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Research article

Intra-abdominal hypertension and abdominal compartment syndrome in patients undergoing gastrointestinal surgery

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Abstract

Background. Intra-abdominal hypertension (IAH) and the abdominal compartment syndrome (ACS) are associated with high morbidity and mortality rates in surgical patients. Most studies on IAH and ACS have been conducted on patients on the intensive care unit (ICU) and have included both medical and surgical patients. We studied the incidence of Intra-Abdominal Hypertension and Abdominal Compartment Syndrome in patients who have undergone abdominal surgery exclusively, the factors associated with their occurrence and their final outcome.

Aim. To evaluate the incidence of Intra-Abdominal Hypertension and Abdominal Compartment Syndrome, the associated factors and their outcome in patients who have undergone gastrointestinal surgery.

Methods. Between September 2012 and November 2013, we prospectively recorded the IAH through the intravesical route in 895 consecutive patients who had undergone surgery in our department of Gastrointestinal Surgery at Sir Ganga Ram Hospital, New Delhi, India. We excluded those who are under 18 years old.

Results. Out of the 895 patients included in the study, 137 (15.3%) and 29 (3.2%) patients were diagnosed with IAH and ACS, respectively. IAH and ACS were most commonly associated with acute necrotizing pancreatitis (ANP), being significantly more common in ICU patients compared to those in the ward (40.2% vs 5.5%). The most common complication was bleeding and low hemoglobin levels that required blood products or inotropes (15.6%) followed by septicemia (15.5%). Most (70%) of the patients had grade I or II IAH. Mortality was significantly higher in patients operated on as emergencies and groups having IAH and ACS than those without IAH (29.9% and 57.1% vs 4.1% respectively).

Keywords : intra-abdominal hypertension (IAH), abdominal compartment syndrome (ACS), intensive care unit (ICU)

Highlights

- ✓ Young males, patients on the ICU who were on ventilators and inotropic support, and patients undergoing emergency operations especially for acute necrotizing pancreatitis are at a higher risk of developing intra-abdominal hypertension and abdominal compartment syndrome compared to the ward patients.

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Introduction

Intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) are relatively newly discovered problems in critically ill patients, but in fact, they have been recognized since the early days of critical care medicine (1-3).

IAH is defined as a sustained increase in the intra-abdominal pressure causing a pathophysiological effect on organ systems, and ACS is a consequence of the effect of IAH in time and it affects several intra- and extra-abdominal organs, leading to multiple organ failure and eventually to death. The reported presence of IAH varies, ranging from 18% to 58% of the patients studied and it depends on whether they have had trauma, surgical operation, or they are medical patients. The intra-abdominal pressure (IAP) is influenced by many factors and in healthy individuals, it ranges from 5 to7 mmHg.

The World Society of the Abdominal Compartment Syndrome (WSACS) has published a consensus statement including definitions and recommendations for the screening and management of IAH and ACS in Antwerp, Belgium in 2007 (4-5).

ACS adversely affects the circulation and diminishes tissue perfusion. In contrast to IAH, ACS is not graded, but it is rather considered an "all or none" phenomenon and, if prolonged and untreated, it has deleterious effects on end-organ functions due to pathophysiological changes such as a drop in the cardiac output, diminished chest wall compliance, decreased renal and visceral blood flow, and increased intracranial pressure. The gastrointestinal and renal systems are usually affected first. It has been suggested that intestinal ischemia might result in multiple organ dysfunction syndrome mediated by the inflammatory response. One of the first visible signs of IAH is oliguria, which occurs at an IAP value of 15-20 mmHg, being frequently seen in patients on the ICU, but not always recognized. Patients with IAH and ACS have a high rate of multiple organ failure and mortality (6).

Intravesical pressure (IVP) measurement is now accepted to be the gold standard in measuring IAP because this method is simple, accurate and widely available (7, 8-10). IVP can be used as a screening method to identify patients at risk. IAP should be measured at end-expiration, in the supine position, after the bladder is fully emptied, and then filled with 25 ml of saline. It is usually expressed in millimeters of mercury.

The early recognition and intervention are important for the management of IAH and ACS. The WSACS recommends a management algorithm of IAH depending upon the presence or absence of ACS, primary or secondary/ recurrent ACS. They recommend decompressive procedures in the presence of primary ACS.

We evaluated the incidence and the factors associated with the occurrence of Intra-Abdominal Hypertension and Abdominal Compartment Syndrome in our patients who had undergone gastrointestinal surgical operations.

Materials and Methods

We conducted a prospective study between September 2012 and November 2013 in order to measure the intra-abdominal pressure in 893 consecutive post-operative patients in the Department of Gastrointestinal Surgery at Sir Ganga Ram Hospital. Patients under 18 years of age, pregnant females, patients undergoing extra-peritoneal procedures such as inguinal hernia repair were excluded from study.

IAH was defined as a rise in the intra-abdominal pressure to more than 12 mmHg without obvious organ failure. It is graded as follows: grade 1, 12-15 mmHg; grade 2, 16-20 mm Hg; grade 3, 21-25 mm Hg and grade 4, higher than 25 mm Hg. ACS was defined as a sustained IAP > 20 mmHg that was associated with organ dysfunction/ failure.

The intra-abdominal pressure was measured by the indirect intra-vesical method with 25 cc of sterile normal saline. The intra-abdominal pressure was measured daily postoperatively, while the patient was catheterized.

The various organ systems were said to have been affected according to the following criteria, if two or more of the above criteria were met.

a) Cardiovascular: Systolic BP < 90 mmHg/ Pulse rate of 120 beats per minute or higher

b) Respiratory: Respiratory rate > 20/ Requiring ventilator support

c) Renal: BUN of > 18/Serum Creatinine > 1.2 mg%/ Decreased urine output < 25ml/hr

The postoperative complications were graded according to the Clavien-Dindo classification. Mortality was defined as death during the same hospital admission or within the first 30 postoperative days.

Statistical Analysis

The descriptive statistics were analyzed using the SPSS version 17.0 software. Continuous variables have been presented as mean ± SD. The categorical variables have been expressed as frequencies and percentages. The nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. A P value of <0.05 was considered to be significant.

Results

Between September 2012 and November 2013, 1,092 patients underwent surgery in the Department of Surgical Gastroenterology and Liver Transplantation at Sir Ganga Ram Hospital, New Delhi. Out of these, 895 patients were included in the study and 178 excluded (those who had extra peritoneal procedures, who were pregnant or who were under 18 years of age). 137 (15.3%) patients were detected to have IAH and, out of these, 29 had ACS.

Their demographic profiles of the patients are shown in Table 1. Out of the 895 consecutive patients who had undergone gastrointestinal surgery, we found 137 (15.3%) who had IAH and 29 (3.2%) who had ACS. The incidence of IAH (5.5%) was significantly lower in ward patients and none had ACS. Patients with IAH and ACS were comparatively younger and significantly more frequently male M: F ratio as compared to the non IAH group. In our study, the majority of the procedures were done for small bowel disease.

IAH and ACS were most commonly associated with acute necrotizing pancreatitis (ANP). All the 32 patients with ANP had IAH (100%) and 19 (59.4%) of these also had ACS. Other diseases associated with IAH and ACS were mesenteric ischemia, pancreatic trauma and gastrointestinal bleeding. All the patients with ACS were operated on as emergencies.

Table 1. The demographic profile of patients

	Total	Non IAH group	IAH group	ACS group	P value
Number of patients	895	758 (84.7%)	137 (15.3%)	29 (3.2%)	
Mean age (years)	47.4 (range : 19-85)	50.3	41.2	34.8	<0.01
M: F ratio	1.9:1	1.8:1	3.7:1	6:1	0.032
Emergency	249 (27.8%)	145 (19.1%)	104 (75.9%)	29 (100%)	<0.001
Elective	646 (72.2%)	613 (80.9%)	33 (24.1%)	0	<0.001
Mortality	72(8%)	31(4.1%)	41(29.9%)	20 (57.1%)	<0.001
Hospital stay (days)	13.1 (1-81)	9	23.5	48	<0.001
ICU stay (days)	1.9 (0-42)	1	7.3	17	<0.001

IAH and ACS were significantly more common in ICU patients compared to patients in the ward (Table 2). 251 patients required ICU care in the postoperative period, out of which 101 (40.2%) developed intra-abdominal hypertension and 29 (11.6%) had abdominal compartment syndrome. The incidence of IAH (36/644, 5.5%) was significantly lower in ward patients.

The incidence of complications in all patients has been shown in Table 3, according to the Clavien-Dindo grading system. The most common complication was bleeding and a low hemoglobin level requiring blood products or inotropes (15.6%) followed by septicemia (15.5%). Most (70%) of the patients had grade I or II IAH. ACS was usually associated with grade III/IV of IAH (Table 4). The renal system was the most common organ system to fail in patients with ACS (86.2%), followed by the respiratory and the cardiovascular system. Mortality was significantly higher in patients with grade III/ IV IAH, patients having ACS and patients operated on as emergencies (Table 5).

Table 2. The comparison between IAH and ACS on ICU patients and ward patients

Patients	Without IAH (N=758)	IAH (N=137)	ACS (N=29)	Total	P value
ICU	150 (19.8%)	101 (73.7%)	29 (100%)	251	<0.001
Ward	608 (80.2%)	36 (26.3%)	0	644	<0.001

Table 3. The comparison between intra- and postoperative variables on patients with IAH and ACS

Variables	Non IAH group (N=758)	IAH group (N=137)	ACS group (N=29)	P value
Mean duration of surgery (minutes)	213	174	119	<0.001
Overall complications	280 (36.9%)	98 (71.5%)	29 (100%)	<0.001
Grade I/II complications	201 (26.5%)	48 (35%)	0	<0.001
Grade III/IV complications	79 (10.4%)	50 (36.5%)	29 (100%)	<0.001
Inotropes	28 (3.7%)	81 (59.1%)	26 (89.7%)	<0.001
Blood transfusion	44 (5.8%)	87 (63.5%)	29 (100%)	<0.001
Mean blood loss (mL)	290	545	610	<0.001

Table 4. Intra-abdominal hypertension/ ACS

	IAH (137)	ACS (29)	Mortality in IAH (41/137)	Mortality in ACS (20/29)	P valve
Grade I	66 (48.2%)	0	8 (19.5%)	-	
Grade II	29 (21.2%)	2 (6.9%)	5 (12.2%)	-	
Grade III	24 (17.5%)	9 (31%)	13 (31.7%)	8 (40%)	<0.001
Grade IV	18 (13.1%)	18 (62.1%)	15 (36.6%)	12 (60%)	<0.001

Table 5. Overall Postoperative Mortality

	Without IAH (n=758)	IAH (n=137)	
		Without ACS (n=108)	With ACS (n=29)
Emergency	11/145 (7.6%)	17/75 (22.7%)	20/29 (70%)
Elective	20/613 (3.3%)	4/33 (12.1%)	-
Total	31/758 (4.1%)	21/ 108 (19.4%)	20/29 (70%)
	31/758 (4.1%)	41/137 (29.9%) (P = < 0.0001)	

Discussions

A rise in IAP is being increasingly recognized as both a cause and consequence of many adverse events in critically ill patients. Much of our initial knowledge about IAH and ACS originates from patients with specific conditions such as ruptured aortic aneurysms, abdominal trauma, severe burns and severe acute pancreatitis (11-13). Previous studies on IAH and ACS have been conducted on patients on the ICU, both medical and after a variety of surgical procedures; our study focuses on patients who have undergone only abdominal operations and who are on the ICU as well as in the ward.

While IAH/ACS is frequent after *major abdominal surgery*, its true incidence is difficult to assess, since earlier studies have used different definitions for IAH and did not always differentiate between IAH and ACS. Using the currently well-accepted criteria in a study on 895 consecutive patients who had undergone gastrointestinal surgery, we found 137 (15.3%) with IAH and 29 (3.2%) with ACS. The incidence of IAH (5.5%) was significantly lower in ward patients and none had ACS. Patients with IAH and ACS were comparatively younger and significantly more frequently male M: F ratio as compared to the non IAH group. In abdominal surgical patients, the incidence of IAH (cut-off 20 mmHg) has been reported in 33 to 39% of the patients and the incidence of ACS (cut-off 20–25 mmHg) between 2–36% (14-18). In the study conducted by Scollay et al., IAH occurred in (5/42) 12% of the patients following major elective abdominal surgery (19). Another study by J.J. Hong et al. reported that 4.2% of the patients undergoing abdominal trauma surgery developed IAH and two thirds of them developed ACS (20).

In critically ill patients, the reported prevalence of IAH ranges from 18% to 58% and from 5 to 12% for ACS. Out of the total number of 251 patients shifted to the ICU in the postoperative period, 101 (40.2%) had IAH and 29 (11.6%) had ACS. Sugrue et al. showed that 40.7% of the patients with abdominal surgery and shifted to the ICU were found to have IAH, which is comparable to the results of our study (21). They also showed that 46% of the emergency gastrointestinal surgical patients requiring intensive care had IAP values ≥ 18 mmHg (22). Our study also revealed a higher incidence of IAH and ACS in patients undergoing emergency surgeries. In our study, 27.8% patients were operated on as emergencies and represented 75.9% of the patients who developed IAH, whereas in the non IAH group, only 19.1% underwent emergency operations. All the patients who developed ACS had undergone surgery on an emergency basis. Most of the patients (48.2%) in our study had grade I IAH; grade II and grade III occurred in 21.2% and 17.5% of the patients, respectively. ACS was most commonly associated with the higher grades (grade III and IV) of IAH.

The most common cause of IAH and ACS in our study was acute necrotizing pancreatitis accounting for 18.2% and 72.4% of the patients, respectively. All the 32 patients with ANP had IAH (100%) and 19 (59.4%) of them were found to have ACS. Other diseases associated with IAH and ACS were mesenteric ischemia, gastrointestinal bleeding and pancreatic trauma. ANP seems to have been associated with IAH/ACS, with IAH occurring in 59% to 78% of the cases and ACS in 27% to 56% of these patients in the literature. Hong Chen et al. showed that IAH and ACS were frequent among patients with ANP occurring in 59.5% and 27% of the patients, respectively (23). In another study by Paivi Keskinen et al., IAH was found in 84% (31 out of 37) of patients and 18/37 (49%) patients had ACS (24). The difference between the incidences may be due to the fact that we have included only patients operated on due to acute necrotizing pancreatitis, while the two above mentioned studies included both operated on and conservatively managed patients.

Patients with acute necrotizing pancreatitis requiring surgery are generally sick and have multiple organ system failure. In our study, the mortality in this group of patients was 56.3% (18/32) and all these patients had ACS. In a study by Paivi Keskinen et al., the overall hospital mortality rate was 24% (9 out of 37) and the hospital mortality rates in grade 1–4 of IAH were 10%, 12.5%, 22.2% and 50%, respectively (24). They also showed that high IAP in critically ill patients with acute pancreatitis correlates with the degree of organ dysfunction and the length of intensive care.

We also found that patients with IAH or ACS had a significantly higher duration of surgery, intraoperative blood loss, inotropic and blood transfusion requirement compared to patients without IAH.

The overall complication rate in our study was 42.2%, according to the Clavien-Dindo classification. The complication rate was significantly higher in the group with IAP compared to that without IAP (71.5% vs 36.9% respectively). Most of the patients with ACS had grade III or IV complications. IAH and ACS contribute significantly to multiple organ failure in critically ill patients and are associated with considerable morbidity and mortality. Various studies have showed that IAH during the intensive care is an independent outcome predictor (7).

In our study, we found respiratory failure and renal failure in 86.2% of the patients with ACS and cardiovascular failure in 75.8% of them. Several studies show the association between IAH and the development of organ dysfunction in severe acute pancreatitis. De Waele et al. showed that there was a 94% incidence of respiratory failure, 94% of cardiovascular failure, and 89% renal failure rate in patients with IAP higher than 12 mm Hg (25).

Sugrue et al. also revealed a clinically significant association between increased IAP and renal impairment in patients admitted to the intensive care unit after laparotomy. In his study, 20/29 (69%) patients were found to have renal failure in the IAH group (21).

The mean hospital stay and the ICU stay in our study were significantly higher in patients with IAH and ACS compared to patients without IAH/ACS [(hospital stay 23.5 and 48 vs 9) and (ICU stay 7.3 and 17.2 vs 1)] ($p<0.001$). This can probably be explained by the fact that most patients who had IAH and ACS underwent surgery on an emergency basis, had multiple organ failure, were on the ICU preoperatively and had more complications compared to those without IAH or ACS. This is similar to the findings in many other studies. Maria Gabriela Vida et al. showed a significantly longer ICU stay (10 vs 3 days) in patients with or without IAH (26). The mortality in our study was significantly higher in groups having IAH and ACS than in groups without IAH 29.9% and 57.1% vs 4.1%, respectively ($p<0.001$), especially in patients with grade III/IV IAH. A study by Hong Chen et al. on severe acute pancreatitis showed that mortality in ACS patients is approximately 75% (23).

Conclusions

In a study on 895 consecutive patients undergoing gastrointestinal surgery, we found the incidence of IAH and ACS to be 15.3% and 3.2%, respectively. Young males, patients on the ICU who were on ventilators and inotropic support and patients undergoing emergency operations especially for acute necrotizing pancreatitis were at a higher risk of developing IAH and ACS compared to ward patients. Patients with IAH/ACS had a significantly higher ICU and hospital stay and postoperative complications were much higher than in those without IAH. IAH and ACS are predictors of mortality in patients undergoing gastrointestinal operations.

Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

Compliance with ethical standards

Any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

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