RESEARCH

COMPARISON OF THE EFFECTS OF INTRAOPERATIVE GOAL DIRECTED AND CONVENTIONAL FLUID MANAGEMENT ON THE INFERIOR VENA CAVA COLLAPSIBILITY INDEX AND POSTOPERATIVE COMPLICATIONS IN GERIATRIC PATIENTS OPERATED FROM PROXIMAL FEMORAL NAIL SURGERY

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Abstract

Introduction: Avoiding undesirable effects of hyper- and hypovolemia is important in geriatric hip fracture patients perioperatively. In our study, we aimed to compare the effects of intraoperative goal directed and conventional fluid therapy on inferior vena cava collapsibility index, postoperative complications and 30-day mortality in these patients.

Materials and Methods: 60 patients aged 65 and over who underwent proximal femoral nail surgery were included in the study.Patients were randomized into two groups; Goal Directed and Conventional Therapy groups. Patients in the Goal Directed Therapy Group were monitored with a MostcareTm (Vygon, VytechHealth, Padova, Italy) haemodynamic monitor. Fluid therapy was applied by targeting Pulse Pressure Variation <10%, Stroke Volume Variation <13%. In the Conventional Therapy group fluid management was administered to the patients according to the 4-2-1 rule. Before anesthesia and leaving the recovery room, inferior vena cava collapsibility index measurements was performed by ultrasonography.

Results: Postoperative inferior vena cava collapsibility index was higher in the Conventional group. Total administered crystalloid fluid volumes were similar in both the groups and more colloids were used in the Goal Directed Therapy group. Intraoperative urine output was observed more in the Goal Directed Therapy group. Postoperative hospital stay was shorter in the Goal Directed Therapy group. There was no significant difference in terms of 30-day mortality and postoperative complications.

Conclusion: According to our study, intraoperative targeted fluid herapy provides optimal postoperative intravascular volume and shortened the postoperative hospital stay.

Keywords: Femoral Fractures; Vena Cava, Inferior; Hemodynamic Monitoring; Fluid Therapy; Postoperative Complications.

INTRODUCTION

It is estimated that the annual number of hip fracture cases will exceed 6 million in 2050, with the rapid increase in the aging population of the world (1).

Advanced age, comorbidities, dehydration, malnutrition and decreased functional and cognitive functions pose a risk for postoperative complications in patients admitted to the hospital due to hip fracture Considering age, frailty and high cardiovascular risk in the geriatric patient group, it is possible that they are resuscitated with insufficient fluid before, during and after surgery, because of the fear of increase in left ventricular failure due to excessive fluid administration (2). Optimization of perioperative haemodynamics and fluid management is important to reduce this risk.

Therefore, managing these high-risk patients using static parameters may reveal the undesirable effects of postoperative hypovolemia and hypervolemia. Vasoconstriction due to hypovolemia may lead to decreased oxygen delivery, decreased tissue perfusion and dysfunction of the peripheral organs. Along with glycocalyx damage due to hypervolemia, tissue oedema, impaired tissue perfusion, local inflammation, delayed wound healing, wound infection and anastomotic leaks can be observed (3). There is no clear consensus on how to perform optimal fluid management in this population, which has many comorbidities and is at a high risk for postoperative complications.

The research for an optimal fluid regimen to avoid intravascular volume overload and maximize tissue perfusion has brought individualized targeted fluid replacement therapies with the help of technology (4). In the approach of goal directed therapy (GDT) approach, parameters such as stroke volume variation (SVV), pulse pressure variation (PPV) and cardiac output (CO) related to global O2 distribution are measured to improve tissue perfusion and clinical outcomes. Replacement with crystalloids, colloids, blood products, or vasopressors is adjusted according to the targeted physiological variables in the dynamic process (5). Developments in recent years have drawn attention to the future of non-invasive or less invasive devices (6).

The inferior vena cava collapsibility index (cIVC) is an easy, bedside, rapid measurement method. It can be used as an indicator of fluid response and as a guide for fluid management in critically ill patients with spontaneous breathing. (7–9). The inferior vena cava (IVC) is a vein with a low intravenous pressure and high collapsibility. Its diameter is modified by the intravascular volume status, right heart function, and respiration (10). During each respiratory cycle, the IVC contracts and relaxes. With the negative pressure resulting from inspiration, venous return to the heart increases in patients and the IVC collapses (9) . With expiration, the IVC diameter increases again and returns to the basal value. An increase or decrease in the collapsibility of the vessel guides the evaluation of the clinical status of the patient. IVC ultrasound has advantages over other fluid response measuring methods it is non-invasive, inexpensive, widely available, can be obtained with minimal training, and can be combined with heart and lung ultrasound to provide a complete sonographic picture of the patient (11).

Although the necessity of providing adequate intravascular volume in intraoperative fluid management is obvious, an optimal fluid management guideline has not yet been established for geriatric and emergency cases with high mortality. The primary aim of our study was to compare the effects of goal directed and conventional fluid management on cIVC in patients undergoing proximal femoral surgery. In addition, evaluation of the amount of fluid administered, blood products, number of perioperative hypotensive events, intraoperative haemodynamics, intraoperative urine output, amount of bleeding, postoperative complications (cardiac, respiratory, renal, etc.), postoperative 30-day mortality, nausea

and vomiting score, postoperative hospitalization days, and comparisons were performed.

MATERIALS AND METHODS

This study was conducted at the Fatih Sultan Mehmet Training and Research Hospital of the Ministry of Health Health Sciences University between July 2021 and November 2021 after obtaining clinical trials (NCT05154435) and ethics committee approval from Istanbul Kartal Koşuyolu High Specialization Training and Research Hospital (2021/14/548).

Sixty patients over 65 years of age, who were scheduled for PFN surgery and had an American Society of Anesthesiologists Physical Evaluation Classification (ASA) score of 1-3 were included in our prospective, randomized, controlled study.

Patients with cardiac arrhythmia, advanced heart and aortic failure, chronic renal failure need for dialysis, advanced obstructive or restrictive respiratory diseases, active lower/upper respiratory tract infection, body mass index (BMI)>35, and IVC that could not be clearly visualized by ultrasonography were excluded from the study.

The patients were randomized into two groups CON (n=30) and GDT (n=30) and the patients were not informed about the group to which they belonged. The study protocol was explained to all patients. A consent form was signed by the patients who volunteered to participate in the study. Patients in both the groups underwent routine electrocardiography (ECG), saturation (SpO2), non-invasive blood pressure and depth of anesthesia monitoring with a bispectral index (BIS) (BIS Complete 2 channel monitoring system Medtronic Limited., UK) probe. All patients were sedated with 1 mg/kg fentanyl (Talinat 50 mcg/10 ml 1 amp, Vem İlaç Sanayi ve Ticaret Ltd.Şti.). Invasive arterial monitoring was performed under sterile conditions, and preoperative blood gas analysis was performed. Systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), heart rate (HR), BIS and SpO2 were recorded every 15 min. IVC ultrasonography was performed in all patients by an experienced anesthesiologist who was blinded to the study. The patient was placed in the supine position, with a convex probe (5 MHz) from the subxiphoid region, that measured the diameter of the IVC inspirium and expirium (EsaoteSpA, Genova-Italy) and the collapsibility index was recorded. All measurements were made by the same anesthesiologist. The IVC was visualized along the longitudinal axis in the subxiphoid position. The intrahepatic segment of the IVC was visualized as it entered the right atrium. The IVC diameter was measured 3-4 cm from the junction of the IVC and the right atrium or 2 cm caudal to the hepatic vein-IVC junction. The M mode was placed perpendicular to the IVC and the IVC was monitored for approximately 10 s over two or three respiratory cycles. The maximum IVC diameter (IVC dmax) was measured at the end of expiration from the inner margin of the vessel wall to the inner rim. The minimum IVC diameter (IVC dmin) was measured and recorded at the end of inspiration. The IVC collapsibility index was calculated as the difference between the maximum and minimum IVC diameters divided by the maximum IVC diameter and was expressed as a percentage. ([IVCdmax–IVCdmin]/IVCdmax×100%).

1-2 mg/kg propofol (Propofol 1% fresenius, FreseniusİlaçSan. ve Tic. Ltd. Şti.), 0.6 mg/kg rocuronium (Muscuron 50 mg/5 ml, KoçakFarma) and 1 mg/kg fentanyl (Talinat 50mcg /10ml 1 amp, Vemİlaç) were administered intravenously to all participants during anesthesia induction. Mechanical ventilation initiated with an oxygen-air mixture with an end-tidal CO_2 value (EtCO2) 35-45, 5 cmH_2O positive end-tidal pressure, 8 ml/kg tidal volume, 2 lt flow rate and 40% oxygen. Anesthesia was maintained with 3-5% desflurane (Suprane 240 ml solution, Eczacıbaşı-Baxter) and 0.25-1 mcg/kg/min remifentanil (Ultiva 5 mg flk, Glaxo Smith

Kline). The aim was to maintain the BIS value between 40 and 60. A balanced electrolyte solution (Eczacıbaşı-Baxter) was used as the maintenance fluid for both the groups. All patients were warmed perioperatively with an active air blown heating blanket and body temperature monitoring was performed. All patients were normothermic.

Patients in the targeted fluid therapy group (GDT Group) were monitored with a MostcareTM (Vygon, VytechHealth, Padova, Italy) haemodynamic monitor after arterial cannulation. CO, SVV, PPV, systemic vascular resistance index (SVRI), arterial elastance (Ea) measurements, and SAB, DAB, MAP, KTA and SpO2 values were monitored. Fluid therapy every 15 min was planned in accordance with our algorithm.

PPV <10%, CI >2.5 L/min/m^2, SVV <13%, and mean arterial pressure >65 mmHg were targeted. If the patient's parameters were within these limits, 4 ml/kg/h balanced crystalloid infusion was administered. When SVV was >13%, 4 ml/kg hydroxyethyl starch (HES) (Voluhes, Hes 130/0.4% 6% Solution for Iv Infusion 500 ml Polifarma) was administered for 5 min and a crystalloid infusion was administered as 8 ml/kg/h. The fluid response was re-evaluated after 15 min (Figure 1). The aim was that the amount of HES administered to the patient within 24 h should not exceed 1000 ml. In case of SVV >13%, CI <2.5 L/min/m^2, MAP <65 mmHg, 0.1-0.2 mcg/kg/min norepinephrine (Cardenor 4 mg/4 ml VEM) infusion was started.

Fluid deficit due to fasting time was calculated in accordance with the 4-2-1 rule for patients in the CON group. (4 ml/kg/hr for the first 10 kg, 2 ml/kg/hr for the second 10 kg, 1 ml/kg/hr for each subsequent kg). Half of the calculated fluid volume was given in the first hour; the remaining half was given at the 2nd and 3rd hours. Bleeding was replaced with HES equal to the amount of bleeding or three times of balanced crystalloid fluid.

In both the groups, intraoperative hypotension (MAP <65 mmHg) was first intervened with 5 mg ephedrine (0.05 g/ml ampoule, Osel İlaç San. ve Tic. A.Ş.) The dose of remifentanil was reduced by 25%. If no response was obtained, 5 mg ephedrine was added and 4 ml/kg crystalloid was administered intravenously (IV) in 15 min. This was recorded as a hypotensive event. When blood loss of more than 20% of the total blood volume or Hb <8 g/dl was detected acutely, erythrocyte suspension and fresh frozen plasma replacement was planned at a ratio of 2:1.

All patients were treated with 1 g paracetamol (Paracerol 10 mg/ml, PF polyfarma), and 1 mg/kg tramadol (Tramosel 100 mg/2 ml, HaverFarma) 20 min before end of the surgery for postoperative analgesia, and 4 mg ondansetron (Zofer 4 mg/ 2 ml, Adeka) for prophylaxis of nausea was administered intravenously. At the end of the surgery, before awakening, all patients underwent a femoral nerve block with 20 ml of 0.25% bupivacaine and a lateral femoral cutaneous nerve block with 5 ml of 0.25% bupivacaine (Buvacin 5 mg/ml VEM) under ultrasound guidance. After the block was applied, the inhalation anesthetic was discontinued and the patients were ventilated with oxygen-air at a flow rate of 6 lt/min and 80% oxygen. In order to reverse the neuromuscular blockade, 0.02 mg/kg atropine and 0.05 mg/kg neostigmine (Neostigmine 0.5 mg/ml ampoule, Adeka) were administered IV after observing the tachycardia response of the patient with a spontaneous respiratory effort.

The amount of crystalloid and colloid administered during the surgery, the amount of inotrope, ephedrine, and atropine, if given; and the amount of blood and blood product transfusions, bleeding and urine output were recorded.

After extubation patient was taken to the post anesthesia care unit (PACU). Postoperative cIVCmeasurements were made in the PACU by the anesthesiologist who performed the preoperative measurements, and the measurements were recorded. The patients were monitored by a PACU nurse who was blinded to the study. Visual

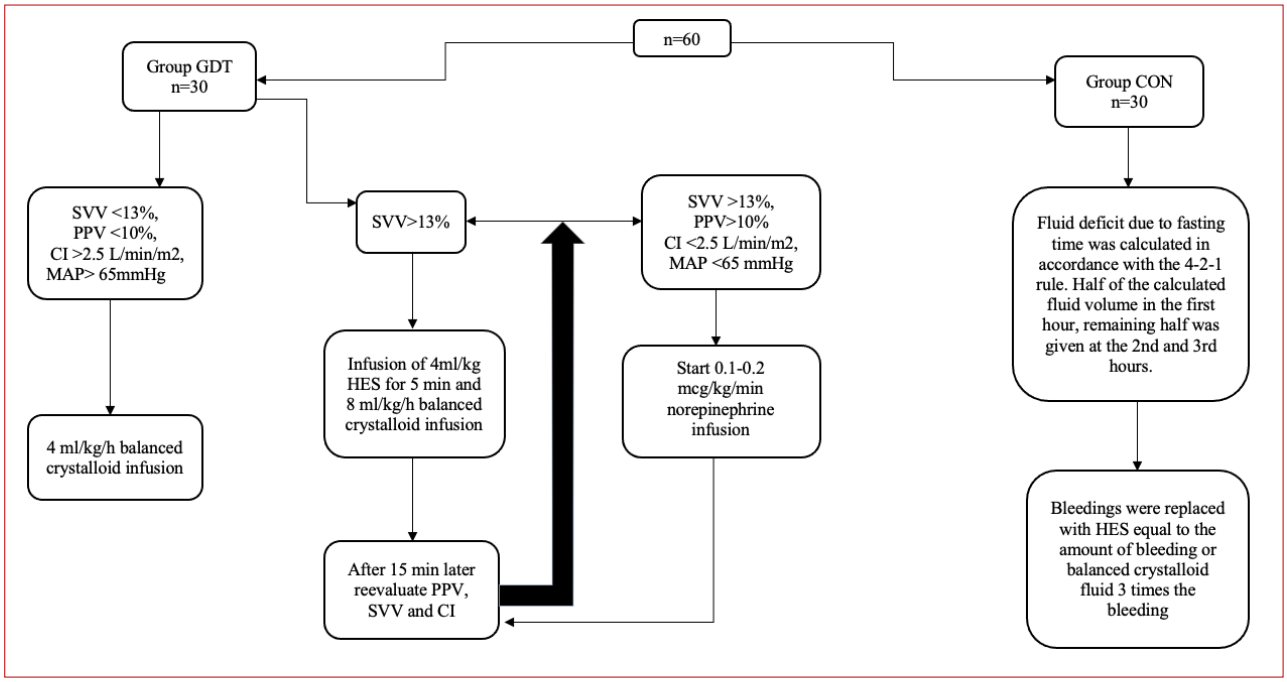

Figure 1. Group GDT and Group CON fluid management

SVV: Stroke Volume Variation, PPV: Pulse Pressure Variation, MAP: Mean Arterial Pressure, CI: Cardiac Index, HES: Hydroxyethyl Starch

analogue scale (VAS) scores, nausea and vomiting status were recorded. Control postoperative blood gas was obtained before arterial cannula removal in the PACU. Control of postoperative biochemistry values (AST, ALT, creatinine) were taken at the 4th postoperative hour in the service.

For the evaluation of the level of nausea, a 4-scale postoperative nausea and vomiting (PONV) scale was used: "0 = no nausea, 1 = mild nausea, 2 = moderate nausea, 3 = severe nausea".

Before discharge, the patients were questioned regarding cardiovascular, respiratory, neurological, gastroenterological, infective, haemorrhagic and renal complications. The patients were called on the 30th postoperative day and the 30-day mortality was assessed.

The Shapiro-Wilk test was used to examine whether the data showed normal distribution in the statistical analysis. Mann-Whitney U test was used to the compare the two groups for normally distributed data. Repeated measurements between groups were compared by calculating the percent change value (percentage change = (last measurement - first measurement) / first measurement) compared to the initial measurement. the Friedman test was used for intergroup comparisons. In the case of significance, Bonferroni correction was applied in pairwise comparisons. In addition, the paired t-test and Wilcoxon signed -rank test were used to compare pre- and post- measurements of dependent variables. Pearson's Chi-square test, Fisher's Exact Chi-square test, and Fisher-Freeman-Halton test were used to the analyze the categorical data. The significance level was set at as α=0.05. Statistical analysis of the data was performed using the IBM SPSS Statistics for Windows version 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.).

RESULTS

Sixty-three patients aged 65 years and older were evaluated in our study. One patient was excluded from the study due to covid positivity in the last 3 months, one patient currently covid positive, and one patient due to discontinued of perioperative arterial monitoring. Data were evaluated in 60 patients: 71% (n=43) were female and 29% (n=17) were male. Sex distrubution, age, ASA scores, weight, anesthesia and duration of surgery of the groups were similar (Table 1).

There was no significant difference in the SAP, DAP, HR and BIS parameters between the groups at 0, 30, 60 and 90 min.

When the IVC expiratory diameter of the patients was measured, no significant difference was found between the two groups in the preoperative measurements (Table 2). In the postoperative measurements, the IVC expiratory diameter was found to be larger in the GDT group ($p<0.05$). In intragroup comparisons, postoperative measurements were wider when the pre- and postoperative IVC expiratory diameters were compared in the GDT group ($p<0.001$). There was no significant difference between pre- and postoperative IVC expiratory diameters in the CON group ($p=0.825$).

When the IVC inspirium diameter was examined, the two groups were found to be similar in preoperative measurements. In the postoperative measurements, the diameter of the IVC inspirium was wider in the GDT group ($p<0.001$). In intragroup measurements, the postoperative IVC inspirium diameter was wider in the GDT group ($p<0.001$). Pre- and postoperative IVC expiratory diameters were similar in the CON group.

When both groups were examined in terms of the IVC collapsibility index, they were found to be similar in their preoperative measurements. In the

Table 1. Comparison of Patients between Groups in terms of Demographic Data, ASA, Anesthesia Duration and Surgery Duration

		Group GDT n=30	Group CON n=30	P Value
Gender %	Female	n=22(%73)	n=21 (%70)	0.774[1]
	Male	n=8 (%27)	n=9 (%31)	
ASA %	1	n=0 (%0)	n=1 (%3)	0.492[2]
	2	n=2 (%6)	n=0 (%0)	
	3	n=28 (%94)	n=29 (%97)	
Age (years) (mean±SD)		80±8	80±7.9	0.8[3]
Weight(kg) (mean±SD)		64.8±10	65.6±12	0.797[3]
Anesthesia duration (min) Median(min-max)		110 (75-120)	105 (60 -125)	0.138[4]
Surgery time (min) Median (min-max)		95 (60-110)	90 (55-110)	0.112[4]

[1]Pearson Chi-Square, [2]Pearson Chi-square test, [3]t-test, [4]Asymp. Sig. (2-tailed), ASA: American Society of Anesthesiologists Physical Assessment Classification, SD: Standard Deviation, Min: Minimum, Max: Maximum.

postoperative measurements, cIVC was lower in the GDT group ($p<0.05$). In the intragroup comparison, preoperative measurements were higher than the postoperative measurements in both the groups ($p<0.05$).

No significant difference was observed between GDT and CON groups when the total volume of crystalloid administered was compared. The Total colloid amount, total bleeding, and total urine output were found to be higher in the GDT group ($p<0.05$). The total amount of blood products administered was similar between the two groups. The number of intraoperative hypotensive events was similar in both the groups (Table 3).

When the patients were examined in terms of postoperative hospitalization days, it was found that the patients in the GDT group were discharged within a shorter time ($p<0.05$). When the 30-day mortality was questioned, one patient in the GDT group was admitted to the hospital on the 7th postoperative day due to respiratory distress and was intubated. The patient, who tested positive for Covid-19, died on the 17th day. There was no significant difference between the groups in 30-day mortality. When examined in terms of postoperative complications, complications developed in a total of 5 patients. Of these patients, two had infective, two had respiratory complications, one had infective and haemorrhagic complications. There was no significant difference between the groups ($p=0.671$).

The Friedman test was used to compare the 0th, 30th, 60th and 90th values of SVV, PPV, and CO in the GDT group, and there was a significant difference (Table 4). Bonferroni correction was applied for pairwise comparisons. There was a significant difference among the values recorded between SVV 0 and 30 minutes and between SVV 0 and 60

Table 2. Comparison of Inferior Vena Cava (IVC) Expirium, IVC Inspirium Measurements and Collapsibility Indices Within and Between Groups

		Group GDT n=30	Group CON n=30	P value
IVC Expirium (cm) Mean±SD	Preop	1.18±0.32	1.30±0.29	[1]0.130
	Postop	1.33±0.33	1.31±0.31	[1]0.02*
	Δ	0.14±0.18	-0.01±0.01	
	P vaue	<0.001*	0.825	
IVC Inspirium (cm) Mean±SD	Preop	0.57±0.26	0.53±0.17	[1]0.499
	Postop	0.81±0.27	0.58±0.17	<[1]0.001*
	Δ	0.53±0.35	0.14±0.31	
	P value	<[1]0.001*	[1]0.055	
Collapsibility Index (%) Mean±SD	Preop	52.70±10.42	59.57±7.66	[1]0.0052
	Postop	38.90±7.25	55.60±9.98	<[1]0.001*
	Δ	-0.25±0.13	-0.06±0.16	
	P value	<[1]0.001*	[1]0.028*	

IVC: Inferior Vena Cava, Preop: preoperative measurement, Postop: Postoperative measurment, Δ: percentage change between preoperative and postoperative measurements. SD: Standard Deviation, *: $p<0.05$, [1]: t-test.

Table 3. Comparison of Intraoperatively Given Crystalloid, Colloid, Total Bleeding, Total Urine Output, Total Amounts of Blood Product Given, Number of Hypotensive Events, Postoperative Hospitalization Days, 30-Day Mortality and Postoperative Complications

		Group GDT n=30	Group CON n=30	P value
Total Crystalloid volume (ml) Med(min-max)		1175 (800-1600)	1125 (700-1650)	[1]0.75
Total Colloid Volume (ml) Med(min-max)		250 (0-650)	0 (0-550)	<[1]0.001*
Total Bleeding Volume (ml) mean± SD		163±38	145±78	[1]0.018*
Total Urine Output (ml) Med(min-max)		100 (0-400)	0 (0-400)	[1]0.007*
Total Given Blood Product(ml) Med(min-max)		0 (0-350)	0 (0-350)	[1]0.42
Number of Hypotensive Events Med(min-max)		1 (0-2)	1 (0-2)	[1]0.204
Postoperative Hospitalization Day Median (min-max)		2 (1-5)	3 (2-21)	[1]0.015*
Postoperative Complications %	no	93 (n=28)	90 (n=27)	0.671[1]
	yes	7 (n=2)	10 (n=3)	
30-Day Mortality %	yes	3 (n=1)	0 (n=0)	1.00[2]
	no	97 (n=29)	30 (n=30)	

*: p<0.05, [1]: Mann-Whitney U Test, [2]: Chi-square test, Med: Median, Min: Minimum, Max: Maximum, SD: Standard deviation

Table 4. Group GDT Stroke Volume Variation (SVV) / Pulse Pressure Variation(PPV) / Cardiac Output (CO) / Systemic Vascular Resistance Index (SVRI) / Arterial Elastance (Ea)

	0. min	30. min	60. min	90. min	P Value
SVV Med (min-max)	22 (7-30)	12 (3-30)	7 (5-46)	6 (4-17)	<[1]0.001*
PPV Med (min-max).	22 (8-43)	11 (4-34)	9 (4-31)	7 (4-11)	<[1]0.001*
CO Med (min-max)	4.60 (3.30-8.10)	4.40 (3.10-6)	4.15 (3.10-5.30)	4.20 (3.10-5.1)	[1]0.019*
SVRI Med (min-max)	1677 (948-2890)	1283 (846-3269)	1272 (958-2680)	1155 (833-1603)	<[1]0.001*
Ea Med (min-max)	1.85 (1.1-2.20)	1.48 (0.83-2.96)	1.15 (0.78- 2.70)	1.20 (0.64-1.919	<[1]0.001*

Time-Related Change and 0-90 min Comparison

[1]: Related-Samples Friedman's Two Way Analysis of Variance By Ranks, *:[1]p<0.05*, SVV: Stroke Volume Variation, PPV: Pulse Pressure Variation, SVRI: Systemic Vascular Resistance Index, Ea: Arterial Elastance, Med: Median, Min: Minimum, Max: Maximum

min ($p<0.05$). SVV values measured at 90th and 60th min were similar ($p=0.8$). SVV values measured at 30 and 60 min were similar ($p=0.07$).

PPV 0-30, 0-60, 0-90: there was a significant difference in the measurements between the30th and 90th min ($p<0.05$). the values recorded between 60-90 min and 30-60 min were found to be similar.

When AST, ALT and creatinine values were compared between the groups, no significant differences were observed in pre- and postoperative measurements. In the intragroup comparison, AST and ALT values were found to be higher postoperatively in the GDT group. In the CON group, no significant difference was observed between the pre- and postoperative measurements in the intragroup comparison. In intragroup comparisons of creatine, the postoperative value measured in CON group was found to be lower than the preoperative value ($p<0.05$). In the GDT group, intragroup pre- and postoperative creatine measurements were similar.

Postoperative nausea and vomiting were not detected in any patient in either group. All the patients were transferred from the PACU to the service. When examined in terms of the method of discharge from the hospital, all patients in both the groups were discharged with full recovery. Postoperative 30th min VAS score of the patients in both the groups were similar.

DISCUSSION

In our study that examined the effects of targeted and traditional fluid management on cIVC and postoperative complications in geriatric patients who underwent proximal femoral surgery, the postoperative cIVC in the targeted therapy group was found to be lower and within euvolemic limits than that in the traditional fluid management group. The cIVC was found to be within the hypovolemic limits in patients followed up using the conventional method. Postoperative IVC inspiratory and expiratory diameters were larger in the targeted therapy group.

While the amount of intraoperative crystalloid infusion was similar, the amount of colloid infusion was higher in the GDT group. While urine output was higher in the GDT group, postoperative creatinine values were similar in both the groups. While there was no significant difference between the two groups in terms of postoperative complications and 30-day mortality, hospital stay was shorter in the GDT group.

There was no significant difference between the two groups in terms of postoperative nausea and vomiting, exit site from PACU and hospital, pre- and postoperative ALT, AST and blood gas values.

In their study, Airepetan et al. evaluated the fluid responsiveness in spontaneously breathing patients in the intensive care unit, and reported that a cIVC ≥42% showed an increase in CO after fluid infusion (9). Szabo et al. reported that a preoperative cIVC ≥50% was associated with post-induction hypotension in their study of 83 spontaneously breathing patients who were scheduled for non-cardiac surgery (12). Nagdev et al. reported that a cIVC ≥ 50% was associated with a CVP ≤8mmHg, in their study with 73 spontaneously breathing patients who were scheduled for central catheterization for CVP measurement for different reasons in the emergency department (13). In our study, postoperative cIVC was 38% in the GDT group, and 55% in the CON group. In parallel with different studies in the literature, a cIVC value of 55% in the CON group can be considered hypovolemia. The high cIVC diameter measured in the CON group may indicate inadequate intraoperative fluid therapy. A lower urinary output supports this finding. Patients undergoing hip surgery may need more pre- and perioperative volume support due to reasons such as dehydration in the preoperative period, prolonged fasting and inability to take oral fluids during surgical preparation, and existing or worsening malnutrition. However, due to common

comorbidities and fragility in advanced age, it is recommended that this volume be given at an optimal level, with appropriate and enough fluid, without causing hypervolemia.

In a meta-analysis of 23 studies performed by Rollins et al in which major abdominal surgery was performed, it was reported that a decrease in the length of hospital stay was found in patients who underwent perioperative targeted fluid therapy, compared to the traditional method; however, no significant difference in mortality was observed between the groups (14). Che et al. reported that postoperative complications were lower in patients who underwent individualized fluid therapy than in those who underwent standard fluid management, and that there was no significant difference between the length of hospital stay and the volumes of fluid administered (15). In a review of 2159 patients by Michard et al. who underwent fluid management with non-calibrated pulse contour analysis methods, the total amount of colloid was found to be higher than that in the control group, and the amount of crystalloid was found to be less than that in the control group. Postoperative morbidity was lower in the targeted therapy group (16).

In our study, no significant differences were observed between GDT and CON groups in terms of postoperative complications. Similar to the studies of Rollins et al., the length of hospital stay was found to be lower in the GDT group, and there was no significant difference in postoperative mortality between the two groups. We believe that our exclusion of patients with an ASA score of 4 and those with advanced cardiac, respiratory and organ failure may have affected this finding. In addition, we believe that increasing sample size will be more appropriate for the evaluation of postoperative mortality and complications.

In our study, unlike Michard et al., no significant differences were observed between the crystalloid volumes given between the groups, while more colloids were given in the GDT group. We believe that the lower cIVC value in the GDT group in preoperative measurements may be due to less fluid requirement compared to the CON group. If equal cIVC were measured in both the groups, it is possible that the total amount of fluid administered would differ.

One of the limitations of our study was that while colloid was administered to reach the targeted parameters in the GDT group, colloid was administered only in case of bleeding in the CON group. While the study was being planned, this protocol was followed in the GDT group in order to reach the target SVV and PPV values in a short time during which the surgery continued. Colloids stay longer in the intravascular space and are more suitable as volume expanders. Since the fluid management of the patients in the CON group was performed using traditional methods, a colloid routine was not added to the protocol. Another limitation was the exclusion of patients who may require postoperative intensive care. Increasing the number of patients and the inclusion of high-risk cases in the study could provide different results in terms of 30-day mortality and postoperative complications. Major complications were examined in our study, and the fact that they were not evaluated in detail in terms of minor complications can be considered among the limitations of our study. In our study, postoperative complications were evaluated during the acute period prior discharge, had it been evaluated over a longer period of time, different results could have been obtained.

The fluid management is an important concern for elderly patients in order to decrease the mortality and morbidity rate. The cIVC may be useful for this aim and although there are some limitations this research may show the usefullnes of using this index for elderly management.

Targeted fluid therapy may be safe and beneficial for the intraoperative follow-up of patients scheduled for high-risk major surgery. Larger studies are needed to determine its effects on postoperative mortality and morbidity, organ perfusion.

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