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ORIGINAL ARTICLE

Continuous Anesthesia: Spinal Versus Epidural for Lower Limb Surgeries

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ABSTRACT

Background: The use of continuous spinal anesthesia (CSA) has been slow because the high risk of post dural puncture headache (PDPH). However, recent research suggests significant reduction in PDPH when intrathecal catheters are used. This study aimed to compare between (CSA) & continuous epidural anesthesia (CEA) in lower limb surgeries.

Patients & Methods: A comparative randomized prospective clinical study to compare onset, effect & side effects between (CSA) & (CEA) in LL surgeries. 46 patients, 21 - 60 years of age who were scheduled for elective LL surgeries, expected to last from 2 - 6 hours, were included in this study & divided into two groups of 23 each. Group S (CSA) & Group E (CEA). All patients were assessed for: hemodynamics, technical implementation period, sensory & motor onset, quality of the block, technical problems , post operative visual analogue scale (VAS) & any complications.

Results: Regarding sensory & motor onset time & technical implementation period all were shorter in group S than group E. There was no significant difference as regard hemodynamics, duration of sensory recession & number of top up doses in both groups. There were no neurological sequelae nor (PDPH) in any patient in both groups.

Conclusion: (CSA) using a 20 G catheter is an easy technique, better onset & quality, ↓ risk of systemic toxicity & no ↑ risk of (PDPH) when compared to (CEA).

Keywords: Continuous, Anesthesia, Spinal, Epidural.

INTRODUCTION

The widespread use of continuous spinal anesthesia (CSA) has been slow because the high risk of post dural puncture headache (PDPH). However, recent researches suggest significant reduction in PDPH when intrathecal catheters are used[(1)].

Spinal anesthesia is a widely used anesthetic technique for lower limb surgery, but risk of severe and prolonged hypotension is associated with spinal anesthesia due to the rapid extension of the sympathetic block, hindering cardiovascular adaptation and causing significant morbidity and mortality[(2)].

Continuous epidural anesthesia (CEA) is generally accepted as a routine method of regional anesthesia for surgery of the lower limb. Also, continuous epidural infusion and programmed intermittent epidural boluses are analgesic techniques routinely used for pain relief in anesthesia[(3)].

Continuous spinal anesthesia is an underutilized technique in modern anesthesia practice [(4)]. However (CSA) has been reported to be more rapid in action, when compared to (CEA) and single shot spinal anesthesia (SSSA)[(5)].

Continuous spinal anesthesia is also an alternative to epidural anesthesia in morbidly obese patients, patients with complex cardiac disease, and patients with prior spinal surgery[(1)].

AIM OF THE WORK

The aim of this study is to compare the onset, effect & side effects of CSA versus CEA in lower limb surgeries.

PATIENTS & METHODS

After taking approval from Institutional Review Board (IRB) Zagazig University and obtaining informed consent from each patient, this comparative randomized prospective clinical study was conducted in 6 months starting from june 2018.

The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Fourty six patients, 21 - 60 years of age, from both sexes, American Society of Anesthesiologists (ASA) I & II, Body mass index (BMI) < 35 kg/m^2.

who were scheduled for elective lower-extremity surgeries, expected to exceed two hours but less than six hours in duration, were included in this study. All the patients received regional anesthesia during the surgeries either in the form of continuous spinal anesthesia (CSA) or continuous epidural anesthesia (CEA).

Preoperative evaluation included a detailed history, physical examination and investigations. The later included estimation of hemoglobin level, platelets count, serum creatinine as well as liver function tests, prothrombin time (INR; International Normalized Ratio), partial thromboplastin time, electrocardiogram (ECG) and chest X-ray. Further investigations were requested when the patients' condition necessitated as echocardiography or pulmonary function tests.

Patients who were excluded from the study were those with infection in the proposed needle insertion site, neuropathy, and lumbar spine deformity as well as those who were expected to be uncooperative during needle insertion. Also excluded from the study were those with anemia (hemoglobin level < 10 g/dL), thrombocytopenia (platelets count < 100 000 platelet/µL), and coagulation defects as evidenced by (high prothrombin time, high partial thromboplastin time (PTT >40 second) or (INR >1.5) & those with history of allergy to the used drugs.

Each patient included in the study has been assigned randomly by a computer-generated randomization table into two equal groups (each containing 23 patients) continuous spinal anesthesia (group S) & continuous epidural anesthesia (group E).

On arrival to the operating room, monitoring of ECG, non-invasive blood pressure (NIBP) and oxygen saturation (SaO_2) were started using Datex-Ohmeda monitor.

In all the patients, Perifix 401 Filter Sets (B.Braun, Melsungen, Germany) were used. They were composed of: Tuohy epidural needle 1.3 x80 mm (18 gauge), epidural catheter with 3 lateral openings 0.85 x 0.45 x 1000 mm (20 gauge), loss of Resistance syringe; 10 ml, Perifix flat filter 0.2 µm and Perifix screw connector.

For intrathecal injection hyperbaric bupivacaine 0.5% was used and for epidural injection isobaric bupivacaine 0.5% was used.

For local infiltration of the skin, subcutaneous tissue and epidural injections, lignocaine 2% (lidocaine HCL 2%, Egypharma , Egypt), were used.

Fentanyl was used in both intrathecal & epidural injections.

In both groups, preanesthetic hydration with 500 ml of Ringer's solution was infused over 20-30 minutes, sedation with (2-3 mg midazolam) and O_2 supplementation at a rate of 3 L/min. The patient was then placed in the sitting position and sterilization of the back was done with povidone iodine solution (7.5%). Local infiltration of the skin and subcutaneous tissue was then done using 3ml lignocaine 2% then an 18-gauge Tuohy needle were inserted in the midline at L_3- L_4 or L_4- L_5 intervertebral space.

Group S (CSA group) included 23 patients; the needle was advanced until obtaining free flow of cerebro-spinal fluid a 20G epidural catheter was threaded cephalad into the subarachinoid space up to a distance of 3 cm & catheter was fixed. The patients were then returned to the supine position and 2 ml of (hyperbaric bupivacaine 0.5 % + 20 mic fentanyl) were injected into the catheter. Subsequent addition of 0.5 ml (bupivacaine 0.5% + 5 mic fentanyl) if the sensory blockade did not reach T_{10} within 20 min, additional doses of 0.5 ml of the same mixture were injected intrathecally every 5 minutes until the level of T_{10} or a maximum of 4 ml of the mixture was

achieved. If the sensory blockade did not reach T_{10}, anesthetic failure was considered, and the patients were excluded from the study. A dose of 0.5 ml of the same mixture was injected intrathecally with the regression of the sensory level by 2 segments. After termination of the surgery, the catheter was removed 24 h post operative and its integrity was checked.

Group E (CEA group) included 23 patients, the needle was advanced until the epidural space was identified by the loss of resistance technique, and then a 20-gauge catheter was inserted 4-6 cm cephalad into the epidural space then Touhy needle was removed & catheter was fixed. The patient was then returned to the supine position and a test dose of 3 mL of 2% lignocaine with adrenaline (1: 200,000) was then injected into the catheter to ensure correct position of the catheter (not intrathecal nor intravascular). Three minutes later, 10 ml of (Lidocaine 2% + isobaric bupivacaine 0.5% 1:1 mixture + 50 mic fentanyl) were injected into the catheter. If the sensory blockade did not reach T_{10} within 20 min of the administration of the initial dose (10 ml of the mixture) , additional doses of 5 ml of the same mixture (Lidocaine 2% + isobaric bupivacaine 0.5% 1:1 mixture + 50 mic fentanyl) were injected epidurally every 10 minutes until the level of T_{10} or a maximum of 25 ml was achieved. If the sensory blockade did not reach T_{10}, anesthetic failure was considered and the patients were excluded from the study. A dose of 5 ml of the same mixture was injected epidurally with the regression of the sensory level by 2 segments. After termination of the surgery, the catheter was removed 24 h post operative and its integrity was checked.

The following variables and events were recorded:

The patient characteristics including the age, sex, BMI, ASA physical status. Also the type & duration of the surgeries were recorded.

Anesthetic data including the used intervertebral space, the performance time -technical implementation period- (the time from skin infiltration until placing the patient in the supine position), the onset time (the time from intrathecal or epidural injection to first signs of the sensory blockade at T_{10}), the upper level of sensory blockade assessed by pinprick (every five minutes after the administration of the local anesthetics for 30 minutes), the quality of motor blockade assessed by a modified Bromage scale (every five minutes after the administration of the local anesthetics for 30 minutes): 1 = complete motor blockade, 2 = almost complete motor blockade; the patient is able only to move the feet, 3 = partial motor blockade; the patient is able to move the knees, 4 = detectable weakness of hip flexion; the patient is able to raise the leg but is unable to keep it raised, 5 = no detectable weakness of hip flexion; the patient is able to keep the leg raised for 10 seconds at least [6]. The recorded anesthetic data also included the duration of sensory recession (the time from the initial intrathecal or epidural injection until the first reinjection), the number of the top up doses & total dose of local anesthetics.

Technical problems such as difficulties in needle or catheter insertion, paresthesias during catheter advancement & blood on aspiration were documented.

The hemodynamic variables including the heart rate and arterial blood pressure (systolic , diastolic & mean) as well as respiratory rate and arterial oxygen saturation. They were recorded before induction of anesthesia (baseline readings) and every 10 minutes after the administration of the local anesthetic for 30 minutes and then every 30 minutes during the operation.

Intraoperative complications as hypotension, bradycardia, nausea, vomiting and others. Hypotension was defined as a decrease in mean arterial pressure 30% from baseline and was treated by intravenous (IV) injection of 3 mg of ephedrine which was repeated until hypotension was corrected. In case of bradycardia (heart rate < 50 bpm), IV atropine (0.5 mg) was administered.

Both drugs were given only if one of these absolute limits was reached and maintained for 30 seconds. The doses of both drugs were recorded.

Postoperative complications as nausea, vomiting, dizziness, headache (postdural puncture headache), pain (backache) and other adverse neurological sequelae (bladder, bowel, sensory and/or motor dysfunction).

Post operative visual analogue scale (VAS) was recorded every 30 min for the 1st 2 hours , then every 2 hours for the rest of the day.

The patients were visited on the 1st& 3rd postoperative days to manage and record any anesthetic complications, if happened.

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(**Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage , quantitative continues group represent by mean ± SD , the following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X^2) . Differences between quantitative independent groups by t test or Mann Whitney. P value was set at <0.05 for significant results &<0.001 for high significant result.

Data were collected and submitted to statistical analysis.

RESULTS

The technical implementation period (which is the duration of the procedure from the start of the skin infiltration until placing the patient in the supine position) is significantly shorter in the CSA group (3.43 ± 0.94 min) if compared to the CEA group (12.21 ± 2.46 min) (table 1).

The sensory onset time (the time from intrathecal or epidural injection to first signs of sensory blockade at T10) was significantly shorter in the CSA group (4.21 ± 0.9 min) compared to the CEA group (15.04 ± 2.14 min) (table 1).

The total dose of bupivacaine was significantly smaller in the CSA group than in the CEA group (16.08±2.8 mg versus 61.6±9.93mg) (table 1).

The duration of sensory recession (the time from the initial intrathecal or epidural injection until the 1st reinjection) was longer in the CSA group, but this was not statistically significant (CSA 109.47±6.17 min versus CEA 109.26±3.75 min) (table 1).

Motor blockade during the 1st 30 minutes was significantly greater in patients who had CSA compared with those who had CEA (100% in the CSA group had their bromage scale between I & I I in comparison to 80% in the CEA group) (table 1).

There was no significant difference as regard duration of surgeries & number of top up doses in the two groups (table 1).

No statistically significant differences were found between the two groups with respect to baseline heart rate, SPO_2, RR, diastolic blood pressure (DBP), systolic blood pressure (SBP) and mean arterial pressure (MAP) values.

CEA showed a significantly higher VAS at 2 &4 hours post operatively (figure 1).

Four patients in both groups had non-specific backache after the operation. The backaches occurred in the lumbosacral area and lasted 3 days. All the patients described the backaches as mild. The backaches required only local heat (table 2).

Difficulty in threading of the catheter was more in the CEA group than in the CSA group but this was not statistically significant (table 2).

There was no significant effect of the anesthetic technique on the number of patients treated for hypotension (table 2).

The incidence of parathesia during catheter insertion did not differ between the two groups (table 2).

There were no neurological sequelae (motor, sensory or autonomic dysfunction) nor post dural puncture headache (PDPH) in any of the patients during the first postoperative week.

Table (1): Procedure characters distribution between studied groups

			CEA group 23 patients	CSA group 23 patients	t/ X^2	P
Duration of surgeries			3.32±0.57	3.26±0.6	0.376	0.709
Tech. imp. Period			12.21±2.46	3.43±0.94	15.942	0.00**
Sensory onset time (min)			15.04±2.14	4.21±0.9	22.336	0.00**
Duration of sensory recession (min)			109.26±3.75	109.47±6.17	-0.144	0.886
Bupivacaine dose (mg)			61.6±9.93	16.08±2.8	21.211	0.00**
Fentanyl dose (ug)			122.82±19.81	32.17±5.6	21.189	0.00**
Degree of Bromage scale	I	N	14	16	4.46	0.107
		%	60.9%	69.6%		
	II	N	5	7		
		%	21.7%	30.4%		
	III	N	4	0		
		%	17.4%	0.0%		
Number of top up doses	I	N	0	6	6.97	0.073
		%	0.0%	26.1%		
	II	N	8	6		
		%	34.8%	26.1%		
	III	N	9	6		
		%	39.1%	26.1%		
	IV	N	6	5		
		%	26.1%	21.7%		
Used Space	L3-L4	N	9	8	0.093	0.76
		%	39.1%	34.8%		
	L4-L5	N	14	15		
		%	60.9%	65.2%		
Total		N	23	23		
		%	100.0%	100.0%		

Data were expressed as Mean ± standard deviation or number and percentage.
CEA = continuous epidural anesthesia. CSA= continuous spinal anesthesia
Tech. imp. Period= technical implementation period n= number
T: independent sample t test
P>0.05 is non-significant X^2 : chi square test

Table (2): Technical problems, intra and postoperative Complications and treating drugs in both groups

			Group		Total	X^2	Ps
			CEA 23	CSA 23			
Tech Problems	None	N	12	12	24	3.36	0.33
		%	52.2%	52.2%	52.2%		
	Blood on aspiration	N	2	0	2		
		%	8.7%	0.0%	4.3%		
	Difficult insertion of the catheter	N	6	5	11		
		%	26.1%	21.7%	23.9%		
	Parathesia	N	4	5	9		
		%	17.4%	21.7%	19.5%		
Intra op. complications	Hypotension	N	5	4	9	0.13	0.71
		%	21.7%	17.4%	19.5%		
	None	N	18	19	37		

			Group		Total	X^2	Ps
			CEA 23	CSA 23			
		%	78.3%	82.6%	80.4%		
Post op complications	Mild backache	N	4	4	8	0.00	1.00
		%	17.4%	17.4%	17.4%		
	None	N	19	19	38		
		%	82.6%	82.6%	82.6%		
Intra op drug	Ephedrine 25 mg	N	5	4	8	0.13	0.71
		%	21.7%	17.4%	17.4%		
	None	N	18	19	38		
		%	78.3%	82.6%	82.6%		
Total		N	23	23	46		
		%	100.0%	100.0%	100.0%		

Data were expressed as number and percentage. N= number
T: independent sample t test
P>0.05 is non-significant
X^2 : chi square test

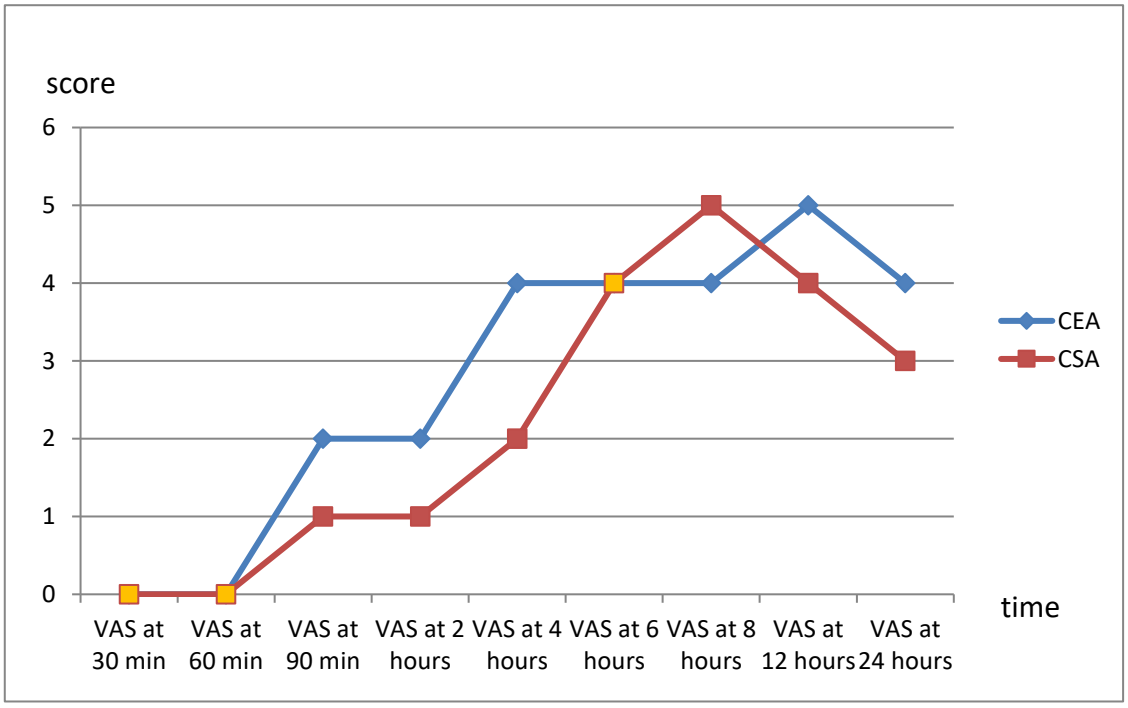

Figure 1: Postoperative VAS score in both groups

(VAS) visual analouge score
(CEA) continuous epidural anesthesia
(CSA) continuous spinal anesthesia

DISCUSSION

Neuraxial anesthesia is an ideal anesthetic technique for lower extremity surgery in elderly patients who often have concomitant medical diseases and reduced physiologic adaptation capacities. Regional anesthesia offers some advantages over general anesthesia. Optimally managed regional anesthesia-analgesia has a number of potential benefits, such as reduced blood loss during surgery, decreased incidence of thromboembolism, improved cardiovascular stability and postoperative pulmonary functions, less impairment of immune functions, and improved immediate postoperative pain relief [6].

In continuous spinal anesthesia (CSA), anesthesia is produced and maintained by small doses of local anesthetics that are injected intermittently into the subarachnoid space via an indwelling catheter. The practice of CSA has remained controversial mainly because of neurological complications associated with it. During the late 1980s, microcatheters (catheters smaller than 24 gauge) were developed to make the CSA technique suitable for use in young patients without incurring an unacceptable risk of post-dural puncture headache (PDPH). However, not only was it difficult to show a decreased frequency of PDPH, but serious neurological complications were reported after the use of spinal microcatheters and high concentrations of hyperbaric local anesthetics. Therefore, in 1992 the Food and Drug Administration (FDA) of the United States of America banned the use of spinal catheters thinner than 24-gauge. This reinforced the misconception that CSA was a dangerous technique [7].

Continuous epidural anesthesia (CEA) in contrast to spinal anesthesia is technically more difficult, less reliable and requires higher pharmacologic doses of local anesthetics, making systemic toxicity a concern. On the other hand, epidural anesthesia offers some advantages; chief among them is the lower risk of PDPH, which makes it suitable for both young and elderly patients [8].

The study was conducted on 46 patients to evaluate CSA Vs CEA during elective lower-extremity surgeries that were expected to last between two to six hours in duration.

In both groups, sets composed of Tuohy epidural needle (18 gauge), and epidural catheter (20 gauge) were used. Although pencil-point needles can be used, most of the cases of CSA nowadays are performed with needles with curved tip (e.g., Tuohy or Hustead needles) to facilitate catheter insertion [7]. Macrocatheters were used to avoid the complications associated with microcatheters in this preliminary experience with CSA.

In group S (CSA group), the Tuohy needle was advanced until cerebrospinal fluid (CSF) was observed, then it was rotated so that the bevel was directed cephalad, and the catheter was inserted. Thus, the catheter was inserted cephalad into the subarachnoid space. This was done because a caudally positioned catheter causes poor dilution of the local anesthetic that remains in the caudal part of the dural sac for long enough to cause toxic lesions to the nerve roots [9]. In addition, to prevent pooling of the anesthetic drugs and maldistributions in the present study, it was decided to choose catheters with lateral openings; those used in this study had 3 lateral openings.

In the present study, long-acting hyperbaric bupivacaine 0.5% was used (in CSA group) since (hyperbaric lidocaine) have been reported to cause transient radicular irritation in patients undergoing spinal anesthesia and cauda equina syndrome after microcatheter CSA [10]. In addition, hyperbaric bupivacaine was used because it produces a suitable and a more controllable anesthesia with moderate hemodynamic changes while isobaric bupivacaine (although demonstrating only moderate hemodynamic changes) has a too great incidence of failure. On the other hand, hypobaric bupivacaine produces unnecessary high cephalad spread with major hemodynamic consequences [11].

In the present study, most of the cases of CSA and CEA were done via the L4-L5 intervertebral space. In CSA, the L2-3, L3-4, L4-5 and L5-S1 interspaces can be used. The L3-4 interspace is preferred because CSA via the L5-S1 and L4-5 interspaces is technically more difficult (especially via the L5-S1 interspace) due to the orientation of the L5 and L4 spinous processes [12]. On the other hand, CSA via the L2-3 can lead to traumatic injury to the spinal cord or roots,

either during puncture or catheter insertion because determination of the level of lumbar puncture is often falsely judged by one interspace in the cephalad direction [15].

The present study showed that identification of the subarachnoid space in CSA was significantly easier than identification of the epidural space in CEA. This is because placement of the Tuohy needle in the subarachnoid space is easily verified by the escape of CSF. This finding is consistent with the finding of "Kestin and colleagues" [16]. The easier identification of the subarachnoid space in CSA may be helpful in elderly patients where the intervertebral spaces are narrowed, and dorsal kyphosis is often present.

Difficulty in threading of the catheter was more in the CEA group (26.1%) than in the CSA group (21.7%) but this is not statistically significant. This low incidence of difficulty in threading of the catheter into the subarachnoid space is much lower than that reported in the study by "Van Gessel and colleagues" [13] where it was about 30%. This may be attributed to the modification of the threading technique in this study once difficulty is encountered. This modified technique was based on the report by "Mollmann and colleagues" [17]. When resistance to threading occurred, withdrawal of the needle by 1-2 mm within the subarachnoid space was done, then re-advancement of the catheter was tried. This was repeated several times if it was necessary. The explanation resides in the fact that the greater pressure applied when performing lumbar puncture with a blunt Tuohy needle provokes tenting of the dura mater before perforation, thus causing the needle to be pushed too far to lie close to the opposite side of the spinal canal.

In the present study, anesthetic failure was documented in two patients in the CEA group who were excluded from the study and received general anesthesia. One patient was excluded because CEA did not achieve the desired level of anesthesia after the initial epidural injection and the additional doses of 5 mL (till the maximum of 25 mL) while in the other patient, no blockade was achieved in the twenty minutes after the first injection. On the other hand, the failure rate in the CSA group was 0%. "Sutter and colleagues" [14], in a retrospective series of 457 patients who had CSA, reported a significantly lower failure rate (1.7%) than the 9% in 274 similar patients who received epidural anesthesia."Van Gessel and colleagues" [13] showed that while the failure rate of CSA for their residents was 8%, it was 0% for their attending staff.

There is still a debate about whether inserting a catheter into the subarachnoid space after dural puncture can significantly decrease the incidence of headache or not. While "Norris and Leighton" [18] concluded that continuous spinal anesthesia after unintentional dural puncture does not decrease the incidence of headache in parturients, "Ayad and and his colleagues" [19] demonstrated that subarachnoid catheter placement after wet tap with removal catheter at the conclusion of delivery reduces the incidence of PDPH, and when the catheter is left in place for 24 hours after delivery the incidence of PDPH significantly decreases.

CONCLUSION

In conclusion, the present study have demonstrated that continuous spinal anesthesia (CSA) using a 20 gauge catheter and hyperbaric bupivacaine 0.5% was easier and had a faster onset when compared to continuous epidural anesthesia (CEA) during lower-extremity surgeries.

The total dose of bupivacaine was significantly smaller in the CSA group than in the CEA group which decreased the risk of systemic toxicity. While the maximum sensory blockade level was not significantly different in the two groups, the degree of motor blockade was significantly greater in patients who had CSA compared with those who had CEA.

Despite the use of a relatively large diameter needle, there was no post-dural puncture headache. Thus, CSA is an appropriate technique for operations in patients undergoing lower-extremity surgeries.

RECOMMENDATIONS

Further studies are needed to show the effect of both techniques on patients suffering from severe uncontrolled medical disease.

Further studies are neede to compare these techniques with addition of general anesthesia.

Limitations

Epidural set was defecient for some time

Conflict of interest : Nil.

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