascial closure after the decompressive procedure and 16 patients required TAC. The majority of the survivors underwent planned ventral hernia repair at a later stage. The mean length of stay in the ICU was 23 ( $\pm$ 16) days. Overall, fifteen patients survived (63%).

**Conclusions.** Decompressive laparotomy was effective in reducing IAP and was associated with an improvement in organ function. In most of the patients, the abdomen could not be closed after decompression, and fascial repair was delayed.

**Key words:** intra-abdominal pressure, abdominal compartment syndrome

## INTRODUCTION

Intra-abdominal hypertension (IAH, defined as a sustained increase in intra-abdominal pressure of 12mmHg or higher) is increasingly recognized in various groups of critically ill patients, and often contributes to organ dysfunction in an important part of them (1). The abdominal compartment syndrome (ACS) refers to organ dysfunction that may occur as a result of increased intra-abdominal pressure (IAP) above 20mmHg (2). Respiratory insufficiency, hypotension and acute kidney injury have been described as most prominent consequences of elevated IAP, but gastrointestinal failure and increased intracranial pressure may also occur (3).

Whereas the consequences of elevated IAP have been extensively studied, the optimal treatment of IAH and ACS remains less clear. Strategies to prevent further increase in IAP such as open abdomen treatment after damage control laparotomy have become standard in trauma care, but interventions aimed at decreasing IAP have less eagerly been adopted by the medical community (4). Both surgical and non-surgical treatment options to reduce IAP are available, and have been documented. Non-surgical treatment consists of a variety of techniques such as the use of neuromuscular blocking agents or percutaneous drainage of intraperitoneal fluid collections (5), whereas abdominal decompression through a midline laparotomy is the usual standard approach for surgical management. Although it has been shown that these measures decrease IAP and improve organ function, surgeons remain reluctant to intervene, especially in patients without prior laparotomy incision. The morbidity associated with the open abdomen treatment is often mentioned as a reason not to decompress a patient with ACS, apart from the perceived futility of the intervention.

In a recent review, the mortality after abdominal decompression was high (6), but as this was not a controlled trial, no conclusions can be made regarding the usefulness of the intervention. IAP was reduced significantly, but the effect on organ function was variable. However, no details regarding severity of illness were available for most patients, and organ function was poorly described in most reports. The true effect of decompression on organ function has not been described.

In our hospital, abdominal decompression for ACS is increasingly performed. The objective of this study was to analyze the characteristics of patients requiring abdominal decompression, to describe the methods used for temporary abdominal closure (TAC), and to study the outcome of these patients, in terms of mortality, organ function score and abdominal closure rate.

**METHODS**

We retrospectively studied all patients admitted to the ICU of the Ghent University Hospital between January 2000 and March 2007 requiring a decompressive laparotomy (DL) for ACS. The indication for DL was decided by the treating physician and surgeon, on an individual patient basis.

The data collected included demographic characteristics (age, gender), severity of illness at admission to the ICU (APACHE (Acute Physiology And Chronic Health Evaluation)-2 score (7) and SAPS (Simplified Acute Physiology Score)-2 score), cause and type of ACS, the type of TAC system used after decompression and length of ICU-stay.

IAP was measured as intravesical pressure, according to the guidelines published by the WSACS (World Society for the Abdominal Compartment Syndrome) (8). Until 2005, 50mL instillation volume was used, from then on this was reduced to the current standard of 20mL. IAP was retrieved from the patients file, and both preoperative values (before DL) and postoperative values (immediately postoperative at ICU admission, and after 12 and 24 hours postoperatively) were retrieved.

The change in organ function was evaluated using the Sequential Organ Failure Assessment (SOFA) score (9), which was calculated preoperatively (on the day of surgery and the day before surgery), and postoperatively at day 1 and day 7. For the individual organ systems, organ failure was defined as a score of 3 or more on the SOFA scoring system.

The abdominal closure rate was determined at hospital discharge for the current episode. Mortality was defined as in-hospital mortality.

Statistical analysis was performed using SPSS for Windows 11.0.1 (SPSS, Chicago, IL, USA). Continuous variables were compared using the Mann Whitney U-test. Categorical data were compared using the Chi-square or Fisher Exact test. Continuous data are expressed as mean (±standard deviation) if the data were normally distributed, or median (interquartile range) if the distribution was not normal. Categorical data are reported as n (%). Changes in IAP and SOFA score were analysed using the Wilcoxon signed ranks test. A double sided p-value of less than 0.05 was considered to indicate statistical significance.

The study was approved by the local ethical committee; a waiver of consent was granted.

**RESULTS**

**Patient characteristics at admission**

Twenty four patients required decompressive laparotomy during the study period: 18 suffered from primary ACS and 6 from secondary ACS. Patients' ages ranged from 18 to 89 years (mean 50.7); 18 of them were male. Median APACHE II score at admission was 20 (15-23); median SAPS2 score 48 (34-57). The causes of ACS are summarized in table 1.

**Table 1: Causes of ACS in 24 patients requiring decompressive laparotomy**

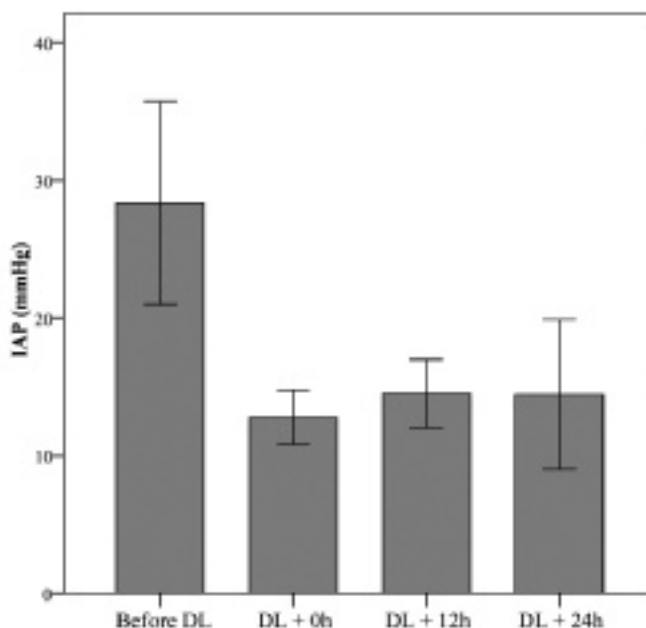
Primary ACS	18
Abdominal surgery	10
Intra-abdominal infection	4
Abdominal trauma	3
Ruptured AAA	1
Secondary ACS	6
Extra-abdominal trauma	2
Severe sepsis	4

Legend. ACS= abdominal compartment syndrome; AAA=abdominal aortic aneurysm.

**Effect of decompression on IAP and organ function**

Cardiovascular, respiratory and renal failure were present in 21 (87,5%), 24 (100%) and 17 (70,8%) patients respectively. The median SOFA score before decompression was 12 (9-17).

The median preoperative IAP was 26 (18-28). After DL, the IAP decreased to 13mmHg (12-16) immediately after DL, 13mmHg (11-16) at 12 hours and 12mmHg (9-15) at 24 hours (p=0.001 for all comparisons) (figure 1).



**Figure 1: Effect of decompressive laparotomy on IAP in 24 patients.** Legend. DL=decompressive laparotomy; IAP=intra-abdominal pressure. Error bars represent the 95% confidence interval. The median SOFA score, which was 12 (9-17) at the day of DL, decreased significantly to 10 (8-14) at the first postoperative day and to 5 (3-10) at the 7<sup>th</sup> postoperative day (p=0.017 and P=0.002, respectively) (figure 2).

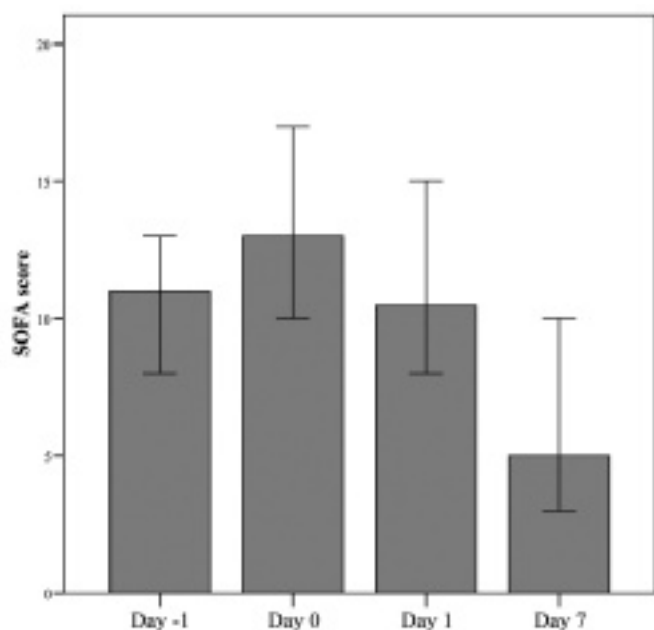


Figure 2: Changes in SOFA score after decompressive laparotomy in 24 patients.

Legend. SOFA = Sequential Organ Failure Assessment

### Abdominal closure

In eight patients, the abdomen could be closed primarily after decompression; in 4 of these patients blood or ascites was evacuated from the peritoneal cavity, three patients had an abdominal packing removed, and in one a hemicolectomy was performed. In all these patients reduction of the intra-abdominal volume resulted in a significant decrease in IAP, which allowed primary fascial closure. Sixteen patients required some form of TAC. In 3 patients vacuum-assisted wound closure (VAC) was used, in 5 patients other TAC systems were used (Bogota bag, Vicryl mesh or moist gauze). In 8 patients a combination of the above methods were used during the postoperative course.

### Outcome

The length of stay in the ICU was 23 ( $\pm$ 16) days. Overall, fifteen patients survived (63%). We could not identify preoperative patient characteristics associated with mortality since there was no significant mortality difference in terms of age, disease severity at admission, IAP level before DL or degree of organ dysfunction at the day of DL. In survivors there was already a trend towards improved organ function on the first postoperative day, which became significant later in the course of the disease: in the non-survivor group, the median SOFA score was unchanged, whereas it steadily decreased in the survivor group (table 2).

Delayed fascial closure (fascial closure during the same hospitalization) was possible in only 2 out of the 15 patients who survived. In 8 patients the fascia was closed at a later stage (planned ventral hernia repair) and 5 were treated with skin graft only, and did not (yet) undergo hernia repair.

Table 2: Characteristics of survivors and non-survivors after decompressive laparotomy for ACS (n=24).

	Survivors (n=15)	Non-survivors (n=9)	p
Age	50 (24-65)	58 (40-76)	0.18
APACHE II score	20 (14-23)	20 (16-24)	0.75
SAPS2 score	46 (31-57)	48 (37-55)	0.95
Primary ACS	12 (80%)	6 (67%)	0.63
Primary abdominal closure	7 (47%)	1 (11%)	0.18
IAP before DL	24 (17-27)	28 (18-36)	0.48
IAP 12h after DL	13 (12-16)	12 (10-18)	0.70
SOFA before DL	11 (9-15)	12 (9-18)	0.70
SOFA POD1	9 (4-13)	12 (10-15)	0.60
SOFA POD7	5 (2-8)	12 (7-19)	0.10

Legend. ACS = abdominal compartment syndrome; APACHE = Acute Physiology And Chronic Health Evaluation; SAPS = Simplified Acute Physiology Score; IAP = intra-abdominal pressure; DL = decompressive laparotomy; SOFA = Sequential Organ Failure Assessment; POD = post-operative day.

### DISCUSSION

In this study, we found that patients requiring DL are severely ill, yet DL results in an immediate and significant decrease of IAP with an associated overall improvement of organ function after DL. Primary fascial closure is possible in some patients, and when the abdomen remains open, various methods for TAC can be used. Mortality in these patients remains considerable, especially when no effect of DL on organ function is observed. Possible explanations for the absence of any effect of DL in these patients may include the timing of the intervention as the DL may come too late, and the relative importance of IAH in the development of organ dysfunction in patients with other overwhelming problems such as septic shock, gastrointestinal ischemia or extensive burn injury. Also, during the study period, indications for abdominal decompression may have changed, as well as the threshold for surgical intervention. During the study period, also the instillation volume for IAP measurement has changed, and possibly, the IAP values in the first years may have been overestimated. It is very unlikely that this has led to inappropriate decisions to decompress.

The abdominal closure rate in this study is low, which has considerable consequences for the patients: apart from the associated morbidity and subjective complaints related to the ventral hernia, a new surgical procedure is necessary, and often prosthetic material is necessary to correct the hernia. This risk of resulting open abdomen is also often a cause of concern for the surgeon involved in the care of the patient, and may be used as an argument against abdominal decompression. The reported closure rate in the literature is higher than in this series (10-13), but publication bias and patient selection may at least partially explain these high figures. On the other hand, the

use of a standard protocol for open abdomen treatment may help to increase the low rate observed in our patient population. Despite the open abdomen, patients have a good quality of life after abdominal decompression, even in those cases where the abdomen remains open (14, 15). Therefore, we feel that the perceived excess morbidity of DL should not be used as an argument against abdominal decompression, especially in patients with very high expected mortality rate without treatment. Rather, all efforts should be made to close the abdomen as soon as organ function allows.

Different methods for TAC have been described in the last decades, and this is probably reflected in the different methods used in this patient series (16). It should be acknowledged that different patients have different needs, and whereas some may be ideal candidates for early VAC dressings, others may need a planned relaparotomy the next day, and this will of course influence the choice of TAC. Also the experience of the surgeon with different TAC techniques may vary, apart from other considerations such as cost. Despite all of the above, a protocol for the care of open abdomen patients should be developed in each centre, according to the local expertise and available materials. The goal of such a protocol should be early closure with minimal morbidity and mortality. It is imperative to closely monitor IAP during this process, and to continue treating IAH and the underlying diseases, e.g. by correcting fluid overload through ultrafiltration or diuretics. Surgeons and intensivists should decide together on the most optimal treatment plan for the individual patient, especially when it comes to the timing of the intervention. Also, tools are available that may help in progressively closing the abdomen such as the ABRA® Abdominal Wall Closure System, which may allow progressive approximation of the surgical wound at the bedside of the patient.

In a considerable number of patients laparotomy was performed for other reasons than decompression alone. Often, an intra-abdominal cause of IAH was identified, and treated during the same procedure. Therefore, IAH seems to be a symptom of intra-abdominal pathology as well as a cause of organ dysfunction, and may be an additional argument for an explorative laparotomy in selected patients with a high a priori chance of complications. Immediate abdominal closure was possible in an important number of patients. The reduction of intra-abdominal volume after bowel resection or fluid removal may be an obvious explanation, and shows that an open abdomen can be avoided in some patients.

This study has a number of important limitations. First of all, it was a retrospective study and the indications for surgery may have varied in the study period, or for individual patients based on other factors. The sample size is small, but this is inherent to procedures that are controversial and only rarely performed. We focused only on patients requiring abdominal decompression, and could not compare the reported results with patients – if any – who did not undergo intervention. Also, the study period is quite long, and insights in the management of these patients may have changed.

A lot of questions remain unresolved regarding the role of decompressive laparotomy in the treatment of IAH and ACS. We are not yet able to identify the patients who may benefit most – or may benefit at all – from decompressive laparotomy. In this study, mortality remained considerable, albeit lower than in a review on the effect of decompressive laparotomy (6), in which mortality was as high as 50%. In patients who

died, organ dysfunction remained unchanged, despite an apparent effect on IAP, but we were not able to identify any patient characteristic that was associated with a bad outcome. However, apart from the inherent flaws of a retrospective study, the number of patients in this study is too limited to draw any firm conclusions. The type of ACS (primary versus secondary), the type of patient (surgical versus medical), the absolute value of IAP or the degree of organ dysfunction should further be explored as potential factors influencing outcome after decompression in larger studies.

When decompression is necessary, the timing of the intervention seems to be an important aspect. Early intervention (possibly at lower IAP) seems to be most logical to prevent organ injury, but may imply unnecessary surgery for some patients; when decompression comes too late, irreversible damage may have occurred, and prognosis might be adversely affected. The dynamic natural history of IAH induced organ dysfunction is probably the determining factor – more and clearer insight in the pathophysiology of IAH is urgently needed. There is evidence that shortlasting hyperacute changes in IAP are well tolerated, and that progressive but slow increase in IAP allows organs to adapt and is therefore also well tolerated (17). How this translates into the clinical management of ICU patients is not clear.

## CONCLUSION

In this study, primary ACS was the main indication for abdominal decompression in critically ill patients with ACS, and decompressive was effective in reducing IAP in all patients. In patients who survived, there was already an improvement in organ function on the first postoperative day. In most of the patients, the abdomen could not be closed after decompression. Definitive abdominal closure was not possible in most of the patients who were left with an open abdomen. Despite the severity of illness of these patients, 63 percent survived.

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