Archives of Anesthesiology and Critical Care (Summer 2025); 11(3): 305-314.

Available online at http://aacc.tums.ac.ir

Research Article

Intrathecal Magnesium Sulfate and Meperidine on Sensory and Motor Block during Spinal Anesthesia: A Randomized Clinical Trial in Iran

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ARTICLE INFO

Article history:
Received 09 November 2024
Revised 30 November 2024
Accepted 14 December 2024

Keywords:
Spinal;
Anesthesia;
Magnesium sulfate;
Meperidine;
Bupivacaine

ABSTRACT

Background: Spinal anesthesia in orthopedic surgeries presents challenges, especially concerning the choice of anesthetic agents and their adjuncts, which affect analgesia quality and potential side effects. This study was conducted with the aim of determining the effects of intrathecal bupivacaine, meperidine and magnesium sulfate on hemodynamic parameters, onset and duration of sensory/motor block in spinal anesthesia in patients with lower limb fractures.

Methods: This double-blind, randomized clinical trial included 130 patients who were candidates for planned lower limb orthopaedic surgery. They were divided into four groups: 1: bupivacaine 10 mg, 2: meperidine (1 mg/kg), 3: bupivacaine 10 mg + magnesium sulfate of 100 mg, and 4: meperidine (1 mg/kg) + magnesium sulfate with (100 mg). Parameters measured included hemodynamic status and sensory and motor block onset and duration. The level of sensory block was assessed via the pinprick sensation method, while the Bromage scale was used to evaluate motor block.

Results: No clinically significant differences in hemodynamic parameters were observed across the groups. The onset of sensory block (P value= 0.235), onset of motor block (P value= 0.097), and duration of motor block (P value= 0.135) were statistically similar across the groups. However, significant differences were found in the duration of the sensory block (P value= 0.035). Magnesium sulfate increased the duration of motor block in the meperidine group (80.93 ± 30.28 minutes). However, it reduced the duration in the bupivacaine group (75.23 ± 38.56 minutes) Motor block onset was prolonged in groups receiving magnesium sulfate, with a significant difference between the meperidine and meperidine with magnesium sulfate groups (CI = 1.10 to 12.52, P value = 0.04).

Conclusion: The intrathecal drugs used did not produce significant side effects, suggesting that they can be used interchangeably... However, magnesium sulfate, as an adjuvant, did not enhance the length or quality of the block in spinal anesthesia when used with meperidine and bupivacaine.

The authors declare no conflicts of interest.
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DOI: 10.18502/aacc.v11i3.18488

Introduction

Anesthesia in orthopedic surgery represents a complex challenge that influences patient pain, hemodynamic stability, and other postoperative outcomes [1]. Regional anesthesia is often the preferred method for surgeries involving the lower abdomen or limbs, mainly because it minimizes potential side effects and reduces the need for medications [2]. The use of intrathecal anesthetics, enhanced by various adjuvants, has grown in popularity. The goal of this approach is to increase the duration of motor and sensory blocks, thus improving pain management of patients, hemodynamic stability, and patient satisfaction [3]. Bupivacaine is a common choice for spinal anesthesia [4]. A diverse array of drugs, including epinephrine, clonidine, neostigmine, opioids, and magnesium sulfate serve as primary adjuvants in regional anesthesia [5].

Magnesium sulfate, used intrathecally, can enhance postoperative analgesia [6]. It acts as an antagonist to the N-methyl-D-aspartate (NMDA) receptor and diminishes central sensitization, often triggered by surgical stimuli [7]. Research has shown negligible adverse effects associated with intrathecal injections of magnesium sulfate [8]. However, one systematic review study highlighted the necessity for additional studies to ascertain its analgesic efficacy in orthopedic surgeries [9]. Wang (2020) has noted that the synergistic use of small doses of non-opioid drugs like magnesium sulfate with opioids in spinal anesthesia offers multiple advantages [7].

Incorporating magnesium sulfate into regional anesthesia regimens has recently gained attention for its potential to enhance and prolong analgesia in various nerve block procedures. Despite not increasing magnesium levels in cerebrospinal fluid, it is suggested that its mechanism of action might be peripheral, targeting NMDA receptors [10]. This method could result in reduced postoperative pain scores, enhanced patient outcomes, improved intraoperative management, and could contribute to alleviating the ongoing drug crisis [11]. Pascual-Ramírez's meta-analysis of 12 randomized trials involving 817 patients indicated that adding 50 -100 mg of intrathecal magnesium to a spinal anesthetic prolongs opioid analgesia without raising safety concerns [12]. Nonetheless, some studies have cast doubt on these results [13-14].

Meperidine, a lipophilic opioid with anesthetic properties, is effectively used alone in spinal anesthesia [15]. It is suitable for surgeries on the lower limbs, perineum, and lower abdomen [16]. It is recommended that dosages be restricted to 0.5 mg/kg for perineal procedures and 0.5 to 1.0 mg/kg for lower limb and abdominal surgeries to minimize side effects [17]. There has been successful use of 1 mg/kg intrathecal meperidine for elective cesarean sections in patients presumed allergic to amide local anesthetics. Additionally, meperidine's affordability and the scarcity of local anesthetics in developing regions promote its frequent use [18].

Considering the beneficial effects of intrathecal magnesium with bupivacaine, the study explored the combination of 'bupivacaine + magnesium sulfate' (Bupi+MS) versus 'meperidine + magnesium sulfate' (Mep+MS) versus sole agents meperidine and bupivacaine. This study was conducted with the aim of determining the effects of these combinations on hemodynamic status and the onset and duration of sensory/motor block in spinal anesthesia for patients with lower limb fractures.

Methods

Design

This double-blind, randomized clinical trial was registered in the Iranian Clinical Trial Registry (IRCT20170413033408N3) on June 11, 2020. After obtaining ethics approval from the Ethics Committee of Golestan University of Medical Sciences (IR.GOUMS.REC.1398.400), the study was conducted between October 2020 and August 2021 in the Gorgan 5th Azar Hospital in northeastern Iran. The hospital is a referral center for orthopedic surgery candidates in western Golestan province.

Participants and Sampling

The study included 130 patients undergoing orthopedic surgery for lower limb fractures. Eligible patients were between 18 and 60 years old, undergoing orthopedic surgery for lower limb fractures in a supine position, and were candidates for spinal anesthesia with American Society of Anesthesiologists (ASA) grade I or II. Patients with contraindications for spinal anesthesia (e.g., infection at the needle entry site), pelvic fractures, or allergies to the study's drugs were excluded.

Exclusion criteria included changes in anesthesia method or the position of the patient during surgery, loss of consciousness following spinal anesthesia, severe agitation post-anesthesia, or patient non-cooperation during post-anesthesia evaluation.

Participants were selected through simple random sampling, and a computer-generated table was used to allocate them into four groups: 1. Sole bupivacaine, 2. Sole meperidine, 3. Bupivacaine + magnesium sulfate (Bupi+MS), and 4. Meperidine + magnesium sulfate (Mep+MS). Random numbers from the table were assigned to the syringes containing the study drugs. Only one of the researchers, uninvolved in drug administration or patient scoring, was aware of the actual syringe contents. This ensured allocation concealment and maintained blinding for both patients and data analysis.

The sample size for this study was calculated to be 172 participants per group. This ensured a 95% confidence level and 90% test power.

Interventions

After explaining the study methodology and obtaining written consent from the participants, the study commenced. All patients fasted for 8 hours before anesthesia. Once in the operating room, baseline readings of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO2) were recorded. Each patient received a 5 mL/kg dose of 0.9% saline before the intrathecal injection.

The patients were randomly divided into four groups (Figure 1). Each group received a specific drug combination:

1. Group 1: bupivacaine (10 mg)
2. Group 2: bupivacaine (10 mg) + magnesium sulfate (100 mg)
3. Group 3: meperidine (1 mg/kg) + magnesium sulfate (100 mg)
4. Group 4: meperidine (1 mg/kg)

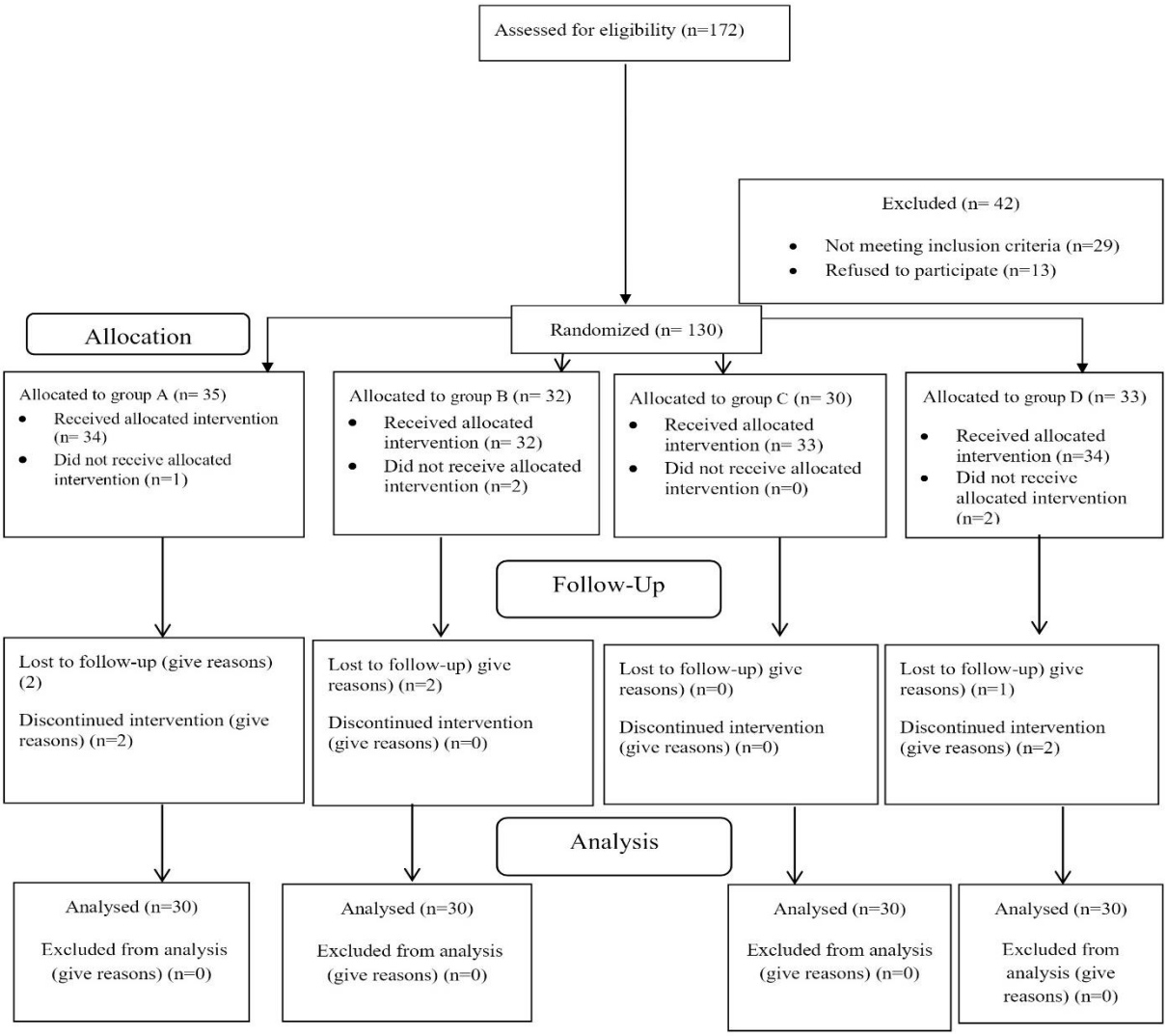

Figure 1- The consort flow chart describing the progress of the subjects through the study

All drugs were diluted with sterile water to obtain a total volume of 3 ml in each syringe. In group 1, 2 ml of bupivacaine (0.5%) was combined with 1 ml of sterile water. In group 2, 2 ml of bupivacaine (0.5%) was mixed with 1 ml of magnesium sulfate (10%). Group 3 received 1 ml of magnesium sulfate (10%) and 1-2 ml of meperidine with sterile water to complete the volume. In group 4, the required amount of meperidine was calculated, and the remaining volume was filled with sterile water.

After preparing the patient and the medication, a subarachnoid block was administered using a midline

approach in the sitting position at the L3-L4 or L4-L5 intervertebral space with a 25-gauge Quincke spinal needle. After confirming the free flow of cerebrospinal fluid, the intrathecal drug was administered over 15 seconds, with the needle bevel oriented caudally. Immediately after spinal anesthesia, patients were placed in a supine position. During anesthesia and in the recovery room, oxygen therapy was administered at 4 liters per minute through a simple face mask.

The sensory block level was assessed using the standard pinprick method with a 23-gauge needle. Adequate sensory block was confirmed as the highest dermatome without pain perception within 20 minutes of the intrathecal injection. The onset of motor block was measured using the modified Bromage Scale:

0. No motor block
1. Unable to raise extended legs but able to move knees and feet
2. Unable to raise extended legs or move knees, but able to move feet
3. Complete motor block of the lower limbs

The time taken to achieve a motor block of grade 2 was defined as the onset of the motor block. The duration of the motor block was measured until the score returned to grade 0. The onset of sensory and motor block was recorded using a digital timer.

Hemodynamic parameters such as HR, SBP, DBP, mean arterial blood pressure, and SpO2 were recorded using patient care monitoring equipment (SAADAT brand, Iran) every 5 minutes from the subarachnoid block until the end of surgery or the sensory/motor block. Hypotension and bradycardia were defined as decreases exceeding 30% of baseline HR or MAP and were treated with ephedrine or atropine, respectively. The incidence of pruritus and nausea/vomiting in the patients was also recorded using a checklist based on the patient's statements and the researcher's observations, conducted every 5 to 10 minutes until the block's effects subsided.

In 2019, Kampo confirmed the effectiveness of sub-hypnotic doses of propofol in mitigating intrathecal-opium-induced pruritus [19]. To alleviate itching after spinal anesthesia, 10-20 mg of propofol was administered to affected patients. For nausea and vomiting, atropine (0.6 mg) or ondansetron (4 mg) was used, depending on the patient's condition.

Data Analysis

The data analysis was conducted using SPSS version 18. The normality of the variables was checked using the Kolmogorov-Smirnov test. Comparisons between the four groups were made using either one-way ANOVA or the Kruskal-Wallis test to measure the means of the variables. The repeated measures test was used to assess the follow-up of variables over time. The relationships between qualitative variables were examined using the Chi-square test and Fisher's exact test. Data are presented as mean ± SD, median with a range, or number of cases. A P value of less than 0.05 was considered statistically significant.

Results

Demographic characteristics

Of the initial 172 patients, 130 completed the study (Figure 1). A total of 29 patients were excluded due to issues such as incomplete blocks, extended surgery duration, or failure to cooperate with block assessment. An additional 13 patients declined to participate in the study and were excluded. Ultimately, data from 30 patients in each group were analyzed. The characteristics of patients in each of the four groups are shown in Table 1. No significant differences were observed among the groups' demographic characteristics (Table 1). The mean age of participants was 39.5 years, and their average weight was 72 kg. Approximately 80% of the patients were male, and 40% had a history of opium addiction.

Sensory & Motor Block

The block level was verified after administering spinal anesthesia and reaching the maximum block level. The sensory block levels were categorized into four distinct areas. The block height generally increased to the T8-T10 dermatome level across all groups. There were no significant differences in sensory block levels among the four groups (Table 2).

Table 1- Baseline characteristics of patients

Variables	Group A (Bupivacaine)	Group B (Meperidine)	Group C (Bupi+MS)	Group D (Mep+MS)	P value
Age (y)	41.76±13.99	40.80±17.54	37.56±16.71	40.80±14.12	0.59
Weight (kg)	76.00±14.58	68.26±13.90	72.53±15.71	72.53±13.09	0.31
Gender (male) (N)	23 (76.7%)	22 (73.3%)	27 (90%)	25 (83.3%)	0.36
Opium Addiction (N)	12 (40%)	11 (36.7%)	14 (46.7%)	12 (40%)	0.88

Table 2- Height of block

Sensory Block Level	Group A, (Bupivacaine) N (%)	Group B, (Meperidine) N (%)	Group C, (Bupi+MS) N (%)	Group D, (Mep+MS) N (%)
T4-T6	2 (6.7)	2 (6.7)	1 (3.3)	1 (3.3)
T6-T8	4 (13.3)	6 (20.0)	5 (16.7)	10 (33.3)

T8-T10	14 (46.7)	19 (63.3)	18 (60.0)	14 (46.7)
T10-T12	10 (33.3)	3 (10.0)	6 (20.0)	5 (16.7)

The onset of motor block was longer in the groups with magnesium sulfate compared to those without, and there was a significant difference between the Meperidine and Mep+MS groups (P value= 0.02). However, the onset of the sensory block was similar across all groups (Tables 3-5).

The Bupi+MS group had a significantly shorter sensory block duration than the Bupivacaine group (P value= 0.06). The Mep+MS group exhibited a slightly longer sensory block duration than the Meperidine group (CI = 1.10 to 12.52, P value= 0.56), but this difference was not statistically significant (Table 3-5).

The duration of motor block was shorter in the Bupi+MS group and marginally longer in the Mep+MS group. However, neither difference was statistically significant (Table 3-5).

Among the opium-addicted patients, the onset and duration of blocks were assessed across the four groups. As with non-addicted patients, the Bupivacaine group exhibited the most extended duration of sensory and motor blocks among the addicted patient groups. Magnesium increased the onset of the motor block in both the Bupivacaine and Meperidine groups (Table 6).

Table 3- Comparison the sensory/motor block between groups

Variables	(Bupivacaine)	(Meperidine)	(Bupi+MS)	(Mep+MS)	P value
Onset of sensory block (second)	61.5±36.48	59.83±88.44	81.16 ± 84.84	54.83 ± 45.09	0.235
Onset of motor block (second)	136.8 ± 92.32	127.30±148.22	171.50±128.78	142.17±100.13	0.097
Duration of sensory block (minute)	99.26 ± 44.50	69.56 ±26.49	75.23±38.56	80.93±30.28	0.035
Duration of motor block (Minute)	120.8±49.12	117.80±115.41	96.63±43.60	99.85±34.36	0.135

Table 4- Outcome measure of sensory and motor block in Bupivacaine groups

Bupivacaine groups		Bupivacaine		Bupi+MS		P value
Variable	Participants based on mean times	Number	Percent	Number	Percent	
Duration of motor block	Shortened	16	53.33	22	73.33	0.11
	Prolonged	14	46.67	8	26.67	
Duration of sensory block	Shortened	15	50.00	22	73.33	0.06
	Prolonged	15	50.00	8	26.67	
Onset of motor block	Shortened	13	43.33	10	33.33	0.43
	Prolonged	17	56.67	20	66.67	
Onset of sensory block	Shortened	15	50.00	14	46.67	0.80
	Prolonged	15	50.00	16	53.33	

Table 5- Outcome measure sensory and motor block in Meperidine groups

Meperidine groups		Meperidine		Mep+MS		P value
Variable	Participants based on mean times	Number	Percent	Number	Percent	
Duration of motor block	Shortened	12	40.00	12	42.86	0.83
	Prolonged	18	60.00	16	57.14	
Duration of sensory block	Shortened	9	30.00	7	23.33	0.56
	Prolonged	21	70.00	23	76.67	
Onset of motor block	Shortened	15	50.00	6	20.69	0.02
	Prolonged	15	50.00	23	79.31	
Onset of sensory block	Shortened	15	50.00	10	33.33	0.19
	Prolonged	15	50.00	20	66.67	

Table 6- Comparison the sensory/motor block between groups in opium addicted participants

Variables	Group A (Bupivacaine)	Group B (Meperidine)	Group C (Bupi+MS)	Group D (Mep+MS)	P value
Onset of sensory block (second)	73.33±38.98	59.09±54.9	84.29± 99.98	43.33±15.42	0.29
Onset of motor block (second)	171.17 ± 104.33	136.27 ± 119.48	174.29 ± 139.87	140.83 ± 115.48	0.61
Duration of sensory block (minute)	91.25±46.94	74.55±21.15	63.43± 30.32	74.58±26.13	0.35

Duration of motor block (Minute)	112.08±51.01	101.36±28.12	84.07±36.55	92.27±32.18	0.35

Other Complications

The frequency of nausea, vomiting, and pruritus differed significantly between the groups. Meperidine was associated with these adverse effects in this study. In group B, 33.3% of patients experienced nausea and vomiting (P value= 0.0001), while in group D, 36.7% had itching complications (P value= 0.002) from the initiation of spinal anesthesia until recovery discharge (Table 7).

Hemodynamic Parameters

No statistically significant differences were found among the groups in terms of SBP (P value= 0.579), DBP (P value= 0.059), or HR (P value= 0.181) (Figure 2) (Table 8).

Sympathomimetic Drug Usage

The groups have no differences regarding atropine and ephedrine consumption (Table 9).

Table 7- Frequency of complications between groups

Variables	Bupivacaine N (%)	Meperidine N (%)	Bupi+MS N (%)	Mep+MS N (%)	P value
Nausea/Vomiting	2 (6.7%)	10 (33%)	1 (3.3%)	10 (33.3%)	0.001
Pruritus	2 (6.7%)	7 (23.3%)	1 (3.3%)	11 (36.7%)	0.002

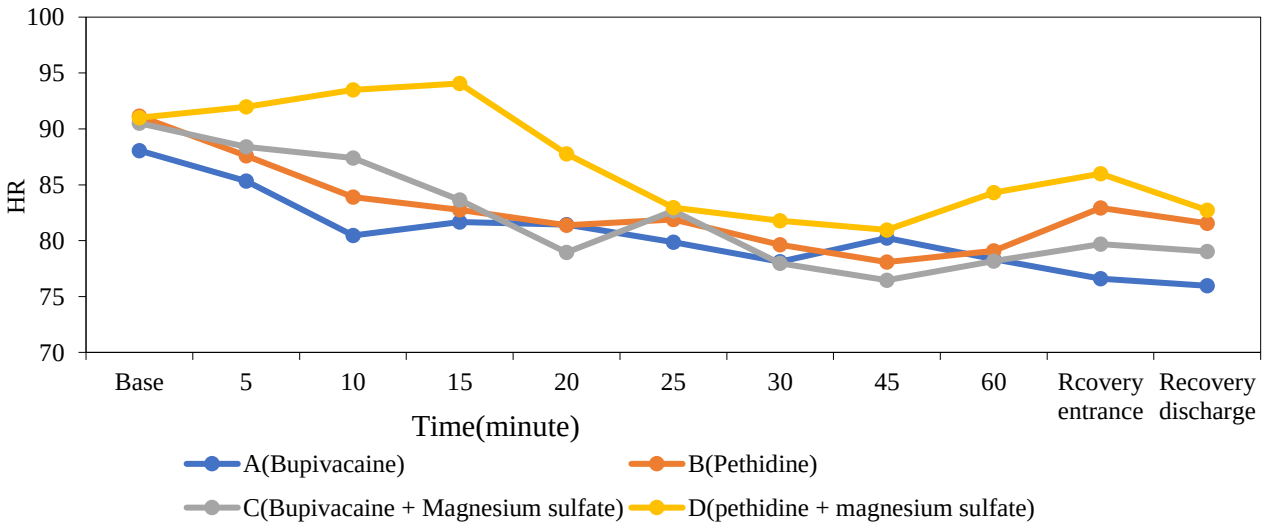

Figure 2- The trend of the mean HR between the groups

Table 8- Mean ± SD of hemodynamic parameters

BP Systole (mmgh)					BP Diastole (mmgh)			
Time/Minute	A	B	C	D	A	B	C	D
Base	137.53±17.196	132.46±14.08	129.20±27.67	131.06±19.57	83.30±16.59	77.0±11.81	82.56±15.94	82.83±11.19
5	127.70±21.04	119.66±18.55	122.80±17.0	123.40±21.06	78.0±14.88	69.53±13.49	74.63±17.02	73.40±13.51
10	123.93±24.61	110.53±16.99	119.50±15.81	117.16±18.24	75.90±13.59	66.68±12.13	70.40±11.80	69.1±12.98
15	126.03±18.77	126.03±16.19	119.36±13.50	113.06±18.59	77.33±11.01	65.2±13.30	67.83±10.35	67.06±13.15
20	127.33±18.42	108.89±13.63	118.03±14.46	112.50±19.58	76.73±12.42	62.21±13.34	68.55±9.89	65.16±12.21
25	125.78±20.60	110.07±14.59	122.0±14.96	112.41±14.74	78.82±11.59	65.46±16.83	71.92±10.98	67.44±9.32

30	129.16±20.05	108.40±15.95	122.14±15.47	108.07±18.65	79.60±11.49	60.07±13.27	72.77±10.15	63.03±13.26
45	131.08±18.75	112.00±13.56	121.0±16.32	112.92±16.15	78.33±11.25	66.37±12.02	74.61±10.27	68.0±13.88
60	135.50±19.82	115.25±16.56	127.27±18.95	154.41±205.90	81.47±13.01	70.3±14.0	77.50±12.45	66.73±17.08
RE	128.46±16.30	115.26±17.25	127.66±18.15	121.13±19.22	78.83±10.50	71.93±13.3	80.66±12.86	74.03±12.44
RD	126.30±15.84	120.06±12.19	126.13±13.36	120.86±14.72	77.56±11.91	75.63±11.89	79.93±11.92	73.0±11.0
Total	10.98±2.12	11.37±1.09	10.59±.91	11.95±1.49	69.99±9.94	76.93±9.86	70.19±8.59	79.16±8.83
P value=0.579					P value=0.059			
Mean ± SD SPO2					Mean ± SD MAP and Heart Rate			
Base	98.36±2.32	98.33±2.03	99.6±1.49	92.16±24.56	88.06±17.48	91.13±14.49	90.50±20.07	91.06±14.48
5	98.56±2.23	98.2±2.2	99.23±1.54	88.83±29.60	85.33±17.06	87.60±11.14	88.40±21.61	91.96±19.27
10	98.53±3.21	98.03±1.99	103.2±19.31	91.93±24.51	80.46±17.94	83.90±13.39	87.40±23.22	93.56±21.55
15	98.8±2.23	97.63±2.38	100.13±4.84	91.66±24.46	81.66±14.77	82.76±19.50	83.63±21.15	94.06±19.72
20	98.63±2.82	97.82±2.8	100.17±3.94	91.66±24.47	81.43±14.67	81.39±14.27	78.93±22.84	87.76±19.40
25	98.89±2.45	97.75±3.25	99.64±1.47	91.55±24.89	79.85±11.83	81.89±12.89	82.67±20.77	82.96±15.26
30	95.24±18.15	98.14±2.69	99.44±1.31	91.60±25.39	78.12±13.6	79.62±12.56	77.96±17.32	81.78±14.77
45	98.4±3.08	98.13±2.51	99.19±1.23	91.39±25.42	80.22±13.81	78.08±12.90	76.46±14.98	80.96±15.93
60	98.61±2.7	98.4±2.28	99.16±1.29	89.47±27.72	78.33±14.35	79.1±14.84	78.16±16.91	84.30±13.73
RE	98.1±3.83	98.16±2.28	99.16±1.29	89.47±27.72	76.6±13.22	82.93±13.72	79.7±17.42	86.0±16.63
RD	98.1±3.83	98.16±2.08	99.5±1.04	95.1±17.70	75.96±12.38	81.56±12.22	79.03±15.64	82.73±16.2
Total	98.19±3.22	98.46±1.79	99.71±2.22	90.18±25.26	87.37±12.21	94.76±11.83	86.47±8.79	99.74±11.43
RE	98.36±2.32	98.33±2.03	99.6±1.49	92.16±24.56	88.06±17.48	91.13±14.49	90.50±20.07	91.06±14.48
	P value=0.575				P value=0.181			

Table 9- Sympathomimetic drug usage between groups

	Bupivacaine N (%)	**Meperidine N (%)**	**Bupi+MS N (%)**	**Mep+MS N (%)**	**P value**	**Bupivacaine N (%)**
Atropine	27(90.0%)	26(86.7%)	28(93.3%)	25(83.3%)	106(88.3%)	P value=0.779
	3(10.0%)	4(13.3%)	2(6.7%)	5(16.7%)	14(11.7%)	
Ephedrine	25(83.3%)	23(76.7%)	27(90.0%)	20(66.7%)	95(79.2%)	P value=0.144
	5(16.7%)	7(23.3%)	3(10.0%)	10(33.3%)	25(20.8%)	

Discussion

This study aimed to evaluate the impact of magnesium sulfate as an adjuvant to two different intrathecal agents, bupivacaine (a long-acting local anesthetic) and meperidine (an opioid), on hemodynamic status and the onset and duration of sensory and motor blockade in patients with lower limb fractures receiving spinal anesthesia. The findings showed that bupivacaine had the most extended onset and duration of sensory and motor blockade among the groups. Meperidine, however, exhibited the highest rate of adverse effects. The combination of magnesium sulfate with the primary drug resulted in unpredictable outcomes.

Banihashem's study on adding intrathecal magnesium sulfate to bupivacaine found that intraoperative

hemodynamic variability was no significant difference between the groups [13]. In one study it was reported that magnesium, used as an adjuvant to bupivacaine, provides better hemodynamic stability than fentanyl [20]. In this study, no significant differences were observed in hemodynamic changes post-spinal anesthesia between the bupivacaine, meperidine, and magnesium sulfate combination groups.

Esmaeldin found that the addition of intrathecal magnesium sulfate to bupivacaine with fentanyl accelerated anesthesia onset [21]. However, Banihashem (2015) reported that magnesium sulfate delayed the onset of sensory blockade compared to bupivacaine alone, with the difference being statistically significant, but the onset of motor blockade showed no difference between the groups [13]. The study found that although magnesium increased the onset time of sensory and motor blocks in the bupivacaine group, the differences were not statistically significant. However, magnesium significantly delayed motor block onset in the meperidine group.

The average duration of the sensory block was shorter than that of the motor block, mainly due to tourniquet pain. Despite the persistence of effective motor block, patients experienced pain, highlighting a failure to differentiate between the end of the sensory block and tourniquet pain.

Most authors have reported that adding intrathecal magnesium sulfate to bupivacaine prolongs the duration of spinal anesthesia [20-23]. In one study this was compared the effects of different doses of magnesium sulfate as adjuvants to bupivacaine, noting that adding 100 mg of magnesium sulfate significantly extended the duration of analgesia [20]. The findings demonstrated that bupivacaine alone provided the longest sensory and motor block compared to the other groups. Additionally, the magnesium combination did not extend the block duration but increased motor block onset in the bupivacaine and meperidine groups.

However, these differences were not statistically significant. This unexpected finding led us to investigate similar but less common studies. This was confirmed that adding magnesium sulfate to intrathecal bupivacaine did not affect motor block duration. Although postoperative analgesia was more prolonged in the magnesium sulfate group, the difference was not significant, and adding intrathecal magnesium sulfate to bupivacaine is not recommended [13]. This was founded that adding magnesium to bupivacaine increased sensory block duration but decreased motor block duration [14]. Xiao (2017) also showed that adding 50 mg of intrathecal magnesium sulfate did not reduce the dose requirement of intrathecal bupivacaine [24]. This led us to conclude that Hung's findings might be accurate, as he reported that magnesium sulfate, co-administered with amide-type local anesthetics, shortened the duration of sciatic nerve blockade in rats. The mechanism of this 1observed antagonism remains uncertain but appears to be independent of the action of local anesthetics and magnesium sulfate at the LA receptor within the sodium channel [25].

The meperidine dose in this study was based on data from Parmar et al. (2017) [26]. Studies have reported that adding intrathecal meperidine to bupivacaine is associated with more side effects, such as nausea, vomiting, and hypotension [15,27]. In this study, the incidence of pruritus and nausea was higher in the meperidine group than in the others.

Limitations

In this study, the focus was exclusively on the analgesic effects of the drugs during surgery and recovery, excluding the duration of postoperative analgesia. Evaluating postoperative analgesia could offer a rationale for using intrathecal magnesium sulfate. Moreover, the impact of the tourniquet was not differentiated from the recovery of the sensory block, but this factor is believed to have not influenced the study's overall findings.

Conclusion

Although adjuvant agents generally enhance the efficacy of intrathecal drugs, intrathecal magnesium sulfate combined with meperidine and bupivacaine, contrary to expectations, not only failed to extend the duration and quality of the block but also increased the onset time. Therefore, magnesium sulfate may not be a suitable adjunct to intrathecal drugs in patients undergoing spinal anesthesia.

Acknowledgment

The authors would like to thank the department of Research and Technology of Golesatn University of Medical Sciences and voluntary participation and cooperation of all patients in the study.

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