

## SPINAL ANESTHESIA FOR ENDOSCOPIC UROLOGICAL SURGERY

### - Low dose vs. Varying doses of Hyperbaric Bupivacaine

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### Summary

*Background and objective:* The aim of this study is to compare the efficiency of low dose vs. varying doses of hyperbaric bupivacaine in spinal anesthesia for endoscopic urological procedures.

*Methods:* Sixty consecutive patients were studied in a randomized prospective manner. They received either of 5 (Gr I), 7.5 (Gr II) or 10 mg (Gr III) of hyperbaric bupivacaine 0.5% combined with 25 µg of fentanyl, through a 25-gauge W

hitacre spinal needle placed in the L3-L4 interspace. Characteristics of sensory and motor block, dose of ephedrine required, secondary effects, the patients, and the surgeons. satisfaction, were noted.

*Results:* The maximum number of blocked segments was  $14 \pm 1$  (Gr I),  $15 \pm 2$  (Gr II) and  $16 \pm 2$  (Gr III). Time to T12 regression was significantly shorter for Gr I ( $53 \pm 13$  min) than for Gr II ( $69 \pm 20$  min) or Gr III ( $94 \pm 14$  min). Bromage 3 block was not found in Gr I compared to 4 patients in Gr II and 15 patients in Gr III. The duration of motor block

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was shorter in Gr I ( $51 \pm 18$  min) than in Gr II ( $86 \pm 19$  min) and in Gr III ( $138 \pm 21$  min). Ephedrine was used for 16 patients in Gr III ( $9.8 \pm 12.2$  mg), 5 patients in Gr II ( $3.7 \pm 7.8$  mg) and 2 patients in Gr I ( $0.5 \pm 1.5$  mg). The difference is statistically significant between Gr III and the other groups.

*Conclusions:* These results suggest that the use of a low dose of bupivacaine (5 mg) added to fentanyl (25  $\mu$ g) for endoscopic urological surgery, resulted in short-acting sensory block, without motor block and a lower incidence of cardiovascular side effects, as compared to either of 7.5 or 10 mg bupivacaine with 25  $\mu$ g fentanyl.

**Key words:** Spinal anesthesia, Bupivacaine, Urologic surgery.

## Introduction

Spinal anesthesia is popular for endoscopic urological surgery because of early recognition of symptoms caused by overhydration, transurethral resection of prostate (TURP) syndrome and bladder perforation. Patients, who are candidates for endoscopic urological surgery, are frequently elderly and have a preexisting cardiovascular and respiratory diseases. In our country (Tunis), the only two local anesthetic agents available are lidocaine and bupivacaine.

Spinal anesthesia with lidocaine has been reported to produce transient neurological syndrome in humans<sup>1,2,3</sup>. The level of sensory block required for this type of surgery is T10. The duration of the surgical procedure rarely exceeds 60 minutes. The principal determinants of the extension and the duration of the anesthetic block depend on the type and the concentration of the local anesthetic used. Lipophilic opioids (e.g., fentanyl and sufentanil) are increasingly being administered intrathecally as adjuvants to local anesthetics. They enhance spinal anesthesia without prolonging motor recovery<sup>4,5</sup>.

This study was designed to examine the effects of three doses of hyperbaric bupivacaine 5, 7.5 and 10 mg added to fentanyl 25  $\mu$ g, for endoscopic bladder and prostatic surgery.

## Methods and Materials

The study was approved by the Hospital Ethical Committee and written, informed consent was obtained from all patients.

Sixty consecutive (ASA I-III) patients, older than 18 years, scheduled for TURP or removal of bladder tumors by endoscopic technique, were studied in a randomized prospective manner. Patients with coagulation abnormalities, cardiac or renal failures, mental disturbances, neurological diseases, deformities of the spinal column, or local anesthetic allergies, were excluded from the study.

Using sealed envelopes prepared according to a randomization table, patients were randomly allocated to one of three groups as follows: Group I (n = 20), bupivacaine 5 mg with fentanyl 25 µg; Group II (n = 20), bupivacaine 7.5 mg with fentanyl 25 µg and Group III (n = 20), bupivacaine 10 mg with fentanyl 25 µg. All solutions were prepared by using bupivacaine 5 mg/mL and fentanyl 50 µg/mL. The final volume was 1.5 mL for Group I, 2 mL for Group II and 2.5 mL for Group III.

Patients were premedicated 2 hours before surgery with hydroxyzine 50-100 mg depending on their weight. After a 16 gauge intravenous (IV) cannula had been inserted at the forearm level, lactated Ringer's solution was administered as a bolus of 10 mL/Kg for 15 min. before subarachnoid block to all patients. Spinal anesthesia was performed at the L3-L4 interspace (L4-L5 in case of failure) with the patient in the sitting position by using a 25 Gauge Whitacre, unidirectional needle with an introducer (Becton-Dickinson, New Jersey, USA). Free flow of cerebrospinal fluid was verified before injection of the anesthetic solution, which was administered at the rate of 1 mL/10 sec without barbotage or aspiration at the end of injection. The direction of the needle aperture was cranial during the injection. All patients were immediately placed in a supine position following the injection.

All patients were monitored using continuous electrocardiography (lead II), heart rate, non-invasive blood pressure, and continuous pulse oximetry. The level of sensory block, defined as the loss of sharp

sensation by using a pinprick test with a 20 Gauge hypodermic needle, was recorded bilaterally at the midclavicular line. The motor block was evaluated using the Bromage scale (0 = no motor block, 1 = hip blocked, 2 = hip and knee blocked, 3 = hip, knee and ankle blocked). All these parameters are noted every 5 min until the end of the operation, then every 10 min until discharge from the Post-Anesthetic Care Unit. After adequate spinal block has been achieved, the time from the end of intrathecal injection to readiness for surgery was recorded. Then, the patient was positioned in the lithotomy position and surgery started.

Hypotension was defined as a systolic arterial blood pressure (SABP) <90 mmHg or a decrease in SABP by 30% or more from baseline values, and was initially treated by 200 mL of Lactated Ringer's solution; when needed a bolus of ephedrine 3 mg was given until the correction of SABP. Bradycardia was defined as a heart rate <50 bpm or a decrease of more than 20% from the initial value and was treated by atropine 0.5 mg in addition to the treatment of hypotension. Respiratory depression was defined as a respiratory rate less than 8 breaths/min and/or oxygen saturation less than 85% in room air. Other adverse effects, including pruritus, nausea and vomiting were recorded. In all cases, a urinary catheter was inserted after surgery.

Analgesia was noted by the Visual Analog Scale (VAS), The requirement for sedation i.v. analgesics or the necessity for general anesthesia, was also noted. Analgesia was good if VAS was less than 30 mm. In addition, the two surgeons involved were asked to estimate the operating conditions on a scale of: good, satisfactory, or poor.

Statistical analysis was conducted mainly with nonparametric methods. First, the overall differences among the three groups were tested with Kruskal-Wallis test. If there was significant difference among the three groups, the analysis was continued with posthoc comparisons of differences between pairs of groups by using Mann-Whitney's U-Test. Multiple comparison correction was performed with Bonferroni correction. The comparison of the three groups in demographic data and the duration of surgery were done with parametric one-way analysis of variance. P value <0.05 was interpreted as statistically significant. The

computations were performed with SAS System for Windows 6.12/1996 (SAS, Cary, NC).

## Results

Patients' demographic data and duration of surgery are listed in Table 1. The three groups were comparable with respect to age, height, weight, ASA status, as well as type and duration of surgery.

*Table 1*  
*Demographic Data and Duration of Surgery*

	Group I	Group II	Group III
Bupivacaine mg	5	7.5	10
Fentanyl $\mu$ g	25	25	25
	(n = 20)	(n = 20)	(n=20)
Age (yr)	69 $\pm$ 8	68 $\pm$ 8	69 $\pm$ 11
Height (cm)	169 $\pm$ 5	170 $\pm$ 6	169 $\pm$ 4
Weight (kg)	71 $\pm$ 12	70 $\pm$ 11	71 $\pm$ 9
ASA I/II/III	11/8/1	9/10/1	9/10/1
Surgery time (min)	39 $\pm$ 10	45 $\pm$ 9	46 $\pm$ 11
TURP/Tumor resection	15/5	15/5	16/4

Values are mean  $\pm$  SD or number, TURP: transurethral resection of prostate.

No statistical differences between the groups.

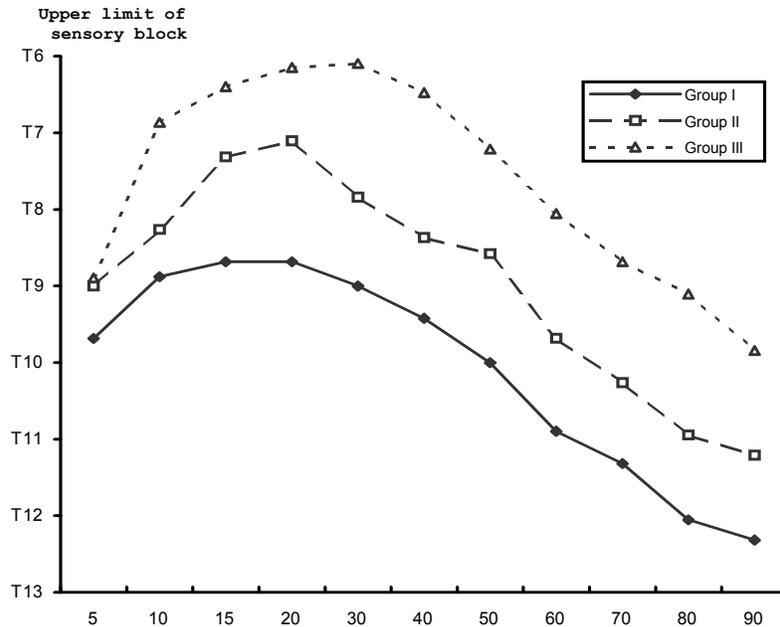
Sensory block assessments are presented in Fig 1. The maximum number of blocked segments was  $14 \pm 1$  in Group I,  $15 \pm 2$  in Group II and  $16 \pm 2$  in Group III. There was a statistically significant difference between Groups I and III and Groups II and III for the maximum number of blocked segments.

As expected, time to T12 regression was shorter for Group I ( $53 \pm 13$  min) than for Group II ( $69 \pm 20$  min) or Group III ( $94 \pm 14$  min). The difference was significant between the three groups. For two patients in Group I and one patient in Group II, intravenous fentanyl ( $50 \mu$ g) was used for pain at the end of surgery (bladder perforation in one case of

Group I). No statistical difference was found between the three groups for the use of complimentary intravenous analgesia.

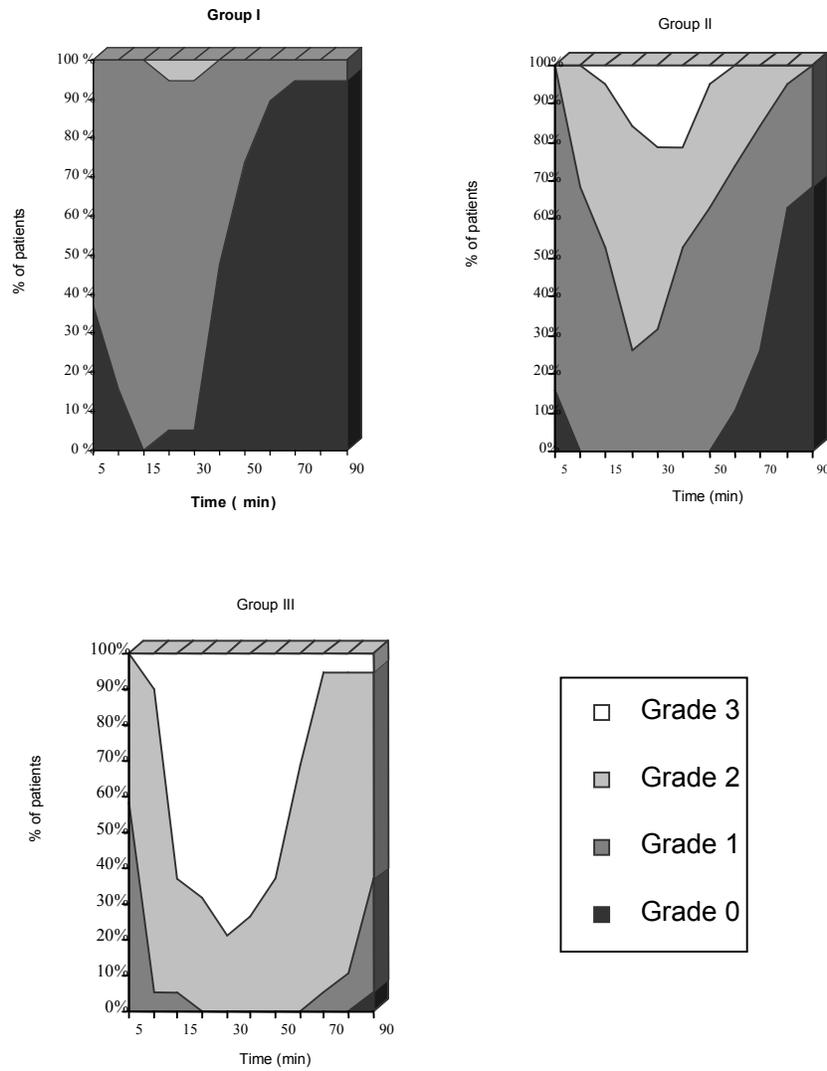
*Fig. 1*

*The mean of the upper limit of the sensory block in the three groups*



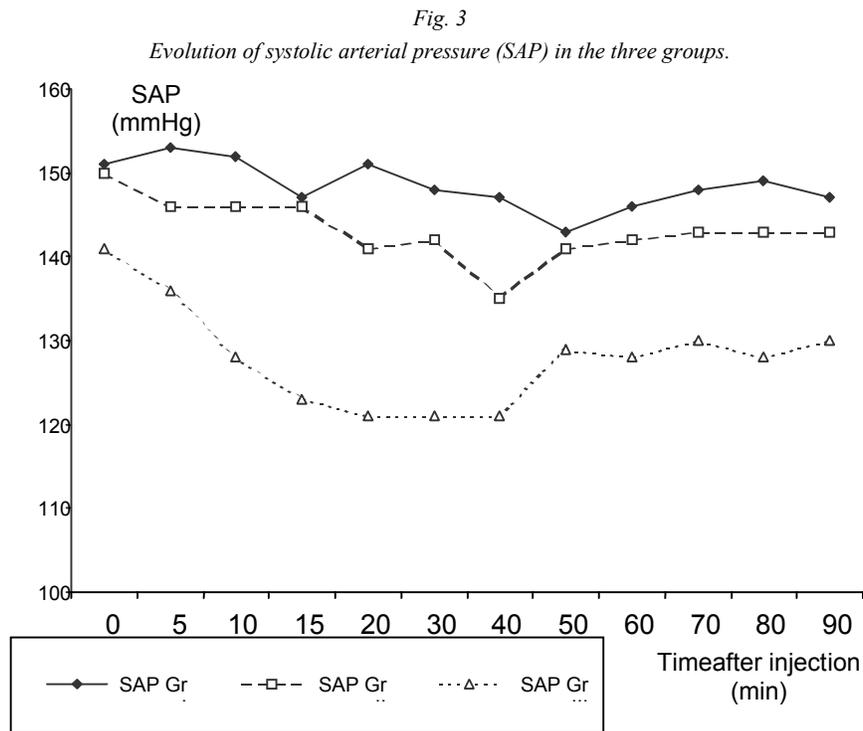
Motor block assessments are summarized in Fig. 2. A significant difference was found between the three groups. Bromage 3 block was not found in Group I compared to 4 patients in Group II and 15 patients in Group III. The duration of motor block was  $51 \pm 18$  min in Group I,  $86 \pm 19$  min in Group II and  $138 \pm 21$  min in Group III. A significant difference was found between the three groups.

Fig. 2  
Motor block score (Bromage; mean  $\pm$  SD) in Groups I, II, III



Quality of analgesia was good (VAS <30 mm) for 95% of the patients. Only three patients who needed intravenous fentanyl, rated spinal anesthesia as inadequate for them. Operating conditions were rated as good by 98% and satisfactory by 2% (one patient in Group II) of surgeons.

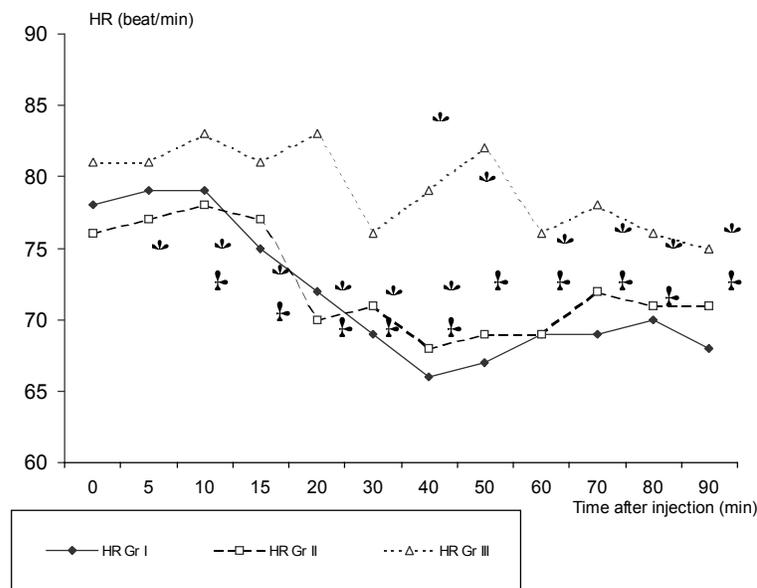
No significant difference was found between Groups I and II for SAP during the 90 min after intrathecal injection. A significant statistical difference was found between Group III and the other groups from 10 to 90 min after intrathecal injection and at 5 min between Groups III and I (Fig. 3).



\* Significant difference between Group I and III. †: Significant difference between Group II and III.

HR was statistically different between the three groups only at 40 and 50 min, when patients from Group III had more elevated HR (Fig. 4). Bradycardia was detected for 2 patients in Group III compared to 1 patient in Group II and none in Group I. The difference between the 3 groups was not statistically significant.

Fig 4  
Evolution of heart rate (HR) in Groups I, II, III



\* Significant difference between Group III and Groups I and II.

Ephedrine was used for 16 patients in Group III ( $9.8 \pm 12.2$  mg), 5 patients in Group II ( $3.7 \pm 7.8$  mg) and 2 patients in Group I ( $0.5 \pm 1.5$  mg). The difference was statistically significant between Group III and the other groups.

The quantity of IV fluid used during the spinal anesthesia was similar between Group I ( $934 \pm 183$  mL), Group II ( $921 \pm 187$  mL) and Group III ( $1092 \pm 442$  mL).

Pruritus was the most common complication; 30% in Groups I, II and 25% in Group III. Nausea and vomiting were recorded in 4 patients from Group II and 2 patients from Group I and from Group III. No significant statistical difference was noted between the three groups for pruritus or nausea and vomiting.

## Discussion

Our study suggests that intrathecal injection of the low dose (Group I) 5 mg of bupivacaine with 25 µg of fentanyl induced less profound short-acting motor block but provides the same adequate level of analgesia for endoscopic urologic surgery than the combination of bupivacaine 7.5 mg and fentanyl 25 µg (Group II) or bupivacaine 10 mg and fentanyl 25 µg (Group III).

The low dose of local anesthetics prompted anesthesiologists to use combinations with other adjuvants. Opioids are the mostly used drugs in combination with local anesthetics to improve quality and duration of the block and to minimize complications of sympathetic block<sup>5</sup>.

Several studies have shown that the volume and concentration variations without modification of the total dose of local anesthetic solutions, did not modify the highest level of motor or sensory block<sup>6,7</sup>. In our present study, in order to exclude the volume factor that can influence the nerve block, we did not use the same volume for the three groups; 1.5 ml (Group I), 2 ml (Group II) and 2.5 ml (Group III).

The use of fentanyl would change the baricity of the solution. To avoid a possible modification in the baricity of the three solutions and the possibility of iso or hypobaricity of the combination used in the Group I, we calculated the density of the three solutions as recommended by Hare et al<sup>8</sup>. The final density of the solutions was 1.011 g/mL for Group I, 1.013 g/mL for Group II and 1.015 g/mL for Group III. All these solutions were hyperbaric at 37°C compared to cerebrospinal fluid (CSF: 1.0003 g/mL<sup>8,9</sup>).

Extension and duration of the block were classically dependent on

the dose of the local anesthetic injected<sup>10</sup>. The number of segments blocked depended on the dose used<sup>6,8</sup>. In fact, there is no linear relation between the number of segments blocked and the dose of local anesthetic. Reducing by half the quantity of the drug injected does not reduce by half the number of segments blocked<sup>10,11</sup>. This hypothesis is confirmed by Burgess et al<sup>12</sup> about continuous spinal anesthesia and the efficiency of 3.75 mg and 5 mg hyperbaric bupivacaine, in peripheral vascular surgery. Gentili<sup>13</sup>, using 8, 6 and 4 mg of hyperbaric bupivacaine for lower limb saphenous vein stripping, found that small doses (6-8 mg) provide adequate sensory block within about 1 hour of mean duration. The 4-mg dose failed to achieve surgical anesthesia in some cases (13%). In other studies<sup>4,14</sup>, the addition of fentanyl with the local anesthetic, intensifies and increases the duration of the sensory blockade without increasing the intensity of motor block or prolonging recovery to micturition or street fitness. The synergistic interaction between spinal opioids and local anesthetics is characterized by enhanced somatic analgesia without effect on the degree or level of the local anesthetic-induced sympathetic or motor blockade<sup>15,16</sup>. In our study, 25 µg of fentanyl was added to the three groups of patients to avoid the possibility of failure of the low doses of bupivacaine, if used alone.

The lumbar interspace chosen for injection of hyperbaric bupivacaine may influence the level of the block<sup>17</sup>. All patients in our study, had the anesthetic solution injected in the L3-L4 interspace with the same velocity and the orifice of the spinal needle turned cephalad.

The time to achieve the highest levels is longer with smaller doses of bupivacaine and is not modified by the use of fentanyl<sup>18</sup>. In our study, the absence of complete motor block in Group I was not a problem for the surgical procedure. However, incomplete motor block might be contraindicated in some urologic procedures in which movements (obturator nerve stimulation in the lateral wall of the bladder) may result in a bladder perforation. The patient in Group I who had a bladder perforation was not due to any movement or decreased analgesia. Possible reasons for the incomplete motor block in Group I and II could be the low dose of bupivacaine used or the lower bupivacaine activity on motor

block. If the motor block was less intense, the recovery and mobilization of the patient could be faster. These findings were demonstrated by the studies of Vaghadia when comparing a small-dose hypobaric lidocaine-fentanyl spinal anesthesia and conventional-dose hyperbaric lidocaine<sup>19</sup>. The problem of the shortness of the sensory block with the low dose of bupivacaine is resolved by adding fentanyl. Kuusniemi showed that adding 25 µg of fentanyl to 10 mg of bupivacaine compared to 10 mg of bupivacaine only, will prolong the sensory block<sup>20</sup>. This observation is in accordance with earlier studies in which duration of the block is found to be dose-related when using either lidocaine<sup>21</sup> or bupivacaine<sup>10</sup>.

The use of 10 mg of ropivacaine plus fentanyl 15 µg provided similar sensory anesthesia, but with shorter duration of motor block, compared with plain bupivacaine 10 mg plus fentanyl 15 µg<sup>22</sup>. The use of levobupivacaine did not attenuate the intensity of hemodynamic changes for the same level of sensory and motor block<sup>23,24</sup>. Weering in a randomized prospective study did not find any significant difference in the maximum degree of motor block or hemodynamic changes, when patients were remained in the sitting position for 2, 5, 10 or 20 minutes after subarachnoid injection of 15 mg of hyperbaric bupivacaine<sup>25</sup>.

Hypotension is common during subarachnoid block and episodes of severe hypotension can be detrimental to the patient, especially for endoscopic urological surgery in the elderly. During subarachnoid block, 69% of elderly patients required treatment for hypotension<sup>26</sup>. Hypotension is the most dangerous side effect and may induce many cardiovascular complications especially when coronary heart disease is present. Cardiovascular side effects requiring treatment occurred at any time during spinal anesthesia in a placebo-controlled study, regardless of the prophylactic regimen by fluid infusions or dihydroergotamine<sup>27</sup>. Hypotension at the end or immediately after surgery when the effect of spinal anesthesia is not ended, is in part due to post-surgery hemorrhage. The same studies demonstrate correlation between the highest level of sensory block and the depth of hypotension<sup>27</sup>. In our study, only 2 patients needed Ephedrine in Group I as compared to 5 patients in Group II and 16 patients in Group III.

Variability in lumbosacral cerebrospinal fluid volume is the most important factor identified that contributes to the variability in the spread of spinal sensory anesthesia<sup>28</sup>. Because cerebrospinal fluid volume cannot be readily predicted, uncertainty in the extent and duration of spinal anesthesia is inevitable after intrathecal injection of a single local anesthetic dose<sup>28</sup>. We believe that reducing the dose of bupivacaine to less than 5 mg + fentanyl 25 µg in a single shot spinal anesthesia, will not procure adequate surgical conditions.

No severe bradycardia occurred in our study, however it was a side effect (9-30%) described with the use of high doses of bupivacaine<sup>27,29</sup>.

Pruritus is the most frequent side effect observed with the use of intrathecal opioids. It may be generalized but is more likely to be localized to the face, neck, or upper thorax. The incidence varies widely, from 0 to 100%, and it is often elicited only after direct questioning. Severe pruritus is rare, occurring in only about 1% of patients<sup>30</sup>. In more recent studies, the global incidence of pruritus was 29.8%<sup>14</sup> and 22.5%<sup>20</sup>, compared to 28% in our study. It was always well tolerated and none of the patients needed treatment.

Intrathecal opioids may provide benefits in increasing depth of spinal anesthesia, but carry a risk of respiratory depression. The use of 25 µg of fentanyl during spinal anesthesia in nonpremedicated elderly men did not alter the respiratory rate, end tidal tension of CO<sub>2</sub>, minute ventilation, respiratory timing, or the ventilatory response to CO<sub>2</sub><sup>31</sup>.

Nausea and vomiting are disagreeable side effects for the patient. Their incidences are 18% for nausea and 7% for vomiting in a prospective study including 1000 patients<sup>29</sup>. Risk factors are sympathetic block higher than T5, bradycardia less than 60 bpm before spinal anesthesia, hypotension and the use of procaine. In our study, nausea only, was found in 14% of patients with no difference between groups. At the end, no postural puncture headache was observed.

In conclusion, the use of a low dose of bupivacaine (5 mg) added to fentanyl (25 µg) resulted in short-acting sensory block, without motor block and a lower incidence of cardiovascular side effects, when

compared to the combination of 10 mg bupivacaine and 25 µg fentanyl, that is compatible with endoscopic urological surgery.

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## References

1. SCHNEIDER M, ETTLIN T, KAUFFMAN M, ET AL: Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. *Anesth Analg*; 76:1154-1157, 1993.
2. BEARDSLEY D, HOLMAN S, GANTT R, ET AL: Transient neurologic deficit after spinal anesthesia: local anesthetic maldistribution with pencil point needles? *Anesth Analg*; 81:314-20, 1995.
3. DE JONG RH: Last round for a "heavyweight"? *Anesth Analg*; 78:3-4, 1994.
4. BEN-DAVID B, SOLOMON E, LEVIN H, ADMONI H, GOLDIK Z: Intrathecal fentanyl with small-dose dilute bupivacaine: better anesthesia without prolonging recovery. *Anesth Analg*; 85:560-5, 1997.
5. CHILVERS CR, VAGHADIA H, MITCHELL GWE, MERRICK PM: Small-dose hypobaric lidocaine-fentanyl spinal anesthesia for short duration outpatient laparoscopy. Optimal fentanyl dose. *Anesth Analg*; 84:65-70, 1997.
6. CHAMBERS WA, LITTLEWOOD DG, EDSTROM HH, SCOTT DB: Spinal Anaesthesia with hyperbaric bupivacaine: effects of concentration and volume administered. *Br J anesth*; 54:75-79, 1982.
7. VAN ZUNDERT AAJ, GROULS RJE, KORSTEN HHM, LAMBERT DH: Spinal anesthesia. volume or concentration-What matters? *Reg Anesth*; 21:112-118, 1996.
8. HARE GMT, NGAN JCS: Density determination of local anaesthetic opioid mixtures for spinal anaesthesia. *Can J Anaesth*; 45:341-46, 1998.
9. RICHARDSON MG, WISSLER RN: Densities of Dextrose-free intrathecal local anesthetics, opioids, and combinations measured at 37°C. *Anesth Analg*; 84:95-9, 1997.
10. LIU SS, WARE PD, ALLEN HW, NEAL JM, POLLOCK JE: Dose-response characteristics of spinal bupivacaine in volunteers: Clinical implications for ambulatory anesthesia. *Anesthesiology*; 85:729-36, 1996.
11. AXELSSON KH, EDSTROM HH, SUNDBERG AEA, WIDMAN GB: Spinal anaesthesia with hyperbaric 0.5% bupivacaine: Effects of Volume. *Acta Anaesthesiol Scand*; 26:439-445, 1982.
12. BURGESS FW, WOIWOOD MD, LUTZ RL, WALZ EJ, PERKINS DE: Continuous spinal anaesthesia with hyperbaric bupivacaine: A dose response analysis. *Reg Anesth*; 16:52-56, 1991.
13. GENTILI M, SENLIS H, HOUSSEL P, MONNIER B, BONNET F: Single-shot spinal anaesthesia with small doses of bupivacaine. *Reg Anesth*; 22:511-4, 1997.
14. LIU SS, CHIU AA, CARPENTER RL, ET AL: Fentanyl prolongs lidocaine spinal anesthesia without prolonging recovery. *Anesth Analg*; 80:730-4, 1995.
15. MAVES TJ, GEBHART GF: Antinociceptive synergy between intrathecal morphine and lidocaine during visceral and somatic nociception in the rat. *Anesthesiology*; 76:91-9, 1992.
16. WANG C, CHAKRABARTI MK, WITHWAM JG: Specific enhancement by fentanyl of the effects of intrathecal bupivacaine on nociceptive afferent but not on sympathetic efferent pathways in dogs. *Anesthesiology*; 79:766-73, 1993.
17. LOWSON SM, BROWN J, WILKINS CJ: Influence of the lumbar interspace chosen for injection on the spread of hyperbaric 0.5% bupivacaine. *Br J Anaesth*; 66:465-468, 1991.
18. SAKURA S, SUMI M, SAKAGUCHI Y, SAITO Y, KOSAKA Y, DRASNER K: The addition of phenylephrine contributes to the development of transient neurologic symptoms after spinal anesthesia with 0.5% tetracaine. *Anesthesiology*; 87:771-8, 1997.
19. VAGHADIA H, MCLEOD DH, MITCHELL GWE, MERRICK PM, CHILVERS CR: Small-dose hypobaric lidocaine-fentanyl spinal anaesthesia for short duration out patient laparoscopy. A

- randomized comparison with conventional dose hyperbaric lidocaine. *Anesth Analg*; 84:59-64, 1997.
20. KUUSNIEMI KS, PIHLAJAMAKI KK, PITKANEN MT, HELENIUS HY, KIRVELA OA: The use of bupivacaine and fentanyl for spinal anesthesia for urologic surgery. *Anesth Analg*; 91:1452-6, 2000.
  21. URMEY WF, STANTON J, PETERSON M, SHARROCK NE: Combined spinal-epidural anesthesia for out patient surgery: dose response characteristics of intrathecal isobaric lidocaine using a 27-Gauge Whitacre spinal needle. *Anesthesiology*; 83:528-34, 1995.
  22. LEE YY, NGAN KEE WD, MUCHHAL K, CHAN CK: Randomised double-blind comparison of ropivacaine-fentanyl and bupivacaine-fentanyl for spinal anaesthesia for urological surgery. *Acta Anaesthesiol Scand*; 49:1477-82, 2005.
  23. LEE YY, MUCHHAL K, CHAN CK, CHEUNG AS: Levobupivacaine and fentanyl for spinal anaesthesia: A randomized trial. *Eur J Anaesthesiol*; 22:899-903, 2005.
  24. LEE YY, MUCHHAL K, CHAN CK: Levobupivacaine versus racemic bupivacaine in spinal anaesthesia for urological surgery. *Anaesth Intensive Care*; 31:637-41, 2003.
  25. WEERING BT, IMMINK-SPEET TT, BURM AG, STIENSTRA R, VAN KLEEF JW: Spinal anaesthesia with 0.5% hyperbaric bupivacaine in elderly patients: effects of duration spent in the sitting position. *Br J Anaesth*; 87:738-42, 2001.
  26. CRITCHLEY LAH, STUART JC, SHORT TG, GIN T: Haemodynamic effects of subarachnoid block in elderly patients. *Br J Anaesth*; 73:464-70, 1994.
  27. ARNDT JO, BOMER W, KRAUTH J, MARQUARDT B: Incidence and time course of cardiovascular side effects during spinal anesthesia after prophylactic administration of intravenous fluids or vasoconstrictors. *Anesth Analg*; 87:347-54, 1998.
  28. CARPENTER RL, HOGAN QH, LIU SS, CRANE B, MOORE J: Lumbosacral cerebrospinal fluid volume is the primary determinant of sensory block extent and duration during spinal anesthesia. *Anesthesiology*; 89:24-9, 1998.
  29. CARPENTER RL, CAPLAN RA, BROWN DL, STEPHENSON C, WU R: Incidence and risk factors for side effects of spinal anesthesia. *Anesthesiology*; 76:906-16, 1992.
  30. CHANEY MA: Side effects of intrathecal and epidural opioids. *Can J Anaesth*; 42:891-903, 1995.
  31. VARASSI G, CELLENO D, CAPOGNA G, ET AL: Ventilatory effects of subarachnoid fentanyl in the elderly. *Anesthesia*; 47:558-62, 1992.