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A COMPARISON OF INTRA-GASTRIC PRESSURE AND INTRA-VESICAL PRESSURE

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ABSTRACT

Objective:. To compare the values of intra-abdominal pressure obtained by intra-gastric measurement with those recorded by intra-vesical validated monitoring technique.

Materials and methods: *Technique for transesophageal intragastric intermittent monitoring of IAP:* Nasogastric tube type Levin (CH/ FG 18 85 cm, MPI, Germany) was connected by a conical connector (REF 4438450, B. Braun, Germany) by an extension line for low pressure (REF 5205263, B.Braun, Germany) and a three way stopcock with reusable transducer (840, 50 μV/ V/ cmHg, Sensonor AS Horten, Norway).

Technique for intermittent measurement of intravesical transurethral intra-abdominal pressure with closed system: The Foley catheter was connected by Y-connection (PB1204, Coloplast AS, Denmark), one end was connected to the drain manifold for urine, and the other to a conical connector (B.Braun REF: 4896629, alternatively B. Braun REF: 4438450) by an extension tube for low pressure measuring (B.Braun REF: 5205263) forming an installation consisting of two series-mounted three way stopcock, a camera (B.Braun REF: 5204100) for reusable transducer (840, 50 μV/ V/ cmHg, Sensonor AS Horten, Norway) and third three way stopcock used to zeroed the transducer.

Results

The study group consisted of 30 patients (n = 30), age: 64,4 (± 9,16) years, of which 22 men (73%), with BMI: 26,55 (± 3.23) kg/ m². Although there are statistically significant differences between values of intra-abdominal pressure measured by the intra vesical and intra gastric method with an average difference of 1.5 to 2,5 mmHg, we can assume that the intra-gastric measurement with Ian Levine nasogastric tube type is cheap and reliable method of assessment of intra-abdominal hypertension, especially when there are contraindications for intra-vesical monitoring

Key words: abdominal compartment syndrome, intra-abdominal hypertension

Intra-abdominal hypertension (IAH) has a multiple harmful effect causing dysfunction and failure of systems in the body. Before claiming the diagnosis of present IAH, the increase of intra-abdominal pressure (IAP) should be regarded as a reflection of a new pathological phenomenon taking place in the abdominal cavity. The duration effect of IAH is usually of greater prognostic value than the increase of absolute value of IAP in relation to patients' outcome. Patients with prolonged untreated elevated levels of IAP due to inadequate perfusion usually end up with subsequent organ failure (1).

Over the last decade by means of better diagnosis and multidisciplinary management survival of patients with developed intra-abdominal hypertension and abdominal compartment syndrome (ACS) has improved significantly. The main cause for this progress is the introduction of protocols for serial measurements of IAP values, which helps establishment of IAH on time, the use of non-surgical strategies to reduce intra-abdominal pressure and restore perfusion of intestines and performance of decompressive laparotomy in

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case of refractory intra-abdominal hypertension (2).

PURPOSE

To compare the values of intra-abdominal pressure obtained by intra-gastric measurement with those recorded by intra-vesical validated monitoring technique.

MATERIALS AND METHODS

Technique for transesophageal intragastric intermittent monitoring of IAP

Nasogastric tube type Levin (CH/ FG 18 85 cm, MPI, Germany) was connected by a conical connector (REF 4438450, B. Braun, Germany) by an extension line for low pressure (REF 5205263, B.Braun, Germany) and a three way stopcock with reusable transducer (840, 50 μV/ V/ cmHg, Sensonor AS Horten, Norway). The correct intragastric position was confirmed by aspiration of gastric contents, auscultatory phenomena of insuflated air through the tube, increasing IAP after applying epigastric pressure, and pH of the aspirated fluid. The proper functioning of the nasogastric tube was assessed by insuflating 100 ml of sodium chloride into the stomach through a 50 ml syringe. After connecting the installation which was pre-filled with fluid probe (about 10 ml), we insuflated 50 ml solution and recorded the average value of pressure at the end of the expirium in a patient who was lying still on the bed, and the transducer was reset at the level of the mid-axillary line. The values of the intra-gastric pressure (IGP) were registered in mmHg (3).

Technique for intermittent measurement of intravesical transurethral intra-abdominal pressure with closed system.

The Foley catheter was connected by Y-connection (PB1204, Coloplast AS, Denmark), one end was connected to the drain manifold for urine, and the other to a conical connector (B.Braun REF: 4896629, alternatively B. Braun REF: 4438450) by an extension tube for low pressure measuring (B.Braun REF: 5205263) forming an installation consisting of two series-mounted three way stopcock, a camera (B.Braun REF: 5204100) for reusable transducer (840, 50 μV/ V/ cmHg, Sensonor AS Horten, Norway) and third three way stopcock used to zeroed the transducer. The measurements were performed by placing the patients in a fully supine position at the end of the experium, due to the effect of elevation on the values (4, 5, 6). In all patients receiving analgetics the assessment of pain according to the Numeric Rating Scale was below 3 (7). Patients with residual gastric volume of more than 300 ml/24 hours were excluded from the study (8). The values of intra-vesical pressure (IVP) were registered in mmHg. Both pressures (intra-gastric and intra-vesical) were measured simultaneously by registering the average value from the monitor.

From March 2012 to June 2012 a prospective observational study was performed in the intensive care unit- KASIM of the University Hospital in Stara Zagora, in which we studied patients over 18 years, not in the risk group of IAH, indicated for insertion of nasogastric tube and urethral catheter, without any contraindication for both intra-gastric and intra-vesical monitoring. The average values of these results were used for the statistic analysis with the use of significance level $P < 0.05$.

RESULTS

The study group consisted of 30 patients (n = 30), age: 64,4 (± 9,16) years, of which 22 men (73%), with BMI: 26,55 (± 3.23) kg/ m².

Descriptive statistics and test of D'Agostino & Pearson for normality of distribution of the recorded values of intra-abdominal pressure measured by the two techniques described (IGP and IVP) as an arithmetic mean, standard deviation, minimum and maximum are presented in **Table 1**.

From the conducted parametric analysis paired t test we established a significant difference in the measured value of intra-abdominal pressure by intra-gastric and intra-vesical method presented in **Table 2** and **Figure 1**.

DISCUSSION

The pathophysiological effects of raised intra-abdominal pressure include reduced venous return and decreased cardiac output, decreased lung compliance and increased airway pressure, alterations in renal blood flow resulting in a reduced glomerular filtration rate, and impaired blood flow to all abdominal organs. A pathological increase in IAP has negative effects on the splanchnic, respiratory, cardiovascular, renal and neurological function. Intra-abdominal hypertension, especially grades 3 and 4 (IAP>20 mmHg), is associated with an increased risk of intra-abdominal sepsis, bleeding, renal failure,

and death. IAH and abdominal compartment syndrome are associated with significant morbidity and mortality (9, 10, 11, 12, 13, 14). The reduction of IAP is a cornerstone of breaking the series of pathophysiological changes that trigger other harmful effects which result in a poor outcome for the patients (15, 16, 17).

Table 1. *Descriptive statistics and D'Agostino & Pearson test.*

Groups	IGP	IVP
Number of values	30	30
Minimum	2,000	3,000
25% Percentile	3,000	5,000
Median	5,000	6,000
75% Percentile	6,250	8,000
Maximum	8,000	9,000
Mean	4,867	6,033
Std. Deviation	1,889	1,884
Std. Error	0,3449	0,3440
Lower 95% CI of mean	4,161	5,330
Upper 95% CI of mean	5,572	6,737
D'Agostino & Pearson omnibus normality test		
K2	5,556	3,232
P value	0,0622	0,1987
Passed normality test (alpha=0.05)?	Yes	Yes
P value summary	ns	ns
Coefficient of variation	38.81%	31.23%
Geometric mean	4,465	5,707
Lower 95% CI of geo. mean	3,785	4,998
Upper 95% CI of geo. mean	5,268	6,516
Skewness	-0,05780	-0,2833
Kurtosis	-1,207	-0,9915
Sum	146,0	181,0

Table 2. *Paired t test*

Paired t test	
IGP vs IVP	
P value	< 0.0001
Are means signif. different? (P < 0.05)	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=8.558 df=29
Number of pairs	30
How big is the difference?	
Mean of differences	-1,167
95% confidence interval	-1.445 to -0.8879
R squared	0,7164
How effective was the pairing?	
Correlation coefficient (r)	0,9217
P Value (one tailed)	< 0.0001
Was the pairing significantly effective?	Yes

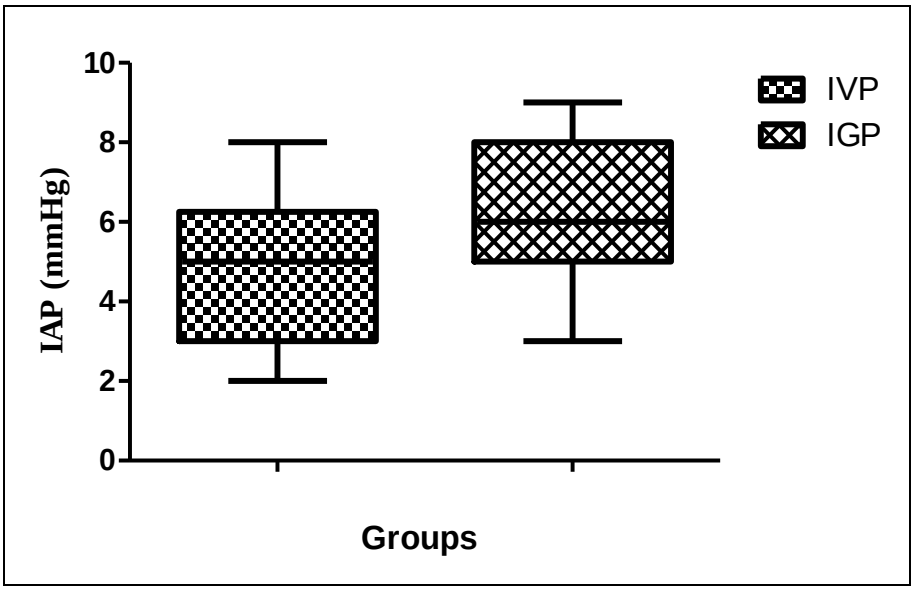

Figure 1. Box & whiskers plot of intra-abdominal pressure values measured by the intra-gastric and intra-vesical method.

According to the World Society of the Abdominal Compartment Syndrome (WASCS) the standard for intermittent monitoring of intra-abdominal pressure is the transvesical method introduced with a maximum volume of 25 ml sterile sodium chloride (1). However, this method is not applicable to all patients at risk of intra-abdominal hypertension and development of abdominal compartment syndrome, which requires the use of an alternative method, possibly technically less complex and less expensive, as it is the one measured with transducer pressure by a simple nasogastric tube.
When using an external transducer in which the system with a fluid column acts as an intermediary between the space of which we want to measure pressure and transducer, the hydrostatic pressure presses the transducer's diaphragm, which leads to changes in resistance and with an integrated circuit called Wheatstone bridge, changes in electricity transforms into pressure. This requires a reset and positioning of the transducer. Folding the lines and the presence of air bubbles cause measurement inaccuracies. As it is with intra-vesical, the intra-gastric IAP monitoring technique also carries the risk of false results, but when performed correctly, they can be easily avoided.

Collee et al. (1993) found that the intra-gastric pressure is approximately 2.5 cm H2O higher or lower than the intravesical simultaneously measured using the manometer technique. This is an inexpensive technique, which has no interference with the drainage of urine and the risk of urinary tract infections (18). Manometry is based on the principle of D. Bernoulli of fluid dynamics, the fluids may be used as an instrument for measuring pressure in the presence of gravity. Commonly used versions of the U-shaped tube half filled with liquid, one side of which communicates with the abdominal space pressure in which we are interested, and the other side is connected to the reference pressure (atmospheric). The difference in liquid level represents the applied pressure (2). It is the cheapest option for low pressure monitoring, but presents greater opportunities for subjectivity and errors of using a transducer and monitor invasive pressure measurements, given the fact that results are obtained in cmH2O and must be recalculated.

Most studies use the highest recorded values of IAP for classifying patients with intra-abdominal hypertension, not the average or median (19). We suggest that the use of average values should be a unified approach like it is in this study.
IAH may not only cause dysfunction of many organs and systems, but also can increase mortality in critically ill patients (20, 21, 22, 23, 24, 25). Mortality caused by IAP/ ACS varies from 30% to 80%. During the last decade mortality associated with ACS was reduced to

1/3 thanks to monitoring of the IAP and the early recognition of IAH with a suitable therapeutic scheme (5).

CONCLUSION

Although there are statistically significant differences between values of intra-abdominal pressure measured by the intra vesical and intra gastric method with an average difference of 1.5 to 2,5 mmHg, we can assume that the intra-gastric measurement with Ian Levine nasogastric tube type is cheap and reliable method of assessment of intra-abdominal hypertension, especially when there are contraindications for intra-vesical monitoring.

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