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Combined Spinal Epidural Causes Higher Level of Block than Equivalent Single-Shot Spinal Anesthesia in Elective Cesarean Patients

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Combined spinal epidural (CSE) is an established technique for lower segment cesarean delivery. In this study we tested the hypothesis that the spinal block from a CSE technique results in a more extensive spread of local anesthetic in the subarachnoid space than the single-shot spinal (SSS) technique. We recruited 30 ASA physical status I parturients admitted for elective lower segment cesarean delivery into our randomized, controlled, double-blind study. All patients intrathecally received 2 mL of 0.5% hyperbaric bupivacaine. The patients were randomized into one of the two groups using sealed opaque envelopes. Group S ($n = 15$) received a SSS technique. Group CS ($n = 15$) received a CSE technique using loss of resistance to 2 mL of air, but the epidural catheter was not inserted after the intrathecal drug administration. The maximal sensory block achieved in group CS was statistically higher than that in Group S (median C6 interquartile range, C5 to C8 versus median T3, T2 to T4, $P < 0.001$). Time taken to reach maximal sensory block was significantly longer in group CS. There were no differences in the time taken for the block to recede to T10, hemodynamic profile, or side effects. In conclusion, the CSE technique without placing an epidural catheter or administering epidural medication resulted in a significantly higher level of sensory block when compared with the SSS technique when the same dose of local anesthetic was given intrathecally.

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Combined spinal epidural (CSE) anesthesia is an established technique for cesarean section. The spinal component allows a rapid onset of anesthesia. The administration of drugs into the epidural space via the catheter can supplement and potentially prolong the duration of analgesia into the postoperative phase (1). It has allowed anesthesiologists to use a much smaller dose of local anesthetic for spinal block for lower segment cesarean section delivery and decrease side effects such as hypotension and nausea and vomiting (2). The use of the CSE technique has been found to be associated with a higher sensory block than the single-shot spinal (SSS) technique in patients undergoing minor gynecological procedures (3). However, no randomized controlled trials have compared these two techniques in patients undergoing cesarean delivery. In this study, we tested this hypothesis that the spinal block from this CSE technique alone (without further administration of local anesthetic or saline into the epidural space) results in a more extensive spread of local anesthetic in the subarachnoid space than the SSS technique.

Methods

With the approval of the hospital research ethics committee and informed written patient consent, we recruited 30 ASA physical status I parturients who were admitted for elective lower segment cesarean section delivery under regional anesthesia and were not in labor into our randomized, controlled, double-blind study.

Parturients with allergy to the study drugs, contraindications to central neuraxial block, obstetric complications such as preeclampsia, multiple pregnancies, or placenta previa were excluded from our study. We excluded parturients who were extreme of height and weight (body mass index <20 or >35, height <145 cm or >180 cm).

Each parturient was administered IV 500 mL of Ringer's lactate solution for hydration. Electrocardiogram, oxygen saturation, and maternal heart rate (HR) and systolic blood pressure (SBP), measured noninvasively (Dinamap, Critikon, Tampa, FL) with the parturient supine and with left uterine displacement,

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were recorded at regular intervals throughout the period of study.

All procedures were performed by anesthesiologists who were proficient in both spinal and CSE anesthesia and with more than 5 yr of anesthetic experience.

The patients were randomized into one of the two groups using sealed opaque envelopes. All patients were positioned in the right lateral decubitus position for regional anesthesia. As with the standard practice in our hospital, all patients received intrathecal (IT) 2 mL of 0.5% (10 mg) hyperbaric bupivacaine (Marcain, AstraZeneca, Sodertalje, Sweden), which was injected over 15 s with the spinal needle orifice facing cephalad. Group S ($n = 15$) received IT 10 mg hyperbaric bupivacaine via a SSS technique performed at L3–4 intervertebral space with a 27-gauge Whitacre spinal needle. Group CS ($n = 15$) received IT 10 mg hyperbaric bupivacaine via a CSE technique. The CSE was performed with an 18-gauge Tuohy needle inserted into the L3–4 intervertebral space. We used the loss-of-resistance to 2 mL of air to identify the epidural space. The dural puncture was performed by passing a 27-gauge Whitacre spinal needle through the epidural needle (Espocan, B. Braun, Melsungen, Germany). We removed the Tuohy needle immediately after the IT drug administration without inserting an epidural catheter.

After administration of local anesthetic, the parturients were placed supine with a 15° left tilt. An independent investigator blinded as to the anesthetic technique used evaluated the patient's hemodynamic status and block profile at 2.5-min intervals for the first 30 min and every 10 min subsequently. Patient assessments during this period included the following: SBP, maternal HR, dermatomal sensory block level (loss of cold to ice), maximal dermatomal sensory block achieved, time taken to reach maximal sensory block, maximum motor block of lower limb based on the modified Bromage scale (0 = no impairment, 1 = unable to raise extended legs but able to move knees and ankles, 2 = unable to raise extended legs as well as flex knees, able to move feet, 3 = not able to flex ankle, feet, or knees), time taken to reach maximal motor block, and presence of side effects (e.g., hypotension, nausea, vomiting, and shivering).

Surgery was allowed to proceed after a sensory height block of T4 was achieved. After surgery, all patients were monitored in the postanesthetic care unit. Hemodynamic and sensory monitoring was continued at regular 10-min intervals by nurses unaware of patient group allocation. We also recorded the time taken for the block to recede to the T10 level. The subsequent postoperative management of the patient was left to the discretion of the primary obstetrician.

Throughout the study period, hypotension after regional block (defined as >20% decrease in SBP from baseline) was promptly treated with fluid bolus of Hartman's solution and IV ephedrine 5-mg boluses. Patients with accidental dural puncture during insertion of the Tuohy needle were excluded from the study and seen daily by the acute pain service team as per hospital protocol.

A sensory block level ≤T8 15 min after IT drug administration or patient complaint of pain intraoperatively was classified as an "inadequate block" and supplemental analgesia was given by the anesthesiologist.

A power analysis assuming a 2-segment difference with a power of 0.8 and $\alpha < 0.05$ indicated a sample size of 15 patients. This was based on a previous study comparing SSS with CSE in gynecological patients (3). Results were analyzed with SPSS v. 11.5 (SPSS, Chicago, IL). We used Student's *t*-test to analyze parametric data (demographic data, hemodynamic profile, duration of surgery, time to maximal sensory block level and time for block regression) and Mann-Whitney *U*-test to compare the nonparametric data (maximal sensory block level) between the two groups. χ^2 test was used to compare the incidence of complications (hypotension, nausea, vomiting, and shivering).

Table 1. Preblock Data

	Group S ($n = 15$)	Group CS ($n = 15$)
Age (yr)	33 ± 6	31 ± 5
Weight (kg)	69 ± 10	73 ± 9
Height (cm)	153 ± 5	156 ± 5
Body mass index (kg/m²)	29 ± 4	30 ± 4
Duration of surgery (min)	47 ± 15	42 ± 12
Baseline SBP (mm Hg)	134 ± 22	127 ± 15
Baseline heart rate (bpm)	92 ± 11	94 ± 21

Values are mean ± SD. No significant differences were detected.
Group S = spinal block provided via a single-shot spinal technique; Group CS = spinal block provided via a combined spinal epidural technique; SBP = systolic blood pressure.

Results

Both groups had similar demographic and baseline hemodynamic profiles. The duration of surgery was also similar in both groups. (Table 1).

There were no failed blocks or inadequate blocks. All patients achieved a sensory level ≥T4 and no patient needed supplemental analgesia intraoperatively.

The maximal sensory blocks achieved in group CS were statistically higher than in Group S (median C6 interquartile range [IQR] C5 to C8 versus median T3 [IQR] T2 to T4; $P < 0.001$) (Figure 1). Time taken to reach maximal sensory block was significantly longer in group CS than in group S; however, the time taken to for the block to recede to T10 was similar (Table 2).

Although there was a trend towards a larger decrease in SBP, maternal HR, and use of ephedrine in group CS than in group S, this did not reach statistical significance. Similarly, the incidence of side effects

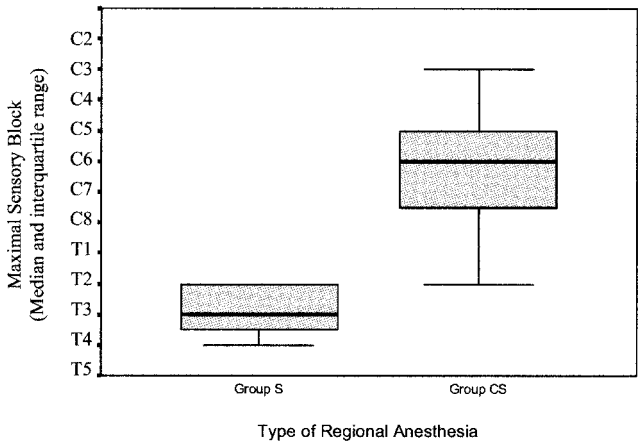

Figure 1. Maximal sensory block to cold. Group S = spinal block provided via a single-shot spinal technique; Group CS = spinal block provided via a combined spinal epidural technique.

(nausea, vomiting, and hypotension) was more frequent in group CS than in group S, but statistical significance was not achieved, as our study was not sufficiently powered to detect this (Table 2).

Discussion

Our results confirmed that the CSE technique performed without placing an epidural catheter or administering epidural medication resulted in a significantly higher level of sensory block when compared with SSS technique when the same dose of IT local anesthetic was given.

Epidural injection of either saline or local anesthetic can enhance spinal anesthesia (4,5), but in this study, the sensory block was extended significantly without either solution added to the epidural space. In a SSS anesthetic, the negative pressure of the epidural space is preserved, whereas in CSE, the negative pressure in the epidural space is counterbalanced by the open connection to atmospheric pressure through the epidural needle, possibly resulting in a reduction of the dural sac volume and consequently a higher level of sensory block after a spinal dose of local anesthetic (6).

In a previous study, we showed that when using the CSE technique (with or without introducing the epidural catheter into the epidural space) there was a two-segment increase in the sensory block height among patients undergoing minor gynecological procedures (3). This result concurred with our current study, demonstrating that in both nongravid and gravid patients, the maximal sensory block achieved was significantly higher in the groups that received a CSE.

There was a five segmental block difference in the gravid group versus a two-segmental block difference in the nongravid group. The reason for this discrepancy is not known. In the obstetric population, the gravid uterus can result in venous compression, epidural venous plexus engorgement and subsequent reduction of cerebrospinal fluid volume. Parturients have reduced dose requirements for central neuraxial block because of the distended epidural veins. Popitz-Bergez et al. (7) also demonstrated that in the gravid state, there is an increased in sensitivity to local anesthetics with subsequent decrease in requirement of local anesthetic to obtain equality of functional block. They compared the susceptibility of nerve blocks between gravid and nongravid rats and found that the block of peripheral neural function was prolonged in pregnant rats and that lidocaine content in the nerve was smaller at a specific stage of neural block.

Time taken to reach maximal sensory block height in the group that received CSE was also significantly increased (Table 2). We postulated that the longer time needed to achieve maximal sensory block was a result of the increase of block by 5 segments. Our previous study among the nongravid population may not have detected this difference, as the difference in segmental level was only two and the sample size may have been underpowered to detect a significant difference.

Although a higher sensory block was achieved in Group CS when compared with group S, the time taken for the block to recede to T10 was similar. This concurred with the findings of Kooger Infante et al. (8), who found that duration of spinal blockade was longer in patients with restricted spread when a similar mass of IT bupivacaine was given. The termination of local anesthetic activity in a subarachnoid block depends on the redistribution of local anesthetic by dural diffusion into the vascular epidural space as well as blood vessels within the subarachnoid space. A less extensive diffusion of local anesthetic into these spaces may be found when there is a restricted spread of local anesthetic within the subarachnoid space (9).

Finally, our study was conducted in the Asian population and extrapolation of the results to other populations must be done cautiously. Our study demonstrated a median sensory block level of C6 when the CSE technique was used, which was not reported in previous studies (10,11). This could be attributed to the difference in the position of the patient during the institution of the regional anesthesia, which may have affected the block height (11). A differential sensory block level is achieved during spinal anesthesia, and different methods used to assess level of sensory blockade could also have resulted in a difference in sensory level achieved in our study when compared with other studies (12).

In conclusion, the administering of IT local anesthetic via the CSE technique results in a higher sensory block than a SSS technique. A smaller dose is therefore required to achieve a similar level of block when the

Table 2. Characteristics of Block

	Group S (n = 15)	Group CS (n = 15)	P value
Maximal sensory block reached	T3 (T2–T4)	C6 (C5–C8)	0.001*
Time to maximal sensory block (min)	4.6 ± 2.8	7.5 ± 4.5	0.049*
Time for block to recede to T10 (min)	109 ± 18	111 ± 26	0.846
Time to maximal motor block (min)	4.8 ± 2.4	4.0 ± 1.8	0.296
Max decrease in systolic blood pressure (mm Hg)	39 ± 23	49 ± 22	0.251
Max decrease in heart rate (bpm)	22 ± 11	26 ± 18	0.481
Ephedrine (mg/patient)	9 ± 10	16 ± 13	0.107
Hypotension	9 (60)	13 (87)	0.107
Nausea	3 (20)	6 (40)	0.427
Vomiting	0 (0)	3 (20)	0.224
Shivering	4 (27)	2 (13)	0.651

Values are medial (interquartile range) or mean + SD or n (%).
Group S = spinal block provided via a single-shot spinal technique; Group CS = spinal block provided via a combined spinal epidural technique.

CSE technique is used. It is also appropriate, as the CSE technique allows rescue analgesia to be reliably administered via the epidural catheter if the spinal anesthesia is inadequate (13).

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