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Research Article

Comparison of Unilateral Spinal and General Anaesthesia in Total Hip Operations: A Prospective Controlled Study

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Abstract: Hip fractures are common, potentially devastating events for elderly patients. Hip fractures are usually treated in hospital with surgery so these patients will need anaesthesia. The impact of anaesthetic techniques in patients experiencing hip fracture is controversial. This study was conducted to compare the effects of two anaestehic techniques: unilateral spinal and general anaesthesia on haemodynamy and postoperative cognitive disfunction (POCD) in elderly patients undergoing hip surgery. Fifty two American Society of Anesthesiologists (ASA) II-III patients, aged between 60-85 years, undergoing hip fracture repair were randomly allocated to receive; unilateral spinal anaesthesia with 7.5 mg 0.5 % hyperbaric bupivacaine (Group USpA, n=26) or general anaesthesia (Group GA, n=26). After maintaining the lateral position for 15 minutes sensorial block levels and motor block degrees were determined at 5, 15, 30 and 45 minutes in group USpA and haemodynamic parameters were determined at 5, 10, 15, 30, 45 and 60 minutes in both groups. POCD was evaluated preoperatively, postoperative 1st day and 3rd month. After 15 minutes 73.3% unilateral spinal anaesthesia was achieved in Group USpA. This ratio was found to be 60% after 30 minutes. Systolic and diastolic blood pressure values were significantly lower than initial values in Group USpA at 5. and 10. minutes and at the 45. minute in Group GA. In group comparisons there was a significant difference in haemodynamic parameters at 5. and 45. minutes. POCD was significantly higher in Group GA than Group USpA in postoperative 1st day but the difference was not significant in postoperative 3rd months. Unilateral spinal anaesthesia generate similar haemodynamic changes compared to general anaesthesia. Besides the effects on POCD similar to general anaesthesia. It was concluded that in elderly patients with high anaesthesia risk unilateral spinal and general anaesthesia have comparable effects.
Keywords: Anaesthesia, unilateral spinal, general; replacement, hip.

INTRODUCTION

Hip fractures are common, potentially devastating events for elderly patients. It was reported that geriatric patients with approximately 1.6 million hip fractures occurring annually worldwide and a projected 6.2 million hip fractures annually by the year 2050 [1].

The impact of anaesthetic techniques in patients experiencing hip fracture is controversial. While maintenance of haemodynamic stability seems the advantage of general anaesthesia (GA), the high incidence of postoperative cognitive disfunction (POCD) compared to regional anaesthesia makes this technique less preferable. Spinal anaesthesia is often used, but the existence of high prevalence of medical problems which can lead a reduction in physiologic compensatory mechanisms in these patients, makes an association with a risk of severe and prolonged hypotension in this technique **[**2-5**]**.

Unilateral spinal anesthesia (USpA) aims to limit the distribution of spinal block to the operated side, with the favorable effect of minimizing the cardiovascular effects of spinal block [6-8]. Therefore it comes up as the suggested anaesthetic technique in operations involving a single extremity [9, 10].

In our study, we aimed to compare haemodynamic effects of USpA with GA in elderly patients scheduled for operation because of hip fracture. The secondary parameter was evaluating the effects of these techniques on POCD.

MATERIALS AND METHODS

After approval by the local Medical Ethical Committee of Sisli Etfal Training and Research Hospital and written informed patient consent, 52 patients aged between 60-85 years in the American Society of Anesthesiologists (ASA) physical status II-III were included this randomized, prospective study. Exclusion criterias were contraindications of spinal anaesthesia, having peripheral neuropathy, comorbidities pre-dispose severe hypotension and/or severely altered mental status, lack of adequate co-operation and patient refusal.

All patients received 7 $ml.kg^{-1}$ Ringer Lactate solution infused over a 30 minute-period through an intravenous (IV) line inserted at the back of the hand, using 20 G IV cannula. None of the patients received premedication. Patients were monitorized with PETAS KMA-175 Monitor (PETAS, Istanbul, Turkey). An observer who were unaware the study groups, recorded systolic and diastolic blood pressure (SBP and DBP), heart rate (HR) and peripheral oxygen saturation (SpO_2).

Patients were randomly allocated to one of two groups by a computer-generated table of random numbers. Patients in group unilateral spinal anaesthesia (USpA) were placed in lateral position with the operative side in dependent position. Dural puncture was performed using a 25 G Quincke spinal needle (Spinocan, Braun Melsungen, Germany) inserted in the midline at the L_{3-4} interspace under aseptic conditions. After observing free cerebrospinal fluid flow, the needle hole was turned toward the dependent side and 0,5% hyperbaric bupivacaine (Marcaine ampule, 4 mL, Astra-Zeneca, Turkey) 7,5 mg was injected over 120 s. After maintaining the lateral position for 15 minutes, the patient was turned to the supine position.

The patients received 1 $\mu g.kg^{-1}$ fentanyl, 2 $mg.kg^{-1}$ propofol for anaesthesia induction in group general anaesthesia (GA). Muscle relaxation was acquired with 0.1 $mg.kg^{-1}$ vecuronium. Anaesthesia was maintained with 4+4 $lt.min^{-1}$ O_2+N_2O mixture in 1-2% sevoflurane. 1 μg/kg fentanyl was used for peroperatory analgesia. 0.5 mg/kg vecuronium was added whenever muscle relaxation was needed. After completion of surgery, the anesthetics were discontinued and the patients were extubated following reversal of neuromuscular blockade with neostigmine and atropine.

The sensory block level was assessed with pinprick test and motor block degree was evaluated with a modified Bromage scale (0= no motor block, 1= hip flexion with extended leg blocked, 2= knee flexion blocked, 3= complete motor block) by a blinded observer on the side of the surgical site and on the contra-lateral site at 2-min intervals for the first 10 min and then 10., 15., 20., 30. and 45. min. The number of patients having unilateral sensorial and motor block, was recorded at the same points in time. The maximum sensorial block level, time to reach it and regression time for 2 segments were recorded. General anaesthesia was planned in patients that we failed to perform USpA. The "Successful unilateral spinal block" rate was defined as patients' percentage who had unilateral sensorial and motor block at 15, 30. and 45. min.

SBP, DBP, HR and SpO_2 were recorded prior to spinal anaesthesia in Group I and prior to induction of anaesthesia in Group II (baseline values) 1-min intervals for the first 10 min, then at 5-min intervals in groups. Any decrease in mean blood pressure (MBP) below 30% of initial value was defined as hypotension and was planned to treat by increasing liquid infusion and with 5 mg incremental ephedrine bolus doses. Bradycardia was defined as a heart rate under 40 beats/min and was planned to treat with atropine 0.5 mg IV.

Mini Mental State Examination [11] and Doors and People [12] were used as neuropsychological tests to evaluate the POCD. Patients were screened preoperatively, 1 day and 3 months after operation.

Sample size was calculated as minimum 20 patients, based on our preliminary results, to provide 90% power and α=0.05 to detect a mean difference in MBP of 15 mmHg between two groups. We decided to study 52 patients to account for possible dropouts. The results are expressed as mean±standard deviation or as a median range for ordinal data. For statistical analysis, the t-test was used for comparison of normally distributed data and the Mann-Whitney U test was used for non-parametric values. The Chi-square test was used to compare the frequencies, with P<0.05 considered significant.

RESULTS

The patients were randomly divided into two groups of 26 patients each. There were no significant differences between the groups with regard to demographics and duration of surgery (Table 1).

The sensorial block levels and motor block degrees in Group USpA have been summarized in Table 2. "Successful unilateral spinal block" values at 15, 30. and 45. minutes were 73.3%, 60% and 53.3% respectively. None of the patients required general anaesthesia because of unsuccessful spinal anaesthesia.

When compared with baseline values the 5. min SBP, DBP and HR values were found significantly lower in Group USpA (Table 3). At 10. min SBP and DBP were significantly lower than baseline values (Table 3). SBP and DBP values improved after 15.min and HR values improved after 10.min and the difference was not clinically significant. In Group GA, at the 45. min SBP, DBP were significantly decreased and HR

was significantly increased compared to baseline values (Table 3). This difference was also observed at the other points in time where measurements were taken but was not clinically significant. In between group comparisons SBP, DBP, HR at 5.min and at 45. min were significantly different between the two groups.

Four patients (15,3%) in group USpA and 1 patient in Group II (3,8%) developed hypotension that required treatment with ephedrine. Also, bradycardia, seen in 2 subjects from each group (7,7%) and was treated with atropine.

The POCD was comparable in both groups preoperatively. At 1 day postprocedure, Group GA had a significantly higher, incidence of POCD than Group USpA. However, by 3 months, there was no statistically significant difference between the incidence of POCD in between of the procedure groups.

Table-1: The demographic characteristics, ASA classifications and operation times of the groups

	Grup USpA	**Grup GA**
Gender (F/ME)	7 / 8	6 / 9
Age (year)*	72.2 ± 5.23	72.66 ± 5.69
Weight (kg)*	63.46 ± 6.25	62.26 ± 4.35
Height (cm)*	157.73 ± 5.37	158.26 ± 4.58
1. ASA†	II (II-III)	II (II-III)
Duration of surgery (min)*	61.46 ± 7.71	62.53 ± 6.94

USpA: Unilateral spinal anaesthesia, GA: general anaesthesia. The data were expressed as *mean ± standard deviation, †median [min-max]

Table-2: The sensorial block levels and motor blockade degree of Group USpA

Highest sensorial block level (Operated side)*	T4 (T4-T12)
Highest sensorial block level (Non-operated side)*	L1 (T12-/)
Time to reach the highest sensorial block level (Operated side) (min)*	20 (10-45)
Regression time for two segments of sensorial block (min)*	45 (25-85)
Patient number of unilateral sensorial block (15 min) (lateral) ¥	9 (%60)
Patient number of unilateral sensorial block (30 min) (supin) ¥	7 (%46.6)
Patient number of unilateral sensorial block (45 min) (supin) ¥	5 (%33.3)
Patient number of unilateral motor block (15 min) (lateral) ¥	13 (%86.6)
Patient number of unilateral sensorial block (30 min) (supin) ¥	11 (%73.3)
Patient number of unilateral sensorial block (45 min) (supin) ¥	11 (%73.3)

(Data were expressed as * median [lowest - highest], ¥ number [%])

Table-3: Haemodynamic parameters of the groups

	Groups	**SBP** (mmHg)	**DBP** (mmHg)	**HR** (beat/min)
Baseline	Group USpA	124.85 ± 10.5	73.84 ± 5.80	72.69 ± 3.03
	Group GA	123.92 ± 10.32	70.46 ± 6.14	74.07 ± 8.66
5.min	Group USpA	109.15 ± 10.31 ***	60.53 ± 5.39 ***	65.69 ± 4.28 ***
	Group GA	118.08 ± 6.80 ǂǂ	69.69 ± 3.35 ǂǂǂ	73.69 ± 6.62 ǂǂǂ
10.min	Group USpA	114.54 ± 7.18 ***	67.07 ± 4.19 **	69.84 ± 3.76
	Group GA	117.31 ± 6.83	69.92 ± 3.68	70.46 ± 3.50
15.min	Group USpA	119.92 ± 5.37	71.38 ± 3.33	69.73 ± 3.04
	Group GA	118.31 ± 7.88	70.69 ± 4.23	70.30 ± 2.28
30.min	Group USpA	120.31 ± 9.02	71.69 ± 4.11	70.23 ± 3.60
	Group GA	116.46 5.15	66.76 3.21	71.92 4.55
45.min	Group USpA	119.08 ± 6.25	69.15 ± 3.95	71.69 ± 7.27
	Group GA	107.54 ± 4.39 ***/ǂǂǂ	62.69 ± 3.92 ***/ǂǂǂ	78.76 ± 4.58 ***/ǂǂǂ
60.min	Group USpA	115.52 ± 9.69	68.46 ± 5.76	71.96 ± 3.18
	Group GA	118.85 ± 10.83	68.46 ± 6.57	69.38 ± 3.59

USpA: Unilateral spinal anaesthesia, GA: general anaesthesia. Data were expressed as mean ± standard deviation (Compared with baseline values **p<0.01, ***p<0.001, in group comparisons ǂǂp<0.01, ǂǂǂp<0.001)

DISCUSSION

Unilateral spinal anaesthesia associated with less side effects compared to bilateral spinal anaesthesia [13] and getting to be used more in current practice, especially with patients undergoing surgeries involving single extremity. Lateral position and the type of the punction

needle have been shown as important factors when performing USpA [14-17]. Also, injection speed of the local anaesthetic is another contributing factor on unilateral spinal block formation [18-20]. In accordance with above references we performed unilateral spinal anaesthesia; with 7.5 mg %0.5 hyperbaric bupivacaine, injected over a 120 second-period, using a 25G Quincke spinal needle, and maintaining the lateral position for 15 minutes, in our study.

Kuusniemi et al [21] achieved a significantly higher ratio of USpA (83 % compared to 37%) in patients with using 6 mg 0,5% bupivacaine after maintaining the lateral position for 20 minutes compared to hypobaric bupivacaine. In a study by Casati et al. [22] with 8 mg 0.5% versus 1% bupivacaine and maintaining the lateral position for 15 minutes, the authors found a significantly higher USB ratio (80% compared to 53%) in the group where they applied lower concentration local anesthetics. 30 min after going back to the supine position, these ratios decreased to 60 % in group 0.5 % and 40% in group 1 %. In another study by Casati et al. [23] the authors achieved a 73% USB ratio with using 8 mg 0.5 % hyperbaric bupivacaine and maintaining 15 min of lateral position. Drug dosage and concentration and the time for lateral decubitus position in our study was in parallelity with these studies. Our USpA ratio is close to the success ratios of Kuusniemi and Casati. The decrease in this ratio to 60% after 30 minutes, has also been found to be in parallelity with Casati's study.

In a study by Casati et al., [20] in subjects where USB was performed with 8 mg 0.5 % hyperbaric bupivacaine injected over an 80 second-period, the highest sensorial block level on the side of the operation was T8 and the time it took to reach that level was 25 minutes. In another study by Casati et al., [22] in subjects that received 8 mg 0.5 % bupivacaine, maximum sensorial block level was T10, time to reach that level was 20 min and time to decrease by two segments was 80 minutes. In our study, similar with these two studies, the highest sensorial block level on the operative side was T8 and the time it took to reach that level was 20 min. The time to decrease by two segments of sensorial block was 45 minutes and this time period is shorter than the time period reported in the study by Casati et al. Even though the subjects in our study group were different than the subjects in the before mentioned studies, the USB ratios and levels achieved with similar dosages were comparable with the above studies.

In a study by Chohan et al., [8] it was demonstrated that in high risk group patients, unilateral spinal block limits sympathetic block and therefore causes minimal haemodynamic changes. In our study the decreased values were at 5., 10. min for sistolic and diastolic blood pressure and at 5. min for heart rate compared to baseline values. This difference was statistically significant but we evaluated this difference not significant clinically. We thought that this decrease could be due to the maximal block level we achieved and to the fact that the average age of our subject group was high. Haemodynamic changes observed in the general anesthesia group at the 45^{th} minute were thought to be associated with the bone cement being placed at this time. Messina et al. compared the haemodynamic changes associated with spinal and general anaesthesia for hip fracture surgery in severe ASA III elderly population in a pilot trial [24]. They concluded that; a more stable hemodynamic profile requiring less intervention to keep MAP close to baseline value occurred in spinal anaesthesia compared general anaesthesia. And hypotension was common in SA and GA after induction and within intraoperative period. Meanwhile larger randomized clinical studies needed to confirm these preliminary data.

As spinal anesthesia complications, Carpenter et al., [17] underline hypotension, nausea-vomiting, bradycardia and dysrhythmia primarily. In our study, we observed bradycardia and hypotension (20%) requiring treatment with ephedrine after USB. Severe hypotension was higher than the ratio of 5 % reported in a study by Casati et al. [20]; however, it was lower than the ratio (33%) reported by Carpenter et al. [17] after bilateral spinal anesthesia.

In studies evalating POCD after general and regional anaesthesia controversies exist. While some authors did not demonstrate any difference in outcome regarding cognitive competence between the two groups receiving regional or GA [25-27], some demonstrated significant difference [28,29]. In the study conducted by Rasmussen et al., regional anesthesia was associated with a significantly low incidence of POCD compared with GA 1 week after surgery. However, the incidences declined at 3 months following surgery and were found to be statistically non-significant [30]. We had significant POCD in postoperative 1st day. In accordance with this study the difference became comparable between groups after 3 months from operation.

CONCLUSION

Unilateral spinal anaesthesia performed with hyperbaric bupivacaine, using slow injection speed and with maintaining lateral position for a 15 minute-period ensures adequate surgical anesthesia, and its haemodynamic effects are minimal in elderly patients. The effects on POCD similar to general anaesthesia. We conclude that; unilateral spinal and general anaesthesia have comparable effects in elderly patients undergoing total hip operations.

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REFERENCES

1. Le-Wendling L, Bihorac A, Baslanti TO, Lucas S, Sadasivan K, Wendling A, et al; A. Regional anesthesia as compared with general anesthesia for surgery in geriatric patients with hip fracture: does it decrease morbidity, mortality, and health care costs? Results of a single-centered study. Pain Med, 2012; 13(7): 948-956.
2. Griesdale DE, Neufeld J, Dhillon D, Joo J, Sandhu S, Swinton F, et al; Risk factors for urinary retention after hip or knee replacement: a cohort study. Can J Anaesth, 2011; 58(12): 1097-1104.
3. Maurer SG, Chen AL, Hiebert R, Pereira GC, DiCesare PE; Comparison of outcomes of using spinal versus general anesthesia in total hip arthroplasty. Am J Orthop (Belle Mead NJ), 2007; 36(7): 101-106.
4. Morgan Jr GE, Mikhail MS, Murray MJ, Larson Jr PL; Clinical Anesthesiology. The Mc Graw-Hill Companies, Inc., third edition, USA, 2002; 782-792.
5. Sharrock NE, Savarese JJ; Anaesthesia for Orthopedic Surgery. In: Anesthesia, Churchill Livingstone, 5th edition, USA, 2000: 2118-2139.
6. Kilinc LT, Sivrikaya GU, Eksioglu B, Hanci A, Dobrucali H; Comparison of unilateral spinal and continous spinal anesthesia for hip surgery in elderly patients. Saudi J Anaesth, 2013; 7(4): 404-409.
7. Akhtar MN, Tariq S, Abbas N, Murtaza G, Nadeem Naqvi SM; Comparison of haemodynamic changes in patients undergoing unilateral and bilateral spinal anaesthesia. J Coll Physicians Surg Pak, 2012; 22(12): 747-750.
8. Chohan U, Afshan G, Hoda MQ, Mahmud S; Haemodynamic effects of unilateral spinal anesthesia in high risk patients. J Pak Med Assoc, 2002; 52(2): 66-69.
9. Moosavi Tekye SM, Alipour M; Comparison of the effects and complications of unilateral spinal anesthesia versus standard spinal anesthesia in lower-limb orthopedic surgery. Braz J Anesthesiol, 2014; 64(3): 173-176.
10. Elzinga L, Marcus M, Peek D, Borg P, Jansen J, Koster J, et al; Hemodynamic stability ensured by a low dose, low volume, unilateral hypobaric spinal block: modification of a technique. Acta Anaesthesiol Belg, 2009; 60(4): 217-220.
11. Folstein MF, Folstein SE, McHugh PR; Mini-mental state-A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 1975; 12(3): 189–198.
12. Morris Robin G; Abrahams S; Alan BD, Charles PE; Doors and People: Visual and verbal memory after unilateral temporal lobectomy. Neuropsychology, 1995; 9(4): 464-469.
13. Borghi B, Wulf H; Advantages of unilateral spinal anaesthesia. Anasthesiol Intensivmed Notfallmed Schmerzther, 2010; 45(3): 182-187.
14. Kuusniemi K, Leino K, Lertola K, Pihlajamäki K, Pitkänen M; Comparison of two spinal needle types to achieve a unilateral spinal block. J Anesth, 2013; 27(2): 224-230.
15. Frank A, Schuster M, Biscoping J; Influence of positioning on the quality of unilateral spinal anesthesia. Anasthesiol Intensivmed Notfallmed Schmerzther, 2002; 37: 659-664.
16. Casati A, Fanelli G, Cappelleri G, Aldegheri G, Leoni A, Casaletti E, et al.; Effects of spinal needle type on lateral distribution of 0.5% hyperbaric bupivacaine Anesth Analg, 1998; 87: 355-359.
17. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R; Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology, 1992; 76: 906-916.
18. Apaydin Y, Erk G, Sacan O, Tiryaki C, Taspinar V; Characteristics of unilateral spinal anesthesia at different speeds of intrathecal injection. J Anesth, 2011; 25(3): 380-385.
19. Rubin AP; Spinal anaesthesia. In: Principles and Practice of Regional Anaesthesia. Wildsmith JAW, Armitage EN, McClure JH (eds), Elsevier Science Ltd, third edition, United Kingdom, 2003: 125-138.
20. Casati A, Fanelli G, Cappelleri G, Leoni A, Berti M, Aldegheri G, et al.; Does speed of intrathecal injection affect the distribution of 0.5% hyperbaric bupivacaine. Br J Anaesth, 1998; 81: 355-7.
21. Kuusniemi KS, Pihlajamaki KK, Pitkanen MT; A low dose of plain or hyperbaric bupivacaine for unilateral spinal anesthesia. Reg Anesth Pain Med, 2000; 25: 605-610.
22. Casati A, Fanelli G, Cappelleri G, Borghi B, Cedrati V, Torri G; Low dose hyperbaric bupivacaine for unilateral spinal anaesthesia. Can J Anaesth, 1998; 45: 850-4.
23. Casati A, Fanelli G, Beccaria P, Aldegheri G, Berti M, Senatore R, et al.; Block distribution and cardiovascular effects of unilateral spinal anaesthesia by 0.5% hyperbaric bupivacaine. A clinical comparison with bilateral spinal block. Minerva Anesthesiol, 1998; 64: 307-312.
24. Messina A, Frassanito L, Colombo D, Vergari A, Draisci G, Della Corte F, et al.; Hemodynamic changes associated with spinal and general anesthesia for hip fracture surgery in severe ASA III elderly population: a pilot trial. Minerva Anestesiol, 2013; 79(9): 1021-1029.
25. Bryson GL, Wyand A; Evidence-based clinical update: General Anesthesia and the risk of delirium and post operative cognitive dysfunction. Can J Anesth, 2006; 53: 667–677.
26. Williams-Russo P, Sharrock NE, Mattis S, Szatrowski TP, Charlson ME; Cognitive effects after epidural versus general Anesthesia in older adults: A randomized trial. JAMA, 1995; 274:44–50.

27. Jones MJ, Piggott SE, Vaughan RS, Bayer AJ, Newcombe RG, et al.; Cognitive and functional competence after Anesthesia in patients aged over 60: Controlled trial of general and regional Anesthesia for elective hip or knee surgery. Br J Anesth, 1990; 30:1683–1687.
28. Mandal S, Basu M, Kirtania J, Sarbapalli D, Pal R, Kar S, et al.; Impact of general versus epidural anesthesia on early post-operative cognitive dysfunction following hip and knee surgery. J Emer Trauma Shock, 2011; 4: 23-28.
29. Papaionnou A, Fraidakis O, Michaloudis D, Balalis C, Askitpoulou H; The impact of the type of anesthesia on cognitive status and delirium during the first postoperative days in elderly patients. Eur J Anesth, 2005; 22: 492–499.
30. Rasmussen LS, Johnson T, Kuipers HM, Kristensen D, Siersma VD, et al.; Does general anesthesia cause postoperative cognitive dysfunction. A randomized study of regional versus general anesthesia in 438 elderly patients? Acta Anesthesiol Scand, 2003; 47: 260–266.