The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89 (2), Page 6716- 6725

Conventional Fluid Management Versus Goal-Directed Fluid Management In Elective Colorectal Surgery

Abdelrahman Mahmoud Abdelrahman, Aboelnour Elmorsy Badran, Amgad Abdelmageed Zagloul, Rania Elmohamady Elbadrawy*

Department of Anesthesia and Surgical Intensive Care, Mansoura University, Dakahlia, Egypt

***Corresponding author:** Rania Elmohamady Elbadrawy, **Mobile:** (+20) 01128819560, **E-Mail:** raniaelmohamady@gmail.com

ABSTRACT

Background: Optimum perioperative fluid therapy is important to improve the outcome of surgical patients, so the assessment of a patient's volume status accurately is an important goal for the anesthesiologist to achieve hemodynamic stability and adequate tissue oxygenation.

Objective: This study compared intraoperative goal-directed fluid therapy (GDFT) versus conventional fluid therapy (CVFT) using noninvasive electrical cardiometry with measuring serum lactate, serum creatinine levels, stroke volume optimization, and postoperative complication.

Methods: One hundred patients ASA I -II, both sexes, aged 21-65 years scheduled for elective colorectal surgery were randomized into 2 groups (50 subjects each). GDFT group used Stroke volume optimization, and CVFT used the conventional method of fluid administration. Hemodynamic variables, amount of fluid given, serum lactate, serum creatinine, and postoperative complication were noted.

Results: Serum lactate levels were insignificant intra& postoperative except at 6 hrs. postoperative was higher in GDFT 1,79±0.21 than CVFT 1.68±0.23with p value=0.02 but still within normal limits. CVFT received significantly more crystalloids 2750(1500-4000) than GDFT 2250 (1000-3350) with p value=0.002, whereas GDFT received more colloids 350(200-1000) than CVFT 250(0-1000) with p value=0.024. Total fluid received were higher in CVFT 3550(2000-5600) than GDFT 2750(1500-5000) with p-value=0.005.

Conclusions: GDFT results in a decreased total volume of crystalloids and fluid given to patients. However, both groups didn't alter organ perfusion inspite of serum lactate being higher in GDFT and with no differences in postoperative complications in both groups.

Keywords: Fluid therapy, Conventional, Goal-directed, Cardiometry, Colorectal surgery.

INTRODUCTION

During the perioperative period, fluid therapy and gastrointestinal function may aid or hinder each other. To prevent delayed gastrointestinal function and promote early oral intake, fluid therapy should be carefully maintained [(1)].

To establish hemodynamic stability and sufficient tissue oxygenation, the anesthesiologist must accurately monitor the patient's volume status. For this reason, various intraoperative fluid management techniques are used. The most typical is conventional fluid management (CFM). Clinical evaluation, heart rate (HR), arterial blood pressure (ABP), and central venous pressure (CVP) monitoring are used to control fluid replacement [(2)].

While goal-directed fluid therapy (GDFT) is a perioperative strategy that uses fluid administration to target continuously measured hemodynamic variables like cardiac output, stroke volume, stroke volume variation, pulse pressure variation, and other factors to direct intravenous and inotropic therapy to maximise tissue perfusion and oxygen delivery [(3)].

Direct measurement of SV using noninvasive techniques has become an accepted tool for stroke volume optimization and guiding fluid administration in high risk surgical patients [(4)].

The accurate method of Impedance Cardiography (ICG) uses electrical impedance changes to produce waveforms that depend on the volume and velocity of blood injected into the aorta as well as the force and rate of left ventricle contraction. Stroke volume, COP, SVR, and other hemodynamic parameters are also deduced from that curve in addition to heart rate and blood pressure [(5)].

This study aimed to compare intraoperative goal-directed fluid therapy (GDFT) versus conventional fluid therapy in patients undergoing elective colorectal surgery using noninvasive electrical cardiometry.

We hypothesized that GDFT is better than conventional fluid therapy to provide sufficient intravascular fluid volume for adequate perfusion without destructing glycocalyx function with fluid overload.

The primary outcome was to compare the effects of both fluid management protocols on organ perfusion regarding Serum lactate, and serum creatinine levels. Stroke volume optimization, Hemodynamic stability, amount of fluid &vasoactive agent administered, and postoperative complication [Wound dehiscence and acute kidney injury (AKI)] were secondary outcomes of this study.

PATIENTS AND METHOD

This randomized, controlled study was conducted at Mansoura Oncology Center. Written informed consent was obtained from all 100 patients and the duration of the study would be 24 months starting from January 2020- January 2022.

Received: 9/7/2022
Accepted: 14/9/2022

Ethical approval:

The study was conducted after obtaining approval from the Institutional Review Board (IRB) of the Faculty of Medicine, Mansoura University (Code: MD.19.03.163) and registered to PACTR Registry with ID: (PACTR202211489398809). Written informed consent was obtained for acceptance of the procedure and this study was carried out following the ethical principles of the world medical association (Declaration of Helsinki).

Patients included those who were scheduled for elective colorectal surgery, aged between 21 - 65 years, either gender, American Society of Anesthesiology (ASA): I&II, Hb >10 g/dl, and Hct >33%.

Patients excluded if they refused, patients with major cardiovascular problems (ejection fraction <45%), patients with Renal impairment with serum creatinine >1.8 mg/dl., with hepatic dysfunction (Child-Pugh B or C), Bleeding and coagulation problems or Metabolic disorder, serum lactate > 2 mmol/L.

Preoperative assessment:

Medical history and systemic examination were carried out. Basic demographic characteristics including age, sex, weight, and height were recorded. Clinical assessment, ECG, and ECHO were done. Routine lab assessments complete blood count (CBC), INR, liver function, serum creatinine, and Arterial blood gases (ABG) were performed. Basal S. Lactate was obtained and recorded before surgery. Electrodes of ICON (ICONTM, OSYPKA medical cardiotonic GMBH, Elixir, Germany) were applied on all patients in both groups (2 electrodes on the left aspect of the neck and 2 electrodes on the left inferior side of the thorax). Basal readings of stroke volume & SVV were recorded before surgery in all patients in both groups.

Intraoperative management:

Baseline vital signs such as heart rate, mean arterial pressure (MAP), and oxygen saturation was recorded. The fasting period would be recorded, and suitable intravenous lines and ultrasound-guided central venous catheter were inserted. A preload of 500 ml of ringer acetate was started before induction. Then 0.03 mg/kg of midazolam was given preoperatively and basal readings were taken. An epidural catheter was inserted before induction in all patients for postoperative analgesia.

Pre-oxygenation was done in all patients then Induction was done by slow intravenous administration of 2mic /kg fentanyl, 1.5-2.5mg/kg propofol, and 0.5 mg/kg atracurium to provide neuromuscular blockade and facilitate endotracheal intubation. Patients were mechanically ventilated using volume control mode (VC mode) with tidal volumes of 6-8 ml/kg, with respiratory rate 12-14breath per minute (bpm), and PEEP 5cmH2O to keep end-tidal Carbone dioxide (ETCO2) at 35-40 mmHg. with 40% oxygen (FiO_2) and isoflurane with a concentration of 1.2-1.5 %. Depth of anesthesia was maintained by the adequate concentration of isoflurane and muscle relaxation was maintained by increments of atracurium guided by the train of four. The anesthetic level was modified to maintain a stable heart rate and blood pressure (baseline ± 20%). Standard monitoring by using electrocardiogram (ECG), noninvasive blood pressure, pulse oximetry, and capnography.

At the end of the surgery, residual neuromuscular blockade was reversed using 40 µg/kg neostigmine and 20 µg/ kg atropine IV. After fulfilling the criteria of extubation, patients were extubated and transferred to ICU.

Sample size calculation:

The sample size was calculated using Power Analysis and Sample Size software program (PASS) version 11.0.4 for windows (2011) using the results published by **Phan et al.[6]** in Anesthesia and intensive care with serum lactate & creatinine as the primary outcome. Group sample sizes of 47 patients in each group are needed to achieve 80% power to detect a mean difference of 10.5 between both groups: goal-directed and conventional, with known groups' means and standard deviations (43.7 ± 16.3, 54.2 ±21.2 respectively) and with a significance level (alpha) of 0.05 using a two-sided two-sample t-test. A 5% drop-out is considered, so a total of 100 patients will be enrolled in this study **[6].**

Randomization:

Patients were randomly assigned to one of two equal groups, according to a computer-generated randomization sequence into:

- **Goal-directed fluid Therapy group (GDFT group) (n=50)** using stroke volume optimization
- **Conventional fluid Therapy group (CVFT group) (n=50)** using the traditional technique of fluid administration

Goal-directed fluid Therapy group (GDFT group):

Basal stroke volume and stroke volume variation were recorded under sedation of 0.03 mg/kg of midazolam preoperatively. 200 ml of Colloid 6% hydroxy ethyl starch 130/ 0.4 (Voluven, Fresenius Kabi, Deutschland GmbH, Bad Homburg, Germany) was infused over 10 minutes and stroke volume response was recorded. If stroke volume increased by more than 10 % for 20 minutes, the bolus would be repeated. No further colloid was given once stroke volume failed to increase more than 10%. The last stroke volume with a higher 10% response was defined as maximum stroke volume (SVmax). When stroke volume decreased intraoperatively by 10% below (SVmax), this would be defined as trigger stroke volume (SVt**) [7].**

Intravenous fluids were infused to maintain stroke volume variation between (8-12 %). If stroke volume variation was less than (8%), the I.V crystalloids

administration rate was decreased. If stroke volume variation was increased above (12%) I.V crystalloids administration rate was increased.

Blood loss of more than 500ml was replaced in a 1:1 ratio. Blood loss of fewer than 500 ml was replaced by ringer solution. If there was a reduction in stroke volume below SVT, an infusion of 200 ml hydroxy ethyl starch 130/0.4 (Voulven) was started. Voulven infusion was repeated 3 times before considering giving the patient inotropes according to other cardiac parameters.

If mean arterial pressure (MAP) drops below 65 mmHg despite the achievement of SVT, a vasoactive agent (ephedrine & Nor adrenaline) was used and doses were recorded.

Conventional fluid Therapy group (CVFT group)

The infusion started with ringer acetate solution after induction according to the fasting period (6 hours of fasting) and maintenance and 3rd space loss according to surgical incision usually at the rate of 6–8 ml/kg/h at colorectal surgery.

The intraoperative fluid infusion was according to the routine techniques by taking the parameters such as HR, mean arterial pressure (MAP), CVP and urine output into consideration. Hypotension was defined as a condition in which the MAP was below 65 mmHg or 20% below the baseline MAP of the patient. In this case, the speed of crystalloid infusion was increased, colloid (6% hydroxy ethyl starch 130/ 0.4 (Voulven)) infusion was initiated, and in case of hypotension persistence, blood was given according to blood loss and to maintain Hb level >10 g/ dl. A vasoactive agent (ephedrine & Nor adrenaline) was used if fluid and blood failed to elevate MAP > 65 mmHg (persistent hypotension) and the used dose was recorded. CVP response and UOP were recorded [(2)].

Recorded data:

- Hemodynamic variables including stroke volume (SV), stroke volume variation (SVV), cardiac output (COP), cardiac index (CI), and thoracic fluid content (TFC) were measured by Cardiac output non-invasive monitor (ICONTM, OSYPKA medical cardiotonic GMBH, Elixir, Germany).
- These hemodynamic variables and CVP readings were obtained at T1(post induction of anesthesia), T2 (1 hrs.), T3 (2 hrs.), T4 (3 hrs.), and T5 (4 hrs.). The postoperative hemodynamic parameter will be obtained at P1 (6 hrs.), P2 (12 hrs.), and P3 (24 hrs.)
- MBP, heart rate, SpO_2 intra and post-operative were recorded. Volumes of fluid administered either crystalloid, colloid, blood or blood products were recorded. Postoperative heart rate and MBP will be recorded at **P1** (6 hrs.), **P2** (12 hrs.) and **P3** (24 hrs.)
- Serum lactate and serum creatinine were recorded at the end of the surgery, 6 hrs., 24 hrs., and 48 hrs. after surgery. These samples were obtained from a central venous catheter.
- Hypotensive episodes, the total dose of ephedrine, and the number of patients who needed vasopressor (nor adrenaline) were recorded.
- Postoperative complications regarding wound dehiscence, burst abdomen, and acute kidney injury were recorded.

Statistical analysis

Data analysis was performed by SPSS software, version 18 (SPSS Inc., PASW statistics for windows version 18. Chicago: SPSS Inc.). Qualitative data were described using numbers and percentages. Quantitative data were described using median (minimum and maximum) for abnormally distributed data and mean± Standard deviation for normally distributed data after testing normality using the Kolmogrov-Smirnov test. The significance of the obtained results was judged at the (0.05) level.

Chi-Square and Monte Carlo tests were used to compare qualitative data between groups as appropriate. Mann Whitney U test was used to compare two studied groups for abnormally distributed data. Student t-test was used to compare two independent groups for normally distributed data. Repeated Measures ANOVA and Paired t-test were used to compare more than two paired readings and two paired readings, respectively for normally distributed data.

RESULTS

One hundred patients of either sex, ASA I and II submitted for elective colorectal surgery were included in this prospective randomized study. 112 patients were assessed for eligibility in this study, 12 patients were excluded, 5 patients were excluded due to high BMI, 2 patients had high creatinine, 3 patients had arrhythmias, and the other two patients with hepatic dysfunction as shown in the CONSORT flow chart (**Figure 1**).

Regarding demographic data (age, gender, height, weight, ASA classification), operative time and type of surgery showed non-significant differences when compared together. **Table 1**

Table (1): Comparison of demographic characteristics, type, and duration of surgery, among the studied groups

	GDFT Group (n= 50)	CVFT Group (n= 50)	test of significance
Age (years)	51.04±11.96	49.88±9.12	t=0.545 p=0.587
Gender Male Female	 28(56%) 22(44%)	 21(42%) 29(58%)	 X^2=1.96 p=0.161
ASA I II	 31(62%) 19(38%)	 29(58%) 21(42%)	 X^2=0.167 p=0.683
BMI(Kg/m2)	28.69±4.62	30.75±5.79	t=1.97 p=0.068
Type of surgery Anorectal cancer Hemicolectomy Total colectomy Sigmoid cancer	 7(14%) 27 (54%) 3(8%) 13(28%)	 12(24%) 25(50%) 1(2%) 12 (24%)	 MC=9.93 P=0.063
Surgery duration (hours)	3.05±0.97	3.16±0.74	t=0.092 p=0.927

t: Student t-test, X^2: Chi-Square test, MC: Monte Carlo test, parameters described as mean± SD and as number (percentage)
GDFT: Goal-directed fluid therapy. CVFT: Conventional fluid therapy. ASA: American society of anesthesia. BMI: Body Mass Index

As regards heart rate and mean arterial pressure, there was no significant difference between both groups in intraoperative and postoperative readings (**Tables 2 & 3**).

Table (2): Comparison of heart rate during follow-up between the studied groups

Heart rate (bpm)	GDFT group (n= 50)	CVFT group (n= 50)	test of significance
T1	80.64±12.37	75.90±13.39	t=1.84 p=0.069
T2	81.58±13.02	76.08±14.42	t=2.37 p=0.085
T3	79.12±11.24	79.14±10.13	t=0.009 p=0.993
T4	81.12±11.76	79.60±12.62	t=0.623 p=0.535
T5	81.83±9.38	86.72±9.91	t=1.63 p=0.111
P1	86.38±9.87	85.04±10.59	t=0.654 p=0.515
P2	86.62±8.80	83.34±10.17	t=1.72 p=0.09
P3	87.44±7.40	86.34±11.42	t=0.572 p=0.569

t: Student t-test, parameters described as mean±SD
GDFT: Goal-directed fluid therapy. CVFT: Conventional fluid therapy.

T1 (post induction of anesthesia), T2 (1 hrs.), T3 (2 hrs.), T4 (3 hrs.) and T5 (4 hrs.). P1 (6 hrs.), P2 (12 hrs.) and P3 (24 hrs.)

Table (3): Comparison of mean arterial blood pressure during follow-up between the studied groups

MAP (mmHg)	GDFT group (n= 50)	CVFT group (n= 50)	test of significance
T1	91.70±11.15	88.90±12.62	t=2.02 p=0.059
T2	87.56±14.59	83.74±10.79	t=1.49 p=0.140
T3	91.70±11.75	90.86±9.03	t=0.401 p=0.689
T4	84.08±12.26	86.65±8.84	t=1.18 p=0.239
T5	90.75±10.53	91.40±7.26	t=0.245 p=0.808
P1	90.22±9.73	89.86±11.68	t=0.167 p=0.867
P2	88.84±9.22	88.82±10.69	t=0.01 p=0.992
P3	88.60±10.21	87.48±11.76	t=0.509 p=0.612

t: Student t-test, parameters described as mean ± SD. GDFT: Goal-directed fluid therapy. CVFT: Conventional fluid therapy.

Stroke Volume (SV) and stroke volume variation (SVV) readings intraoperatively showed no significant difference between both studied groups (**Tables 4 & 5**).

Table (4): Comparison of stroke volume during follow-up between the studied groups

SV (ml)	GDFT group (n= 50)	CVFT group (n= 50)	test of significance
T1	73.10±11.19	72.50±11.78	t=0.261 p=0.795
T2	69.20±10.68	71.38±10.44	t=1.98 p=0.051
T3	75.92±9.93	74.20±9.39	t=0.890 p=0.376
T4	72.76±11.55	73.30±9.18	t=0.259 p=0.796
T5	78.88±11.96	73.72±7.55	t=2.07 p=0.063

t: Student t-test, parameters described as mean ± SD. SV: Stroke Volume

Table (5): Comparison of SVV during follow-up between the studied groups.

SVV (%)	GDFT group (n= 50)	CVFT group (n= 50)	test of significance
T1	9.50±1.92	10.30±2.43	t=1.95 p=0.054
T2	9.68±2.24	10.24±2.55	t=0.292 p=0.771
T3	10.54±2.40	10.96±2.40	t=0.839 p=0.404
T4	10.38±2.13	10.42±2.47	t=0.069 p=0.945
T5	9.20±0.79	9.84±2.31	t=0.389 p=0.060

t: Student t-test, parameters described as mean±SD , significant (if $p \leq 0.05$). SVV: Stroke volume variation

Regarding fluids given to the patients intra-operatively, CVFT patients needed significantly larger volumes of crystalloids 2750 (1500-4000) than GDFT patients 2250 (1000-3350) with a p-value of 0.002. On the other hand, GDFT patients needed significantly larger amounts of Voulven 350(200-1000) than CVFT patients 250(0-1000) and the p-value was 0.024. While the total amount of fluid was significantly higher in CVFT 3550 (2000-5600) than in GDFT 2750(1500-5000) and the p-value was 0.005. There was a non-significant difference in blood given between both studied

groups (**Table 6**). Also, comparing hypotensive attacks, the total dose of ephedrine, and the number of patients needed nor adrenaline there was no significant difference between the two studied groups. **Table (6)**

Table (6): Comparison of intraoperative hypotension, ephedrine doses, noradrenaline, and fluid requirements, during follow-up between the studied groups

	GDFT group (n= 50)	**CVFT group (n= 50)**	**test of significance**
Hypotensive episodes No One Two	 38(76%) 10(20%) 2(4%)	 40(80%) 8(16%) 2(4%)	 MC=0.872 P=0.647
Ephedrine total dose (mg)	6(5-30)	5(5-30)	0.571
Number of patients needed vasopressor (nor ad.)	2(4%)	1(2%)	0.109
Crystalloid/ml	2250 (1000-3350)	2750(1500-4000)	z=4.05 p=0.002*
Voluven/ml	350(200-1000)	250(0-1000)	z=1.32 p=0. 024*
Blood/ml	500(500-1500)	500(500-2000)	z=0.116 p=0.908
Fluids total/ml	2750(1500-5000)	3550(2000-5600)	z=2.82 p=0.005*

MC: Monte Carlo test, Z: Mann Whitney U test, parameters described as median(min-max) and as number (percentage), *statistically significant (if p≤0.05).

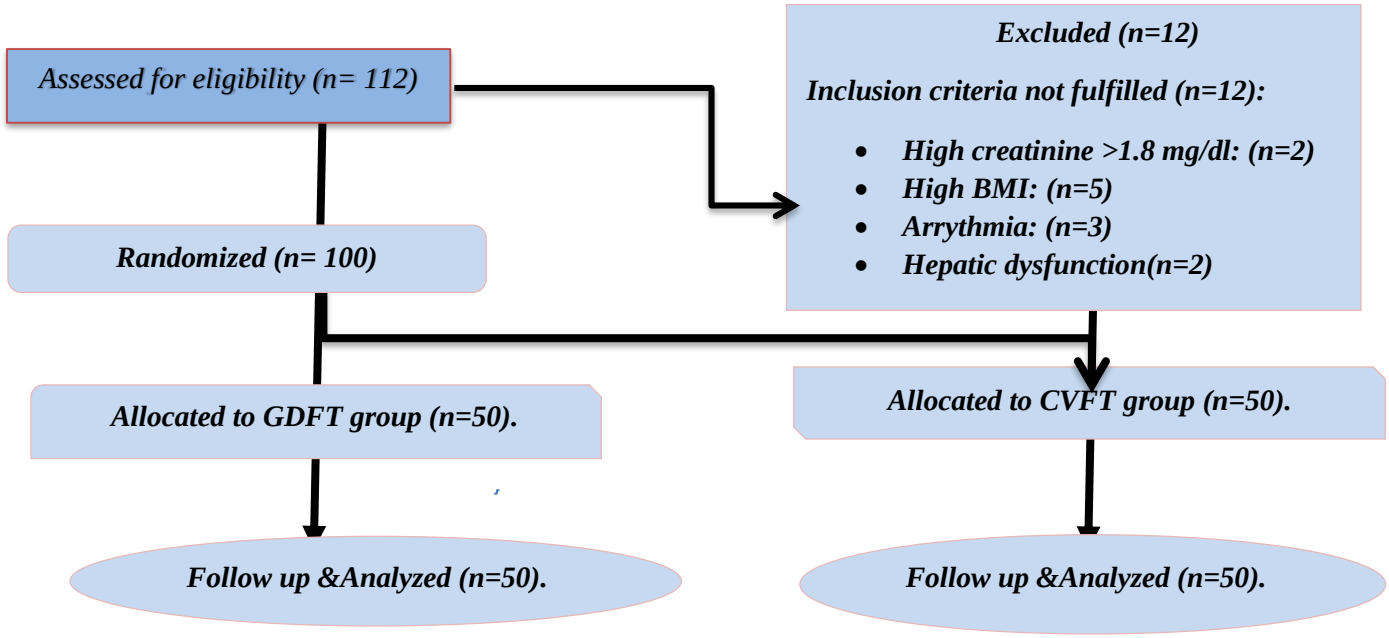

Figure (1): Consort flow of participants.

GDFT group: goal directed fluid therapy group, CVFT group: conventional fluid therapy group.

Despite of higher reading of CVP in the CVFT than in the GDFT group, there was no significant difference between both studied groups. Cardiac output, cardiac index, and thoracic fluid content readings showed no significant difference between both groups during the operation.

While serum lactate level showed a non-significant difference between the intraoperative and postoperative readings in both groups except at 6 hrs. postoperative which was significantly higher in GDFT at 1.79±0.21 while in

CVFT was 1.68±0.23 and p-value was 0.02. While in the same group serum lactate was highly significant in both groups in comparison to basal reading. As shown in **Figure (2).**

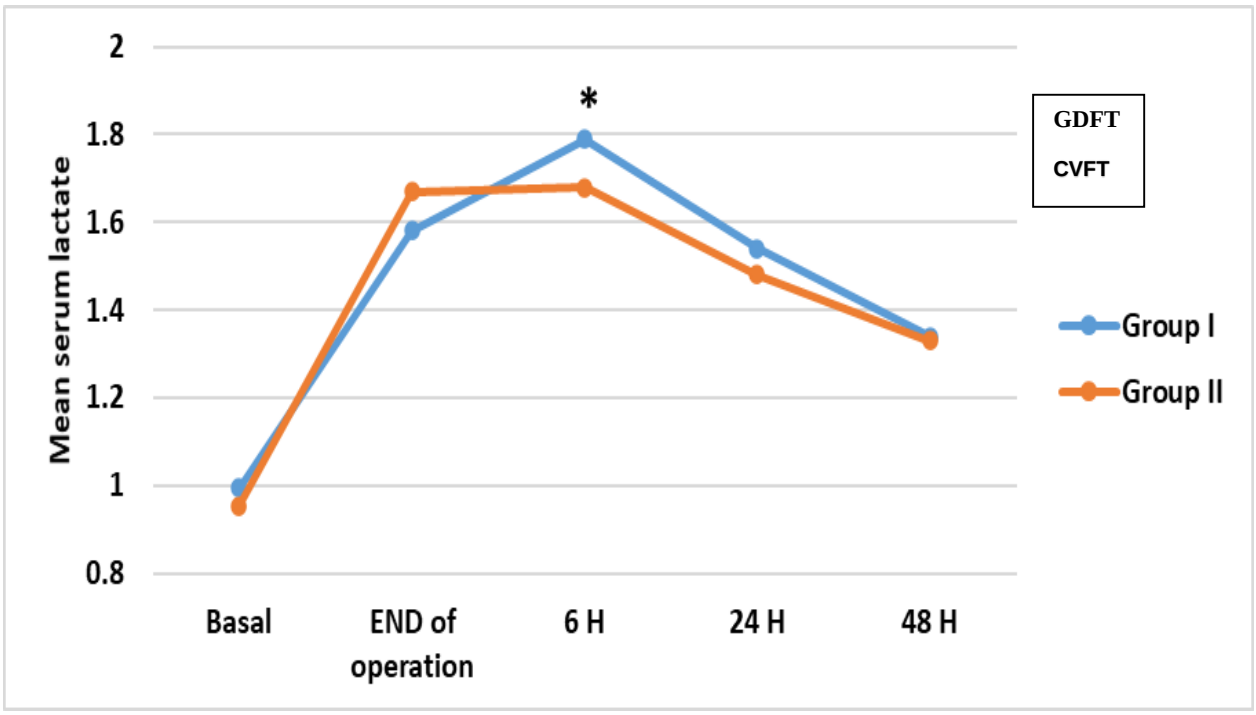

Figure (2): Line graph showing the change of mean serum lactate during follow-up and between studied groups (* indicates significant difference between both studied groups).

Serum creatinine levels showed a non-significant difference between the intraoperative and postoperative readings in both groups. As shown in **Figure (3).**

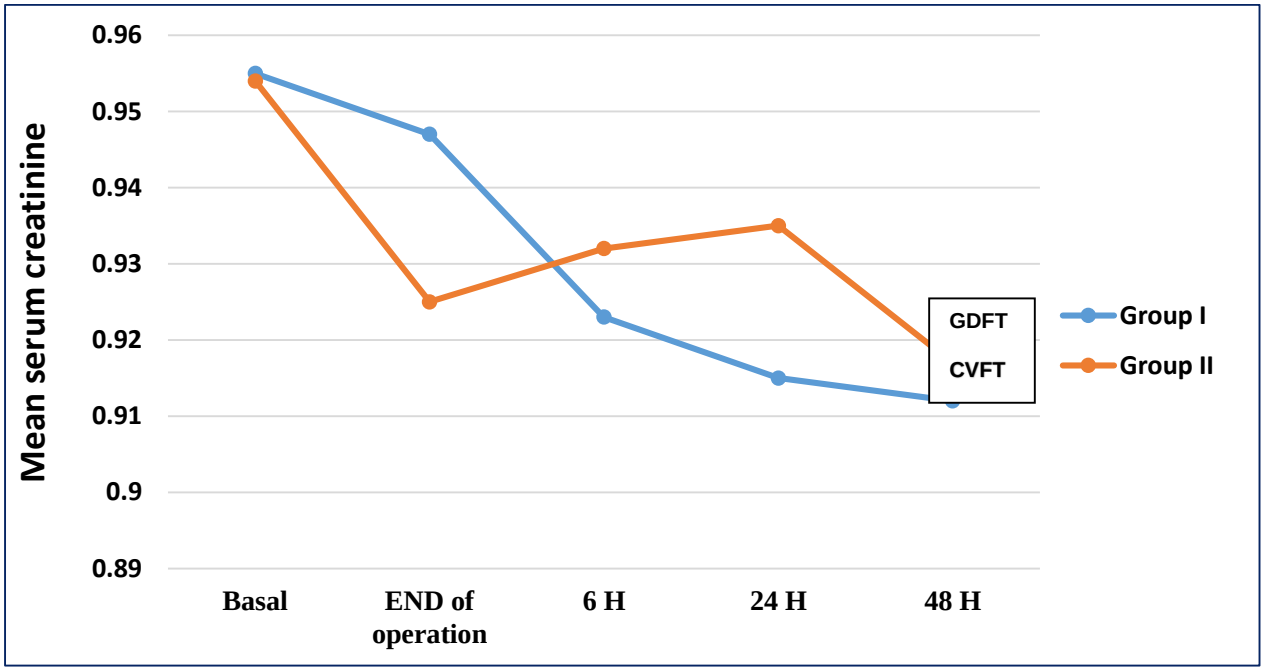

Figure (3): Line graph showing changes in mean serum creatinine during follow-up between both studied groups.

Postoperative complication rate (AKI & Wound Dehiscence) in both groups showed a non-significant difference between both studied groups as shown in **Figure 4.**

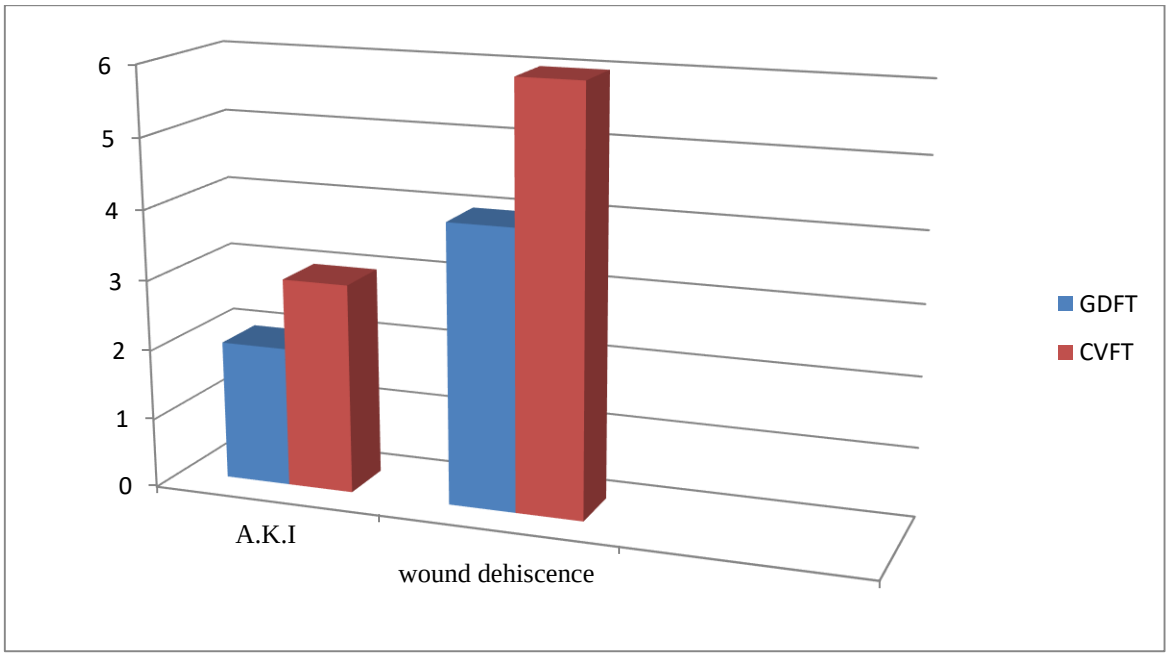

Figure (4): Bar graph of postoperative complications between the studied groups

DISCUSSION

As regards heart rate, the current study reported that there was no significant difference between both groups in the intraoperative and postoperative periods.

This is parallel to the results of **Summit *et al.*[8]** as they compared Goal-directed Fluid guided Therapy by TEE (Trans Esophageal Echo) measured left ventricular outflow tract velocity time integral Versus Conventional Fluid Therapy During Craniotomy and Clipping of Cerebral Aneurysm as there was on significant difference during the intraoperative and postoperative period**.**

Regarding mean arterial blood pressure, the current study found no significant difference between the intraoperative and postoperative readings in both groups and found no significant difference between both groups as regards CVP follow-up despite of higher reading of CVP in CVFT.

This is parallel to the results of **Cesur[2]** which included seventy ASA I–II elective colorectal surgery patients who were randomly assigned to conventional fluid management or goal-directed fluid management (based on PVI) which showed the difference between both groups regarding MBP**.**

On the other hand, **Scheeren *et al.*[9]** evaluated sixty-four patients undergoing major abdominal surgeries included in two groups either Goal-directed intraoperative fluid therapy guided by stroke volume and its variation or the control group (conventional fluid therapy) which showed no difference as regards CVP measurements during the intraoperative period.

Interestingly, the current study evaluated the stroke volume showing no significant difference between both groups during the operation. When comparing stroke volume variation (SVV) in both groups, there was a non-significant difference between both groups. **Scheeren and his colleagues[9]** agreed with the results of this study regarding stroke volume monitoring and stroke volume variation.

Also, this study showed that the cardiac output and cardiac index readings showed non-significant differences between both groups during the operation which was agreed with **Scheeren and his colleagues[9].** The current study found a non-significant difference between the intraoperative and postoperative readings in both groups regarding serum lactate level except at 6 h postoperative which was higher significantly in GDFT (1.79±0.21) than CVFT (1.68±0.23) & p=0.02 despite of difference readings still in the normal limit of lactic acidosis. Serum lactate increased significantly in the same group concerning basal reading. Serum creatinine showed a non-significant difference between both groups and the same group.

The lactate level is a sensitive but indirect indicator of organ perfusion. An inadequate intravascular volume, tissue hypoxia, and energy failure because of blood flow redistribution are all associated with elevated lactate [10].

Sujatha *et al.* [11] studied goal-directed vs traditional approach during open major bowel surgery included 306 patients in three groups 102 patients each; control (conventional), PVI, and Flo trac although all three groups' post-surgery lactate levels rose significantly, there was no statistically significant difference between the groups at various time points (preoperative, immediate postoperative period, and the next day). Despite the lengthy operation, the lactate levels in all three groups were under the usual limit of (23 mg/dl).

Lactate levels, which indicate organ perfusion, were altered similarly by both fluid management protocols, according to **Cesur *et al.*** [2] when they compared traditional fluid management with PVI-based goal-driven fluid management in elective colorectal surgery. When the preoperative and postoperative

creatinine values were examined, there was no significant difference between the two groups, and the postoperative creatinine values according to the beginning values according to the AKI criteria did not significantly alter. **Cesur *et al.*** [2] also believed that these findings indicated that the effects of both fluid regimes on renal function were comparable.

Regarding fluids given to the patients intra-operatively, the current study found that CVFT patients needed significantly larger volumes of crystalloid 2750(1500-4000) than GDFT patients 2250 (1000-3350) with a p-value of p=0.002. Also, a highly significant total volume of fluid CVFT 3550(2000-5600) and in GDFT 2750 (1500-5000) with a p-value of 0.005. On the other hand, GDFT patients needed significantly larger amounts of Voulven 350 (200-1000) than CVFT patients 250(0-1000) and the p-value was 0.024. There was a non-significant difference regarding blood given between both studied groups.

Sujatha *et al.* [22] also discovered that compared to the other two groups, the control group (CVFT patients) received noticeably more crystalloids, a smaller volume of colloids, and a bigger net volume of fluid. Fluid administration was comparable between the PVI and FloTrac groups. **Cesur *et al.*** [2] also agreed with our results as regards needing a significantly larger volume of the crystalloid and total volume of fluid in CVFT than in GDFT**.**

Cecconi *et al.* [12] reported that patients who had their fluid requirements handled with a goal-directed protocol received more colloids than those who had standard or restrictive fluid management.

Against our results, **Benes and his coworkers**[13] registered lower hypotensive episodes in the GDFT group when they use SVV as a marker for fluid administration versus routine intraoperative care in the control group, while we didn't find any significance between both groups and that may be explained by using a larger volume of crystalloid in CVFT and larger volume of colloid in GDFT**.**

Also, the current study found, regarding the total dose of ephedrine and the number of patients who needed vasopressor in hypotensive attacks, that there was no significant difference between the two studied groups. Nor-epinephrine was used intraoperatively for a short time and stopped within few hours postoperatively in the ICU after extubation. **Cesur *et al.*** [2] results were similar as regards the total dose of ephedrine needed**.**

Pestana *et al.* [14] in their study on 142 patients prepared for major abdominal and colorectal surgery compared goal-directed fluid therapy using non-invasive cardiac output monitoring methods and a control group (standard technique) following the institution protocol in major abdominal surgery. The GDFT group patients were given fluids to maintain a goal of MAP > 65mmhg and a CI > 2.5L/min/ m^2. The results showed non-significant differences regarding, hemodynamics, and postoperative complications. They also used nor-epinephrine in both groups with no significant difference between the studied groups.

Salzwedel *et al.* [15] in their multi-center study for comparison between goal-directed fluid therapy using radial arterial pulse pressure variation and a control group in major abdominal surgery. The results showed a non-significant difference in nor-epinephrine use**.**

The current study reported that the postoperative complication rate (AKI & Wound Dehiscence) in both groups showed a non-significant difference between both groups.

Gomez *et al.* [16] compared goal-directed fluid with control group in laparoscopic colorectal surgery and reported no significant difference in clinical outcome and postoperative complications such as paralytic, ileus wound dehiscence, and length of hospital stays.

The incidence of AKI in the current study has been similar to the results of a study done by **Bahlmann and his colleagues**[17] where there was no significant difference in renal dysfunction between their studied groups.

Scheeren *et al.* [9] discovered, in contrast to our findings, that the GDT group had a lower percentage of patients with at least one complication and a lower average number of postoperative issues per patient. Additionally, they concluded that a goal-directed approach would lessen postoperative organ dysfunction.

Limitations: The drawbacks and restrictions of the device itself, such as physical factors that affect the conductivity of electricity between the electrodes and the skin, usage of electrical cautery that impairs reading and causes the device to malfunction, and the inability to use ICON in patients with arrhythmia, were the study's limitations.

CONCLUSION

Goal-directed fluid therapy using electrical cardiometry has been associated with a non-significant reduction in the number and severity of hypotensive episodes with maintenance of hemodynamic stability, adequate plasma volume status, and decrease total fluid amounts given to patients with little effect on organ perfusion when compared with conventional fluid therapy, with no differences in complications in both studied groups.

REFERENCES

1. **Patel S, Lutz J, Panchagnula U *et al.* (2012):** Anesthesia and perioperative management of colorectal surgical patients–specific issues (part 2). Journal of Anaesthesiology Clinical Pharmacology, 28: (3): 304-13.

2. **Cesur S, Çardaközü T, Kuş A *et al.* (2019):** Comparison of conventional fluid management with PVI-based goal-directed fluid management in elective colorectal surgery. Journal of Clinical Monitoring and Computing, 33(2): 249-257.
3. **Joosten A, Alexander B, Delaporte A *et al.* (2015):** Perioperative goal-directed therapy using automated closed-loop fluid management: the future? Anestezjologia Intensywna Terapia, 47: (5): 517-523.
4. **Meng L, Heerdt P (2016):** Perioperative goal-directed hemodynamic therapy based on flow parameters: a concept in evolution. British Journal of Anaesthesia, 117: 3-17.
5. **Sanders M, Servaas S, Slagt C (2020):** Accuracy and precision of non-invasive cardiac output monitoring by electrical cardiometry: a systematic review and meta-analysis. Journal of Clinical Monitoring and Computing, 34(3): 433-460.
6. **Phan T, An V, D'Souza B *et al.* (2014):** A Randomised Controlled Trial of Fluid Restriction Compared to Oesophageal Doppler-Guided Goal-Directed Fluid Therapy in Elective Major Colorectal Surgery within an Enhanced Recovery after Surgery Program. Anesthesia and Intensive Care, 42(6): 752-760.
7. **Pearse R, Harrison D, MacDonald N *et al.* (2014):** Effect of a perioperative, cardiac output–guided hemodynamic therapy algorithm on outcomes following major gastrointestinal surgery. JAMA., 311: (21): 2181-90.
8. **Summit B, Panda N, Jangra K *et al*. (2022):** Goal-directed Fluid Therapy Versus Conventional Fluid Therapy During Craniotomy and Clipping of Cerebral Aneurysm: A Prospective Randomized Controlled Trial. Journal of Neurosurgical Anesthesiology, 34(4):407-414.
9. **Scheeren T, Wiesenack C, Gerlach H *et al.* (2013):** Goal-directed intraoperative fluid therapy guided by stroke volume and its variation in high-risk surgical patients: a prospective randomized multicentre study. Journal of Clinical Monitoring and Computing, 27: (3): 225-233.
10. **Valenza F, Aletti G, Fossali T *et al.* (2005):** Lactate as a marker of energy failure in critically ill patients: a hypothesis. Critical care (London, England), 9: (6): 588-593.
11. **Sujatha P, Nileshwar A, Krishna H *et al.* (2019):** Goal-Directed vs Traditional Approach to Intraoperative Fluid Therapy during Open Major Bowel Surgery: Is There a Difference? Anesthesiology Research and Practice, 19: 3408940. doi: 10.1155/2019/3408940
12. **Cecconi M, Fasano N, Langiano N, *et al.* (2011):** Goal-directed hemodynamic therapy during elective total hip arthroplasty under regional anesthesia. Critical Care (London, England), 15: (3): 132. doi: 10.1186/cc10246.
13. **Benes J, Chytra I, Altmann P *et al.* (2010):** Intraoperative fluid optimization using stroke volume variation in high-risk surgical patients: Results of a prospective randomized study. Critical Care, 14 (3): 118. doi: 10.1186/cc9070
14. **Pestana D, Espinosa E, Eden A *et al.* (2014):** Perioperative goal-directed hemodynamic optimization using non-invasive cardiac output monitoring in major abdominal surgery: a prospective, randomized, multicentre, pragmatic trial: POEMAS Study (Perioperative goal-directed therapy in Major Abdominal Surgery). J J A & Analgesia, 119: 579-587.
15. **Salzwedel C, Puig J, Carstens A *et al.* (2013):** Perioperative goal-directed hemodynamic therapy based on radial arterial pulse pressure variation and continuous cardiac index trending reduces postoperative complications after major abdominal surgery: a multi-center, prospective, randomized study. Randomized Controlled Trial, 17(5): 1-11.
16. **Gómez-Izquierdo J, Trainito A, Mirzakandov D *et al.* (2017):** Goal-directed Fluid Therapy Does Not Reduce Primary Postoperative Ileus after Elective Laparoscopic Colorectal Surgery. Anesthesiology, 127(1): 36-49.
17. **Bahlmann H, Hahn R, Nilsson L (2018):** Pleth variability index or stroke volume optimization during open abdominal surgery: a randomized controlled trial. BMC Anesthesiol., 18(1):115. doi: 10.1186/s12871-018-0579-4.