AN OBSERVATION ON SIGNIFICANCE OF INTRA-ABDOMINAL PRESSURE WITH RESPECT TO PROGNOSIS OF ACUTE ABDOMEN CASES

Ravikant Kumar, Rohit Kumar Jha, Mrityunjay Mundu, Shital Malua, R.G. Baxla.

1. Junior Resident. Department of General Surgery, Rajendra Institute of Medical Sciences. Ranchi
2. Senior Resident. Department of General Surgery, Rajendra Institute of Medical Sciences. Ranchi
3. Assistant Professor, Department of General Surgery, Rajendra Institute of Medical Sciences. Ranchi
4. Associate Professor. Department of General Surgery, Rajendra Institute of Medical Sciences. Ranchi
5. Professor, Department of General Surgery, Rajendra Institute of Medical Sciences. Ranchi

CORRESPONDING AUTHOR:
Dr. Ravikant Kumar,
C/O dr. Shital Malua,
Department of surgery, RIMS, RANCHI
E-mail: dial4ravi@gmail.com

ABSTRACT: Increased intra-abdominal pressure is an important factor with respect to prognosis among acute abdomen cases, as most of the cases of acute abdomen have raised intra-abdominal pressure. Here we present a study about significance of IAH among patients of acute abdomen. 

AIM: To study the role of intra abdominal pressure in prognosis of acute abdomen cases.

MATERIAL AND METHODS: Intra-abdominal pressure was measured at the time of admission and on 1st post-operative day (in patients who were managed by operative interventions) indirectly by estimating intra vesicle pressure. Organ system parameters, complications and mortality were observed.

RESULTS: Intra abdominal pressure has positive impact on different organ system compromise, surgical complications and mortality in critically ill patients. The mean IAP among survivors was 14.38±5.87 mm of Hg as compared to 19.12±5.78 mm of Hg of non-survivors (p=0.0038, significant).

KEY WORDS: Intra abdominal pressure, Intra abdominal hypertension, Abdominal compartment syndrome

INTRODUCTION: Acute abdomen is one of the most common surgical cases in day to day practice. Acute abdomen cases include- Intestinal perforation, acute pancreatitis, retroperitoneal hemorrhage, and many more. Most of these cases present with distension of abdomen and are associated with increased intra-abdominal pressure. An elevated intra-abdominal pressure may lead to intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) 1.

Both intra-abdominal hypertension and abdominal compartment syndrome are etiologically related to increased morbidity and mortality of critically ill patients.

INCIDENCE OF IAH /ACS/: With increase in awareness and significant increase in the number of studies related to IAH/ACS in recent years, IAH/ACS is seen with an increasing frequency in a wide variety of critically ill patients.2 The incidence of IAH is variable, ranging from 18% to 80% of ICU patients. However it depends on the threshold used to define IAP and also on the type of population studied. Malbrain et al (2004) demonstrated in a 1-day-point prevalence study (97 patients, 13 ICUs) that 50.5% of patients had IAH and 8.2% had ACS.3 In a follow-up study with 265 mixed ICU patients, the same authors observed recently a high incidence of IAH (32.1%)4
**DEFINITIONS: INTRA-ABDOMINAL PRESSURE:** The abdomen can be considered a closed box with walls both rigid (costal arch, spine, and pelvis) and flexible (abdominal wall and diaphragm). The elasticity of the walls and the character of its contents determine the pressure within the abdomen at any given time. Since the abdomen and its contents can be considered as relatively non-compressive and primarily fluid in character, behaving in accordance with Pascal's law, the IAP measured at one point may be assumed to represent the IAP throughout the abdomen (with the rare exception of upper ACS). It is therefore defined as a steady-state pressure concealed within the abdominal cavity. IAP increases with inspiration (diaphragmatic contraction) and decreases with expiration (diaphragmatic relaxation).

**RANGE OF IAP:** Normal IAP in surgical patients ranges from sub-atmospheric to 0 mmHg. Certain physiological conditions such as morbid obesity and pregnancy may be associated with chronic IAP elevations. In the critically ill, IAP is frequently elevated above the patient's normal baseline. Recent abdominal surgery, sepsis, organ failure, the need for mechanical ventilation and changes in body position are all associated with elevations of IAP. Normal IAP is approximately 5–7 mm Hg in critically ill patients (Sanchez N et al, 2001).

**INTRA-ABDOMINAL HYPERTENSIO:** In healthy individuals, normal IAP is <5–7 mmHg. The upper limit of IAP is generally accepted to be 12 mmHg by the WCACS, reflecting the expected increase in normal pressure from clinical conditions that exert external pressure to the peritoneal envelope or diaphragm, including obesity and chronic obstructive pulmonary disease. In contrast, IAH is defined as a sustained or repeated pathologic increase in IAP >12 mmHg (Carlotti A et al, 2009).

According to the level of IAP, IAH is graded as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>IAP (mmHg)</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>12–15</td>
</tr>
<tr>
<td>II</td>
<td>16–20</td>
</tr>
<tr>
<td>III</td>
<td>21–25</td>
</tr>
<tr>
<td>IV</td>
<td>&gt;25</td>
</tr>
</tbody>
</table>

**ABDOMINAL COMPARTMENT SYNDROME (ACS)**
Critical IAP in the majority of patients appears to reside between 10 and 15 mmHg. It is at this pressure that reductions in microcirculatory blood flow and the initial development of ACS occur. ACS represents the natural progression of end-organ dysfunction, and develops if IAH is not recognized and treated appropriately. Classically, ACS is defined by the triad:

(a) Pathologic state caused by an acute increase in IAP >20–25 mmHg,
(b) Presence of adverse effects on end-organ function, and
(c) Abdominal decompression has beneficial effects

Common causes of increased IAP in surgical patients are...
Pneumoperitoneum
Abdominal (vascular) surgery, especially with tight abdominal closures
Abdominal wall bleeding or rectus sheath hematomas
Correction of large hernias, gastroschisis or omphalocele
Burns with abdominal eschars
Sepsis
Gastroparesis/gastric distention/ileus/Colonic pseudo-obstruction
Abdominal tumour
Retroperitoneal/ abdominal wall hematoma
Major burns
Liver dysfunction with ascites
Abdominal infection (pancreatitis, peritonitis, abscess
Haemoperitoneum

EFFECTS OF INCREASED IAP ON VARIOUS ORGAN SYSTEMS:

GASTROINTESTINAL SYSTEM: The effect of IAH on the splanchnic organs leads to diminished gut perfusion. The consequences of this change lead to ischemia, acidosis of the mucosal bed, capillary leak, intestinal edema, and translocation of gut bacteria. As IAP increases, pressure is placed on the arteries, capillaries, and veins in the abdominal cavity. This increased pressure causes diminished arterial blood flow to the organs and resistance to drainage into the veins.

RENAL SYSTEM: IAH leads to impaired renal function was first described by Wendt (1973)\textsuperscript{11}. Bradely and Bradely (1947)\textsuperscript{12} showed decreased glomerular filtration rate and renal plasma flow with increased IAP Persistent pressures of 15 mm Hg or greater have been independently associated with renal impairment.

PULMONARY SYSTEM: As the abdomen distends with intestinal gas, fluid, or edematous organs, the diaphragm is pushed upward, impinging on the thoracic cavity. Approximately 50\% of the IAP is dispersed across the diaphragm and affects respiration and ventilation (Malbain et al, 2009).\textsuperscript{13} Pulmonary dysfunction may be one of the earliest signs of ACS (Ivatury et al, 2006).\textsuperscript{14} Because the lungs cannot expand fully, respiratory excursion is limited, thereby reducing inhaled tidal volume, leading to hypoxemia. Conversely, carbon dioxide is retained, causing hypercarbia and respiratory acidosis.

CARDIOVASCULAR SYSTEM: One significant effects of IAH is the effect of the abnormality on the cardiovascular system. The increased intrathoracic pressure compresses the heart and major vessels, causing a tamponade-like effect, especially with the higher grades of IAH. Central venous pressures (CVPs) and pulmonary artery wedge pressures (PAWPs) are falsely elevated because of the effects of IAH (Ivatury et al, 2006).\textsuperscript{14} These elevations may lead clinicians to false impression that a patient is volume loaded or overloaded. The components of cardiac output (i.e., preload, afterload, and contractility) are all adversely affected by increased IAH.\textsuperscript{14}
CENTRAL NERVOUS SYSTEM: Increased intrathoracic pressure puts back pressure on the jugular veins and decreases drainage of cerebrospinal fluid and blood, leading to increased intracranial pressure (Ropper AH et al, 2009). In patients with increased intracranial pressure, the effects of IAH can cause a further increase in the pressure in the cranium and decrease cerebral perfusion pressure.

MATERIAL AND METHODS: The study was carried out in the Department of general surgery, Rajendra Institute of Medical Sciences, Ranchi. The period of data collection was from September 2010 to September 2012. The cases selected were acute abdomen cases with abdominal distension.

INCLUSION CRITERIA: all patients between ages 15-65 years either male or female with acute abdomen, which presented with abdominal distension was included in the study. Family members gave informed consent.

EXCLUSION CRITERIA: Patients of age groups below 15 years & above 65 years, Patients who were known cases of any malignancy and Acute abdomen cases which presented without abdominal distension were excluded from the study.

METHODOLOGY: Detailed history was taken and clinical examination was done in every case. Blood samples was taken at time of admission and sent for complete blood count, serum electrolytes, Liver function tests, renal function test and special blood investigations as per need of patients. Patients were managed as per hospital protocols by conservative or operative methods according to disease of patients. Conservative management also included intraperitoneal drain insertion in patients of intestinal perforation with very poor general condition. Informed consent was taken from each patient/relatives.

There are various ways to measure intra-abdominal pressure.

1. Direct: measurement of intra-abdominal pressure directly through a manometer directly connected to abdominal cavity.
2. Indirect: measurement of intra-abdominal pressure by estimating
   a. intravesical pressure through Foley’s catheter
   b. intragastric pressure through nasogastric pressure
   c. inferior vena caval pressure
   d. femoral vein pressure

In the present study intra-abdominal pressure was measured indirectly by estimating intravesical pressure through a Foley’s catheter.
Figure 1: Measurement of IAP by water column

Technique followed was to instill 50-70 ml of normal saline in empty bladder. Distal end of the catheter was clamped and a needle was inserted proximal to the clamp and attached to a manometer made of water column. Manometer measurement was in centimeters of water, the zero point being the pubic symphysis. The reading was converted in mm of Hg with multiplying factor of 0.73.17

Intra-abdominal pressure was measured at the time of admission and on 1st post-operative day (in patients who were managed by operative interventions). During study following parameters of patients were monitored:

1. Cardiovascular compromise in terms of: Pulse Rate > 100/min and Systolic blood pressure (< 90 mm of Hg)
2. Respiratory compromise in terms of: Incidence of Tachypnea, Incidence of Dyspnea and 02 saturation less than 90%
3. Excretory system compromise in terms of: Decreased Urine output (< 0.5 ml/kg/hr) and Raised Blood urea and serum creatinine levels
4. Incidence of post-operative complications: Wound dehiscence, Anastomotic leak and Septicemia
5. Incidence of mortality.

The results of above observation was analyzed, by calculating relative risk and odds ratio, using chi-square test, t-test and ‘p’ value <0.05 was considered significant.

Observation and Results: 61 patients with acute abdomen admitted from surgical emergency of RIMS, fitting in our inclusion criteria, IAP was monitored. Out of 61 cases studied 37 were males constituting a percentage of 60.65% and 24 were female (39.94%). The male to female ratio was about 1.5:1. Majority of the cases in the study were of age more than 36 years. The maximum incidence was found in age group 46-55 years (27.86%). Minimum proportion of cases was from age group 15-25 years comprising 10% of total cases. Disease profile of the patients in the study was intestinal perforation, intestinal obstruction, acute pancreatitis, blunt abdominal trauma and obstructed inguinal hernia. Maximum number of the patients was of intestinal perforation comprising about 40% of total (24 cases). In this group most patients were having duodenal
perforation (12 cases) followed by ileal perforation (7 cases), gastric perforation (3 cases) and jejunal perforation (2 cases). 18 patients were having intestinal obstruction due to various reasons. 9 patients were of acute pancreatitis, 7 of blunt abdominal trauma and 3 were having obstructed inguinal hernia. 8 cases in the study were having IAP in normal range. Most cases having raised IAP were having grade 1 or grade 2 intra-abdominal hypertension. Overall incidence of IAH in study group was about 86%. Out of 61 cases 23 cases were managed conservatively. Conservative management also included intra peritoneal drain placement in cases of intestinal perforation with poor general condition.

Table 1: clinical profile of patients

<table>
<thead>
<tr>
<th>Range of IAP (in mm of Hg)</th>
<th>total No. of patients</th>
<th>No. of patients with pulmonary compromise</th>
<th>No. of patients with cardiovascular compromise</th>
<th>No. of patients with renal compromise</th>
<th>No. of patients managed by normalization of IAP after operation</th>
<th>No. of patients developed respiratory compromise</th>
<th>No. of patients developed cardiovascular compromise</th>
<th>No. of patients expired</th>
<th>No. of patients Postoperative complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-11 (normal)</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12-15 (grade 1 IAH)</td>
<td>20</td>
<td>13</td>
<td>11</td>
<td>10</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>16-20 (grade 2 IAH)</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>12</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>21-25 (grade 3 IAH)</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>&gt; 25 (grade 4 IAH)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>55</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>45</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>30</td>
<td>16</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

IAP: Intra abdominal pressure, IAH: Intra abdominal hypertension

In all patients in the study cardiovascular parameters were monitored clinically (pulse rate, blood pressure). Those patients, in which pulse rate more than 100 per minute and/or systolic blood pressure ≥90 mm of Hg was present, were considered having cardiovascular compromise. 40 out of total 61 cases (65.57%) were having cardiovascular compromise. In all patients included in the study respiratory rate, presence or absence of dyspnea, \( O_2 \) saturation was noted. Any patients with one or more of the following conditions were considered having respiratory compromise:
- Tachypnea (respiratory rate greater than 20)
- Presence of dyspnea
- \( O_2 \) saturation less than 90%

45 out of total 60 patients (75%) developed respiratory compromise. The relative risk of these compromise with above normal IAP was 3.24 (odds ratio12.9, p=0.034 significant). The relative risk of respiratory compromise was increased from 2.6 in grade 1 IAH to 4 in grade 4 IAH. Patient’s
urine output was measured from time of admission to 1st 24 hours (in patients who did not survive the average urine output till patient survived) was monitored. Blood urea and serum creatinine levels were measured from blood samples taken at the time of admission. If average urine output was less than 0.5 ml/kg/hr or blood urea and serum creatinine levels were deranged patients were considered having renal compromise. In present study 40 out of total 61 patients (65.57%) developed these complications.

Patients in which surgical interventions were done a second measurement of IAP were done on 1st post operative day. Post operative IAP was matched with IAP at time of admission and improvement (to normal range IAP) was noted. In 30 out of 38 operated patients (78.94%) improved IAP was noted.

Patients who were operated, were observed for post operative complications like wound dehiscence, anastomosis leak and septicemia. Most common complication observed was wound dehiscence (8 cases) followed by septicemia (5 cases) and duodenal perforation leak (3 cases). 16 out of 38 operated patients (42.1%) developed these complications. The relative risk of development of these complications was 2.33 as compared with cases having normal IAP values (odds ratio 3.33, p=0.55, not significant). The association may be insignificant due to other factors like age of patients and other comorbid conditions. However the relative risk was increased from 1.86 in grade 1 IAH to 4 in grade 4 IAH.

Overall incidence of mortality was 34% (21 cases). However it was more in cases of IAH. the relative risk of death as compared with cases having normal IAP was 3.01. The relative risk gradually increased from 2.66 in grade 1 IAH to 4.44 in grade 4 IAH. The mean IAP among survivors was 14.38±5.87 mm of Hg as compared to 19.12±5.78 mm of Hg of non-survivors.

DISCUSSION: Mean IAP of cases was 15.86 ±SD 6.157mm of Hg. Overall incidence of intra-abdominal hypertension in study group was 86%. The incidence of IAH is variable, ranging from 18% to 80% of ICU patients. However it depends on the threshold used to define IAP and also on the type of population studied. Malbrainet al3 (2004) demonstrated in a 1-day-point prevalence study (97 patients, 13 ICUs) that 50.5% of patients had IAH and 8.2% had ACS. Maria V et al18 (2004-05) in their study of incidence and clinical effects of IAH in critically ill patients in a heterogeneous intensive care unit population, observed that occurrence of IAH for the whole group was 64%. High incidence of IAH in my study group of my case may be due to difference in patient population (disease profile) included for the study.

40 out of total 61 cases (65.57%) were having cardiovascular compromise. The overall relative risk of cardiovascular compromise in patients with raised IAP was 2.86 (odds ratio 7.6, p=0.0284 {significant}) as compared with cases having normal IAP. The relative risk of cardiovascular compromise increased from 2.2 in grade 1 IAH to 4 in grade 4 IAH. According to prospective study of Shehtaj K et al19 (2010) conducted at Jawaharlal Nehru medical college hospital, Aligarh among 197 patients using same parameters, the relative risk of development of cardiovascular complications was 1.30 (odds ratio 2.35).
CASE SERIES

Figure 2: Incidence of organ system complications according to IAH

Grade, IAH: Intra abdominal hypertension

45 out of total 60 patients (75%) developed respiratory compromise. The relative risk of these compromise with above normal IAP was 3.24 (odds ratio 12.9, p=0.034 significant). The relative risk of respiratory compromise was increased from 2.6 in grade 1 IAH to 4 in grade 4 IAH. Obeid et al (1995) measured the dynamic compliance of patients undergoing laparoscopic cholecystectomy before and during the procedure. They demonstrated significant decreases in dynamic compliance and pulmonary function at 16 mm Hg IAP. According to prospective study of Shehtaj Khanet al (2010) among 197 patient using same parameters, the relative risk of development of pulmonary complications was 1.51 (odds ratio 2.33).

In present study 40 out of total 61 patients (65.57%) developed renal complications. The relative risk of development of renal compromise was 3.01 as compared with cases having normal IAP values (odds ratio 9.2, p=0.0284 {significant}). The relative risk was increased from 2.2 in grade 1 IAH to 4 in grade 4 IAH. Maria GV et al (2008) in their study of incidence and clinical effects of IAH in critically ill patients done in 2004 to 2005 studied the epidemiology and outcomes of intra-abdominal hypertension in a heterogeneous intensive care unit population. The occurrence of IAH for the whole group was 64%, renal dysfunction/failure was found in 58% of IAH group and 27% of non IAH group. Lidia et al (2008) in their study of IAH and acute renal failure in critically ill patients done in 2007, of 123 patients, 37 (30.1%) developed IAH. Twenty-three patients developed ARF (with an overall incidence of 19%), 16 (43.2%) in IAH and 7 (8.1%) in non-IAH group, and concluded that in critically ill patients IAH is an independent predictive factor of ARF at IAP levels as low as 12mmHg, although the contribution of impaired systemic hemodynamics should also be considered. The high incidence of renal complications in our case (64.15) in our study may be due to high incidence of IAH in study group.

Patients in which surgical interventions were done a second measurement of IAP were done on 1st post operative day. Post operative IAP was matched with IAP at time of admission and improvement (to normal range IAP) was noted. In 30 out of 38 operated patients (78.94%) improved IAP was noted (p=0.034, significant). This implies that surgery had definite role in
management of cases of IAH. The incidence of post operative IAH was 21%. However the incidence gradually increased with increase in IAP (0% in grade 1 IAH to 60 % in grade 4 IAH). Shehtaj Khanet al (2010) did a prospective study of IAP in trauma patients undergoing laparotomy. The incidence of post-op ACS was 3.05% in the general population and 13.16% in trauma patients having pre-operative raised IAP. The mortality rate for this subgroup was 100%.

Patients who were operated, were observed for post operative complications. Overall 42.1% of operated patients developed these complications. The relative risk of development of these complications was 2.33 as compared with cases having normal IAP values (odds ratio 3.33, p=0.55, not significant). The association may be insignificant due to other factors like age of patients and other co-morbid conditions. However the relative risk was increased from 1.86 in grade 1 IAH to 4 in grade 4 IAH.

![Figure 3: Incidence of mortality in relation to IAP](image)

(IAP: Intra abdominal pressure, IAH: Intra abdominal hypertension)

Overall incidence of mortality was 34%. However it was more in cases of IAH. The relative risk of death as compared with cases having normal IAP was 3.01. The relative risk gradually increased from 2.66 in grade 1 IAH to 4.44 in grade 4 IAH. The mean IAP among survivors was 14.38±5.87 mm of Hg as compared to 19.12±5.78 mm of Hg of non-survivors (p= 0.0038, significant). Nataša Kovač et al (2003) did a prospective study in 50 patients and observed that mean IAP amongst the survivors was 15 mm Hg. It is significantly lower than the values of non-survivors according to the nonparametric statistical Kruskal-Wallis test. The median for non-
survivors was 18 mmHg (rang 6-30) and for survivors the median was 15 mmHg (rang 6-36) with significance $p < 0.009$. Malbrain et al (2005) enrolled 265 consecutive surgical and medical ICU patients to evaluate the incidence of IAH/ACS. On ICU admission, 68 per cent of patients had a normal IAP, whereas 32 per cent had evidence of IAH (IAP 12 mmHg or greater). He observed that the development of IAH during the ICU stay was an independent predictor of mortality (relative risk 1.85 [95% CI, 1.12 to 3.06; $P < 0.01$]). Reguiera et al (2008) studied medical and surgical patients admitted to the ICU with a diagnosis of septic shock. An overall ACS incidence of 40 per cent was reported (but not stratified by patient type). According to him maximal IAPs were higher in non-survivors (19.9 ± 5.6 vs 17.2±5.3 mmHg; $P <0.04$). So IAP has definite role in prognosis of acute abdomen cases and results of my study correlates with other studies.

CONCLUSION: In our study there is strong correlation of raised intra-abdominal pressure with development of cardiac, pulmonary renal impairment, surgical complications and mortality. With these finding it would be advisable to adopt a more routine approach to intra-abdominal pressure measurement in critically ill patients in view to identify the ongoing process of abdominal compartment syndrome and prevent it, as measuring intra-abdominal pressure by intravesical pressure is an easy and cost effective method.

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