Comparison of Intraoperative and Postoperative Effects of Lateral Epidural and Midline Epidural Anaesthesia in Patients Undergoing Unilateral Lower Extremity Operation

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Objective: We aimed to compare lateral and midline epidural anaesthesia using a levobupivacaine–fentanyl combination in patients undergoing unilateral lower extremity operation for anaesthetic effects and postoperative complications.

Methods: The study included 40 American Society of Anesthesiologists (ASA) I-II group patients. At the L4-5 space, an epidural catheter was placed in patients in Group 1 by directing the tip of the needle at a 45-degree angle to the operation side and in Group 2 with the needle tip in the cephalad direction. Patients in both groups were administered a combination of 10 mL 0.5% levobupivacaine and 50 µg fentanyl via the epidural catheter. Sensorial and motor block levels during the perioperative and postoperative periods and postoperative complications were recorded.

Results: The maximum level of sensory block on the operated side was found to be at the T10 (T8-T10) level in both groups, while the level of sensory block on the non-operated side was at the L2 (L3-T10) level in Group 1, and at the T10 (T8-T10) level in Group 2 (p=0.000). The motor block was more intense on the non-operated side in Group 2 than in Group 1. The postoperative motor block ended earlier in Group 1. The incidence of complication development was similar between the groups.

Conclusion: With a shorter lasting and lower level sensorial and motor block, lateral epidural anaesthesia may be a more advantageous method than midline epidural anaesthesia.

Keywords: Epidural anaesthesia, levobupivacaine, distribution

Introduction

The administration of regional anaesthesia is becoming more common these days. Regional anaesthesia has some advantages over general anaesthesia. These include the patient being conscious during operation, the continuity of spontaneous respiration, protection of airway reflexes and provision of analgesia during the post-operative period. Providing analgesia during the post-operative period accelerates the mobilization of patients and protects them against the possible risk of thromboembolism (1, 2). Epidural anaesthesia is an anaesthetic technique that is also frequently used in lower extremity surgery, and it increases patient's perioperative comfort compared with general anaesthesia.

Unilateral spinal anaesthesia, which is administered using a small dose of hypobaric or hyperbaric anaesthetic agents in the lateral decubitus position, is a preferable regional anaesthesia method (3). Unilateral spinal anaesthesia restricts the distribution of spinal block in the area that will be operated; therefore, it decreases the cardiovascular side effects of spinal block and problems caused by post-operative bilateral paralysis (4-6).

Unilateral epidural anaesthesia was previously reported to provide inadequate blockade or to cause complications (7, 8). This was thought to be associated with anatomical barriers or catheter position (7-10). The placement of lateral epidural catheters was then investigated as an option for anaesthesia in some studies (11-13). These studies revealed that unilateral epidural anaesthesia could have some advantages over classical epidural anaesthesia such as the use of less local anaesthetic agents and

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decreased incidence of complications. A combination with ropivacaine and sufentanil was used in these studies (11).

In this study, we aimed to compare lateral and midline epidural anaesthesia administration, in which levobupivacaine-fentanyl was used for patients undergoing unilateral lower extremity surgery, with regard to anaesthetic effects and post-operative complications.

Methods

This study was conducted in the Department of Anaesthesiology and Reanimation in the Medical School of Süleyman Demirel University. Approval was received from the Advisory Committee of Scientific Research Projects of the faculty, and written informed consents were obtained from all patients. Forty American Society of Anaesthesiologists (ASA) I–II group patients who were scheduled to undergo unilateral major lower extremity surgery were included in the study. Patients who rejected epidural anaesthesia, who took anticoagulant treatment and who had coagulation defects, infection in the injection site, advanced decompensated hypovolemia or shock status, spinal cord and acute brain disorder, increased intracranial pressure and a history of sensitivity to local anaesthetics were excluded from the study. Premedication was not administered to the patients. All patients were first taken to the recovery room. Then, an 18-gauge intravenous catheter was inserted in the dorsum of one hand, and prehydration was performed with 500 mL of balanced electrolyte solution. After that, fluid treatment was continued with a dose of 2 mL kg⁻¹ h⁻¹ balanced electrolyte solution. Electrocardiogram, non-invasive arterial pressure, and peripheral oxygen saturation of the patients who were transferred to the operating room were monitored.

The patients were divided into two groups on the basis of their choice of one of the two closed envelopes. The patients in Group 1 (n=20) were administered lateral epidural anaesthesia, and those in Group 2 (n=20) were administered midline epidural anaesthesia. For Group 1 patients in the sitting position, the puncture site was covered with a sterile dressing following disinfection. For local anaesthesia, 2 mL of 2% lidocaine was administered from the L4–L5 space into the skin and below the skin. The epidural region was reached from the L4–L5 space through the loss of resistance technique using a disposable kit with an 18-gauge Tuohy needle. The tip of the needle was inserted at a 45° angle to the direction of intervention. A 20-gauge epidural catheter was inserted through the needle for 3–4 cm into the epidural region. Oxygen at a rate of 2–3 litres per min was given to the patients through a facial mask. In total, 3 mL of 2% lidocaine was given in 15 s as a test dose, and then, there was a 3-min wait. After being sure that there was no sensory or motor loss, epidural anaesthesia application was initiated.

In the patients in Group 2, unlike those in Group 1, an epidural catheter was inserted for 3–4 cm into the epidural region at the cephalic direction. Epidural anaesthesia was administered with 11 mL of solution consisting of 10 mL of 0.5% levobupivacaine (chirocaine flacon 0.5%*, Abbott, USA) and 50 µg fentanyl (fentanyl citrate*, Abbott, USA) for both groups. The tingling and electric shock sensation that occurred in the lower limb while advancing the catheter was considered to be paraesthesia. Paraesthesia that developed in the intervention or other sides was recorded. Sensory and motor block levels in the intervention and other sides were recorded at the 1st, 5th, 10th, 15th, and 20th minutes after the application of epidural anaesthesia. The sensory block level was controlled with the pinprick test. On the other hand, the motor block level was evaluated using the Bromage score. Moreover, maximum sensory and motor block levels and the time of reaching the maximum sensory and motor block levels were recorded for both sides. We aimed to keep the sensory block level between T8 and T10 at the intervention side. In case of the level below T10, we planned to add 5 mL of solution including 10 mL 0.5 % levobupivacaine and 50 µg fentanyl. After the formation of sensory block in the surgery site, intervention was allowed. A two-segment regression time of sensory block was recorded for both sides.

The time from the administration of anaesthesia to the beginning of surgery was recorded as the time to prepare for surgery. The type of surgery and its duration were also recorded.

At the post-operative 2nd, 6th, and 12th hours, the sensory and motor block levels and complications (nausea, vomiting, itching, headache, hypotension, bradycardia and urinary retention) were recorded for both the operated and the other sides. Bladder dysfunction requiring the insertion of a urinary catheter was considered to be urinary retention.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences for Windows 15.0 (SPSS; IBM, Chicago, IL, USA) software. The data were expressed as mean±standard deviation, numbers or percentage. Chi-square test was used for evaluating categorical data. Moreover, the Mann–Whitney U test was employed in the intergroup comparison of continuous variables. P<0.05 was considered to be statistically significant.

Results

A total of 40 patients were included in the study. No difference was observed between the two groups with regard to gender, age, height, weight, ASA class distributions, preparation time for operation and duration of operation (p>0.05) (Table 1).

Table 1. Demographic features, ASA class, time to prepare for surgery and duration of surgery

	Group 1	Group 2	p value
Gender (M/F)	8/12	14/6	0.329
Age (years) (Mean±SD)	64.3±13.3	63.2±13.2	0.839
Height (cm) (Mean±SD)	164.1±9.2	169±9.5	0.329
Weight (kg) (Mean±SD)	74.8±8.9	77.8±12.1	0.978
ASA (I/II)	5/15	6/14	0.45
Time to prepare for surgery (min) (Mean±SD)	16.5±4	18.3±2.4	0.176
Duration of surgery (min) (Mean±SD)	120.2±14.8	115.3±21.8	0.408
M: male; F: female; SD: standard deviation; ASA: American Society of Anaesthesiologists			

Table 2. Distributions of patients according to the types of surgery

Type of surgery (Number-%)	Group 1	Group 2	p value
Total hip prosthesis	7-35	10-50	0.578
Total knee prosthesis	8-40	7-35	
Others	5-25	3-15	

Table 3. Maximum sensory block level in the operated side

	Maximum sensory block level			p value
	T10 (Number-%)	T9 (Number-%)	T8 (Number-%)	
Group 1	18-90		2-10	0.195
Group 2	15-75	3-15	2-10	

The distribution of patients according to the types of surgery was similar in both groups (Table 2).

The rate for the development of paraesthesia in the operated side was higher in Group 1 (65%) than in Group 2 (25%) ($p=0.011$), whereas there was no difference between the groups in terms of the rate of paraesthesia development in the non-operated side (0% in Group 1, 15% in Group 2; $p=0.072$). The total rates of paraesthesia developing in both sides were not different between the groups (65% in Group 1, 40% in Group 2, $p=0.560$).

The maximum sensory block level reached in the operated side was between T₈ and T₁₀ in both groups. In terms of the maximum sensory block level distribution, no difference was found between the two groups (Table 3).

The maximum sensory block level reached in the non-operated side varied between T₁₀ and L₃ in Group 1 and between T₈ and T₁₀ in Group 2. The maximum sensory block was at lower levels in Group 1 than in Group 2 ($p<0.001$) (Table 4).

Figure 1. Comparison of the groups with regard to post-anaesthesia, per-operative and post-operative sensory levels in the operated side
* $p<0.05$

Figure 2. Comparison of the groups with regard to post-anaesthesia, per-operative and postoperative sensory levels in the non-operated side
* $p<0.05$

The time for reaching maximum sensory blockade after anaesthesia was similar in both groups in the operated side (16.8 ± 3.7 min in Group 1; 18.5 ± 2.4 min in Group 2), but it was shorter in Group 1 (15.8 ± 5.4 min) than in Group 2 (19 ± 2.1 min) in the non-operated side ($p=0.043$).

In the operated side, the sensory block levels were similar in both groups at all post-anaesthesia and per-operative measurement times and at the post-operative 2nd and 12th hours. At the post-operative 6th hour, the sensory block was not observed in the operated side of any patient, while it continued in 20% of the patients in Group 2 (Figure 1).

It was detected that the sensory block levels were lower in Group 1 than in Group 2 in the non-operated side from the 15th minute after anaesthesia, at all per-operative measurement times and at the post-operative 2nd hour. At the post-operative 6th hour, the sensory block was not observed in the non-operated side in any patient in Group 1, but it continued in 20% of the patients in Group 2. The sensory block ended in all patients in Group 2 at the post-operative 12th hour (Figure 2).

While the two-segment regression time of the sensory block did not display any difference in the operated side between both groups, it was shorter in Group 1 than in Group 2 in the non-operated side ($p<0.001$) (Table 5).

Table 4. Maximum sensory block level in the non-operated side

	Maksimum duyu bloğu seviyesi							p value
	L ₃ (Number-%)	L ₂ (Number-%)	L ₁ (Number-%)	T ₁₂ (Number-%)	T ₁₀ (Number-%)	T ₈ (Number-%)	T ₉ (Number-%)	
Group 1	4-20	7-35	4-20	2-10	3-15	-	-	<0.001
Group 2	-	-	-	-	15-75	3-15	2-10	

Table 5. Comparison of the two groups with regard to the two-segment regression time of sensory block in the operated and non-operated sides

Two-segment regression time (min)	Group 1 (Mean±SD)	Group 2 (Mean±SD)	p value
Operated	142±24	153±20.3	0.109
Non-operated	101.8±10.2	143±25.3	<0.001
SD: standard deviation			

In the operated side, the post-anaesthesia maximum motor block level was similar in the two groups (Table 6).

After anaesthesia, a complete motor block developed in the non-operated side in five patients from Group 2, while no complete motor block was observed in any patient in Group 1. The maximum motor block level was more severe in Group 2 than in Group 1 ($p=0.029$) (Table 6).

The time of reaching the maximum motor block level after anaesthesia in the operated (18.4±2.4 min in Group 1, 18.2±3.7 min in Group 2) and other sides (16.9±2.5 min in Group 1, 17.3±2.6 min in Group 2) was similar in both groups.

The post-operative motor block levels in the operated side were similar in both groups (Table 7).

At the post-operative 2nd hour, no motor block was observed in the non-operated side in 70% of the patients in Group 1, while the motor block was not seen in 40% of the patients in Group 2. At the post-operative 2nd and 6th hours, the motor block levels were lower in Group 1 than in Group 2 ($p=0.013$ and $p=0.004$) (Table 7).

There was no difference between the two groups with regard to the development of complications (Table 8).

Discussion

Unilateral spinal anaesthesia has been a preferred technique in unilateral lower extremity operations because it decreases the rate of cardiovascular side effects and disorders associated with paralysis to the minimal level by restricting the spinal block to the level of the surgical site. Following the insertion of an epidural catheter, the development of unilateral sensory and/or motor blocks or unilateral analgesia was reported as an undesired effect (8, 14-16). Fukushima et al. (17) associated

unilateral epidural block with connective tissue barriers, but Hogan et al. (18) found that block is associated with catheter position rather than anatomic positions on computed tomography. In this study, it was revealed that the tips of most catheters were with anterior and lateral localizations in patients with unilateral epidural block (18).

Although it is thought that epidural block is not affected by gravity and patient position (11), some authors report that patient position and gravity can have an influence in unilateral blocks (7, 8, 19, 20). The distribution of drugs restricted to the operated side can provide many advantages, especially in orthopaedic patients who undergo unilateral surgery. Restricting the epidural block to the surgical site will come with a lot of benefits like in unilateral spinal anaesthesia (11). It has been reported that this can be possible by directing the catheter to the operated side (11, 12, 17, 20). Dauri et al. (20) operated patients who were administered lateral anaesthesia in the lateral decubitus position and midline anaesthesia in the sitting position. In the group that was to undergo lateral anaesthesia, researchers entered into the epidural space with a Tuohy needle tip at an angle of 10° to the surgical direction, and they then inserted the catheter by turning the needle for an angle of 45° towards the surgical site (20). In our study, as described in the studies of Bucheit et al. (12) and Borghi et al. (11), the catheter was placed by turning the Tuohy needle for an angle of 45° towards the surgical site after entering the epidural space. In both groups, the intervention was performed in the sitting position. In some studies, the position of the epidural catheter was controlled through computed tomography (10). However, it is difficult to apply this method. Because epidural catheters used in our study were not radiopaque, it was impossible to monitor with X-rays.

Dauri et al. (20) used the paraesthesia effect of lateral catheter placement as an indicator. However, it was reported that paraesthesia that developed while inserting the epidural catheter increased the risk for neuronal trauma (21). In our study, the development of paraesthesia was not used as an indicator, and it was found that paraesthesia occurred in the direction of catheter in 65 of the patients who were administered lateral anaesthesia. On the other hand, paraesthesia developed in the operated side in 25% and in the other side in 15% of the patients catheterized from the midline. The insertion of the catheter laterally did not significantly increase the risk of the development of paraesthesia in statistical manner.

Table 6. Post-anaesthesia maximum motor block levels in the operated and non-operated sides

Operated	Maximum motor block level				p value
	0 (No block) (Number-%)	1 (Number-%)	2 (Number-%)	3 (Complete block) (Number-%)	
Group 1	4-20	4-20	6-30	6-30	0.745
Group 2	6-30	2-10	7-35	5-25	
Non-operated					
Group 1	7-35	8-40	5-25	-	0.029*
Group 2	6-30	2-10	7-35	5-25	

Table 7. Post-operative motor block levels in the operated and non-operated sides

Operated	Bromage Skalas				p value
	0 (No block) (Number-%)	1 (Number-%)	2 (Number-%)	3 (Complete block) (Number-%)	
Group 1 (2 nd hour)	12-60	2-10	6-30	-	0.339
Group 2 (2 nd hour)	8-40	5-25	7-35		
Group 1 (6 th hour)	17-85	3-15	-	-	0.144
Group 2 (6 th hour)	13-65	7-35			
Group 1 (12 th hour)	20-100	-	-	-	1.000
Group 2 (12 th hour)	20-100	-	-	-	
Non-operated					
Group 1 (2 nd hour)	14-70	6-30	-	-	0.013
Group 2 (2 nd hour)	8-40	5-25	7-35	-	
Group 1 (6 th hour)	20-100	-	-	-	0.004
Group 2 (6 th hour)	13-65	7-35	-	-	
Group 1 (12 th hour)	20-100	-	-	-	1.000
Group 2 (12 th hour)	20-100	-	-	-	

Table 8. Comparison of the groups with regard to the frequency of the development of post-operative complications

Types of complication		Group 1 (Number-%)	Group 2 (Number-%)	p value
Nausea	Yes	10-50	11-55	0.752
	No	10-50	9-45	
Vomiting	Yes	6-30	5-25	0.723
	No	14-70	15-75	
Itching	Yes	5-25	6-30	0.723
	No	15-75	14-70	
Headache	Yes	6-30	9-45	0.327
	No	14-70	11-55	
Hypotension	Yes	2-10	4-20	0.376
	No	18-90	16-80	
Bradycardia	Yes	0-0	0-0	1.000
	No	20-100	20-100	
Urinary Retention	Yes	3-15	8-40	0.077
	No	17-85	12-60	

The maximum sensory block level reached in the operated side was between T_8 and T_{10} in both groups. In the other side, the maximum sensory block level remained at the L_2 (T_{10} - L_3) level in the patients who were administered lateral anaesthesia, while it reached the level of T_{10} (T_8 - T_{10}) in the patients who were administered midline anaesthesia. Borghi et al. (11) found similar findings in their study and reported that in the operated side, the sensory block level was at the T_9 (T_6 - T_{10}) level in the lateral anaesthesia group and at the T_{10} (T_7 - T_{10}) level in the midline anaesthesia group. In the non-operated side, the sensory block level remained at the level of L_3 (T_{12} - L_5) in the lateral anaesthesia group but reached the level of T_{10} (T_9 - T_{12}) in the midline anaesthesia group. Dauri et al. (20) evaluated cold sensitivity and loss of touch sensation in their study on anterior cruciate ligament reconstruction surgeries. They stated that the rate of the development of cold sensitivity and loss of touch sensation in the non-operated side was lower in the lateral anaesthesia group.

In our study, no statistically significant difference was detected in terms of the time for reaching the maximum sensory

blockade in the operated side between the groups. On the other hand, in the non-operated side, the time for the reaching maximum sensory blockade was found to be shorter in the lateral anaesthesia group.

Moreover, there was no difference between the groups with regard to the time to prepare for surgery. Borghi et al. (11) also found no difference between lateral and midline anaesthesia administration in terms of the time to prepare for surgery.

At the post-operative 6th hour, while the sensory blockade disappeared in both the operated and non-operated sides in all patients who were administered lateral anaesthesia, it continued in both sides in 20% of the patients who were administered midline anaesthesia. Dauri et al. (20) detected a lower number of cases with post-operative cold sensitivity and loss of touch sensation in the non-operated side in the lateral anaesthesia group than that in the midline anaesthesia group. In our study, because the sensory block level in the non-operated side was lower in patients who were administered lateral epidural anaesthesia, the sensory block ended earlier in the post-operative period. Because post-operative numbness is a problem that disturbs patients, the administration of lateral anaesthesia provides an advantage from this aspect.

In our study, the two-segment regression time of sensory block in the non-operated side was shorter in the lateral anaesthesia group than that in the midline anaesthesia group. Degikli et al. (22) revealed that two-segment regression time in the non-operated side was shorter in the lateral anaesthesia group. The results of our study are consistent with those of the studies conducted by Borghi et al. (11).

Borghi et al. (11) detected that the time for reaching the maximum motor blockade in the operated side was shorter in the lateral anaesthesia group and that the motor block level in the non-operated side was lower in the lateral anaesthesia group than that in the midline anaesthesia group. In our study, no statistically significant difference was detected between the two groups in terms of the time for reaching the maximum motor block. In the evaluation of the maximum motor block level, it was observed that a more severe motor block developed in the non-operated side in the midline anaesthesia group. At the post-operative 2nd hour, no motor block was found in the non-operated side in 70% of the patients who were administered lateral epidural anaesthesia and in only 40% of the patients who were administered midline epidural anaesthesia. At the post-operative 6th hour, while motor block was not observed in any patient from the lateral anaesthesia group, it was observed in only 65% of the patients from the midline anaesthesia group. These findings are consistent with the studies by Borghi et al. (11) and Dauri et al. (20). A lower motor block level in lateral anaesthesia improves the comfort of patients. On the other hand, earlier discontinuity of motor block provides an opportunity for early mobilization.

Borghi et al. (11) found that urinary retention requiring bladder catheterization developed in 45% of 24 patients who were administered lateral epidural anaesthesia and in 75% of 24 patients who were administered midline anaesthesia. Dauri et al. (20) reported the need for bladder catheterization in 5 of 40 patients who were administered lateral anaesthesia and in 19 of 35 patients who were administered midline anaesthesia. A lower rate of urinary retention in the lateral epidural anaesthesia group was attributed to the nerves of the bladder being less affected because of the unilateral distribution of the drug and lower dose of the drug that was used. In our study, bladder catheterization was needed in 3 (15%) of the 20 patients who were administered lateral anaesthesia and 8 (40%) of 20 patients who were administered midline anaesthesia. However, the frequency of catheterization was not statistically significant. Borghi et al. (11) and Dauri et al. (20) used ropivacaine and sufentanil in their studies, but we used levobupivacaine and fentanyl in our study. Cappelleri et al. (23) found that bladder function returned more rapidly in unilateral spinal anaesthesia performed with 7.5 mg of 0.5% ropivacaine than with 7.5 mg of 0.5% levobupivacaine.

No difference was found between the groups in terms of other complications including headache, nausea, vomiting, itching, post-operative hypotension and bradycardia in our study. Dauri et al. (20) also found no difference between the lateral and midline anaesthesia groups with regard to similar complications.

In our study, the person who collected per-operative and post-operative data was the anaesthetist himself, and he also administered epidural anaesthesia. Therefore, the study was not blinded.

Conclusion

We suggest that lateral epidural anaesthesia rather than midline epidural anaesthesia is a more advantageous technique for patients undergoing unilateral lower extremity surgery because it provides shorter and lower levels of sensory and motor blocks. However, further studies are needed to be conducted with larger series.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Süleyman Demirel University Faculty of Medicine.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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