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ARTERIAL BLOOD GAS ALTERATIONS IN RETROPERITONEAL AND TRANSPERITONEAL LAPAROSCOPY

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ABSTRACT

Background: Due to its numerous benefits laparoscopic surgery become very popular among physicians, hospitals and patients nowadays. In the urologic pathology laparoscopy can be performed with retroperitoneal or transperitoneal approach. Insufflation of CO_2 for achieving visibility in both of the approaches can be absorbed in the vessels and can lead to alterations in arterial blood gasses.

Material and Method*:* Study population was elective urologic patients scheduled for laparoscopic surgery. Investigated arterial blood gas variables were determined in three time points: T_0 before induction – basal, T1 after one hour of CO_2 insufflation, and T_2 at the end of the surgery.

Results: Alterations in arterial blood gasses were seen in T_1 and T_2 for PaO_2 in retroperitoneal vs transperitoneal group 173.3 ± 19 vs 196.6 ± 29 ($p < 0.003$) and 95.5 ± 5.4 vs 101.1 ± 8.2 ($p < 0.001$). The $PaCO_2$ was also statistically significant in second observed time point T_1 in retroperitoneal vs transperitoneal group 45.9 ± 4.1 vs 38.2 ± 0.3 ($p < 0.002$).

Conclusion: The findings that we have presented can suggest that both approaches are safe although hypercarbia is observed in retroperitoneal group.

Key Words: arterial blood gasses, retroperitoneal laparoscopy, transperitoneal laparoscopy, urologic laparoscopy.

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Introduction:

Due to its numerous benefits laparoscopic surgery became very popular, clinically applicable and universally accepted among physicians, patients and hospitals (1). The advantages over open surgery are: small incision, less postoperative pain, superior cosmetic results, brief recovery, fewer postoperative complications, decreased length of hospital stay and lower mortality (2). On the other side, laparoscopy requires insufflation of carbon dioxide (CO_2) and creating pneumoperitoneum for achieving satisfactory visibility and further alterations in position from supine to Trendelenburg (3). There is a wide field of urologic interventions that can be performed laparoscopically either through retroperitoneal or transperitoneal approach (4). Retroperitoneal approach for laparoscopy was started 1979, but due to the inability to create a satisfactory pneumoperitoneum, the same was abandoned and it was only restored after Gaur announced his creative balloon technique of dissection of the retroperitoneal space previous to CO_2 insufflation (5, 6). While retroperitoneal approach for laparoscopy may have some advantages; like secure port placement and decreased manipulation with abdominal vessels, on the other hand, it can be challenging due to limited working space, port closeness, higher CO_2 insufflation for creating pneumoperitoneum and achieving better visibility and bigger Trendelenburg position which require superior anesthesia management and aggressive mechanical ventilation (MV) (7). Due to its high solubility in the blood, CO_2 can enhance alterations in arterial blood gasses (ABG). Therefore, the aim of our study was to compare the alterations in ABG occurring during transperitoneal or retroperitoneal laparoscopic urological intervention.

Material and Methods:

This prospective non- randomized study was performed on elective urological patients, according the American Society of Anesthesiologists physical status - classification status (ASA) I/ II, scheduled for urological laparoscopic intervention in the University Clinic for Anesthesia, Reanimation and Intensive Care and University Clinic for Urology - Clinical Center "Mother Theresa" for the period from January until December 2018. All morbidly obese patients with body mass index (BMI) more than 30, where excluded from the study, other exclusion criteria were cardiac or respiratory insufficiency and renal or liver dysfunction. Each patient signed Informed Consent before enrolment in the study.

All patients underwent standard preoperative evaluations and physical status check-ups. For premedication, patients received diazepam 5mg orally night before surgery and in the morning of surgery. In the operation theatre standard monitoring was placed and radial artery cannulation was done. Induction in anesthesia was with midazolam 1 or 2 mg, fentanyl 2-10 mcg/ kg, propofol 1-2 mg/ kg, rocuronium 0,6 mg/ kg. After 2 minutes patients were intubated and placed on MV. Pressure was controlled/ volume guarantied with PEEP 5cm H_2O and 50% mix of air/ oxygen, changes in respirator rates and tidal volume were done when decreased oxygen saturation, increased PIP or increased end expiratory CO_2 (Et CO_2) were observed. Hemodynamic

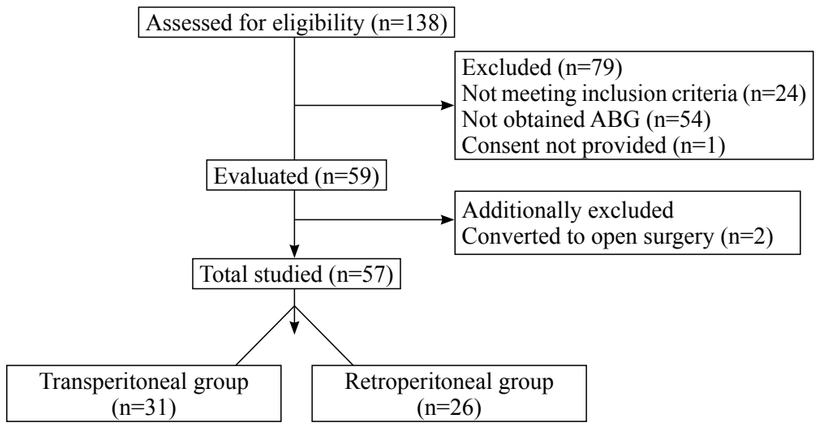
parameters were recorded during whole time of surgery and ABG analyses were investigated at three time points: T_0 before induction – basal, T1 after one hour of CO_2 insufflation, and T_2 at the end of the surgery.

Statistical analysis was done with STATISTICA version 10; IBM SPSS 20.0. For quantitative variables data are presented as mean and standard deviation (SD), for categorical variables as number and percentage. For analysis, Analysis of Variance U test and Post hoc Tukey HSD test were used. P value of less than <0.05 was considered statistically significant.

Results:

A total of 138 patients were operated laparoscopically during the observed period. Only 57 patients from them meet the inclusion criteria and were enrolled in the study. From the other 81 excluded patients: 54 were without ABG analysis, 24 didn't complied with the inclusion criteria, 1 patient refused to participate in the study and 2 patients were converted to open surgery. In Figure 1 the flow chart diagram of the patients is presented.

Figure 1. Study's participants flow diagram



In Table 1, we present the demographic characteristics and characteristic of the interventions in both retroperitoneal and transperitoneal group.

Table 1. Demographic characteristics and characteristics of the surgery.

Variables	Retroperitoneal group (n=26)	Transperitoneal group (n=31)
Gender (Male/Female)	16 / 10	19/12
Age (years)	44.6 ± 11.5	46.3 ±15.63
BMI (normal 18.5-24.9)	18	20
(overweight 25-29.9)	8	11
Insufflation time (minutes)	105 ± 80.11	107 ± 77.33
Surgery time (minutes)	159.3 ± 79.06	168.1 ± 58.54

Data presented as mean and SD.

After CO_2 insufflation and pneumoperitoneum created in every patient from both groups, $EtCO_2$ was increased and MV was adjusted according to the changes in order to maintain $EtCO_2$ in normal ranges. The ABG samples collected over the three investigated time points intervals were analyzed with Siemens rapid point 500 ABG analyzer over 10 minutes period after assembling. There was significant difference between the observed partial pressure of oxygen and partial pressure of carbon dioxide in the observed groups in investigated time points. The PaO_2 in retroperitoneal vs transperitoneal group was statistically significant in T_1 173.3 ± 19 vs 196.6 ± 29 ($p < 0.003$) and in T_2 95.5 ± 5.4 vs 101.1 ± 8.2 ($p < 0.001$). The $PaCO_2$ was also statistically significant in second observed time point T_1 in retroperitoneal vs transperitoneal group 45.9 ± 4.1 vs 38.2 ± 0.3 ($p < 0.002$). The data obtained in ABG analysis are presented in Table 2.

Table 2. Arterial blood gas analyses.

Variables	Investigated times	Retroperitoneal (n=26)	Transperitoneal group (n=31)	P value
SaO_2%	T_0	94.2 ± 1.65	95.1 ± 1.41	> 0.05
	T_1	97.7 ± 1.07	98.1 ± 0.5	> 0.05
	T_2	94.6 ± 1.4	95.1 ± 1.76	> 0.05
PaO_2	T_0	95.6 ± 5.1	94.1 ± 6.7	> 0.05
	T_1	173.3 ± 19	196.6 ± 29	< 0.05
	T_2	95.5 ± 5.4	101.1 ± 8.2	< 0.05
$PaCO_2$	T_0	35.8 ± 2.3	35.1 ± 2.3	> 0.05
	T_1	45.9 ± 4.1	38.2 ± 0.3	< 0.05
	T_2	40.1 ± 3.2	37.01 ± 3.4	> 0.05
Ph	T_0	7.41 ± 0.02	7.41 ± 0.03	> 0.05
	T_1	7.31 ± 0.04	7.39 ± 0.05	> 0.05
	T_2	7.35 ± 0.05	7.35 ± 0.03	> 0.05

Data presented as mean and SD, SaO2 % - oxygen saturation, PaO2 – partial pressure of oxygen, PaCO2 – partial pressure of carbon dioxide.

Observed hemodynamic parameters are shown in Table 3. We observed the heart rate, systolic and diastolic blood pressure. There wasn't significance in the observed parameters in the investigated time points between groups. Only one patient in the transperitoneal group developed subcutaneous emphysema.

Table 3. Hemodynamic parameters.

Variables	Investigated times	Retroperitoneal (n=26)	Transperitoneal group (n=31)	P value
HR	T_0	90.7 ± 12	85.6 ± 11.3	> 0.05
	T_1	71.2 ± 8.5	71.2 ± 7.0	> 0.05
	T_2	69.9 ± 13.5	66.3 ± 10.4	> 0.05
SKP	T_0	146.5 ± 11.2	145.7 ± 17.2	> 0.05
	T_1	125.5 ± 10.1	122.7 ± 9.3	> 0.05
	T_2	120.7 ± 11.5	119.5 ± 10.0	> 0.05
DKP	T_0	85.1 ± 9.2	87.2 ± 10	> 0.05
	T_1	76.7 ± 11.9	80.4 ± 14	> 0.05
	T_2	77.4 ± 12.4	76.3 ± 8.0	> 0.05

Data presented as mean and SD, HR – heart rate, SKP – systolic blood pressure, DKP – diastolic blood pressure.

Discussion:

Insufflation of CO_2 in the retroperitoneal or intraperitoneal cavity creates pneumoperitoneum and increases the intraabdominal pressure. Increased intra-abdominal pressure has influence on every organ and organ system in the body (1,8-11). Intraabdominal pressure moves the diaphragm cephalic and compresses the thoracic cavity leading to decreased compliance and increased resistance, lower functional residual capacity to the lung leading to deteriorated gas exchange (11, 12). Furthermore, the gas exchange is deteriorated from the insufflated CO_2 that is absorbed in the blood leading to ventilation mismatch, hypoxia, hypercarbia and ABG alterations (8, 10).

There is still ongoing debate if the retroperitoneal or transperitoneal laparoscopic approach is associated with greater CO_2 absorption. In our study, the investigated alterations in ABG analyses in the second time point or one hour after insufflation of CO_2, showed that PaO_2 is significantly decreased in retroperitoneal group, compared to transperitoneal group and on the other hand, $PaCO_2$ is increased in the retroperitoneal group in comparison to the transperitoneal group. Further on, PaO_2 was significantly decreased in the third investigated time point. These results from our evaluation are similar to the results presented from Shah and colleagues in their study of 45 patients whereby they conclude that position of patients was the superior factor that interfered with the ABG changes (8). Another study from Wolf and coauthors, conducted in 63 laparoscopic urological interventions, showed higher CO_2 absorption when compared the retroperitoneal to transperitoneal approach, and also showed that retroperitoneal group had higher risk for developing subcutaneous emphysema (13). Additionally, in other prospective study on three groups with 10 patients in each of them: retroperitoneal nephrectomies, laparoscopic cholecystectomies and control group of open orthopedic surgeries had similar results to our findings. They believe that due to cutting up areolar retroperitoneal tissue, retroperitoneal group has higher CO_2 absorption (14). Contrary, there are studies that do not show increased CO_2 absorption in retroperitoneal laparoscopies - one is the study of Ng et al., which includes prospective evaluation of 51 patients (15).

As for hemodynamic parameters (heart rate, systolic and diastolic blood pressure) our study didn't show any statistically significant results between groups. However, in the literature there are presented findings similar and contrary to ours (1, 8, 16). We believe that this is due to the fact that CO_2 insufflation can provoke hemodynamic changes depending on volume status, anesthesia management, patient's position and the level of intraabdominal pressure that occurred from CO_2 insufflation. The different interaction among these factors can provoke diverse outcomes in different patients.

Conclusion:

Urological laparoscopy can be performed through retroperitoneal and transperitoneal approach. The findings that we have presented can suggest that both approaches are safe although hypercarbia is observed in retroperitoneal group. Moreover, maybe this study can obtain information about the secure approach in compromised patients and can increase the awareness of the anesthesiologists for careful observation of these patients.

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