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Comparative Study between Spinal Anesthesia and Lumbar Plexus Block for Intraoperative Anesthesia and Postoperative Analgesia in Fracture Femur Surgery

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Authors' contributions

This work was carried out in collaboration among all authors. Author MGN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NKM and RSAE managed the analyses of the study. Author OMS managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Fracture femur is common in elderly. Spinal anesthesia (SA) in elderly patients can be associated with major hemodynamic changes whereas lumbar plexus block (LPB) can provide ideal perioperative analgesia as there is no hemodynamic instability or depression of pulmonary functions. The purpose of this study is to compare the efficacy of SA versus LPB for intraoperative anesthesia and postoperative analgesia in fracture femur surgery.
Materials and Methods: This prospective randomized controlled study was carried out 70 patients of either sex with age >20 years, ASA physical status I - III scheduled for fracture femur surgery. Patients were randomly classified into two equal groups (n = 35); group I (SA) received SA by heavy bupivacaine HCL 0.5% 2.5-3.5 ml and group II (LBP) received posterior LPB by 30-35 ml bupivacaine 0.5%.

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Results: The time for performing the block was significantly longer in group LPB than group SA. The onset of sensory and motor block was significantly increased in group LPB than group SA. The intraoperative HR was significantly increased, and intraoperative MAP was significantly decreased in group SA compared to group LPB at 5, 10, 15, 20, 25 and 30 minutes. Postoperative HR and MAP was significantly increased in group SA compared to group LPB at 1 and 6 h. Postoperative VAS was significantly increased in group SA than group LPB at 1 and 6 h. The duration of sensory and motor block was significantly increased in group LPB than group SA. The time of postoperative first analgesic requirement was significantly longer and the total pethidine consumption in the 1st 24 h was significantly lower in group LPB than group SA. SA was associated with significant increase in hypotension, nausea, vomiting and headache.
Conclusion: LPB is an effective alternative to SA as an anesthetic technique for femur fracture surgeries. LBP offers a more stable intraoperative hemodynamics and provides longer duration of analgesia postoperatively with less side effects. However, SA has shorter time for performing the block with earlier onset of sensory and motor block.

Keywords: Spinal anesthesia; lumbar plexus block; fracture femur.

1. INTRODUCTION

Fractures are common and fracture femur is common amongst elderly especially females because of osteoporosis [1]. These patients are of geriatric age group and may have associated cardiac, respiratory and neurological problems which increases risk for perioperative and postoperative complications [1,2].

Regional anesthesia has much to offer to patient, surgeon and anesthesiologist due to simplicity of administration, preservation of consciousness, good analgesia, least side effects and improved intraoperative as well as postoperative pain relief [3]. Spinal anesthesia (SA) in elderly patients can be associated with major hemodynamic changes. Contraindications to SA includes head injury with neurological damage, history of epilepsy, stenotic valvular diseases etc., whereas peripheral nerve blocks of lower limb can provide ideal perioperative analgesia because there is no hemodynamic instability or depression of pulmonary functions [4,5].

Lumbar plexus block (LPB) by various approaches is becoming a standard technique. At hip level, L1 to L4 dermatome blockade is required and posterior approach to LPB is most appropriate technique [6,7]. LPB is technically difficult but with introduction and availability of US and nerve locator, it is relatively easy to administer and reliable technique of anesthesia for surgical procedures on hip and knee [8,9].

LPB provides better hemodynamic stability even in high risk geriatric patients with associated medical diseases [10]. LPB is associated with potential complications like epidural spread, retroperitoneal hematoma, intravascular injection, ureteral damage etc. but it is an attractive option if performed with caution [11,12].

The aim of the study is to compare the efficacy of SA versus LPB for intraoperative anesthesia and postoperative analgesia in fracture femur surgery.

2. SUBJECTS AND METHODS

This prospective randomized controlled study was carried out on 70 patients of either sex with age >20 years, ASA physical status I - III scheduled for fracture femur surgery in Tanta university Hospital in orthopedic surgery Department from February 2019 to November 2019 .The exclusion criteria included: patient refusal, hypersensitivity to local anesthetics, spinal deformity, local infection at the site of block, coagulation abnormalities, mental disorders, psychiatric illness, communication difficulties and severe valvular heart disease.

History, clinical examination and laboratory in vestigations were conducted. All patients were explained about the procedure to be done. During the pre-anesthetic assessment, all patients were familiarized with visual analogue scale (VAS), from 0 to 10, with 0 represent no pain while 10 represent maximum intolerable pain.

Patients were randomly classified with computer generated random numbers and sealed opaque envelops into two equal groups. Group I (SA) received SA and group II (LPB) received posterior LPB.

On arrival to the operating room, every patient was connected to continuous ECG, pulse oximetry and non-invasive blood pressure. Intravenous access was established and 500 mL of saline 0.9% was infused.

2.1 Group I: Spinal Anesthesia

Subarachnoid block was performed in sitting position (patient position was maintained with assistant) at L3-L4 or L4-L5 space using 25 G spinal needle after local infiltration of 3 ml lidocaine 2% under all aseptic precautions, heavy bupivacaine HCL 0.5% 2.5-3.5 ml were injected in subarachnoid space after clear CSF flow. Then the patient was put in supine position with head up 30 degrees. Then the level of sensory and motor block was assessed.

2.2 Group II: Lumbar Plexus Block

The patient was placed in the lateral position with the side to be anesthetized facing up. A low frequency curved US transducer was placed transversally in the abdominal flank, immediately cranial to the iliac crest. The muscles of the abdominal wall (external oblique, internal oblique and transversus abdominis muscle) were visualized.

The transducer was then moved dorsally until the quadratus lumborum muscle was seen medial to the aponeurosis of the transversus abdominis muscle. The quadratus lumborum muscle inserts with a small tendon in the apex of the L4 transvers process. Hence, when tilting the transducer caudally, the transverse process and vertebral body of L4 was visualized as bunny head on the medial side of the quadratus lumborum muscle. With the psoas muscle anteriorly, the erector spinae muscle posteriorly and the quadratus lumborum muscle situated at the apex of the transverse process, a well recognizable pattern of a shamrock with three leaves can be seen.

Hyperechoic round oval structures representing the nerves of the LP are found in the medial and posterior part of the psoas muscle, typically within a distance of two centimeters from the transverse process. By moving the transducer cranially, the course of the L3 root could be followed to the intervertebral foramen. When the transducer was tilted caudally, the transverse process of L4 disappears from the US image. This probe position permitted an in-plane posteroanterior needle approach. The needle was directed anteriorly under real-time US guidance until the needle tip is in a position lateral to the L3 nerve root.

Nerve stimulation could be used to confirm needle placement, the nerve stimulator should be initially set to deliver 3 mA current. As the needle was advanced, local twitches of the paravertebral muscles were obtained first at a depth of a few centimeter. The needle then advanced further until twitches of the quadriceps muscle were obtained (usually at the depth of 6-8 cm). After the twitches were obtained, the current was lowered to obtain stimulation between 0.5 mA and 1.0 mA, then slowly injecting a volume of 30 to 35 ml bupivacaine 5 mg/ml was done, perineural local anesthetic spread could be visualized by US.

Then the patient was put in supine position. Then, the level of sensory and motor block was assessed. Propofol IV in sedating dose (10-50 µg/kg/min) was used in patients who had discomfort during surgery.

2.3 Measurements

Time for performing the block, time of onset of sensory and motor block and level of sensory and motor block were measured. Level of sensory block was assessed by pinprick's test every minute till sensory block occurs at the level of T10 and VAS at this level is zero, Motor block was assessed by using 4 point Bromage scale.

Mean arterial blood pressure and heart rate were recorded before performing the technique and every 5 minutes for the first 30 minutes then every 30 minutes till the end of operation, then were recorded 1,3,6,12,18 and 24 hours postoperatively, the results of spinal and LPB groups were compared. Duration of sensory and motor block were recorded. Total dose of atropine and ephedrine intraoperative were recorded and compared between the two groups.

Assessment of pain: By Visual analog scale (VAS) was used to assess the intensity of pain in patients for 24h after the end of surgery at interval of 2 hours VAS scale from 0-10 (0 being the absence of pain and 10 the maximum level of pain). pain intensity was rated as mild (VAS between 1-3), moderate (VAS between 4-6), and sever (VAS between 7-10). The patient was given rescue analgesia in the form of 25 mg pethidine intravenous, if the VAS is more than 3. Patient with VAS between 1-3 was given paracetamol 1 gm intravenous, The time to first analgesic requirement was recorded, Total dose of pethidine rescue analgesia in the first 24 h postoperative was recorded. Any complications or side effects (e.g. hypotension, bradycardia, retroperitoneal hematoma) was recorded up to 24 h after the surgery.

2.4 Statistical Analysis

The sample size was calculated using Epi-Info software statistical package created by World Health organization and center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. The criteria used for sample size calculation (n>33) were 95% confidence limit, 80% power of the study, expected outcome in in treatment group 90% compared to 60% for control groups.

Analysis of data were performed by SPSS v25 (SPSS Inc., Chicago, IL, USA). Quantitative parametric variables (e.g. age) were presented as mean and standard deviation (SD). They were compared between the two groups by unpaired student's t- test and within the same group by paired T test. Quantitative non-parametric variables (e.g. VAS) were presented as median and range and compared between the two groups by Mann Whitney (U) test and within the same group by Wilcoxon test. P value < 0.05 was considered significant.

3. RESULTS

Patient flowchart of each step of the trial is shown in Fig. (1). As regards demographic data (age, weight and gender), ASA physical status and duration of surgery, there were insignificant differences between the two groups. The time for performing the block was significantly increased in group LPB (22.14 ± 4.45 min) than group SA (6.74 ± 1.78 min) (P <0.001). Table (1).

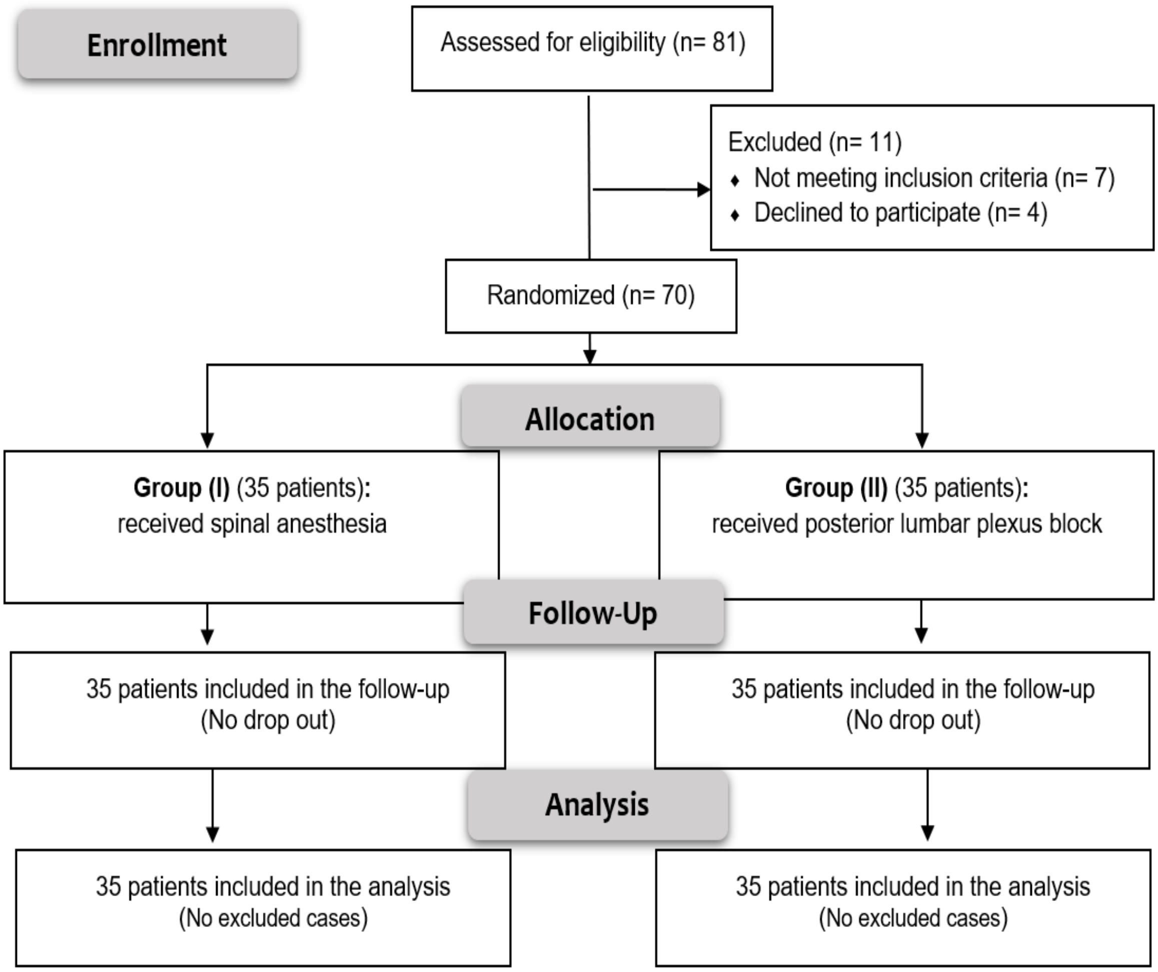

Fig. 1. Patient flowchart

Table 1. Demographic data of the studied groups

		Group SA (n = 35)	Group LPB (n = 35)	P value
Age (y)		48.3 ± 11.8	53.5 ± 10.8	0.065
Weight (kg)		80.8 ± 13.0	78.1 ± 9.7	0.328
Sex	Male	16 (45.7%)	13 (37.1%)	0.628
	Female	19 (54.3%)	22 (62.9%)	
ASA physical status	I	10 (28.6%)	14 (40%)	0.483
	II	21 (60%)	16 (45.7%)	
	III	4 (11.4%)	5 (14.3%)	
Duration of surgery (min)		114.3 ± 19.0	122.6 ± 19.5	0.080
Time for performing the block (min)		6.74 ± 1.78	22.14 ± 4.45	**<0.001***

*Data are presented as mean ± SD or number (percent), ASA: American Society of Anesthesiologists *significant as P value < 0.05*

Table 2. Onset and duration of sensory and motor blocks, time of postoperative first analgesic requirement and total pethidine consumption in the 1st 24 h of the studied groups

	Group SA (n = 35)	Group LPB (n = 35)	P value
Onset of sensory block (min)	6.71 ± 1.63	22.28 ± 4.05	**<0.001***
Onset of motor block (min)	10.14 ± 2.09	26.29 ± 4.42	**<0.001***
Duration of sensory block (min)	154.86 ± 42.06	495.43 ± 56.62	**<0.001***
Duration of motor block (min)	201.43 ± 23.19	541.14 ± 38.38	**<0.001***
Time of postoperative first analgesic requirement (min)	40.57 ± 23.05	372.86 ± 37.15	**<0.001***
Total pethidine consumption (mg) in the 1st 24 h	93.57 ± 20.1	137.86 ± 27.0	**<0.001***

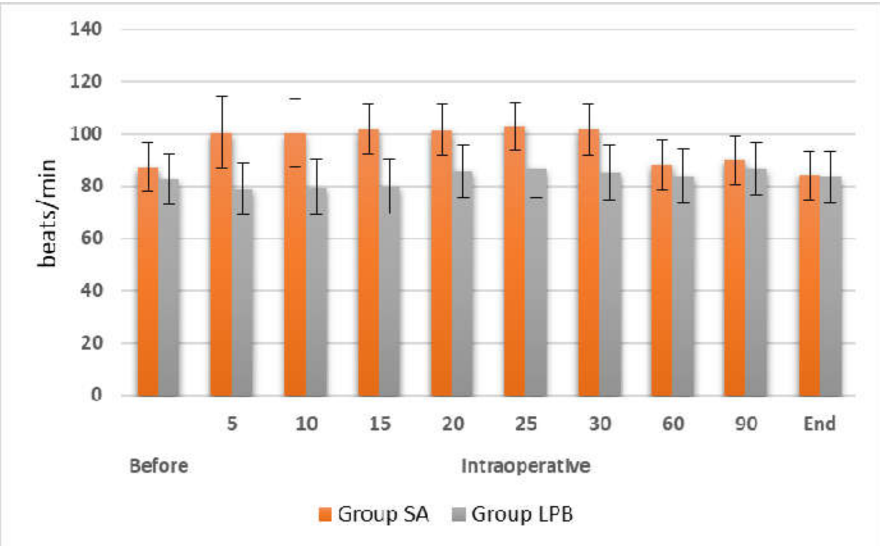

Fig. 2. Intraoperative HR (beats/min) in both groups

The onsets of sensory and motor block were significantly increased in group LPB than group SA. Table (2).

The intraoperative HR was significantly increased, and intraoperative MAP was significantly decreased in group SA compared to group LPB at 5, 10, 15, 20, 25 and 30 minutes. Figs. (2,3).

The total dose of ephedrine showed statistically significant increase in group SA (7.54 ± 10.2 mg) than group LPB (0.17 ± 1.0 mg) (P <0.001). The total dose of atropine showed statistically insignificant difference between group SA (0.029 ± 0.1 mg) and group LBP (0 ± 0 mg) (P <0.001).

Postoperative HR was significantly increased in group SA compared to group LPB at 1 and 6 h (P

= 0.001, <0.01) Fig. (4). Postoperative MAP was significantly increased in group SA compared to group LPB at 1 and 6 h (P =0.006, <0.001).

Postoperative VAS was significantly increased in group SA than group LPB at 1 and 6 h (P = <0.001). Table (3).

The durations of sensory and motor block were significantly increased in group LPB than group SA. Table (2).

The time of postoperative first analgesic requirement was significant longer in group LPB (372.86 ± 37.15 min) than group SA (40.57 ± 23.05 min). The total pethidine consumption in the 1st 24 h showed statistically significant increase in group SA (137.86 ± 27) than group LPB (93.57 ± 20.1). Table (2).

As regards complications and side effects, SA was associated with significant increase in hypotension, nausea, vomiting and headache. Table (4).

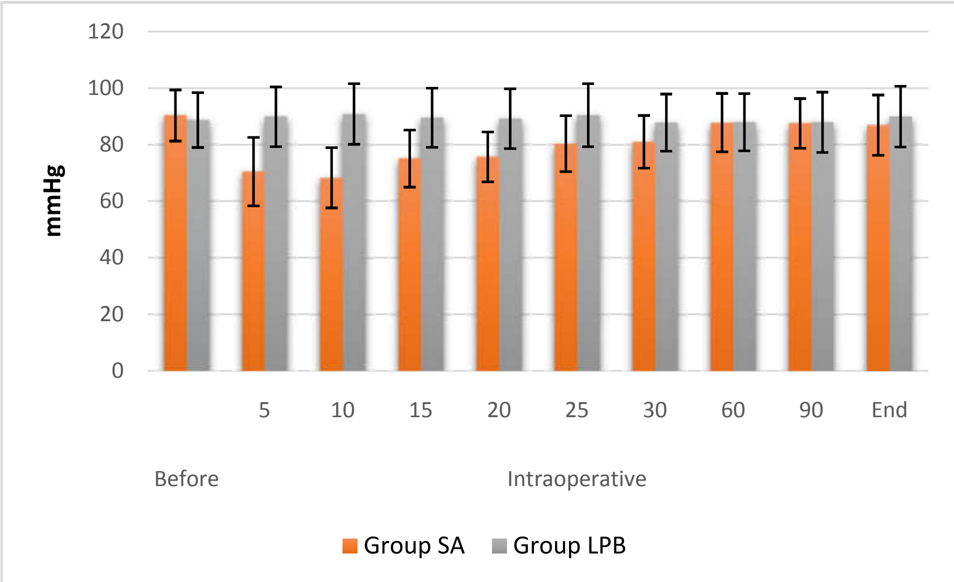

Fig. 3. Intraoperative MAP (mmHg) in both groups

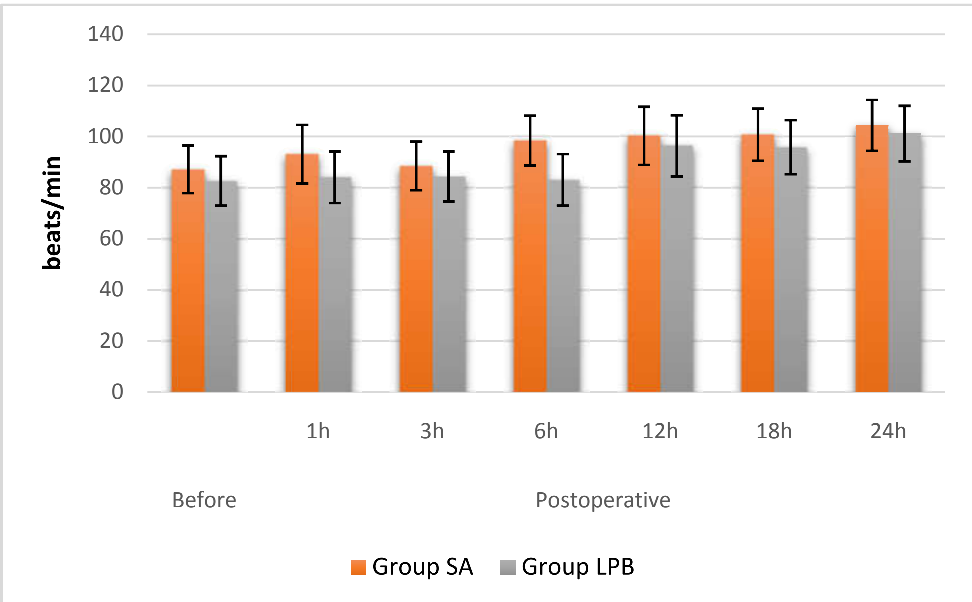

Fig. 4. Postoperative HR (beats/min) in both groups

Table 3. Postoperative VAS in both groups

		0	1h	3h	6h	12h	18h	24h
Group SA (n = 35)	Median	1	4	1	4	4	4	4
	Range	0-2	2-6	0-2	4-5	4-5	3-4	1-5
Group LPB (n = 35)	Median	1	1	1	2	4	4	4
	Range	0-2	0-2	0-2	1-2	4-5	3-4	3-5
P value		0.865	**<0.001***	0.545	**<0.001***	0.470	0.293	0.060

**significant as P value < 0.05*

Table 4. Complications and side effects

	Group SA (n = 35)	Group LPB (n = 35)	P value
Hypotension	12 (34.3%)	1(2.9%)	0.002*
Bradycardia	2(5.7%)	0(0.0%)	0.492
Nausea and vomiting	2(5.7%)	1(2.9%)	1
Headache	13(37.1%)	0(0.0%)	<0.001*
IV injection	0(0.0%)	0(0.0%)	----
Retroperitoneal hematoma	0(0.0%)	1(2.9%)	1

**significant as P value < 0.05*

4. DISCUSSION

Regional anesthesia is usually the mode of anesthesia for femur fracture surgeries, and various regional anesthetic techniques have been described to achieve surgical anesthesia of the femur, which requires blockade of the femoral, obturator, and the lateral cutaneous nerve of the thigh [13]. SA and peripheral nerve blockade are the two techniques commonly employed. The postoperative outcome in these elderly patients undergoing surgical repair for proximal femoral fractures and the type of anesthesia administered have still not been determined with certainty [10].

In agreement with study by Ahamed and Sreejit in 2019 [14], which found that the time for performing the block was significantly longer in the LPB group (20.72 ± 3.985 min) compared to SAB group (7.68 ± 1.701 min).

Also, Gandhi et al [15] demonstrated that mean time for performing the block was significant longer in Group II (LBP) than in Group I (SA). In contrary to our results, study by Amiri et al. in 2012 [16] found that the time for performing the block was prolonged in group I than group II (12.2 ± 3.3 vs. 4.93 ± 1.6 min, P = 0.001). This difference is attributed to adding femoral nerve block to spinal block.

In agreement with study by Ahamed and Sreejit in 2019 [14], which found that the onset of sensory block was also significantly longer in the LPB group (9.44 ± 2.219 min) as compared to SAB group (3.44 ± 0.917 min).

Also, Gandhi et al. [15] demonstrated that onset of sensory blockade was statistically significant longer in group II (LPB) (17.32 ± 2.61 min) as compared to group I (SA) (3.76 ± 0.91 min), and onset of motor blockade was longer in group II (22.76 ± 2.67 min) as compared to group I (8.64 ± 0.91 min).

In agreement with study by Ahamed and Sreejit in 2019 [14], which found that a statistically significant reduction in blood pressure was noted in the SAB group in comparison with LBP group. It was found that there was no clinically significant fall in the blood pressure after LPB, whereas 44% of patients undergoing SAB developed a significant fall in blood pressure. This showed that an LPB is a good alternative to SAB for hip fracture surgeries.

Also, study by Amiri et al. in 2014 [17] showed that hemodynamic stability was pleasantly achieved with LPB. This because LPB accompanied by less sympathetic involvement because of the unilateral approach and somatic dominant effect.

In a study by Davis et al. [18], it was found that larger decrements of systolic blood pressure occur with spinal and epidural anesthesia. The study also reported that hypotension defined as a decrease of systolic blood pressure more than

20% of preinduction values for >10 min, occurred in 38% of patients with SAB and 24% of patients under general anesthesia.

In contrary to our results, study by Amiri et al. in 2012 [16], which found that there were no significant differences in hemodynamic parameters regarding the method of anesthesia in the 2 groups. This mostly is due to the low volume used in SA (1.5 mL of hyperbaric bupivacaine 0.5% with 0.5 mL pethidine (25 mg)) and addition of femoral block.

This was in agreement with study by Ahamed and Sreejit in 2019 [14], which found that the time for the first request for analgesia was significantly longer in the LPB group (8.702 ± 1.26 hours) as compared to SAB group (3.796 ± 0.728 hours).

Moreover, study by Cao et al. [19] showed that the duration of postoperative analgesia of Group A (LPB group) [(420 ± 152 min)] was significantly longer than that of Group B (Epidural group) [(204 ± 44) min]. There were significant differences in the change of blood pressure and heart rate between these 2 groups. The blood pressure decreased significantly from 10 to 60 min after anesthesia in Group B, and remained stable in Group A.

In contrary to our results, study by Amiri et al. in 2012 [16], found that the duration of analgesia in the combined femoral nerve block/ SA group was longer than that in the LPB group, but the difference was not significant (17 ± 7.3 vs. 16.5 ± 8.5 h, P = 0.873).

Also, Eyrolle et al. [9] showed that VAS scores was not statistically significant between LPB group and SA group.

Our result showed that, the post-operative total pethidine consumption in the 1st 24 h showed statistically significant increase in group SA (137.86 ± 27) than group LPB (93.57 ± 20.1). In agreement with our results, study by Marino et al. [20] which found that LBP significantly reduced the total hydromorphone consumption. Also, Gandhi et al. in 2017 [15] demonstrated that rescue analgesics were needed more in Group I (SA) 15, 7, 3 and 0 patients as compared to 0, 1, 8 and 1 patients in Group II (LBP) respectively at 30, 60, 90 and 120 min intervals. So postoperative pain relief was for longer interval with LPB as compared to SA. In agreement with study by Ahamed and Sreejit in 2019 [14], which found that the occurrence of nausea was significantly higher in the SAB group, whereas there were no complications observed in the LPB group. A meta-analysis regarding anesthesia for major orthopedic surgical procedures of the hip performed by Urwin et al. [21], This meta-analysis reported that blocking of peripheral nerves in the lower extremity resulted in fewer side effects such as hypotension, urinary retention, nausea, and itching.

Our recommendations are Using of LPB as an anesthetic technique for femur fracture surgeries is recommended especially in patients with compromised cardiac reserve as geriatric and cardiac patients. Further studies are needed to study different combinations (lidocaine, bupivacaine, levobupivacaine) and concentrations of local anesthetic and different additives (e.g. dexmedetomidine, dexamethasone, neostigmine,).

5. CONCLUSION

LPB is an effective alternative to SA as an anesthetic technique for femur fracture surgeries. LBP offers a more stable intraoperative hemodynamics and provides longer duration of analgesia postoperatively with less side effects. However, SA has shorter time for performing the block with earlier onset of sensory and motor block.

CONSENT AND ETHICAL APPROVAL

Obtaining permission from institutional ethical committee and an informed consent was taken from all patients.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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