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Intra-abdominal Hypertension at Combined Injuries of the Abdominal Organs

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Abstract The largest cavity of the human body is the abdominal cavity where there is a huge system of blood flow and many nerve endings, i.e. a huge receptor system. An increase of intra-abdominal pressure above normal levels can lead to negative consequences. Intra-abdominal pressure is a nonspecific manifestation of various surgical diseases. Therefore, high intra-abdominal pressure has independent practical importance. In pathological conditions, an increase of intra-abdominal pressure plays, may be not a key role in the development of systemic disorders, but competes with the leading damaging states. It has been proved that an increase of intra-abdominal pressure can have both a direct mechanical effect on the abdominal organs, and indirectly, through the diaphragm, on the lungs and heart, until the development of acute respiratory failure and decompensated circulatory failure. We have conducted a study of intra-abdominal pressure in 84 patients with combined abdominal trauma from 2008 to 2018in the Samarkand branch of the RRCEM. The age of the victims varied from 18 to 70 years (30.5 ± 8.9), while the majority of the victims were people of working age (up to 50 years), mostly men (n = 69). Combined abdominal injuries were accompanied by craniocerebral injury in 37 (44%) patients. The cause of the injury in most cases was a traffic accident (n = 67-79.7%), an unlawful injury - in 10 (11.9%) cases, catatrauma - in 7 (8.4%) victims. Alcohol intoxication was observed in 41 (48.8%) patients. In those patients whose surgery ends with suturing the abdominal wound tightly there is a high risk for developing intra-abdominal pressure and intra-abdominal hypertension syndrome. The signs of multiple organ failure were significantly expressed in the same group of patients, one of the reasons for which can be an increased intra-abdominal hypertension. Intra-abdominal pressure higher than 12 mm Hg is a "borderline" indicator, the increase of which leads to an increase of mortality.

Keywords Abdominal trauma, Intra-abdominal pressure, Intra-abdominal hypertension syndrome

1. Introduction

Intra-abdominal pressure (IAP) is the formed pressure in the abdominal cavity. The IAP is normally approximately 5 mm Hg. A significant increase in intra-abdominal pressure occurs in 30% of casesat severe polytrauma, peritonitis. Syndrome of intra-abdominal hypertension (SIAH) (in the English-language sources Abdominal Compartment Syndrome (ACS)) is a pathological complex of symptoms that develops as a result of increased intra-abdominal pressure and is manifested by the onset of multiple organ failure [1-2] and is observed in 5.5% of such patients, with a mortality rate of 42% to 68% [3-4,14]. According to the data,in patients who were operated on due to the closed abdominal organ injury, ACS was up to 15% [11,14]. Due to the fact that against the background of an increase in intra-abdominal pressure, the development of multiple organ failure (MOF) is possible, mortality in patients with diagnosed ACS, according to the data, reached 70% [5,13]. Intra-abdominal pressure occupies a special place among the causes of multiple organ failure that arise after surgeries on the abdominal organs at severe polytrauma. In 1872 E. Wendt was the first to report on the phenomenon of intra-abdominal pressure, illustrated the formation of MOF and the high mortality rate of experimental animals which underwent an artificial increase of intra-abdominal pressure [6].

The relevance of intra-abdominal hypertension in severe patients who are in serious condition is constantly increasing. There are evidences that the progressive increase of intra-abdominal pressure in these patients significantly increases the mortality rate [3,7]. Due to the considerable wording in the definition of ACS and its conducting, the first ever conference which was devoted to the problems of ACS was held in 2004. After multicenter international studies, the concept of the syndrome, the methodology of instrumental examination of patients were formulated, and methods for prevention and therapy were proposed [1,12]. According to data that have been cited in foreign literature, the numbers on

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the incidence of ACS vary significantly [8]. There are many reasons that can lead to the formation of ACS, but most often this syndrome occurs after severe injury of the abdominal organs, intra- or extra-abdominal bleeding [2,9].

Aim of the study is to establish the diagnostic reliability of the intra-abdominal hypertension control for the choice of treatment method in patients with abdominal polytrauma.

2. Materials and Methods

A study of intra-abdominal hypertension was performed in 76 patients with combined abdominal injury for the period of 2008-2018. The age of the studied victims ranged from 18 to 70 years (30.5 ± 8.9), while the majority of the victims were people of working age (up to 50 years), mostly men (n = 61). In 37 (48.6%) patients combined abdominal injuries were accompanied by traumatic brain injury. The cause of the injury in most cases was a traffic accident (n = 61-80.2%), in 10 (13.1%) patients - a wrongful injury, in 7 (9.2%) ones - a catatrauma. Alcohol intoxication was observed in 41 (53.9%) cases.

The "golden standard" of the indirect measurement of intra-abdominal hypertension today is the use of the urinary bladder. Since the wall of the urinary bladder is well tensile and elastic, with a volume of not more than 25 ml it acts as a passive membrane and shows intra-abdominal pressure (IAP) for certain [9,10].

3. Results and Discussion

According to the investigation protocol, IAP was measured upon admission to the ICU from the operating room and then every 6 hours for 5 days. These IAP indices are presented in table 1.

Table 1. Indices of intraabdominal pressure (IAP)

Index	Characteristics
Measurement	IAP, mm Hg, it is necessary to determine at the end of exhalation lying in a state of relaxation of the muscles of the abdominal wall using a sensor zeroed at the level of the mid-axillary line. Exemplary is the measurement through the bladder by the injection of 25 ml of a sterile solution of sodium chloride
Normal index	Up to 5-7 mm Hg.
Intraabdominal hypertension (IAP)	Persistent or recurrent pathological increase in IAD 12 mm Hg
IAP classification	1st stage of severity: 12-15 mmHg 2nd stage of severity: 16-20 mmHg 3rd stage of severity: 21-25 mmHg 4th stage of severity: >25 mmHg
Abdominal Compartment Syndrome	It is characterized by persistent IAD greater than 20 mm Hg associated with emerging organ disorders or insufficiency

Surgical interventions in 40 patients were completed by suturing the anterior abdominal wall tightly, in 9 patients - "Damage control" with temporary closure, and in 27 patients - "Damage control" with laparostomy (table 2).

Table 2. IAP in patients during the admission from the operating room

IAP, mmHg	Severity stage	Tight sewing n=40	"Damage control" with temporary closure of abdominal injuries n=9	"Damage control" with laparostomy n=27
12-16, n	I	11	5	27
17– 20, n	II	22	2	–
21-25, n	III	7	2	–
Total		40	9	27

Intraabdominal pressure was not detected in the third group of patients (patients with laparostomy). In patients of the first and second groups upon admission to the ICU IAP> 12 mm Hg was 76.8% and 36.4%, respectively ($p < 0.05$). Among the patients included in the first group, there was a significantly higher incidence of IAP from 16 to 20 mm Hg compared with the second group ($p < 0.05$).

During the IAP assessment, it was revealed in dynamics that in patients of the 2nd and 3rd groups this criterion was identical (without the presence of significant deviations) and after the entire observation period compared with the 1st group, in the presence of significant differences in the 1st , 2nd and 4th day of observation ($p < 0.05$) (Fig.1).

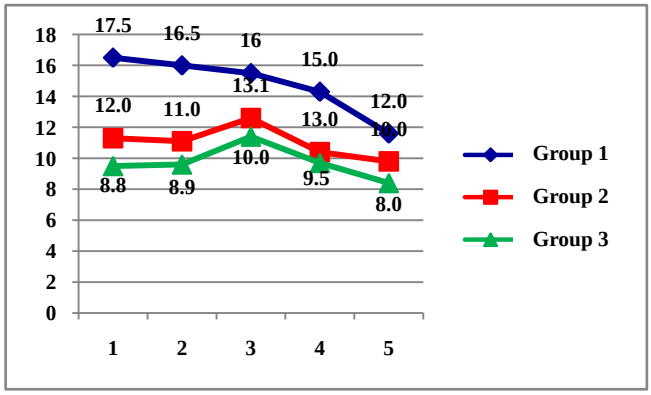

Figure 1. Dynamics of intra-abdominal pressure over 5 days in patients with various options for closing the abdominal wound

The increase of intra-abdominal pressure in the second and third groups of victims on the 3rd day, apparently, was associated with the second stage of surgical treatment and the final closure of the wound. Abdominal Compartment Syndrome (ACS) was developed in 15 (37.5%) patients of the first group. In the second group of patients, despite an increase in IAP of more than 12 mm Hg no cases matching ACS criteria have been identified. The frequency of the organ dysfunction development according to the criteria [12] and the SOFA score were compared on the second day of the postoperative period, since it was during this time period that

the most significant difference in IAP indices was revealed between the first and second, and the first and third groups (Table 3).

Table 3. Organ dysfunction and SOFA score on day 2 of the postoperative period

Groups Systems	Tight sewing, n=40 (100%)	"Damage control" with temporary closure of abdominal injuries, n=9 (100%)	"Damage control" with laparostomy n=27 (100%)
Cardio-vascular system	9(22.5%)*	5 (55.5%)	9(37.03%)
Urinary system	18(45%)*	2 (22.2%)	6 (22.2%)
Respiratory system	34 (85%)	9 (100%)	17 (62.9%)
Coagulation system	4 (10%)	2 (22.2%)	1 (3.7%)
Metabolic dysfunction	13 (32.5%)*	1 (11.1%)	2 (7.40%)
Central nervous system (CNS)	35(87.5%)	7(77.7%)	29 (107.4%)
SOFA, point	7.3±1.8*	3.4±1.5	3.7±1.8

Note: •– significant differences between the first and second, the first and third groups.

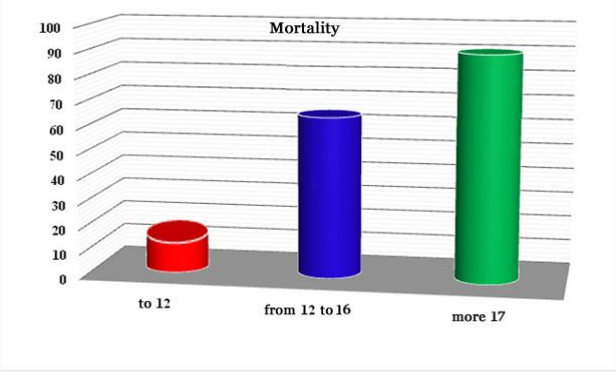

Figure 2. Mortality (%) in groups depending on the IAP rate

The high incidence of acute cerebral insufficiency in all groups is explained by the nature of the injury, that is, abdominal injuries were almost always combined with craniocerebral, which caused a neurological deficit by the Glasgow coma scale. Manifestations of hepatic impairment were not noted in any of the cases, and disturbances of the coagulating system were also rare and did not significantly differ between the groups. But, nevertheless there were significantly more patients with disorders in the cardiovascular, urinary and metabolic systems, in the first group. This group of patients actually needed much more inotropic therapy. The SOFA score gave a truly greater score in the severity of organ disorders in the first group. The overall mortality rate in patients (from 76) with abdominal injuries with severe polytrauma was 67.8%. 35 from 40 (87.5%) patients of the first group died, in the second - 4 from 9 (44.4%), and in the third - 13 from 27 (48.1%). Differences between the 2nd and 3rd groups are not significant ($p < 0.05$). However, the differences in the indices of the 1st and 2nd , the 1st and 3rd groups are significant ($p < 0.05$). The treatment results were studied in absolutely all patients with different IAP scores at the time of admission to the ICU. The average IAP in those patients who survived was 8.5 ± 3.2 mm Hg, and in deceased patients it made up 24.2 ± 1.8 mm Hg ($p < 0.05$). But in this case, there was a natural dynamics of increasing mortality with increasing of IAP. Moreover, mortality in patients with ACS (n = 12) was 100%. Then, the mortality depending on the IAP upon their admission to the ICU was analyzed (Fig. 2).

4. Conclusions

In those patients in whom the operation ends with suturing the anterior abdominal wall tightly, the risk of IAP developing is high and the probability of ACS developing is high. In the same group of patients, signs of multiple organ failure are significantly evident, one of the reasons for which may be increased intra-abdominal hypertension. ACS is a rather unfavorable prognosis complication. The intra-abdominal pressure is greater than 12 mm Hg is a "borderline" indicator, the increase of which leads to an increase of mortality.

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