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The effect of epidural top-up technique with saline in combined spinal-epidural anesthesia: a prospective study*

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Aim: To investigate the influence of saline injection as an epidural top-up on sensory block characteristics in combined spinal-epidural anesthesia.

Materials and methods: A group of 50 patients scheduled for transurethral prostate resection surgery received a subarachnoid 10 mg of 0.5% hyperbaric bupivacaine and were randomly allocated to 1 of 2 groups. Patients in Group S received 10 mL of epidural saline 5 min after spinal block, and those in Group C did not receive anything via epidural catheter. The sensorial block level, motor block degree, and hemodynamic variables were recorded at 5 min intervals. The time to S1 segment regression of sensorial block and complete recovery of motor block were also recorded.

Results: Sensorial block level was significantly higher in Group S than Group C at 15, 20, and 30 min ($P < 0.05$). Time to S1 segment regression, time to complete recovery of motor block, and hemodynamic data were similar between the 2 groups.

Conclusion: Saline injection via epidural catheter as an epidural top-up provided an increase in sensory block level in combined spinal-epidural anesthesia without changing the hemodynamic data or the time to complete recovery from sensorial and motor block.

Key words: Spinal anesthesia, epidural anesthesia, saline solution, hypertonic

Kombine spinal-epidural anestezide salin ile epidural top-up tekniğinin etkisi: prospektif çalışma

Amaç: Bu çalışma epidural salin enjeksiyonunun, kombine spinal-epidural anestezide sensorial blok karakteristikleri üzerine etkisinin araştırılması için planlanmıştır.

Yöntem ve gereç: Transuretral prostat rezeksiyon cerrahisi geçirecek 50 olguya subaraknoid yoldan 10 mg % 0,5 hiperbarik bupivakain uygulanmış ve olgular randomize olarak iki gruba ayrılmıştır. Grup S'deki olgulara spinal bloktan 5 dk sonra 10 mL epidural salin verilmiş, Grup C'ye epidural kateterden herhangi bir uygulama yapılmamıştır. Sensorial blok seviyesi, motor blok derecesi, hemodinamik değişkenler 5 dk.lık aralıklarla kaydedilmiştir. Sensorial bloğun S1 segmentine gerileme zamanı ve motor bloğun tamamen ortadan kalkma zamanı ayrıca kaydedilmiştir.

Bulgular: Sensorial blok seviyesi Grup S'de 15, 20 ve 30 dklarda Grup C'den anlamlı olarak yüksekti ($P < 0,05$). S1 segmentine gerileme, motor bloğun tam geri dönüş zamanları, hemodinamik veriler iki grup arasında benzerdi.

Sonuç: Kombine spinal-epidural anestezide epidural kateter aracılığıyla salin enjeksiyonunun; sensorial ve motor bloğun geri dönüşüm zamanlarını ve hemodinamik verileri değiştirmeden, sensorial blok seviyesinde artışa neden olduğu sonucuna varılmıştır.

Anahtar sözcükler: Spinal anestezi, epidural anestezi, salin

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Introduction

Combined spinal-epidural (CSE) anesthesia has gained increasing interest as it combines the reliability of spinal block and the flexibility of epidural block. The epidural top-up technique can be explained partly by an epidural volume effect and partly by an effect of the local anesthetic itself (1). Carpenter et al. (2) and Higushi et al. (3) demonstrated significant correlations between lumbosacral cerebrospinal fluid (CSF) volume and peak sensory block level using magnetic resonance imaging. The disturbance in CSF flow did not correlate with the extent of the dural sac compression. Many different factors can affect the patterns of solution distribution and dural sac compression: different catheter design, injection speeds or pressures, sex, timing of saline injection, and increased abdominal pressure. Therefore, there has been great variability in the results regarding the extent of epidural saline injection-induced spinal anesthesia in previous studies (4-8).

The primary outcome of this study was to determine the influence of saline as an epidural top-up on the maximum sensory block level in CSE anesthesia. The other goals were to assess the effect of this method on motor block period, time to sensory block recovery, and hemodynamic parameters.

Materials and methods

In the present prospective, randomized, double-blind study, 50 patients, between 45 and 75 years old and with ASA physical status I or II, undergoing elective transurethral resection of the prostate (TUR-P) were enrolled. The study protocol was approved by the local ethics committee of Şişli Etfal Training and Research Hospital, and written informed consent was obtained from all patients. Patients were randomly allocated to 1 of 2 groups using the sealed envelope method: the saline group (Group S, epidural top-up with 10 mL of saline) and the control group (Group C, no epidural top-up). We excluded patients with contraindications to regional anesthesia, history of congestive heart failure and/or ejection fractions below 50% (if available), and a height of less than 145 cm and/or a weight of more than 100 kg.

Upon arrival to the operating room, all patients were prehydrated with 500 mL of lactated Ringer's solution, and standard monitoring was applied, including automated noninvasive blood pressure, electrocardiography, and pulse oximetry. Baseline arterial blood pressure and heart rate (HR) values were recorded. The epidural space was identified at the L_{3-4} interspace with an 18-gauge Tuohy needle, using the loss of resistance to less than 0.5 mL of saline and a median approach in the sitting position. Using the needle-through-needle technique, a long 27-gauge Whitacre needle was introduced into the subarachnoid space. After obtaining a free flow of CSF, 10 mg of 0.5% hyperbaric bupivacaine was administered into the subarachnoid space, and the spinal needle was then withdrawn. A 20-gauge epidural catheter (3 lateral holes) was positioned 3 cm into the epidural space and kept there until the end of the surgery, because of the probability of an extension in surgery time. All patients were then turned to a supine position and received 500 mL of crystalloid solution, including 10 mg of ephedrine, during surgery, as in our daily practice. In group S, patients received 10 mL of saline via epidural catheter 5 min after spinal injection. In group C, patients received no epidural top-up. An observer who was unaware of the patients' assigned groups recorded HR, systolic arterial pressure (SAP), mean arterial pressure (MAP), level of sensory block, and time to S_1 segment regression to loss of pain using the pinprick test at 5 min intervals for the first 20 min, and thereafter every 10 min during the perioperative period.

Surgery was allowed when the sensory block level reached T_{10}. If the level of sensory block failed to reach the T_{10} dermatome after 20 min, a bolus dose of 5 mL of plain bupivacaine (0.5%) would be supplemented epidurally. If the level was then still inadequate, general anesthesia would be offered to the patient. Time to complete recovery from motor block was determined between the time when the modified Bromage scale (0 = able to move hip, knee, and ankle; 1 = unable to move hip, able to move knee and ankle; 2 = unable to move hip or knee, able to move ankle; 3 = unable to move hip, knee, or ankle) reached its maximum point and the time of complete resolution (return of a full range of motion).

A decrease of more than 30% from baseline or to less than 90 mmHg SAP was defined as hypotension and would be treated with IV fluids or an ephedrine

bolus of 5 mg; a HR less than 50 bpm was defined as bradycardia and would be treated with 0.5 mg of intravenous atropine. All other adverse events (nausea, vomiting, etc.) were followed and recorded throughout the study. Fluid and blood losses were replaced according to the prescriptions of our department.

In the recovery room, all patients were monitored by a trained nurse blinded to the type of study protocol administered. The time to S_1 segment regression, using the pinprick test, and complete recovery of motor block, using a modified Bromage score, were evaluated and recorded by an anesthesiologist who was unaware of the study groups.

Simple size calculations showed that at least 20 patients per group were required to detect an increase of at least 2 segments in the maximum level of sensory block with a power of 90% (2-tailed alpha = 0.05). Statistical analyses were performed using SPSS version 10.0 for Windows with an unpaired t-test, Mann-Whitney U-test, and chi-square test, when appropriate. Data are presented as mean ± standard deviation, and $P < 0.05$ was considered statistically significant.

Results

All patients enrolled completed the study successfully. Epidural catheter insertion was uneventful in all patients, and all patients were placed in the supine position within 3 min after subarachnoid injection. None of the patients required general anesthesia or epidural supplementation of local anesthetics due to the failure of anesthesia. There were no differences in the surgical management of the groups.

Table 1. Demographic characteristics and duration of surgery.

	Group S	Group C
Age (years)	67.2 ± 5.3	68.3 ± 5.6
Height (cm)	167 ± 5.2	168 ± 6.2
Weight (kg)	73.5 ± 9.2	76.2 ± 8.3
Duration of surgery (min)	69.5 ± 23.6	68.0 ± 33.0

Data are expressed as mean ± standard deviation.

The demographic data of the patients and the duration of surgery were similar between the groups (Table 1).

The maximum sensory block level was significantly higher in Group S than Group C at 15, 20, and 30 min ($P < 0.05$) (Table 2). The time of S_1 segment regression and complete recovery from motor block were similar between the groups (Table 2).

Hemodynamic data did not differ between the groups (Table 3). The lowest SAP, MAP, and HR levels were similar in group S and group C (Table 3).

There were no side effects or complications noted due to the procedure in the 2 groups.

Table 2. Block characteristics.

	Group S	Group C
Sensory block level		
at 5th min	L_4 ± 1.1	L_4 ± 0.9
at 10th min	T_{11} ± 0.8	T_{12} ± 1
at 15th min	T_{10} ± 1.1	T_{12} ± 0.9*
at 20th min	T_9 ± 0.9	T_{12} ± 1.2*
at 30th min	T_9 ± 1.1	T_{11} ± 0.9*
Time to S_1 segment regression (min)	112.3 ± 9.42	108.3 ± 10.73
Complete recovery of motor block (min)	76 ± 6.85	73.3 ± 7.47

Data are expressed as mean ± standard deviation. *$P < 0.05$ compared to Group S.

Table 3. Hemodynamic parameters.

	SAP (mmHg)		MAP (mmHg)		HR (bpm)	
	Group S	Group C	Group S	Group C	Group S	Group C
Baseline	136.6 ± 15.63	132.3 ± 17.59	103.3 ± 14.59	101.6 ± 13.80	69.3 ± 8.34	69.4 ± 7.36
5 min	138.6 ± 16.20	134.2 ± 18.96	98.7 ± 13.72	97.2 ± 12.71	68.5 ± 8.49	71.2 ± 8.40
10 min	135.1 ± 14.19	131.6 ± 17.56	96.1 ± 17.16	96.7 ± 15.24	70.8 ± 7.21	68.2 ± 6.29
15 min	131.2 ± 19.31	129.8 ± 15.81	93.8 ± 14.60	94.6 ± 16.97	67.4 ± 6.67	69.7 ± 8.14
20 min	127.6 ± 14.33	128.7 ± 16.70	94.4 ± 15.76	95.8 ± 14.57	68.9 ± 7.90	70.1 ± 6.37
25 min	123.4 ± 16.35	125.8 ± 14.85	92.9 ± 13.64	95.3 ± 12.98	70.8 ± 6.75	71.6 ± 7.96
30 min	124.5 ± 18.96	129.3 ± 15.73	93.8 ± 12.28	96.3 ± 14.54	69.1 ± 8.54	70.4 ± 6.47
45 min	127.6 ± 17.60	131.7 ± 14.65	96.2 ± 15.28	98.8 ± 16.70	67.4 ± 7.95	69.4 ± 8.96
60 min	131.5 ± 19.42	133.6 ± 16.29	98.4 ± 14.69	99.6 ± 18.36	67.4 ± 8.34	67.1 ± 6.12
75 min	134.7 ± 17.54	137.8 ± 15.96	101.2 ± 13.58	104.3 ± 14.63	66.8 ± 7.49	68.6 ± 8.16

Data are expressed as mean ± standard deviation. SAP: Systolic arterial pressure, MAP: mean arterial pressure, HR: heart rate, bpm: beats per minute.

Discussion

In our study, the maximum analgesia level increased 2 or 3 segments after the injection of 10 mL of saline through the epidural catheter 5 min after spinal injection. This result is most likely explained by the volume effect, which is similar to the findings of previous studies (3,6). However, the time to S_1 segment regression and complete recovery of motor block were similar in both groups.

Epidural injection of local anesthetics after spinal anesthesia produces a rapid extension of analgesia (9,10). Previously, the mechanism was thought to be the diffusion of local anesthetics from the epidural space to the subarachnoid space. However, Blumgart et al. (4) and Stienstra et al. (6) showed that there was no significant difference between saline and bupivacaine in the extension of the sensory block level when they were injected into the epidural space 5 min after spinal anesthesia. A few authors have demonstrated, using different techniques, the reduction in CSF volume and dural compression after epidural injection (5,11-13). Thus, the mechanism of the extension of spinal anesthesia after epidural injection is now considered to be the volume effect. In our study, epidural injection of 10 mL of saline soon after the administration of intrathecal bupivacaine resulted in an increased cephalad extent of the sensory block, which can be explained as a result of the volume extension effect, similar to other studies.

The use of epidural supplementation may play an important role in allowing intrathecal local anesthetic doses to be reduced while still providing acceptable anesthesia. The deliberate use of a small intrathecal dose has been shown to reduce hypotension and motor block, and to provide good cardiovascular stability (14), which are desirable effects for high-risk cases, such as for patients undergoing TUR-P operations.

The lumbosacral CSF volume is the major determinant of the sensory block spread of spinal anesthesia (2,3). There is great variability in the results regarding the extent of epidural saline injection-induced spinal anesthesia, and there have been many studies about the effects of epidural saline injection on reinforcement of spinal anesthesia in CSE (4-8). These different results seem to be time- and volume-dependent. Doganci et al. (15) and Stienstra et al. (7) also compared different volumes of

saline (5, 10, 15, and 20 mL) with no saline (control) for epidural volume expansion following single-shot spinal anesthesia. The maximum level of spinal anesthesia was significantly lower in the control group compared to the saline treatment groups, but there was no significant difference among the epidural saline groups. In our study, the sensory block level was higher in the saline group compared to the control group, and our results were comparable to the previous studies mentioned above.

Beyond 20 min or after the onset of 2-segment regression, an epidural top-up with saline does not affect sensory block extension (6,7). Trautman et al. (8) concluded that 10 mL of epidural saline, when administered after 2-segment regression, is an ineffective top-up and may decrease the duration of initial spinal anesthesia during CSE anesthesia. In our study, the timing of the epidural saline injection was preferred as 5 min after spinal injection.

It is possible that differences between the sexes would cause different results. Leeda et al. (16) reported that women have a smaller increase in peak sensory block level than men after an epidural loading dose following an epidural top-up with ropivacaine. However, our study did not include female patients.

It is possible that 10 mL of epidural saline would decrease the duration of spinal anesthesia during CSE. The change in CSF flow dynamics is a possible factor in the distribution and clearance of the spinal agent in CSE (8,9). Doganci et al. (15) concluded that epidural saline after single-shot anesthesia had no influence on the motor block period. The results of our study show that 10 mL of epidural saline injection did not change the time to S_1 segment regression and complete recovery from motor block.

In our study, there was no significant difference between the hemodynamic parameters during the operation, including systolic and diastolic blood pressure and heart rate values, in the 2 groups. In a study in which different volumes of saline and no saline were compared for epidural volume expansion, vital signs did not differ between the groups, as in our study (15).

We conclude that epidural injection of 10 mL of saline 5 min after spinal anesthesia resulted in an increase in the sensory block level in CSE anesthesia, without changing the hemodynamic variables or the time to complete recovery of sensory and motor block during TUR-P.

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