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# Intra-abdominal pressure monitoring in the management of patients with blunt injury abdomen: Prospective observational study

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**Abstract**
**Background and Aim:** Abdominal trauma can result in the increase of intra-abdominal pressure (IAP) for a variety of reasons including the accumulation of blood or free fluid in the peritoneal cavity, oedema of the intestinal wall, retroperitoneal hematoma or abdominal packing for haemorrhage control. The aim was to study the role of intra-abdominal pressure (IAP) monitoring in the management of patients with blunt injury abdomen.
**Material and Methods:** Hospital based prospective observational study in 100 patients who presented to emergency medicine department later shifted to department of general surgery in Tertiary care Institute of India, over a period of 18 months. IAP was measured in emergency medicine department and ICU at presentation, that is, 0 hours, 3 hours, 6 hours, 12 hours, 24 hours, 48 hours, 72 hours and 96 hours. Parameters noted were blood pressure, pulse rate, respiratory rate, oxygen saturation (SpO2), urine output, blood urea, serum creatinine, IAP, time of presentation to hospital after injury, duration of ICU and hospital stay, need for ventilatory support, morbidity (new organsystem dysfunction) and mortality.
**Results:** Correlation between IAP and vital parameters, renal parameters at 0, 3, 6, 24 and 72 hours were found statistically significant. Observation between IAP and vital parameters, renal parameters at 12 hours all parameters are significant except IAP has weak positive correlation with DBP and this was found statistically insignificant. Hospital stay decreased as IAP increases in surgically intervened group because IAP returned to normal after surgical decompression, but this finding was statistically significant only at 72 hours in our study.
**Conclusion:** Before development of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS), the potential candidates should be offered surgical decompression at proper time.

**Keywords:** abdominal trauma, abdominal compartment syndrome, intra-abdominal hypertension, intra-abdominal pressure

## Introduction
Since 19th century, intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) have been recognized. ACS has been indicated as a complication in serious blunt abdominal trauma (BAT) for more than 50 years. It develops as a consequence of increased intraabdominal pressure (IAP) not only in abdominal trauma, but also in intestinal obstructions with serous edema of the bowels or a chronically growing ascites [1, 2].
Trauma has been called the neglected disease of modern society, despite its close companionship with man. Trauma is the leading cause of death and disability in developing countries and the most common cause of death under 45 years of age [3]. Trauma is the second largest cause of disease accounting for 16% of global burden. The WHO estimates that by 2020, trauma will be the first or second leading cause of years of productive life lost for the entire world population [4]. Pre-hospital transportation, initial assessment, thorough resuscitative measures and correct diagnosis are of utmost importance in trauma management. World over injury is the 7th cause of mortality and abdomen is the third most common injured organ. Abdominal injuries require surgery in about 25% of cases. 85% of abdominal traumas are of blunt character [5].
Abdominal trauma continues to account for a large number of trauma-related injuries and deaths. Blunt injury to the abdomen can also occur as a result of fall from height, assault with blunt objects, sports injuries, and bomb blasts [6].

Unnecessary deaths and complications can be minimized by improved resuscitation, evaluation, and treatment. Rapid resuscitation is necessary to save the unstable but salvageable patient with abdominal trauma [7].

Abdominal trauma can result in the increase of IAP for a variety of reasons including the accumulation of blood or free fluid in the peritoneal cavity, oedema of the intestinal wall, retroperitoneal hematoma or abdominal packing for haemorrhage control. Therefore the continuing hepatic haemorrhage and increasing amounts of bloody ascites found in failed non operative management can lead to an elevation in IAP. Evaluation of a patient with abdominal trauma can be a most challenging task that a surgeon may be called upon to deal with. Investigative modality can only supplement the clinical evaluation and cannot replace it in the diagnosis of blunt abdominal trauma [8].

Normally IAP is approximately 5-7 mm Hg.4 IAH is sustained or repeated pathological elevation of IAP of 12 mm of Hg or more. ACS is sustained IAP greater than 20 mm of Hg (with or without abdominal perfusion pressure less than 60 mm of Hg), associated with new organ dysfunction or failure. Even slight increase and sustained increase in intraabdominal pressure above baseline as low as 10 mm Hg, has deleterious effects on end-organ function, impairing neurologic, cardiac, respiratory, gastrointestinal, hepatic and renal homeostasis [8].

Measuring intra-vesicle pressure (indirect, non-invasive, near accurate method of measurement of IAP) and monitoring other vital parameters periodically in surgical cases with traumatic acute abdomen helps in early decision of surgical intervention and subsequently decreases mortality and morbidity. Unrecognized abdominal injury is a frequent cause of preventable death after trauma. Non operative management (NOM) is the treatment of choice for BAT since last few decades because of increased evidence of surgery related complications [8].

Non Operative Management (NOM) is the treatment of choice for BAT since last few decades because of increased evidence of surgery related complications [9, 10]. NOM consists of five therapeutic strategies to overcome IAH/ ACS, includes evacuation of intra luminal content, evacuation of intra-abdominal space occupying lesions, improvement in abdominal wall compliance, optimization of fluid administration and tissue perfusion by serially monitoring of patients with the help of different imaging techniques [11].

IAP should be measured and monitored by any standard available method, with all aseptic precautions, in all cases of blunt injury abdomen. Along with IAP, patients will be monitored meticulously for simple parameters like heart rate, blood pressure, respiratory rate, urine output because variations in these parameters can predict the impending IAH and ACS before actual rise in IAP. Despite the increase in awareness and guideline recommendations, there remains some resistance to adopting regular screening and monitoring practices. Increased attention to IAP, along with changes in the clinical management of critically ill or injured patients, have led to an exponential growth in research relating to IAH and ACS in recent years.[6] Therefore, by monitoring the intraabdominal pressure we would be able to identify patients with increased intraabdominal pressure and by intervening prevent the morbidity and mortality related to IAH and ACS.

## Material and Methods

Hospital based prospective observational study in 100 patients who presented to emergency medicine department later shifted to department of general surgery in Tertiary care Institute of India, over a period of 18 months.

Age ≥ 18 years, patients with acute blunt injury abdomen were included in the study. Patients with head and spinal injury, urinary bladder injury, history of neurogenic bladder or previous bladder surgery were excluded from the study as above conditions would cause variations in bladder pressure measurements.

Ethical approval was taken from the institutional ethical committee and written informed consent was taken from all the participants.

Sample size was calculated using formula

$$N = \frac{z^2\sigma^2}{L2,}$$

Where, N=sample size, z=1.96 at 95% CI, σ=(standard deviation)=22.8 (APACHE III score Tiwari *et al*), 7 L=6% (precision) Making it to near value sample size considered is 100. The study included patients admitted with blunt injury abdomen in our hospital.

IAP was measured in emergency medicine department and ICU at presentation, that is, 0 hours, 3 hours, 6 hours, 12 hours, 24 hours, 48 hours, 72 hours and 96 hours. Duration of ICU and hospital stay, occurrence of intraabdominal hypertension, new organ function damage, need for ventilatory support and mortality in patients of blunt trauma abdomen were noted as outcomes.

Parameters noted were blood pressure, pulse rate, respiratory rate, oxygen saturation (SpO2), urine output, blood urea, serum creatinine, IAP, time of presentation to hospital after injury, duration of ICU and hospital stay, need for ventilatory support, morbidity (new organsystem dysfunction) and mortality.

IAP was measured indirectly by estimating intra vesical pressure through a Foley's catheter. The whole procedure was carried out under aseptic precautions. In already inserted per-urethral Foleys catheter (assuming and assuring empty urinary bladder, 25 ml of normal saline (NS) instilled into bladder, sterile transparent tubing attached to it and held vertically at 90° at pubic symphysis. The length of vertical normal saline column was measured when steady. It is calculated as intra vesicle pressure in terms of cm of water and was calculated in terms of mm of Hg with help of following formula, 1 cm of water=0.736 mm of Hg. After completion of this procedure, Foleys catheter was reconnected to urobag.

Blunt injury abdomen patients were managed as per advanced trauma life support (ATLS) guidelines in our study. Patients, who were in need of assisted ventilation, were managed with mechanical ventilator. Post-operative clinical outcome was measured in terms of survival and mortality. Patients which showed impending signs and sequels of raised IAP, early surgical decompression of abdomen was performed in the form of DCS. Any of the clinical signs like tachycardia, drop in blood pressure or urine output, tachypnoea, distention of abdomen and increase in IAP were considered as signs of impending IAH. Patients who required surgical decompression (on basis of 2 consecutive findings of raised IAP in case of solid organ injury and all cases with hollow organ perforation, IAP >20 mm of Hg were considered for surgical intervention and inspite of IAP< 20 mm of Hg if vital parameters were deranged were also considered for surgical decompression of abdomen.), underwent emergency exploratory laparotomy. In patients with ACS, the decision to proceed with decompressive laparotomy was decided by primary surgeon in-charge of the patient, who deteriorated upon a trial of non-operative management, after taking in to above clinical and laboratory parameters [12].

**Statistical analysis**

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

**Results**

100 patients who presented with blunt injury abdomen to emergency medicine department, who fulfilled the inclusion and exclusion criteria were studied. Out of 100 patients, 86 were male (86%), 14 were female (14%). Mean time of presentation to the hospital was 7.40 hours, hospital stay 8.025 days. Most common age group involved is 20-30 years.

Correlation between IAP and vital parameters, renal parameters at 0, 3, 6, 24 and 72 hours were found statistically significant. Observation between IAP and vital parameters, renal parameters at 12 hours all parameters are significant except IAP has weak positive correlation with DBP and this was found statistically insignificant. SpO2 has strong negative correlation with IAP and this was found statistically insignificant.

Observation between IAP and vital parameters, renal parameters at 96 hours all parameters are insignificant except PR has strong positive correlation with IAP and this was found statistically significant and RR has weak positive correlation with IAP and this was found statistically significant. High respiratory rate associates with low IAP. Overall hospital stay (considering both conservatively managed and surgically intervened patients) increased significantly as IAP increases at 0, 3, 6, 24, 48, 72, 96 hours, except at 12 hours.

Hospital stay decreased as IAP increases in surgically intervened group because IAP returned to normal after surgical decompression, but this finding was statistically significant only at 72 hours in our study. In our present study of 100 patients with blunt injury abdomen Hospital Stay increased as IAP increases in conservatively managed patients, this finding is statistically significant at 0, 3, 6, 12, 24, 48, 72, 96 hours.

**Table 1:** Conservative/surgical management of study participants

| Management | Number | Percentage |
|---|---|---|
| Conservative | 58 | 58 |
| Surgery | 42 | 42 |
| Total | 100 | 100 |
| **Ventilatory Support** | | |
| Yes | 16 | 16 |
| No | 84 | 84 |
| Total | 100 | 100 |

**Table 2:** Observation between IAP and hospital stay in surgically intervened patients

| Time | | Mean | Standard Deviation | P value |
|---|---|---|---|---|
| 0 | IAP | 10.20 | 3.4 | 0.07 |
| | Hospital Stay | 10.45 | 1.68 | |
| 3 | IAP | 12.41 | 3.87 | 0.15 |
| | Hospital Stay | 10.62 | 1.70 | |
| 6 | IAP | 13.20 | 4.80 | 0.41 |
| | Hospital Stay | 10.84 | 1.45 | |
| 12 | IAP | 16.98 | 19.23 | 0.09 |
| | Hospital Stay | 10.68 | 1.70 | |
| 24 | IAP | 16.90 | 7.78 | 0.25 |
| | Hospital Stay | 10.45 | 1.54 | |
| 48 | IAP | 13.20 | 5.43 | 0.32 |
| | Hospital Stay | 10.26 | 2.01 | |
| 72 | IAP | 11.93 | 7.5 | 0.01* |
| | Hospital Stay | 10.48 | 1.73 | |
| 96 | IAP | 8.64 | 0.90 | 0.002* |
| | Hospital Stay | 10.63 | 1.80 | |

* indicates statistically significance at $p \leq 0.05$

**Table 3:** Observation between IAP and hospital stay in conservatively intervened patients

| Time | | Mean | Standard Deviation | P value |
|---|---|---|---|---|
| 0 | IAP | 9.40 | 2.12 | 0.01* |
| | Hospital Stay | 6.24 | 1.89 | |
| 3 | IAP | 9.47 | 2.4 | 0.005* |
| | Hospital Stay | 6.4 | 1.84 | |
| 6 | IAP | 9.40 | 2.02 | 0.02* |
| | Hospital Stay | 6.25 | 1.54 | |
| 12 | IAP | 9.20 | 2.03 | 0.001* |
| | Hospital Stay | 6.2 | 1.89 | |
| 24 | IAP | 8.50 | 1.70 | 0.04* |
| | Hospital Stay | 6.2 | 1.9 | |
| 48 | IAP | 8.35 | 1.60 | 0.05* |
| | Hospital Stay | 6.47 | 1.88 | |
| 72 | IAP | 7.84 | 0.55 | 0.02* |
| | Hospital Stay | 6.5 | 1.8 | |
| 96 | IAP | 7.40 | 1.23 | 0.003* |
| | Hospital Stay | 6.25 | 1.91 | |

* indicates statistically significance at $p \leq 0.05$

**Discussion**

Abdominal trauma can result in the increase of IAP for a variety of reasons, including the accumulation of blood or free fluid in the peritoneal cavity, edema of the intestinal wall, retroperitoneal hematoma or abdominal packing for hemorrhage control. Therefore the continuing hepatic hemorrhage and increasing amounts of bloody ascites found in failed NOM can lead to an elevation in IAP [13]. ACS with multiple organ dysfunction is a consequence of the effects of IAH on multiple organ systems. Elevated IAP results in impaired physiology and organ functions due to the limited abdominal wall compliance [14]. In patients with severe trauma the incidence of ACS has been reported at 14% − 15% after damage control laparotomies. To date there are very few reports describing the changes in IAP or the development of IAH or ACS while the patients are receiving NOM after BAT [13].

Most common age group involved in our study was 20-30 years, similar finding was observed in study conducted by Mehta *et al* (21-30 years), Amuthan *et al* (20-30 years) [4, 15]. In present study 86 were male, 14 were female. Similar finding was observed in study conducted by Mehta *et al*, Bhoir *et al*. [5, 6]

SBP, DBP decreased significantly as IAP increases at 0, 3, 6, 24, 48 and 72 hours of hospital admission in our study. Similar finding was seen in study conducted by Bhoir *et al* in which they observed inverse relation between B.P and IAP.4 P. R. increased significantly as IAP increases at 0, 3, 6, 12, 24, 48, 72 and 96 hours of hospital admission in our data. Similar finding is seen in study conducted by Bhoir *et al*. [16] R. R. increased significantly as IAP increases at 0, 3, 6, 12, 24, 48, 72 and 96 hours of hospital admission. Similar finding was seen in study conducted by Bhoir *et al*. [16] In our data, SpO2 decreased significantly as IAP increases at 0, 3, 6, 24, 48 and 72 hours of hospital admission. Similar finding was seen in study conducted by Bhoir *et al*. [16]

U/O decreased significantly as IAP increases at 3, 6, 12, 24, 48 and 72 hours of hospital admission. This finding was in concordance with study conducted by Bhoir *et al*. [16] As IAP increases serum creatinine increased significantly at 0, 24, 48, 72 and 96 hours of hospital admission. This was in concordance with studies conducted by Khan *et al*, Bhoir *et al*. [16, 17] As IAP increases serum creatinine increased significantly at 0, 24, 48 and 72 hours of hospital admission. Similar observation noted in study conducted by Khan *et al* in which they noted statistically significant increase in B.U. in patients of IAH [17].

In our present study considering both conservatively managed and surgically intervened patients overall hospital stay increased significantly as IAP increases at 0, 3, 6, 24, 48, 72, 96 hours except at 12 hours. This was in contrast to study conducted by Khan *et al*, in which there was no significant correlation between IAP and duration of hospital stay [17]. Hospital stay decreased as IAP increases in surgically intervened patients because IAP returned to normal after surgical decompression, but this finding was statistically significant only at 72 hours (p value was 0.0001) in our study.

Ventilator acquired pneumonia in one patient and sepsis with MODS in other patients of surgically intervened patients were the causes of death. Cheatham *et al* had found that elevated IAP alone not a useful predictor of mortality [18].

## Conclusion

Blunt trauma to abdomen is on rise due to excessive use of motor vehicles. It poses a therapeutic and diagnostic dilemma for the attending surgeon due to wide range of clinical manifestations ranging from no early physical findings to progression to shock. Hence, the trauma surgeon should rely on his physical findings in association with the use of modalities such as X-ray abdomen, USG abdomen, and abdominal paracentesis. Along with IAP, patients should be monitored meticulously for simple parameters like heart rate, blood pressure, respiratory rate, urine output because variations in these parameters can predict the impending IAH and ACS before actual rise in IAP. Hence by this study we have proposed that monitoring of IAP and other vital parameters holds a great value in management of acute traumatic abdomen with good clinical outcome. Nonoperative management for blunt abdominal trauma was found to be highly successful and safe in our analysis. Management by NOM depends on clinical and hemodynamic stability of the patient, after definitive indications for laparotomy are excluded. During NOM of patients with BAT and multiple solid organ injuries, IAP monitoring may be a simple and objective guideline that might be in future included in Trauma Severity Scales to suggest further intervention whether NOI or OI. Although routine bladder pressure measurements will result in unnecessary monitoring of large number of patients it is hoped that patients with IAH can be detected early and subsequent ACS with morbid abdominal exploration can be prevented. However the criterion for non-operative failure and the point of decompression needs further refinement to prevent an increase of nontherapeutic operations.

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