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ORIGINAL INVESTIGATION

Fluid preloading before beach chair positioning for arthroscopic shoulder procedures: a randomized controlled trial

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KEYWORDS
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Abstract
Background and objectives: The Beach Chair Position (BCP) has many advantages such as less neurovascular injury and better intra-articular visualization, but it has also negative consequences, including hemodynamic instability. Although maintaining normal Mean Arterial Pressure (MAP) is important, fluid management is also a crucial concept for hemodynamic stability. The main objective of this study is whether preloading before positioning would be effective for less hemodynamic instability.
Methods: This randomized, controlled study was conducted in a single center in the Istanbul University, Istanbul Faculty of Medicine. Forty-nine patients undergoing elective arthroscopic surgery in the BCP were recruited. In the study group, crystalloid fluid at 10 mL.kg^{-1} of ideal body weight was administered intravenously 30 min before the BCP for preloading. The primary outcome measures were differences of hemodynamic variables as MAP, Stroke Volume (SV), Heart Rate (HR), and Cardiac Output (CO). The secondary outcome measures were Postoperative Nausea and Vomiting (PONV) rates in postoperative first day, surgical satisfaction scale, total ephedrine dose used during surgery, and total amount of fluid.
Results: The MAP, CO, and SV measurements of the study group were higher than those of the control group in the 5th minute after the BCP (respectively, $p = 0.001$, $p = 0.016$, $p = 0.01$). The total amount of crystalloid and surgical satisfaction scales were higher in the study group (respectively, $p = 0.016$, $p = 0.001$). Total amount of colloid and ephedrine dose used in the intraoperative period, and PONV rates were lower in the study group ($p = 0.003$, $p = 0.018$, $p = 0.019$, respectively).
Conclusion: Consequently, preloading can be favorable approach to preserve hemodynamic stability.

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Introduction

The Beach Chair Position (BCP) is the preferred patient position for arthroscopic shoulder procedures because it offers several advantages over the lateral decubitus position, including a lower risk of brachial plexus and vascular injury and better intra-articular visualization.[1,2] However, Mean Arterial Pressure (MAP), Stroke Volume (SV), and Cardiac Output (CO) decrease and total peripheral resistance increases in BCP.[3] For these reasons, maintaining cerebral perfusion and oxygenation, especially in patients taking antihypertensive medications, such as Angiotensin-Converting Enzyme Inhibitors (ACEI) and Angiotensin Receptor Blockers (ARB), is challenging for physicians.[4] Salazar et al. reported cerebral desaturation in 18% of patients during shoulder surgery in the BCP.[5]

Perioperative fluid management is an important concept for preserving adequate tissue oxygenation and maintaining CO. While hypovolemia can reduce the oxygen delivery to the tissues and cause secondary organ diseases, hypervolemia can induce interstitial edema and the disruption of alveolar gas exchange through glycocalyx damage.[6–8] The aim of intraoperative fluid therapy is to maintain the patient in a normovolemic state by administering targeted fluid therapy and to prevent the harmful effects of hypovolemia and hypervolemia.[9] When patients are positioned in the BCP under anesthesia, significant hemodynamic changes, such as decreases in MAP, SV, and CO, may develop. Therefore, anesthesia management during surgery is performed with the patient in this position with the goal of ensuring the continuity of tissue perfusion and oxygenation.

The primary hypothesis of this study was that preloading before positioning the patient would be effective in minimizing hemodynamic changes, the need for vasopressors and aggressive intravenous fluid therapy, and the occurrence of hypertension-hypotension episodes secondary to vasoactive drugs; therefore, we aimed to examine whether there would be a significant difference in CO reduction as a result of the BCP in patients undergoing shoulder surgery. We speculated that since more stable hemodynamics would be achieved, there would be a decrease in the total ephedrine requirement and the amount of bleeding and an increase in surgical satisfaction due to the improvement in arthroscopic image quality resulting in shorter surgery and anesthesia durations, thereby leading to a decreased incidence of postoperative complications. Although there have been studies regarding of hemodynamic variables and monitorization techniques in the BCP, our study is one of the few studies investigating the effect of preloading before positioning.

Methods

Ethics

This prospective, randomized, controlled study was approved by the Clinical Studies Ethical Committee of the Istanbul Faculty of Medicine, Istanbul University (2018/166711, Chairperson Prof. A.Y. Uresın) on 25 May 2018, and was registered in a database with ClinicalTrials.gov (NCT04671537, https://clinicaltrials.gov/ct2/show/NCT04671537).

Study

The study was conducted between June 2018 and June 2019 at the Orthopaedics Clinic of the Istanbul Faculty of Medicine. Written informed consent was obtained from each of the participants after providing them with an explanation regarding the anesthesia procedure and publication of the present study. The inclusion criteria were patients aged from 18 to 65 years, with an American Society of Anesthesiologists (ASA) physical status I–II, who were scheduled to undergo elective arthroscopic shoulder surgery in the BCP, and who consented to the study protocol. The following exclusion criteria were used: patients with preoperative arrhythmia, significant heart failure, valvular heart disease or pre-existing cerebrovascular disease, and those using ACEI or ARB as antihypertensive medication.

Randomization was performed using a computer software. The study participants were allocated into two groups: Group C (control group) and Group P (study group). In the patients in Group P, after anesthesia induction and radial artery cannulation, crystalloid fluid was administered intravenously at 10 $mL.kg^{-1}$ of the ideal body weight 30 minutes before positioning them in the BCP. After anesthesia induction and radial artery cannulation, we did not administer any interventions in Group C. In both groups, the patients were raised to a 70° upright position with the head secured in a neutral position using a beach chair. A pressure transducer was placed at the level of the external auditory canal in the BCP. Hemodynamic variables (MAP, Heart Rate [HR], Systolic Arterial Pressure [SAP], Diastolic Arterial Pressure [DAP], CO, and SV) were recorded after positioning the patient in the BCP, followed by at specific time intervals (5th, 10th, 30th, 60th min). We set the threshold Stroke Volume Variation (SVV) limit to 13% in order to administer goal-directed fluid therapy. In cases where SVV rised above 13, a mini fluid challenge was done by giving 250 cc crystalloid firstly, and if no response was obtained, bolus dose ephedrine was used to support CO. In cases where SVV was normal and CO was low, ephedrine bolus treatment was used to support contractility instead of fluid therapy. Hypotension was defined as a 15% decrease in MAP, which was initially treated with 5 $mL.kg^{-1}$ colloid fluid replacement and subsequently with a bolus of ephedrine (5 mg). Patients who needed an infusion of vasoactive drugs were excluded from the study. Further, Postoperative Nausea and Vomiting (PONV) incidences, surgical satisfaction scale scores (0–10, being 0, lowest score; 10, highest score), total amounts of crystalloid and colloid fluids, ephedrine usage, and the durations of anesthesia and surgery were recorded as secondary outcomes. After standard monitoring, the first hemodynamic variables (SAP, DAP, and HR) were recorded. The operations were performed by the same surgeon, and the surgical team was blind to the type of intervention and treatment groups.

Anesthesia and patient monitoring

Probes/monitors for routine noninvasive monitoring were attached, including those for Noninvasive Blood Pressure

(NIBP), HR, pulse oximetry (SpO_2), Electrocardiography (ECG), and temperature (°C) monitoring. Anesthesia was induced using midazolam (2 mg), fentanyl (1 mcg.kg^{-1}), propofol (2–2.5 mg.kg^{-1}), and rocuronium (0.6 mg.kg^{-1}). The trachea was intubated, and anesthesia was maintained with sevoflurane (1–2%, 1 Minimum Alveolar Concentration (MAC)), remifentanil (0.25–0.5 mcg.kg^{-1}.min^{-1}) infusion, and oxygen/nitrous oxide (40%/60%) through the duration of procedure. The patient's lungs were ventilated with a tidal volume of 6–8 mL.kg^{-1} of the ideal body weight and Positive End-Expiratory Pressure (PEEP) of 5 cm H_2O, and the respiratory rates were adjusted to maintain an end-tidal CO_2 pressure of 35–40 mmHg. Subsequently, a radial artery cannula was inserted and connected to a FloTrac/Vigileo system (software version 3.02, Edwards Lifesciences, CA, USA) to measure CO, SV, and SVV.

Statistical analysis

All statistical analyses were performed using the Number Cruncher Statistical System (NCSS, 2007; Kaysville, Utah, USA). All demographic data, such as age, sex, body mass index (BMI), and ASA physical status, were analyzed using descriptive statistical methods (mean, standard deviation, frequency, median, minimum, and maximum). Data distribution was evaluated using the Kolmogorov-Smirnov test, Shapiro-Wilk test, and graphical evaluations. If the data were not normally distributed, non-parametric tests were performed. Comparisons between groups were performed using Student's *t*-test for normally distributed data and the Mann-Whitney *U* test for non-parametric data. Fischer's exact test was used for all the categorical data. Post-hoc analyses with the Bonferroni correction were performed for multiple comparisons when repeatedly measured variables exhibited significant differences between the groups. A *p*-value < 0.05 was considered statistically significant.

A sample size of 44 patients achieved a power of 80%, which allowed for the detection of a 20% SV difference through a two-sided *t*-test at a significance level of 0.05, with possible dropouts, by using the Power Analysis Program (G-Power, P.S. version 3.1.2) according to study published in literature.[10]

Results

A total of 62 patients who were scheduled for elective arthroscopic shoulder surgery in the BCP were assessed for eligibility. Eleven patients were excluded from the study: 4 refused to participate in the study, and 7 did not meet the inclusion criteria. One of the 51 patients was excluded from the study because this patient was shifted to open surgery during the intraoperative period, and one of them was excluded because a noradrenaline infusion was required due to deep hypotension after anesthesia induction. Forty-nine patients allotted to two groups, 23 (46.9%) patients in Group C and 26 (53.1%) in Group P, completed the study and were included in the final analysis (Fig. 1).

There were no statistically significant differences in the mean age, sex distribution, BMI measurements, and ASA physical status of the patients between the groups ($p > 0.05$) (Table 1).

The crystalloid amounts administered to the patients ranged from 800 to 3500, with an average of 1967.35 ± 573.87; the administered colloid amounts varied between 0 and 500, with an average of 111.22 ± 204.96. A statistically significant difference was found between the crystalloid and colloid amounts administered to the patients between the groups. The crystalloid amounts administered in the study group were higher than those in the control group ($p = 0.016$; $p < 0.05$); by contrast, the colloid amounts administered in the study group were lower than those in the control group ($p = 0.003$; $p < 0.05$). A statistically significant difference was found between the ephedrine ratios in the patients between the groups ($p = 0.018$; $p < 0.05$); the ephedrine ratios in the study group patients were lower than those in the control group patients. A statistically significant difference was found in the PONV ratios in the patients between the groups ($p = 0.019$; $p < 0.05$); the PONV ratios in the study group were lower than those in the control group. A statistically significant difference was found in the surgical satisfaction levels between the groups ($p = 0.001$; $p < 0.05$), and the satisfaction levels in the study group were higher than those in the control group. There was no statistically significant difference in the operation duration in the patients between the groups ($p = 0.001$; $p > 0.05$) (Table 2).

There was no statistically significant difference in the MAP measurements in the supine position between the groups ($p > 0.05$). A statistically significant difference was found in the 0, 5, and 10-min MAP measurements in the BCP between the groups ($p = 0.035$; $p < 0.05$, $p = 0.001$; $p < 0.05$, $p = 0.027$; $p < 0.05$, respectively). The MAP measurements in the study group were higher than those in the control group. There was no statistically significant difference in the HR measurements in the supine position between the groups ($p > 0.05$) (Table 3).

There was no statistically significant difference in the CO measurements in the supine position between the groups ($p > 0.05$). A statistically significant difference was found in the 5, 10, and 30-min CO measurements in the BCP between the groups ($p = 0.016$; $p < 0.05$, $p = 0.009$; $p < 0.05$, $p = 0.018$; $p < 0.05$, respectively). The CO measurements in the study group were higher than those in the control group. There was no statistically significant difference in the SV measurements in the supine position between the groups ($p > 0.05$). The 0 and 60-min SV measurements in the BCP were not statistically significantly different between the groups ($p > 0.05$). A statistically significant difference was found in the 5 and 30-min SV measurements in the BCP between the groups ($p = 0.010$; $p < 0.05$, $p = 0.022$; $p < 0.05$, respectively). The SV measurements in the study group were higher than those in the control group (Table 4).

Discussion

The BCP facilitates better access to the surgical area and reduces the amount of bleeding during arthroscopic shoulder surgery compared to the lateral position; however, it has negative consequences such as venous blood pooling in the lower extremities, relative hypovolemia, and reduction of MAP, SV, and CO.[11] Therefore, the challenge associated with anesthesia management in patients in the BCP is the

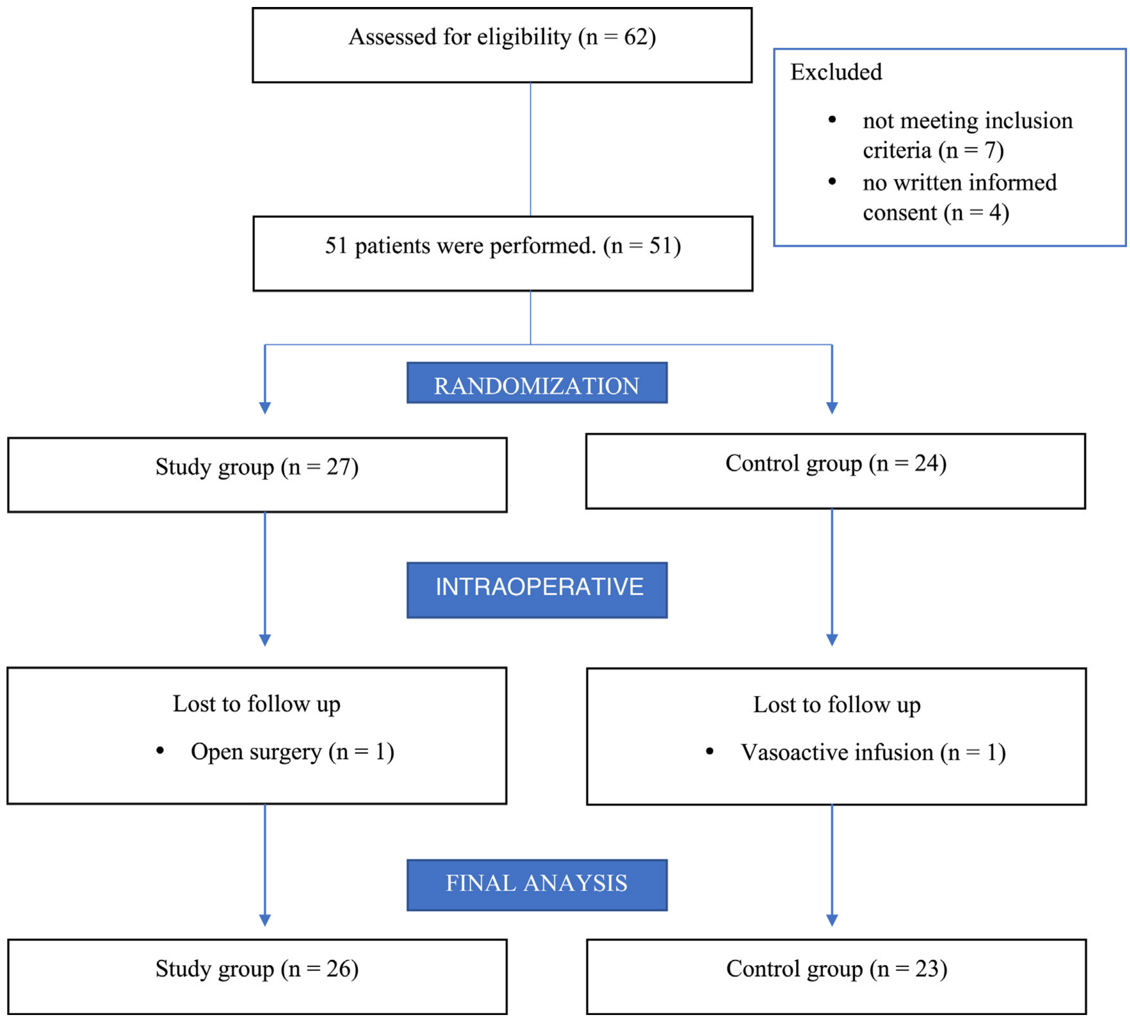

Figure 1 CONSORT flow.

maintenance of tissue perfusion and oxygenation.[12] For these reasons, fluid management is very important during the preoperative period in patients undergoing arthroscopic shoulder surgery in the BCP.

The BCP activates the sympathetic nervous system and baroreceptor reflexes, but the sympathetic response may weaken during anesthesia, leading to a greater reduction in MAP. It has been reported that epinephrine, norepinephrine, and cortisol levels secreted in response to surgical stimuli are lower in cases in which anesthesia is maintained with a propofol and remifentanil infusion than in those in which anesthesia is maintained with sevoflurane.[13] Hypotension (MAP < 50 mmHg) was more commonly observed in 55% of patients who received surgery under anesthesia with a propofol and remifentanil infusion in the BCP.[14] Therefore, anesthesia was maintained using sevoflurane during this study. Antihypertensive drugs, especially ACEIs and ARBs, can contribute to intraoperative hypotension, especially after general anesthesia induction.[15,16] Therefore, patients who were known to use ACEIs and ARBs for preventing deep hypotension were excluded from the study.

Triplet et al. stated that NIBP measurement is not reliable in the BCP, especially when used to predict cerebral perfusion pressure.[17] In their study, Papadonikolakis et al. emphasized that blood pressure can be inaccurately measured up to 50 mmHg depending on the location of the blood pressure cuff.[2] For this reason, the perspective that patients should be monitored more closely in terms of hemodynamics has become widespread over time. However, even if MAP is measured using technically accurate methods, it is recommended for the detection of acute intravascular fluid deficiencies that dynamic preload parameters, such as SVV, CO, cardiac index, SV, and Stroke Volume Index (SVI), be measured.[18,19] It is well known that blood flow depends on MAP and Systemic Vascular Resistance (SVR). The correction of low intraoperative MAP values with vasoconstrictor drugs alone does not guarantee good organ perfusion.[20,21] Buhre et al. showed a 14% volume transition from the intrathoracic area to the extra thoracic area after patients were positioned in the BCP.[22] It was reported that the preservation of normovolemia may be more beneficial than using vasoconstriction to increase MAP alone in order to preserve cerebral perfusion; therefore, increasing intravascular volume in a way that prevents rapid and relative hypovolemia would be effective in protecting patients from possible hypoperfusion.[23] The available information is consistent

Table 1 Patient characteristics.

	Control group (n = 23) n (%)	Study group (n = 26) n (%)	*p*
Age (years)			
Min–Max (Median)	20–77 (53)	24–86 (52)	0.209[a]
Mean ± SD	55.26 ± 14.89	49.92 ± 14.40	
< 45	4 (17.4)	9 (34.6)	
45–59	10 (43.5)	9 (34.6)	
≥ 60	9 (39.1)	8 (30.8)	
Gender			
Female	12 (52.2)	10 (38.5)	0.336[b]
Male	11 (47.8)	16 (61.5)	
BMI (kg.m^{-2})			
Min–Max (Median)	18.5–42.2 (28.4)	18.8–43 (26.4)	0.335[a]
Mean ± SD	29.02 ± 6.41	27.42 ± 5.08	
Normal	6 (26.1)	9 (34.6)	
Overweight	8 (34.8)	12 (46.2)	
Obesity	9 (39.1)	5 (19.2)	
ASA			
I	5 (21.7)	6 (23.1)	0.911[b]
II	18 (78.3)	20 (76.9)	

BMI, Body Mass Index; ASA, American Society of Anaesthesiologists.
[a] Student's *t*-test.
[b] Pearson Chi Square Test.

Table 2 Patients' descriptive statistics.

	Control group (n = 23) n (%)	Study group (n = 26) n (%)	*p*
Crystalloid (mL)			
Min–Max (Median)	800–2600 (1900)	1200–3500 (2000)	0.016[a,d]
Mean ± SD	1760.87 ± 539.14	2150.00 ± 550.09	
Colloid (mL)			
Min–Max (Median)	0–500 (0)	0–500 (0)	0.003[b,e]
Mean ± SD	210.87 ± 246.78	23.08 ± 99.23	
Ephedrine			
No	18 (78.3)	26 (100)	0.018[c,d]
Yes	5 (21.7)	0 (0)	
PONV			
No	16 (69.6)	25 (96.2)	0.019[c,d]
Yes	7 (30.4)	1 (3.8)	
Surgical satisfaction			
Min–Max (Median)	3–10 (8)	7–10 (10)	0.001[c,e]
Mean ± SD	7.74 ± 1.68	9.31 ± 0.93	
Operation duration (min)			
Min–Max (Median)	65–290 (120)	55–210 (92.5)	0.127[c]
Mean ± SD	131.09 ± 61.46	105.77 ± 40.61	

PONV, Postoperative Nausea and Vomiting.
[a] Student's *t*-test.
[b] Mann Whitney U Test.
[c] Fisher's Exact Test.
[d] $p < 0.05$.
[e] $p < 0.01$.

with the SV decreases noted in the results of this study. In the BCP, statistically significant differences were found among the 5, 10, and 30-min SV measurements between the study and control groups ($p < 0.05$), and the SV values were higher in the study group. In our study, although the amount of administered crystalloid was higher in the study group, the need for colloid was found to be lower ($p < 0.05$). Based on this data, it can be concluded that the requirement for

Table 3 Comparison of MAP and HR values.

	MAP values			HR values		
	Control group (n = 23)	Study group (n = 26)	*p*	Control group (n = 23)	Study group (n = 26)	*p*
Supine position						
Min/Max (Median)	66/120 (80)	63/113 (76)	0.497[a]	50/104 (77)	53/103 (81.5)	0.667[a]
Mean ± SD	83.48 ± 14.93	80.54 ± 15.07		75.04 ± 12.84	76.69 ± 13.69	
BCP 0th min						
Min/Max (Median)	50/93 (69)	60/95 (79.5)	0.035[a,e]	48/97 (69)	50/98 (72)	0.186[a]
Mean ± SD	71.22 ± 11.94	77.92 ± 9.72		67.43 ± 11.81	72.15 ± 12.68	
BCP 5th min						
Min/Max (Median)	47/83 (65)	57/94 (75.5)	0.001[a,f]	44/95 (60)	45/95 (66.5)	0.308[a]
Mean ± SD	63.04 ± 10.38	74.81 ± 8.76		62.83 ± 13.08	66.54 ± 12.16	
BCP 10th min						
Min/Max (Median)	55/84 (71)	57/97 (75)	0.027[a],[e]	45/82 (58)	48/79 (60)	0.493[a]
Mean ± SD	71.00 ± 7.87	76.69 ± 9.38		59.96 ± 9.81	61.88 ± 9.68	
BCP 30th min						
Min/Max (Median)	56/89 (76)	52/101 (74)	[a]0.343	50/77 (57)	45/76 (65)	0.194[a]
Mean ± SD	73.52 ± 8.84	76.19 ± 10.47		59.17 ± 7.96	62.58 ± 10.09	
BCP 60th min						
Min/Max (Median)	51/86 (76)	58/99 (71.5)	0.557[a]	50/90 (57)	49/82 (59.5)	0.131[a]
Mean ± SD	73.35 ± 8.46	71.88 ± 8.78		58.65 ± 9.03	62.96 ± 10.58	
p[c]	0.001[f]	0.024[e]		0.002[f]	0.001[f]	
Supine – BCP 0th min						
Min/Max (Median)	-45/10 (-9)	-42/21 (-1)	0.020[b,e]	-29/19 (-9)	-38/20 (-3.5)	0.346[b]
Mean ± SD	-12.26 ± 15.32	-2.62 ± 15.92		-7.61 ± 11.48	-4.54 ± 13.44	
p[d]	0.013[e]	1.000		0.065	1.000	
Supine – BCP 5th min						
Min/Max (Median)	-52/2 (-22)	-35/16 (-2)	0.002[b,f]	-27/15 (-13)	-41/18 (-10.5)	0.428[b]
Mean ± SD	-20.43 ± 15.17	-5.73 ± 14.78		-12.22 ± 10.75	-10.15 ± 13.31	
p[d]	0.001[f]	0.887		0.001[f]	0.010[e]	
Supine – BCP 10th min						
Min/Max (Median)	-48/14 (-10)	-44/22 (-0.5)	0.054[b]	-40/9 (-14)	-37/6 (-12)	0.865[b]
Mean ± SD	-12.48 ± 16.62	-3.85 ± 17.53		-15.09 ± 13.62	-14.81 ± 13.12	
p[d]	0.024[e]	1.000		0.001[f]	0.001[f]	
Supine – BCP 30th min						
Min/Max (Median)	-45/16 (-6)	-44/25 (-6.5)	0.293[b]	-48/12 (-18)	-42/6 (-11.5)	0.595[b]
Mean ± SD	-9.96 ± 17.32	-4.35 ± 16.89		-15.87 ± 14.98	-14.12 ± 12.71	
p[d]	0.173	1.000		0.001[f]	0.001[f]	
Supine – BCP 60th min						
Min/Max (Median)	-50/11 (-7)	-46/23 (-4.5)	0.849[b]	-43/27 (-20)	-40/16 (-12)	0.336[b]
Mean ± SD	-10.13 ± 16.45	-8.65 ± 16.85		-16.39 ± 15.56	-13.73 ± 14.11	
p[d]	0.110	0.222		0.001[f]	0.001[f]	

MAP, Mean Arterial Pressssure; R, Heart Rate; CP, Beach Chair Position.
[a] Student *t* Test.
[b] Mann Whitney U Test.
[c] Repeated Measures Test.
[d] Bonferroni Test.
[e] $p < 0.05$.
[f] $p < 0.01$.

the use of colloid solution as a hypotension recovery maneuver decreases because of the smaller decrease in MAP, CO, and SV when pre-position fluid loading is performed.

Jeong et al. found a serious decrease of up to 60 ± 18 mmHg in MAP 5-minutes after patient positioning despite the administration of standard intravenous fluid treatment and ephedrine.[14] In this study, the lowest MAP of 47 mmHg was recorded during the 5-min measurements after positioning the patients in the BCP in the control group, and it was found that the MAP decrease was smaller in the study group ($p < 0.05$) at the 0th, 5th, and 10th min after positioning.

The number of studies focused on investigating the effects of intraoperative fluid management on postoperative outcomes is increasing day by day. A general decrease in PONV as a result of preloading intravenous solutions has

Table 4 Comparison of CO and SV values.

	CO values			SV values		
	Control group (n = 23)	Study group (n = 26)	p	Control group (n = 23)	Study group (n = 26)	p
Supine position						
Min/Max (Median)	3.4/10.4 (4.2)	2.7/8.1 (4.1)	0.385[a]	38/96 (62)	33/112 (64)	0.972[a]
Mean ± SD	5.14 ± 1.79	4.72 ± 1.59		65.26 ± 15.66	65.08 ± 19.76	
BCP 0th min						
Min/Max (Median)	2.3/6.9 (3.9)	3/7.6 (4.5)	0.109[a]	32/99 (58)	31/113 (69.5)	0.126[a]
Mean ± SD	4.17 ± 1.19	4.77 ± 1.36		61.61 ± 17.31	69.58 ± 18.34	
BCP 5th min						
Min/Max (Median)	1.6/7.4 (3.9)	2.8/7.6 (4.4)	0.016[a,e]	27/103 (60)	40/122 (72.5)	0.010[a,e]
Mean ± SD	3.73 ± 1.34	4.70 ± 1.36		59.74 ± 17.82	73.46 ± 17.86	
BCP 10th min						
Min/Max (Median)	2.2/5.2 (3.8)	2.7/7.1 (4.5)	0.009[a,f]	43/94 (63)	46/116 (77.5)	0.022[a,e]
Mean ± SD	3.78 ± 0.74	4.52 ± 1.15		63.39 ± 12.61	73.88 ± 17.59	
BCP 30th min						
Min/Max (Median)	1.9/5.2 (4)	2.3/6.7 (4.4)	0.018[a,e]	34/91 (64)	44/104 (79.5)	0.036[a,e]
Mean ± SD	3.83 ± 0.71	4.47 ± 1.05		65.96 ± 15.08	75.77 ± 16.56	
BCP 60th min						
Min/Max (Median)	3.2/5.2 (4.3)	2.4/7 (4.2)	0.083[a]	45/91 (74)	27/126 (81)	0.176[a]
Mean ± SD	4.20 ± 0.50	4.70 ± 1.30		71.52 ± 12.96	78.58 ± 21.40	
[c]p	0.001[f]	0.462		0.001[f]	0.001[f]	
Supine – BCP 0th min						
Min/Max (Median)	-3.5/0.2 (-0.8)	-1.2/1.6 (0)	0.001[b,f]	-23/23 (-4)	-15/23 (1.5)	0.001[b,f]
Mean ± SD	-0.97 ± 0.89	0.06 ± 0.70		-3.65 ± 10.93	4.50 ± 9.41	
[d]p	0.001[f]	1.000		1.000	0.333	
Supine – BCP 5th min						
Min/Max (Median)	-3.9/0.5 (-1.1)	-1/1.7 (0)	0.001[b,f]	-35/28 (-6)	-10/29 (9.5)	0.001[b,f]
Mean ± SD	-1.41 ± 1.11	-0.02 ± 0.72		-5.52 ± 14.45	8.38 ± 11.14	
[d]p	0.001[f]	1.000		1.000	0.01[e]	
Supine – BCP 10th min						
Min/Max (Median)	-6.7/1.3 (-0.7)	-3.5/2 (-0.1)	0.014[b,e]	-27/16 (-4)	-20/40 (10.5)	0.031[b,e]
Mean ± SD	-1.36 ± 1.83	-0.20 ± 1.05		-1.87 ± 13.42	8.81 ± 15.08	
[d]p	0.026[e]	1.000		1.000	0.095	
Supine – BCP 30th min						
Min/Max (Median)	-7.5/0.5 (-0.5)	-3.8/1.8 (-0.1)	0.029[b,e]	-33/24 (-1)	-25/44 (12)	0.042[b,e]
Mean ± SD	-1.30 ± 1.87	-0.24 ± 1.18		0.70 ± 15.53	10.69 ± 15.61	
[d]p	0.044[e]	1.000		1.000	0.027[e]	
Supine – BCP 60th min						
Min/Max (Median)	-5.2/0.6 (-0.3)	-4/3 (0)	0.048[b,e]	-26/33 (6)	-32/47 (12)	0.133[c]
Mean ± SD	-0.93 ± 1.48	-0.02 ± 1.18		6.26 ± 15.63	13.50 ± 20.55	
[d]p	0.092	1.000		1.000	0.039[e]	

CO, Cardiac Output; SV, Stroke Volume; BCP, Beach Chair Position.
[a] Student *t* Test.
[b] Mann Whitney *U* Test.
[c] Repeated Measures Test.
[d] Bonferroni Test.
[e] $p < 0.05$.
[f] $p < 0.01$.

been reported by Holte et al. in laparoscopic cholecystectomies and by Magner et al. in gynecological laparoscopic surgeries.[24,25] Ghafourifard et al. demonstrated a lower incidence of PONV in both their study groups that were formed for comparing the effects of administering a preoperative intravenous bolus of 7 mL.kg^{-1} 3% modified gelatin (Haemaccel) and 7 mL.kg^{-1} Ringer's lactate solution, respectively.[26] Similar to the findings in the literature, in our study, PONV was observed less frequently in the study group in which fluid replacement was performed during the preoperative period compared to in the control group, and this difference was statistically significant ($p < 0.05$).

In our study, larger amounts of colloid and ephedrine were administered in the control group, and hypertension-hypotension episodes were more common in this patient group. Arthroscopic image quality is adversely affected by such fluctuations in blood pressure. Therefore, surgical satisfaction was higher in the study group. Although there was a statistically significant difference between the amount of crystalloids used for the patients in the study group and the control group, there was no clinically significant difference. In our opinion, the most important reason for this is the amount of crystalloids used to compensate the clinical situation as a result of SVV elevations and hypotension attacks in the control group.

This study has some limitations. The data and results presented are entirely dependent on the numerical values of the hemodynamic parameters. Tests to evaluate organ functions in order to control the continuity of tissue perfusion were not performed in our patients (preoperative and postoperative creatinine values, preoperative and postoperative cognitive function tests, etc.). Bispectral Index (BIS) monitoring ensures that the patients' anesthesia depths are standardized and that hemodynamic data are not affected by reasons such as superficial anesthesia; however, this parameter was not monitored in this study. Although the lack of BIS monitoring is one of the important limitations of our study, standardization of the anesthetic depth of the patients included in the study was achieved with the end-tidal inhaler anesthetic agent concentration and the same dose of remifentanil infusion. The fact that cerebral Near Infrared Spectrometry (NIRS) monitoring was not used in our study is also our limitation. The use of monitoring methods such as BIS and NIRS and the examination of microhemodynamic variables should be evaluated in future studies.

Conclusion

In conclusion, in this study, the outcomes between patients undergoing arthroscopic shoulder surgery in the BCP who received fluid loading before beach chair positioning and those undergoing the same surgery who were switched to the BCP without fluid loading were compared. In patients undergoing shoulder surgery in the BCP, crystalloid fluid loading before positioning appears to be an effective alternative for protecting patients from hemodynamic instability. However, to confirm our results, this study needs to be repeated in larger patient groups, and further studies are required for investigating the type and efficacy of the fluid to be loaded.

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Conflicts of interest

The authors declare no conflicts of interest.

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