Crystalloid preload versus crystalloid coload during spinal anesthesia for ureterorenoscopy: A randomized controlled trial

Üreterorenoskopi için spinal anestezi sırasında kristalloid preloada karşı kristalloid koload: Randomize kontrollü çalışma

Nurhayat Kılınç   Mustafa Nuri Deniz   Elvan Erhan

Ege University School of Medicine, Department of Anesthesiology and Reanimation, Izmir, Turkey

Abstract

Aim: The optimal strategy of fluid administration during spinal anesthesia is still unclear. In this double-blind randomized study, we assessed the timing of fluid administration for spinal anesthesia in patients undergoing ureterorenoscopy.

Materials and Methods: 60 ASA I-III patients scheduled for anesthesia were randomly allocated to receive either 500 ml crystalloid preload (30 minutes before spinal anesthesia) or 500 ml crystalloid coload (at the start of spinal anesthesia). Ephedrine 5 mg boluses were administered when the systolic blood pressure decreased more than 20% of the baseline value. Atropine 0.5 mg was given to the patients whose heart rate decreased bellow 50 beats/minutes. Hemodynamic variables were recorded during the surgery.

Results: The groups were compared in terms of demographic data and surgical time and there was no difference between them. In Group II, only 1 patient needed ephedrine, while in Group I, no patient was administered ephedrine. No patients in both groups needed atropine for bradycardia. There was no difference between the groups in terms of the need for ephedrine.

Conclusion: Crystalloid preload and crystalloid coload administration do not differ in terms of the need for vasopressor agents in patients undergoing ureterorenoscopy under spinal anesthesia.

Keywords: Spinal anesthesia, preload, coload, crystalloid.

Öz

Amaç: Spinal anestezi sırasında optimal sıvı yönetimi stratejisi hala belirsizdir. Bu çift kör randomize çalışmada, üreterorenoskopi yapılan hastalarda spinal anestezi için sıvı uygulamasının zamanlamasını değerlendirdik.

Gereç ve Yöntem: Anestezi alması planlanan 60 ASA I-III hasta, 500 ml kristalloid preload (spinal anesteziden 30 dakika önce) veya 500 ml kristalloid koload (spinal anestezinin başlangıcında) alacak şekilde rastgele ayrıldı. Sistolik kan basıncı, bazal değerin %20'sinden daha fazla azaldığında, Efedrin 5 mg bolus uygulandı. Kalp atım hızı 50 atım/dakikaya düşen hastalara atropin 0,5 mg verildi. Ameliyat sırasında hemodinamik değişkenler kaydedildi.

Bulgular: Gruplar demografik veriler ve cerrahi süre açısından karşılaştırıldı. Gruplar arasında demografik veriler ve operasyon süreleri açısından herhangi bir fark saptanmadı. Grup II'de sadece bir hastada efedrin gereksinimi olurken Grup I'de hiçbir hastaya efedrin uygulanmadı. Her iki grupta da hiçbir hastada bradikardi için atropine ihtiyaç duyulmadı. Gruplar arasında efedrin ve atropine gereksinimi açısından herhangi bir fark saptanmadı.

Sonuç: Üreterorenoskopi yapılan hastalarda, spinal anestezi öncesi ve spinal anestezi sırasında uygulanan kristalloid infüzyonları, vazopressör ajanlarına ihtiyaç açısından farklılık oluşturmamaktadır.

Anahtar Sözcükler: Spinal anestezi, preload, koload, kristalloid.

Corresponding author: Mustafa Nuri Deniz
Ege University School of Medicine, Department of
Anesthesiology and Reanimation, Izmir, Turkey
E-mail: *mnurideniz@hotmail.com*

Introduction

Hypotension and bradycardia are the most frequent and serious side effects of spinal anesthesia. In extensive studies, the incidence of hypotension is reported to be 33% (8-30%) in non-obstetric findings (1). Sympathectomy, caused by spinal anesthesia, causes systemic vascular resistance (SVR) to drop and the venous capacitance to increase; and secondary relative hypovolemia causes hypotension in turn. In order to preserve the arterial blood pressure, the decrease in SVR should be minimalized and the increase in cardiac output (CO) should be maximized through an optimal fluid/vasopressor regimen. Numerous methods have been analyzed for the prevention and treatment of hemodynamic disturbances. Optimal fluid therapy has been acknowledged to be essential to that end; in addition, the type and volume of fluid and its administration time frame are regarded to be important (1, 2). To this respect, the pre-spinal anesthesia administration of crystalloid and colloid solutions is the most frequently applied method to prevent hypotension (3, 4). Nevertheless, recent studies have shown colloid solution administration during spinal anesthesia to be more successful in preventing hypotension than pre-spinal anesthesia solution administration (preload). However, the majority of these studies were carried out on obstetric findings (2, 5).

The objective of this prospective study was to investigate the effects of crystalloid solution administration on hypotension 30 minutes before and during spinal anesthesia in ureterorenoscopy (URS) under anesthesia.

Materials and Methods

The study was designed to be prospective, randomized, and double-blind. After the necessary permissions were obtained from the Faculty of Medicine Clinical Research Ethics Committee, 60 female and male patients aged 18-65 to receive URS surgery in the urology operating theatre in ASA I-III groups participated in the study voluntarily, whose written consent forms were received. Patients with hematologic disorders and receiving anticoagulant therapy along with those with serious heart failure (New York Heart Association III/IV) and receiving beta-blocker treatment were excluded from the scope of the study.

Vascular access was established with 18G branule before the operation in all the participant patients. Standard monitoring was applied to the patients taken into the operating room before the premedication was administered, following which their basal systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), heart rate (HR), and SpO2 levels were measured and recorded. Among the patients divided into two groups in a randomized method, 500 ml 0.9% NaCl was administered to those in Group I (preload) 30 minutes before spinal anesthesia while 500 ml 0.9% NaCl intravenous infusion was administered to the patients in Group II (coload) immediately before spinal anesthesia. Spinal anesthesia was performed on the patients in both groups in the sitting position with 12.5 mg 0.5% bupivacaine heavy (2.5 ml) through a 25-gauge Quincke needle at the L3-L4 interspace, immediately following which the patients were placed to the supine, and then the lithotomy positions. Then, 2 ml/kg/h 0.9% NaCl infusion was administered to the patients in both groups. The SAP, DAP, MAP, HR, SpO2 and sensory block levels of the patients were measured and recorded in basal values prior to spinal anesthesia (T0), in the sitting position prior to spinal anesthesia (T1), in the supine position after spinal anesthesia (T2), upon being placed to the lithotomy position (T3), in every 5 minutes during each operation afterward, and also at the end of each operation, immediately before being placed from the lithotomy position to the supine position (T4), in initial values after being placed from the lithotomy position to the supine position (T5), and after 15, 30, 45, and 60 minutes following the operation. In addition, their pre-operation and post-operation Hb values were recorded. 5 mg Ephedrine Hydrochloride intravenous (iv) was administered to the patients whose SAP levels expressed a 20% lower value during the operation than their basal levels, and 0.5 mg atropine iv was administered to the patients whose HR levels dropped below 50 beats/min These dosages were re-administered when necessary; also, their administration time intervals, total dosage amounts, and side effects if experienced (such as nausea and vomiting) were recorded.

The researcher anesthesiologist doctor, who monitored the patients, recorded data and carried

out necessary evaluations, worked blinded during the study along with the participating patients. In addition, the solutions were administered by another researcher so as not to enable either the researcher or the patients to see them.

Regarding the statistical assessments, Student's t-test was used to compare parametric data between the groups, and the Mann-Whitney U test was used to compare non-parametric data between the groups. Chi-squared test was used to compare qualitative data. The value $p<0.05$ was acknowledged to be significant.

Results

No statistically significant differences were observed between the groups in terms of their demographic data and surgical duration (Table-1). Both groups had similar sensory block levels. No statistically significant differences were observed between the groups in terms of their vasopressor (VP) necessities (In group II, only 1 patient needed vasopressor), administered solution amounts, pre-operation and post-operation hemoglobin (Hb) values, and intraoperative additional analgesia necessities (Table-2). Also, no patients in both groups needed atropine for bradycardia.

Table-1. Demographic data, surgical durations, and ASA distributions of the groups

	Group I (n=30)	Group II (n=30)	P
Age (years)	47.3 ± 9	46.4 ± 11.5	0.74
Weight (kg)	77 ± 9.6		0.95
		77 ± 13	
Height (cm)	168 ± 7.5	168.4 ± 10	0.88
ASA I/II	18/12	17/13	1
Surgical duration (min)	16 ± 7	16.3 ± 6.5	0.85
Block Levels	8.2 ± 1.3	7.9 ± 1.2	0.42

Mean ± Standard deviation

No statistically significant differences were observed between the groups in terms of their vasopressor (VP) necessities, administered solution amounts, pre-operation and post-operation hemoglobin (Hb) values, and intraoperative additional analgesia necessities (Table-2).

Table-2. The vasopressor necessities, the solution amounts administered pre-operation, and pre-operation and post-operation Hb values of the groups.

|	Group I (n=30)	Group II (n=30)	P
VP Necessity (n)	30/0	29/1	1
Pre-operation Solution (ml)	546 ± 19	566 ± 20.6	0.69
Pre-operation Hb (mg/dl)	13 ± 1.5	13.8 ± 1.6	0.95
Post-operation Hb (mg/dl)	12.5 ± 1.4	13 ± 1.6	0.59

VP: Vasopressor

Among the hemodynamic values obtained from the groups, statistically significant differences were observed only between basal heart rate values of the groups, and between basal HR levels (T_0) and post-operation fifteenth-minute HR levels of each group ($p<0.05$) (Figure-1).

Regarding the comparison of SAP levels, while there was a decrease compared to basal SAP levels, this decrease was observed not to be statistically significant (Figure-2).

After comparing DAP levels, it was determined that there was a statistically significant decrease in DAP levels in the supine position after spinal anesthesia (T_2), immediately after the lithotomy position was administered (T_3), during the last measurement in the post-operation lithotomy position (T_4), after being placed from the lithotomy position to the supine position (T_5), and after the first fifteen minutes during the post-operation period, compared to basal DAP levels (T_0), and this decrease was more significant in Group I than in Group 2 ($p<0.05$) (Figure-3).

Regarding the measured MAP levels; compared to the initial MAP levels, there was a decrease in the levels obtained in the supine position after spinal anesthesia (T_2), after being placed from the lithotomy position to the supine position after the operation (T_5), and a statistically significant difference between these two time periods were observed. Based on the comparison between the groups, the measurements of MAP levels were found to be significantly lower in Group I than in Group II ($p<0.05$) (Figure-4).
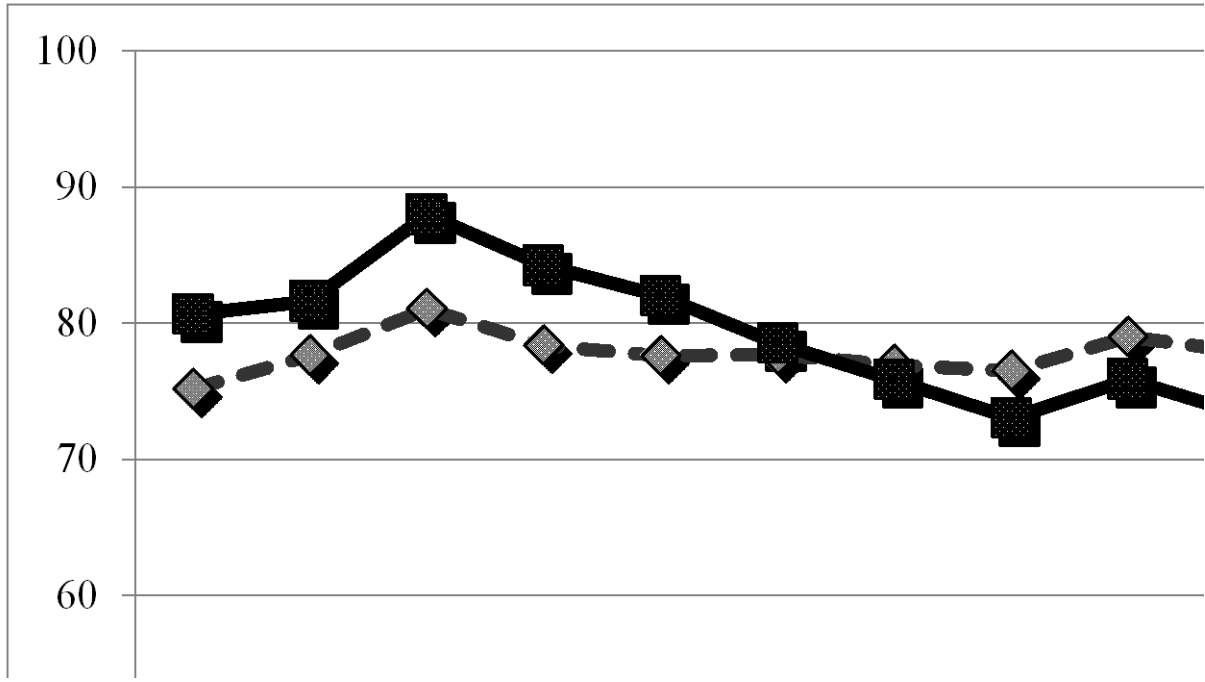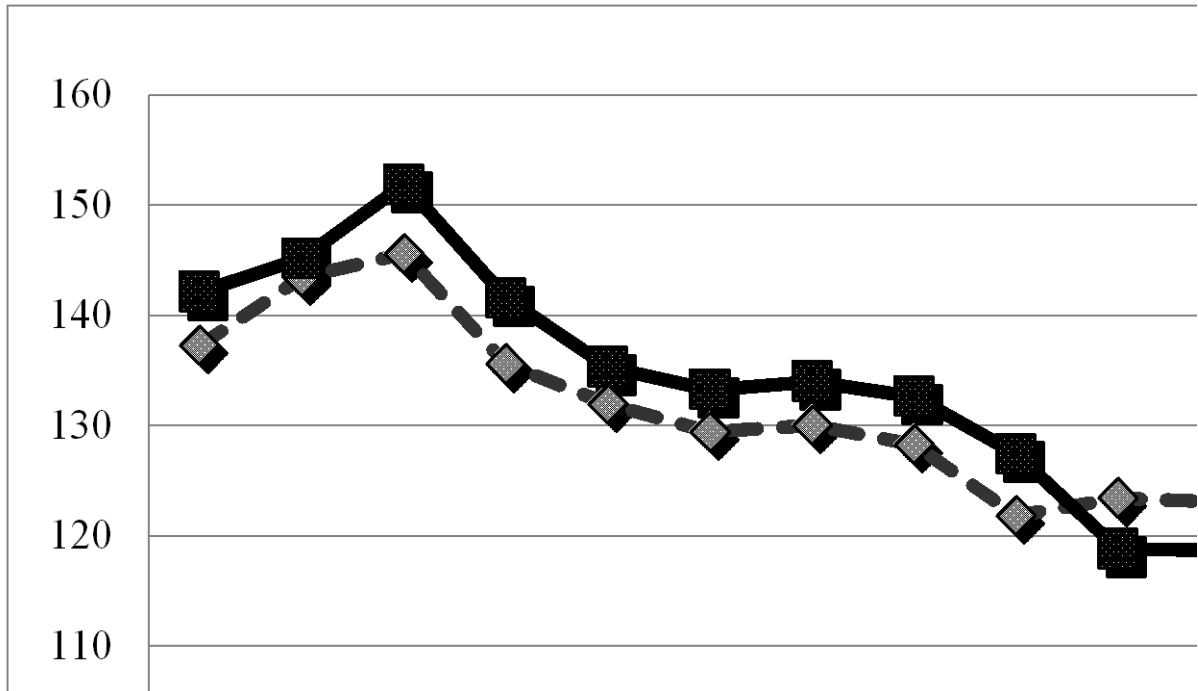
Figure-1. Measured heart rates of each group.

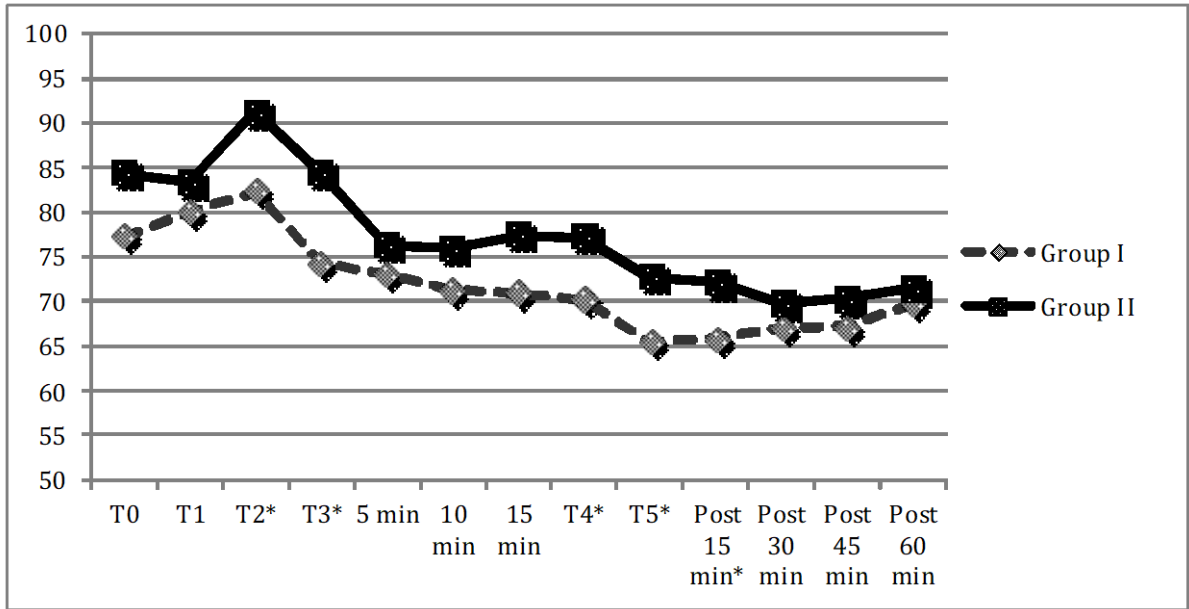**Figure-2.** Measured systolic arterial pressure levels of each group.

Figure-3. Measured diastolic arterial pressure levels of each group (*p<0.05).
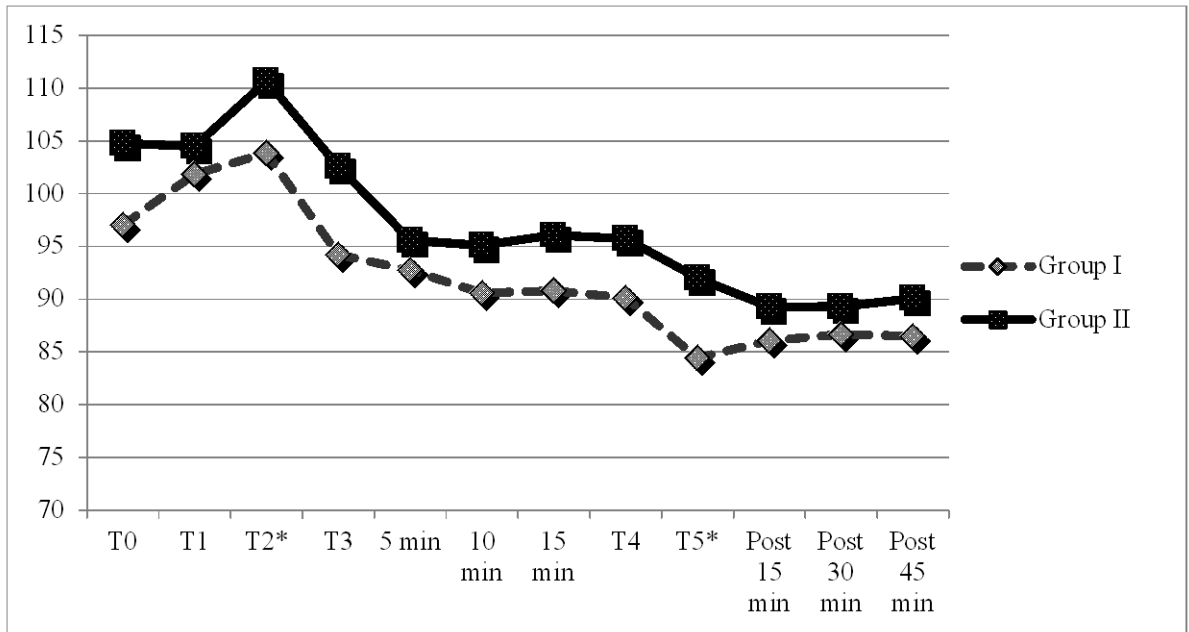
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Figure-4. Measured mean arterial pressure levels of each group (* p<0.05).

Discussion

Apart from its advantages, the most frequent and serious side effects of spinal anesthesia are hypotension and bradycardia (6). The incidence rates of hypotension based on spinal anesthesia are reported differently on the basis of the definition of hypotension preferred in studies and studied patient groups. In the cases of caesarian attempts under spinal anesthesia, the incidence has been reported to be 25% when the blood pressure is below 100 mm/Hg and 21% when it drops below 80% of the initially measured levels (7). Carpenter et al (8) studied 952 patients under

spinal anesthesia with no preloads and determined that these patients developed hypotension by 33%. In a study carried out by Critchley et al (9). Analyzing the results of spinal anesthesia administration in old patients, they reported that these patients developed hypotension by 70%. Numerous studies have been carried out investigating the administrations of phenylephrine and ephedrine to prevent SVR from decreasing, and solutions to provide an increase in cardiac output (6). There are also several studies comparing the administration of crystalloid or colloid solutions before (preload) or during (coload) spinal anesthesia (10-12). The preload administration of crystalloid solutions (10-20 ml/kg) has been utilized for years to prevent hypotension. In a study carried out by Rout et al. (10) on cases undergoing caesarian operations under spinal anesthesia, they administered 20 ml/kg crystalloid solution as preload to the first group, while they did not administer any preloads to the second group. Consequently, they observed that while the preloaded group developed hypotension by 66%, the group without any preloads developed hypotension by 71%. Studies have reported and suggested that administering crystalloids 30 minutes before spinal anesthesia (preload) cannot completely prevent hypotension in elderly patients, which may be related to the fact that 80% of crystalloid fluids lodge in the interstitial space and they have a short duration of volume effect due to their low molecular weight (9). Considering the fast redistribution of crystalloids, fluids are recommended to be efficiently administered during the formation process of sympathetic blockage. In addition, high amounts of crystalloids degrade the capacity of blood to transfer oxygen and may cause pulmonary edema (4). Administering high amounts of such fluids have been reported to dilute plasma proteins, causing decreased colloid oncotic pressure and increased extravasation (11). In a study carried out by Park et al. (11), cases were divided into three groups and preloaded with 10, 20 and 30 ml/kg crystalloids, and no significant differences were observed among the groups in terms of hypotension incidence and ephedrine necessity. In this study, it has been reported that preloading with a higher volume than 10 ml/kg does not provide an advantage. Later studies have suggested that crystalloid administration is more effective in preventing hypotension if it is rapidly infused during the starting process of

intrathecal injection (12). Considering the fast redistribution of crystalloids, fluids are recommended to be efficiently administered when the hypotension risk is at its highest level, i.e. during the first 5-7 minutes of sympathetic blockage formation (1).

In our study in which we compared the administrations of 500 ml crystalloid 30 min before (preload) and during (coload) spinal anesthesia in cases undergoing URS under spinal anesthesia, we observed a significant decrease in both groups' DAP and MAP levels after spinal anesthesia (T_2) and upon being placed from the lithotomy position to the supine position after the operation (T_5) compared to the initial levels (p<0.05). Since DAP and MAP levels of the preloaded first group was lower (p<0.05) compared to the coloaded second group in the aforementioned time frames, coload administration may seem more advantageous for blood pressure levels. However, the absence of a difference between the groups requiring treatment for hypotension suggests that preloading and coloading with crystalloid are actually similar with regard to blood pressure levels. In addition, low levels of spinal anesthesia performed for URS surgery may have reduced the need for vasopressors in these patients.

Based on this study we have carried out on the cases undergoing URS, we are of the opinion that placing the patients to the lithotomy position after spinal anesthesia can be a factor that decreases the incidence of hypotension since the lithotomy position which is used in transurethral surgery is extremely crucial. Keeping the patient in this position can often help maintain the blood pressure by enabling a significant volume of blood and interstitial fluid to flow back to the heart. In the case of replacing the patient to the supine position after the operation has been carried out, a blood accumulation on the lower extremity and a consequent decrease in blood pressure may be observed (13, 14).

As a result, it can be concluded within the scope of the study that the preload and coload crystalloid administrations are similar due to the absence of a difference between the groups in terms of the incidence of hypotension requiring treatment in URS surgery, while the lithotomy position can be a factor that decreases the incidence of hypotension.

Conflict of interest: The authors have not declared any conflict of interest in this study.

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