e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(6); 220-224

Original Research Article

Investigating the Incidence and Impact of Intra- Abdominal Hypertension and Abdominal Compartment Syndrome in Emergency Laparotomy Patients

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Received: 21-03-2024 / Revised: 23-04-2024 / Accepted: 29-05-2024
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Conflict of interest: Nil

Abstract

Background: Although initially recognized over 150 years ago, the patho-physiologic implications of elevated intra- abdominal pressure (IAP) have essentially been rediscovered only within the past two decades. The aim of the study was to evaluate the incidence, morbidity and mortality of intra-abdominal hypertension and abdominal compartment syndrome in emergency laparotomy patients in tertiary care rural hospital.

Method: IAP measurement was done in all patients undergoing emergency laparotomy with manometry technique (U tubetechnique) using per- urethral foley's catheterization.

Results: Our study population was a group of patients who underwent laparotomy for various indications which included traumatic as well as non-traumatic causes. In total, 104 patients, with 30 females and 74 males were included in the study population who fulfilled the study criteria. The mean ± SD age in our study were 40.2±13 years with 20-30yrs being the most common age group. Most of the studies on IAH and ACS analyse either trauma or ICU patients. Little has been reported on ACS in general 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, hence a predominance of general surgical patients.

Conclusions: Findings suggest that the incidence of ACS in our study is 3.84 % and found to be more common in trauma patients. There is significant association between increased Intra-abdominal pressure at 6 and 24 hours after laparotomy and organ dysfunction. The total mortality rate in ACS group was 75%. There is significant association between increased Intra-abdominal pressure and mortality.

Keywords: Morbidity, Mortality, Laparotomy.

Introduction

Acute Compartment Syndromes as a result of increased pressure in the myofascial compartment of extremities are well recognised. Once diagnosed, treatment by compartment decompression is necessary to avoid complications [1]. In recent years compartment syndromes associated with raised intraabdominal pressure has been recognised and treated by decompression. Effect of increased IAP in various organ systems has been studied over the past centuries. Historically, some effects of raised IAP were reported as far back as nineteenth century. In 1911, the literature was reviewed by Emerson. It was noted that if IAP was raised above the range of 19-33 mmHgin small animals (cats & guinea pigs) then death from respiratory failure ensued. He also concluded that excessive IAP diminishes venous return to the heart, resulting in cardiovascular failure [2]. In 1948, Gross [3]noted that closing the abdominal wall in neonates with large omphaloceles was frequently followed by respiratory and cardiovascular failure and subsequently death. It was postulated that this was due to 'abdominal crowding'. Bradley and Bradley [4] measured renal plasma flow and glomerular filtration rate and monitored pressures in the inferior vena cava and renal veins while manipulating IAP and concluded that decreased renal plasma flow and GFR are seen with increased IAP. Baggot[v]in 1951 described the clinical effects of abdominal wound closure under tension after dehiscence. He also noted the similarly high mortality was associated with analogous procedures in adults with high tension repairs of acquired abdominal wall defect. More recently with increasing number of laparoscopic procedures, the adverse effects of raised IAP, particularly on the cardiovascular system have been widely reported [6].

IAH has been identified as a continuum of

pathophysiologic changes beginning with regional blood flow disturbances and culminating in frank end-organ failure and the development of ACS. Previously present, but significantly under-appreciated, IAH and ACS are now recognized as common occurrences in the intensive care unit (ICU) setting.

Intra-Abdominal Pressure (IAP):

IAP is defined as "thesteady-state pressure concealed within the abdominal cavity". The normal IAP is 0-5 mmhg in healthy patients. The abdomen can be considered a closed box with walls either rigid (costal arch, spine, and pelvis) or flexible (abdominal walland diaphragm) behaving in accordance to Pascal's law. The elasticity of the walls and the character of its contents (volume of viscera, ascites, spaceoccypying lesions) directly determine the IAP. IAP increases withinspiration (diaphragmatic contraction) anddecreases with expiration (diaphragmatic relaxation). The mean IAP in critically ill adults is approximately 5-7mmhg.

Intra-Abdominal Hypertension (IAH)

IAH is sustained or repeated pathological elevation of IAP of 12mmhg or greater. A modification of the original Burch et al. grading system is appropriate to stratify patients with elevated IAP and guide clinical treatment[8].

• Grade I: IAP 12-15 mmHg

• Grade II: IAP 16-20 mmHg

• Grade III: IAP 21-25 mmHg

• *Grade* IV*: IAP >25 mmHg*

Abdominal Compartment Syndrome (ACS)

ACS is the natural progression of pressure-induced end-organ changes. ACS is defined as a sustained IAP >20 **mmHg** (with or without an APP <60 mmHg) that is associated with new organ dysfunction/failure. The generally accepted *"triad"* of ACS is: (a) a pathologicalstate caused by an acute increase in IAP above 20mmHg which (b) adversely affects end-organ function or can cause serious wound complications, and in which (c) abdominal decompression has beneficial effects[8].

Abdominal Perfusion Pressure (APP): Directly analogous to the concept of cerebral perfusionpressure is abdominal perfusion pressure (APP). Abdominal perfusion pressure (APP) calculated as mean arterial pressure (MAP) minus IAP (APP=MAP - IAP) has been proposed as a more accurate *predictor of visceral perfusion* and a potential endpoint for resuscitation [9]. A target APP of at least 60 mmHg has been demonstrated to correlate with improved survival from IAH and ACS [9, 10].

Morbidity and mortality

Cheatham *et al*. had found that elevated IAP alone does not have sufficient sensitivity or specificity to beuseful as a predictor of mortality[12]. But in our patients, elevated IAP pre-op, post-op at 6 hours and 24 hours was found to independently predict the occurrence of death ($P< 0.001$).

The mortality rate in pre-op IAH group was found to be 5% while that in ACS group was 75%. The mortality associated with ACS as shown in literaturs is 100%[11] compared, supporting the view that ACS, if left untreated, is having a high mortality rate indicating that a patient of ACS is salvageable only till the organ dysfunction is in a reversible phase.

Materials and Methods

This was a prospective observational study conductedin Department of General Surgery, at NMCH, Jamuhar, Sasaram.

Exclusion Criteria

1. Pregnant patients.
2. Patients in whom urethral catheterization was not possible and having SPC.
3. Patient not willing for surgical intervention.
4. Patients refusing consent for participation in study.

IAP measurement was done in all patients undergoing emergency laparotomy with manometry technique (U tube technique) using per- uretheralfoleys catheterization.

Interpretation

Grading of intra-abdominal hypertension

1. Grade I: 12–15 mm Hg;
2. Grade II: 16–20 mm Hg;
3. Grade III: 21–25 mm Hg; and
4. Grade IV: >25 mm Hg.

Cardiovascular system

1. Blood pressure <80 mm Hg systolic or
2. heart rate > 100/minute or

Respiratory system

1. Respiratory rate > 24/minute or
2. SpO_2< 90% or
3. the patient requires ventilatory support

Renal

1. serum creatinine > 1.5 mg% or
2. urine output <500 ml/24 hour

Results and discussion

Our study population was a group of patients who underwent laparotomy for various indications which included traumatic as well as non-traumatic causes. In total, 104 patients, with 30 females and 74 males were included in the study population who fulfilled the study criteria. The mean ± SD age in our study

were 40.2±13 years with 20-30yrs being the most common age group.Most of the studies on IAH and ACS analyse either trauma or ICU patients. Little has been reported on ACS in general 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, hence a predominance of general surgical patients.

Table 1: Comparisons of various variables in different studies are depicted in the following table:

Variables	Meldrum et al.[14]	Shehtaj Khan et al.[11]	Hong et al.[13]	Our study
Mean age (years)	39 ± 9	34.78±14.9	42	40.2±13
Sex Male: Female (%)	70: 30	76:24	72:28	71.2:28.8
Incidence of ACS (%)	-	3.05%	11%	3.84%
Mean IAP Before laparotomy (mm Hg)After laparotomy (mm Hg)	27 ± 2.3 14 ± 4.6	18.0± 4.8 6.0±1.7	- -	13.1±1.04 7.1±1.34

In the trauma group (34 patients, 32.7%), the injury mechanics was blunt in 15 (44.11%) and penetrating in 19 (55.88%) patients. Three (8.8%) patients underwent packing. Meldrum *et al*.[15] reported 60% blunt injuries and packing in 67% cases. This reflects the demographic variations in the study population.In developed countries, road traffic accidents are the most common cause of trauma, hence higher incidence of blunt injuries in their study.

Table 2: Percentage distribution of the sampleaccording to IAH grade

IAH grade		Count	Percent
Pre-OP	No IAH	44	42.3
	Grade I	59	56.7
	Grade II	1	1.0
0 hr	No IAH	104	100.0
6 hr	No IAH	99	95.2
	Grade I	1	1.0
	Grade II	2	1.9
	Grade III	2	1.9
24 hr	No IAH	101	97.1
	Grade II	3	2.9

The mean± SD IAPs before and after laparotomies were 13.1± 1.04 mm Hg and 7.08 ± 1.34 mm Hg, respectively, in the patients who had IAH at admission. The mean (SD) IAPs in the study group of Sugrue*et al*.[15] before and after decompressions were 16.6 (9.4) mm Hg and 10.3 (3.1) mm Hg, respectively. Meldrum *et al*.[14] reported higher values of IAP (SD) pre- and post-op: 27 (2.3) and 14 (4.6) mm Hg, respectively**.** This can be explained by the observation that in our study, 41.3% of the patients had perforation peritonitis and 24 % of patient had intestinal obstruction leading to elevated IAP which, after decompression and removal of liters of fluid andgas, returned to normal level immediately.
At 6 hours post-op, five patients were found to have IAH. Of these four had one or more newly developed organ system failure and hence a diagnosis of ACS was made in them. The IAP at this point was found to have significant detrimental effect on all the organ systems. Abdominal compartment syndrome remains a major cause of mortality and morbidity despite aggressive management with advanced supportive care, and decompressive laparotomy. Most of the studies on IAH and ACS analyze either trauma or ICU patients. Little has been reported on ACS in general surgical population. Our study population was a group of patients who underwent emergency laparotomy for various indications predominantly non traumatic general surgical patients 70 out of 104 (67.30%) and traumatic 34out of 104 pts (32.7%). The mean ± SDage in our study was 40.2±13 years.

Table 3: Comparisons of various variables in different studies are depicted in the following table:

Variables	Meldrum et al.[14]	Shehtaj Khan et al.[11]	Hong et al.[13]	Our study
Mean age (years)	39 ± 9	34.78±14.9	42	40.2±13
Sex				
Male: Female (%)	70: 30	76:24	72:28	71.2:28.8
Incidence of ACS (%)	-	3.05%	11%	3.84%
Mean IAP				
Before laparotomy (mm Hg)	27 ± 2.3	18.0± 4.8	-	13.1±1.04
After laparotomy (mm Hg)	14 ± 4.6	6.0±1.7	-	7.1±1.34

In the trauma group, the injury mechanics was blunt in 15 (44.11%) and penetrating in 19 (55.88%)patients. Three (8.8%) patients underwent packing. Meldrum *et al*. reported 60% blunt injuries and packing in 67% cases[14]. This reflects the demographic variations in the study population. In developed countries, road traffic accidents are the most common cause of trauma, hence higher incidence of blunt injuries in their study. Meldrum et al. reported higher values of IAP (SD) pre- and post-op: 27 (2.3) and 14 (4.6) mm Hg, respectively[14]. Whereas in our study the mean± SD IAPs before and after laparotomies were 13.1 ± 1.04 mm Hg and 7.08 ± 1.34 mm Hg, respectively, in the patients who had IAH at admission. This can be explained by the observation that in our study, 41.3% of the patients had perforation peritonitis and 24 %of patient had intestinal obstruction leading to elevated IAP which, after decompression and removalof liters of fluid and gas, returned to normal levelimmediately.

The incidence of IAH in our study was 57.69% at admission and 4.8% at 6 hours post-op. The incidenceof post-op ACS was 3.84% in the general population, 8.8% in trauma patients, and 2.8% in non-trauma patients. The incidence of IAH and ACS reported by various studies ranges from 2 to 78% and 0.5 to 36%, respectively, and depends on the population and the values used to define these entities[11] 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 veryhigh incidence compared with that seen clinically in the general population overall. By measuring the IAP prospectively in all patients, this study obtained true overall incidence. Also, an incidence of 3.84% in general population is significant enough to warrant further investigation in this group. Cheatham *et al*. had found that elevated IAP alone does not have sufficient sensitivity or specificity to beuseful as a predictor of mortality[12]. But in our patients, elevated IAP pre-op, post-op at 6 hours and 24 hours was found to independently predict the occurrence of death (P< 0.001). The mortality rate in pre-op IAH group was found to be 5% while that in ACS group was 75%. The mortality associated with ACS as shown in various studies is 100% compared to in[11], supporting the view that ACS, if left untreated, is having a high mortality rate indicating that a patient of ACS is salvageable only till the organ dysfunction is in a reversible phase.

Conclusion

Incidence of ACS in our study is 3.84 % and found to be more common in trauma patients.

There is significant association between increased Intra-abdominal pressure at 6 and 24 hoursafter laparotomy and organ dysfunction (e.g. cardiopulmonary and renal dysfunction).

The total mortality rate in ACS group was 75%.

There is significant association between increased Intra-abdominal pressure and mortality.

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