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THE INFLUENCE OF GASTRIC VOLUME IN THE MEASUREMENT OF INTRA-GASTRIC PRESSURE

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ABSTRACT

Objective: To establish the effect of introduced/ insufflated intra-gastric volume upon the intra-abdominal pressure.

Materials and methods: Transesophageal intragastrical technique for intermittent monitoring of IAP: The 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-port faucet with reusable transducer (840, 50 µV/ V/ cm Hg, Sensonor AS Horten, Norway). . According to the introduced amount of fluid the measured values of IAP were divided into 7 groups: Group A – 20 ml; Group B - 50 ml; Group C - 100 ml; Group D - 150 ml; Group E - 200 ml; Group F – 250 ml and Group G - 300 ml

Results: The study group consisted of 30 patients (n = 30), age: 64,4 (± 9,16) years, of which 22 men (73%), with VMI: 26,55 (± 3.23) kg/ m². Based on the results we can assume that the introduction of fluid volumes over 150 ml intragastrically for the purpose of measuring the intra-abdominal pressure through a hydraulic system with an external transducer by the described above technique will result in false elevated values of IAP. On the other hand there is no need to introduce more than 20 ml of fluid as they appear sufficient for the proper coupling of the transducer to the fluid column.

Key words: abdominal compartment syndrome, intra-abdominal hypertension, intra-abdominal pressure

INTRODUCTION

It is inaccurate to determine the presence of intra-abdominal hypertension (IAH) only by clinical examination. There is a standardized measurement of intra-abdominal pressure which is fundamental for defining the intra-abdominal hypertension and the abdominal compartment syndrome (ACS) (1, 2).

IAH contributes for the development of multiple organ dysfunction (MODS). At the beginning the process is mainly mechanical causing significant organ dysfunction mostly due to the effect of the increased pressure on the organ perfusion and function. Meanwhile progressive and untreated IAH induces immune and inflammatory effects which may result in progressive organ dysfunction known as MODS (3, 4). Intra-abdominal hypertension and abdominal compartment syndrome are associated with significant morbidity and mortality. The identification of patients at risk of developing IAH / ACS by screening measurement of IAP is important in order to undertake early effective preventive therapeutic actions (5).

Direct monitoring of IAP is not indicated and applied in intensive care units due to its high degree of invasiveness. Indirect measurement of IAP on the other hand can be accessed through the natural openings of the abdominal cavity: transesophageal intragastrical; transvaginal intrauterine; transanal intrarectal; intravesical transurethral, percutaneous transfemoral to the subdiaphragmatic inferior vena (6). Monitoring of intra-abdominal pressure of critically ill patients is not routinely undertaken in the intensive care units in the country. On the other

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hand guidelines of World Society of the Abdominal Compartment Syndrome (WSACS), recommend the use of the intravesical method, but not as a "golden standard" as it was in the previous publications of the society. In regards to the monitoring and used sets of techniques there is still much to debate (6).

Some of the disadvantages of the transurethral intravesical method are possible contraindications when performed on patients with diseases, bleeding, surgery or trauma to the bladder, the higher risk of urinary tract infections including sepsis of urinary origin. Most of the poly-traumatized patients have tampered pelvic bones, lacerations of the soft tissues in the abdominal-pelvic region with intraperitoneal and retroperitoneal hematoma. These patients however are at risk of developing IAH and are contraindicated for intravesical measurement and therefore need to be monitored in an alternative way.

The transesophageal intragastric method for measuring IAP uses a natural access to the abdominal space just like the intravesical method. There are two main techniques one of which requires the use of ordinary nasogastric tube and the other nasogastric tube with balloon. The last one requires special equipment and is relatively more expensive (1, 7, 8, 9, 10).

The effect of intravesical insufflated volume upon the IAP is well studied by several authors and is defined as a recommendation of the WSACS, while there is no electronic database on the effect of the introduced intragastrical volume on the intra-gastric pressure (11, 12, 13, 14).

PURPOSE

To establish the effect of introduced/ insufflated intra-gastric volume upon the intra-abdominal pressure.

MATERIALS AND METHODS

Transesophageal intragastrical technique for intermittent monitoring of IAP. The 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-port faucet with reusable transducer (840, 50 μV/ V/ cm Hg, Sensonor AS Horten, Norway). The accurate position of the nasogastric tube was confirmed by aspiration of gastric contents, auscultatory phenomena of insufflated air through the tube, the increasing of IAP after application of epigastric pressure, and pH of the aspirated stomach fluid.

The proper functioning of the nasogastric tube was assessed by a gastric lavage with 100 ml sodium chloride with a 50 ml syringe. After connecting the installation with a pre-filled up with fluid (around 10 ml), we introduced 20 ml and registered the average value of IAP, then an additional amount of fluid was administered through the three-way tap faucet with a 50 ml syringe and the results were reported for each of the target volumes.

The intra-abdominal pressure was measured at the end of the expirium, as the patient was lying in a still position on the bed and the transducer was reset on the level of medium axillary line. Whenever presence of air bubbles in the system was observed if necessary we re-washed the entire hydraulic system in order to avoid recording of false results. According to the introduced amount of fluid the measured values of IAP were divided into 7 groups: Group A – 20 ml; Group B - 50 ml; Group C - 100 ml; Group D - 150 ml; Group E - 200 ml; Group F – 250 ml and Group G - 300 ml.

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, without any contraindication for intra-gastric monitoring of IAP. 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 VMI: 26,55 (± 3.23) kg/ m^2.

The measured values of intra-gastric pressures according to the different applied volumes are presented in **Table 1** as an average, minimum, maximum, standard deviation, standard error and confidence interval. The same table provides a test for normality of the distribution of D'Agostino & Pearson.

Table 1. *Descriptive statistics.*

Group	A	B	C	D	F	G	H
Number of values	30	30	30	30	30	30	30
Minimum	2,000	2,000	2,000	2,000	3,000	5,000	6,000
25% Percentile	3,000	3,000	3,750	4,750	5,750	8,000	8,750
Median	5,000	5,000	5,500	6,000	7,000	9,000	10,00
75% Percentile	6,000	6,250	7,000	7,000	8,000	10,00	11,00
Maximum	8,000	8,000	8,000	9,000	10,00	12,00	14,00
Mean	4,767	4,867	5,133	5,767	6,900	8,567	10,03
Std. Deviation	1,794	1,889	1,852	1,870	1,863	1,888	2,109
Std. Error	0,3276	0,3449	0,3381	0,3413	0,3402	0,3447	0,3850
Lower 95% CI of mean	4,097	4,161	4,442	5,069	6,204	7,862	9,246
Upper 95% CI of mean	5,437	5,572	5,825	6,465	7,596	9,272	10,82
D'Agostino& Pearson omnibus normality test							
K2	4,823	5,556	5,146	1,882	1,839	0,4608	0,08051
P value	0,0897	0,0622	0,0763	0,3903	0,3987	0,7942	0,9605
Passed normality test?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P value summary	ns	ns	ns	ns	ns	ns	ns
Coefficient of variation	37.64%	38.81%	36.08%	32.42%	27.01%	22.04%	21.02%
Geometric mean	4,396	4,465	4,753	5,414	6,607	8,346	9,806
Lower 95% CI of geo. mean	3,744	3,785	4,060	4,690	5,867	7,630	9,024
Upper 95% CI of geo. mean	5,160	5,268	5,565	6,249	7,440	9,128	10,66
Skewness	-0,08482	-0,05780	-0,2435	-0,3825	-0,5639	-0,2755	-0,09415
Kurtosis	-1,160	-1,207	-1,160	-0,7311	-0,2293	-0,1704	-0,2758
Sum	143,0	146,0	154,0	173,0	207,0	257,0	301,0

The statistical analysis Repeated Measures ANOVA **(Table 2)** showed significant difference in the measured values of pressure at the introduction of different volumes of liquid intragastrically. From the multiple comparison test Dunnett **(Table 3)** it is apparent that there is no statistically significant difference between the measurement results after the introduction of 20 ml, 50 ml and 100 ml, and that the presence of significant difference between the results is obtained with larger volumes which is shown on **Figure 1**.

Table 2. *Repeated Measures ANOVA*

Repeated Measures ANOVA		ANOVA Table	SS	df	MS
P value	< 0.0001	Treatment (betweencolum.)	748,6	6	124,8
Are means signif. different? (P < 0.05)	Yes	Individual (between rows)	652,1	29	22,49
Number of groups	7	Residual (random)	78,56	174	0,4515
F	276,3	Total	1479	209	
R squared	0,9050	Was the pairing significantly effective?			
R squared	0,4408	Is there significant matching? (P < 0.05)			Yes
F	49,81	P value	< 0.0001		

Table 3. *Dunnett's Multiple Comparison Test*

Dunnett's Multiple Comparison Test	Mean Diff.	q	Significant? P < 0.05?	95% CI of diff
Group A vs Group B	-0,1000	0,5764	No	-0.5511 to 0.3511
Group A vs Group C	-0,3667	2,113	No	-0.8177 to 0.08440
Group A vs Group D	-1,000	5,764	Yes	-1.451 to -0.5489
Group A vs Group E	-2,133	12,30	Yes	-2.584 to -1.682
Group A vs Group F	-3,800	21,90	Yes	-4.251 to -3.349
Group A vs Group G	-5,267	30,36	Yes	-5.718 to -4.816

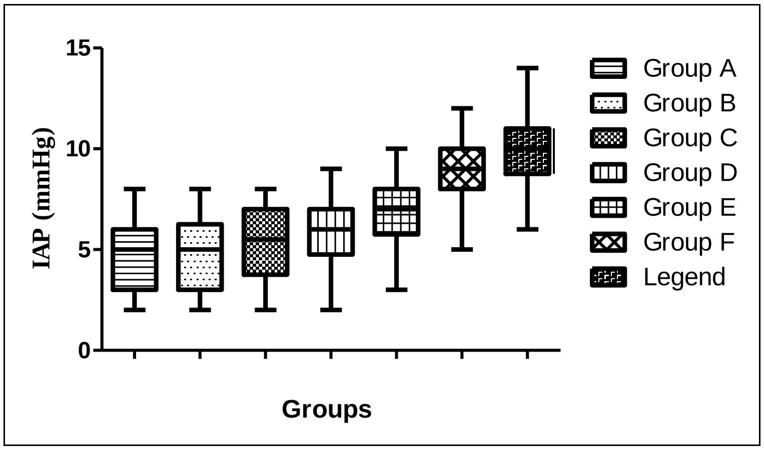

Figure 1. IAP according to the introduced liquid volumes.

DISCUSSION

This technique for monitoring of the intra-abdominal pressure is cheap; there is no interference with the drainage of urine and risk of urinary tract infections. Some of the disadvantages include the interference of the enteral feeding and migratory motor complex that originate in the stomach and are generated every 5-10 minutes in the phases between each meal and continue for about a minute. All the air from the stomach should be aspirated, but full evacuation is difficult to achieve. As it often happens there is a residual gastric content which is not evacuated, particles get into the tube and as a consequence false results are reported especially in cases of intestinal contents into the stomach. The mid-axillary line at the level of processus xiphoideus is used for zeroed and when the patient is not in a complete horizontal position a significant deviation in the measurements of intra-gastric pressure occurs, and higher values are recorded, as it also happens with the intravesical method of monitoring (1, 15, 16, 17).

We should consider the large amount of residual gastric volume which is normally observed in critically ill patients and is the reason for experiencing difficulties when measuring IAP by the intra-gastrical method (18).

For an accurate measurement of intra-abdominal pressure intragastrically it is necessary to have sufficient volume of fluid in the stomach and the hydraulic system providing transmission of hydrostatic pressure to the transducer, with no air bubbles or larger air collections.

When introducing a little more than 25 ml of liquid intravesically there is a chanse for false results due to the overextension of the bladder walls, and in this case we measure the compliance of the bladder rather than the equilibrium pressure of the abdominal space (11, 12, 13, 14). The stomach has different characteristics (compliance) when compared with the bladder, and also opens at both ends, and therefore the introduction of liquid volumes within the range of 20 to 150 ml causes no significant effect upon the measured values established in our study.

CONCLUSION

Based on the results we can assume that the introduction of fluid volumes over 150 ml intragastrically for the purpose of measuring the intra-abdominal pressure through a hydraulic system with an external transducer by the described above technique will result in false elevated values of IAP. On the other hand there is no need to introduce more than 20 ml of fluid as they appear sufficient for the proper coupling of the transducer to the fluid column.

The optimization of organ function and identification of clinical events that have a negative effect on patients' outcome is crucial for the good medical practice in the intensive care units. The IAP became a significant prognostic factor for the objective condition of not only surgical critically ill patients but also of therapeutic ones. Intensive monitoring and diagnosing the causes for IAH is of great importance (3).

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