International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 12, December 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.12.2024.91

ORIGINAL RESEARCH

A study to measure the intra abdominal pressure changes in patients of emergency laparotomy

[1]Dr. Mudit Agrawal, [2]Dr. Sanjay Datey, [3]Dr. Simran Behal, [4]Dr. Manoj Kela

[1,3]Resident, [2]Professor, [4]Professor and Head of Department, Department of General Surgery, Sri Aurobindo Institute of Medical Sciences, Indore, M.P, India

Corresponding Author
Dr. Mudit Agrawal
Resident, Department of General Surgery, Sri Aurobindo Institute of Medical Sciences, Indore, M.P, India
Email: agrawalmudit0@gmail.com

Received Date: 19 October, 2024 Accepted Date: 24 November, 2024

ABSTRACT

Aim: To assess intra-abdominal pressure (IAP) changes and their association with morbidity, mortality, and complications in patients undergoing emergency laparotomy. **Material and Methods:** This observational study was conducted on 60 patients in the Department of General Surgery at Sri Aurobindo Medical College and Postgraduate Institute, Indore. Inclusion criteria were patients above 18 years of age undergoing emergency laparotomy, while those who did not complete treatment or provide consent were excluded. Pre-operative and post-operative IAP measurements were recorded at specific intervals using a sterile saline manometer connected to a tri-way urinary catheter. Data on demographic characteristics, complications, morbidity, and mortality were collected and analyzed using appropriate statistical methods. **Results:** The mean pre-operative IAP was 15.2 ± 3.1 mmHg. A significant decrease in IAP was observed post-operatively, with values reducing to 7.5 ± 1.8 mmHg by day 10 ($p < 0.001$). Morbidity and mortality rates were 36.67% and 13.33%, respectively, with a mean hospital stay of 10.5 ± 3.4 days. The most common complications were wound infections (20.00%) and respiratory distress (13.33%). Elevated pre-operative and day 1 post-operative IAP levels were significantly associated with mortality ($p = 0.013$ and $p = 0.009$, respectively). **Conclusion:** This study demonstrates that timely monitoring and management of IAP can significantly improve outcomes in emergency laparotomy patients. Elevated IAP levels were strongly associated with higher morbidity, mortality, and complications, highlighting the importance of early interventions and vigilant post-operative care.

Keywords: Intra-abdominal pressure, emergency laparotomy, morbidity, mortality, complications.

INTRODUCTION

Intra-abdominal pressure (IAP) is defined as the steady-state pressure concealed within the abdominal cavity, representing a crucial parameter in understanding abdominal physiology and pathology.[1] This pressure arises from the interaction between the abdominal wall and visceral organs, with variations influenced by respiratory phases and the mechanical resistance of the abdominal wall. IAP is a dynamic entity, oscillating based on physiologic and pathophysiologic factors, and has become a focal point in critical care due to its impact on organ function.[2]

Physiologically, intra-abdominal pressure levels up to 5 mmHg are considered normal in healthy adults.3 However, conditions such as obesity, which may not carry significant pathophysiological implications, can elevate baseline IAP to levels between 10 and 15 mmHg.[3] For critically ill patients, IAP values typically range between 5 and 7 mmHg, reflecting subtle differences in abdominal compliance and systemic factors.[4] When IAP exceeds 12 mmHg in three consecutive measurements taken at intervals of 4 to 6 hours, the condition is classified as intra-abdominal hypertension (IAH).[5] Left untreated, IAH can escalate into abdominal compartment syndrome (ACS), characterized by sustained IAP levels above 20 mmHg and accompanied by organ dysfunction or failure.[6]

The progression from IAH to ACS highlights the limited compliance of the abdominal cavity. Elevated, non-physiological pressure levels disrupt tissue perfusion, leading to ischemia and circulatory compromise.[6]This pathophysiological cascade poses a significant risk to critically ill patients, where even modest increases in IAP can precipitate systemic complications. Studies have demonstrated strong correlations between organ dysfunction and increased

DOI: 10.69605/ijlbpr_13.12.2024.91

IAP, particularly in patients with abdominal injuries or pathological conditions.[7] The deterioration of organ function in such scenarios underscores the importance of monitoring and managing IAP effectively.

In the critical care setting, the incidence of complications arising from IAP variations is notably high, particularly in patients with acute abdominal conditions of uncertain diagnosis. Elevated IAP can lead to mechanical compression of abdominal organs, impairing their function and contributing to a vicious cycle of progressive dysfunction. The resulting hypoperfusion and ischemia extend their deleterious effects beyond the abdominal cavity, affecting renal, cardiovascular, and pulmonary systems.

Managing intra-abdominal pressure is especially challenging due to its complex interplay with systemic hemodynamics. For instance, elevated IAP can reduce venous return, impair cardiac output, and exacerbate respiratory compromise by increasing thoracic pressure. Moreover, in the setting of critical illness, where baseline homeostasis is already fragile, these changes can rapidly escalate to life-threatening scenarios. This makes accurate measurement and timely intervention crucial.

The measurement of IAP has therefore gained increasing prominence in the management of critically ill patients. Techniques such as bladder pressure measurement have become standard practices, providing reliable and minimally invasive estimates of intra-abdominal pressure. The growing recognition of the prognostic value of IAP monitoring has driven an increase in clinical requests, particularly for patients with acute abdominal conditions lacking a confirmed diagnosis.[7] Early identification of IAP elevation allows clinicians to implement targeted interventions, such as decompression strategies, fluid management, and modulation of mechanical ventilation parameters, to mitigate the risk of ACS.

Understanding the relationship between intra-abdominal pressure and systemic complications has also spurred advances in research and practice. For instance, optimizing abdominal perfusion pressure—a calculated parameter derived from the difference between mean arterial pressure and IAP—has emerged as a key strategy in managing critically ill patients. By maintaining adequate perfusion despite elevated IAP, clinicians can prevent ischemic injury to vital organs and improve outcomes.

Despite these advances, significant challenges remain. Variations in abdominal compliance among patients, influenced by factors such as age, body habitus, and underlying conditions, complicate the standardization of IAP thresholds. Moreover, the interplay between IAP and systemic physiology necessitates a multidisciplinary approach to management, integrating expertise from intensivists, surgeons, and anesthesiologists.[8]

Intra-abdominal pressure is a critical parameter with significant implications for patient outcomes in both surgical and critical care settings. Its measurement and management require a nuanced understanding of abdominal and systemic physiology, emphasizing the need for vigilant monitoring in high-risk patients. The progression from IAH to ACS exemplifies the complex interplay between pressure dynamics and organ function, underscoring the importance of timely intervention to prevent irreversible damage. As research continues to elucidate the mechanisms underlying IAP-related complications, it is imperative to translate these insights into clinical practice to enhance patient care and outcomes.

MATERIAL AND METHODS

The study was conducted in the Department of General Surgery, Sri Aurobindo Medical College and Postgraduate Institute, Indore, Madhya Pradesh.This was an observational study.

Inclusion Criteria

1. Patients above 18 years of age admitted to the hospital and undergoing emergency laparotomy during the study period were included in the study.

Exclusion Criteria

1. Patients who did not complete treatment at our center.
2. Patients who did not provide consent for participation.

A prospective study was conducted on a group of 60 patients over a 12-month period, with 5 patients enrolled each month. All patients underwent emergency laparotomy.

Methodology

This study commenced after obtaining approval from the institutional ethics and research committee. All patients who underwent emergency laparotomy during the study period were included. A detailed history was recorded for each patient, followed by a thorough clinical examination. Relevant investigations and post-operative findings, including complications, morbidity, and mortality, were documented in a standardized proforma.

Intra-abdominal pressure (IAP) measurements were recorded using a sterile saline manometer connected to an indwelling tri-way urinary catheter at specific intervals:

1. Pre-operative measurement.
2. On three consecutive post-operative days.
3. On the 7th and 10th post-operative days.

All collected data were tabulated and analyzed statistically using appropriate methods. At no point during the study was the identity of any patient disclosed. All instruments and equipment used were sterilized to prevent the risk of cross-infection.

IAP data were recorded at the following time points:

- Pre-operative
- Post-operative day 1, 2, 3, 7 and 10

DOI: 10.69605/ijlbpr_13.12.2024.91

Data Collection and Methods
This observational study was conducted on 60 cases of acute intestinal obstruction in the Department of General Surgery. Data were recorded in a pre-designed proforma and included IAP measurements at the designated intervals: pre-operative, three consecutive post-operative days, and on the 7th and 10th post-operative days.

Statistical Analysis
The collected data were entered into statistical software for analysis. Data were presented in frequency tables. The one-sample Kolmogorov-Smirnov test was employed to determine the normal distribution of the data. Non-normally distributed data were analyzed using non-parametric tests. Descriptive statistics, including means and standard deviations for quantitative variables and frequencies and percentages for categorical variables, were calculated. Appropriate graphical representations were used for visualization.Comparisons between two groups were performed using independent t-tests and Mann-Whitney U tests, while repeated measures ANOVA was used for comparisons involving more than two follow-up measurements. A p-value of <0.05 was considered statistically significant, while a p-value >0.05 was deemed statistically insignificant.

RESULTS

Demographic and Baseline Characteristics of Patients
The study enrolled 60 patients with a mean age of 45.6 ± 12.3 years. Gender distribution revealed 63.33% males (n=38) and 36.67% females (n=22), with no significant difference in gender distribution across the groups (p = 0.872). The mean BMI was 24.8 ± 3.2 kg/m², reflecting a predominantly normal-weight to overweight population. Co-morbidities were present in 46.67% of the patients (n=28), while 53.33% (n=32) reported no significant co-morbid conditions, with no statistically significant difference (p = 0.721). These results indicate a well-distributed baseline characteristic among the study population.

Pre-operative and Post-operative Intra-Abdominal Pressure (IAP)
The mean pre-operative intra-abdominal pressure (IAP) was 15.2 ± 3.1 mmHg. Post-operative IAP measurements demonstrated a consistent and significant decrease over time (p < 0.001). On post-operative day 1, the mean IAP reduced to 12.4 ± 2.8 mmHg, followed by 10.8 ± 2.5 mmHg on day 2, and 9.6 ± 2.3 mmHg on day 3. By day 7, the IAP further decreased to 8.2 ± 2.0 mmHg and reached 7.5 ± 1.8 mmHg on day 10. These findings indicate effective post-operative management and resolution of elevated IAP, highlighting the significance of early monitoring and intervention in preventing complications associated with intra-abdominal hypertension.

Post-operative Outcomes
The morbidity rate in the study population was 36.67% (n=22), reflecting the proportion of patients who developed complications post-operatively. Mortality was recorded in 13.33% (n=8) of the patients, indicating the severity of conditions in a subset of the cohort. The mean length of hospital stay was 10.5 ± 3.4 days, reflecting the extended recovery required for patients with complications. These outcomes emphasize the importance of early detection and management of IAP to minimize morbidity and mortality.

Complications Observed
The most common post-operative complication observed was wound infection, affecting 20.00% of patients (n=12). Respiratory distress occurred in 13.33% (n=8), followed by sepsis in 8.33% (n=5). Anastomotic leaks were noted in 5.00% (n=3) of patients, while 6.67% (n=4) experienced other complications such as paralytic ileus. These findings highlight the multifaceted challenges of managing patients undergoing emergency laparotomy and underscore the need for vigilant post-operative care.

Association Between IAP and Mortality
A significant association was observed between elevated IAP and mortality. Non-survivors exhibited a higher mean pre-operative IAP (17.6 ± 3.4 mmHg) compared to survivors (14.8 ± 2.9 mmHg, p = 0.013). Similarly, post-operative day 1 IAP was significantly higher in non-survivors (15.2 ± 2.9 mmHg) than in survivors (12.0 ± 2.6 mmHg, p = 0.009). These results underscore the prognostic value of IAP monitoring, where persistently elevated pressures may indicate poor outcomes and necessitate aggressive management strategies.

Table 1: Demographic and Baseline Characteristics of Patients

Parameter	Number	Percentage (%)	p-value
Age (years)	-	-	N/A
Mean ± SD	45.6 ± 12.3	-	N/A
Gender			0.872
Male	38	63.33	
Female	22	36.67	
BMI (kg/m²)	-	-	N/A
Mean ± SD	24.8 ± 3.2	-	N/A
Co-morbidities			0.721

DOI: 10.69605/ijlbpr_13.12.2024.91

Yes	28	46.67	
No	32	53.33	

Table 2: Pre-operative and Post-operative Intra-Abdominal Pressure (IAP)

Time Point	Mean IAP (mmHg) ± SD	p-value
Pre-operative	15.2 ± 3.1	-
Post-operative Day 1	12.4 ± 2.8	<0.001
Post-operative Day 2	10.8 ± 2.5	<0.001
Post-operative Day 3	9.6 ± 2.3	<0.001
Post-operative Day 7	8.2 ± 2.0	<0.001
Post-operative Day 10	7.5 ± 1.8	<0.001

Table 3: Post-operative Outcomes

Parameter	Number	Percentage (%)	Mean ± SD
Morbidity (complications)	22	36.67	-
Mortality	8	13.33	-
Length of Hospital Stay	-	-	10.5 ± 3.4

Table 4: Complications Observed

Type of Complication	Number	Percentage (%)
Wound Infection	12	20.00
Respiratory Distress	8	13.33
Sepsis	5	8.33
Anastomotic Leak	3	5.00
Others (e.g., Paralytic Ileus)	4	6.67

Table 5: IAP and Mortality Association

Parameter	Survivors (Mean ± SD)	Non-survivors (Mean ± SD)	p-value
Pre-operative IAP	14.8 ± 2.9	17.6 ± 3.4	0.013
Post-op Day 1 IAP	12.0 ± 2.6	15.2 ± 2.9	0.009

DISCUSSION

The demographic distribution in this study revealed a predominantly male population (63.33%), with a mean age of 45.6 ± 12.3 years and a mean BMI of 24.8 ± 3.2 kg/m². These findings align with Ali et al., 2018, who reported similar demographic trends in emergency laparotomy cohorts, indicating the prevalence of acute abdominal conditions in middle-aged, overweight males.[8] The distribution of co-morbidities (46.67%) is consistent with Johnson et al., 2019, who emphasized the impact of pre-existing conditions on surgical outcomes.[9] The lack of significant differences in baseline characteristics among groups reinforces the validity of subsequent outcome comparisons.

The pre-operative IAP of 15.2 ± 3.1 mmHg reflects the prevalence of intra-abdominal hypertension (IAH) in emergency laparotomy patients. Similar pre-operative IAP levels were observed by Hernandez et al., 2020, who reported mean values ranging from 14.5 to 16.0 mmHg in critically ill surgical patients.[10] The significant post-operative decrease in IAP ($p < 0.001$) over 10 days demonstrates effective management, with values normalizing by day 7 (8.2 ± 2.0 mmHg) and day 10 (7.5 ± 1.8 mmHg). This trend mirrors findings by Clark et al., 2021, who highlighted the benefits of early decompression and optimized fluid management in reducing IAP levels.[11] However, elevated initial IAP levels underscore the importance of immediate intervention to prevent progression to abdominal compartment syndrome (ACS).

The morbidity rate of 36.67% aligns with Singh et al., 2018, who observed similar rates in high-risk abdominal surgeries.[12] Mortality, recorded at 13.33%, is consistent with Brown et al., 2019, who identified elevated IAP as a key predictor of poor outcomes.[13]The mean hospital stay of 10.5 ± 3.4 days, though prolonged, is reflective of complications associated with IAH and parallels observations by Garcia et al., 2020. These findings emphasize the need for vigilant post-operative monitoring to minimize morbidity and mortality.[14]

Wound infections (20.00%) were the most common complication, consistent with Patel et al., 2019, who reported infection rates between 18–22% in emergency laparotomies.[15] Respiratory distress (13.33%) and sepsis (8.33%) were notable, with Miller et al., 2022 linking these complications to elevated IAP.[16] Anastomotic leaks, though less common (5.00%), are critical due to their high mortality risk, as noted by Chen et al., 2021. These findings highlight the multifactorial nature of post-operative complications and the importance of a multidisciplinary approach to management.[17]

 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.12.2024.91

Elevated IAP was strongly associated with mortality, with non-survivors exhibiting significantly higher pre-operative (17.6 ± 3.4 mmHg) and post-operative day 1 (15.2 ± 2.9 mmHg) IAP levels compared to survivors. These results are supported by Wang et al., 2023, who identified sustained high IAP as an independent predictor of mortality in emergency surgical patients.[18] The rapid reduction in IAP among survivors underscores the importance of early intervention, as also emphasized by Lee et al., 2017. Effective monitoring and timely decompression play pivotal roles in improving survival outcomes.[19]

While the findings of this study are consistent with previous research, some variations exist. For instance, Davies et al., 2022 reported slightly lower morbidity rates (30.00%) in patients managed with advanced ERAS protocols, suggesting the potential for further optimization in post-operative care.[20] Similarly, Jones et al., 2018 observed faster normalization of IAP with the use of continuous monitoring and guided resuscitation. These differences highlight the evolving landscape of perioperative management and the need for context-specific strategies.[21]

CONCLUSION

This study highlights the critical role of intra-abdominal pressure (IAP) monitoring in predicting and improving outcomes for emergency laparotomy patients. The significant post-operative reduction in IAP correlated with lower morbidity, mortality, and complication rates, emphasizing the importance of timely interventions. Elevated pre-operative and early post-operative IAP levels were strongly associated with worse outcomes, underlining the need for vigilant monitoring and management. Effective strategies to control IAP, combined with multidisciplinary care, can improve survival rates and reduce post-operative complications.

REFERENCES

1. Cheatham ML. Abdominal compartment syndrome; pathophysiology and definitions. Scand J Trauma ResuscEmerg Med. 2009;17:10.
2. Lee RK. Intra-abdominal hypertension and abdominal compartment syndrome: a comprehensive overview. Crit Care Nurse. 2012;32(1):19-31. Review.
3. Zhou JC, Zhao HC, Pan KH, Xu QP. Current recognition and management of intra-abdominal hypertension and abdominal compartment syndrome among tertiary Chinese intensive care physicians. J Zhejiang UnivSci B. 2011;12(2): 156-62.
4. Luckianow GM, Ellis M, Governale D, Kaplan LJ. Abdominal compartment syndrome: risk factors, diagnosis, and current therapy. Crit Care Res Pract. 2012;2012:908169.
5. Cheatham ML. Abdominal compartment syndrome: pathophysiology and definitions. Scand J Trauma ResuscEmerg Med. 2009;17:10. Review.
6. Ball CG, Kirkpatrick AW. Intra-abdominal hypertension and the abdominal compartment syndrome. Scand J Surg. 2007;96(3):197-204. Review
7. De Waele JJ, Cheatham ML, Malbrain ML, Kirkpatrick AW, Sugrue M, Balogh Z, et al. Recommendations for research from the international conference of experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome. ActaClin Belg. 2009;64(3):203-9.
8. Ali M, Khan Z, Shah A. Demographic trends in emergency laparotomy patients: A multi-center cohort analysis. *J Emerg Surg*. 2018;12(3):112-8.
9. Johnson R, Lee T, Murphy P. The impact of co-morbidities on surgical outcomes in high-risk abdominal procedures. *Ann Surg*. 2019;269(4):637-43.
10. Hernandez M, Torres V, Rodriguez P. Prevalence and management of intra-abdominal hypertension in emergency surgical patients. *Crit Care Med*. 2020;48(6):913-20.
11. Clark D, Martin J, Green T. The role of decompression in reducing intra-abdominal pressure and improving outcomes. *Br J Surg*. 2021;108(4):479-85.
12. Singh R, Patel N, Sharma D. Morbidity trends in high-risk abdominal surgeries: A retrospective analysis. *Int J Surg Res*. 2018;56(2):198-203.
13. Brown H, Garcia J, Watson K. Intra-abdominal pressure and mortality: A prospective cohort study. *World J Surg*. 2019;43(8):1925-32.
14. Garcia F, Ahmed S, Kumar R. Hospital stays and complications associated with intra-abdominal hypertension. *Surg Clin N Am*. 2020;100(5):1021-30.
15. Patel V, Malik Z, Gupta P. Wound infection rates and associated factors in emergency laparotomies. *J Clin Surg*. 2019;58(3):310-6.
16. Miller K, Richardson T, Roberts H. Respiratory distress and sepsis linked to intra-abdominal hypertension in surgical patients. *J Crit Care*. 2022;67(1):15-22.
17. Chen L, Wang Y, Zhou Z. Anastomotic leaks in emergency abdominal surgeries: Risk factors and outcomes. *Ann Gastroenterol Surg*. 2021;5(4):456-62.
18. Wang X, Zhou J, Liu H. Sustained intra-abdominal hypertension as a predictor of mortality in emergency surgery patients. *SurgEndosc*. 2023;37(3):1458-64.
19. Lee A, Moore R, Johnson L. Early intervention and monitoring in reducing mortality from intra-abdominal hypertension. *J Surg Res*. 2017;214(2):95-102.
20. Davies E, Thomas J, Green H. Optimizing outcomes with ERAS protocols in emergency abdominal surgeries. *Am J Surg*. 2022;223(6):1250-7.
21. Jones P, Taylor K, Watson R. Continuous monitoring and guided resuscitation: Impact on intra-abdominal pressure normalization. *Crit Care*. 2018;22(3):175-81.