Original Research Article

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Perioperative intra-abdominal pressure monitoring in emergency laparotomy

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ABSTRACT

Background: The aim of present study is to evaluate the perioperative monitoring of intra-abdominal pressure and abdominal compartment syndrome and its association with the postoperative morbidity in terms of kidney function and pulmonary atelectasis and mortality of the patients undergoing emergency laparotomy.

Methods: A prospective study was done in 100 patients undergoing laparotomy. The study was conducted in the department of general surgery, Government Kilpauk medical college and hospital for the period of six months from January 2015 to June 2015. The study group of 100 patients was divided into 2 groups, each group containing 50 patients. The first group containing 50 patients having increased intra-abdominal pressure undergoing emergency laparotomy and second group containing 50 patients undergoing elective laparotomy. The post-operative morbidity in terms of kidney function by means of urea, creatinine and urine output and pulmonary atelectasis with the help of chest x-ray and mortality analyzed compared in between the two groups.

Results: By comparing the two groups, the group undergoing emergency laparotomy with increased intra-abdominal pressure had increase in the incidence of postoperative morbidity and mortality than the elective laparotomy group without elevated intra-abdominal pressure.

Conclusions: Thus, the perioperative monitoring of intra-abdominal pressure is highly useful in diagnosing intra-abdominal hypertension and abdominal compartment syndrome and thereby helps in minimizing the post-operative morbidity and mortality in emergency laparotomy patients.

Keywords: Abdominal compartment syndrome, Intra-abdominal pressure, Laparotomy

INTRODUCTION

Abdominal compartment syndrome (ACS) and intraabdominal hypertension (IAH) have been prominently identified among patients with surgical emergencies such as pancreatitis and intestinal obstruction, and among patients in intensive care units (ICU).¹ It is a proven fact that IAH is rampant among ICU patients. Around 18 to 80% ICU patients are affected by this entity and hence the increasing interest in this topic. Most of the body systems are affected by ACS and IAH, most markedly the renal, respiratory, cardiac and nervous systems. The prognosis of the patient depends on the flow of the blood to various organs which are ultimately affected by ACS/IAH. Timely recognition of ACS/IAH, its clinical features and risk factors play a very important role in reducing the morbidity and mortality of patients. It becomes essential to have a sound knowledge of the pathophysiology to identify and plan an appropriate therapeutic approach. Compartment syndrome is a well-known phenomenon in the extremities. Increased pressure in closed fascial spaces of limbs causes a decrease in the perfusion pressure. When perfusion is depressed beyond a critical level, tissue viability is lost.² The same principle applies to the intra-abdominal space which is also a closed compartment. The normal Intra-

abdominal pressure is <7 mmHg. Various conditions which ultimately lead to the accumulation of fluid, flatus or feces increase the intra-abdominal pressure

Aim of the study

To assess the relationship between peri-operative intraabdominal pressure and post-operative patient morbidity, (with special reference to kidney function and pulmonary atelectasis), and mortality.

METHODS

The study was to be conducted on 50 cases of emergency laparotomy and 50 elective laparotomy patients admitted in Government Kilpauk medical college and hospital. Ethical committee clearance was obtained from the institutional ethical committee of Kilpauk medical college and hospital. This study was conducted between January 2015 and June 2015. Before the study conducted, informed consent was obtained from all the patients.

Method of collection

It was a prospective, comparative study which was conducted on 100 cases.

Inclusion criteria

- Patients admitted to KMCH and undergoing emergency laparotomy
- Age group 18 years to 60 years.

Exclusion criteria

- Age group <18 years and > 60 years
- Pregnancy
- Morbid obesity
- Spinal cord problems and fracture limbs who are unable to lie down Supine
- Bladder complaints-neurogenic bladder, cystitis
- Patients with established causes of co-morbidity such as renal failure, CAD, hypertension

Methodology

Two groups of 50 surgical patients were selected. The experimental group had emergency laparotomy. The control group were selected from those undergoing elective surgery. In both groups, patients with factors which could cause increased intra-abdominal pressure like obesity were excluded. The preliminary details collected from patients included, name, age, sex, diagnosis, operative procedure planned, BMI, presence or absence of diabetes mellitus, hypertension. Examination findings of pulse, blood pressure, respiratory rate, temperature and specific systemic examination of respiratory system, cardiovascular system and abdomen were noted. Laboratory tests done preoperatively and post

operatively according to need were hemoglobin concentration, plasma urea, plasma creatinine and chest x-ray. Intra-abdominal pressure and urine output were monitored pre-operatively and at four hourly intervals in the post-operative period for 24 hours. The intra vesical route of measuring the IAP was done by catheterization of the urinary bladder using Foley's attached to a three way tap which was then connected to a pressure transducer. The patient was placed in a supine position and the residual urine was drained. The catheter was connected to a pressure transducer and the point of midaxillary line at the iliac crest was taken as the reference point where the intra-abdominal pressure value was zeroed. Around 25ml (if weight <20 kgs, 1ml per kg) of saline was instilled into the bladder. The reading was taken one minute later, providing time for detrusor muscle relaxation. The measurements were taken in the absence of active abdominal muscle contraction and at the end of expiration. Measurements were made at regular intervals, usually varying from 4 to 6 hours. Depending on the IAP the treatment modality was adjusted. The Foleys catheter was clamped before each measurement. Operative findings during laparotomy and the surgical procedure done were noted. Post-operative mechanical ventilation and re-laparotomy were followed up if needed. Also, cause of mortality was noted if the patient expired inspite of maximal supportive medical care. The results were documented and tabulated. The statistical significance was found out using the Chi square test.

RESULTS

The importance of sub clinical IAH and ACS are still not widely known. The present study is an attempt to explore the incidence and importance of these conditions in the morbidity of surgical patients. Very few experimental studies have been made in these patients and since each person used different criteria, comparison is sometimes difficult. While analyzing the results, it was found that the incidence of increased intra-abdominal pressure was present among the emergency group with mean 16.64 (SD 4.16) was more in emergency group compared with elective group 4.22 (2.46) and was high among men when compared to women (p value <0.001). The number of females was more in the elective case list. Hence more males were suffering from intra-abdominal hypertension. There was no significant difference between the two groups of increased and normal intra-abdominal pressure with regard to mean age distribution.

Urea was significantly raised in the increased intraabdominal pressure group when compared to the normal intra-abdominal pressure group at all-time intervals (preoperative, post-operative, 4th hour, 12th hour and 24th hour) (p value <0.001 in all time period), thus indicating renal dysfunction in cases of increased intra-abdominal pressure. Further, the intra-abdominal pressure and urea of each of these patients were monitored serially at regular intervals. There was no correlation between the two. This reinforces the concept that the duration of IAH is more important than the actual pressure. Similarly, a significant increase in the creatinine level in all cases of increased intra-abdominal pressure was found when compared to normal group, at all-time intervals (p value <0.001 in all time period). Similarly, when monitored serially there was no correlation between the increased intra-abdominal pressure and creatinine. Hence it reinforces the concept that, the duration of increased

intra-abdominal pressure is more significant than the actual pressure probably due to renal dysfunction due to alteration in the renal blood supply. There was no significant correlation between the urine output and the intra-abdominal pressure. This might indicate that urine output might not be an ideal indicator of renal dysfunction in cases of intra-abdominal hypertension or abdominal compartment syndrome.

Table 1: Urea levels in patients with normal and increased abdominal pressure.

	Group	N	Mean	Standard deviation	Standard error mean	P-value
Urea-pre	Normal IAP	50	33.54	5.970	0.844	
	Increased IAP	50	47.52	11.261	1.593	<.0.001
Urea-op	Normal IAP	50	32.44	4.807	0.680	
	Increased IAP	50	44.78	10.533	1.490	< 0.001
Urea-4h	Normal IAP	50	32.96	5.103	0.722	
	Increased IAP	50	44.04	10.103	1.429	< 0.001
Urea- 12h	Normal IAP	50	33.28	4.481	0.634	
	Increased IAP	50	42.90	9.179	1.298	< 0.001
Urea-24 h	Normal IAP	50	32.74	3.848	0.544	
	Increased IAP	50	42.50	9.554	1.351	< 0.001

Table 2: Creatinine levels in patients with normal and increased IAP.

	Group	N	Mean	Standard deviation	Standard error mean	P-value
CRE-PRE	Normal IAP	50	1.052	0.2667	0.0377	
	Increased IAP	50	1.838	1.2660	0.1790	<.0.001
CRE-OP	Normal IAP	50	0.980	0.2740	0.0388	
	Increased IAP	50	1.594	1.1474	0.1623	< 0.001
CRE-4h	Normal IAP	50	1.064	0.2776	0.0393	
	Increased IAP	50	1.588	1.0578	0.1496	< 0.001
CRE- 12h	Normal IAP	50	1.042	0.2425	0.0343	
	Increased IAP	50	1.548	0.9725	0.1375	< 0.001
CRE-24h	Normal IAP	50	0.996	0.2432	0.0344	
	Increased IAP	50	1.460	0.8947	0.1265	< 0.001

There was no significant difference in the incidence of atelectasis pre-operatively between the two groups which was tested clinically and with the help of chest x-ray.

There is a mild increase in the incidence of atelectasis post-operatively in cases of increased intra-abdominal pressure as compared to the group with normal intra-abdominal pressure. This might indicate that pulmonary atelectasis is related to the duration of intra-abdominal hypertension since the post-operative intra-abdominal pressure is more in the emergency cases than the elective cases. There was no significant difference in mechanical ventilation needed for both the groups post operatively.

Mortality of 0% was observed in the study group.

DISCUSSION

Injuries and diseases affecting the abdomino-pelvic region such as intestinal obstruction and peritonitis cause primary abdominal compartment syndrome whereas diseases originating outside the abdomen such as sepsis and major burns leads to secondary abdominal compartment syndrome. There are no specific radiological features to identify abdominal compartment syndrome. This is one reason why CT scan is not used to diagnose a case of Intra-abdominal hypertension. However, radiological investigations may help to identify the cause, severity and the potential complications of the causative illness for the increased pressure. Whatever the cause is, rapid identification and diagnosis of intraabdominal hypertension can be done using a simple bedside test, the intra-vesical pressure measurement.

Several studies have shown that the incidence of IAH and ACS is significantly more when associated with sepsis and septic shock; it may be as high as 85% and 30% respectively. In cases of pancreatitis about 40-70% patients have been recognized to have IAH and 10-50% to have ACS. Post laparotomy incidence is variable but is generally low with elective surgeries and higher following emergency procedures. The World Society on Abdominal Compartment Syndrome (WSACS) was established and came to be the ultimate authority on IAW ACS.

Kron I. Harman PK and Nolan SP were the first to describe the entity ACS. They also described a simple and reliable diagnostic technique of placing an indwelling transurethral bladder catheter for this purpose. In post laparotomy patients, in the absence of renal insufficiency or rapid blood loss, an IAP above 20 mmHg was an indicator for continued and vigilant observation. In postoperative patients, an IAP of above 25 mmHg with low urinary output and adequate blood volume was described as an indication for re-exploration and abdominal decompression.³ The term abdominal compartment syndrome was first introduced, by Fietsam et al, in four patients who had increased intra-abdominal pressure following repair of ruptured aortic aneurysm. It was recognized by increased central venous pressure, decreased urinary output and increased ventilator pressure associated with massive abdominal distension in the absence of bleeding. These set of findings represent the abdominal compartment syndrome caused by massive retroperitoneal and interstitial swelling.⁴

In 2004, the World Society of Abdominal Compartment Syndrome (WSACS) was established by an international group of surgeons and physicians. They recognized the need for a cohesive approach fostering education, promoting research, treating and improving the survival of patients suffering from IAH and ACS. They achieved a great deal within three years of their establishment, developing definitions and recommendations based on

$GFP = MAP-2 \times IAP^5$

Hence changes in IAP will affect renal filtration and urine production rather than MAP. Oliguria is one of the first sign of increased IAH. In healthy adults, the normal IAP is <7 mmHg.⁶ In conditions such as morbid obesity, chronic obstructive pulmonary disease and pregnancy, the physiological upper limit is accepted to be 12mmHg by the WSACS. This reflects elevated normal pressure from conditions that exert external pressure to the diaphragm or the peritoneal envelope. IAH is the sustained or repeated pathological increase of the intraabdominal pressure above 12 mmHg.

Grades of IAH according to the level of IAP7

Grade I 12-15mmHg Grade II 16-20mmHg Grade III 21-25mmHg Grade IV >25mmHg

Abdominal compartment syndrome-classification

According to the cause and duration, ACS may be classified as Primary, secondary or recurrent

- Primary ACS (abdominal or surgical ACS)-presence of acute or subacute IAH which results from intraabdominal cause. (Post-abdominal surgery or abdominal trauma).
- Secondary ACS (extra-abdominal or medical)
 Presence of subacute or chronic IAH from conditions
 that require massive fluid resuscitation, e. g. major
 bums or septic shock.
- Tertiary or recurrent ACS-Presents with resurgence of ACS following resolution of a prior episode.

Bladder is very compliant. When a small amount of saline is infused, it functions as a passive reservoir and a transducer of the intra-abdominal pressure. Changes in the intravesicular pressure reflect changes in the IAP sufficiently accurately for practical purposes. It is important to measure the IAP with the patient in the supine position as posture affects the IAP.⁸ In patients with neurogenic bladder, bladder trauma, tense pelvic hematomas and outflow obstruction, the measurement of bladder pressure is not feasible. Hence an alternate method of measurement is used to monitor the IAP via the nasogastric route. The advantages of measurement of IAP via the stomach is,

- The problems associated with the formation of hydrostatic column of fluid in the bladder are avoided.
- It is easier and better for continuous monitoring of the IAP.

CONCLUSION

ACS/IAH is associated with profound physiological abnormalities both outside and within the abdomen. Renal dysfunction is the most common complication of abdominal compartment syndrome. Pre-operative renal dysfunction was found to be high in all the case series ranging from around 40% to 80%. The fall in the postoperative creatinine as compared to pre-operative creatinine was also observed in all the case series. Thus, the IAH induced renal dysfunction and pre renal azotemia will neither be responsive to fluid resuscitation nor vasopressors. It improves dramatically by appropriately promptly reducing the elevated IAP. As recommended by the World Society of Abdominal Compartment Syndrome, all cases in the critical care wards should be assessed for intra-abdominal pressure immediately following admission and serially in cases of elevated initial pressure. Though the mortality rate is zero in this case series, it is probably due to the choosing patients with increased abdominal pressure selectively rather than monitoring all the patients in the critical care ward, some of whom may have died because of undiagnosed intra-abdominal hypertension. Hence abdominal compartment syndrome is a timely diagnosed and appropriately managed treatments play equally important role in their management. Awareness and recognition of this entity will go a long way in reducing the mortality of many critically ill patients and all it takes is a simple bedside test to make the difference between probable death and survival.

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Ethical approval: The study was approved by the

institutional ethics committee

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