Egyptian Journal of Anaesthesia (2013) 29, 109–116

Egyptian Society of Anesthesiologists

Egyptian Journal of Anaesthesia

www.elsevier.com/locate/egja
www.sciencedirect.com

Research Article

Retroperitoneal versus transperitoneal laparoscopy for simple nephrectomy

Sanaa A. El-tohamy *, Haitham M. Shello

Anaesthesia Department, Urology Department, Faculty of Medicine, Zagazig University, Egypt

Received 27 September 2012; revised 15 November 2012; accepted 21 November 2012
Available online 12 January 2013

KEYWORDS
Laparoscopy;
Retroperitoneal;
Transperitoneal;
Nephrectomy;
Cardio-respiratory

Abstract *Background:* Laparoscopic surgery is a safe and reliable option for renal procedures. Many renal procedures are performed laparoscopically through two approaches namely transperitoneal and retroperitoneal. We assessed at similar insufflation pressure alterations in hemodynamic, ventilatory and cerebral variables during retroperitoneal and transperitoneal CO_2 insufflation.
Patients and methods: Thirty adult patients of ASA I, II were randomly allocated into two groups; retropernroneal group (Ret group, $n = 15$) and transperitoneal group (Tran group, $n = 15$) for simple laparoscopic nephrectomy under general anesthesia. After carbon dioxide insufflation, cardiovascular and respiratory variables were measured at predetermined times with the same insufflation pressure while ventilation was adjusted to maintain normal end tidal CO_2. Also, cerebral blood flow velocity (CBFV) was measured by using transcranial doppler ultrasonography.
Results: Mean arterial pressure and heart rate were significantly greater with transperitoneal (Tran) than retroperitoneal (Ret) group during CO_2 insufflation period. While both groups required increased minute ventilation to adjust $ETCO_2$, transperitoneal CO_2 insufflation resulted in a significantly greater increase of $PaCO_2$ than retroperitoneal group at the same insufflation pressure. Furthermore, significantly greater peak airway pressure was required with Tran group than Ret group to administer the same minute ventilation. Following CO_2 decompression, all these variables did not differ significantly from preinsufflation values. Peak airway pressure also decreased after decompression; however, values still differed significantly when compared to preinsufflation in transperitoneal group. Transperitoneal CO_2 insufflation resulted in a rapid increase in CBFV

* Corresponding author. Address: Anaesthesia Department, Faculty of Medicine, Zagazig University, Egypt. Tel.: +20 226175434.
E-mail address: sahmedtoha@yahoo.com (S.A. El-tohamy).
Peer review under responsibility of Egyptian Society of Anesthesiologists.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.egja.2012.11.002

during the first 30 min of pneumoperitoneum and attained a plateau throughout the procedure. In contrast, CBFV increased gradually throughout the retroperitoneal CO_2 insufflation and both groups returned to baseline values after desufflation.

Conclusion: Retroperitoneal laparoscopic approach for simple nephrectomy is not associated with greater effects on ventilatory, hemodynamic and cerebral functions compared to transperitoneal laparoscopy.

1. Introduction

Laparoscopic surgery is a safe and reliable option for kidney surgery, and it has possible advantages over open procedures; it is associated with a lower degree of postoperative morbidity and pain, and discharge to home is much more rapid [1].

Many renal procedures are currently carried out laparoscopically via transperitoneal and retroperitoneal approaches. These approaches have become the techniques of choice at an increasingly number of centers for several indications, including simple nephrectomy, living donor nephrectomy, partial or radical nephrectomy and nephroureterectomy [2].

Some studies believe that retroperitoneal laparoscopy (RPL) might be advantageous over transperitoneal laparoscopy (TPL) due to safe port placement, visceral handling with a lesser risk of injury, more rapid access to the renal pedicle and easier renal artery control [3,4].

Conversely, RPL may be technically more challenging because of the smaller working space and port proximity with resulting problematic ergonomy [5].

While several experimental and clinical studies have addressed the cardiovascular effects of CO_2 insufflation and increased intra-abdominal pressure, the pathophysiology is complex. In fact, reported results differ depending on what population of patients was studied [6,7] and the results are affected by volume loading or patient positioning [8].

The physiological aspects of CO_2 insufflation during TPL have been widely studied [9]. Conversely; the effects of retroperitoneal insufflation have been studied in limited fashion [10].

Little is known about its interference with ventilatory, circulatory and cerebral functions in humans during general anesthesia. So, we compared cerebral, hemodynamic and ventilatory effects of transperitoneal versus retroperitoneal CO_2 insufflation in adult patients undergoing simple nephrectomy.

2. Patients and methods

After local ethical research committee approval and an informed written patient consent, this double blinded randomized study was done on thirty patients scheduled to undergo elective simple laparoscopic nephrectomy at our University Surgical Hospital, from September 2011 to May 2012. Adult ASA physical status I and II patients of either sex with body mass index less than 28 kg/m^2 were included in the current study. Simple nephrectomy is indicated in treatment of most benign renal diseases in which permanent loss of renal function has occurred such as simple hydronephrosis, reflux nephropathy and multicystic kidney. Exclusion criteria included morbid obesity, uncontrollable coagulopathy, cardiovascular, respiratory or cerebrovascular disease, severe liver or kidney disease and previous laparotomy.

Patients were randomly assigned into two groups: retroperitoneal group (group Ret, $n = 15$) and transperitoneal group (group Tran, $n = 15$).

For both groups, general anesthesia was performed. Patients were premedicated with 0.1 mg/kg midazolam and 0.5 mg atropine intramuscularly 1 h before surgery. Anaesthesia was induced with 1–2 μg/kg fentanyl and thiopental sodium 4–6 mg/kg after pre-oxygenation, and muscle relaxation was obtained with rocuronium (0.6 mg/kg). The trachea was intubated, and the lungs were mechanically ventilated with a tidal volume of 8–10 ml/kg and a respiratory rate of 10–12 breaths/min. The ventilation was adjusted to maintain $ETCO_2$ of less than 40 mmHg. The radial artery was canulated for arterial blood gas analysis. Anesthesia was maintained with isoflurane in a mixture of oxygen and air with incremental doses of rocuronium (0.1 mg/kg) and fentanyl infusion of 0.5 μg/kg/h using the infusion pump. An inline capnograph was connected between tracheal end and breathing circuit and end-tidal carbon dioxide concentration ($ETCO_2$) was monitored. Peak airway pressure (PAP), mean arterial pressure (MAP) and heart rates (HRs) were recorded.

The blood flow velocity in the middle cerebral artery (CBFV) was measured using a transcranial doppler ultrasonography probe (DWL-multi, Dop P-ELEKTRONIC the system GmbH-Bios version1.0.3) The probe, which transmits a 2-MHz pulsed wave, was positioned over the temporal bone window (the temporal area just above the zygomatic arch) and was fixed to the patient's head with an elastic bandage so that the angle of insonation remained constant during the investigation [11]. Doppler signals from the middle cerebral artery were identified and measured at a depth of 45–50 mm. When all of hemodynamic and respiratory variables were stable, (changes in MAP, HR, $ETCO_2$ of $< 10\%$ within 10 min) measurements were recorded after induction (baseline), 5 min after patient positioning, 5 min after CO_2 insufflation and at 10-min interval for 60 min after the onset of the operation then at 120 and 180 min intraoperatively, and 10 min after deflation of peritoneal cavity from CO_2.

TPL patients were positioned in a 60–70 degree lateral position (modified lateral position) and pneumoperitoneum was obtained by the Veress needle technique. A standard 3 or 4 port technique was used. RPL procedures were performed with patients positioned in a 90-degree lateral position using an open access technique and retroperitoneal dilation balloon. Gas tight sutures around the first port were used to prevent gas leakage. Insufflation pressure was initially set at 15 mmHg using a CO_2 insufflation, then pressure maintained constantly at 10 mmHg for the duration of surgery.

Table 1 Demographic data.

	Ret group (n = 15)		Tran group (n = 15)	
Age (years)	35.5 ± 5.0		34.9 ± 6.0	
Gender				
Male/female	9/6		8/7	
Duration of CO_2 insufflation (h)	3.4 ± 0.5		3.3 ± 0.5	
BMI (kg/m^2)	24.5 ± 6.3		25.3 ± 5.9	
Lateral position	N	%	N	%
RT	7	46.7	8	53.3
LT	8	53.3	7	46.7
ASA (I/II)	9/6		7/8	

Values are given as mean ± SD and %.
There were no significant differences between the groups for listed parameters.

Hemodynamic and ventilatory monitoring continued after desufflation. Ventilation was adjusted to obtain ventilatory parameters within normal range. Finally, anesthesia had been terminated and the patients once again in the horizontal position. The patient who was awake and recovered from neuromuscular block received neostigmine and atropine and was extubated to breath spontaneously in stable hemodynamic and ventilatory conditions. In the PACU, hemodynamic and respiratory monitoring continued with treatment of postoperative nausea, vomiting and pain.

Statistical analysis; data were checked, entered and analyzed by using (SPSS version 19). Data were presented as mean ± SD for quantitative variables, number and percentage for categorical variables. CHI-squared x^2) or Fisher exact and t-test were used when appropriate. $P < 0.05$ was considered statistically significant.

3. Results

A total of 30 patients undergoing simple nephrectomies: 15 retroperitoneosopically, (Ret group) and 15 transperitoneally (Tran group) were included in the study. Eight patients were placed in the right and seven in the left modified lateral position in Ret group, seven patients were placed in right and 8 in the left lateral position in Tran group and all laparoscopic intervention was completed successfully in all enrolled patients.

There were no significant differences ($P > 0.05$) in age, body mass index, and duration of pneumoperitoneum between both groups (Table 1). MAP and HR in the Tran group were significantly greater than in Ret group ($P < 0.05$) throughout the operative procedure starting at insufflation time. Following CO_2 decompression, values of variables approached their baseline and did not differ significantly from preinsufflation values (Figs. 1 and 2).

In Ret group; respiratory changes during insufflation were small. $PaCO_2$ did not change significantly during the insufflation period (Fig. 3). To adjust $ETCO_2$ to less than 40 mmHg, minute ventilation had to be increased significantly (Fig. 4). Consistent with increased minute ventilation, PAP increased throughout the insufflation period reaching 18.7 ± 3.0 cmH2O at 30 min postinsufflation (Fig. 5). Following CO_2 decompression, no significant differences were observed in these variables when compared to preinsufflation baseline.

In Tran group; major respiratory changes occurred with transperitoneal insufflation. To adjust $ETCO_2$ within the normal range, a marked increase in minute ventilation was required, and accompanied by a marked increase in PAP throughout the insufflation period reaching maximally 30.0 ± 4.2 cmH2O at 40 min postinsufflation. PAP decreased after deflation, however, values still differed significantly in comparison to preinsufflation (Fig. 5). Despite unchanged $ETCO_2$, $PaCO_2$ significantly increased throughout the insufflation period (Fig. 3).

Comparison between the two groups: despite similar insufflation pressure throughout the procedure, PAP increased maximally and significantly in Tran group (by 13 cmH2O from a baseline of 17 cmH2O) than Ret group (increased by 2.4 cmH2O from a baseline of 16.1 cmH2O) at 40 min post insufflation and also throughout the insufflation period (Fig. 5). Furthermore, despite similar minute ventilation ($P > 0.05$) in both groups, required to maintain $ETCO_2$ (Fig. 4), the increased $PaCO_2$ was significantly greater following transperitoneal CO_2 insufflation (Fig. 3).

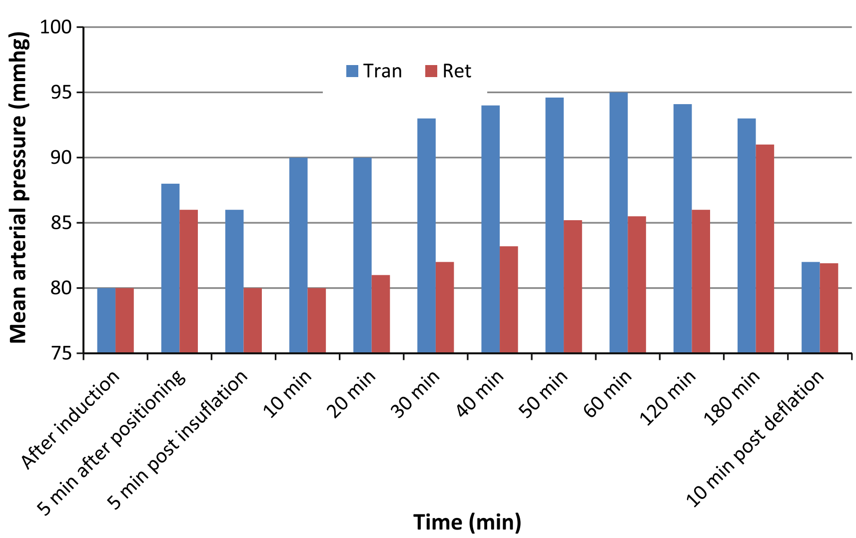

Figure 1 Mean arterial pressure changes during retroperitoneal and transperitoneal CO_2 insufflation.

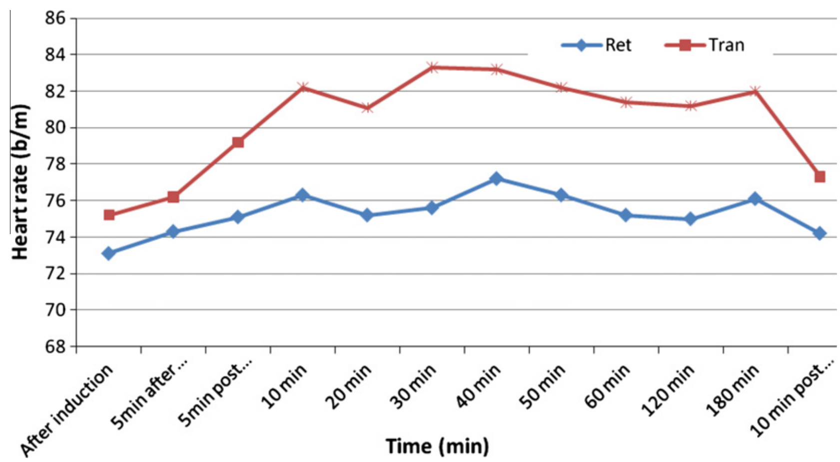

Figure 2 Heart rate during retroperitoneal and transperitoneal CO_2 insufflation. (*) Mean significant differences between groups.

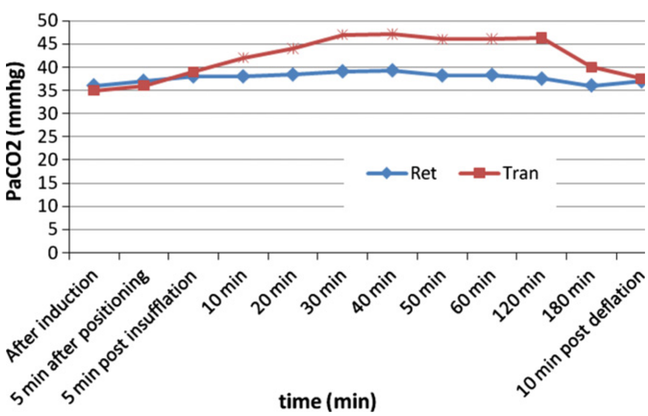

Figure 3 Arterial carbon dioxide tension ($PaCO_2$) during retroperitoneal and transperitoneal CO_2 insufflation. (*) Mean significant differences between groups.

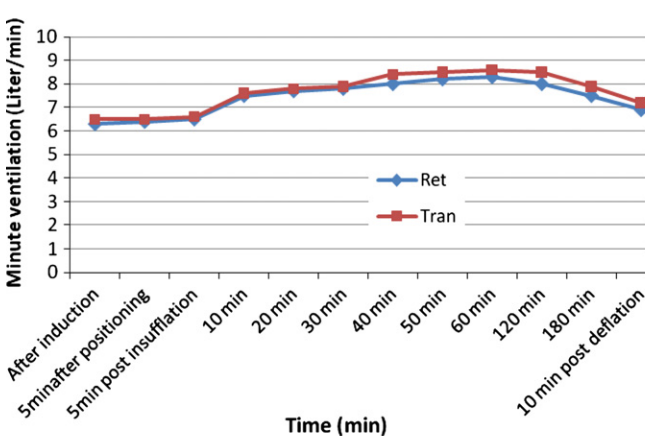

Figure 4 Minute ventilation changes during retroperitoneal and transperitoneal CO_2 insufflation. Data represented as mean, there were no significant differences between the two groups.

During the period of insufflation, CBFV increased significantly in Tran group than Ret group ($P < 0.05$) especially in the first 30 min of pneumoperitoneum, (with maximum increase of 45% in Tran group) thereafter CBFV attained a plateau throughout the pneumoperitoneum in Tran group. In contrast, CBFV increased gradually throughout the retroperitoneal insufflation period (with maximum increase of 15%). CBFV decreased to baseline values after desufflation in both groups (Fig. 6).

4. Discussion

Laparoscopic nephrectomy offers multiple advantages compared with the open approach; the visualization is magnified, better cosmetic results and quicker return to normal activities. The initial limitation of longer operative times and greater costs are becoming less prominent factors as experience has increased [12].

The advantages and benefits of each approach (retroperitoneal or transperitoneal) have frequently been debated. Some prefer a TPL approach, because it offers a larger working space and a more natural orientation to adjacent anatomic landmarks [12]. Although postoperative adhesions can occur after TPL, studies have shown that these adhesions are not clinically significant [13].

Some have found that the RPL approach allows quicker access to the kidney hilum and prefer to avoid any dissection of the colon. It has been argued that dissection might increase the risk of bowel injury and ileus formation [14].

However, in the last few years, retroperitoneoscopy has emerged as the treatment of choice for nephrectomy for benign non-functioning kidney [15].

There are several fundamental anesthesia related differences between the RPL and the TPL approaches, namely: exposure to CO_2 of the retroperitoneal space or transperitoneal cavity, patients lateral positioning for RPL versus 60–70 degree lateralization for TPL and pressure on one (RPL) or 2 hemi diaphragms (TPLs) [2].

In the present study, MAP increased in both groups after CO_2 insufflation but it was smaller in the Ret group. With CO_2 insufflation pressure less than 20 mmHg, it was reported that CVP as well as cardiac output (CO) increased, probably secondary to increased venous return from abdominal visceral venous beds. In contrast, when CO_2 is insufflated to a pressure greater than 20 mmHg, CVP and CO decreased secondary to decreased venous return from the lower body [2].

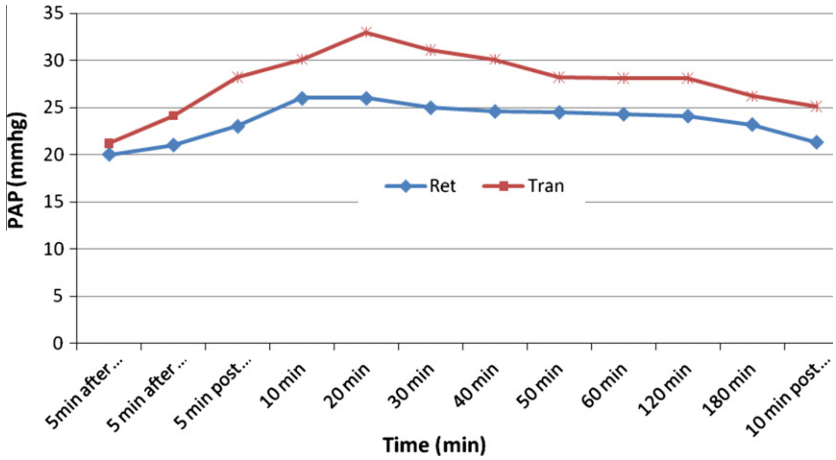

Figure 5 Peak airway pressure (PAP) changes during retroperitoneal and transperitoneal CO_2 insufflation. Asterisk (*) represents significant differences between the groups ($p < 0.05$).

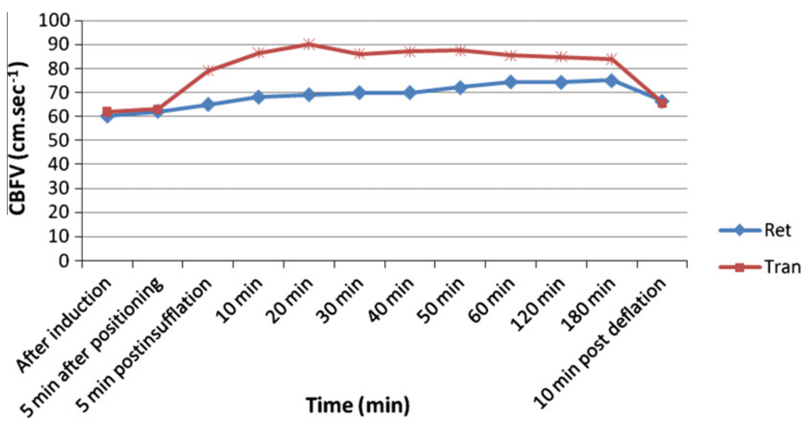

Figure 6 Changes in cerebral blood flow velocity (CBFV). All values are expressed as mean. (*) Mean significant difference between the two groups.

Haemodynamic changes with CO_2 insufflation depend on many factors, including patient position, patient's level of hydration, anesthetic agents, partial CO_2 pressure, trans-thoracic pressure and trans-abdominal pressure of insufflated CO_2 [16].

In the present study, trans-abdominal pressure is kept between 10 and 15 mmHg and patients are euvolemic. So, position must be considered. Lateral versus 60–70 degree (modified lateral) positioning alone seems to have had no significant effects on MAP which is consistent with Nadu et al. study [2]. Also, *Gottumukkala et al.* [17] reported that lateral decubitus position has minimal effects on major organ function when the patient is carefully positioned.

In *Joris et al.* [18] study, They reported decrease in CVP as well as MAP with positioning (the reverse Trendelinberg position) but increased with CO_2 insufflation in patients undergoing laparoscopic cholecystectomy, although CO, which decreases with positioning, further decreases with CO_2 insufflation as systemic vascular resistance increases. In contrast, during laparoscopic nephrectomy, patients are euvolemic and are positioned laterally and then, whereas CVP and MAP again increase with pneumoperitoneum, CO increases and calculated SVR decreases [19]. We assume that this is what occurred in the present study, although we did not measure CO or SVR. Also *Wolf et al.* [20] found that MAP, CO and central venous pressure for the same insufflation pressure were significantly greater with TPL than with extraperitoneal CO_2 insufflation. The increase in abdominal pressure may induce a pressure gradient along the inferior caval vein that is consistent with a Starling resistor concept of abdominal venous return, where flow is a function of the pressure difference between upstream venous and abdominal pressure rather than downstream central venous pressure.

An inferior caval vein pressure gradient was not observed with retroperitoneal insufflation despite similar inflation pressures and hence does not appear to impair systemic lower body venous return up to inflation pressure of 20 mmHg. [8] This is surprising since one would expect both cavity pressures to act on the surface of the inferior caval vein. However, it is possible that unilateral retroperitoneal CO_2 insufflation exerts less surface pressure on the inferior caval vein because CO_2 is either propagated in other tissue planes or acts on the caval vein only over a smaller length. The latter hypothesis is supported by the observation that the artificial retroperitoneal cavity created by insufflation is much smaller than the intraperitoneal cavity [21], so much less resistance to venous return can be expected with retroperitoneoscopic compared to laparoscopic surgery.

Using lower insufflation pressures, changes were milder and transient. The 3 min after the onset of pneumoperitoneum at pressure 8–12 mmHg, Branche et al. [22] observed a 25.7% increase in mean arterial pressure, a 49% increase in left ventricular afterload. All measured variables returned to pre-insufflation values after 30 min of pneumoperitoneum and thereafter were no longer significantly affected by postural changes (10° head up position) or pneumoperitoneum exsufflation.

A further reduction of the insufflation pressure was possible in children. During laparoscopic fundoplication for gastro-esophageal refux and at 5 mmHg, an increase of 22% in cardiac index was recorded along with 21% increase in mean arterial pressure and 17% increase in heart rate [23]. The results of all these above mentioned studies illustrate that the hemodynamic changes depend directly on intra-abdominal pressure [17].

In the present study, there was increase in heart rate during transperitoneal versus retroperitoneal laparoscopy that is consistent with *Bickel et al*. [24] and *Nadu et al*. [2].

Bickel and his colleagues [24] attributed the change in HR to the autonomic system stimulation during CO_2 insufflation that evaluated by heart rate variability analysis using a fast Fourier transform algorithm. In the current study, we did not use this type of analysis and cannot draw any definite conclusions regarding differences in autonomic stimulation between the studied groups.

Notably, the protocol of the present study mandated the maintenance of normal $ETCO_2$. Several studies have shown that CO_2 absorption during RPL or TPL increases significantly during the first 30 min of surgery, attaining a steady state thereafter [20]. This coincides with the hemodynamic changes in most of the patients with TPL. Which of the approaches ultimately results in greater CO_2 absorption remains a matter of debate. In the present study, intraperitoneal but not retroperitoneal Co2 insufflation had markedly higher $PaCO_2$ *Bennenberg et al*. [25] compared the influence of extraperitoneal and transperitoneal insufflation with CO_2 at 15 mmHg in pigs ventilated at a fixed rate of 12 breaths per minute. They observed that TPL was associated with significantly $ETCO_2$ and the appearance of respiratory acidosis attributable to increased CO_2 absorption during transperitoneal laparoscopy. Also, an explanation for this could be the greater surface area for CO_2 absorption (Ficks' principle) during insufflation where the peritoneal membrane may have greater absorptive capacity [26]. Coupled with the larger space and therefore, greater absorptive area available in the peritoneal cavity, this finding may explain the greater systemic absorption of carbon dioxide during intraperitoneal insufflation.

Ng et al. [26] suggested that retroperitonescopic renal and adrenal surgery is not associated with greater carbon dioxide elimination compared to similar transperitoneal laparoscopy, while Wolf et al. [20] found that retroperitoneal laparoscopy was associated with greater CO_2 elimination when retrospectively reviewed 63 patients who underwent laparoscopic renal surgery and compared the transperitoneal with the retroperitoneal approach. Both Wolf and his colleagues [20] and Ng et al. [26] used carbon dioxide elimination as indirect measurement of CO_2 absorption, but the surgical insufflation time was 5 h in the series of Wolf et al. and 3 h in Ng et al. study, also there were significant technical differences between both studies (Ng al et al. preferred the open technique of obtaining retroperitoneoscopic access, while Wolf et al. used the closed Veress technique). Wolf and his colleagues noted that if insufflation is limited to the retroperitoneal space, absorption of carbon dioxide appear to be reduced compared to intraperitoneal insufflation.

The mechanical effect of the intraperitoneal pressure is responsible for the increase in intrathoracic pressure explaining the increase in peak airway pressure (PAP) in the present study. This increase in the inspiratory pressure is likely to modify the ventilation to perfusion ratio with an increase in the physiological dead space if the intraperitoneal pressure is higher than 10 mmHg [27]. The increase in dead space (ventilation-perfusion mismatch) is responsible for an increase in capnea which comes in addition to that linked to the diffusion of CO_2. At the exsufflation of pneumoperitoneum, the ventilatory pressure resumed their basic values; the CO_2 diffuses easily from the peritoneal cavity towards the circulation and is transported to the lungs where it is eliminated during hematosis. This exogenous contribution of CO_2 determines the increase of $ETCO_2$ when the minute ventilation is kept constant [27].

To achieve normocapnea ($ETCO_2$of 34–37 mmHg), in an experimental study, significantly greater peak airway pressure was necessary in intraperitoneally than retroperitoneally insufflated animals to administer an adequate tidal volume which is consistent with our results [8].

In the present study, there was immediate increase in peak airway pressure 5 min after CO_2 insufflation that may be due to the decreased chest wall elasticity secondary to fixed extrinsic pressure on the diaphragm. There is cephalad displacement of the diaphragm that also directly compromises the pulmonary compliance. Since the artificial retroperitoneal cavity is much smaller, compliance was not decreased significantly during retroperitoneal insufflation until an insufflation pressure of 20 mmHg was applied [2].

So the significantly lesser changes in airway pressure in RPL group support the hypothesis that a less significant disturbance in pulmonary mechanics occurred in this group [2].

Lorenzo et al. [28] reported significant changes in $ETCO_2$, PAP and MAP with no changes in HR in retroperitoneal laparoscopy, Lorenzo and his colleagues only studied the retroperitoneal effects and the lack of comparison to a prospectively enrolled transperitoneal group was the limitation of their study. Also, they adjusted the ventilator setting to obtain an initial $ETCO_2$ of 35 mmHg However, the setting were not adjusted throughout the study period, so $ETCO_2$ reached 49 mmHg, while in the present study $ETCO_2$ maintained of less than 40 mmHg. Lastly, their studied group was the children, the characteristic of retroperitoneum in children seem different from those of the pelviscopy in adult, which causes a larger resorption of CO_2 than laparoscopy [29]. Is there a difference in the absorption of CO_2 according to age? It has been shown that young children have little fat in the retroperitoneal space contrary to adults; the impact of this difference is unknown. *Streich et al*. [30] found that the retroperitoneal space differs significantly from the peritoneal cavity, offering less of a barrier to CO_2 accumulation and absorption.

So, the majority of clinical studies showed that a greater burden is placed on the cardiorespiratory system during intraperitoneal CO_2 insufflation [2,8].

Cerebral blood flow (CBF) can be measured by several techniques. Transcranial Doppler Ultrasound is a safe, noninvasive method. Although CBF cannot quantify with this method, measurements revealed a close correlation between changes in CBF and changes in CBFV during vasomotor reactivity test [31]. Therefore, in the current study, changes in CBFV can be assumed to reflect a large change in CBF.

The major finding of this study was an increase in CBFV and this increase in CBFV seems to be progressively and gradually during retroperitoneal CO_2 insufflation period, while in transperitoneal laparoscopy, there was more rapid increase in cerebral blood flow velocity and attained a plateau effect during transperitoneal laparoscopy. The increase in CBFV indicates either an increase in CBF or a constriction of the middle cerebral vessel.

CBF may be changed with the change in blood pressure, cardiac output, body temperature, intrathoracic pressure and depth of anesthesia. Whereas halothane tends to increase CBF, neither isoflurane nor sevoflurane (0.5–1.5 MAC) produce significant dose-related changes in blood flow velocities. On the other hand, CBF remains constant if cerebral perfusion pressure varied between 60 and 130 mmHg of MAP [31].

The creation of pneumoperitoneum during laparoscopic surgery elevates the ICP because the increased the abdominal pressure obstructs the venous return from the lumber venous plexus [32]. Pneumoperitoneum also increases cerebral blood flow due to an increase in $PaCO_2$ and an increase in catecholamine release independent of $PaCO_2$ [31,11]. In the present study, we did not determine CBFV-CO_2 reactivity during pneumoperitoneum. Thus it remains open why CBFV is altered during pneumoperitoneum.

Fujii et al. [11] suggested that intraperitoneal CO_2 insufflation during laparoscopic cholecystectomy increase cerebral blood flow due to an increased $PaCO_2$ which was in agreement with a previous report by Liu et al. [33]. $PaCO_2$ profoundly influenced CBF, and hypercapnea cause intense cerebral vasodilatation and increase CBF [11].

In contrast, *Huettemann et al.* [31] found that induction of pneumoperitoneum leads to an increase in middle cerebral artery blood flow velocity in young children independent from changes in $PETCO_2$ and that CO_2 reactivity is preserved.

The present study is consistent with Karslia et al. [34] who studied the physiological changes in transperitoneal versus retroperitoneal laparoscopy and found that CBVF and $ETCO_2$ increased progressively and gradually during retroperitoneal laparoscopy and attributed these physiological changes to the smaller absorptive surface in the retroperitoneal space.

The limitation of the current study is that we did not determine CBFV-CO_2 reactivity as the aim of the current study was to compare the two groups as regards the cerebral effects and not to study the relation between CBFV and CO_2 absorption during pneumoperitoneum.

To our knowledge, our study is the first non-urology study to prospectively compare ventilatory, hemodynamic and cerebral effects of transperitoneal versus retroperitoneal laparoscopic renal surgery. We can conclude that retroperitoneoscopy, associated ventilatory, hemodynamic and cerebral implications are less deleterious than during transperitoneal laparoscopy. Although the choice of approach should be determined by surgeon preference, patient anatomy or the procedure to be performed, this might be an advantage especially in patients with compromised ventilatory, cardiac or cerebral function.

References

[1] Taue R, Izaki H, Koizumi T, et al. Transperitoneal versus retroperitoneal laparoscopic radical nephrectomy: a comparative study. Int J Urol 2009;16:263–7.

[2] Nadu A, Ekstein P, Szold A, et al. Ventilatory and hemodynamic changes during retroperitoneal and transperitoneal laparoscopic nephrectomy: a prospective real-time comparison. Am Urol Assoc 2005;174:1013–7.

[3] Gill IS. Retroperitoneal laparoscopic nephrectomy. Urol Clin North Am 1998;25:343.

[4] Gomella LG. Editorial: laparoscopy and urologic oncology. I: now pronounce Youman and wife. J Urol 2003;169, 2057-2.

[5] Ponsky LE, Cherullo E, Banks KLW, et al. Laparoscopic radical nephrectomy: incorporating advantages of hand-assisted and standard laparoscopy. J Urol 2003;169:2053.

[6] Ho HS, Cunther RA, Wolfe BM. Intraperitoneal carbon dioxide insufflation and cardiopulmonary functions: laparoiscopic cholecystectomy in pigs. Arch Surg 1992;128:928.

[7] Barnes GE, Laine GA, Giam PY, et al. Cardiovascualr responses to evaluation of intra-abdominal hydrostatic pressure. Am J Physiol 1985;248:R208.

[8] Giebler RM, Kabatnik M, Stegen BH, et al. Retroperitoneal and intraperitoneal CO_2 insufflation have markedly different cardiovascular effects. J Surg Res 1997;68:153–60.

[9] Pelosi P, Fotti G, Cereda M, et al. Effects of carbon dioxide insufflation for laparoscopic cholecystectomy on the respiratory system. Anaesthesia 1996;51:744.

[10] Halachmi S, El-Ghoneimi A, Bissonnette B, et al. Hemodynamic and respiratory effect of pediatric urologic laparoscopic surgery: a retrospective study. J Urol 2003;170:1651.

[11] Fujii Y, Tanaka H, Tsuruokat S, et al. Middle cerebral arterial blood flow velocity increases during laparoscopic cholecystectomy. Anesth Analg 1994;78:80–3.

[12] Kim CH, McKay K, Docimo SG. Laparoscopic nephrectomy in children: systematic review of transperitoneal and retroperitoneal approaches. Urology 2009;73:280–4.

[13] Pattaras JG, Moore RG, Landman J, et al. Incidence of postoperative adhesion formation after transperitoneal genitorurinary laparoscopic surgery. Urology 2002;59:37–41.

[14] Tarrado X, Rovira J, Garcia, et al. Retroperitoneoscopy: minimally invasive renal surgery. Cir Pediatr 2003;16:189–92.

[15] Gupta NP, Goel R, Hemal AK, et al. Should retroperitonneoscopic nephrectomy by the standard of care for benign non-functioning kidneys? An outcome analysis based on experience with cases in a 5-year period. Am Urol Assoc 2004;127:1411–3.

[16] Cunningham AJ, Brull SJ. Laparoscopic cholecystectomy: anesthetic implications. Anesth Analg 1993:76–1120.

[17] Gottumukkala V. Positioning of patients for operation in Anesthesiology, Longnecker DE, 1314–38, The MC GrawHill companies, New York, 0-07-145984-7.

[18] Joris JL, Noirot DP, Legrand MJ, et al. Hemodynamic changes during laparoscopic cholecystectomy. Anesth Analg 1993;76:1067–71.

[19] Fujise K, Shingu K, Matsumoto S, et al. The effects of lateral position on cardiopulmonary function during laparoscopic urological surgery. Anesth Analg 1998;87:925.

[20] Wolf JS, Carrier Jr, Stoller ML. Intraperitoneal versus extraperitoneal insufflation of carbon dioxide gas for laparoscopy. J Endourol 1995;9:63.

[21] Walz MK, Peitgen K, Krause U, et al. Posterior retroperitoneoscopy as a new minimal invasive approach for

adrenalectomy: results of 30 adrenalectomies in 27 patients. World J Surg 1993;201:769.

[22] Branche PE, Duperret SL, Sangard PE, et al. Left ventricular loading modifications induced by pneumoperitoneum; a time course echocardiographic study. Anesth Analg 1998;86: 482–7.

[23] De wael EE, Kalkman CJ. Hemodynamic changes during low pressure carbon dioxide pneumoperitoneum in young children. Paediatric Anesthaesia 2003;13:18–25.

[24] Bickel A, Yahalom M, Roguin N, et al. Improving the adverse changes in cardiac autonomic nervous control during laparoscopic surgery, using an intermittent sequential pneumatic compression device. Am J Surg 2004;187:124.

[25] Bennenberg JJ, Rademaker BM, Froeling FM, et al. Hemodynamics during laparoscopic extra- and intra-peritoneal insufflation: an experimental study. Surg Endosc 1997;11:911.

[26] Ng CS, Gill IS, Sung GT, et al. Retroperitonneoscopic surgery is not associated with increased carbon dioxide absorption. Am Urol Assoc 1999;126:1268–72.

[27] Diemunsch BP, Becmeur F, Meyer P. Retroperitoneoscopy versus laparoscopy in piglets: ventilatory and thermic repercussions. J Pediatr Surg 1999;34:1514.

[28] Lorenzo AJ, Karsli C, Halachmi S, et al. Hemodynamic and respiratory effects of pediatric urological retroperitoneal laparoscopic surgery: aprospective study. Am Urol Assoc 2006;175:1461–6.

[29] Mullet CE, Viale JP, Sagnard PE, et al. Pulmonary CO_2 elimination during surgical procedures using intra-extraperitoneal CO_2 insufflation. Anesth Analg 1993;76: 622–6.

[30] Streich B, Decailliot F, Perney C, et al. Increased carbon dioxide absorption during retroperitoneal laparoscopy. Br J Anaesth 2003;91:793.

[31] Huettemann E, Terborg CH, Sakka S, et al. Preserved CO_2 reactivity and increase in middle cerebral arterial blood flow velocity during laparoscopic surgery in children. Anesth Analg 2002;94:255–8.

[32] Halverson A, Buchanan R, Jacobs L. Evaluation of mechanism of increased intracranial pressure with insufflations. Surg Endosc 1998;12:266–9.

[33] Liu SY, Leighton Davis I, et al. Prospective analysis of cardiopulmonary responses to laparoscopic cholecystectomy. J Laparoendosc Surg 1991;1:241–6.

[34] Karslia c, El-Houtb Y, Lorenzob AJ, et al. Physiological changes in transperitoneal versus retroperitoneal laparoscopy in children: aprospective analysis. J Urol 2011;168: 1649–52.