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Original Research Article

Analyzing intra-abdominal pressures and outcomes in patients undergoing laparotomy

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ABSTRACT

Background: Despite the abundance of knowledge, IAH still remains strangely under-diagnosed. A national postal questionnaire in United Kingdom reported that despite widespread awareness of IAH and the ACS, many intensive care units never measure the IAP. The aim was to evaluate the effects of intra-abdominal hypertension and to assess whether intra-abdominal pressure is a predictor of morbidity and mortality in patients undergoing laparotomy.
Methods: This was a prospective observational study conducted in Department of General Surgery, Kamineni Hospitals, L. B. Nagar, Hyderabad, India on patients undergoing emergency and elective laparotomy, over a period of 2 years from October 2012 to October 2014. The study included 51 patients who underwent laparotomy. IAP was measured preoperatively and then post-operatively at 0, 6, 24, 48 and 72 hours. If IAP remained below 12 mmHg, measurement was discontinued after 24 hours. Duration of ICU and hospital stay, occurrence of burst abdomen, new organ function damage, need for ventilatory support and mortality in patients undergoing laparotomy were noted as outcomes.
Results: At admission, an overall 65% incidence of intra-abdominal hypertension (IAH) was observed. In this group of 33 patients, CVS dysfunction was seen in 11 patients (33.3%), Respiratory dysfunction was seen in 9 patients (27.2%) and renal dysfunction was seen in 11 patients (33.3%). At 24 hours improvement was seen in all organ dysfunctions. Number of patients with CVS, respiratory and renal dysfunction in this group of 33 patients at 24 hours was 5 (15%), 4 (12%) and 6 (18%) respectively. This signifies that along with decrease in incidence of IAH, there is concomitant decrease in incidence of organ dysfunctions and morbidity.
Conclusions: Raised intra-abdominal pressure (IAP) is associated with higher morbidity and mortality in patients undergoing laparotomy. Intra-abdominal hypertension (IAH) has detrimental effect on various organ systems and decompression leads to improvement in all the parameters.

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

INTRODUCTION

The effect of the increased intra-abdominal pressure (IAP) on various organ systems has been studied over the past century.[1] Emerson first noted the cardiovascular morbidity and mortality associated with elevated IAP in 1911.[2] IAP is the pressure concealed within the abdominal cavity.[3] Although IAP can physiologically reach elevated values transiently up to 80 mmHg (cough, Valsalva maneuver, weight lifting, etc), these values cannot be tolerated for long periods.[4,5]

Intra-abdominal hypertension is defined as a ‘‘sustained or repeated pathological elevation in intra-abdominal

pressure (IAP) ≥ 12 mmHg,'' whereas Abdominal compartment syndrome (ACS) is defined as ''sustained IAP > 20 mmHg (with or without an Abdominal perfusion pressure < 60 mmHg) that is associated with new organ dysfunction/ failure".[6]

Normally IAP is approximately 5-8 mmHg. The presence of IAH is associated with an 11-fold increase in mortality compared with patients without IAH.[7] The detrimental effects of IAH occur long before the manifestation of compartment syndrome. The ACS, therefore, should be viewed as the end result of a progressive, unchecked increase in IAP from a myriad of disorders that eventually leads to multiple organ dysfunctions.[1] Rapid progression of IAH leads to ACS. Elevated IAP produces multiple derangements in both intra- and extra-abdominal organs. While adverse effects on kidneys and lung have been well recognized, subsequent studies have documented an impact on virtually every organ except the adrenal glands.[8]

Surgical decompression through a midline laparotomy or decompressive laparotomy remains the sole definite therapy for ACS.[9] The effects of decompressive laparotomy have been poorly investigated, and only a small number of studies report its effect on parameters of organ function. Although IAP is consistently lower after decompression, mortality remains considerable.[9]

But there are always two sides to a coin, and IAP is no different. The beneficial effect of raised IAP has been reported in a study that found that intra-peritoneal chemotherapy with increased IAP, in comparison with conventional IP or IV chemotherapy, improved the tumor accumulation and the antitumor effects of Cisplatin.[10]

Despite the abundance of knowledge, IAH still remains strangely under diagnosed. A national postal questionnaire in United Kingdom reported that despite widespread awareness of IAH and the ACS, many intensive care units never measure the IAP.[11] Hence, we should endeavor to increase the awareness and make an attempt to decrease the morbidity and mortality due to this problem.

METHODS

This was a prospective observational study conducted in Department of General Surgery, Kamineni Hospitals, L. B. Nagar, Hyderabad, India on patients undergoing emergency and elective laparotomy, over a period of 2 years from October 2012 to October 2014.

Inclusion criteria

- Age ≥ 18 years
- Patients undergoing laparotomy.

Exclusion criteria

- Pregnant females
- Patients in whom catheterization was not required
- Patients with bladder pathology
- Patients with previous established co-morbidities.

Methodology

The study included 51 patients who underwent laparotomy in our hospital. Patients were included in the study only after a decision to operate upon him/her was taken for a particular indication. IAP was measured preoperatively and then post-operatively at 0 hours, 6 hours, 24 hours, 48 hours and 72 hours.

If IAP remained below 12 mmHg, measurement was discontinued after 24 hours. Duration of ICU and hospital stay, occurrence of burst abdomen, new organ function damage, need for ventilatory support and mortality in patients undergoing laparotomy were noted as outcomes.

Noted parameters

- Blood pressure
- Pulse rate
- Respiratory rate
- Oxygen saturation (SpO_2)
- Urine output
- Blood urea
- Serum creatinine
- Intra-abdominal pressure
- Operative findings
- Duration of surgery
- Duration of ICU and Hospital stay
- Need for ventilatory support
- Morbidity (burst abdomen, new organ-system dysfunction)
- Mortality.

Measurement of intra-abdominal pressure

The abdominal pressure was indirectly determined by measuring urinary bladder pressure by a Foley's catheter. Patient was catheterized with a 16-guage Foley's catheter.

The bladder was drained and then filled with 25 ml of sterile saline through the Foley's catheter. The tubing of the collecting bag was clamped. The catheter was connected to a saline manometer.

The symphysis pubis was the zero reference, and pressure measured in cm of water at end-expiration. A conversion factor of 1.36 was used to convert pressure into mmHg.

Interpretation

Grading of intra-abdominal hypertension

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

The term "abdominal compartment syndrome" was used when Intra-abdominal pressure > 20 mmHg was associated with at least one newly developed organ system dysfunction. In patients with ACS, the decision to proceed with decompressive laparotomy was in the hands of the primary surgeon in charge of the patient.

Organ system derangements

Cardio-vascular system

Blood pressure < 90 mm of Hg systolic and heart rate > 100 / min.

Respiratory system

Respiratory rate > 20/min and SpO_2 < 90% or patient required ventilatory support.

Renal

Blood urea > 40 mg%, serum creatinine > 1.4 mg%, urine output < 30 ml/hr, any two or all of the above.

The data was analyzed and calculated in terms of mean, standard deviation and percentage. Mean IAP was calculated at various intervals for the study population and its effects were seen in terms of various morbidities and mortality.

RESULTS

A total of 51 patients were included in this study. Out of these, there were 39 men and 12 women (M: F: 3:1).

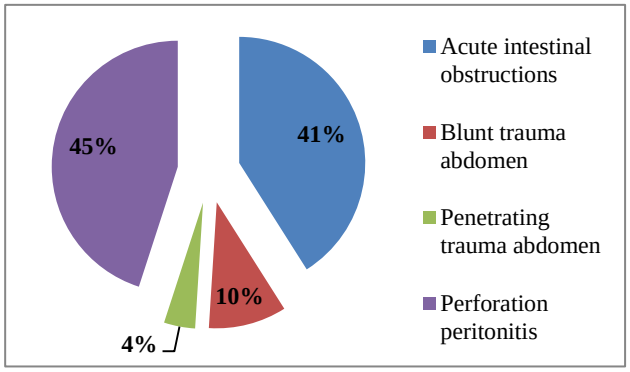

Figure 1: Various indications of laparotomy in study population.

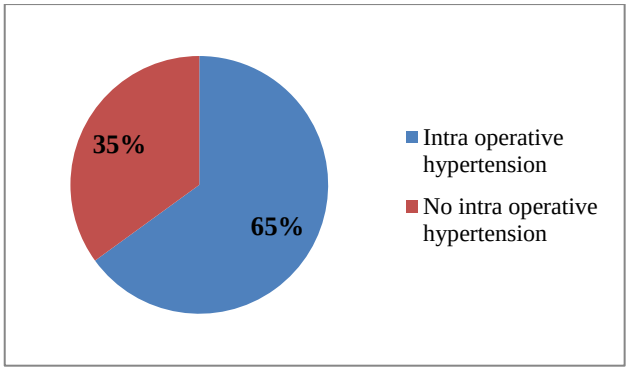

Figure 2: Incidence of intra operative abdominal hypertension in study population.

65 % of the patients presented with intra-abdominal hypertension while 35% of the patients were having intra-abdominal pressure less than 12 mmHg.

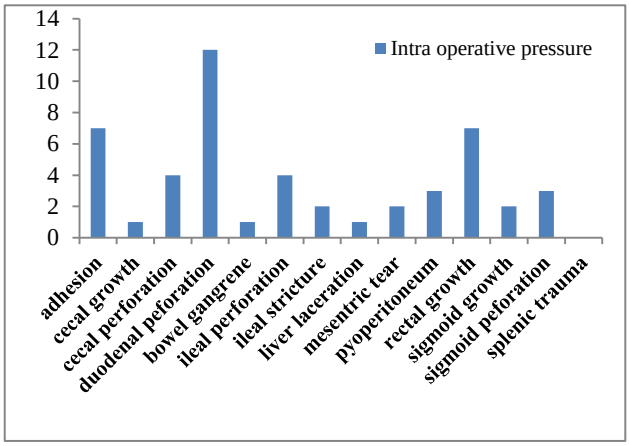

Figure 3: Intra-operative findings in patients.

Table 1: Post-operative intra-abdominal pressure grading.

	IAP at 6 hours	IAP at 24 hours
Incidence	8%	8%
Pre-operative CVS dysfunction	75%	75%
Pre-operative respiratory dysfunction	50%	50%
Pre-operative renal dysfunction	100%	100%
CVS dysfunction at 24 hours	75%	75%
Respiratory dysfunction at 24 hours	75%	50%
Renal dysfunction at 24 hours	100%	100%
Ventilator	50%	25%
Prolonged hospital stay	75%	75%
Prolonged ICU stay	100%	75%
Burst abdomen	25%	25%
Abdominal compartment syndrome	00	25%
Mortality	25%	25%

Most of the cases presented to us were perforation peritonitis and the most common finding was a duodenal perforation. We had a good number of cases of large bowel malignancies presenting as obstruction. Other common cases were adhesions due to previous surgeries and small bowel perforation.

No IAH was observed at 0 hours post-op. At 6 hours, 4 out of 51 patients had IAH i.e. ~ 8%. Out of 4 patients, 3 were males. All 4 cases were of Intestinal obstruction out of which 3 patients continued to have intra-abdominal hypertension at 24 hours also. Preoperatively, out of these 4 patients, 3 had CVS dysfunction, 2 had respiratory dysfunction and all 4 had renal dysfunction. These patients when followed at 24 hours, 3 had CVS and respiratory dysfunction while all 4 had renal dysfunction. Prolonged ICU stay was seen in all 4 cases while prolonged hospital stay was seen in 3 out of 4 cases. 2 cases required ventilatory support while one of them had burst abdomen and 1 patient expired.

Table 2: Organ system dysfunctions.

Organ system dysfunction	Pre operatively	Post operatively
CVS dysfunction	15 (29.5%)	07 (13.7%)
Renal dysfunction	14 (27.4%)	07 (13.7%)
Respiratory dysfunction	12 (23.5%)	05 (9.8%)

Cardiovascular dysfunction reduced from 30% patients pre-operatively to 14% at 24 hours post operatively. Renal dysfunction was reduced from 27% patients pre-operatively to 14%. Respiratory dysfunction was reduced from 23% patients pre-operatively to 10%.

Table 3: Incidence of various morbidities and mortality.

Various morbidities	Number	Percentage
Prolonged hospital stay	24	47
Prolonged ICU stay	20	39.2
Burst abdomen	02	3.9
Ventilatory support	04	7.8
Death	02	3.9

Prolonged hospital stay was the most common in 47% of cases followed by prolonged ICU stay in 39.2% of cases. Death rate was only 3.9%.

Table 4: Mean IAP in various cases.

Various cases	pre operatively	post operatively
Burst abdomen	19.8	15
Ventilator support	18.7	12.4
Death	25.7	18

Mean IAP significantly reduced post operatively in all cases

DISCUSSION

Most of the studies on IAH and ACS analyze either trauma or ICU patients. Little has been reported on IAH in non-traumatic surgical population. Our study population was a group of patients who underwent laparotomy for various indications which included traumatic as well as non-traumatic causes. There were 39 (76%) males and 12 (24%) females. A similar ratio was seen in the studies by Hong et al (72% males), Meldrum et al (70% males) and Khan et al (76% males).[12-14]

The mean±standard deviation (range) age in our study was 43.6±17.4 (range 18-80) years. Most of the studies report the mean age to be higher than what we observed. Similar age distribution was seen in studies done by Hong et al 42 years, Cheatham et al 51±19 years, Meldrum et al, 39±9 years, Khan et al 35±15 years.[13-15] Most of the patients were in range of 21-30 years. Of the 51 patients, there were 7 (14%) trauma patients. This is in contrast to the study by Cheatham et al who had 68% trauma patients in their study group.[15] This can be explained by the population selected for the study. Their patients were those who critically ill and required ICU care hence a predominance of trauma patients, while our sample included all those who underwent laparotomy, hence a predominance of general surgical patients. Study by Khan et al had similar number of trauma patients (19%).[14]

In the trauma group, the injury mechanics was blunt in 5 (70%) and penetrating in 2 (30%) patients. Meldrum et al reported 60% blunt injuries.[13] This reflects the demographic variations in the study population. In developing countries, injuries due to assault are a major contributor of trauma patients. These are mostly gunshots or stab injuries. While in developed countries, road traffic accidents are the most common cause of trauma, hence higher incidence of blunt injuries.

The mean IAPs before and after laparotomies were 19.7±5.4 mmHg and 6.4±2.6 mmHg respectively in the patients who had IAH at admission (33 patients). The mean (S.D) IAPs in the study group of Sugrue et al before and after decompression were 16.6 (9.4) mmHg and 10.3 (3.1) mmHg respectively.[6] Meldrum et al reported higher values of IAP (S.D) pre- and post-op: 27 (2.3) and 14 (4.6) mmHg respectively.[13] This can be explained by the observation that in our study, 86 % of the patients had perforation peritonitis and Intestinal obstruction leading to elevated IAP which, after decompression and removal of litres of fluid and gas, returned to normal level immediately.

Though many of our patients at admission had elevated IAP along with multiple organ dysfunctions they could not be identified as cases of primary ACS as the baseline

data on their organ system functions was not available. However, we selected patients without previous existing co-morbid conditions, which help in decreasing the bias in results which might have occurred in terms of morbidity. In the subgroup of patients with Intra-abdominal hypertension at admission, associated renal dysfunction was seen in 11 (33.3%) patients and elevated IAP was found to have detrimental effect on blood urea, serum creatinine and urine output. Sugrue et al reported renal impairment in 20 (69%) patients of IAH.[7] There was no IAH seen in immediate post-operative reading implying that no closure was done under tension.

There was significant improvement seen in cardio-vascular, renal and respiratory systems following laparotomy in patients who had pre-op IAH associated with organ system derangements. The mean (S.D.) pre- and post-op values of Urine Output in our pre-op IAH patients were 42.9 (12.5) and 50.4 (15.8) ml/hr. respectively, and that of serum creatinine was 1.6 (0.8) and 1.4 (0.6) mg/dl respectively. Sugrue et al reported mean (S.D.) pre- and post-op values of urine output to be 1399 (617) and 1770 (870) ml/24 hours and that of serum creatinine to be 151 (86) and 128 (70) µmol/ L respectively.[7]

The incidence of IAH in our study was 65% at admission and 8 % at 6 hours and 24 hours post-op. The incidence of post-op ACS was 1.9%. The incidence of IAH and ACS reported by various studies ranges from 2 - 78% and 0.5-36% respectively, and depends on the population and the values used to define these entities.[16] The lower incidence observed was because this study includes low-risk as well as high risk patients, whereas most of the previous studies confined data collection to high risk patients. While the latter approach ensures a good yield of patients with ACS, it may result in a very high incidence compared with that seen clinically in general population overall. Furthermore, such an approach potentially misses those patients who are not at high risk, and yet may have multiple organ dysfunction syndrome (MODS) falsely attributed to sepsis or irreversible shock when in fact patients, this study obtained true overall incidence. This may be further signified by larger study groups.

At 24 hours, 4 out of 51 patients had IAH i.e. ~8%. 3 out of these 4 patients were having intra-abdominal hypertension at 6 hours. Out of 4 patients, 3 were males. 3 cases were of intestinal obstruction and 1 case was perforation peritonitis. Preoperatively, out of these 4 patients, 3 had CVS dysfunction, 2 had respiratory dysfunction and all 4 had renal dysfunction. At 24 hours, 3 had CVS dysfunction, 2 had respiratory dysfunction and all 4 had renal dysfunction. Prolonged ICU stay and prolonged hospital stay was seen in 3 out of 4 cases.

1 case required ventilatory support while 1 of them had burst abdomen, 1 had abdominal compartment syndrome and 1 patient expired. Cheatham et al had found that elevated IAP alone does not have sufficient sensitivity or specificity to be useful as a predictor of mortality. However, in our patients we have higher morbidity and mortality in patients with intra-abdominal hypertension.[15]

In a retrospective study of patients with secondary ACS, overall mortality was 60%, with 43% mortality for those decompressed.[17] The mortality despite decompression could have been due to early fulminant MODS or delay in decompression as the IAP readings were taken at 0 and 6 hours post-op with no reading in between. Hence a more frequent IAP monitoring is recommended, at least in high-risk patients, as IAP measurement is simple and easy to perform. Also it has high reproducibility and is minimally invasive.

CONCLUSION

Raised intra-abdominal pressure (IAP) is associated with higher morbidity and mortality in patients undergoing laparotomy. Intra-abdominal hypertension (IAH) has detrimental effect on various organ systems and decompression leads to improvement in all the parameters. The diagnosed cases of post-op abdominal compartment syndrome (ACS) have high mortality. Organ dysfunction caused by intra-abdominal hypertension may be under recognized because it usually affects patients who are significantly unwell and whose dysfunction may be falsely attributed to the progression of primary illness. Constant vigil and a more frequent monitoring of IAP with prompt decompression may be helpful in decreasing the morbidity and mortality.

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