ORIGINAL ARTICLE

INTRABDOMINAL PRESSURE AND ITS CORRECTION IN ACUTE SURGICAL PATHOLOGY

DOI: 10.36740/WLek202202108

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ABSTRACT

The aim: Improving the results of treatment of patients with acute surgical pathology of the abdominal cavity by correcting intra-abdominal hypertension (IAH).

Materials and methods: The results of examination and treatment of 187 patients with acute surgical pathology, which was accompanied by elevation of IAP. To compare the results, depending on the chosen diagnostic and treatment tactics, patients were divided into two groups: comparison and main. The comparison group (85 people (45,5%) included patients who have been treated with traditional approaches in diagnosis and treatment according to existing treatment protocols. The main group (102 people (54,5%) included patients in whose treatment we additionally used our proposed step-by-step approach in the treatment of IAH.

Results: Systemic complications occurred in 12 patients of the main group (11,8%) and in 46 patients of the comparison group (54,1%), while in the second group the frequency of systemic complications was significantly higher ($\chi 2 = 38,6$, CI 29,3-53,6, $p < 0,0001$). 20 patients (10,7%) died (2 patients of the main group (1,96%) and 18 patients of the comparison group (21,2%) ($\chi 2 = 17,85$, CI 10,4-29,18, $p < 0,0001$).

Conclusions: Use in the complex treatment of patients with acute surgical pathology of the abdominal cavity, accompanied by IAH, the proposed step-by-step approach has improved treatment outcomes by reducing the incidence of systemic complications from 54,1% to 11,8%, total mortality from 21,2% to 1,96% and postoperative mortality - from 22,4% to 2,4%.

KEY WORDS: intra-abdominal hypertension, abdominal compartment syndrome, staged treatment

Wiad Lek. 2022;75(2):372-376

INTRODUCTION

Increased IAP remains an urgent problem, which occurs in acute surgical pathology of organs of the abdominal cavity and retroperitoneal space. Thus, according to the literature data, abdominal traumas, acute pancreatitis and other diseases of the abdominal cavity manifest the increase of IAP in 83,6% of patients leading to ACS development in 16,8% of cases [1,2]. In turn, ACS is accompanied by the development of severe dysfunction of body systems and causes mortality in 45,2% -95% of cases [3].

The pathogenesis of elevated IAP is based on increasing intra-abdominal volume due to paresis or pathological volume in the abdominal cavity, intestinal edema and mesenteric tissue in acute inflammatory processes of the abdominal cavity (acute pancreatitis, closed abdominal trauma, acute peritonitis) [4]. Surgical interventions in this category of patients increase the phenomena of dynamic intestinal obstruction in the early postoperative period, leading to the elevation of IAP [5].

Elevation of IAP can also occur with decreased abdominall cavity volume after various types of gernio- and/or abdominoplasty [6]. Separately, we should focus on laparoscopic technology, which is used in most cases to create carboxyperitoneum, which leads to increased pressure in the abdominal cavity. This limits the use of laparoscopic surgery for IAH in the setting of urgent care [7].

It should be noted that there are many methods of IAH treatment, most of which are invasive and require an anesthesiologist, and are limited for use in patients treated conservatively [8]. There is also no clearly formulated algorithm of actions to prevent ACS development that would solve the problem of complex abdominal pressure correction depending on the cause of ACS elevation (external, internal), the nature of the patient's breathing (mechanical ventilation, spontaneous breathing), etc. [9].

THE AIM

The purpose of the work is to improve the results of treatment of patients with acute surgical pathology of the abdominal cavity by correcting intra-abdominal hypertension.

MATERIALS AND METHODS

The results of examination and treatment of 187 patients with acute surgical pathology, which was accompanied by elevated IAP, who were hospitalized in the hospital of the Department of Surgery № 2 of the Bogomolets national medical university in the period from 2012 to 2020 were analyzed. The World Society of the Abdominal Compartment Syndrome (WSACS) classification was used to assess

the degree of IAH. There were 117 men (62,6%) and 70 women (37,4%). To compare the results depending on the chosen diagnostic and treatment tactics, the patients were divided into two groups: the comparison group and the main group. The comparison group (85 people (45,5%) included patients who have been treated with traditional approaches to diagnosis and treatment according to current treatment protocols. The main group (102 patients (54,5%) included patients in the treatment of which we additionally used our proposed step-by-step approach in the treatment of IAH. The study group consisted of 64 males (62,7%), 38 females (37,3%), and the comparison group consisted of 53 (62,4%) and 32 (37,4%) subjects respectively (groups representative of the statistic (p>0,05). The patients' age ranged from 21 to 85 years, mean age was 46,25±1,12 years. The patients of the two groups did not differ significantly in age and nosological forms of acute surgical pathology. The mean age of the main group and the comparison group was 46,18±1,59 and 46,33±1,57 years respectively (p>0,05). The study included patients with the following nosological forms of acute surgical pathology: strangulated abdominal wall hernia was observed in 28 (15%) patients, closed abdominal trauma with damage to internal organs - 36 (19,3%) patients, acute pancreatitis - 35 (18,7%) patients, perforated duodenal ulcer - 11 (5,9%) patients, tumor perforation - 3 (1,6%) patients, acute intestinal obstruction - 30 (16%) patients, acute calculous cholecystitis - 22 (11,8%) patients, acute appendicitis - 22 (11,8%) patients. 139 (74.3%) patients were operated. Among the patients of the main group were operated 77 patients (75.5%) and the comparison group – 62 (72,9%), patients in both groups did not differ significantly in the type of surgical interventions (p>0,05).

For the determination of IAP we used the method of monitoring the pressure in the bladder (MBP), and during the laparoscopic intervention, the pressure was measured directly using an insufflator manometer.

Treatment tactics for patients with acute surgical pathology of the abdominal cavity, accompanied by IAH, were chosen depending on the underlying disease. First of all, the main factor of IAP increase was revealed - increase in abdominal volume (increase in intestinal volume due to paresis, intestinal edema, accumulation of fluid, gas in the abdominal cavity, etc.) - 159 (85,02%) patients and decrease in volume abdominal cavity due to surgery on the anterior abdominal wall (hernioplasty, abdominoplasty), its compression in the early postoperative period with compression bandages, etc.), as well as a combination of these factors - 28 (14,97%) patients.

Prophylaxis and treatment of IAH in the main group were divided into 3 stages. For normalization of IAP in *the first stage* the following was used: 1) decompression of the upper digestive tract, 2) drug control of intestinal flatulence, 3) evacuation of pathological contents. The patients were monitored for adequate pain relief and sedation, also avoided the use of compression bandages and corsets in the early postoperative period. If the patient was on a mechanical ventilation, normalization of IAP was achieved by correcting the ventilator settings: decreasing the volume of inspiration and increasing the respiratory rate on the machine (the inspiratory pressure should be less than 30 cm Hg).

The second stage included optimization of systematic and regionary perfusion in the direction of decreased water balance (zero or negative) through the use of hypertonic and colloidal solutions, and in stable patients - through the use of diuretics. In the case of prolonged intestinal paresis, peristalsis was stimulated by using lavage and siphon enemas. Liquid formations of the abdominal cavity were eliminated by puncture drainage under ultrasound control. Part of the patients was fed both parenterally and by enteral tube feeding (ETF). During the third phase of treatment, prolonged epidural anaesthesia (PEA) and complete refusal of ETF were used. If the IAP was no lower than 20 mmHg as a result of these measures, surgical treatment (decompression laparostomy) or laparolifting systems were used.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistica 10 (Serial Number: STA999K347150-W) and MEDCALC® (open-access website, https://www.medcalc.org/calc/). Data distribution normality was checked using the Shapiro-Uilk criterion. Comparison of the data between the groups was carried out using the paired Student's t-criterion for unrelated samples. Comparison of the indicators in dynamics was carried out using Student's t-criterion for related samples. No abnormal distribution was observed in the study. To compare the frequency of the signs in the unrelated samples, we used «n-1» xi-square test ($\chi 2$) according to Campbell (2007) and Richardson's (2011) recommendations. The confidence intervals given in the article were constructed for the confidence level of 95%.

RESULTS

Main group patients with *acute pancreatitis* had markedly lower IAP than hospitalized patients even after 24 years of treatment (16,59 ± 0,74 and 15,29 ± 0,77 mmHg, p < 0,05, respectively) and continued to decrease, returning to the group average values on the last day of therapy (11,82 ± 0,71 mmHg). In patients of the comparison group, on the contrary, the IAP significantly increased in the first (16,38 ± 0,66 and 17,26 ± 0,71 mm Hg, p <0,05, respectively) and the second day (16,38 ± 0,66 and 17,25 ± 0,77 mm Hg, p <0,05, respectively), and a probable decrease in IAP was registered only on the 10th day of therapy (16,38 ± 0,66 and 13,41 ± 0,95 mm Hg, p <0,05, respectively).

However, in 7 patients (20%) the signs of IAH not only did not subside during the first week but even tended to grow slowly, IAP exceeded 21 mm Hg, which was subsequently the reason for decompression laparostomy in two patients of the comparison group and surgical treatment in six patients (17,1%).

Complications occurred in 12 patients with severe acute pancreatitis (34,3%), the incidence of side effects in the

comparison group was probably higher, (52,9 and 16,7%, respectively, $\chi 2 = 4,9$, $p = 0,03$). In the main group, the development of these complications was registered in three (16,7%) patients (one (5,6%) patient with a lethal outcome), in the comparison group in 9 (52,9%) patients, of which - 6 (35, 3%) of patients (three operated and three non-operated) with lethal outcome, that is the total mortality was reduced from 35,3% to 5,6% ($\chi 2 = 4,7$, $p = 0,03$).

When comparing the results of treatment in patients with *acute intestinal obstruction* from the first day of the postoperative period in patients of the main group there was a statistically significant decrease in IAP (from 17,2 ± 0,8 to 15,5 ± 0,9 mm Hg $p < 0,05$ by Student's t-test for related samples). In patients of the comparison group, despite intensive care, a probable increase in IAP on the first day after surgery (up to 17,7±1,1 mm Hg, $p < 0,05$) compared with hospitalization, a probable decrease in this indicator was achieved only on the 7th day of treatment (up to 14,7±1,1 mm Hg). Total complications occurred in 4 urgently operated patients (22,2%): three people in the comparison group (42,9%) and one - the main group (9,1%). Two patients of the comparison group died in the early postoperative period due to progressive cardiovascular failure. Complications also occurred in 4 patients (33,3%), in whom during the conservative measures were eliminated acute intestinal obstruction: three patients of the comparison group (75%) and one - the main group (respiratory failure - eliminated conservatively) (16,7%). One patient in the comparison group died due to the progression of renal failure. Thus, the use of a step-by-step approach in the complex treatment of IAH in patients with acute intestinal obstruction has significantly reduced the overall incidence of complications from 46,2% to 11,8% ($\chi 2=3,92$, $p<0,05$), the incidence of postoperative complications - from 55,6% to 8,3% ($\chi 2=4,79$, $p < 0,05$), and postoperative mortality - from 33,3% to a minimum ($\chi 2=4,44$, $p < 0,05$).

When comparing the results of treatment of patients with *acute peritonitis*, probably lower IAP values were registered in the main group starting from 3rd day of therapy (14,3±0,8 and 16,8±0,6 mm Hg, $p < 0,05$). The dynamics of indicators after surgery deserves special attention. In patients of the main group, elevated IAP values after surgery returned to baseline on the second day, and in patients of the comparison group - on the fourth. In addition, in the main group on the first day the IAP indicator/ values was on average higher by 5,6%, and in the comparison group - by 17,6%.

In total, complications were found in 8 patients with acute peritonitis (36,4%). The incidence of complications was exponentially higher in the comparison group: 6 out of 10 patients in the comparison group (60%) and in 2 out of 12 patients in the main group (16,7%), ($\chi 2 = 4,16$, $p<0,05$). In one patient of the comparison group with destructive cholecystitis (stage II IAH) and concomitant chronic renal failure, chronic renal failure progressed, resulting in death of the patient from multiple organ dysfunction syndrome (MODS). The second patient with perforation of the colon tumor (stage III IAH) developed acute cardiovascular insufficiency, which, despite intensive therapy, steadily progressed, leading to death. In the third patient of the comparison group with perforated duodenal ulcer (stage III IAH), the phenomena of MODS progressed, which led to his death (postoperative and overall mortality - 30%). Two patients of the main group developed acute respiratory failure, which was eliminated conservatively. That is, postoperative mortality was reduced from 30% to a minimum ($\chi 2 = 4,50$, $p < 0,05$).

When comparing the results of treatment in patients with *closed abdominal trauma* in patients of the main group after 3 days, a statistically significant decrease in IAP was obtained (from 17,5 ± 0,8 to 16,0 ± 0,6 mm Hg, $p < 0,05$). At patients of the comparison group, significant differences of indicators from basic were received on the fourth day of treatment. When comparing the results of treatment in the two groups, probably lower IAP values were registered in the main group starting from 9 days of therapy (9,6 ± 0,4 and 12,9±0,9 mm Hg, $p < 0,05$). Complications developed in 9 patients with closed abdominal trauma (25%): in 7 (out of 17) (41,2%) patients of the comparison group and in two (out of 19) (10,5%) - the main group ($\chi 2=4,2$, $p<0,05$). Two patients of the comparison group died (11,8%): due to the progression of MODS in pancreatic slaughter and thromboembolic complications after splenectomy. In the main group, complications occurred in 2 patients: acute respiratory distress syndrome in a patient with pancreatic contusion and acute liver failure in a patient with splenic injury (the patient died). That is, we managed to identify a tendency to reduce postoperative mortality from 11,8% to 5,2% ($p > 0,05$).

When comparing the results of treatment in patients with *strangulated abdominal wall hernia* in patients of the main group, IAP values were probably lower in a day after hospitalization (16,34±0,75 and 13,8±0,63 mm Hg, respectively, $p<0,05$). In patients of the comparison group, on the contrary, the IAP probably increased one day after the start of therapy (16,79 ± 0,94 and 18,26±0,77 mm Hg, respectively, $p < 0,05$), returned on the second day to baseline and became significantly lower only on the seventh day of therapy (16,79 ± 0,94 and 13,83±1,11 mm Hg, respectively, $p < 0,05$). Complications in the early postoperative period occurred in 10 patients with strangulated hernias of the abdominal wall (35,7%): 2 patients (13,3%) of the main group and 8 patients (61,5%) of the comparison group ($p<0,01$). In one patient with a strangulated postoperative ventral hernia from the comparison group, acute respiratory failure progressed, leading to death. Three patients in the comparison group developed thromboembolic complications, which led to the death of patients. That is, mortality in the comparison group was probably higher, four patients of the comparison group died and none in the main group ($\chi 2 = 5,5$, $p < 0,05$).

In *laparoscopically operated patients*, an important factor in the control of IAH was the elimination of postoperative pain by multimodal analgesia (systemic and local use of non-narcotic analgesics), which in a set of treatment mea-

Table I. The structure of systemic complications

Complications	Total	Groups of patients				Differences in the frequency of complications
		The main		The comparison group		
		n	%	n	%	
Acute respiratory failure	24(12,8)	6	5,9	18	21,2	P=0,002 χ^2=9,6
Cardiovascular insufficiency	14(7,5)	4	3,9	10	11,8	P=0,002 χ^2=9,6
Acute liver failure	2(1,1)	1	0,9	1	1,1	P=0,9 χ^2=0,02
Multiple organ failure	13(7,0)	1	0,9	12	14,1	P=0,02 χ^2=15,4
Thromboembolic complications	5(2,7)	–	–	5	5,9	P=0,0004 χ^2=12,5
Total	58(31,0)	12	11,8	46	54,1	P=0,0001 χ^2=38,6

sures contributed to a statistically significant reduction in IAP in the main group compared to the comparison group, starting from the 2nd day of the postoperative period. (11,8 ± 0,8 and 15,2 ± 1,2 mm Hg, p <0,001). Postoperative complications occurred in 11 patients (30,6%) (in one patient of the main group (4,8%) and in 10 patients (66,7%) - comparison (χ2 = 14,3, P = 0,0002).

To summarise the above, the structure of systemic complications in patients who received comprehensive treatment is shown in Table I.

Thus, systemic complications occurred in 12 patients in the main group (11,8%) and in 46 patients in the comparison group (54,1%), and in the second group the frequency of systemic complications was significantly higher (χ2 = 38.6, p <0, 0001). 20 patients (10,7%) died (2 patients in the main group (1,96%) and 18 patients in the comparison group (21,2%) (χ2 = 17,85, p<0,0001).

DISCUSSION

The development of IAH in acute surgical pathology of the abdominal cavity is caused by both internal factors (increase in intestinal volume due to paresis, intestinal edema, accumulation of fluid, gas in the abdominal cavity, etc.) and external factors (decrease in the volume of the anterior abdominal wall by abdomino - or hernioplasty, its compression in the early postoperative period with bandages, etc.), as well as a combination of these factors. It should be noted that the measurement of IAP by prolonged monitoring of MBP enables to timely select and initiate the necessary treatment tactics aimed at combating IAH and avoid the development of ACS. It is clear that the stage of care for patients with IAH syndrome is conditional. Thus, in acute pancreatitis, the fight against intestinal paresis in the early stages of the disease includes, in addition to medical correction, decompression of the gastrointestinal tract and cleansing enemas, and PEA [10]. However, the use of a staged approach in the prevention and treatment of intra-abdominal hypertension immediately after hospitalization allows to limit the measures of the first level in 67,6% of cases, the second - in 22,5% and to avoid decompression laparostomy. It is well known that the effectiveness of ETF depends on the timing of recovery of intestinal motor function and intestinal absorption [11]. Even after normalization of these functions, an increase in the volume and concentration of the solution for ETF can cause an increase in intestinal dysphagia and, as a consequence, the progression of IAH. Therefore, in the 2nd stage, you should reduce the volume of the solution, avoid the use of concentrated solutions.

CONCLUSIONS

1. IAH is an important factor in the pathogenesis of acute surgical pathology of the abdominal cavity, which significantly affects the prognosis.
2. The development of IAH in acute surgical pathology of the abdominal cavity is caused by both internal factors (paresis, intestinal edema, accumulation of fluid, gas) and external factors (reduction of the volume of the anterior abdominal wall due to surgery or its external compression), as well as a combination these factors.
3. The use in the complex treatment of patients with acute surgical pathology of the abdominal cavity, accompanied by IAH, the proposed step-by-step approach has improved the treatment of this category of patients by reducing the incidence of systemic complications from 54,1% to 11,8%, overall mortality from 21,2% to 1,96% and postoperative mortality - from 22,4% to 2,4%.

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The work was performed in accordance with the plan of research work of the Department of Surgery №2 of Bogomolets national medical university: "Development and implementation of methods for diagnosis and treatment of surgical pathology of the abdominal cavity and blood circulation". The authors did not receive additional financial support.

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Conflict of interest:
The Authors declare no conflict of interest.

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Received: 25.03.2021
Accepted: 28.08.2021

A - Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article