Renal Protection during Laparoscopic Sleeve Gastrectomy

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Abstract: Background: Laparoscopic **S**leeve Gastrectomy (LSG) is an effective and widespread treatment for obesity. Increased intraabdominal pressure accompanied with hypovolemia decreases blood flow to vital organs such as the kidney, so using liberal fluid therapy or a low dose of dopamine infusion is recommended. **Aim:** The aim of this study was to evaluate different methods for renal protection during laparoscopic sleeve gastrectomy. **Patients and Methods:** This single-blind RCT was carried out on 90 patients, both sex, 20-40y, BMI ≥35 kg/m2 scheduled for elective LSG who were allocated into 3 equal groups and received after induction of anesthesia: Group I: 10ml/kg normal saline up to 1000ml before pneumoperitoneum, Group II: 10ml/kgHES 130/0.4 (voluven) up to 1000 ml before pneumoperitoneum and Group III: dopamine 2μg/kg/min till the end of surgery. Hemodynamics (HR, MAP & CVP): before and after induction then /15 min till the end of operation, urine output (intraoperative, 1st 24h & 2nd 24hr postoperative), serum blood urea & creatinine: before, 6 & 24 postoperative, & creatinine clearance before, 6, 24 & 48h postoperative. **Results**: There was a significant increase in HR & decrease in MAP & CVP in group I and group III compared to group II at all times of measurement but insignificant between group I and III. UOP was significant decrease in Group I & III compared to Group II intraoperative but insignificant postoperatively. Blood urea, serum creatinine & creatinine clearance level showed significant difference preoperatively and 6hr postoperatively between three groups. At 24h and 48h postoperative, there was significant increase in crystalloid and dopamine group compared to colloid group (remain within normal value) but insignificant between crystalloid and dopamine group. **Conclusion:** Prehydration with voluven was an effective measure for protecting renal function during LSG against the adverse effects of pneumoperitoneum compared to dopamine and crystalloid.

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1. Introduction

Sleeve gastrectomy is an effective and widespread treatment for obesity especially with the laparoscopic technique[1].

Laparoscopic surgery became daily-performed surgery in most countries. It has the advantages of better cosmetic, less postoperative pain, and rapidreturnto usual activities, so it replacedopen technique in many surgeries. However, the laparoscopic approach has potential complications that are unique to this approach[2].

Pneumoperitoneum at 12 mmHg compresses renal parenchyma & vessels and inferior vena cava which decreases renal blood flow[3].

Increased intraabdominal pressure accompanied with hypovolemia decreases blood flow to vital organs such as the kidney, so using liberal fluid therapy or a low dose of dopamine infusion is recommended [4].

The aim of this study was to evaluate different methods for renal protection during laparoscopic sleeve gastrectomy.

2. Patients and Methods

This single-blinded randomized controlled study was carried out in Tanta University Hospitals in General Surgery Department from July 2014 to July 2016 on 90patients, both sex, age from 20 to 40 years old, BMI ≥ 35 kg/m^{2}scheduled for elective laparoscopic sleeve gastrectomy. Written informed consent was obtained from all patients. Every patient received an explanation to the purpose of the study and would have a secret code number to ensure privacy to participants and confidentiality of data. Research results were only used for scientific purposes. Procedures were approved by both the Institutional and the Regional ethical committees (code number 2661/08/14). Any unexpected risk appeared during the course of the research cleared to the participants and ethical committee on time and proper measures were taken to overcome or minimize these risks. Exclusion criteria were: Patient refusal to participate, cardiac disease, renal impairment., previous gastric surgery, hepatic disease, pulmonary disease, and diabetes mellitus and known allergy to study drugs.

Preoperative evaluation: which included: history, physical examination, laboratory investigations (CBC, liver function tests, renal function tests, blood glucose level, serum electrolytes, creatinine clearance, urine examination, hepatitis markers, lipid profile, arterial blood gases, pulmonary function tests, chest radiography, electrocardiogram, and echocardiography).

All patients premedicated byranitidine 50mg IV and metoclopramide 10mg IV1 hr before anesthesia, antithrombotic prophylaxis (Enoxaparin 40mg subcutaneous) 2hr before anesthesia and elastic stocking was applied.

On arrival to the operating room (OR), the patient was connected to monitor display the following parameters (pulse oximetry, noninvasive blood pressure & ECG, (end tidal CO_2, and temperature probe after induction of anesthesia)). Peripheral cannula was inserted for induction of anesthesia. Preoxygenation was done until O_2 saturation > 95%. Anesthesia was induced by fentanyl 2µg/kg, propofol 2mg/kg and atracurium 0.5mg/kg (ideal body weight). Manual ventilation was done for 3 minutes then endotracheal tube was inserted. Adequate ventilation was confirmed by observation of chest wall movement, bilateral auscultation of breath sound and appearance of square wave on capnography. Then the tube was connected to artificial ventilation which was adjusted to maintain SpO_2> 95% and $EtCO_2$ between 32-35mmHg. Central line, arterial line, urinary catheter, nasogastric tube (for gastric decompression) were inserted.

Patients were randomizedby a computer program which generates random numbers and these numbers were put in sealed envelopes that were opened by other personnel who weren't involved in patients' care after obtaining informed consent.

Before surgery the patients were randomly classified into 3 equal groups 30 patients each: Group I (Crystalloid group): received 10ml / kg normal saline up to 1000 ml after induction of anesthesia and before pneumoperitoneum, Group II (Colloid group): received 10ml / kghydroxyl ethyl starch 130 / 0.4 (voluven) up to 1000 ml after induction of anesthesia and before pneumoperitoneum and Group III (Dopamine group): received dopamine 2µg/kg/min after induction of anesthesia and till the end of surgery.

All patients received lactated ringer solution at rate 5 ml/kg/hr and subsequent blood loss was replaced by crystalloid in a 1: 3 volume replacement up to 500 ml blood loss.

Measurements were: demographic data: (age, sex, BMI), duration of anesthesia, duration of surgery, duration of pneumoperitoneum and pneumoperitoneal pressure,blood loss during surgery, intraoperative fluid administration, hemodynamics (HR, MAP & CVP): before induction and after induction of anesthesia then every 15 min till the end of operation, urine output (intraoperative, 1st 24h & 2nd 24hr postoperative), serum blood urea, serum creatinine: before surgery, 6h and 24h postoperative & creatinine clearance (ml/min) before surgery, 6h and 24h & 48h postoperative.

[Creatinine clearance in male: ((140-age (y) X weight (Kg) ideal body weight) / (72 X serum creatinine (mg / dl). Creatinine clearance in female: ((140-age (y) X weight (Kg) ideal body weight) / (72 X serum creatinine (mg / dl) X 0.85].

The sample size was calculated according to the results of a previous study[5] using epi- info software computer program created by center of disease prevention and control, version 2002. It was calculated as 30 patients for each study group based on the following criteria: 95% confidence limit, 80%power of study.

The primary outcome was the hemodynamic changes, while the renal function and adverse effect were the secondary outcomes.

The collected data were organized, tabulated and statistically analyzed using SPSS (IBM, USA) software statistical computer package version 25. For quantitative data: the range, mean and standard deviation were calculated. For qualitative data: comparison between two groups was done using Chi-square test (X^2). For comparison between means of parametric data, ANOVA (Analysis of variance) tests were used with post-hoc test (LSD) if p value <0.05. The level of significance was adopted at P value < 0.05.

3. Results

In this study, 105 patients were assessed for eligibility;15 patients were excluded (did not meet the inclusion criteria). 90 patients were randomized into 3 equal groups. All patients were followed-up and analyzed [Figure (1)].

There was no statistically significant difference between three groups as regard to demographic data which included (Age, sex, BMI), duration of surgery, duration of anesthesia, duration of pneumoperitoneum, pneumoperitoneal pressure, intraoperative crystalloid intake and intraoperative blood loss [Table (1)]. There was statistically significant change in HR, MAP & CVP (increase in HR & decrease in MAP & decrease in CVP) in group I and group III compared to group II at all times of measurement (p value < 0.05) but insignificant between group I and group III [Figure (2-4)].

Urine output (UOP) was statistically significantly decreased in crystalloid group and dopamine group compared to colloid group intraoperative but insignificant postoperatively. As regard blood urea, serum creatinine & creatinine clearance level, there was no significant difference preoperatively and 6hr postoperatively between three groups. At 24h and 48h postoperatively, there was significant increase in crystalloid and dopamine group compared to colloid group (remain within normal value) but insignificant between crystalloid and dopamine group.

Table (1): Comparison of demographic data and operation details in the three groups:

	G I (Crystalloid)	GII (Colloid)	GIII (Dopamine)	P value
Age (years)	34.17 ± 5.38	33.10 ± 6.10	34.9 ± 5.05	0.451
Gender M/F	5/25	7/23	8/22	0.638
BMI (kg/m^2)	49.17 ± 5.52	50.03 ± 4.55	50.87 ± 4.17	0.391
Duration of surgery (min)	205.50 ± 28.51	208.27 ± 29.03	203.33 ± 24.54	0.941
Duration of anesthesia (min)	232.46 ± 29.75	235.12 ± 31.54	227.91 ± 26.83	0.632
Duration of pneumoperitoneum (min)	170.63±30.51	174±26.79	172.9 ±27.13	0.894
Pneumoperitoneal pressure (mmHg)	14.23±0.73	14.53±0.57	14.53±0.57	0.175
Intraoperative blood loss (ml)	143.33 ± 37.68	160 ± 39.72	154.17 ± 38.33	0.242
Intraoperative fluid intake (ml)	1700.3 ± 110.8	1900.2 ± 175.5	1650.5 ± 142.1	0.115

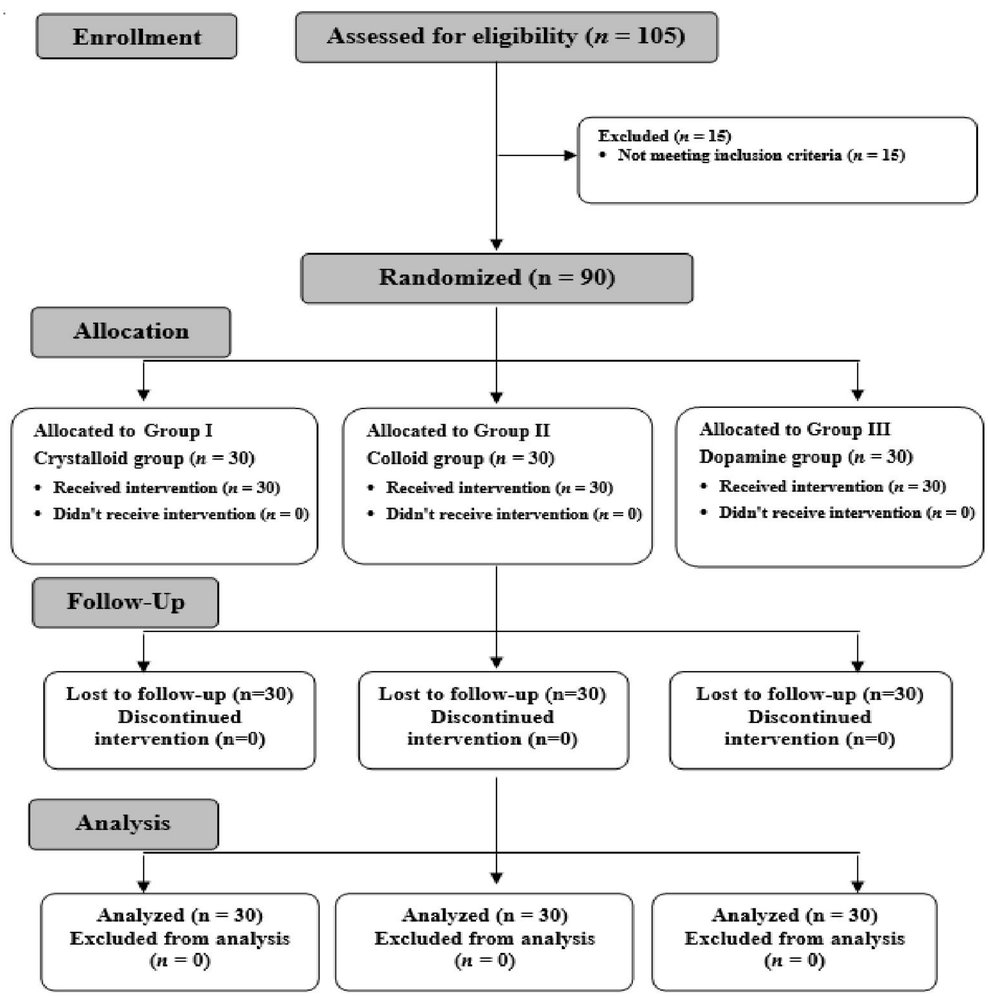

Figure (1): Patient flowchart summarizing enrollment, allocation, follow-up and analysis in the study protocol

Table (2): Comparison of urine output, serum creatinine (mg/dl), blood urea (mg/dl) and creatinine clearance (ml/min) in three groups:

	G I (Crystalloid)	G II (Colloid)	G III (Dopamine)	P value	P1	P2	P3
Urine output							
Intraoperative	318.33±100.42	485.00±107.60	320±95.23	<0.001*	<0.001*	0.998	<0.001*
1st 24 h	1881.7±327.34	1938.3±248.68	1781.7±268.29	0.101			
2nd 24 h	1868.3±228.75	1915.0±239.67	1811.7±235.51	0.238			
Serum creatinine (mg/dl)							
Preoperative	0.95± 0.13	0.94 ± 0.13	0.99 ± 0.13	0.254			
6h post	1.02± 0.12	0.99 ± 0.11	1.04 ± 0.11	0.154			
24h post	1.14 ± 0.17*	0.97 ± 0.12	1.13 ± 0.15*	<0.001*	<0.001*	>0.05	<0.001*
Blood urea (mg/dl)							
Pre	23.83± 2.18	24.97± 2.75	24.7 ± 2.04	0.153			
6hpost	27.07 ± 3.02	26.07 ± 2.50	27.3 ± 2.77	0.193			
24h post	31.77 ±6.04*	26.60 ± 3.43	31.13±4.22*	<0.001*	<0.001*	>0.05	<0.001*
48h post	33.33±11.52*	27.13 ± 5.90	33.47±10.93*	0.019*	>0.05	>0.05	>0.05
Creatinine clearance (ml/min)							
Pre	122.93 ± 8.91	121.57 ± 9.54	120.7 ± 9.78	0.652			
6h post	121.13 ± 8.89	120.3 ± 9.47	119.43 ± 9.48	0.778			
24h post	113.93 ± 7.91*	119.8 ± 7.91	113.17±7.79*	0.003*	<0.05	>0.05	<0.01*
48 h post	112.90±7.65*	119.77±7.42	111.87±7.09*	<0.001*	<0.01*	>0.05	<0.001*

***P value significant if <0.05, P1 (GI vs GII), P2 (GI vs GIII), P3 (GII vs GIII)**

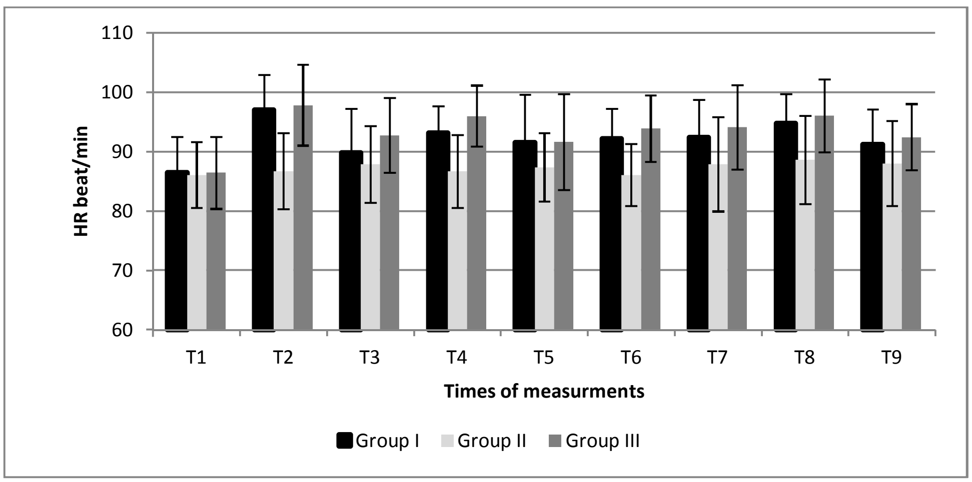

Figure (2): Comparison of HR (b/min) between three groups

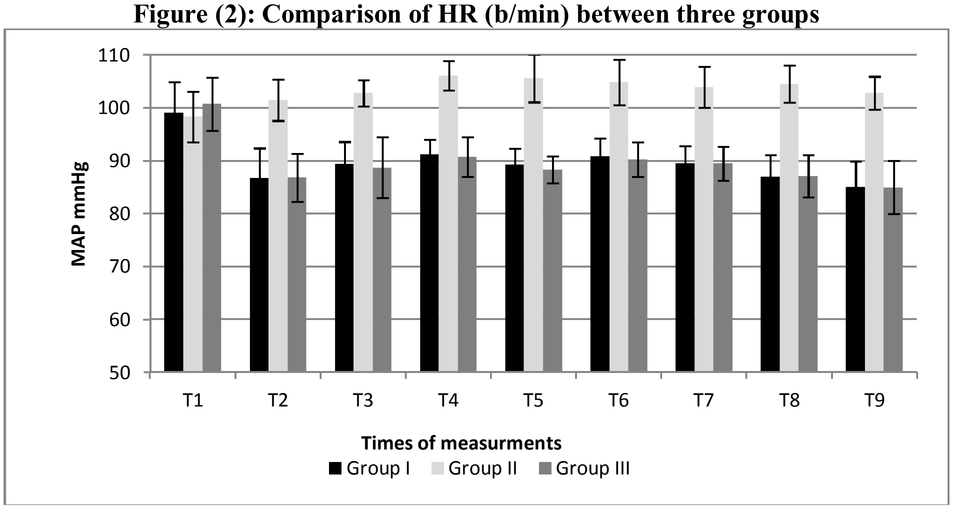

Figure (3): Comparison of MAP (mmHg) between three groups

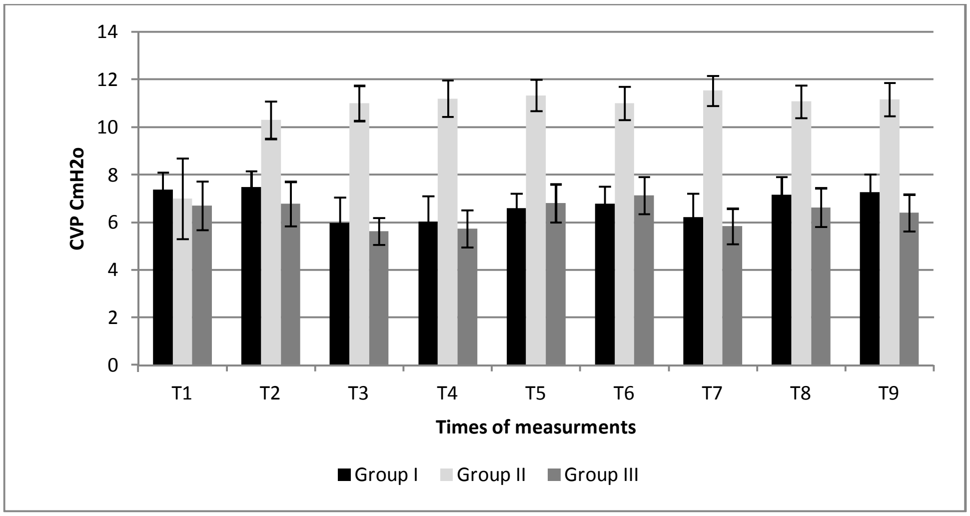

Figure (4): Comparison of CVP (cmH_2O) changes in three groups

4. Discussion

Pneumoperitoneum during laparoscopy has a different effect on different abdominal organs; directly by the pressure of the gas and indirectly by absorption of CO2[6]. Most cases of AKI that occur in the perioperative period are not due to intrinsic renal disease but are associated with relative hypoperfusion of the kidney and/or exposure of the kidney to nephrotoxins [7].

One of the most important factors for preventing AKI remains good hydration either by crystalloid or colloid administration. Balanced HES solution leads to hemodynamic stability and decrease of usage of fresh-frozen plasma without renal impairment [8].

Our results demonstrated no statistically significant difference as regard to duration of surgery, duration of anesthesia, duration of pneumoperitoneum, pneumoperitoneal pressure, intraoperative crystalloid intake & intraoperative blood loss.

There was statistically significant change in HR, MAP & CVP (increase in HR & decrease in MAP & decrease in CVP) in group I and group III compared to group II at all times of measurement (p value $<$ 0.05) but insignificant change between group I and group III. The hemodynamics remain almost stable in group II and this could be explained as voluven has lower molecular weight with the same effect on volume expansion and hemodynamics, less plasma accumulation, less coagulopathy than the other HES products, so it can be used in renal patients safely[9].

In agreement with our study, **Amin & Fathy**[9] studied the e□ect of preoperative hypervolemic hemodilution in laparoscopic gastric bypass surgery and concluded that voluven had stable hemodynamics than crystalloid. Also, **Feldheise et al** [8] concluded that using a goal-directed hemodynamic algorithm to optimize stroke volume, a balanced HES solution is associated with better hemodynamics and decreased fresh frozen plasma usage than crystalloid.

Also, **Osthaus et al**[10] demonstrated that MAP remained within the normal range in the colloid and control groups (with no pneumoperitoneum (PP)) in piglet but was significantly lower in the crystalloid group during PP until the end of the study. Moreover, **Otsuki et al**[11] concluded that HES is superior to lactated Ringer as a replacement fluid in a pig model of acute normovolemia hemodilution which was demonstrated by increases in cardiac index, stroke volume index, and left ventricular stroke work index for longer time in the HES group than the lactated Ringer's group.

In our study, UOP was statistically significant decrease in crystalloid group and dopamine group compared to colloid group intraoperatively but insignificant postoperatively. As regard blood urea, serum creatinine & creatinine clearance level, there was no significant difference preoperatively and 6hr postoperatively between three groups. At 24h and 48h postoperative, there was significant increase in crystalloid and dopamine group compared to colloid group (remain within normal value) but insignificant between crystalloid and dopamine group.

This is attributed to hypervolemia occurred after voluven with sustained plasma level than crystalloid which led to near normal MAP without hypotension. This provides intraoperative adequate renal perfusion and urine output with postoperative normal renal function. Also, voluven has rapid metabolism and renal excretion which is more superior to older type of HES. All these factors overcome the prolonged pneumoperitoneum complications on the kidney during laparoscopic sleeve gastrectomy.

In agreement, **Amin & Fathy**[9] found that intraoperative urine output and postoperative creatinine clearance increased significantly in HES group. Also, **Jover et al**[12] demonstrated that diuresis and creatinine clearance were significantly higher in the group that received prehydration with voluven than lactated Ringer solution in laparoscopic cholecystectomy. Moreover, **london et al** [13] concluded that intravascular volume expansion, either by a large volume of isotonic solution or a small amount of 7.5% saline solution, improved UOP during prolonged pneumoperitoneum. Also, **O'Dair et al** [14] found that intraoperative dopamine (at renal dose) during nephrectomy had no benefit for either donor or recipient.

Against our results, **Matot et al**[15] who concluded that the amount of fluid (Ringer's lactate solution) administrated intraoperatively in the range of 2-8ml/kg/hr had no significant effect on urine output. There was no association between increased fluid administration & augmented urine output. Also, **Perez et al** [16] concluded that an intrabdominal pressure of 15 mmHg induces a time-limited renal dysfunction, and low doses of dopamine could prevent this undesirable effect.

5. Conclusion:

Prehydration with hydroxyl ethyl starch 130 / 0.4 (voluven) was an effective measure for protecting renal function during laparoscopic sleeve gastrectomy against the adverse effects of pneumoperitoneum compared to dopamine and crystalloid.

Conflicts of interest: Nil.
Authors' Contributions: All authors had equal role.

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