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PULMONARY, HAEMODYNAMIC AND OPERATIVE OUTCOMES DURING LAPAROSCOPIC RADICAL CYSTECTOMY UNDER TOTAL INTRAVENOUS ANAESTHESIA; A PRELIMINARY REPORT

Atef Demian
Anaesthesia Department Department Faculty of medicine, Mansoura University

Ahmed Shoma
Urology Department Department Faculty of medicine, Mansoura University

PULMONARY, HAEMODYNAMIC AND OPERATIVE OUTCOMES DURING LAPAROSCOPIC RADICAL CYSTECTOMY UNDER TOTAL INTRAVENOUS ANAESTHESIA; A PRELIMINARY REPORT

By

Atef D. Demian MD* And Ahmed M Shoma, MD **

From

Anaesthesia Department and Urology Department***

Faculty of medicine , Mansoura University

ABSTRACT

Background : The tolerance of patients subjected to laparoscopic radical cystectomy to the diffused Co_2 and Trendelenburg position has not been reported . We studied pulmonary and haemodynamic changes in addition to postoperative outcome following laparoscopic radical cystectomy under total intravenous anaesthesia. Patients and methods : A prospective cohort study was conducted on 21 patients anaesthetized by a combination of epidural and total intravenous anaesthesia . Anaesthesia was induced by fentanyl (1µg kg $^{-1}$) , midazolam (0.1 mg kg^{-1}) and ketamine (2 mg kg^{-1}) and maintained by intravenous infusion of the three drugs in a decreasing dose regimen. Vecuronium was used for muscle relaxation . Surgery was done while the patient in head down position (45^0) . Lungs were ventilated using air – oxygen ($FiO_2 = 0.35$) with a tidal volume of 10 ml kg^{-1} at a rate of 14 min^{-1} . Lung mechanics , gasometric and haemodynamic variables were recorded at different strategic points . Results : Two patients were excluded as they resorted to open surgery . Nine of 19 patients (47%) had preoperative medical problems and 7 patients (37%) received blood . There were significant changes in both lung mechanics and haemodynamic variables associated with pneumoperitoneum and Trendelenburg position but without deleterious effects . The used anaesthetic technique yielded accepted recovery with satisfactory postoperative outcome . Conclusion : laparoscopic radical cystectomy can be performed safely under total intrave-

nous anaesthesia .

INTRODUCTION

With advances in laparoscopic technology and more experience of urologists in this technique, Laparoscopic surgery has been performed successfully in many urological procedure. These included radical [1] and donor nephrectomy[2], adrenalectomy for pheochromocytoma [3], simple nephrectomy in end stage renal failure [4], radical prostatectomy [5] and – recently – radical cystectomy and urinary diversion [6,7]. The impetus for this is that laparoscopic techniques are associated with less blood loss , less pain , lower incidence of postoperative ileus ,shorter hospital stay and quicker return to normal activities compared to conventional open surgery [3,6,7,8] .

Laparoscopic transperitoneal radical cystectomy is a new major surgery being performed often on patients with mild to moderate systemic diseases . Bladder cancer patients are usually male , cigarette smoking , elderly , debilitated and or dehydrated . In addition , insufflation of Co_2 is associated with haemodynamic [9-11] and respiratory [12] effects which are further exaggerated by head – down position [11,12] . These changes may compromise cardiac and pulmonary functions particularly in elderly or obese patients with limited reserve .

The initial results of total intravenous anaesthesia (TIVA) using ketamine and midazolam in open radical cystectomy proved satisfactory [13]. It avoided distension of both colon and ileum by inhalation gases, provided haemodynamic stability and profound analgesia in addition to low cost .

We sought to report pulmonary and haemodynamic changes in addition to postoperative outcome in patients subjected to laparoscopic radical cystectomy under TIVA .

PATIENTS AND METHODS

This prospective cohort study was conducted on 21 patients (ASA I - III) with bladder cancer undergoing laparoscopic radical cystectomy in Urology and Nephrology Centre , Mansoura University . All the procedures were performed by one surgeon (AS) . Exclusion criteria included major organ diseases and patients for whom there was a resort to open surgery . The protocol was approved by our centre research ethics committee and a written consent was obtained from every patient.

Lumbar epidural anaesthesia was produced in all patients by administration of 10 ml. bupivacaine 0.25% mixed with 2 mg morphine given via L 2-3 space. Central venous cannulation was done under local lidocaine through internal jugular approach. Anaesthesia was induced by fentanyl (1 μg kg^{-1}), midazolam (0.1 mg kg^{-1}) and ketamine (2 mg kg^{-1}). Vecuronium was used to facilitate tracheal intubation and to maintain muscle relaxation during surgery. Anaesthesia was maintained in the first hour by intravenous infusion of ketamine (30 μg kg^{-1} m^{-1}), fentanyl (1 μg $kg^{-1}hr^{-1}$) and midazolam (40 μg kg^{-1} hr^{-1}) from a separate infusion pump. The doses then decreased every hour to reach 5 μg kg^{-1} m^{-1}, 0.5 μg kg-1 hr^{-1} and 10 μg kg-1 hr^{-1} for ketamine, fentanyl and midazolam respectively at time of wound closure. The lungs were ventilated using Oxygen enriched air (FiO2 = 0.35) with a tidal volume of 10 ml kg^{-1} using a pressure regulation volume controlled / support mode at a rate of 14 / min.

Surgery was performed while the patient in Trendelenburg position with 45^{0} head – down tilt. All procedures were performed through transperitoneal approach. The abdominal cavity was insufflated by Co_2 till a pressure of 15 mmHg.

Perioperative monitoring included: heart rate, continuous 5 lead electrocardiography, pulse oximetry, capnography and non- invasive arterial blood pressure. Recorded data included lung mechanics (dynamic compliance " Dyn C ", peak airway pressure "Pp" and mean airway pressure "Mp"), peripheral oxygen saturation "SpO_2", end– tidal Co_2 tension "$EtpCo_2$" and haemodynamic variables (heart rate "HR", mean arterial blood pressure "MBP" and central venous pressure "CVP"). These data were recorded after induction of general anaesthesia (basal), after Trendelenburg position (AT), 15, 30, 60 min after Co_2 insufflation (AI), before deflation (BD) and 15, 30, 60 min after deflation (AD). Lung mechanics data were recorded from Servo Screen 390 attached to Servo 300 ventilator. The duration of Co_2 insufflation, amount of total blood loss, state of recovery and postoperative outcomes were also recorded.

Descriptive statistics (means and

95 % confidence interval) were carried out using SPSS program version 10.0 . To study change over time in each measured variable , repeated measure ANOVA procedure was used . A value of $P <0.05$ was considered as a level of significance .

RESULTS

The demographic and clinical characteristics of the studied patients are shown in table " 1 " . Two patients were excluded from the study as they were resorted to open surgery due to uncontrolled bleeding . Nine patients (47%) had preoperative medical problems and 7 patients (37%) received blood (1 -3 units) .

Dynamic compliance decreased while Pp and Mp increased significantly as related to both basal and " AT " values in all readings during Co_2 insufflation (table 2) . After deflation, lung compliance continued to be significantly lower than the basal reading - parallel to high Pp and Mp - but higher than "AT ' reading associated with significantly low Pp (table 2) .

End tidal Co_2 tension ($EtpCo_2$) increased significantly as compared to either basal or "AT " readings starting from 30 min AI and continued till 30 min AD , reaching its maximum value before deflation . However , except BD value , all the recorded readings of $EtpCo_2$ were within accepted range (table 3) .

Heart rate decreased and mean blood pressure increased significantly as related to basal reading during nearly all insufflation period . As related to "AT" reading , HR showed significant decrease in most readings during insufflation and significant increase after deflation . Central venous pressure increased significantly as related to either basal or " AT " readings and this continued throughout the study period (table 4) .

Of 19 studied patients , 12 patients (63%) were recovered from anaesthesia immediately after surgery while 7 patients were put on ventilatory support in high dependency recovery room for 1-2 hours . Two patients only needed postoperative analgesia due to dynamic (1 patient) or static (1 patient) pain . Five patients developed complications : subcutaneous emphysema in the chest extending up to the neck (3 patients) , severe postoperative nausea and vomiting (1 patient) and pulmonary embolism (1 patient) . The last complication was seen in the second postoperative day , treated by heparin and the patient recovered. Only 4 patients (21 %) could ambulate early in the first postoperative day in recovery room while the second postoperative day was the ambulation time for the rest of the patients .

Table (1) : Demographic and clinical characteristics of the patients enrolled in the study .

	Mean ± SD (range) or number (%)
Age (years)	57.3 ± 8 (42 -70)
Gender (M/F)	18 / 1
Body weight (kg)	73.5 ± 10 (56 – 95)
Height (cm)	166.7 ± 6 (155 – 177)
Time of CO_2 insufflation (min)	263.2 ± 43 (195 – 360)
Total time of operation (min)	470.3 ± 61 (405 – 520)
Blood loss (ml.)	710.5 ± 41 (200 – 1800)
Preoperative medical diseases :	
- Hypertension	3 (15.8)
- Ischemia & conduction defects	2 (10.5)
- Diabetes mellitus	2 (10.5)
- Emphysema	1 (5.3)
- Hepatic impairment	1 (5.3)

Table (2) : Intraoperative lung mechanics of the studied patients . Values are mean ± SD (95 % CI) .

	Compliance (ml / cm H_2O)	Peak pressure (cm H_2O)	Mean pressure (cm H_2O)
Basal (after induction)	40 ± 8 (36 – 44)	14 ± 3 (13 – 15)	5.3 ±1 (5 – 6)
After Trendelenburg	30 ±7* (26 – 33)	19 ±3* (18 – 21)	6.4 ±1* (6 – 7)
After Co_2 insufflations :			
15 min	21 ± 6*# (18 – 24)	26 ± 5*# (24 – 28)	7.9 ±1*# (7.3 – 8.5)
30 min	21 ±5*# (18 – 23)	26 ± 4*# (24 – 28)	8.1 ±1*# (7.4 -8.8)
60 min	21 ± 6*# (18 – 23)	27 ± 4*# (25 – 29)	8.4 ± 2*# (8 – 9)
Before deflation	21 ±7*# (18 – 24)	27 ± 5*# (25 – 30)	8.6 ± 2*# (8 – 10)
After deflation :			
15 min	34 ±9*# (30 – 38)	18 ±3*# (16 – 19)	6.4 ±1* (6 – 7)
30 min	34 ±10*# (30 – 39)	17 ± 3*# (16 – 19)	6.1 ±1* (6 – 7)
60 min	35 ±7*# (32 – 39)	17 ± 2*# (16 – 18)	6.1 ±1* (5 –7)

* Significant change ($p< 0.05$) from basal value .

Significant change ($P < 0.05$) from the value after Trendelenburg position .

Table (3): Intraoperative peripheral Oxygen saturation (SpO_2) and End tidal Co_2 tension ($EtpCo_2$). Values are mean ± SD (95 % CI) .

	SpO_2 (%)	$EtpCo_2$ (mmHg)
Basal (after induction)	98.3 ±2 (97.8 – 99)	30 ±3 (29 – 32)
Basal (after induction)	98 ±2 (97.2 – 98.8)	31 ± 3 (29 – 33)
After Co_2 insufflations :		
15 min	97.7 ±2*# (96.7 – 98.8)	32 ±2 (31 – 33)
30 min	97.7 ±2 (96.7 -98.8)	33 ±3*# (31 – 35)
60 min	97.7 ±2 96.8 -98.7)	36 ± 4*# (35 -38)
Before deflation	98.1 ±2 (97.3 – 98.8)	40 ±5*# (38 – 43)
After deflation :		
15 min	97.9 ±2 (97.1 – 98.8)	36 ±5*# (34 -38)
30 min	98.2 ±2 (97.5 - 98.9)	34 ±3*# (32 – 35)
60 min	98.8 ±1 (98.2 – 99.4)	32 ±3 (30 – 33)

* Significant change (p< 0.05) from basal value .

\# Significant change (P < 0.05) from the value after Trendelenburg position .

Table (4) : Haemodynamic variables of the studied patients . Values are mean ± SD (95 % CI) .

	Heart rate (bpm)	Mean blood pressure (mmHg)	Central venous pressure (mmHg)
Basal (after induction)	79 ±11 (74 – 85)	81 ±13 (75 – 88)	3.7 ± 2 (3 -5)
After Trendelenburg	73 ±10* (68 – 78)	88 ±14* (82 – 95)	12.6 ± 3* (11 – 14)
After Co_2 insufflations :			
15 min	69 ±10*# (64 – 74)	93 ±10* (88 -98)	17.8 ±5*# (16 – 20)
30 min	70 ±10*# (65 -74)	90 ± 9* (86 -95)	18.8 ±4*# (17 -21)
60 min	71 ±10* (66 -75)	94 ±9* (90 – 99)	18.6 ± 5*# (16 – 21)
Before deflation	82 ±12# (76 – 88)	95 ±12* (90 -101)	17.4 ± 4# (16 – 19)
After deflation :			
15 min	85 ±12# (79 -90)	87 ±13 (81 – 93)	9.3 ± 4*# (8 – 11)
30 min	84 ±10# (79 – 89)	90 ±11* (84 – 95)	9.6 ±3*# (8 – 11)
60 min	83 ±12# (77 – 89)	93 ±10* (88 – 98)	9.7 ±3*# (8 – 11)

* Significant change ($p< 0.05$) from basal value .

Significant change ($P < 0.05$) from the value after Trendelenburg position .

DISCUSSION

This study revealed that although - nearly- half of the patients subjected to laparoscopic radical cystectomy had preoperative medical problems , no major complications or abnormal events have been reported . The effects of Co_2 insufflation and Trendelenburg position on pulmonary and haemodynamic variables were statistically significant but without any deleterious effects . Our anaesthetic regimen yielded accepted recovery with good postoperative outcome .

The effects of pneumoperitoneum and Trendelenburg position on pulmonary functions in other laparoscopic surgeries has been extensively studied . These included decreased lung volumes and compliance [14] , with further demonstratable decrease after head down position but minimal effects on oxygenation and Co_2 elimination [12] . However , there was greater compromise of respiratory function in obese and elderly [15]. Our patients were mostly elderly and about 50% had cardiovascular, pulmonary or hepatic diseases, so, we demonstrated about 50% reduction in compliance following Trendelenburg position and Co_2 insufflation compared with 30% in other laparoscopic surgery [14,16]. It was reported that the decrease in compliance was immediately reversible upon abdominal deflation [17] but in this study the reduction *in compliance as related to basal* reading continued up to 1 hr after deflation. However it was higher than AT reading. This indicate that both head down position and pneumoperitoneum participated in reduction of compliance as the patients remained in Trendelenburg position after deflation to complete open urinary diversion. The significant increase in both peak and mean airway pressures after Co_2 insufflation and head down position confirmed the decrease in compliance and not the increase in airway resistance indicated by high peak pressure only. However, in spite of these changes, no major pulmonary complications – apart from 3 cases of mild subcutaneous emphysema that resolved spontaneously without rescue treatment – were recorded .

Due to the difficult access for arterial sampling , we depended on $EtpCo_2$ as a rough estimation of pulmonary ventilation . Although less reliable as a predictor of $PaCo_2$ during laparoscopy than conventional open surgery , $EtpCo_2$ is useful as a gross guide to the adequacy of venti-

lation (14). *We reported a progressive* significant increase in $EtpCo_2$ reaching its maximum reading 30 min after deflation . However , all readings were within the accepted range recorded in previous literatures (4). Arterial oxygenation was maintained in our study which has been attested in previous reports during laparoscopy in different patients populations (10, 18-20) .

The mean arterial blood pressure and CVP increased significantly indicating increase in systemic vascular resistance and preload respectively (10,11) . Nevertheless , these changes were well tolerated in both healthy and elderly patients with cardiovascular implications . The significant bradycardia was due to the effect of epidural anaesthesia in addition to balanced TIVA . Pneumoperitoneum and head-down position caused acute volume loading which antagonize the hypotensive effect of epidural anaesthesia , accordingly , the haemodynamic variables - except acute elevation of CVP - remained within accepted range all over the study period .

One of the advantages of laparoscopic radical cystectomy is minimal blood loss with almost negligible transfusion rate as compared with open surgery . However , the average blood loss during laparoscopic radical cystectomy was 710.5 ml which is higher than reported during robotic laparoscopic radical cystectomy (21) and similar to open surgery (8) . In addition , more than one-third of our patients received blood . The contributing factors might be the early learning curve in this technique and possible vascular injury during lymphadenectomy (3 cases).

To perform prolonged laparoscopic abdominal surgery, anaesthesia has to provide adequate relaxation, haemodynamic stability and good analgesia. Avoidance of inhalation anaesthetic agents resulted in lack of distension of the intestiine. So, we used ketamine, fentanyl, midazolam TIVA which was used successfully without fentanyl in open radical cystectomy(13). This technique is simple, effective and quite inexpensive. In this study, this anaesthetic regimen provided perioperative haemodynamic stability, optimum surgical condition, good recovery and profound analgesia .

From this study, we conclude that

laparoscopic radical cystectomy can be performed safely under TIVA .

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