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ORIGINAL ARTICLE

Comparative Study of Haemodynamic Stability, Sensory and Motor Blockade in Lateral Spinal Anesthesia at Two Different Speed of Intrathecal Bupivacaine Injection

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ABSTRACT

Background: Spinal anesthesia has some of complications such as hypotension, bradycardia, headache and nausea during the operation. few of these complications can be minimized by selectively distributing anesthesia to the operating side, this technique is often called a unilateral spinal anesthesia.

Aim of the study: Comparison of sensory, motor blockade between dependent side and non-dependent side, haemodynamic stability and need for vasopressor in lateral spinal anesthesia at two different speed of intrathecal bupivacaine injection.

Patient and method: single blind clinical trial was conducted included 50 patient received lateral spinal anesthesia with 3ml of hyperbaric bupivacaine (0.5%). Patients assigned into two equal groups; first group receive rapid injection rate at (6sec), second group receive slow injection rate at (60 sec) and maintaining patient in lateral position for (10 min) then turning patient to supine. Motor, sensory blockade and hemodynamic state were monitored and reported.

Result: Comparison of sensory block level at 10 and 30 minutes in both studied groups showed no significant difference in the sensory level, at dependent and non-dependent side, (P>0.05). In motor assessment, Bromage motor blockade score at dependent side and none-dependent side were not significantly different between both groups at 10 and 30 minutes, (P>0.05). The blood pressure, heart rate and need for vasopressor were not significantly different between both groups.

Conclusion: The speed of injection had no significant effect on distribution of lateral spinal anesthesia.

Keywords: *Lateral spinal anesthesia, Bupivacaine, Speed of injection.*

1. INTRODUCTION

Spinal anesthesia is a form of neuraxial regional anesthesia involving the injectionof a local anesthetic into the cerebral spinal fluid in the subarachnoid space, generally through a fine needle first use in 1900 [1]. Spinal anesthesia provides excellent operating conditions for obstetric/gynecologic procedures, hernia repairs, genitourinary procedures and orthopedic procedures. They have different advantages and disadvantages that can be addressed, the advantages [2,3] include easy to perform, reliable, provides excellent operating conditions for the surgeon, less costly than general anesthesia, normal gastrointestinal function returns faster with spinalanesthesia, patient maintains a patent airway a decrease in pulmonary complications and decreased incidence of deep vein thrombosis and pulmonary emboli formation. However, some disadvantages also reported with spinal anesthesia such as risk of failure even in skilled hands. Always be prepared to induce general anesthesia. Normal alteration in the patient's hemodynamics. It is essential to place the spinal block in the operating room, while monitoring the patient's ECG, blood pressure, and pulse oximetry. Resuscitation medications should be available. The operation could outlast the spinal anesthetic. Alternative plans (i.e. general anesthesia) should be preparedin advance [4].

The distribution of local anesthetic within subarachnoid space determines loss of neurological function during spinal anesthesia. When nonisobaric solutions are used, the spread of anesthesia can be influenced by position of patient [5].

More than 30 years ago, effort to restrict the spread of anesthesia to one side of the body using hypobaric or hyperbaric anesthetic were reported [6,7]. Because the level of sympathetic denervation determines the magnitude of cardiovascular responses to spinal anesthesia, it might be anticipated that the higher rate of unilateral sympathetic block, the lower would be the change in cardio-circulatory parameters. In the presence of a partial sympathetic blockade, a reflex increase in sympathetic activity occurs in sympathetically intact areas [8]. Restriction of sympathetic denervation during spinal anesthesia may minimize hemodynamic alterations Theoretically, the use of nonisobaric anesthetics may allow unilateral anesthesia and thus restrict sympathetic denervation to one side of the body[9]. The adverse haemodynamic effects of spinal block may be mitigated during unilateral spinal anesthesia, as the reduced extent of sensory block could theoretically be associated with a lower degree of sympathetic block [10,11]. It is worth mentioned that spinal anesthesia has some of complications such as hypotension, bradycardia, headache and nausea during the operation. few of these complications can be minimized by selectively distributing anesthesia to the operating side, this technique is often called a unilateral spinal anesthesia. We aimed in this study to compare sensory and motor blockade between dependent side and non-dependent side, hemodynamic stability and need for vasopressor in lateral spinal anesthesia at two different speed of intrathecal hyperbaric bupivacaine 0.5% injection.

2. METHODOLOGY

This was single blind clinical trial, carried out in Orthopedic, vascular and urology operation theaters at Al-Sader medical city in Al-Najaf-Iraq during a period of 9 months. A total of 50 patients were enrolled in the study and randomly assigned into two equal groups.

Inclusion criteria

Adult Iraqi patients aged 18-65 years of both genders with ASA class I or II and a body mass index of < 35 kg/m²ge:

Exclusion criteria:

Patient who refused to participate, having contraindication to spinal anesthesia, allergic to the used agents, or could not tolerate positioning for spinal anesthesia (e.g., due to a pelvis fracture), were excluded from the study

Study protocol

Standard anesthesia protocol and monitoring were strictly followed and applied. In both groups of slow and rapid speed of injection, the patients were placed in the lateral decubitus position on operating table, which was held in strictly horizontal position, the lower limb was the target limb. the L3-L4 inter-vertebral space was detected, spinal anesthesia performed with a 25-G Quincke spinal needle, using midline approach, intraspinal position of the needle tip was verified by visualization of spinal fluid in luer connector of needle, then aperture of needle rotated toward dependent site.

We use (3ml) of hyperbaric bupivacaine 0.5% injected at rate of (6 sec) in rapid group and at rate of (60 sec) in the slow group and patients were kept in lateral position for (10 min) after injection, then turned to supine. Hemodynamic variables (BP, PR) were monitored in nondependent side before spinal anesthesia every 3 minutes until 42 min of intrathecal injection for all patients. When hypotension occurred, it was managed accordingly.

The level of sensory block was checked using a cold object (iced water bottle), we assess the sensory block at both dependent and non-dependent side at (10 min) from injection and then at (30 min) after injection (20 min from turning patient supine)

The motor block was checked using Bromage scale, of 0-3 score, at (10 min) from intrathecal injection and (30 min) from intrathecal injection.

Statistical analysis

Data of the 50 patients in both Rapid and Slow groups were entered, managed and analyzed using the statistical package for social sciences (SPSS), version 26 and Microsoft Excel 2018 software. Variables were presented according to their types as mean, standard deviation, frequencies and percentages. Comparison of means was done with student's t test and ANOVA test when applicable. Fisher's exact test was applied for categorical variables. The changes within each group in categorical variables were compared using Wilcoxon Signed Ranks To assess the possible effect of baseline characteristics of the studied groups on the changes of SBP, DBP, MAP and Heart rate in both groups, bivariate Pearson's and Spearman's correlation analysis were performed accordingly. Level of significance set at P. value of ≤ 0.05 to be significant.

3. RESULTS

A total of 50 patients were enrolled in this study and assigned equally into two groups. The baseline characteristics of the studied groups were insignificantly different between both groups, P. value > 0.05, (**Table 1**). The level of sensory block between groups was neither significant in dependent nor non-dependent side at 10 and 30 minutes, (P>0.05). Comparison of dependent and non-dependent sides at 10 and 30 minutes, revealed that loss of sensory block reached significantly higher levels than it was at 10 minutes, in both groups, (P<0.05), (**Table 2 & Table3**). Bromage motor blockade score at dependent side was not significantly different between both groups at 10 and 30 minutes, however, in rapid group the change within group was significant, (P<0.05), while in slow group the difference was insignificant, (P>0.05). In non-dependent side, no significant difference was found between groups at 10 and 30 minutes, (P>0.05), but there was a statistically significant difference within both groups, (P<0.05) (**Table 4 & Table 5**). On the other hand, when dependent side compared vs. non-dependent, the difference in Bromage motor blockade score was neither significant at 10 minutes nor at 30 minutes, (P>0.05), (**Table 6 &Table7**). Regarding changes in Systolic blood pressure (SBP), no significant difference between both groups had been reported except at 12 minutes, 18 minutes, 30 minutes and 42 minutes where the rapid group had significantly lower SBP, (P<0.05), (**Table 8**). For the diastolic blood pressure, it was significantly lower in rapid group at 21, 24, 39 and 42 minutes compared to slow group, (P<0.05), (**Table 9**). Comparison of mean arterial pressure (MAP) across the 42 minutes in both studied groups revealed a significant lower value in rapid than slow group at 18, 24, 27, 36, 39 and 42 minutes, (P<0.05), (**Table 10**).

Heart rate was significantly lowered in both studied groups with the time and the significant difference between both groups in heart rates observed at the 18th minutes and the subsequent time, it was higher in rapid than slow group, (P<0.05), (**Tabe 11**).

Only, 8 patients in Rapid group and 4 patients in slow group needed Ephedrine 5 mg; with no significant difference reported in number of doses between both groups, (P>0.05). So as for atropine where it was needed in only one patient in the slow group vs. none in the rapid group, with no significant difference, (P>0.05), (**Table 12**).

Bivariate Pearson's and Spearman's correlation analysis were performed and revealed no significant correlation between baseline patients' characteristics and changes in vital signs in both studied groups, in all comparisons, P>0.05, (Table 13 and Table 14).

Table 1. Baseline characteristics of the studied groups

Variable	Rapid group (n = 25)	Slow group (n = 25)	
Gender, male/female	19/6	18/7	0.747
Age, mean (SD) year	28.4 (7.8)	28.8 (10.6)	0.864
Weight, mean (SD) kg	68.4 (12.6)	66.4 (14.2)	0.602
BMI, mean (SD) kg/m²	22.5 (2.8)	22.1 (3.8)	0.722
*SD: standard deviation			

Table 2. Comparison of sensory block level between dependent and non-dependent side at 10 minutes in both studied groups

Sensory block level	Rapid group (n=25)		Slow group (n=25)	
	Dependent	Non-dependent	Dependent	Non-dependent
T4	1	0	4	1
T5	3	3	1	2
T6	6	1	3	4
T7	1	1	2	1
T8	4	6	2	3
T9	0	0	1	0
T10	4	8	10	4
T11	1	0	0	1
T12	5	4	2	6
L1	0	1	0	3
L2	0	1	0	0
*Fisher's exact test, P. value	0.003		< 0.001	

Table 3. Comparison of sensory block level between dependent and non-dependent side at 30 minutes in both studied groups

Sensory block level	Rapid group (n=25)		Slow group (n=25)	
	Dependent	Non-dependent	Dependent	Non-dependent
T4	1	1	4	1
T5	4	3	1	3
T6	6	2	4	4
T7	2	2	1	2
T8	2	6	4	2
T9	1	0	2	0
T10	7	6	7	7
T11	0	1	12	0
T12	2	2	0	4
L1	0	2	0	2
*Fisher's exact test, P. value	0.003		< 0.001	

Table 4. Comparison of Bromage motor blockade score at dependent side at 10 and 30 minutes in both studied groups

Time	Bromage Motor blockade score	Rapid group (n=25)	Slow group (n=25)	P. value, between groups
At 10 minutes	0	0	0	0.083
	1	1	0	
	2	10	4	
	3	14	21	
At 30 minutes	0	0	0	1.00
	1	0	0	
	2	1	1	
	3	24	24	
*Fisher's exact test, P. value		0.001	0.102	

Table 5. Comparison of Bromage motor blockade score at non-dependent side at 10 and 30 minutes in both studied groups

Time	Bromage Motor blockade score	Rapid group (n=25)	Slow group (n=25)	P. value, between groups
At 10 minutes	0	16	14	0.066
	1	5	1	
	2	4	6	
	3	0	4	
At 30 minutes	0	0	0	1.00
	1	0	0	
	2	10	10	
	3	15	15	
*Fisher's exact test, P. value		**<0.001**	**<0.001**	

Table 6. Comparison of Bromage Motor blockade score between dependent and non-dependent side at 10 minutes in both studied groups

Side	Bromage Motor blockade score	Rapid group (n=25)	Slow group (n=25)
Dependent	0	0	0
	1	1	0
	2	10	4
	3	14	21
Non-dependent	0	16	14
	1	5	1
	2	4	6
	3	0	4
*Fisher's exact test, P. value		0.404	0.102

Table 7. Comparison of Bromage Motor blockade score between dependent and non-dependent side at 30 minutes in both studied groups

Side	Bromage Motor blockade score	Rapid group (n=25)	Slow group (n=25)
Dependent	0	0	0
	1	0	0
	2	1	1
	3	24	24
Non-dependent	0	0	0
	1	0	0
	2	10	10
	3	15	15
*Fisher's exact test, P. value		0.400	0.400

Table 8. Comparison of systolic blood pressure across the 42 minutes in both studied groups

Time	Rapid group (n = 25)		Slow group (n = 25)		P. value
	Mean (mmHg)	SD	Mean (mmHg)	SD	
Baseline	125.6	14.1	133.5	14.2	0.054
3 min	116.5	13.7	123.6	15.6	0.096
6 min	117.6	14.5	123.9	14	0.123
9 min	119.1	14.5	121.4	21.4	0.662
12 min	116.3	16	127.6	14.6	**0.012**
15 min	118.8	14.3	126.4	14.7	0.068
18 min	117.8	12.6	127.5	17.4	**0.029**
21 min	118.8	13.7	124.7	15.3	0.159
24 min	119.8	15.3	125.6	13.4	0.158
27 min	115.5	17.5	124	14	0.065
30 min	117	13.9	124.4	11.6	**0.048**
33 min	117.8	13.9	122.7	10.9	0.172
36 min	118.8	13.7	125.9	16.3	0.101
39 min	116.5	16.8	122.4	13.6	0.177
42 min	112.2	15.4	123.2	18.7	**0.028**
P. value	**0.001**		**0.002**		

Table 9. Comparison of Diastolic blood pressure across 42 minutes in both studied groups

Time	Rapid group (n = 25)		Slow group (n = 25)		P. value
	Mean (mmHg)	SD	Mean (mmHg)	SD	
Baseline	70.3	14.4	76.5	13.6	0.124
3 min	66.7	13.2	70	12.8	0.383
6 min	64.3	13.1	69.6	11.6	0.135
9 min	66	13.3	67	11.4	0.777
12 min	66.1	12.9	70	14.6	0.314
15 min	65	11.9	69	11.6	0.230
18 min	62.1	12.5	67.2	11.4	0.136
21 min	61	14	68.4	11.4	0.048
24 min	61.2	13.2	68.4	11.8	0.048
27 min	60.6	17.1	65.8	13.2	0.231
30 min	64.5	12.2	67.4	12	0.393
33 min	62.6	12.2	68.1	11.7	0.111
36 min	62.6	13.4	68.5	11.3	0.099
39 min	59.6	13	70.7	13.5	0.005
42 min	60.3	11.1	68.8	13.9	0.021
P. value	**0.007**		**0.01**		

Table 10. Comparison of mean arterial pressure across 42 minutes in both studied groups

Time	Rapid group (n = 25)		Slow group (n = 25)		P. value
	Mean	SD	Mean	SD	
Baseline	87	14.3	92.1	13.3	0.195
3 min	82.6	14.7	85	12.1	0.532
6 min	81.3	14.2	86.7	10.8	0.136
9 min	81.9	15.2	84.4	13	0.539
12 min	82.9	12.9	89.5	11.8	0.065
15 min	81.9	12.3	85.7	10.1	0.233
18 min	79.8	10.3	86.7	13	**0.044**
21 min	81.1	13.4	86.2	11	0.144
24 min	79.1	12.1	85.8	11	**0.046**
27 min	78	14.1	85.2	11.1	**0.048**
30 min	79.9	13.2	83.5	9.9	0.28
33 min	80.8	14.9	86.6	10.2	0.117
36 min	79.3	13.6	87.6	10.7	**0.021**
39 min	77	11.9	85.4	11.5	**0.015**
42 min	77	12.3	85	13.4	**0.031**
P. value	**0.009**		**0.008**		

Table 11. Comparison of heart rate across 42 minutes in both studied groups

Time	Rapid group (n = 25)		Slow group (n = 25)		P. value
	Mean	SD	Mean	SD	
Baseline	91.9	14.8	87.2	13.8	0.348
3 min	90.6	15.5	87.3	12.8	0.482
6 min	91	16.9	86.3	14.1	0.292
9 min	92.2	17.9	85.3	15.3	0.167
12 min	91.1	16.2	84.5	16.1	0.155
15 min	90.4	14.7	84.5	16.3	0.184
18 min	89.8	15.8	81.4	12.4	**0.042**
21 min	86.8	17.2	77.8	12.9	**0.041**
24 min	88	18.9	77.8	11.8	**0.027**
27 min	84.7	14.1	76.5	10.9	**0.048**
30 min	87.2	19.9	76.4	11.7	**0.023**
33 min	86.8	17.9	76.6	12	**0.022**
36 min	87.8	16.6	76.2	12.1	**0.007**
39 min	89	17	76.1	14.1	**0.041**
42 min	88	16.8	75.8	11.9	**0.017**
P. value	**0.024**		**0.004**		

Table 12. Needed Ephedrine and Atropine administration among the studied group

Agent		Rapid group	Slow group	Total	P. value
Need Ephedrine	Yes	8	4	12	0.645
	No	17	21	38	
Need Atropine	Yes	0	1	1	1.00
	No	25	24	49	
Total		25	25	50	

Table 13. P. values bivariate analysis (Pearsons/Spearman's test) for the correlation of baseline characteristics and vital signs

Group		P. values for correlations			
	Variable	SBP	DBP	MAP	HR
Rapid group	Age	0.988	0.56	0.967	0.791
	Gender	0.919	0.973	0.292	0.634
	Weight (kg)	0.654	0.187	0.077	0.531
	BMI (kg/m²)	0.812	0.155	0.234	0.708
	ASA	0.483	0.311	0.394	0.906
Slow group	Age	0.633	0.865	0.81	0.451
	Gender	0.634	0.833	0.19	0.977
	Weight (kg)	0.282	0.901	0.639	0.38
	BMI (kg/m²)	0.232	0.499	0.724	0.649
	ASA	0.411	0.22	0.222	0.067

4. DISCUSSION

Speed of injection predicted to affect spread of local anesthetic in spinal anesthesia where pattern of anesthetic flow can affected by speed of injection, high speed may produce turbulent flow and thus lead to irregular distribution of anesthetic agent (Bourke et al.1993) [12].In (Rigler and Drasner,1991; Ross et al.1992) in vitro studies using micro catheters have shown that fast injection rate may lead to turbulent flow and dilution of anesthetics, whereas slow injections make distribution toward gravity (dependent side) [13,14]. In earlier studies, no significant effect of injection rate on distribution of anesthetics had been reported [15–17]. On the other hand, Martin-Salvaj and colleagues did not obtain unilateral spinal anesthesia in any patient by using heavy tetracaine (2.5 ml) at injection speed of (10 sec) and maintain patient in lateral dependent side for (18 min) post injection [18] .

Motor assessment:

Regarding motor assessment in current study we found that after (10 min) of injection and after turning patient to supine, the degree of block of both groups was more dense in operative side, we observe no significant difference in degree of block between two different groups, but after (30min) from injection (20min from turning patient supine), the non-operative side's degree of blockage increased to nearly degree of operative side in both group. In Casati et al.(1998) study [19], they used 1.6ml of hyperbaric bupivacaine and injection rate was (80 sec) in group of slow injection and (6 sec) in group of rapid injection and patient maintain for 15 min then turn patient to supine the result was, patient with unilateral block at 15min from injection was (83%) in group of slow injection and in group of rapid was (83%) then after 45min from turning patient to supine the block reduce to (80%) in group slow and (63%) in rapid rate group, which is considered not significant between both groups. In Apaydin et al.(2011) study [20], they used 1ml 0.5% Marcaine injected into two speed first one was slow at 1ml/min (1 min) and second speed was slower at 0.5 ml/min (2min) and after 15 minutes in a lateral posture, the patient was switched to supine, and the outcome was , At 10, 20, 30, 40, and 50 min post-intrathecal, motor blockade of the operated lower limb was not different between the groups at any time, while the non-operated lower extremity was blocked in considerably more patients in Group slow than in Group of slower injection ,which is considered more restricted motor block at operative side.

Sensory assessment:

According to results of sensory assessment in the current study we found that at (10 min) from injection and after turning patients supine ,the extent of sensory block in operating side of both groups was significantly higher than non-operative side, but after (20 min) from turning to supine ,the degree of sensory block between operative and non-operative side of both groups was nearly equal in each side and there is no significant difference of both group at sensory level. In Casati et al. study [19], the patient with unilateral sensory block at 15min was (73%) in group of slow injection and (60%) in group of rapid injection reduce to (56%) in group slow to (43%) in group rapid at 45 min from supine position ,which is considered not significant between both group. Apayden et al. [20] found that in group of slower injection, a completely unilateral sensory block detected in (87.9%) of patients 15 minutes after intrathecal injection and, interestingly in (93.9%) of individuals at the conclusion of the procedure. A completely unilateral sensory block was detected in group slow (no sensory block observable on the non-operative side). (75.8%) at 15 min post-intrathecal injection reduce to (66.7%) patients and at the end of the operation, which is considered more restrictive sensory at operative side.

Hemodynamic results:

From the side of hemodynamic state we found that the change in blood pressure and heart rate was not significant between both groups. In Casati et al. [19], there is no differences in the incidence of hypotension were observed between the group. So as Apayden et al. [20] did not find significant difference at any time in the mean blood pressure and heart rate between groups. Cho Hs et al. [21] used 2ml of (0.5%) bupivacaine at two injection rate the rapid was injected at (30 sec) and slow injected at (1min), no significant variations in blood pressure were seen between the two groups at 5, 10, 15, 30, and 60 minutes after injecting the hyperbaric bupivacaine (0.5%).

It is important to reduce anesthetic the dose to restrict the anesthetic to dependent side, as an obvious association between dose and lateral sensory block had been reported [22,23]. Low injection rate helps to reduce spread of anesthetic to ipsilateral side. flow of anesthetic become more laminar at low rate of injection which reduce dilution of anesthetic in the cerebrospinal fluid and improve occurrence of lateral spinal anesthesia [24]. According to baricity of anesthetics in cerebrospinal fluid, unilateral block can be obtained if the patient remain in a lateral decubitus position, but turning patient to supine position lead to partial spread to non-dependent side [25]. Also, Enk D. mentioned the importance of low dose, low volume and slow speed in achieving unilateral spinal block [26].

5. CONCLUSIONS

The speed of injection of local intrathecal hyperbaric Marcaine 0.5% had no clinically significant effect on hemodynamic stability, motor and sensory blockade in lateral spinal anesthesia. We suggest that no need to reduce rate of injection when we give lateral spinal anesthesia. However, further studies are highly suggested with larger number of patients in more than center to confirm the findings

Ethical Approval:

All ethical issues were approved by the author. Data collection and patients' enrollment were in accordance with Declaration of Helsinki of World Medical Association, 2013 for the ethical principles of researches involving human. Signed informed consent was obtained from each participant and data were kept confidentially.

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