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The Value of Intra-abdominal Pressure Measurement in Patients with Acute Abdomen

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AIM: To find out the potential benefit of bladder pressure (BP) measurement as a diagnostic tool for acute abdomen.
BACKGROUND: Acute abdomen is one of the most important clinical entities among general surgical clinics. The diagnosis can be achieved by considering the patient's history, physical examination, laboratory analysis or by different imaging modalities. Abdominal compartment syndrome (ACS) occurs due to elevated intra-abdominal pressure (IAP), and can be diagnosed by measurement of BP. We observed in our clinical routine elevated IAP levels in patients with acute abdomen.
METHODS: Two groups were established: one containing 65 consecutive patients diagnosed as having acute abdomen in the emergency room, and the control group of 10 consecutive patients with no acute abdominal complaints elected for laparoscopic operation. IAP measurements were performed before the operations. BP was measured in the supine position with 50 mL of sterile saline instilled into the bladder after the bladder had been emptied. The catheter was connected to a water manometer with the reference point being the symphisis pubis. BP levels greater than 7 cmH_2O were accepted as abnormal and interpreted as a diagnostic criteria for acute abdomen.
RESULTS: Sensitivity, specificity, positive predictive value, negative predictive value and the accuracy are calculated 95.4%, 80%, 96.9%, 72.7%, 93.3%, respectively.
CONCLUSION: We found elevated IAP may support the physician's diagnosis of acute abdomen with approximately 27.3% false negative rate. [*Asian J Surg* 2009;32(1):33–8]

Key Words: acute abdomen, peritonitis

Introduction

The term acute abdomen denotes sudden, progressive abdominal symptoms predominantly abdominal pain. Acute abdomen is one of the most important clinical entities among general surgical clinics. The diagnosis can be achieved by history taking, physical examination, laboratory analysis or by different imaging modalities.[1,2] Since there is frequently a progressive pathology, delay in accurate diagnosis and treatment negatively affects any outcome.[3,4] It is possible to meet a patient with acute abdomen in any level of healthcare. Because of the heterogeneity of medical staff and equipment of emergency services especially in rural areas of developing countries, the delay in diagnosis of acute abdominal pathology is possible.

Increased intra-abdominal pressure (IAP) may occur in a variety of clinical situations such as peritonitis, intestinal obstruction, tense ascites, abdominal haemorrhage, large abdominal tumours, during laparoscopy, use of military anti-schock trousers, and peritoneal dialysis.[5,6] IAP can be determined through the measurement of bladder pressure (BP) indirectly according to Iberti et al.[6] Abdominal compartment syndrome (ACS) occurs due to elevated IAP above critical levels with negative systemic effects on the human

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organism. Kron et al were the first to measure IAP after surgery, and to use this as a criterion for abdominal decompression. ACS can be diagnosed by measurement of BP.[5–8]

We observed in our clinical routine elevated IAP levels even lower than the critical levels for ACS in patients with acute abdomen. This observation encouraged us to plan our study which aims to find out the potential benefit of BP measurement as a diagnostic tool for acute abdomen. We also examined statistically our hypothetic relationships between the BP level and the elevated white blood cell count, the interval between the onset of abdominal complaints and admittance in emergency service, and the mortality of patients with acute abdomen.

Patients and methods

Seventy five patients (55 men, 20 women) with an age range of 21–85 years were studied. Two groups are established. The acute abdomen group (G_{ab}) included 65 consecutive patients (49 men, 16 women) diagnosed as acute abdomen in the emergency room after physical examination, laboratory findings and/or imaging studies. The control group (G_c) covered 10 consecutive patients (six men, four women) with no acute abdominal complaints elected for laparoscopic operation. Approval of the local ethics committee had been obtained. Exclusion criterias were the presence of ventral hernia, pregnancy, and a history of abdominal and/or bladder surgery.

The patient's name, sex, age, the period between the onset of complaints and admission to the emergency room (in days according to the history of the patient), physical examination findings including abdominal tenderness, guarding, and rebound tenderness (as absent or present), white blood cell count (WBC) on admission (normal value ≤ 10,000/mm^3 according to the reference value of the biochemical laboratory), and BP level in cmH_2O before planned treatment were documented. IAP measurements were performed before the operations but were not taken into account for establishing the diagnosis of acute abdomen and/or for decision of laparotomy. The normal range of BP was taken as 0–7 cmH_2O.[5] BP was measured as follows: in the supine position, a Foley catheter is passed into the bladder and clamped distal to the aspiration port after the bladder had been fully emptied. Next 50 mL of sterile saline was instilled into the bladder. The catheter was then connected to a water manometer with the reference point being the symphisis pubis. The pressure level was read as the height of the water column in cm through the manometer with "0 point" referring to the level of symphisis pubis.[6] The two groups of BP levels were established; the first group included the patients with BP greater than 7 cmH_2O (GBP7) and second group included the patients with BP greater than 10 cmH_2O (GBP10). Accurate diagnosis which was divided into the local (acute appendicitis, acute cholecystitis, acute pancreatitis, rupture of an ovarian cyst, etc.) and diffuse (peptic ulcer perforation, mechanical bowel obstruction, mesenteric ischaemia, colonic perforation, diffuse peritonitis, etc.). Abdominal illness groups, type of treatment and prognosis were also recorded.

Statistical evaluation

The appropriateness of continuous variables for normal distribution was evaluated using the Kolmogorov-Smirnov test. Whereas normally distributed continuous variables were compared through parametric tests, continuous variables that do not show normal distribution were compared through non-parametric statistical tests. Gender distribution between the groups, BP levels and physical findings were compared through the chi-square test. Age distribution between the two groups was examined with Student's *t* test. BP levels in localised and diffuse abdominal illnesses were compared using the Kruskal-Wallis test. The correlation between the period between the onset of complaints and admission to the emergency room in days, and BP level was evaluated using the Pearson analysis. Mortality rates and BP level were compared using the Mann-Whitney *U* test. Statistical evaluation of the relationship between the diagnosis of acute abdomen and BP level, and the WBC count was performed through the calculation of sensitivity, specificity, positive predictive values, negative predictive values and the accuracy according to the cut-off levels.

Results

A total number of 75 patients (55 (73.3%) male, 20 (26.7%) female) were enrolled in our study. The acute abdomen group (G_{ab}) included 65 patients and control group (G_c) included 10 patients. Gender distribution between the groups G_{ab} and G_c were compared with the chi-square test and no statistically significant difference was detected. Both of the groups were homogenous relating to the gender of the enrolled patients ($p = 0.442$). The mean age was 60.55 in G_{ab} and 49.40 in G_c and there was no statistically

Table 1. Comparison of the BP levels between subgroups of G_{ab}, LG_{ab}, DG_{ab}, and G_c

	LG_{ab}	DG_{ab}	G_c	p*
Patients, *n*	18 (24%)	47 (62.7%)	10 (13.3%)	
Median BP in cmH_2O	10 (3–31)	16 (5–42)	6.5 (2–8)	$p = 0.000$

*Chi-square test. BP = bladder pressure; G_{ab} = acute abdomen group; LG_{ab} = local abdominal illness subgroup; DG_{ab} = diffuse abdominal illness subgroup; G_c = control group.

Table 2. Elevated WBC count on admission and diagnosis of acute abdomen

	Patients with elevated WBC count, *n*	Patients with normal WBC count, *n*	Total
Patients with acute abdomen, *n*	53	12	65
Patients with no acute abdomen, *n*	0	10	10
Total	53	22	75

WBC = white blood cell count.

Table 3. BP > 7 cmH_2O on admission and diagnosis of acute abdomen

	Patients with BP > 7 cmH_2O, *n*	Patients with BP ≤ 7 cmH_2O, *n*	Total
Patients with acute abdomen, *n*	62	3	64
Patients with no acute abdomen, *n*	2	8	10
Total	64	11	75

BP = bladder pressure.

Table 4. BP > 10 cmH_2O on admission and diagnosis of acute abdomen

	Patients with BP > 10 cmH_2O, *n*	Patients with BP ≤ 10 cmH_2O, *n*	Total
Patients with acute abdomen, *n*	53	12	65
Patients with no acute abdomen, *n*	0	10	10
Total	53	22	75

BP = bladder pressure.

significant difference related to age between G_{ab} and G_c ($p = 0.078$). The local abdominal illness subgroup G_{ab} (LG_{ab}) included 18 (24%) patients and the diffuse abdominal illness subgroup G_{ab} (DG_{ab}) included 47 (62.7%) patients. The median BP level was 10 cmH_2O (range, 3–31 cmH_2O) in LG_{ab}, 16 cmH_2O (range, 5–42 cmH_2O) in DG_{ab}, and 6.5 cmH_2O (range, 2–8 cmH_2O) in G_c. The comparison of the BP levels among LG_{ab}, DG_{ab}, and G_c showed a statistically significant difference ($p = 0.000$) (Table 1).

A WBC count on admission greater than 10,000/mm^3 was accepted as leucocytosis according to the reference values of the laboratory. The sensitivity, specificity, positive predictive value, negative predictive value and the accuracy of the elevated WBC count on admission for the diagnosis of acute abdomen were 81.5%, 100%, 100%, 45.5% and 84%, respectively (Table 2). The sensitivity, specificity, positive predictive value, negative predictive value and the accuracy of the BP level greater than 7 cmH_2O on admission for the diagnosis of acute abdomen were 95.4%, 80%, 96.9%, 72.7% and 93.3%, respectively (Table 3). The sensitivity, specificity, positive predictive value, negative predictive value and the accuracy of the BP level greater than 10 cmH_2O on admission for the diagnosis of acute abdomen were 81.5%, 100%, 100%, 45.5% and 84%, respectively (Table 4). Abdominal tenderness, guarding, and rebound tenderness among the groups GBP7 and GBP10 were compared with chi-square test. The comparison showed statistically significant differences in GBP7 between G_{ab} and

Table 5. Comparisons separately in GBP7 and GBP10 between G_{ab} and G_c related to leucocytosis

	Patients with leucocytosis, *n*	Patients with no leucocytosis, *n*	Total	*p**
GBP7	50 (78.1%)	14 (21.9%)	64 (100%)	$p = 0.002$
GBP10	42 (79.2%)	11 (20.8%)	53 (100%)	$p = 0.024$

*Chi-square test. GBP7 = group with bladder pressure > 7 cmH_2O; GBP10 = group with bladder pressure > 10 cmH_2O; G_{ab} = acute abdomen group; G_c = control group.

G_c related to abdominal tenderness ($p = 0.000$), guarding ($p = 0.003$), and rebound tenderness ($p = 0.007$). There was also a statistically significant difference in GBP10 between G_{ab} and G_c related to abdominal tenderness ($p = 0.000$), guarding ($p = 0.003$), and rebound tenderness ($p = 0.002$). Leucocytosis among the groups GBP7 and GBP10 were compared with chi-square test. The WBC counts were statistically different between G_{ab} and G_c in GBP7 ($p = 0.002$). The WBC counts were also statistically different between G_{ab} and G_c in GBP10 ($p = 0.024$) (Table 5). The Pearson analysis showed no correlation between the BP level and the period between the onset of complaints and admission, in days ($p = 0.166$). Sixty two of the patients (82.6%) recovered and 13 (17.3%) of the patients died in the course of treatment. No mortality was detected in G_c. The mortality rate in G_{ab} was 20%. The comparison between the BP levels of recovered and exitus patients showed no statistically significant difference ($p = 0.108$).

Discussion

Acute abdomen means the sudden onset of abdominal complaints including a wide spectrum of pathologies of intra-abdominal organs which almost always require emergent approaches including surgical intervention.[9] The physician should promptly make a differential diagnosis because of the emergent nature of acute abdomen. Careful medical history analysis and a detailed physical examination can be enough for the diagnosis of acute abdomen in 75–80% of cases.[9] Laboratory analysis including complete blood count (CBC), the biochemical analysis of serum and urine analysis, and imaging studies including radiography, sonography, abdominal tomography or mesenteric angiography may further support the diagnosis of acute abdomen.[3,10–12] Acute abdomen syndrome covers abdominal pathologies like localised and diffuse forms of peritonitis and intra-abdominal space-occupying lesions. The similarity of a etiologies of acute abdomen and ACS are obviously seen.[3,13–16] Tons et al reported normal values of BP, which helped us in establishing the control group G_c. The comparison of groups G_c and G_{ab} showed no differences related to the age and gender among groups ($p > 0.05$). There have been no large series to determine normal IAP in hospitalised patients. In the literature there are different reports regarding the normal value of IAP[17–20] We chose 7 cmH_2O and 10 cmH_2O as our cut-off values according to the majority of reports encountered in the literature notifying 7 cmH_2O and 10 cmH_2O as median levels of IAP. After measurement of BP levels in G_c and G_{ab} the GBP7 group was established. We constituted another group, GBP10, raising the cut-off level of BP to 10 cmH_2O. But this effort showed a significant drop in sensitivity, accuracy and a negative predictive value (GBP10: 81.5%, 45.5%, 84%; GBP7: 95.4%, 72.7%, 93.3%, respectively). We concluded that 7 cmH_2O as cut-off level for BP is more reliable for the diagnosis of acute abdomen. The CBC should never be used solely to make the diagnosis according to Graff et al and Cardall et al.[21,22] We agree with them that the determination of the WBC count only is not safe enough to diagnose acute abdomen. The interpretation of BP level together with WBC count seems to be more effective because of the statistically significant difference in GBP7 between G_{ab} and G_c related to the elevated WBC count ($p < 0.01$). Pain is the focal issue in the evaluation of the patient suspected of having an acute abdomen.[3,18] Physical examination findings like abdominal tenderness, guarding and rebound tenderness were found to be strongly suggestive for the diagnosis of acute abdomen in both GBP7 and GBP10 groups.

In order to examine and figure out the rationale behind our observation about the elevated levels of IAP in patients with localised peritonitis, we divided the acute abdomen group (G_{ab}) into two subgroups, LG_{ab} and DG_{ab}. Statistically significant differing BP levels between LG_{ab}, DG_{ab}, and G_c may be interpreted as a potential benefit of BP measurement in patients even with signs of localised peritonitis for the diagnosis of acute abdomen. Due to the absence of correlation between the BP level, mortality, and the interval between the onset of complaints and admission, neither we can estimate the time of initiation of the abdominal pathology retrospectively, nor we can use BP levels as a predictor of mortality in patients with acute abdomen.

Our study has some limitations. First, the number of patients involved is small; with only 10 patients in the control group it is difficult to apply the findings of this study to larger populations. Second, we hypothesised a potential correlation between the BP level, mortality, and the interval between the onset of complaints and admission according to our observations. Unfortunately, we were not be able to prove this. The absence of a correlation between the BP level, mortality, and the interval between the onset of complaints and admission could be related to the small number of patients in the control group. We can only examine potential relationships in futher studies with suitable design.

Although there is a wide spectrum of diagnostic tools, an experienced physician almost always gives precedence to the clinical evaluation of the patient which is tightly linked with the diagnosis of acute abdomen. For standard evaluation of patients with acute abdomen by emergency services, standardisation of medical staff and equipment is necessary. A BP measurement may help the primary physician anywhere with limited laboratory and/or imaging choices or even in the absence of a specialist for the evaluation.

Elevated IAP solely can not effect the final decision for establishing the diagnosis of acute abdomen. But interpretation of elevated IAP, demonstrated through BP measurement, with history, physical examination findings, laboratory findings and/or imaging studies, may be helpful in supporting the diagnosis of acute abdomen. Although the determination of the specific abdominal pathology is impossible, BP greater than 7 cmH_2O seems to be valuable in patients with acute abdomen. We need further controlled randomised studies with larger series to be able to integrate BP measurements into the clinical routine as a new diagnostic parameter.

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