Original Article

Haemodynamic Changes & Complications between Unilateral and Bilateral Spinal Anesthesia in Elderly Type-2 Diabetic Patient Undergoing Hemiarthoplasty – A Comparative Study

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Abstract

Background*: During spinal anesthesia, extend of sympathetic blockade causes hemodynamic instability, such as hypotension and bradycardia.It can lead to develop cardiac arrest in some cases. Elderly patient do not compensate these haemodynamic change easily because of aging process leads some physiological changes in all system especially on cardio vascular system e.g; decreased elasticity of vessels, decreased vascular and myocardial compliance and also decreased autonomic responsiveness. It is hypothesized that unilateral spinal anesthesia restrict the spread of hyperbaric bupivacaine to one side only (dependent side) thus sparing the opposite sympathetic chain and hence would cause less haemodynamic changes.*

Materials & Methods*: This cross sectional study, took place in the department of Anaesthesiology and SICU, BIRDEM General Hospital, Shahbag, Dhaka. A total 60 elderly (age-60 to 80 years), ASA grade II and III, type-2 Diabetic patients scheduled for hemiarthoplasty were enrolled in this study. Patients were divided into two groups U & A, 30 patients in each. Subarachnoid (spinal) anaesthesia was performed in all patients with 0.5% hyperbaric bupivacaine intrathecally, at L3 - L4 interspinous spaces, with 25G Quinke's spinal needle. Patients of group U were kept in lateral decubitus position which was maintained for 15 minutes after injecting bupivacaine and patients of group B were kept in supine position. Changes of BP, pulse and development of any complication was recorded in 5 minute interval after spinal anesthesia. All the informations were recorded in preformed data collection sheet.*

Result*: Compared with group U, group B showed statistically significant increase inheart rate at 10 min after spinal anesthesia ($p<0.05$).Systolic BP was significantly lower in group B compared to group U in all recorded time interval except at 60 minute.Diastolic blood pressure was significantly lower in group B compared to group U at 15, 30 and 45 minute reading. Regarding maen arterial pressure we found it was reduced significantly in group B compared to group U in all the recorded time except at 60 minute ($p<0.05$). Present study showed none of the patients in the unilateral group experienced vomiting; only two patients noticed nausea. In the bilateral group, seven patients had nausea and three of them experienced episodes of vomiting ($p = 0.02$). In group U, no case found hypotensive, only single developed bradycardia. In Group B 7 patients experienced hypotensions and 4 patients had bradycardia.*

Conclusion: *This study showed that the unilateral spinal anesthesia reduces the incidence and severity of hypotension, bradycardia and other complication in elderly type-2 diabetic patients. So unilateral spinal anaesthesia is more benifecial for elderly type-2 diabetic patient in hemiarthoplasty.*

Key words: *Haemodynamic changes, complications, Unilateral SAB, Bilateral SAB, Type-2 DM, Hemiarthroplasty*

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Introduction

The most common and serious side-effects of spinal anaesthesia are hypotension and bradycardia. In addition, many representative case reports through literature have discussed cardiac arrest fatalities during spinal anaesthesia. A high ASA physical status and advanced age of patients could contribute to such cardiac arrest fatalities. Hemiarthoplasty is a major portion of orthopaedic surgery. Most of the patients are elderly. Anaesthesia of elderly patients is always challenging for the anesthesiologist. Spinal anesthesia induced hypotension is more common and hazardous in elderly, as they have decreased physiological reserve and compromised blood supply to various vital organs[1]. An important effect of sympathetic inhibition during spinal or epidural anaesthesia is a significant decrease in venous return due to dilatation of resistance and capacitance vessels. Unilateral spinal anaesthesia is very effective in restricting the sympathetic block as all high risk patients showed minimal haemodynamic changes following the technique[2]. Several factors are required for successful unilateral spinal anesthesia, including: the type of needle and its bevel direction, the speed of injection[3], volume, baricity, the concentration of local anesthesia as well as the position of the patient on the operating table[4]. Unilateral spinal anesthesia with a low dose (7.5 mg), limited volume (1.5 ml) and low-flow injection (1 ml/30 s) technique induces sufficient sensory and motor block with an appropriate level of analgesia. The technique is therefore suitable for lower limb surgery. This technique achieves stable haemodynamics, particularly in elderly and ASA class III/IV patients. It also results in rapid recovery and greater satisfaction among outpatients, in addition to preventing unnecessary nerve block in the contra lateral limb[5]. To comprehensively investigate the benefits of unilateral

as compared with bilateral spinal anesthesia, we evaluated the effects on sufficient sensory and motor block, optimum analgesia, hemodynamic changes, nausea, vomiting and headache.

Materials & Methods

It was a cross sectional study took place in the department of Anaesthesiology and SICU, BIRDEM General Hospital, Shahbag, Dhaka from 1st July 2016 to 31st December 2016. This study was carried out to assess the haemodynamic changes & complications between unilateral and bilateral spinal ansethesia in elderly type-2 diabetic patient undergoing Hemiarthoplasty. Ethical clearance was taken from the concerned authority. Informed written consent was taken from all individual participants.

Participants were elderly type-2 Diabetic patient scheduled for hemiarthoplasty. Total 60 patients were enrolled in this study, divided into two groups, U & A, 30 in each. Inclusion criteria's were patients undergoing hemiarthroplasty, age 60 to 80 years, ASA physical status II & III, Type-II diabetic patients (well control with insulin). Exclusion criteria's were patient refusal, infection at the side of injection, uncontrolled hypertension, coagulopathy, patients with neurological disorder, patients with sinus tachycardia or bradycardia, patients with hypo or hyperthyroidism, patient with renal impairment, low EF.

Sample was selected by random sampling in two group distributed as- group B (bilateral block), group U (Unilateral Block). Sixty patients, classified by American Society of Anesthesiologists (ASA- II, III, listed for operative procedure under spinal anaesthesia were randomized by card method in two groups of 30 patients each. After arrival to preoperative room, all patients ware inserted an 18 gauge venous cannula in the largest apparent vein on the dorsum of hand. Then all patients started lukewarm fluids of Lactated Ringer's solution, infused at 10ml/kg/h over 30 min before spinal anaesthesia. The infusion rate was then reduced to 6 ml/kg/h. The ambient temperature was maintained at 22-24 ^{0}C. Base line parameters like BP, Pulse, oxygen saturation, ECG and axillary temperature were recorded before anesthesia. Subarachnoid (spinal) anaesthesia was performed in all patients with 7.5mg (1.5ml) of 0.5% hyperbaric bupivacaine intrathecally, at L_3 - L_4interspinous spaces, with 25G Quinke's spinal needle. U group patient's were kept in lateral decubitus position which was maintained for 15 minutes after anaesthesia and B group patient was at sitting position then remain in supine position. Motor block assessed by bromage scale. Sensory block was assessed by icepack, pin prick sensation and dermatome levels tested every 2 min until

the highest level had stabilized by consecutive tests. On achieving T10 sensory blockade level, surgery was allowed. Main outcome variables were heart rate, blood pressure, intraoperative complications (e.g. nausea, vomitting, hypotension, cardiac arrest).

Changes of BP, pulse and development of any complication was recorded in 5in interval after unilateral and bilateral spinal anesthesia. Appearance of hypotension, bradycardia or any complication recorded and managed accordingly. If blood pressure decreased by more than 30% of baseline and heart rate dropped to less than 50 beats/min, the patient was considered to suffer from hypotension and bradycardia respectively. The hypotension was managed by rapid IV infusion of 250 mL of lactated Ringer's solution. Bradycardia was managed using 0.5-1 mg of intravenously administered atropine. If the hypotensive patient did not respond to treatment, ephedrine 5 mg was injected. All the informations were recorded in preformed data collection sheet. All collected questionnaire checked very carefully to identify the error in the data. Data processing work consist of registration schedules, editing computerization, preparation of dummy table, analyzing and matching of data.

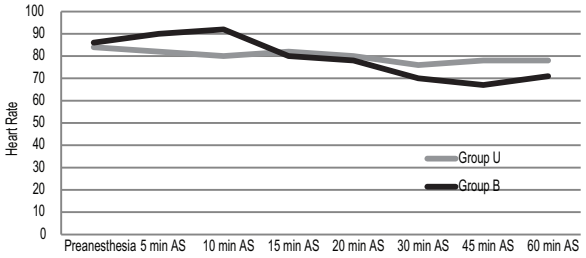
Statistical analysis

Data were collected in questionnaire. Data processing work consist of registration schedules, editing computerization, preparation of dummy table, analyzing and matching of data. After collection of all information, these data were checked, verified for consistency and edited for finalized result. After editing and coding, the coded data directly entered into the computer by using SPSS version 6. Data cleaning validation and analysis was performed using the SPSS/PC software and graph and chart by MS excel.

Results and observations

Regarding age it was found that majority of the patients i.e. 81.6% (n=49) were between 60-70 years, 18.3% (n=11) were between 71-80 years. Mean age was found 66.3±11.5 years. In the Group U, 19(63.3%) were ASA II and 11(36.6%) were ASA III. In Group B, 18(60%) were ASA II and 12(40%) were ASA III.

After introducing bupivacaine to the sub arachnoid space, The average time to anesthetic onset in the unilateral group was 6.18 ± 1.3 min. In the bilateral group, this value was 4.12 ± 0.41 min. The difference between groups was statistically significant (p= 0.0001). The rate of block progression of the unilateral side was higher than other groups (group B); at the same time the level of block was higher and the duration of block was longer. At the time of 10^{th} min after injection, in case of Group-U highest level of sensory block was T9 in all patients 30(100%) achieved sensory block. But in case of Group B at that same time highest sensory level blockade found T_{11} 28(93%)) to T_{12} 2(7%) of patients.



AS= after spinal anaesthesia.

Figure 1 *Trends of heart rate (HR) in the studied group (n=60)*

Regarding heart rate, no significant difference was detected between groups at preanesthesia and 5 min afterwards. Compared with group U, group B showed statistically significant increase inheart rate at 10 min after spinal anesthesia ($p<0.05$). Following that heart rate decreased in both the groups but the difference was not significant statistically.

Table 1 *Trends of systolic blood pressure (SBP) between groups with respect to time*

Systolic BP (mmHg)	Group U (n=30) Mean±SD	Group B (n=30) Mean±SD	p value
Preanesthesia	120.6±6.3	121.3±5.0	0.261
After 5 min	115.5±6.8	104.4±9.2	0.001
After10 min	95.3±7.1	85.5±5.1	0.001
After 15 min	95.6±11.2	84.3±4.8	0.001
After 20 min	95.9±4.7	82.3±5.0	0.001
After 30 min	97.6±15.6	87.8±5.0	0.002
After 45 min	98.6±11.6	86.3±8.2	0.001
After 60 min	100.6±6.0	102.2±9.4	0.467

Regarding systolic blood pressure no significant difference was there before anaesthesia (sub arachnoid block). But there were significant difference found from the 5 minutes to 45 minutes after anaesthesia ($p<0.05$). At 60 minute the difference was not significant statistically.

Table II *Trends of diastolic blood pressure (DBP) between groups with respect to time*

Diastolic BP (mmHg)	Group U (n=30) Mean±SD	Group B (n=30) Mean±SD	*p* value
Preanesthesia	80.6±6.0	81.2±9.4	0.348
After5 min	73.9±5.2	71.2±9.6	0.213
After 10 min	65.4±5.6	62.5±9.5	0.186
After 15 min	60.6±7.4	54.5±9.7	0.013
After 20 min	60.5±7.1	54.9±9.7	0.096
After 30 min	66.0±6.8	61.2±9.4	0.039
After 45 min	67.2±5.6	63.5±9.5	0.001
After 60 min	68.5±5.0	69.2±7.4	0.432

When we compared diastolic blood pressure between groups, we found at 15, 30 and 45 minute difference was statistically significant ($p<0.05$). But other follow up were not statistically significant ($p>0.05$) between groups.

Table III *Trends of mean arterial pressure (MAP) between groups with respect to time*

Time point after spinal anaesthesia	Mean arterial pressure -MAP(mmHg) Group U (n=30)	Group B (n=30)	*p* value
Preanaesthesia	93.60±11.6	94.93±9.1	0.883
After 5 min	84.45±8.2	78.90±9.5	0.0001
After 10 min	75.40±7.9	70.25±10.2	0.0001
After 15 min	76.92±8.1	69.18±9.5	0.0001
After 20 min	76.31±8.6	68.73±9.1	0.0001
After 30 min	77.57±10.2	71.18±7.5	0.0001
After 45 min	78.05±9.3	79.46±11.4	0.035
After 60 min	81.55±6.8	82.52±7.1	0.486

Regarding meanarterial pressure no significant difference was there before anaesthesia (sub arachnoid block). But there were significant difference found from the 5 minutes to 30 minutes after anaesthesia ($p<0.05$). At 45 minutes onwards the difference was not statisticallysignificant.

Table IV *Occurrence of complication*

Complications	Frequency of occurrence Group U(n=30)	Group B(n=30)
Nausea	2	7
Vomiting	0	3
Headache	3	10
Hypotension	0	7
Bradycardia	1	4

When we assesed complications, none of the patients in the unilateral group experienced vomiting, only two patients noticed nausea. In the bilateral group, seven patients had nausea and three of them experienced episodes of vomiting ($p = 0.02$). Three patients in the unilateral group and ten patients in the bilateral group had headaches ($p = 0.03$).

Discussion

In this study, it was found that unilateral spinal anaesthesia is associated with stable cardiovascular profile and therefore is a valuable technique in high risk patients. From 5th minute to recovery room readings, significant difference was found at various time intervals between groups with systolic blood pressure, mean blood pressure and diastolic blood pressure. The unilateral group found more stable in this study.

Diabetes mellitus (DM) is a strong risk factor for cardiovascular (CV) disease[6]. Compared with those who do not have DM, people with DM have a 2- to 4-fold increased risk of subsequent CV disease[7-9]. Several risk factors like microvascular and macrovascular complication are associated with DM patients. A study by Sen and Aydin concluded that elderly patients with low ejection fractions were more likely to predispose to higher sensorial block level. Hypotension was more common during spinal anaesthesia with supine position compared to lateral decubitus position[10]. The choice of anesthetic has important implications, not only for the intra-operative course, but also for the post-operative outcome. The most common serious side-effects from spinal anaesthesia are hypotension and bradycardia. Unilateral spinal

anaesthesia is effective in restricting the sympathetic block in high risk patients like elderly with existence of co-morbid condition e.g. DM.

The patient's position during and immediately after spinal anesthesia influences the spinal distribution of drugs. If an anesthetic drug solution is hypo- or hyperbaric with respect to the cerebrospinal fluid, it is possible to create a unilateral block. Moreover, the distance between the left and right nerve roots in the lumbar and thoracic regions is about 10-15 cm, which makes it possible to achieve unilateral spinal anesthesia[11].

Kuusniemi et al. reported that hyperbaric bupivacaine is more effective in achieving unilateral spinal anesthesia than plain bupivacaine[12]. However, determining the optimal time for lateral positioning is difficult when a high dose of hyperbaric bupivacaine (12-20 mg) is used[13-14]. The anesthetic drug may migrate even when the patient is placed in the lateral position for 30-60 min. Conversely, if a low dose (5-8 mg) of anesthetic solution is used, putting the patient in the lateral position for 10-15 min may prevent migration of the anesthetic drug. In this study, we injected hyperbaric bupivacaine 0.5% at a dose 7.5mg to achieve spinal anesthesia. The patientswere kept in the lateral position for 10-15 min, which led to unilateral spinal anesthesia in 94.45% of cases. In a studyperformed by Esmaoglu et al. the patient was in the lateral position for 10 min. This approach yielded an 85.7% success rate. This discrepancy in terms of the success rate seems to be dependent on the duration of time spent in the lateral position[15].

In another study by Imbelloni et al. all patients received unilateral spinal anaesthesia with 5 mg of 0.5% hyperbaric bupivacaine at the rate of 1 ml/ minute had observed no hypotension. These patients were kept in lateral decubitus position for 20 minutes resulted in block on dependent site with minimal haemodynamic changes[16]. Similar results were observed in another study done by Park et al. in which the patients positioned immediately supine showed a greater decrease in arterial blood pressure and heart rate than the patients who were kept in the lateral decubitus position for 20 minutes after the induction of spinal anaesthesia.[17]

The observations recorded in this study support the view that unilateral spinal anaesthesia is associated with a more stable cardiovascular profile than the conventional spinal anaesthesia[2]. A similar study conducted by Khan and colleagues found haemodynamic stability slightly more in unilateral spinal group but results were statistically insignificant.[18]Rao concluded that unilateral block could be a more useful concept in older age group and autonomically compromised patients. As in younger age group, patients haemodynamic changes were negligible most probably due to active sympathetic system at the unblocked area.[19] Unilateral sensory and motor block, a faster recovery profile, and a stable haemodynamic state can be achieved with doses of 5 mg and 7.5 mg of hyperbaric bupivacaine 0.5% injected slowly throughpencil-point directional needles in patients who are maintained in the lateral decubitus position for 20 minutes.[20] Unilateral spinal anaesthesia ensures higher intraoperative haemodynamic stability.[21]

Valanne used 4 or 6 mg of bupivacaine to induce unilateral spinal anesthesia in 106 patients scheduled to undergo knee arthroscopy. While both doses were sufficient for sensory and motor block, 4 mg of bupivacaine achieves a more rapid regression of motor function[22]. Headache after spinal anesthesia was reported in two and eight patients in the unilateral and bilateral groups, respectively. In contrast, Smaoglue used 1.5 cm^3 and 3 cm^3 of hyperbaric bupivacaine 0.5% for unilateral and bilateral anesthesia, respectively: six and nine patients, respectively, experienced headache. This discrepancy may be related to the type of needle used (Quincke) or the relatively young age of the patient population[13]. Notably, spinal anesthesia can disturb bladder function by disabling the micturition reflex. Kamphuis and colleagues reported that voiding disturbance continues until the nerve block has regressed to the third sacral root[23]. In our study, there was no bradycardia in the unilateral group, but in the bilateral group, 5 patients had bradycardia ($p = 0.04$). On average, the time to the onset of anesthesia and immobility was faster in the bilateral as compared to the unilateral spinal anesthesia group ($p = 0.00$). The sensory and motor block lasted for less time in the unilateral as compared to the bilateral group. Unilateral spinal anesthesia is therefore suitable for lower limb surgery.

Conclusions

In this study, it was found that unilateral spinal anaesthesia is associated with stable cardiovascular profile and less associated with nausea and vomitting.This valuable technique is a good alternative of conventional spinal anaesthesia for elderly diabetic high risk patients. But there is found some extends of contralateral block which is minimum.

Limitations of the study

This study was not without limitation. The limitations of the studies were as follows:

- Small sample size of the study population.
- It was a single centre study. Only patients admitted in BIRDEM general hospital were taken for the study. So this will not reflect the overall picture of the country. A large scale study needs to be conducted to reach to a definitive conclusion
- Others limitation were short duration of study and limited investigation facility.

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