Comparison of low-dose spinal anesthesia and single-shot femoral block combination with conventional dose spinal anesthesia in outpatient arthroscopic meniscus repair

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Abstract. – OBJECTIVE: In the current prospective, randomized study, we aimed to compare the effects of low dose selective spinal anesthesia with 5 mg of hyperbaric bupivacaine and single-shot femoral nerve block combination with conventional dose selective spinal anesthesia in terms of intraoperative anesthesia characteristics, block recovery characteristics, and postoperative analgesic consumption.

PATIENTS AND METHODS: After obtaining institutional Ethics Committee approval, 52 ASA I-II patients aged 25-65, undergoing arthroscopic meniscus repair were randomly assigned to Group S (conventional dose selective spinal anesthesia with 10 mg bupivacaine) and Group FS (low-dose selective spinal anesthesia with 5 mg bupivacaine + single-shot femoral block with 0.25% bupivacaine). Primary endpoints were time to reach T12 sensory block level, L2 regression, and complete motor block regression. Secondary endpoints were maximum sensory block level (MSBL); time to reach MSBL, time to first urination, time to first analgesic consumption and pain severity at the time of first mobilization.

RESULTS: Demographic characteristics were similar in both groups (p > 0.05). MSBL and time to reach T12 sensory level were similar in both groups (p > 0.05). Time to reach L2 regression, complete motor block regression, and time to first micturition were significantly shorter; time to first analgesic consumption was significantly longer; and total analgesic consumption and severity of pain at time of first mobilization were significantly lower in Group FS (p < 0.05).

CONCLUSIONS: The findings of the current study suggest that addition of single-shot femoral block to low dose spinal anesthesia could be an alternative to conventional dose spinal anesthesia in outpatient arthroscopic meniscus repair. Clinical trials Registration number: NCT02322372.

Key Words: Bupivacaine, Outpatient surgery, Femoral block, Low-dose spinal anesthesia.

Introduction

At the present time, to decrease health-care costs, many surgical procedures have come to be performed in an outpatient setting. The success of perioperative management of outpatients is to provide an adequate duration of surgical anesthesia, rapid recovery with minimal side effects, early mobilization with minimal pain, early oral intake, short hospital stay, prevention of unplanned rehospitalizations, and patient satisfaction1-3.

Knee arthroscopy is the most frequent outpatient procedure in orthopedic surgery. Although general anesthesia, central blocks, and peripheral nerve blocks could be used in arthroscopic knee surgery, spinal anesthesia, being a simple, reliable, low-cost anesthetic procedure that induces better postoperative pain relief, is the most preferred method4-6.

Intermediate, short-acting local anesthetics such as lidocaine, prilocaine, and mepivacaine are used for spinal anesthesia in outpatient surgery; however, the risk of developing transient neurologic symptoms (TNS) that occurs more frequently with lidocaine and the insufficient duration of surgical anesthesia have limited their use7-11. Bupivacaine, due to its long duration of action and low prevalence of TNS, has been also used in spinal anesthesia practice; however, its long duration of action and resulting increased risk of urinary retention and prolonged hospitalization have led the in-
Patients and Methods

This study was registered at clinicaltrials.gov (Registration number: NCT02322372). After obtaining Institutional Ethics Committee approval and written informed patient consent, a total of 52 ASA I-II patients between 25 and 65 years of age who were scheduled to undergo arthroscopic meniscus repair were enrolled in this randomized, prospective study.

Exclusion criteria included contraindications to regional anesthesia (coagulopathy, severe aortic or mitral insufficiency, increased intracranial pressure, infection, hypovolemia, etc..), previous lumbar surgery, diabetes mellitus, neurological dysfunction, unable to cooperate, allergy to study medications, ASA III-IV patients, BMI > 38, height < 150 cm, and > 185 cm and conversion to general anesthesia.

Patient monitorization included electrocardiography (ECG), noninvasive blood pressure (NIBP), and pulse oximetry (SpO2). All patients were premedicated with 0.025-0.05 mg/kg intravenous (IV) midazolam hydrochloride. Before surgery, 0.5 mg/kg dexamethasone, and 4 mg ondansetron was given by intravenous route to all patients for postoperative nausea and vomiting, and 1 mg/kg tramadol HCL IV was administered for postoperative analgesia.

The patients were randomly assigned to one of two groups as Group S and Group FS. Randomization was provided by sealed, opaque, and numbered envelope technique. The randomization scheme is demonstrated in Figure 1. In Group S, spinal anesthesia was performed with 2 mL of hyperbaric bupivacaine 10 mg (Bustesin 0.5% spinal heavy, Vem Ilaç San Tic Ltd, Turkey). In Group FS, single-shot femoral block with a mixture of 15 mL bupivacaine 0.5% (Bustesin 0.5%, Vem Ilaç San Tic Ltd., Turkey) and 15 mL isotonic NaCl solution (bupivacaine 0.25%) was administered in the supine position, under the guidance of peripheral nerve stimulator (Plexyon nerve stimulator, Vygon) and high-resolution 8 to 12 MHz linear ultrasonic probe (Vivid-I; GE, Wauwatosa, WI, USA). Then, the patients were turned to the lateral decubitus position and spinal anesthesia was performed with 1 mL hyperbaric bupivacaine 5 mg, diluted in 1 mL of sterile water. The procedures were performed in the preparation room and the anesthesiologist who performed the procedures was not involved in the patient evaluations.

In all patients, the spinal technique was performed in the lateral decubitus position with a
midline approach at the L3-L4 or L4-L5 interspace, with the operative knee dependent. A 25-gauge Whitacre spinal needle (B. Braun, Melsungen, Germany) was used and the dose in each group was injected over 20 sec. The lateral decubitus position was maintained for 10 minutes following the subarachnoid injection and then the patients were held in a 20° Trendelenburg position.

The level of sensory and motor block were evaluated at two-minute intervals during the first 20 minutes following spinal injection and at five-minute intervals thereafter until the end of surgery, and at ten-minute intervals after completion of the surgery. The sensory block level was evaluated with a pinprick test using an intradermal needle. The motor block level was evaluated according to modified Bromage scale (Table I)\(^\text{34}\).

The time to reach the T12 sensory block level (the time from completion of spinal injection to achieving T12 sensory block level), maximum level of sensory block, and the time to reach the maximum sensory block level in both extremities were recorded.

The maximum level of motor block and the time to reach maximum motor block level in both extremities were recorded.

Adequate surgical block was defined as achieving T12 sensory block level and the absence of pain in the knee and thigh in the operated extremity. Adequate surgical anesthesia was defined as reaching a sensory block level of T12 and not necessitating general anesthesia for completion of surgery. The lower extremity relaxation quality and its response to surgical mobilization was evaluated by the surgeon as good or bad.

The patients were followed up in the postanesthesia recovery unit until full recovery of motor and sensory block. The time from spinal injection to complete recovery of motor block (Bromage score of 0) was defined as the time to complete motor recovery and the time from spinal injection to the regression of sensory block to the L2 level was defined as time to L2 regression and the duration of time to complete recovery and time to L2 regression were recorded.

Patient-controlled analgesia (PCA) with intravenous tramadol was started at the end of the surgery. PCA was arranged to give a bolus dose of 20 mg in each demand with a lock-out period of 30 minutes. The time from spinal injection to first demand of tramadol was defined as the time to first analgesic requirement. The time to first analgesic requirement and the total tramadol consumptions within the first six postoperative hours were recorded. According to the routine practice in our orthopedics department, all patients were mobilized at the postoperative sixth hour and the severity of pain at the time of mobilization was evaluated with VAS.

The time from spinal injection to first spontaneous urination was recorded. In the postoperative period, the patients were evaluated in terms of hemodynamic side effects, nausea/vomiting, and transient neurological symptoms such as backache, pain in the legs, and dysesthesia.

**Statistical Analysis**

Our primary outcome was the time to complete motor block regression, defined as the duration of time from intrathecal injection to a modified Bromage scale score of 0. A preliminary estimate of a sample size of 25 patients per group, with Type I error of 0.05 and the assumption of a 90% power was based on an expected 30 min difference in mean time to complete motor recovery, based on a previous study\(^\text{17}\). In order to compare the two independent groups in terms of categorical variables, the chi-square test was used and that of metric variables Student’s \(t\)-test/Mann-Whitney U-test were performed. While the frequency (percent) was used to describe categorical variables, mean±standard deviation or median (min-max) was given for metric variables. The data was expressed as means ± SD and number of patients. \(p\) value adjustment, dividing the \(p\) value by two for every comparison repeated within a group, was done to avoid a Type II error.

When the number of patients with a maximum motor block level of 0, 1, 2, or 3 in the modified Bromage scale were analyzed, the number of boxes with the number of expected frequencies lower than 5 was 75% and an appropriate significance value could not be achieved. Thus, for statistical analysis, the maximum motor block level in the operated extremity was classified as complete motor block (Bromage score of 3) or incomplete motor block (Bromage score of 0, 1, or 2) and the number of patients with complete and

<table>
<thead>
<tr>
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<th>Modified Bromage scale(^\text{34}).</th>
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<tbody>
<tr>
<td>0</td>
<td>Full movement</td>
</tr>
<tr>
<td>1</td>
<td>Inability to raise the extended leg, can bend knee</td>
</tr>
<tr>
<td>2</td>
<td>Inability to bend knee, can flex ankle</td>
</tr>
<tr>
<td>3</td>
<td>No movement</td>
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</table>
incomplete motor block was reevaluated with the chi-square test. The maximum motor block level in the nonoperated extremity was classified as the presence of motor block (Bromage score of 1, 2, or 3) and the absence of motor block (Bromage score of 0). The number of patients with and without motor block was reevaluated with the chi-square test.

All statistical analyses were computed by SPSS version 20.0 software (SPSS Inc., Chicago, IL, USA). A p value of < 0.05 was considered statistically significant.

Results

Fifty-eight patients scheduled for arthroscopic meniscus repair were eligible and two patients were excluded because of their refusal and 56 were randomly assigned to one of the two groups, with 28 patients in each group (Figure 1). There was incomplete anesthesiain one patient in the conventional dose spinal anesthesia group and in one patient in the femoral block+spinal anesthesia group; thus, general anesthesia was performed and these patients were excluded from analysis. One patient in the spinal anesthesia group and one patient in the femoral block+spinal anesthesia group could not complete the study due to difficulties with cooperation. As a result, a total of 52 patients completed the study, with 26 patients in each group (Figure 1).

There was no difference between groups in age, height, weight, gender, ASA physical status classification, operation type, and duration of surgery (Table II) (p>0.05). There was no signifi-

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**Table II.** Demographical variables of patients.

<table>
<thead>
<tr>
<th></th>
<th>Group S (n = 26)</th>
<th>Group FS (n = 26)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>46.9 ± 13.2</td>
<td>47.4 ± 12.6</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.2 ± 7.9</td>
<td>165.1 ± 10.2</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>78.5 ± 8.1</td>
<td>75.1 ± 9.5</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Gender (F/M) (n)</td>
<td>15/11</td>
<td>17/9</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>ASA I/II (n)</td>
<td>19/7</td>
<td>21/5</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>52.5 (23-140)</td>
<td>55 (33-135)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

n: number of patients The values are presented as number, means ± standard deviation and median (min-max).
Low-dose spinal anesthesia and SSFB combination with conventional dose spinal anesthesia

Table III. Characteristics of sensory block.

<table>
<thead>
<tr>
<th></th>
<th>Group S (n = 26)</th>
<th>Group FS (n = 26)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to reach T12 sensory block level on the operated side (minute) (median) (min-max)</td>
<td>4 (0-8)</td>
<td>3 (1-14)</td>
<td>p = 0.932</td>
</tr>
<tr>
<td>Highest level of sensory block on the operated side</td>
<td>T10 (T7-T12)</td>
<td>T10 (T8-T12)</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>Time to reach highest sensory block level on the operated side (minute) (median) (min-max)</td>
<td>10 (0-18)</td>
<td>9 (2-20)</td>
<td>p = 0.644</td>
</tr>
<tr>
<td>Time to L2 regression of sensory block level on the operated side (minute) (mean ± SD)</td>
<td>149.85 ± 45.48</td>
<td>105.62 ± 31.87</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>Sensory block on the nonoperated side (present/absent) (n) (%)</td>
<td>16/10 (61.5%/38.5%)</td>
<td>12/14 (46.2%/53.8%)</td>
<td>p = 0.266</td>
</tr>
</tbody>
</table>

n: number of patients. The values are presented as number, means ± standard deviation and median (min-max).

There was no statistically significant difference between two groups in terms of intraoperative hemodynamic parameters (p > 0.05).

**Sensory Block**

There was no statistically significant difference between the groups in terms of time to reach T12 sensory block level, the highest sensory block level, and the time to reach the highest sensory block level in the operated extremity. The highest level of sensory block in the operated extremity was T10 (T7-T12) and T10 (T8-T12) in Group S and Group FS, respectively (p > 0.05). The time to L2 regression of sensory block in the operated extremity was significantly shorter in Group FS (p < 0.001) (Table III).

There was no sensory block in 10 patients (38.5%) and 14 patients (53.8%) in Group S and Group FS, respectively. The difference was not statistically significant (p > 0.05) (Table III).

**Motor Block**

The maximum motor block level in the operated extremity was classified as complete motor block (Bromage score of 3) or incomplete motor block (Bromage score of 0, 1, or 2). There was complete motor block in 25 patients and in 18 patients in Group S and Group FS, respectively. The difference between groups was statistically significant (p = 0.01). There was no statistically significant difference between groups in terms of time to reach maximum motor block level in the operated extremity (p > 0.05). The time to complete recovery of motor block in the operated extremity was significantly shorter in Group FS (p = 0.002) (Table IV).

Table IV. Characteristics of motor block.

<table>
<thead>
<tr>
<th></th>
<th>Group S (n = 26)</th>
<th>Group FS (n = 26)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromage scale score =3 (complete motor block) (n)</td>
<td>25</td>
<td>18</td>
<td>p = 0.01</td>
</tr>
<tr>
<td>Maximum level of motor block as 0/1/2/3 in Bromage scale score on the operated side (n)</td>
<td>0/1/0/25</td>
<td>1/3/4/18</td>
<td></td>
</tr>
<tr>
<td>Time to reach maximum motor block level on the operated side</td>
<td>10 (4-20)</td>
<td>12 (0-20)</td>
<td>p = 0.603</td>
</tr>
<tr>
<td>Time to complete recovery of motor block on the operated side (min) (median (min-max))</td>
<td>178 (65-248)</td>
<td>115 (0-403)</td>
<td>p = 0.002</td>
</tr>
<tr>
<td>Bromage scale score=0 (absence of motor block) (n)</td>
<td>15</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Maximum level of motor block as 0/1/2/3 in Bromage scale score on the nonoperated side</td>
<td>15/2/2/7</td>
<td>21/0/0/5</td>
<td>p = 0.071</td>
</tr>
<tr>
<td>Time to complete recovery of motor block on the nonoperated side (min) (median (min-max))</td>
<td>109 (45-205)</td>
<td>105 (90-185)</td>
<td>p = 0.743</td>
</tr>
</tbody>
</table>

n: number of patients. The values are presented as number and median (min-max).
The maximum motor block level in the nonoperated extremity was classified as the presence of motor block (Bromage score of 1, 2, or 3) and the absence of motor block (Bromage score of 0). The number of patients without motor block in the nonoperated extremity was 15 and 21 in Group S and Group FS, respectively, and the difference between groups was not statistically significant \((p>0.05)\). The time to reach complete recovery of motor block in the nonoperated extremity was similar in both groups \((p>0.05)\) (Table IV).

The time to first spontaneous urination was significantly shorter in Group FS \((p=0.01)\) (Table V). The time to first analgesic requirement was longer in Group FS \((p<0.001)\). The total amount of tramadol consumption was significantly lower in Group FS \((p<0.001)\). The VAS scores at the time of first mobilization was significantly lower in Group FS \((p=0.019)\) (Table V).

There were no hemodynamic side effects, nausea, vomiting, or transient neurological symptoms such as backache, pain in the legs, and dysesthesia in any patient in either study group. No patients fell down during the first mobilization in either study group. There was no difference between groups in terms of patient and surgeon satisfaction \((p>0.05)\).

### Discussion

The current prospective, randomized study demonstrated that the addition of single-shot femoral nerve block (SSFB) with 0.25% bupivacaine to selective spinal anesthesia with low concentration, low dose bupivacaine (5 mg in 2 mL) in arthroscopic meniscus repair surgery provided similar intraoperative block characteristics with conventional dose spinal anesthesia (10 mg) and decreased the pain severity during the first mobilization and analgesic consumptions without prolonging the duration of motor block and time to first spontaneous micturition. These findings suggest that the addition of a single-shot femoral block to low dose spinal anesthesia could be an alternative to conventional dose spinal anesthesia in outpatient arthroscopic meniscus repair.

Arthroscopic procedures are the most common outpatient procedures in orthopedic surgery and there is still no consensus related to perioperative anesthesia management in these procedures.

In most of the studies in which adjuvant agents were added to low dose spinal anesthesia during arthroscopic meniscus repair, the same dose of local anesthetic was used in the study groups and the effect of addition of adjuvants were investigated\(^{12,14-24}\). However, in the current study, we hypothesized that addition of SSFB to low dose bupivacaine could provide similar block characteristics with the conventional dose (10 mg) and by the addition of SSFB to low dose spinal anesthesia, we aimed to reach the discharge criteria earlier, to prevent the risk of inadequate block, and also to benefit from the analgesic effect of SSFB. Although the efficacy of SSFB in postoperative pain management during knee surgery has been demonstrated in previous studies, to our knowledge there are no studies in the literature in which SSFB was used to increase the effectiveness of spinal anesthesia with low dose local anesthetic\(^{30}\).
In the present study, we choose 10 mg as the conventional dose because the rate of block failure and conversion to general anesthesia is too high when smaller doses of the commercially available preparate of hyperbaric bupivacaine (Bustesin 0.5% spinal heavy, Vem İlaç San Tic Ltd, Turkey) is used.

In the study of Valanne et al\textsuperscript{13}, in which they compared two different low doses of hyperbaric bupivacaine (4 mg and 6 mg) in outpatient knee arthroscopy, they found a failure rate of 4% in all patients. In the current study, insufficient block developed in one patient in the two study groups and general anesthesia was performed. In the current study, the failure rate in both groups was 3.7% and this was similar to the study of Valanne et al\textsuperscript{13}.

In low dose spinal anesthesia studies, the most important side effect encountered by the addition of fentanyl to low dose local anesthetics is pruritus and nausea/vomiting and these side effects negatively affect patient satisfaction and comfort\textsuperscript{35,36}. Another problem in low dose spinal anesthesia is inadequate operation conditions. In the current study, the time to reach T12 sensory block level, the highest level of sensory block and the time to reach highest level of sensory and motor block in the operated extremity was similar in both groups, which demonstrates that the addition of SSFB made the spinal anesthesia characteristics similar to the conventional dose group. Both the surgeon and patient satisfaction were good in the study groups.

In previous studies in which magnesium and clonidine was added to low dose local anesthetic, it was reported that although the time to the first analgesic requirement was prolonged, the duration of the motor block was also prolonged, which is an unwanted outcome in outpatient procedures\textsuperscript{23,25,26}. However, in the present study, the time to L2 regression of the sensory block and the time to complete recovery of the motor block were shorter and the time to first analgesic requirement was longer in the femoral block group. The number of patients with complete motor block (Bromage=3) in the operated extremity was lower in Group FS when compared to Group S; however, this did not affect the operation conditions (p<0.05). Although not statistically significant, the number of patients who had no motor block in the nonoperated extremity was lower in Group FS and this was another positive result for patient satisfaction.

In the current study, the lower amount of tramadol consumption in Group FS was a result of the analgesic effect of the single shot femoral block. In both groups, tramadol PCA was sufficient for analgesia and no additional analgesic was used.

One of the significant problems encountered by spinal anesthesia is prolonged micturition, which is also an unwanted situation in outpatient surgery. The occurrence of urinary retention in spinal anesthesia has been reported as 17\%\textsuperscript{6}. In this respect, low dose spinal anesthesia could be beneficial as it shortens the time to first spontaneous urination. In the present study, the time to first spontaneous urination was also shorter in the low dose group and addition of femoral block had no negative effect.

In the current study, diluted bupivacaine (15 mL of bupivacaine 0.5% was diluted in 15 mL sterile water to achieve a concentration of 0.25\%) was used for SSFB to prevent the risk of postoperative motor block prolongation, weakness of the quadriceps muscle, and the risk of falling. No muscle weakness was observed during the first mobilization in any patient. The shorter time to complete motor regression and first spontaneous urination in Group FS is a favorable condition for outpatient surgery and in this respect, the addition of femoral block to low dose spinal anesthesia could be a good option in outpatient knee surgery.

Black et al\textsuperscript{35} reported that a short acting agent such as prilocaine could also be used in combination with fentanyl; however, in the current study, we preferred low dose of a long-acting local anesthetic. As it has been already demonstrated in the results section, the duration of operation was prolonged up to 140 minutes in our cases. Additionally, the prilocaine preparations that are available in Turkey contain preservative solutions and they are not suitable for spinal use.

Postoperative pain is also an important factor in outpatient surgery, which has negative effects on the recovery period and it is the most common cause of unplanned rehospitalizations\textsuperscript{13}. In a previous study, Demirel et al\textsuperscript{17} have compared unilateral spinal anesthesia and combined sciatic and psoas compartment block in patients undergoing partial hip prosthesis and they have demonstrated that peripheral nerve blocks have extended the initial time of the need for analgesia. Although arthroscopic meniscus surgery causes less severe pain than knee arthroplasty, analgesia could be necessary, especially in meniscus repair. In the current study we also included the cases undergoing meniscus repair.
Therefore, the addition of femoral block could be beneficial in this respect. In the present study, the analgesic requirements were lower and the time to the first analgesic requirement was prolonged in the femoral block group. There was no need for rehospitalization in any of the patients.

Hadjic et al. reported that peripheral nerve block have several advantages according to general anesthesia in outpatient procedures. However, the longer duration of the preoperative preparation period limits the use of peripheral nerve blocks. In the current study, we did not evaluate the duration of the preparation period, which is a criticism to our study.

As is routine practice in our hospital, the patients undergoing meniscus repair are hospitalized for 12 hours, although they reach the discharge criteria. Therefore, the patients in the current work were hospitalized for 12 hours and the time to discharge wasn’t evaluated. However, when comparing the factors to reach discharge criteria, low dose spinal anesthesia and SSFB combination seems to be more preferable with earlier motor block recovery, lower pain scores at time of mobilization and shorter time to first urination.

Conclusions

In the current study it has been demonstrated that low dose selective spinal anesthesia combined with single-shot femoral block provides adequate anesthesia without prolonging motor and sensory block duration and without causing muscle weakness and with less analgesic consumption and lower pain scores at the time of mobilization.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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