Effects of Different Intraabdominal Pressure Values on Internal Jugular Vein, Liver and Kidney Functions in Obese Patients Undergoing Laparoscopic Sleeve Gastrectomy

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Abstract

Objective: The aim of this study was to investigate whether there was a difference in LSG performed with 10 mmHg and 13 mmHg intraabdominal pressure values in terms of their effects on the internal jugular vein (IJV) diameter and volume and the results of liver and kidney function tests evaluated in blood. Material and Method: The patients were divided into two groups to apply LSG with 10 mmHg and 13 mmHg intraabdominal pressure. The patients' age, additional disease, surgery history, height, weight, body mass index, family history, intraabdominal pressure value applied during surgery, duration of surgery, length of hospital stay, and the right IJV diameter and volume on the Doppler ultrasound before intubation during surgery (t1), 10 minutes after insufflation (t2), and at the end of insufflation (t3) were recorded. Results: Preoperative and postoperative kidney and liver function values of the patients in both groups were within the reference range. In both groups, while there was a significant decrease in the IJV diameter and flow measurement values at t2 compared to t1, and a significant increase was observed at t3 compared to t2 ($p<0.05$). The mean IJV diameter and flow were significantly higher in the 10 mmHg pressure group compared to the 13 mmHg group ($p<0.05$). Conclusion: We consider that LSG performed with CO2 pneumoperitoneum at low pressure is a safe, effective and feasible method that can facilitate the application of intraoperative central venous catheterization due to less changes in the IJV diameter and volume compared to the standard technique.

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measurement values at t2 compared to t1, and a significant increase was observed at t3 compared to t2 ($p<0.05$). The mean IJV diameter and flow were significantly higher in the 10 mmHg pressure group compared to the 13 mmHg group ($p<0.05$).

Conclusion:

We consider that LSG performed with CO_2 pneumoperitoneum at low pressure is a safe, effective and feasible method that can facilitate the application of intraoperative central venous catheterization due to less changes in the IJV diameter and volume compared to the standard technique.

Keywords: laparoscopic sleeve gastrectomy, internal jugular vein catheterization, liver and kidney functions

Consent of all patients was obtained.

Approval for the study was obtained from the local ethics committee of the University of Health Sciences Numune Training and Research Hospital. (E-19-2576)

Laparoscopic sleeve gastrectomy is widely performed all over the world. Our study emphasizes that LSG with low intra-abdominal pressure may be beneficial especially in patients who require central catheterization during the operation.

Introduction:

Laparoscopic sleeve gastrectomy (LSG), first introduced in the treatment of morbid obesity in 1993 by Marceau et al., is a bariatric surgical procedure defined as an alternative to distal gastrectomy, which is the restrictive part of malabsortive duodenal switch surgery. Today, the popularity of LSG is increasing. The procedure usually involves resection of 80% of the stomach with the help of a vertical or laparoscopic stapler, starting approximately 4 cm proximal to the pylorus and extending 1 cm lateral to the esophagogastric junction along the greater curvature (1,2). Although LSG is relatively safe, any complication that may arise can be serious, as well as being irreversible and amputatory. In LSG, postoperative complications are observed at a rate of 0 to 24%, and the overall mortality rate is around 0.5% (3). Patient compliance in the postoperative period plays an important role in the treatment of complications. While major complications that can lead to organ failure and death may rarely develop, minor complications, such as nausea, gastroesophageal reflux, cholelithiasis, ventral hernia, and wound infection are frequently encountered and can be successfully treated (4).

As in other laparoscopic procedures, LSG is performed by the insufflation of CO_2 gas into the peritoneal cavity at a pressure of 13-15 mmHg. CO_2 is easily excreted through the lungs after being absorbed from the peritoneum and dissolved 20 times more in serum than room air or oxygen (5). Although laparoscopic operations have many advantages over laparotomy, pneumoperitoneum (PP) has negative effects, especially on the cardiovascular and respiratory systems (6). Studies have shown that PP can increase systemic vascular resistance and decrease stroke volume, cardiac output, and vascular return. These side effects are especially important in the elderly and individuals with additional diseases (7). One of the important hemodynamic changes due to PP is a temporary decrease in the hepatic blood flow. Pressure generated by the intrabdominal route and elapsed time have been found to be directly related to hepatic ischemia. This may be demonstrated by an increase in the liver enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), total/direct bilirubin, and international normalized ratio (INR) (8,9). In addition, changes in the internal jugular vein (IJV) and central venous pressure can be seen in LSG due to increased intraabdominal pressure (IAP) caused by the Trendelenburg position and especially CO_2insufflation. Therefore, less CO_2 insufflation and lower IAP may reduce patient morbidity (10).

In this study, we aimed to investigate whether there was a difference between the effects of 10 mmHg or 13 mmHg IAP during LSG on the IJV diameter, blood volume, and liver and kidney functions.

Material and Method:

Forty patients between the ages of 18-60, who underwent LSG (11) for morbid obesity with the standard technique by the same surgeon at the General Surgery Clinic of Health Sciences University Ankara Numune Training and Research Hospital between July 2018 and April 2019 were included in the study. The study sample was divided into two equal groups: 20 patients that underwent LSG with 10 mmHg pressure and 20 patients that underwent LSG at 13 mmHg pressure. The demographic characteristics of the patients in both groups, comorbidities, surgery history, height, weight, body mass index (BMI), family history, IAP applied during surgery, operation time, length of hospital stay, and the right IJV diameter and volume on the Doppler ultrasound before intubation during surgery (t1), 10 minutes after insufflation (t2), and at the end of insufflation (t3) were recorded.

An ultrasonography (USG) examination was performed using a GE Logiq E9 USG (General Electric Company, Boston, USA, 2016) device in all patients by two radiologists with at least eight years' experience. A GE 11L Linear Probe (GE, General Electric Company, Boston, USA, 2016) high-resolution (3-11 MHz) probe was used for the grayscale mode and Doppler mode. IJV was visualized at the carotid bifurcation level, and then all measurements were performed at this level. The IJV diameter was measured in the transverse plane using the grayscale mode. Doppler USG was undertaken to measure the blood velocity of IJV. Grayscale USG and Doppler USG were performed in the same session by the same radiologist. All sonographic data were recorded separately.

Blood urea, creatine, AST, ALT, GGT, ALP, total bilirubin, direct bilirubin, prothrombin time (PT) and INR values were measured preoperatively and at postoperative hours 6, 12 and 48. Patients with a history of intraabdominal surgery, an acute/chronic liver, kidney and cardiovascular disease, an active infection or cancer, those that had undergone intraabdominal radiotherapy, and cases in which IAP was changed during surgery were excluded from the study.

Statistical Analysis:

The data were transferred to IBM SPSS Statistics v. 23 for analysis. Descriptive statistics (mean, standard deviation) were given for numerical variables while evaluating the study data. The independent samples t-test was used to determine any difference between the two groups, the Pearson correlation analysis was undertaken to examine the relationship between two numerical variables, and the repeated-measures ANOVA test was conducted to measure the differences in values measured at more than two times. $P < 0.05$ was accepted as statistically significant.

Results:

The mean age of the groups was 37.35 ± 10.91 years, and the mean BMI was 44.70 ± 4.37 kg/m^2. While 17.5% of the patients had a history of operation, 82.5% had not previously undergone surgery. The mean duration of exposure to IAP was 85.18 ± 27.1 minutes, while the mean duration of hospital stay was 5.98 ± 1.23 days (Table 1). Preoperative and postoperative kidney and liver function values of the patients were within the reference range in both groups (Table 2). There was no statistically significant difference between the groups in terms of age, BMI, duration of exposure to pressure, and length of hospital stay ($p > 0.05$) (Table 3). The direct bilirubin value measured at the sixth hour was significantly higher in the 10 mmHg pressure group compared to the 13 mmHg group ($p < 0.05$), but there was no significant difference in terms of the mean measurement of the remaining blood parameters ($p > 0.05$) (Table 4).

In both groups, while there was a significant decrease in the IJV diameter and flow measurement values at t2 compared to t1, a significant increase was observed at t3 compared to t2 ($p < 0.05$). In addition, at all measurement times, the IJV diameter and flow measurement averages were significantly higher in the 10 mmHg pressure group compared to the 13 mmHg group ($p < 0.05$) (Table 5). In the latter, as BMI increased, the IJV diameter (cm) measured at t1 and t3 significantly decreased compared to t2 ($p <0.05$), and when the duration of exposure to pressure (min) increased, the IJV flow values (mm/sec) measured at t1 and t3 were significantly higher compared to t2 ($p < 0.05$) (Table 6).

Discussion:

Although laparoscopic operations have that benefits of shorter hospital stay, minimal postoperative pain, and rapid return to work, they can also lead to unfavorable systemic side effects due to intraperitoneal CO_2 insufflation and increased IAP. CO_2insufflation in the abdominal region can cause an upward displacement in the diaphragm and an increase in the risk of regurgitation, a decrease in lung volume and compliance, an increase in airway resistance and ventilation perfusion rate. In addition, an increase in systemic vascular resistance and mean arterial pressure may cause a decrease in venous return due to the compression of the inferior vena cava, thereby leading to a decrease in cardiac output. During the operation, a decrease in the renal blood flow due to prolonged CO_2PP, and consequently a decrease in the glomerular filtration rate and urine output may be observed (12). According to the 2006 definition of the World Society for the Abdominal Compartment Syndrome, an IAP of 12 mmHg or more is considered as intraabdominal hypertension (13). During PP, an increase in IAP and an increase in the central venous pressure occur. The increase in IAP also causes a decrease in the perfusion of the mesenteric artery, intestinal mucosa, and hepatic and splanchnic areas. In cases of massive pressure increases, cardiac output and hepatic lactate clearance decrease and fatal lactic acidosis may be seen (14). In their study comparing patients who underwent laparoscopic cholecystectomy by applying PP at 7 mmHg and 15 mmHg IAP, Dexter et al. showed that heart rate and mean arterial pressure increased in both groups, and cardiac output and stroke volume decreased in the 15 mmHg group (10 and 26%, respectively) (15). McLaughlin et al. reported a 30% decrease in cardiac output and stroke volume and a 60% increase in the mean arterial pressure after the application of 15 mmHg PP (16). High-pressure PP can cause the pooling of blood from intraabdominal organs in venous reservoirs, end-organ damage, and hypoperfusion ischemia in tissues and organs.

Temporary increases in hepatic transaminases can be seen in the early period after laparoscopic surgery. The major factor in this increase may be CO_2 PP since more changes in hepatic parameters may occur in laparoscopy involving 14 mmHg CO_2 PP compared to gasless laparoscopy (17). Tan et al. examined serum liver enzymes at 24 and 48 hours and seven days after laparotomy and laparoscopic surgery involving CO_2 PP, and evaluated AST and ALT values at postoperative hours 24 and 48. The authors reported that the AST and ALT values measured at postoperative hours 24 and 48 increased more in the laparoscopic CO_2 PP group compared to the patients that underwent laparotomy. While there was a slight increase in the total and direct bilirubin values, no change was found in the ALP, LDH and GGT values (18).

The increase in CO_2 PP in hepatic parameters may also be proportional to the increase in CO_2 pressure and IAP. Morino et al. (19) also emphasized that the increase in liver enzymes in laparoscopy performed with 10 mmHg CO_2 pneumoperitoneum was less than observed in higher-pressure CO_2 PP. According to Bendet et al. (20), postoperative aminotransferase levels increase especially after laparoscopic cholecystectomy as a result of the damage of Kupffer and endothelial cells in laparoscopic procedures. Volz et al. argued that in a short surgical time, such as laparoscopic cholecystectomy, which involves an increase and decrease in IAP causes an undulation in the portal blood flow, and and this fluctuation leads to reperfusion damage on the organ blood flow, especially Kupfer and endothelial cells in hepatic sinusoids and is associated with an increase in liver enzymes (21). Hoekstra et al. applied 14 mmHg and 25 mmHg IAP in a pig model and investigated the effect of prolonged PP on liver function and perfusion using the indocyanine green clearance test and intraoperative hepatic hemodynamics measured by simultaneous reflection spectrophotometry (venous oxygen saturation StO2 and relative tissue hemoglobin concentration). As a result, the authors reported that no additional damage occurred in the liver due to prolonged PP during laparoscopic surgery (22).

In our study, in the two groups in which we performed LSG by applying CO_2 PP with 10 mmHg and 13 mmHg pressure, we compared the preoperative and postoperative 6th-, 12^{th}-and 48^{th}-hour blood urea, creatinine, AST, ALT, GGT, ALP, total and direct bilirubin, PT and INR values of the patients. To the best of our knowledge, there is no study in the literature evaluating hepatic parameters after LSG performed with 10 mmHg and 13 mmHg IAP. In our study, there was no significant difference between the hepatic parameters of the two groups. In the literature, it has been suggested that there may be a decrease in the sinusoidal blood flow in the fatty liver at a level that can be detected in both microvascular level and on Doppler USG (23). As a result, ischemic preconditioning occurs in the fatty liver, which can lead to the liver tissue becoming resistant to ischemic-reperfusion damage (24). Therefore, we consider that in our sample, the presence of morbidly obese patients with fatty liver in both groups may have resulted in non-significant differences in hepatic parameters.

Taura et al. measured blood lactate levels in different IAP groups (10-15 mmHg) among patients who underwent laparoscopic sigmoidectomy and showed that as IAP increased (maximum 15 mmHg), the lactate values also increased. Berg et al. reported that the lactate values increased from 1.12 to 1.159 mmol with PP (25).

Oliguria is a common condition observed during laparoscopic surgery. Razvi et al. argued that renal dysfunction occurred as a result of compression in both the renal parenchyma and renal arteries and veins as a result of increased IAP (26). Studies have shown that when IAP increases from 0 mmHg to 20 mmHg, vascular resistance increases by 555%, the renal glomerular filtration rate decreases by 25%, and the flow reduction in the renal vein can continue for two hours postoperatively (27). In our study, we found no difference between the two groups in terms of renal function test results. In a randomized controlled study involving 90 patients admitted to the hospital with the diagnosis of symptomatic cholelithiasis, laparoscopic cholecystectomy was performed with CO_2 PP at 7 mmHg, 10 mmHg and 13 mmHg pressure values, and the total antioxidant status, total oxidant status, ischemia-modified albumin (IMA), IMA-to-serum albumin ratio, oxidative stress index and albumin parameters were evaluated. As a result, the authors observed that oxidative stress markers were increased values at higher IAP levels (28).

In the recent past, two randomized controlled studies, one including laparoscopic colorectal surgery (IPPCollapse-II) and the other bariatric surgery, were undertaken to evaluate the effect of low IAP on the surgical area, duration of surgery, pain score, and postoperative complications compared to a standard pressure group, and it was argued that the low-pressure group had lower pain scores and a clear and good surgical appearance compared to the standard pressure group (29). The European Association for Endoscopic Surgery, taking into account the potential negative effects of PP, especially on cardiopulmonary functions and postoperative pain, recommends that PP planned as part of laparoscopic surgery should be performed using the minimum pressure that would allow an adequate view of the surgical area rather than the application of a standard pressure (30). In addition, Sherwani et al. recommended the use of PP with the lowest CO_2 pressure as possible during laparoscopic operations that are expected to continue for an extended time in elderly people and patients with comorbidities, such as cardiovascular diseases (31). Another benefit of a low IAP is that it can be a facilitator for central venous catheterization (CVC), which involves the placement of a catheter often at the junction of the superior vena cava-right atrium via IJV and the subclavian vein (SCV) (11). CVC is used for various reasons, such as hemodynamic monitoring and drug administration, especially in patients who are hemodynamically unstable and/or those planned to undergo major surgery (32). Today, CVC is not routinely used preoperatively in laparoscopic surgery for the monitoring of patients with a low ASA grade. However, CVC may be urgently needed intraoperatively in case of cardiovascular failure and respiratory complications that arise during laparoscopic surgery. Although some centers benefit from USG in CVC, many centers still perform the procedure blindly. The diameter of the target central vein (internal jugular or subclavian) and the blood volume within the vein may affect the success of the procedure during both USG-guided and blind CVC. Since the media layers of the veins containing muscle are very thin and the veins do not have tension that can resist pressures unlike arteries, collapse may occur due to the pressure effect on the target vein during skin puncture with the Seldinger needle. In USG-guided catheterization, the weight of the probe may cause a collapsed vein. A larger central venous diameter and greater blood volume may be useful in counteracting the venous collapse caused by this pressure effect and can increase the success of venous puncture. During CVC, internal carotid artery puncture and pneumothorax are complications that can have serious consequences (33). Kusminsky et al. emphasized that hypovolemia and BMI $>$ 30 were risk factors for CVC (34). The patients in our study were also in the high-risk group for CVC; therefore, we consider that the results of our study are important. Keeping IAP as low as possible during laparoscopy can contribute to preventing the development of this complication, as well as eliminating the need for emergency CVC during the operation.

It has been shown that the use of PEEP, Trendelenburg position, and different IAP values during laparoscopic operations have significant effects on the cross-sectional area (CSA) during intravenous catheterization. PP applied with a pressure of 12 mmHg causes significant changes in IJV and SCV in both expiration and inspiration. In the study conducted, it was thought that the measurements in the desufflation period provided more IJV CSA than the basal measurements, which was probably caused by the high intrathoracic pressure due to mechanical ventilation. It is known that venous flow decreases as a result of increased resistance to venous return in the abdomen and extremities after increased IAP (35). In our study, we observed higher values of the right IJV diameter and volume in LSG applied with 10 mmHg IAP compared to the 13 mmHg IAP group. According to our results, as the IJV diameter and the blood volume increased under 10 mmHg IAP, there were fewer collapses caused by puncture during CVC and compression due to the USG probe. These results of our study can be interpreted as indicating that a low IAP can increase the feasibility of CVC. However, there is a need for further on this subject.

Conclusion:

We observed that in LSG performed by creating CO_2 PP with a low pressure, adequate exposure was achieved when compared with the standard technique, and the complication rates and laboratory parameters were similar in the two IAP groups. In intraoperative emergencies requiring IJV catheterization, due to the IJV diameter and volume being higher than the standard IAB during LSG performed with a low IAP, catheterization may be fasciculate. We consider that LSG performed with a low pressure without compromising patient safety can positively contribute to both anesthesia and the surgical team.

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Descriptive Statistics

		N
Groups	10 mmHg	20
	13 mmHg	20
Age (mean±SD)	Age (mean±SD)	37.35±10.91
BMI	BMI	44.70±4.37
Operation history	Present	7
	Absent	33
Duration of exposure to pressure (min) (mean±SD)	Duration of exposure to pressure (min) (mean±SD)	85.18±27.1
Hospital stay (days) (mean±SD)	Hospital stay (days) (mean±SD)	5.98±1.23

Descriptive Statistics of Blood Parameters

	Preoperative	**Hour 6**	**Hour 6**	**Hour 12**	**Hour 24**
Urea	25.83±6.89	19.33±4.55	19.33±4.55	16.20±4.78	13.90±4.85
Creatinine	0.69±0.19	0.68±0.18	0.68±0.18	0.64±0.14	0.66±0.14
AST	18.75±5.72	39.90±30.35	39.90±30.35	37.10±33.09	37.90±33.23
ALT	24.23±13.90	40.05±26.77	40.05±26.77	37.65±28.12	38.85±35.72
GGT	25.80±11.82	23.23±11.68	23.23±11.68	22.83±11.26	22.08±10.49
Total bilirubin	0.48±0.29	0.49±0.32	0.49±0.32	0.64±0.45	0.73±0.60
Direct bilirubin	0.26±0.25	0.23±0.15	0.23±0.15	0.28±0.24	0.30±0.16
ALP	76.05±21.02	69.49±19.18	69.49±19.18	63.97±17.62	59.03±17.72
PT	13.24±2.56	13.24±2.56			
INR	1.00±0.11	1.00±0.11			

Table 3: Comparison of Demographic and Clinical Parameters between the Study Groups

	10 mmHg	**10 mmHg**	**13 mmHg**	**13 mmHg**	**t**	**p**
	Mean	**SD**	**Mean**	**SD**		
Age	38.50	10.57	36.20	11.39	0.662	0.512
BMI	44.16	4.32	45.24	4.46	-0.778	0.441
Duration of exposure to pressure (min)	77.30	13.95	93.05	34.38	-1.898	0.069
Hospital stay (days)	5.90	0.97	6.05	1.50	-0.375	0.710

t: Independent samples t-test

Table 4: Comparison of Blood Parameters between the Study Groups

	10 mmHg	10 mmHg	13 mmHg	13 mmHg	t	p
	Mean	**SD**	**Mean**	**SD**		
Urea (preoperative)	26.50	6.86	25.15	7.02	0.615	0.542
Urea (hour 6)	19.35	4.92	19.30	4.27	0.034	0.973
Urea (hour 12)	17.65	4.73	14.75	4.48	1.991	0.054
Urea (hour 48)	15.25	4.79	12.55	4.63	1.813	0.078
Creatinine (preoperative)	0.69	0.18	0.69	0.20	0.024	0.981
Creatinine (hour 6)	0.68	0.13	0.68	0.21	-0.062	0.951
Creatinine (hour 12)	0.62	0.13	0.66	0.15	-0.911	0.368
Creatinine (hour 48)	0.64	0.12	0.68	0.15	-0.758	0.453
AST (preoperative)	18.75	6.50	18.75	4.98	0.000	1.000
AST (hour 6)	35.50	20.10	44.30	38.03	-0.915	0.366
AST (hour 12)	31.80	17.95	42.40	43.20	-1.013	0.317
AST (hour 48)	36.60	27.86	39.20	38.56	-0.244	0.808
ALT (preoperative)	24.25	17.04	24.20	10.29	0.011	0.991
ALT (hour 6)	35.95	24.74	44.15	28.71	-0.968	0.339
ALT (hour 12)	33.60	23.40	41.70	32.27	-0.909	0.369
ALT (hour 48)	38.10	32.15	39.60	39.80	-0.131	0.896
GGT (preoperative)	28.00	13.54	23.60	9.66	1.183	0.244
GGT (hour 6)	25.35	14.40	21.10	7.94	1.156	0.255
GGT (hour 12)	26.10	13.52	19.55	7.39	1.901	0.065
GGT (hour 48)	24.35	11.60	19.80	8.95	1.388	0.173
Total bilirubin (preoperative)	0.53	0.35	0.43	0.22	1.055	0.298
Total bilirubin (hour 6)	0.59	0.39	0.40	0.21	1.930	0.061
Total bilirubin (hour 12)	0.75	0.57	0.54	0.27	1.433	0.163
Total bilirubin (hour 48)	0.87	0.80	0.58	0.23	1.571	0.130
Direct bilirubin (preoperative)	0.28	0.23	0.24	0.28	0.491	0.626
Direct bilirubin (hour 6)	0.27	0.18	0.18	0.09	2.160	**0.040***
Direct bilirubin (hour 12)	0.34	0.32	0.23	0.13	1.385	0.178
Direct bilirubin (hour 48)	0.34	0.19	0.26	0.11	1.802	0.081
ALP (preoperative)	75.53	23.59	76.50	19.19	-0.138	0.891
ALP (hour 6)	71.82	21.44	67.50	17.35	0.678	0.502
ALP (hour 12)	66.53	20.48	61.80	14.97	0.810	0.423
ALP (hour 48)	64.71	16.12	54.20	17.98	1.857	0.072
PT	13.64	3.55	12.85	0.69	0.976	0.340
INR	1.01	0.14	0.98	0.05	0.660	0.513

t: Independent samples t-test

* $p < 0.05$

Table 5: Comparison of the Intrajugular Vein Diameter and Flow Values of the Study Groups According to Measurement Times

	10 mmHg	10 mmHg	13 mmHg	13 mmHg	t	p
	Mean	**SD**	**Mean**	**SD**		
t1 vein diameter (cm)	2.12	0.41	1.59	0.43	3.991	**0.000****
t2 vein diameter (cm)	1.53	0.29	0.95	0.28	6.480	**0.000****
t3 vein diameter (cm)	1.84	0.27	1.22	0.28	7.021	**0.000****

	10 mmHg	10 mmHg	13 mmHg	13 mmHg	t	p
Statistical analysis (F/p)	**46.814**	**0.000****	**36.076**	**0.000****		
t1 flow (mm/sec)	20.11	3.69	15.63	2.68	4.387	**0.000****
t2 flow (mm/sec)	16.94	2.97	10.31	2.13	8.108	**0.000****
t3 flow (mm/sec)	18.76	3.27	14.15	2.46	5.042	**0.000****
Statistical analysis (F/p)	**28.141**	**0.000****	**47.864**	**0.000****		

F: Repeated-measures ANOVA; t: Independent samples t-test

** p < 0.001

Table 6: Relationship between Measurements and Investigated Parameters

		Age	**Age**	**BMI**	**BMI**	**Duration of exposure to pressure (min)**	**Duration of exposure to pressure (min)**	**Hospital stay (days)**	**Ho sta (d**
		r	**p**	**r**	**p**	**r**	**p**	**r**	**p**
10 mmHg	t1 vein diameter (cm)	-0.071	0.766	-0.021	0.931	-0.095	0.69	-0.173	0.4
	t2 vein diameter (cm)	-0.27	0.249	-0.206	0.384	0.03	0.899	0.017	0.9
	t3 vein diameter (cm)	0.03	0.9	0.12	0.614	-0.15	0.528	-0.171	0.4
	t1 flow (mm/sec)	0.029	0.905	0.296	0.205	-0.344	0.138	-0.217	0.3
	t2 flow (mm/sec)	0.185	0.435	0.229	0.332	-0.177	0.455	-0.184	0.4
	t3 flow (mm/sec)	0.121	0.612	0.312	0.181	-0.281	0.229	-0.262	0.2
13 mmHg	t1 vein diameter (cm)	-0.285	0.223	**-0.492**	**0.027***	0.167	0.48	-0.112	0.6
	t2 vein diameter (cm)	0.06	0.802	-0.334	0.151	-0.093	0.696	-0.265	0.2
	t3 vein diameter (cm)	-0.074	0.755	**-0.487**	**0.029***	0.02	0.934	-0.144	0.5

	Age	Age	BMI	BMI	Duration of exposure to pressure (min)	Duration of exposure to pressure (min)	Hospital stay (days)	Ho sta (d
t1 flow (mm/sec)	-0.192	0.418	-0.209	0.375	**0.472**	**0.036***	0.128	0.5
t2 flow (mm/sec)	-0.119	0.616	0.027	0.911	0.26	0.267	0.058	0.8
t3 flow (mm/sec)	-0.096	0.688	-0.188	0.428	**0.493**	**0.027***	0.148	0.5

r: Pearson's correlation coefficient

* $p < 0.05$

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`Tables.pdf` available at https://authorea.com/users/368134/articles/487381-effects-of-different-intraabdominal-pressure-values-on-internal-jugular-vein-liver-and-kidney-functions-in-obese-patients-undergoing-laparoscopic-sleeve-gastrectomy