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Research Article

The Effect of Adding Dexamethasone to Bupivacaine on Spinal Anesthesia Duration in Candidates of Lower Extremities Surgery

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ABSTRACT

BACKGROUND: Bupivacaine is one of the most common drugs that is used in spinal anesthesia using intrathecal injection for local anesthetic. This study aimed to determine the effect of adding dexamethasone to bupivacaine on the starting and duration of spinal anesthesia for elective surgery in patients with lower extremity is done.

METHODS This is a double blinded clinical trial study that was done on 40 patients' candidate for lower extremities orthopedic surgeries. First group received 2 mL bupivacaine 0.5 % plus 1 mL of saline with size 3 CC in intrathecal space, and the treatment group received 2 mL bupivacaine with bupivacaine plus dexamethasone 4 mg (1 cc volume) with a total volume of 3 ml.

RESULTS: The mean age of the study population was 52.27 ± 18.74 years. Visual analog score (VAS) in both groups was not significantly different (P: 0575) although digit of highest thoracic dermatome involvement (P: 0.003), time of knee motion inability (P: 0.002), Time of return of knee motion ability (P: 0.000), time of reaching the anesthetic to the tenth thoracic dermatome (P: 0.000) and time of reaching the anesthetic to the tenth thoracic dermatome (P: 0.002) were significantly different in the two groups.

CONCLUSION: In surgeries that returning time of physical activity affect the surgical outcome, addition of dexamethasone to bupivacaine find a particular importance. Despite the results of the safety of intrathecal administration of dexamethasone, further studies with more patients on the benefits and side effects of the medication may be necessary.

KEYWORDS: Bupivacaine, Dexamethasone, Spinal anesthesia

INTRODUCTION

The intraspinal injection of local anesthetics is one of the common methods of anesthesia for orthopedic surgeries in lower extremities and inferior abdominal operations. The advantages of this method include absence of the hazards of general anesthesia such as aspiration of gastric contents and intubation problems [1]. Bupivacaine is one of the local anesthetics used in spinal anesthesia. The use of bupivacaine is suitable in surgical operations lasting between 90-120 min [1-3]. However, other drugs like epinephrine, phenylephrine, clonidine, morphine, and phentanyle are added to the local anesthetic at the time of injection to make the effect of the anesthetic more durable and promote the anesthesia quality [2-5]. The addition of any of these drugs has its own advantages as well as some disadvantages. For instance, adding epinephrine causes tachycardia, hypertension, and pale complexion of the patient which are dangerous for patients with underlying cardiovascular diseases [1]. Moreover, adding opioids to local anesthetics in intraspinal injection may induce CNS effects

and respiratory depression. Considering these shortcomings of the used drugs, the idea of using less hazardous newer drugs to be added to local anesthetics has been always present in the clinicians' minds. Regarding the use of corticosteroids to lengthen the local neurologic blocks, the idea of the use of these drugs for spinal anesthesia was introduced. Several studies have approved the safety of intraspinal administration of these drugs [6-8]. Moreover, the efficacy of dexamethasone in reducing chronic pains of cancers and inhibition of incidence of neurologic conditions or specific complications at spinal injection [6-8] encouraged the use of dexamethasone as an adjuvant to the local anesthetic. This study determined the effect of adding dexamethasone to bupivacaine on duration of spinal anesthesia in candidates of lower extremities surgery.

MATERIALS AND METHODS

This observational clinical trial was a randomized double-blind study. The required data were collected in orthopedic operating rooms of ShahidSadoughi Hospital in Yazd during September 2012 to September 2013.This study was approved by the Ethic Committee of ShahidSadoughi University of Medical Sciences, Yazd, Iran. To double-blind the study, drug preparations were made by an anesthetist without informing the anesthesiologist considering the random numbers table and the assigned group. The study was conducted on 40 patients aged 18-70 years who were candidates of orthopedic surgery of lower extremities at ShahidSadoughi Hospital. The exclusion criteria included history of cardiovascular diseases, diabetes, history of chronic pains, long-term consumption of analgesics, addiction, history of sensitivity to local anesthetics, long-term use of corticosteroids, infection at the site of local anesthesia, history of neurologic and psychological disorders, history of spinal surgery, and history of chronic lower back pain. Using random numbers table, the patients were assigned into two groups of 20: Group 1 received only bupivacaine while group 2 received bupivacaine plus dexamethasone. After wheeling the patient onto the surgical table, the patient was monitored by electrocardiography, pulse oximetry, and noninvasive measurement of blood pressure. All of the patients were then given 5 cc/kg of ringer lactate plus other calculated required fluids through a venous cannula. Also, all patients received midazolam 1 mg as premedication. To induce spinal anesthesia, the intended drug was injected in the L4-L5 space in the sitting position after prepping and draping using the midline method with Kwinke #25 spinal needle. In so doing, the "bupivacaine group" received %0.5 bovicaine 2 cc plus NSS 1cc with the total volume of 3 cc in the spinal space while the "bupivacaine plus dexamethasone group" received bupivacaine 2 cc and dexamethasone 4 mg (with 1 cc volume) and total volume of 3 cc. After spinal anesthesia, the patients were placed in the supine position. The bed was placed parallel to the horizontal line and the patients were given 3-5 L of oxygen by facial mask. The patients' blood pressure and heart beat were measured and recorded at the time of arrival, immediately after spinal anesthesia, then every 3-15 min till the end of the surgery, and next at recovery every 15 min. After induction of spinal anesthesia, the neurosensory level was checked every 30 s to 20 min. The sensory level was determined with dull-pointed needle at the mid-axillary line of both sides. Then, the patient was asked every 5 min about the onset of pain and the ability to move the knee and the results were recorded. The time of stability of neural block (onset of drug effect) was defined as "the time interval between induction of spinal anesthesia till reaching the highest level of sensory anesthesia" and recorded. To ensure of and compare the effect of the drug, the anesthesia achievement in T10 and L1 was also measured and recorded. The time interval between reaching the maximum level of anesthesia and onset of the patient's pain at the site of surgery was considered as the sensory block duration. In the case of hypotension greater than %30 of the initial (baseline) blood pressure, a bolus of ephedrine by 0.01 mg per kg of body weight was given and in the case of bradycardia with heartbeat less than 50 bpm, atrophine 0.01 mg/kg was administered. After the onset of the patient's pain at the site of surgery, it was measured with the VAS rating system using the

0-10-point scale and recorded. In the case of a pain score greater than 10, 25 mg of petidine was administered to the patient. The patients were assessed and followed up at discharge from recovery, before discharge from hospital, 1 month later for neurologic problems requiring hospitalization, and feeling of paraesthesia and discomfort in the lower extremities. The patients' demographic information including height, weight, age, and sex were also recorded. Complications such as nausea and vomiting were treated by 0.15 mg/kg of metochlopramide in the case of incidence. The gleaned data were analyzed with SPSS using Fisher Exact test and Mann-Whitney U test ($P<0.05$).

RESULTS

In this study, 40 patients were investigated in two groups of 20. Before data analysis, demographic information of the patients including age, height, weight, and body mass index (BMI) were surveyed indicating no significant difference between the two groups in these variables (Table 1).A comparison of the time parameters of the two groups under study displayed in Table 2 is also considerable (Table 2).Using visual assessment scale (VAS), the rate of pain at the end of anesthesia was assessed as one of consequences investigated in the two groups in this study which showed no significant difference between the two groups regarding $P=0.575$ obtained by Mann-Whitney U test. The data on pain rate at the end of anesthesia and also the highest level of neural block are presented in Table 3 (Table 3).As the results show, there was no significant difference in the highest level of neural block between the two groups ($P=0.904$)). Also, regarding the rate of nausea and vomiting in the two groups, it was observed that 5 patients (25%) in the control group and 3 patients (15%) in the case group had nausea which indicated no significant difference. No patient suffered from vomiting. Moreover, receiving ephedrine during anesthesia following hypotension was evaluated in both groups showing that 11 patients (55%) in the control group and 6 patients (31.6%) in the case group had received ephedrine. This difference was not significant, yet. A comparison of heart beat in both groups revealed that although the heart beat of case group was higher before drug administration compared to the control group, the heartbeat decreased in the case group following the injection of dexamethasone so that it was not statistically different from the mean heartbeat of the patients in the control group till the end of 1 h (Figure 1). Moreover, the systolic pressures at 0 and 15 min were not significantly different. Nonetheless, at 30, 45, and 60 min, the systolic pressure decreased significantly (Figure 2). An analysis of diastolic pressure displayed in Figure 3 demonstrated no significant difference at 0, 15, and 30 min; however, it decreased significantly 45 and 60 min. Finally, no complication was reported in any group with respect to neurologic conditions, unpleasant feeling in the lower extremities, and paresthesia.

DISCUSSION

This study investigated the effect of adding dexamethasone to bupivacaine on increasing the analgesia duration and speed of onset of anesthesia. Our findings indicated increased speed of anesthesia onset and increased analgesia (anesthesia) time in patients, faster initiation, and shorter duration of motor block in the case group compared to the control group. On the basis of our findings, the speed of anesthetic involvement of dermatome of T10 and L1 and also induction of anesthesia in the highest involved dermatome increased in the case group compared to the control group. To increase the accuracy of the study, the times of regaining sensation at the L1 and T10 levels were also studied indicating a significant difference in the two parameters between the two groups ($P<0.05$). In the only similar study carried out by Banihashem et al., adding 8 mg of dexamethasone to spinal bupivacaine did not produce any difference in the onset of effect [9]. Moreover, faster initiation of anesthesia and shorter duration of neural block was observed in the case group. In the study by Movafeq et al., adding epinephrine and dexamethasone to lidocaine caused no difference in the onset of sensory-motor block [10]. In Banihashem et al.'s study, the time of onset of motor block was not investigated though, of course, an increase in motor block duration was reported. In the present study, the motor block duration in

dexamethasone group was less than the control group. In the present study, there was a significant increase in anesthesia duration in the case group compared to the control group; nevertheless, there was no significant difference between the two groups in the patient's pain at the end of anesthesia using VAS. Previous studies, specially Banihashem et al.'s study in which 8 mg of bupivacaine was added to bupivacaine, and other studies in which dexamethasone was added to lidocaine[10, 11], reported increased time of anesthesia (analgesia). Several studies have reported the increased efficacy of local anesthetics in the induction of neural blocks by adding dexamethasone [12-14] and increased anesthesia duration due to addition of dexamethasone and hydrocortisone to epidural injections [15-16]. It has been also demonstrated that the administration of systemic steroids results in a reduction in postoperative pain [17-21]. It appears that several mechanisms contribute to the patients' increased anesthesia time. On the other hand, the systemic absorption and the effect of dexamethasone on the immune system influence the increased anesthesia duration in patients. On the other hand, it has been demonstrated that the intraspinal injection of steroids reduces the production of prostaglandins via inhibiting the cycles of oxygenase and phospholipase A2 [14]. Additionally, some studies suggest that local administration of dexamethasone may lead to increased effect of local anesthetics through inhibiting the release of inflammatory mediators. Another assumption is that the vessel-constricting effect of steroids and their effect on glucocorticoid receptors increase the anesthesia time. Regarding nausea and vomiting, 25% (5 patients) of the control group and 15% (3 patients) of the case group had nausea none of which resulted in vomiting. Despite the absence of any significant difference, a smaller rate of nausea was observed in the dexamethasone group. In the study by Movafeq et al., no difference was observed between the "dexamethasone plus lidocaine group" and "lidocaine only" group". However, a significant decrease in nausea and vomiting was observed in dexamethasone group in three other studies [22]. Various mechanisms are said to be responsible for this effect. It appears that the systemic absorption of dexamethasone and its effect on steroid receptors of postrema region involved in nausea and vomiting regulation induce this effect [23] although the exact mechanism is not known yet. Perhaps the low number of patients in our study has led to insignificant results. The highest level of anesthesia was not significantly different between the two groups which is justifiable seeing the equal drug volumes and the similar condition of the patients. One of the strong points of the present study compared to previous ones was the use of a smaller dose of dexamethasone and also smaller total volume of the drug (3 cc) injected in the spinal fluid and thus reducing the concerns with the involvement of higher thoracic dermatomes. In Banihashem et al.'s study, no significant difference was observed in hemodynamic parameters between dexamethasone plus bupivacaine groups and bupivacaine only groups; nevertheless, in the study by Naziri et al. decreased systolic pressure was observed in dexamethasone group [11]. In the present study, blood pressure and heartbeat were measured and recorded at arrival and immediately after spinal anesthesia induction, then one time every 3-15 min, next every 5 min till the end of surgery, and then again in recovery every 15 min. However, in the related tables, they are reported only at 0 min and then every 15 min to 1 h, i.e., the times with important results. According to our results, there was no significant difference in heartbeat at numerous times. An interesting point was the significant difference in heartbeat before administration of spinal drug in the case group so that there was an obvious drop in heartbeat following intraspinal injection of local anesthetic plus dexamethasone while there was no significant difference between the two groups after 1 h. Statistical analysis revealed no significant difference in systolic pressure at 0 and 15 min, yet, the systolic pressure decreased significantly at 30, 45, and 60 min. However, this drop in pressure was not in the range requiring treatment. Furthermore, the statistical analysis of diastolic pressure showed that there was no significant change at 0, 15, and 30 min

although it was reduced significantly at 45 and 60 min, of course, not in the range requiring treatment. May be increased duration of drug effect and increased anesthesia of the patients contribute to this decreased blood pressure. There was no significant difference between the two groups with respect to administration of ephedrine for which the administration criterion was a drop in blood pressure greater than 30% of the baseline pressure, yet, 55% of the patients in the control group and 31.6% of the patients in the case group required administration of adjuvant drug. Drop in blood pressure in the permitted range not requiring treatment in the case group is a remarkable finding which is useful in surgical operations requiring greater control on blood pressure. Various studies have been conducted on intraspinal administration of steroids indicating safety of these drugs and absence of any neurologic conditions [22-27]. Moreover, regarding the efficacy of steroids in reducing chronic pains and lack of incidence of any neurologic complications at the time of intraspinal injection of dexamethasone [26, 27], the present study also demonstrated that no neurologic condition leading to hospitalization or feeling of paresthesia and discomfort in the lower extremities in intraspinal dexamethasone group was observed during the follow-up till discharge and during one-month follow-up after discharge.

CONCLUSION

Adding dexamethasone to bupivacaine increases the speed of onset of local anesthetics effects (considering the sensory-motor criteria), promotes the anesthesia duration, and also reduces motor inability time in patients. This finding is of utmost significance especially in surgical operations in which the regaining of physical activities by patients affects the consequences of the surgery. Furthermore, lack of any effects on hemodynamic parameters and the surface of the involved dermatome by dexamethasone decreases concerns about the negative effects of intraspinal injection of dexamethasone. In spite of promising results on the safety of intraspinal injection of dexamethasone, more research is needed on the advantages and complications of this drug with greater patient populations.

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Table 1. Comparison of background variables in the two groups under study.

Group / Variables		Interventional	Control	P-Value
Age(Y)		50/05±18/37	54/5±19/32	0/46*
Sex	Male	16(80%)	12(60%)	0/3**
	Female	4(20%)	8(40%)	
Height(cm)		172/55±7/3	170/45±6/587	0/35*
Weight(Kg)		71/6±10/59	67/3±9/8	0/191*
BSA(m^2/Kg)		25/5±4/96	24/09±3/59	0/31*

Table 2. Comparison of various time parameters in the two groups under study.

Variables	Interventional	Control	P-Value*
Analgesia duration(min)	381±36/08	207±19/97	0/004
Motor block duration(min)	106±34/66	135±17/18	0/000
Onset of highest level of neurosensory blockade (min)	6/34±2/76	9/32±2/68	0/003
Time of target numbness (T10)	5/75±2/7	8/14±2/46	0/000
Time of target numbness(L1)	3/5±2/49	6/3±2/25	0/002
Onset of motor block (min)	3/8±2/12	6/7±1/87	0/002

Table 3. Frequency distribution of patient's pain status at the end of anesthesia and the highestlevel of neurosensory blockade in the two groups under study.

Variables		Interventional	Control	P-Value*
patient's pain status at the end of anesthesia	3,4	13(65)	12(60)	0/575
	5,6	7(35)	6(30)	
	7,8	0	2(10)	
highest level of neurosensory blockade	4,5,6	6(30)	5(25)	0/904
	7,8	4(20)	5(25)	
	9,10	10(50)	10(50)	