ORIGINAL REPORT

The Hemodynamic Effects of Spinal Block with Low Dose of Bupivacaine and Sufentanil in Patients with Low Myocardial Ejection Fraction

Mehdi Sanatkar[1,4], Mostafa Sadeghi[2], Nafiseh Esmaeili[3], Hossein Sadrossadat[4], Mehrdad Shoroughi[4], Shahrokh Ghazizadeh[3], Ebrahim Khoshraftar[5], Hassan Pour Anvari[5], and Nasim Alipour[5]

[1] *Department of Anesthesiology, Razi Hospital, Tehran University of Medical Sciences, Tehran, Iran*

[2] *Department of Anesthesiology, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran*

[3] *Autoimmune Bullous Disease Research Center, Razi Hospital, Tehran University of Medical Sciences, Tehran, Iran*

[4] *Department of Anesthesiology, Farabi Hospital, Tehran University of Medical Sciences, Tehran, Iran*

[5] *Department of Anesthesiology, Besat Hospital, Hamedan University of Medical Sciences, Hamedan, Iran*

Received: 6 Jun. 2012; Received in revised form: 16 Jan. 2013; Accepted: 15 Feb. 2013

Abstract- The aim of this study was to assess the effect of spinal block with low dose of bupivacaine and sufentanil on patients with low cardiac output who underwent lower limb surgery. Fifteen patients who had ejection fraction less than 40% (group 1) were compared with 65 cases with ejection fraction more than 40% (group 2) in our study. Our subjects underwent spinal block with 7.5 mg hyperbaric bupivacaine 0.5% and 5 µg sufentanil. We recorded early events such as hypotension, bradycardia, vasopressor need and ST segment change in our cases. The average mean arterial pressure decreased 13% (110 mmHg to 95.7 mmHg) in group 1 and 20% (160 mmHg to 128 mmHg) in group 2 (P<0.001). Hypotension due to spinal anesthesia was observed in none of our subjects in both groups and none of our cases need to vasopressor support. All patients remained alert, and no ST segment changes were observed in two groups. In our study none of subjects complained of pain intraoperatively. The subjects were without complaints during the spinal anesthetic in both groups. Spinal block with low dose local anesthetic and sufentanil was a safe and effective method for lower limb surgery in patients with low ejection fraction.

Acta Medica Iranica, 2013; 51(7): 438-443.

Keywords: Bupivacaine; Ejection fraction; Hypotension; Spinal block

Introduction

Subarachnoid block is often considered as a safe method of anesthesia because of low decrease in myocardial contractility and modest decrease in cardiac output (1). Therefore, these situations are very attractive for patients with cardiac diseases and especially known congestive heart failure. In patients with congestive heart failure the activity of sympathetic nervous system increases (2,3), and with spinal anesthesia in these cases the systemic vascular resistance (SVR) and blood pressure may decrease more than patients with good left ventricular function (4). Previous studies showed that hypotension after spinal block could be minimized by using of small dose of local anesthetics (5). Elderly patients who underwent spinal anesthesia for hip surgery by 5 mg bupivacaine showed low incidence of hypotension. (5) The main problem of spinal anesthesia with small dose of local anesthetic may be limitation of distribution of the block and inadequate level of sensory block (1). We can decrease this problem by combination of local anesthetic with opioid because it could be enhance the sensory block without increase of degree of sympathetic blockade (6). Sufentanil is a short-acting lipophilic opioid and may be the best opioid for combination with local anesthetic in spinal block because it has a higher affinity for the opioid receptor and may be stabilizing the hemodynamic variables better than other opioids such as fentanyl especially in elderly patients or patients with cardiac dysfunction (7). The aim of this study was to identify the hemodynamic effects of subarachnoid block with small dose of bupivacaine and sufentanil in patients with congestive heart failure who undergoing lower limbs surgery.

Corresponding Author: Mostafa Sadeghi
Department of Anesthesiology, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran
Tel: +98 21 66581537, Fax: +98 21 66581519, E-mail: sadeghim@tums.ac.ir

Materials and Methods

In this case-control clinical trial eighty patients with society of anesthesiologists (ASA) physical status I–III underwent subarachnoid anesthesia for hip surgery (total hip replacement surgery in 15 cases and hip fracture surgery in 65 cases) from June 2011 until February 2012 after review of board approval in our hospital. In our study fifteen cases who had ejection fraction 40% or less that established with echocardiography (group 1) were compared with other subjects (n=65) with ejection fraction more than 40% (group 2). The etiology of low ejection fraction in group 1 was ischemic heart disease. Patients with acute disturbance in their medical status such as recent severe uncompensated heart failure, malignant arrhythmia, unstable angina, severe mitral valve stenosis and severe aortic valve stenosis were excluded from our study. The monitoring of our subjects during the operation and post operation was non invasive arterial blood pressure measured every five minutes, pulse-oximetry, five leads continuous ECG and ST segment analyzer (Novin S1800, Iran). To identify the motor block we use modified Bromage scale (0 = no motor block; 1= hip blocked; 2= hip and knee blocked; 3= hip, knee and ankle blocked) and surgery was began when anesthesiologist justify the modified Bromage score 2 or 3 on the operated limb. All subjects preloaded with ringer lactate 5 ml/kg before spinal block. Spinal anesthesia was performed with midline approach at the L3-4 interspace with 25-Gauge Whitacre spinal needle. After entrance of needle to subarachnoid space 7.5 mg hyperbaric bupivacaine 0.5% plus 5 µg sufentanil was injected and patients were immediately turned to supine position. We recorded all complications or events after spinal block such as hypotension, bradycardia, tachycardia and volume or vasopressor need. Hypotension following spinal anesthesia defined as decrease of mean arterial pressure more than 20% from the baseline or systolic blood pressure less than 90 mmHg after spinal block. We treated hypotension if needed first with loading of crystalloid fluid or intravenous ephedrine. The statistical significance of the effect of spinal anesthesia was assessed by a paired, two-tailed Student's t-test and the ANOVA test. Associations among variables were assessed with the Pearson correlation coefficient. Values are reported as mean±SD. Significance was defined as $P<0.05$.

Results

The age range of patients was between 45 and 85 years. The duration of surgery in our subjects was 140±40 minutes. The average mean arterial pressure decreased 13% (110 mmHg to 95.7 mmHg) in group 1 and 20% (160 mmHg to 128 mmHg) in group 2 ($P<0.001$) (Table 1 and Figures 1-3).

Table 1. The comparison of percent decreased of systolic, diastolic, mean arterial pressure and heart rate in the response to spinal anesthesia in both groups.

Variables		The percent of decrees of arterial pressure and heart rate after spinal block		*P*-value
		EF=<40%	EF>40%	
Systolic Blood Pressure	5 min	2.8±0.4	10.8±1.4	<0.001
	10 min	7.0±0.9	16.5±3.4	
	30 min	11.9±1.8	20.0±3.6	
Diastolic Blood Pressure	5 min	2.2±0.6	8.7±1.8	<0.001
	10 min	3.3±0.4	14.5±2.9	
	30 min	16.6±2.6	18.4±4.0	
Mean Arterial Pressure	5 min	1.9±0.2	10.0±2.5	<0.001
	10 min	4.7±0.8	15.7±2.1	
	30 min	13.0±2.8	19.6±3.8	
Heart Rate	5 min	3.1±0.4	6.2±0.6	<0.001
	10 min	6.2±0.8	7.4±0.9	
	30 min	9.3±1.4	13.5±2.9	

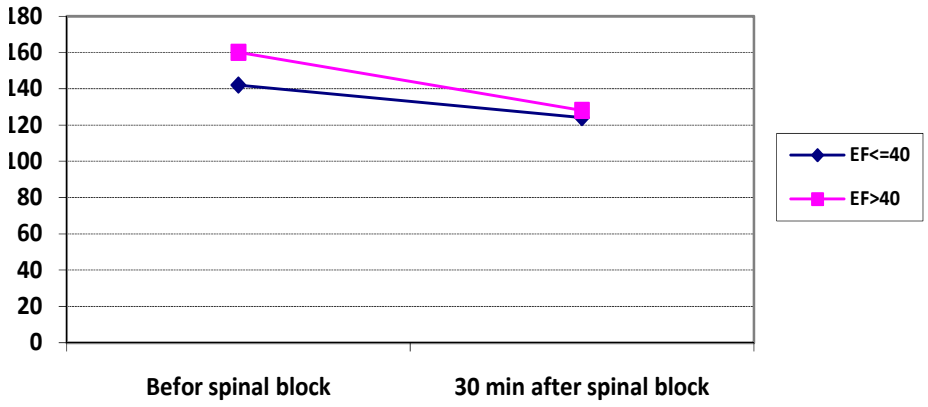

Figure 1. The comparison of systolic blood pressure (mmHg) before and 30 minutes after spinal anesthesia in both groups.

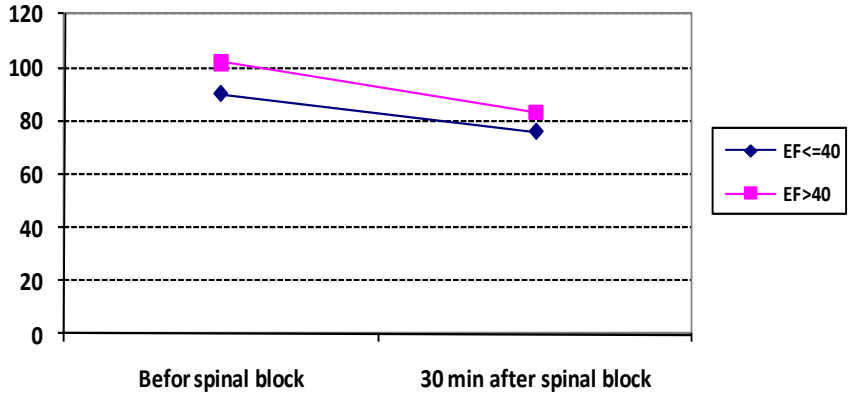

Figure 2. The comparison of diastolic blood pressure (mmHg) before and 30 minutes after spinal anesthesia in both groups.

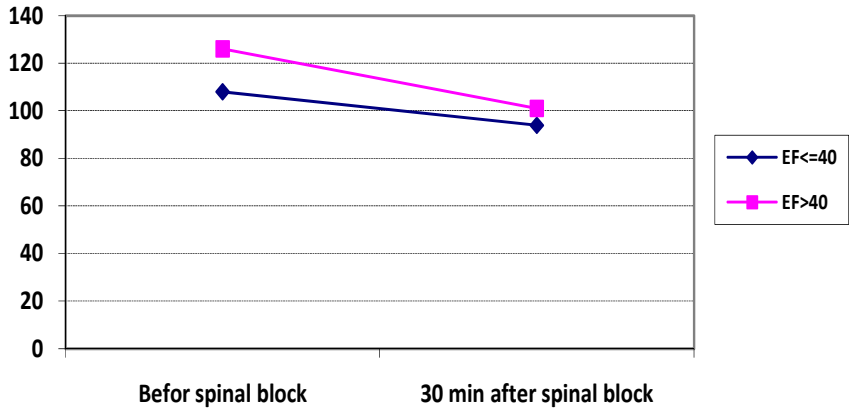

Figure 3. The comparison of mean arterial pressure (mmHg) before and 30 minutes after spinal anesthesia in both groups.

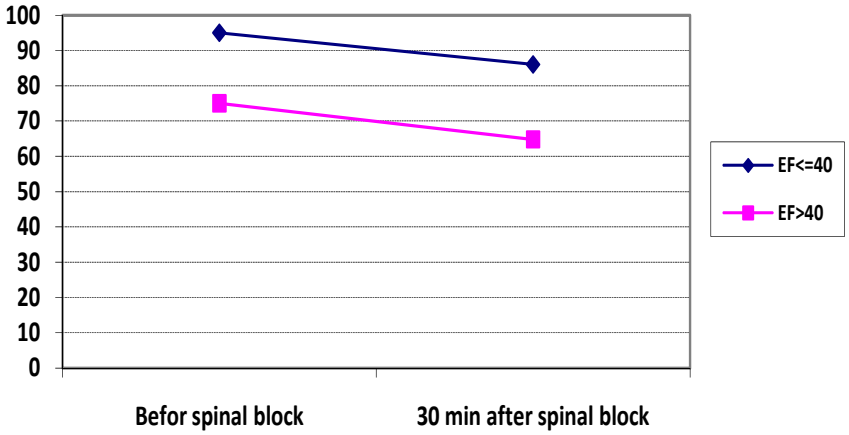

Figure 4. The comparison of heart rate (bpm) before and 30 minutes after spinal anesthesia in both groups.

The level of sensory block following anesthesia was observed in T7 (n=1), T8 (n=12) and T10 (n=2) in group 1 and T6 (n=2), T7 (n=7), T8 (n=48) and T10 (n=8) in group 2 (*P*=NS). The grade of motor block after spinal anesthesia was 0(none), 1 (none), 2 (n=3) and 3 (n=12) in group 1 and was 0 (none), 1 (none), 2 (n=13) and 3 (n=52) in group 2 (*P*=NS). Hypotension due to spinal anesthesia was observed in none of our subjects and none of our cases need to vasopressor support in both groups. No subject had a heart rate above 90 bpm and below 60 bpm during spinal anesthesia (Figure 4). All patients remained alert, and no ST segment changes were observed intra-operative and till 6 hours after operation in all our subjects.

In our study none of subjects complained of pain intraoperatively, although some of the surgical operation lasted as long as 120 minutes. All patients were without complaints such as hemorrhage, infection, respiratory complication and renal complication during and after operation.

Discussion

This study evaluates the hemodynamic effects of small dose of bupivacaine and sufentanil in 15 patients with low ejection fraction who underwent lower limb surgery. The 13% average decrease in mean arterial pressure in group 1 and 20% decreased in group 2 were not dramatic compared to other report with 21% to 32% decrease in mean arterial pressure in patients with regular dose of bupivacaine (8,9). Two variables that identify cardiac output are ejection fraction and heart rate, and ejection fraction dependent to myocardial contractility and end diastolic filling. The patients who have decrease myocardial contractility for maintain cardiac output are very dependent on left ventricular end-diastolic volume (LVEDV) and in these subjects increase of heart rate could not be efficacious (10,11). In these patients sympathetic system activity and therefore SVR increased and this modification could more decrease the cardiac output (12,13). Spinal anesthesia with loss of sympathetic activity cause peripheral pooling of blood and could reduce end-diastolic volume. Patients with low ejection fraction are preload-dependent and spinal block introduce to further lowering stroke volume and decrease cardiac output. Previous studies identified that spinal block may decrease up to 19% in left ventricular end-diastolic volume and this modification was the primary cause of decrease in cardiac output especially in patients with low ejection fraction (14). Patients with low cardiac index who underwent spinal block with low dose of local anesthetic showed less decrease in mean arterial pressure because small dose of local anesthetic blocked sympathetic system less than traditional dose (5).

Moreover, we observed that decrease of systolic, diastolic and mean arterial pressure in patients with low ejection fraction were lower than patients with EF>40%. We think that this finding related to increase of cardiac output due to reducing of SVR and afterload in patients with low ejection fraction more than control group. Managing of hypotension after spinal block may range from overloading intravenously fluids and using vasopressors (15). Overloading in subjects with myocardial dysfunction may put them at risk of precipitating pulmonary edema (16). Therefore, use of vasopressor in these patients may be preferred. Moreover, ephedrine treatment of hypotension increases heart rate and would be expected to be particularly deleterious in patients with low ejection fraction (17). Epinephrine infusion during spinal anesthesia has been shown to restore systolic arterial pressure and increase

cardiac output, but with no increase in diastolic or mean arterial pressure (18). The incidence of deep vein thrombosis and pulmonary embolism increase in patients with left ventricular dysfunction therefore spinal block may be prefer to general anesthesia in these patients because thromboembolic events decrease with regional anesthesia (19,20). Our study showed that spinal block with small dose of bupivacaine plus sufentanil in patients with low ejection fraction provide successful anesthesia and minimum decrease in arterial pressure without need to vasopressor support. In our study none of our cases complained of pain during operation. It may be due to delayed pharmacokinetics of drugs in subjects with cardiac dysfunction (21). Sufentanil with high affinity with opioid receptors could be intensifying the blockade of small dose of local anesthetic with minimum block of sympathetic system and only modest decrease of blood pressure (22). These characteristics are attractive for subjects with impaired myocardial contractility that predispose to hemodynamic instability. With agreement with previous studies we observed minimum heart rate changes after spinal block with small dose of local anesthetic, that this finding is very important in patients with low ejection fraction who had lower cardiac reserve. Therefore, we concluded that spinal block with low dose local anesthetic and sufentanil was a safe and effective method for lower limb surgery in patients with low ejection fraction.

References

1. Wilkins K. Health care consequences of falls for seniors. Health Reports 1999;10(4):47–55.
2. Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. Osteoporosis Int 1997;7(5):407–13.
3. Beaupre LA, Jones CA, Saunders LD, Johnston DW, Buckingham J, Majumdar SR.. Best practices for elderly hip fracture patients. A systematic overview of the evidence. J Gen Intern Med 2005;20(11):1019–25.
4. Ben-David B, Frankel R, Arzumonov T, Marchevsky Y, Volpin G. Minidose bupivacaine-fentanyl spinal anaesthesia for surgical repair of hip fracture in the aged. Anesthesiology 2000;92(1):6–10.
5. Selda S, Aydin K, Discigil G. Hypotension induced by lateral decubitus or supine spinal anesthesia in elderly with low ejection fraction undergoing hip surgery. Journal of Clinical Monitoring and Computing 2007;21(2):103–7
6. Lakatta EG, Gerstenblith G. Cardiovascular disorders. In: Evans JG, Williams TF, Beattie BL, Michel JP, Wilcock GK (eds) Oxford textbook of geriatric medicine. 2nd Edition. New York, Oxford University press 2000; 323–43.
7. Kim SY, Cho JE, Hong JY, Koo BN, Kim JM, Kil HK. Comparison of intrathecal fentanyl and sufentanil in low-dose dilute bupivacaine spinal anaesthesia for transurethral prostatectomy. Br J Anaesth 2009;103(5): 750-4.
8. Rooke GA, Freund PR, Jacobson AF. Jacobson. Hemodynamic Response and Change in Organ Blood Volume During Spinal Anesthesia in Elderly Men with Cardiac Disease. Anesth Analg 1997;85(1):99-105.
9. Chan VW, Chung F, Gomez M, Seyone C, Baylon G. Anesthetic and hemodynamic effects of single bolus versus incremental titration of hyperbaric spinal lidocaine through microcatheter. Anesth Analg 1994;79(1):117-23.
10. Fanelli G, Borghi B, Casati A, Bertini L, Montebugnoli M, Torri G. Unilateral bupivacaine spinal anaesthesia for outpatient knee arthroscopy. Can J Anesth 2000;47(8):746–51.
11. Elzinga L, Marcus M, Peek D, Borg P, Jansen J, Koster J, Enk D. Hemodynamic stability ensured by a low dose, low volume, unilateral hypobaric spinal block: modification of a technique. Acta Anaesthesiol Belg 2009;60(4):217-20.
12. Rooke GA, Robinson BJ. Cardiovascular and autonomic nervous system aging. Prob. Anaesthesia 1997;9:482–97.
13. Mebazaa MS, Ouerghi S, Ben Meftah R, Ben Cheikh M, Mestiri T, Ben Ammar MS. Reduction of bupivacaine dose in spinal anaesthesia for caesarean section may improve maternal satisfaction by reducing incidence of low blood pressure episodes. Middle East J Anesthesiol 2010;20(5):673-8.
14. Mayl GB, Lanea LF, Lynn-Schoomer MG. Effect of high spinal anesthesia on the cardiac output of normal and hypertensive patients. Am J Med 1949;7:251.
15. Roofthooft E, Van de Velde M. Low-dose spinal anaesthesia for Caesarean section to prevent spinal-induced hypotension. Curr Opin Anaesthesiol 2008;21(3):259-62.
16. Gudaityte J, Marchertiene I, Karbonskiene A, Saladzinskas Z, Tamelis A, Toker I, Pavalkis D. Low-dose spinal hyperbaric bupivacaine for adult anorectal surgery: a double-blinded, randomized, controlled study. J Clin Anesth 2009;21(7):474-81.
17. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R. Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology 1992;76(6):906-16.
18. Akcaboy EY, Akcaboy ZN, Gogus N. Low dose levobupivacaine 0.5% with fentanyl in spinal anaesthesia for transurethral resection of prostate surgery. J Res Med Sci 2011;16(1):68-73.

19. Atalay C, Aksoy M, Aksoy AN, Dogan N, Kürsad H. Combining intrathecal bupivacaine and meperidine during caesarean section to prevent spinal anaesthesia-induced hypotension and other side-effects. J Int Med Res 2010;38(5):1626-36.
20. Kim SY, Cho JE, Hong JY, Koo BN, Kim JM, Kil HK. Comparison of intrathecal fentanyl and sufentanil in low-dose dilute bupivacaine spinal anaesthesia for transurethral prostatectomy. Br J Anaesth 2009;103(5):750-4.
21. Arzola C, Wieczorek PM. Efficacy of low-dose bupivacaine in spinal anaesthesia for Caesarean delivery: systematic review and meta-analysis. Br J Anaesth 2011;107(3):308-18.
22. Florio P, Puzzutiello R, Filippeschi M, D'Onofrio P, Mereu L, Morelli R, Marianello D, Litta P, Mencaglia L, Petraglia F. Low-dose spinal anesthesia with hyperbaric bupivacaine with intrathecal fentanyl for operative hysteroscopy: a case series study. J Minim Invasive Gynecol 2012;19(1):107-12.