

Acid Base Balance Alterations during Transperitoneal and Retroperitoneal Laparoscopic Urologic Surgeries.¹Shah Rajkiran B., D.N.B., Associate Professor²Nama Rajnish, D.N.B., Associate Professor³Butala Beena P., M.D., Professor and Head,⁴Parikh Geeta P., M.D., Professor

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Conflicts of Interest: Nil.

Abstract

Background: The laparoscopic approach requires CO₂ gas insufflation with positive pressure resulting in increased intra abdominal pressure (IAP) and systemic CO₂ absorption. This may lead to acid base alterations of respiratory, metabolic or mixed in nature. While degree of CO₂ absorption and its cardiorespiratory changes have been compared for the transperitoneal and retroperitoneal laparoscopic approaches by few studies, none of the study have compared metabolic changes in urologic laparoscopic surgeries to our knowledge.

Aims and Objectives: We conducted a study to compare the change in acid base balance in patients undergoing elective laparoscopic urologic surgeries either through transperitoneal or retroperitoneal approach.

Settings and design: single centre prospective nonrandomized human study

Methods: Patients were divided into two groups according to the laparoscopic approach used; Transperitoneal (Trans) and Retroperitoneal (Retro). All patients were given general anesthesia and were mechanically ventilated. Minute ventilation was adjusted to maintain EtCO₂ level 35 +/- 5 mmHg. Arterial blood samples were taken twice; first, before gas insufflation,

and second, at the end of surgery after desufflation for the analysis of PaCO₂, pH, bicarbonate, base excess, lactate and anion gap. Data collected and compared statistically.

Results: Duration of pneumoperitoneum was longer in Trans group than Retro group (196.6 +/- 65.63 min vs 148 +/- 69.43 min, p = 0.022). pH shifts from normal to acidic at the end of pneumoperitoneum in both the groups. Decrease in the bicarbonate in Trans group was statistically significant as compared to Retro group (20.66 +/- 2.23 vs 21.94 +/- 1.78 mEq/L, p = 0.013). Out of 60% patients who developed acid base disturbance in Trans group, 36%, 20% and 4% had mixed, metabolic and respiratory acidosis, respectively. While in Retro group, 40 percent had acid base balance disturbance with metabolic, respiratory and mixed acidosis developed in 16%, 16% and 8% of the patients, respectively.

Conclusion: Acid base balance shifts toward acidosis at the end of pneumoperitoneum in both the approaches during laparoscopic urologic surgeries. Acidosis in retroperitoneal approach was attributable to respiratory component more while in transperitoneal approach it was more related to metabolic component.

Keywords: Transperitoneal, Retroperitoneal, Metabolic acidosis, Respiratory acidosis, Acid base balance, laparoscopy

Introduction

Laparoscopic approach is increasingly being used for various urologic surgeries due to its advantage of decreased postoperative pain, minimal scars, rapid recovery and short convalescence. The laparoscopic approach requires CO₂ gas insufflation with positive pressure resulting in increased intra abdominal pressure (IAP) and systemic CO₂ absorption. This may lead to acid base alterations of respiratory, metabolic or mixed in nature [1]. Retroperitoneal organs can be operated either through transperitoneal or retroperitoneal approach. While degree of CO₂ absorption and its cardiorespiratory changes have been compared for the two approaches by few studies, none of the study have compared metabolic changes in urologic laparoscopic surgeries to our knowledge [2-5]. So, we conducted a study to compare the change in acid base balance (ABB) in patients undergoing elective laparoscopic urologic surgeries either through transperitoneal or retroperitoneal approach.

Material and Methods

After local ethics committee approval and informed patient consent, this nonrandomized prospective study was done on 50 patients scheduled to undergo elective urological laparoscopic surgeries at our institute, from January 2017 to July 2017. Adult American society of anesthesiology (ASA) physical status 1 to 3 patients of either sex were included in the study. Exclusion criteria were metabolic disorders, morbid obesity, cardiorespiratory insufficiency, severe liver or renal dysfunction.

Fifty patients posted for urological laparoscopy were divided into two groups according to the approach; either transperitoneal (Trans) or retroperitoneal (Retro). The type

of approach was chosen by the surgeon according to his/her comfort and patients surgical status. The routine preoperative evaluation for laparoscopic surgeries was done. General anesthesia was used for both groups. Patients were premedicated with 1-2 microgram/kg fentanyl and 0.004 – 0.008 microgram/kg glycopyrrolate intravenous (i.v.) in the operation theatre. Anesthesia was induced with thiopentone sodium 4-6 mg/kg i.v. and muscle relaxation was obtained with atracurium 0.5-0.8 mg/kg i.v. for tracheal intubation. Anesthesia was maintained with isoflurane in a mixture of oxygen and air with incremental doses of atracurium and fentanyl. Volume controlled mode was used with tidal volume 8 ml/Kg and respiratory rate 12/min. Change in tidal volume or respiratory rate was done to maintain end tidal CO₂ pressure between 35 to 40 mmHg. Heart rate, blood pressure, EtCO₂, peak airway pressure and compliance were monitored, also.

Patients were given 60 to 80 degree semi lateral position in transperitoneal group and pneumoperitoneum was created by Veress needle technique. In Retroperitoneal group patients were given 90 degree lateral position with flexion at the flank and retroperitoneal space created by open access Gaur's balloon dilation technique. A standard three to four port technique was used in patients of both the groups. IAP was kept between 12 to 15 mmHg in both the groups.

Arterial catheter was inserted in radial artery to measure pH, PaCO₂, bicarbonate, base excess and lactate level. Samples were taken twice; 1) after induction but before the start of insufflation, 2) at the end of pneumoperitoneum. Data were presented as mean \pm standard deviation (SD) for quantitative variables, and as number and percentage for categorical variables. Chi-square and t-test were used where appropriate. P value < 0.05 was considered significant.

Results

There were 25 patients in each group; Trans group and Retro group. There was no significant difference in age, sex and weight between the two groups ($p > 0.05$) (Table 1). Duration of pneumoperitoneum and duration of surgery was significantly higher with transperitoneal approach ($p < 0.05$) (Table 1). Table 2 shows the type of surgeries that patients underwent in both the groups. All the patients remained hemodynamically stable intraoperatively and had successful outcome without any complication.

Table 3 shows the average and standard deviation (SD) values of various metabolic parameters for Trans and Retro groups with their comparison (p-value). There was decrease in pH at the end of pneumoperitoneum as compared to baseline in both the groups. Though minute ventilation was increased to maintain normal EtCO₂, PaCO₂ increased in both the groups at the end. Compared to baseline values, bicarbonate and base excess decreased and lactate level increased in both the groups at the end. The anion gap increased in Trans group while it decreased in Retro group. Differences in these metabolic parameters between the two groups were statistically insignificant ($p > 0.05$) except for the decrease in bicarbonate level in Trans group which was statistically significant ($p < 0.05$).

Sixty percent of the patients in Trans group developed ABB disturbances in the form of acidosis (Table 4). Out of these, 36%, 20% and 4% had mixed, metabolic and respiratory acidosis, respectively. While in Retro group, 40 percent had acid base balance disturbance with metabolic, respiratory and mixed acidosis developed in 16%, 16% and 8% of the patients, respectively.

Discussion

While physiological changes during laparoscopy through transperitoneal approach have been extensively studied, very few studies have explored the effect of retro or extra

– peritoneal approach [4, 6]. Retroperitoneal approach for urologic surgeries has the advantage of safe port placement and lesser handling of abdominal viscera, but it may be technically challenging due to smaller working space and port proximity as compared to transperitoneal approach [7].

Demographic data were comparable between the two groups. The average time of pneumoperitoneum was higher in Trans group than in Retro group (196 min vs 148 min) and was statistically significant ($p < 0.05$). More number of patients in Trans group developed acidosis either metabolic, respiratory or mixed in nature than in Retro group [15 (60%) vs 10 (40%)]. Distribution of type of acidosis differs between the two groups with Trans group having either mixed or metabolic nature in majority while Retro group having either metabolic or respiratory nature in majority. Although in both the groups, pH, bicarbonate and base excess decreased and PaCO₂ increased at the end as compared to baseline, the decrease in bicarbonate in Trans group was statistically significant as compared to Retro group ($p < 0.05$).

Wolf et al retrospectively studied the association of CO₂ absorption with type of approach in 63 laparoscopic renal surgeries and found to have greater CO₂ absorption with extraperitoneal approach and in patients who developed subcutaneous emphysema [8]. Study by Sumpf et al in extra- or trans-peritoneal hernioplasty found that CO₂ absorption is consistently less with transperitoneal approach but reduction of pulmonary compliance is greater [9]. Demirogluk et al compared the effect of intraperitoneal (cholecystectomy) and extraperitoneal (hernioplasty) CO₂ insufflation on blood gases perioperatively [10]. They found similar decrease in pH and increase in PaCO₂ in both the groups at desufflation and in recovery period compared to baseline. However, PaCO₂ significantly increased in recovery period

compared with desufflation in extraperitoneal group in their study. Higher rate of CO₂ absorption with retroperitoneal approach explains the more number of respiratory acidosis in Retro group than in Tran's group (16% vs 4%) in our study.

Gandara et al studied the ABB alterations during laparoscopic cholecystectomy in 132 patients [11]. In their study, 67% developed acidosis during insufflation period with 44% as pure metabolic, 21% as mixed type and 8% as pure respiratory. Similar results were obtained in our study, also. Probable reason of metabolic acidosis might be tissue hypoperfusion due to increased IAP in transperitoneal laparoscopy.

Ishizaki et al. noticed increases in portal and inferior cava vein pressures and a decrease in splanchnic blood flow due to the increase in abdominal pressure [12]. Lesser effect on Splanchnic blood flow during retroperitoneal approach explains less number of patients with metabolic (16% vs 20%) or mixed acidosis (8% vs 36%) in Retro group as compared to Trans group in our study.

Joris et al. have shown an increase in lactate levels during laparoscopic period, which supports the presence of an anaerobic metabolism, probably due to ischemia tissue phenomena [13]. However, increase in lactate level in both the groups at the end in our study was within physiological range.

Duration of pneumoperitoneum can have effect on acid base disturbance. Taura et al found that prolonged pneumoperitoneum at 15 mmHg during laparoscopic sigmoidectomy causes lactic acidosis [14]. While a study by Meininger et al in robotic prostatectomy lasting more than 10 hours did not find major acid base disturbances [15].

In our study, duration of transperitoneal surgeries was higher and statistically significant than duration of

retroperitoneal surgeries which could be the reason for metabolic acidosis in Tran's group.

Randomized trial by Seft R et al to evaluate correlation between different intra abdominal pressures (10 vs 15 mmHg) and acid base alterations during laparoscopic cholecystectomy found that ABB alterations was mostly respiratory or mixed type [16]. Lowering intra abdominal pressure from 15 to 10 mmHg did not contribute to elimination of Acid base disturbances in their study. In a study by Ibrahim OA et al, bicarbonate decreased and lactate increased significantly in high IAP (12 – 14 mmHg) group as compared to low IAP (6 – 8 mmHg) during laparoscopic cholecystectomy [17]. In our study, we kept the IAP constant between 12 – 15 mmHg and did not record its correlation with acid base balance.

Our study has certain limitations. First, ours is not the randomized study. So, level of evidence of our study will be inferior compared to randomized study. Second, we did not measure blood gases and other metabolic parameters after the surgery in recovery period which could have given further idea on how the body recovers from ABB disturbances after laparoscopy.

Conclusion

Acid base balance shifts toward acidosis at the end of pneumoperitoneum in transperitoneal and retroperitoneal approach during laparoscopic urologic surgeries. Acidosis in retroperitoneal approach was attributable to respiratory component more while in transperitoneal approach it was more related to metabolic component.

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Table 1. Demographic data (mean +/- SD)

	Transperitoneal (N=25)	Retroperitoneal (N=25)	p-value
Age (years)	43.92 +/- 17.35	51.8 +/- 11.34	0.0840
Sex (Male/Female)	13/12	15/10	
Weight (Kg)	54.28 +/- 10.6	60.24 +/- 13.38	0.0679
Duration of Pneumoperitoneum (min)	196.6 +/- 65.63	148 +/- 69.43	0.022*
Duration of surgery (min)	233.4 +/- 71.14	182.4 +/- 71.32	0.022*

* statistically significant difference (p<0.05)

Table 2. Type of surgery

	Transperitoneal (N=25)	Retroperitoneal (N=25)
Donor Nephrectomy	-	11
Simple Nephrectomy	13	10
Partial Nephrectomy	-	1
Radical Nephrectomy	7	1
Pyeloplasty	4	-
Ureterectomy	1	
Ureterolithotomy	-	2

Table 3. pH, PaCO₂, Bicarbonate, Base excess, Lactate and Anion gap.

		Transperitoneal	Retroperitoneal	p-value
pH	Baseline	7.411 +/- 0.046	7.416 +/- 0.036	0.653
	End	7.341 +/- 0.055	7.333 +/- 0.050	0.624
PaCO ₂ (mmHg)	Baseline	35.29 +/- 4.34	35.47 +/- 3.45	0.833
	End	39.72 +/- 6.44	42.04 +/- 5.94	0.134
Bicarbonate	Baseline	21.92 +/- 2.19	22.50 +/- 1.74	0.237
	End	20.66 +/- 2.23	21.94 +/- 1.78	0.013*
Lactate	Baseline	1.52 +/- 0.643	1.58 +/- 0.402	0.733
	End	2.09 +/- 1.22	2.01 +/- 0.60	0.777
Base excess	Baseline	-2.18 +/- 2.37	-1.34 +/- 2.26	0.146
	End	-4.55 +/- 2.43	-3.63 +/- 1.99	0.136
Anion gap	Baseline	17.42 +/- 5.28	16.69 +/- 2.79	0.571
	End	18.90 +/- 4.87	16.55 +/- 3.01	0.061
Minute ventilation	Baseline	7.05 +/- 1.45	7.10 +/- 1.69	0.901
	End	7.93 +/- 1.45	7.91 +/- 1.88	0.969

* statistically significant difference (p<0.05)

Table 4. Type of acid base disturbances at the end of pneumoperitoneum

	Trans (N=25)	Retro (N=25)
Normal	10 (40%)	15 (60%)
Metabolic acidosis	5 (20%)	4 (16%)
Respiratory acidosis	1 (4%)	4 (16%)
Mixed disorders	9 (36%)	2 (8%)