The Effect of Intraoperative Fluid Management on Haemodynamics during Laparoscopic Radical Cystectomy

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Abstract

Background: Prolonged pneumoperitoneum in laparoscopic radical cystectomy (LRC) leads to impairment in haemodynamics. This is manifested by increase in systemic vascular resistance, decrease in cardiac output and arrhythmias.

Aim of the Study: To determine whether intraoperative fluid management could prevent cardiovascular changes from hazards of pneumoperitoneum in patients undergoing laparoscopic radical cystectomy operations.

Study Design: Randomized controlled trial.

Methodology: Eighty patients with cancer bladder scheduled for laparoscopic radical cystectomy, classified by the American Society of Anesthesiologist (ASA) to class (ASAII or ASAIII) were divided into 2 equal groups group I received 2ml/kg/hr LR (Lactated ringer), group II received 8ml/kg/hr LR. Both groups received 8ml/kg LR as a preload.

Results: No statistical significant difference was found in HR and MAP while there was statistical significant difference in CVP after 180 minutes T6 (5.6 ±2.42 versus 7.1 ±2.73).

Conclusion: In patients undergoing laparoscopic radical cystectomy, intraoperative infusion of 8ml/kg/hr Lactated Ringer could maintain haemodynamic stability without causing pulmonary edema or volume overload compared to low volume infusion of 2ml/kg/hr Lactated Ringer.

Key Words: Pneumoperitoneum – Fluid replacement therapy – Haemodynamics.

Introduction

BLADDER cancer is the most common cancer among men in Egypt with the highest mortality rate. Nowadays, laparoscopic radical cystprostatectomy is considered the gold standard treatment, with many advantages over open surgery as it has lower morbidity, better haemostasis, less postoperative pain and early mobilization, so it shortens hospital stay and costs [1,2].

On the contrary, laparoscopy has longer operative time, which leads to prolonged pneumoperitoneum time and more CO2 absorption that can result in serious complications as pneumothorax, gas embolism, ventilation-perfusion mismatch, decrease in CO, increase in SVR, PVR, MAP and CVP, significant bradycardia and asystole. While, hypercarpia activates the sympathoadrenal axis with release of catecholeamines, cortisol, antidiuretic hormone and aldosterone increasing heart rate and cardiac output [3].

Optimizing cardiac preload improves hemodynamics and organ perfusion. Many protocols and fluid doses are studied to improve the patient outcome perioperatively. In addition to the standard 4-2-1 rule in fluid replacement, restrictive, liberal and goal directed fluid therapy are described [3].

Restrictive fluid administration has the advantages of decreasing perioperative cardiopulmonary complications, gut edema, disruption of bowel motility and improves wound healing. On the other hand, it causes intraoperative hypovolemia, postoperative nausea, dizziness, fatigue and thirst sensation [4,5].

Liberal fluid replacement prevents anesthesia-induced hypotension and protects organ function, especially the kidneys. It causes significant reduction in stress response. However, it leads to tissue edema, coagulation abnormalities, impaired pulmonary gas exchange, microvascular perfusion and tissue oxygenation [6,7].

In a trial for improving haemodynamics, the current study was trying to evaluate a volume of 8ml/kg/hr LR versus 2ml/kg/hr LR during laparoscopic radical cystectomy operation.
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Patients and Methods

Method. Patients were assigned to one of the two groups as follow:

Group (I): (Control group): Received 2ml/kg/h of intravenous (i.v.) Lactated Ringer.

Group (II): Received 8ml/kg/h of intravenous Lactated Ringer.

All patients were premedicated by antiemetics (Ondansetron 8mg i.v) and antacids (ranitidine 50mg i.v) one hour before operation.

On arrival to the operating theatre, all patients were monitored for electrocardiogram (ECG), pulse oximetry and non invasive blood pressure. Base line values of heart rate (HR) and mean arterial blood pressure were recorded (T0). Capnogram was applied after intubation.

IV anxiolytic (midazolam 1-2mg) was given. Pre-anesthetic hydration by 8ml/kg/Lactated Ringer over 20 minutes was infused to all patients through i.v. cannula G 20.

After sterilization of the patient back, a Tuohy needle 16 gauge was inserted using mid-line approach. Epidural catheter was then fixed and tested by 2cm lidocaine 2% mixed with adrenaline 1:200,000.

General anesthesia was induced by fentanyl 2gg/kg, propofol 2mg/kg and 0.5mg/kg atracurium, then tracheal intubation using cuffed endotracheal tube was done. Patients were ventilated using mechanical ventilation (MV) and ventilator parameters were adjusted to maintain normocapnia.

Anesthesia was maintained with inhaled isoflurane 1.2% in oxygen air mixtures 1:1. Atracurium infusion was adjusted to maintain adequate muscle relaxation as monitored with nerve stimulator with average dose 5-10 µg/kg/min. Epidural activation was done by a mixture of plain bupivacaine 0.25% and fentanyl 50gg. Incremental doses were given until the desired level was achieved. Contiguous epidural infusion of mixed local anesthetics and opioid (bupivacaine 0.125% and fentanyl 1 µg/ml) administered with a rate of approximately 10ml/hr to maintain mean arterial blood pressure (MAP) and HR within 20% of baseline values. Bradycardia was corrected by i.v. atropine 0.5-1mg and hypotension was corrected by incremental doses of i.v. ephedrine 3-12mg.

Temperature probe, sterile urinary Foley's catheter and naso-gastric tube were all inserted. After performing modified Allen's test, arterial cannulation of the non-dominant hand using 20-gauge heparinized cannula was done under complete aseptic precautions. Invasive blood pressure was continuously monitored and recorded every 30 minutes. Central venous catheterization of the internal jugular vein, using Seldinger's technique was done under complete aseptic precautions and monitoring. Central venous pressure (CVP) was measured and recorded. Patients were positioned in the Trendelenberg position with padding of the pressure points on mattress to keep body temperature. All vital signs, end tidal CO2 and peak airway pressure were continuously monitored during CO2 insufflation. Arterial blood gases (ABGs) samples were withdrawn after 2 hours from starting CO2 insufflation and before the end of surgery.

Using individual sealed envelope blood (MABP) pressure were recorded (T0).
Any derangement in ABG was corrected accordingly. Blood loss was replaced by Hydroxyethyl starch 6% in a ratio 1:1 until it exceeded 15% of the total volume, packed red blood cells (PRBCs) units were given.

At the end of surgery, reversal of the neuromuscular block was done by i.v. neostigmine 0.04mg/kg and atropine 0.01mg/kg as deteeted clinically and by nerve stimulator. Patients were extubated and transferred from operating room according to modified Aldrete scoring with minimum score 9 points.

Patients were then transferred to intensive care unit and routine visits were done for the following 72 hours for data collection and record.

For both groups the following variables were recorded:
- MABP, HR and CVP were recorded every 30 minutes till the end of surgery (T1-T8).

**Statistical analysis:**

A previous study was done by Idit Matot et al., (2012) [8] reported a comparison between low volume fluid infusion and high volume fluid infusion in patients undergoing laparoscopic bariatric surgery on 78 patients and haemodynamics were recorded, so we planned to use a sample size of 80 patients (40 patient per group) to compensate for possible dropouts.

Data of each patient was collected in a special file then it was coded and fed to the computer on Microsoft excel worksheet and transferred to SPSS statistical package program version 16 for statistical analysis. All normally distributed continuous data will be presented as means and (Standard Deviations). Unpaired t-test will be used for analysis of continuous data between the two study groups. Repeated measure ANOVA will be used for data analysis within each group. Chi square test or Fisher test will be used appropriately to compare the frequency of categorical data.

A p-value of <0.05 will be considered significant.

**Results**

This study is a randomized clinical trial that was conducted in order to evaluate and to compare two methods of fluid administration during laparoscopic radical cystectomy operation. The study included 80 patients divided randomly into 2 equal groups. There was no statistically significant difference between both groups as regard age, sex, weight, height and BMI (Table 1).

As regard HR, in group I, HR showed statistically significant difference in T1 (76.80±8.9), T2 (77.97±8.8), T3 (80.42±7.2), T4 (80.5±6.4), T5 (80.4±7.5), T6 (80.9±8.1) and T7 (83±13.1) compared to T0 (87.08±13.7) (Table 2).

In Group II, there was statistically significant difference at T1 (79.4±11.1), T2 (78.4±7.5), T3 (79.7±8.2), T4 (80.3±6), T5 (79.7±7.3), T6 (79.6±5.9), T7 (78.3±73), T8 (80.5±6.1) and T9 (85.3±9.5) compared to T0 (92.4±13.7) (Table 3).

On comparing both groups, there was no significant difference in all recorded measurements (Table 4).

As regard MAP, in group I, MAP showed statistically significant difference in T1 (83.52±9.4), T2 (80.07±8.6), T3 (79.18±8.5), T4 (79.27±8.9), T5 (79.75±7.6), T6 (79.12±5.7), T7 (75.8±6.6), T8 (80.4±5.9) and T9 (80.2±6.5) versus T0 (90.75±12.5) (Table 2).

In Group II, there was statistically significant difference at T1 (79.8±10.4), T2 (81.7±7.7), T3 (81±7), T4 (82.2±5.3), T5 (81.4±5.8), T6 (82.3±6), T7 (77.8±7.04), T8 (80.2±5.9) and T9 (80.5±6.67) compared to T0 (86.7±8.5) (Table 3).

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In Group I, CVP showed statistically significant difference in T1 (79.8±10.4), T2 (81.7±7.7), T3 (81±7), T4 (82.2±5.3), T5 (81.4±5.8), T6 (82.3±6), T7 (77.8±7.04), T8 (80.2±5.9) and T9 (80.5±6.67) compared to T0 (86.7±8.5) (Table 3).

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On comparing both groups, there was no statistically significant difference (Table 4).

**Table (1): General characteristics of the 2 groups.**

<table>
<thead>
<tr>
<th></th>
<th>Group I N = 40</th>
<th>Group II N = 40</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>57.52±5.78</td>
<td>57.28±6.0</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Gender (N, %):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>34 (85%)</td>
<td>32 (80%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Females</td>
<td>6 (15%)</td>
<td>8 (20%)</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>174.5±8.5</td>
<td>176.4±8.9</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Weight</td>
<td>79.4±9.6</td>
<td>79.6±8.7</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>BMI</td>
<td>27.5±2.1</td>
<td>27.8±3.1</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

p-value is significant >0.05.
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Table (2): Haemodynamic measurements at different follow-up periods in comparison to the pre-operative value among group I.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>p-value (in comparison to the peroperative value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR0</td>
<td>87.08</td>
<td>13.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HR1</td>
<td>76.80</td>
<td>8.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HR2</td>
<td>77.97</td>
<td>8.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HR3</td>
<td>80.42</td>
<td>7.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HR4</td>
<td>80.5</td>
<td>6.4</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>HR5</td>
<td>80.4</td>
<td>7.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HR6</td>
<td>80.9</td>
<td>8.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HR7</td>
<td>83.0</td>
<td>13.1</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>HR8</td>
<td>85.0</td>
<td>17.7</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>HR9</td>
<td>86.125</td>
<td>9.4</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>MAP0</td>
<td>90.750</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>MAP1</td>
<td>83.52</td>
<td>9.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP2</td>
<td>80.075</td>
<td>8.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP3</td>
<td>79.18</td>
<td>8.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP4</td>
<td>79.27</td>
<td>8.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP5</td>
<td>79.75</td>
<td>7.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP6</td>
<td>79.12</td>
<td>5.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP7</td>
<td>75.8</td>
<td>6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP8</td>
<td>80.4</td>
<td>5.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP9</td>
<td>80.2</td>
<td>6.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CVP0</td>
<td>5.6</td>
<td>2.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CVP1</td>
<td>7.9</td>
<td>3.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CVP2</td>
<td>7.9</td>
<td>3.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CVP3</td>
<td>6.4</td>
<td>2.71</td>
<td>&lt;0.001</td>
</tr>
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<td>6.5</td>
<td>2.42</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>CVP5</td>
<td>5.7</td>
<td>2.40</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>CVP6</td>
<td>5.6</td>
<td>2.42</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>CVP7</td>
<td>6.2</td>
<td>1.60</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>CVP8</td>
<td>6.0</td>
<td>1.4</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>CVP9</td>
<td>5.1</td>
<td>1.9</td>
<td>&gt;0.05</td>
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</table>

Discussion

Perioperative fluid management is a daily practicing challenge facing the anesthetist. Fluid replacement therapy should be optimized especially in major prolonged surgeries as it has a great impact on the perioperative outcome. Several fluid administration strategies have been studied to evaluate the outcomes. Standard, liberal and restrictive strategies have been compared in different types of surgery comparing different outcomes. However, there is no classical definition and there is no single end point for intravascular resuscitation. The main aim is to maintain tissue perfusion and oxygenation [9,10].

The current study is aimed to assess the effect of administration of two different intraoperative fluid volumes, 2ml/kg/hr versus 8ml/kg/hr with preoperative volume loading in both groups by 500cc lactated ringer (LR), haemodynamics in patients subjected to prolonged pneumoperitoneum during laparoscopic radical cystectomy (LRC) which is known to be major, lengthy and bloody operation.

Studies on the cardiovascular consequences of pneumoperitoneum are often contradictory. This discrepancy may be explained by the fact that
alterations of cardiovascular function depend on the interaction of multiple factors such as IAP, patient position, CO2 absorption and duration of the procedure. Also, patients intravascular volume status, pre-existing cardiopulmonary status, administration of anesthetic agents and neurohumoral factors as catecholamines, anti-diuretic hormone and the renin aldosterone system [11-15].

In the current study, there was statistical significant decrease in HR and mean arterial blood pressure (MAP), while there was statistical significant increase in central venous pressure (CVP) in group I. The same was found among patients in group II. However, there was almost no statistically significant difference between both groups. In spite of the statistically significant alterations but they were all within the accepted clinical range.

In consistence with the current study, a prospective study done by Menekse Oksar et al., [16] in patients undergoing laparoscopic radical cystectomy receiving 2ml/kg/hr crystalloid infusion, they found that there was significant decrease in heart rate at initiation of pneumoperitonium. However, they noted significant increase of MAP at the same time, which did not occur in the current study, but after a while, there was almost hemodynamic stability. CVP was elevated when patients were placed in deep trendelenburg position [16].

In another prospective study done by AA Sharrab et al., [17] Patients undergoing LRC received maintenance fluid only intraoperatively, had significant decrease in HR and increased CVP but on the contrary to the current study their MAP increased during pneumoperitonium and trendelenberg position. They also assured that all these changes were within the normal clinical range [17].

Dina N. Abbas et al., [18], found the same results as A.A. Sharrab et al., but there was no significant change in HR [18].

This is also matched with a prospective clinical trial done by Darlong et al., [19] on patients undergoing robot-assisted laparoscopic radical prostatectomy (RALRP) in steep Trendelenburg position (45°), they found that HR and MAP were significantly decreased from their baseline values, while CVP was significantly increased during pneumoperitonium period [19].

In a study done by Stephen et al., [20] they found that there were significant rise in MAP and CVP without significant increase in HR, as patients were receiving 10ml/kg as loading and 4-8ml/kg/hr as maintenance crystalloids. However, the population study had underlying cardiovascular dysfunction and ischemic heart diseases, the authors reported that there was decrease in ejection fraction and cardiac performance on insufflations. The authors in that study claimed that anesthesia and analgesia were not enough [20].

In a study done by Aurika Karbonskiena et al., [21] on giving patients received 500cc Ringer solution preload before insufflations and maintenance fluid 1500cc in average 120±80min in patients with average body mass index 27±4, they found no change in HR during and after insufflation, but there was significant rise in MAP [21].

In the current study both volume groups had received combined general epidural anaesthesia. Neuroaxial block is known to decrease catecholamine release and sympathetic activity [22]. That may explain why patients in the current study did not show significant rise in heart rate or mean arterial blood pressure and tended to have lower values than their preoperative baseline.

**Conclusion:**

Maintaince fluid infusion of 8ml/kg/hr LR with volume preload did not show hazards of pulmonary edema or volume overload and maintained haemodynamic stability.

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