Unilateral bupivacaine spinal anesthesia for outpatient knee arthroscopy

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Purpose: To compare unilateral and conventional bilateral bupivacaine spinal block in outpatients undergoing knee arthroscopy.

Methods: One hundred healthy, premedicated patients randomly received conventional bilateral (n = 50) or unilateral (n = 50) spinal anesthesia with 8 mg hyperbaric bupivacaine 0.5%. A lateral decubitus position after spinal injection was maintained in unilateral group for 15 min. Times from spinal injection to readiness for surgery, block resolution, and home discharge were recorded.

Results: Three patients in each group were excluded due to failed block. Readiness for surgery required 13 min (5 – 25 min) with bilateral and 16 min (15 - 30) with unilateral spinal block ($P = 0.0005$). Sensory and motor blocks on the operated limb were T_9 ($T_{12} - T_2$) with a Bromage score 0/1/2/3: 0/2/0/45 in the unilateral group and T_7 ($T_{12} - T_1$) with Bromage score 0/1/2/3: 4/1/6/36 with bilateral block ($P = 0.026$ and $P = 0.016$, respectively). Vasopressor was required only in five bilateral patients ($P = 0.02$). Two segment regression of sensory level and home discharge required 81 ± 25 min and 281 ± 83 min with bilateral block, and 99 ± 28 min and 264 ± 95 min with unilateral block ($P = 0.002$ and $P = 0.90$, respectively).

Conclusion: Seeking unilateral distribution of spinal anesthesia provided more profound and longer lasting block in the operated limb, less cardiovascular effects, and similar home discharge compared with bilateral spinal anesthesia, with only a slight delay in preparation time.

Objectif : Comparer le bloc rachidien unilatéral au bloc bilatéral traditionnel chez des patients ambulatoires qui subissent une arthroscopie du genou.

Méthode : Cent patients sains ont reçu une prémédication et, de façon aléatoire, une rachianesthésie bilatérale traditionnelle (n = 50) ou unilatérale (n = 50) avec 8 mg de bupivacaïne hyperbare à 0,5 %. Après l'injection, les patients du groupe unilatéral ont été maintenus en décubitus latéral pendant 15 min. On a enregistré : le temps écoulé entre l'injection et le début de l'opération, le temps nécessaire à la résolution du bloc et le moment de la sortie du service.

Résultats : Trois patients ont été exclus dans chaque groupe à cause de l'échec du bloc. Il a fallu 13 min (5 - 25 min) de préparation à l'opération avec le bloc bilatéral et 16 min (15 - 30) avec le bloc unilatéral (P = 0,0005). Les blocs sensitif et moteur sur le membre opéré ont été de T_9 (T_{12} - T_2) avec des scores de 0/1/2/3: 0/2/0/45 à l'échelle de Bromage dans le groupe unilatéral et de T_7 (T_{12} - T_1) et des scores de Bromage de 0/1/2/3: 4/1/6/36 avec le bloc bilatéral (P = 0,026 et P = 0,016, respectivement). Des vasopresseurs ont été nécessaires chez cinq patients seulement du groupe bilatéral (P = 0,02). Le temps nécessaire à la régression de deux segments du bloc sensitif et au congé a été de 81 ± 25 min et de 281 ± 83 min avec le bloc bilatéral, et de 99 ± 28 min et 264 ± 95 min avec le bloc unilatéral (P = 0,002 et P = 0,90, respectivement).

Conclusion : La rachianesthésie unilatérale, comparée à la rachianesthésie bilatérale, produit un bloc plus profond et plus long dans le membre opéré, moins d'effets cardiovasculaires, un séjour hospitalier de durée similaire et seulement un léger délai de préparation à l'intervention.

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SPINAL anesthesia with lidocaine has been widely used for outpatient procedures for many years.[1] However, transient neurological symptoms occurring after spinal lidocaine administration have modified clinical practice,[2] and small doses of bupivacaine have been suggested when performing spinal block in outpatients.[3–5]

It has been suggested that a unilateral distribution of spinal anesthesia can be attempted by using the lateral decubitus position with small doses of hypo- or hyperbaric local anesthetic solution.[4,6,7] Also directional pencil point needles[8] have been advocated for short procedures involving only one lower limb[4,6,7] to minimize the cardiovascular effects of spinal block.[9,10] However, no randomized studies have been reported to evaluate the efficacy, latency of surgical block, and patient discharge of either unilateral or conventional bilateral spinal anesthesia performed with the same dose of hyperbaric bupivacaine.

We conducted a prospective, randomized study to compare times from spinal injection to achieve surgical anesthesia and hospital discharge in outpatients undergoing knee arthroscopy with either conventional bilateral or unilateral bupivacaine spinal anesthesia.

Methods

After the study protocol had been approved by the local Ethical Committee, written informed consent was obtained from one hundred ASA physical status I-II patients, aged 18 - 65 yr, undergoing outpatient knee arthroscopy. Patients with contraindication to regional anesthesia, respiratory or cardiac disease, diabetes or peripheral neuropathy as well as patients receiving chronic analgesic therapy were excluded.

After an 18-Gauge intravenous (*iv*) cannula had been inserted at the forearm, all patients received premedication with 0.05 mg·kg^{-1} midazolam and 50 mg ketoprofen *iv* 20 min before block placement, followed by 7 ml·kg^{-1} infusion of Ringer's lactate solution. Further fluids were given only if required to treat adverse hemodynamic events. Clinically relevant hypotension was a decrease in systolic arterial blood pressure by 30% or more from baseline values. It was initially treated with 200 ml Ringer's lactate solution; if this proved to be ineffective, 5 mg etilephrine were given. Clinically relevant bradycardia was defined as a heart rate decrease to < 45 bpm, and was treated with 0.5 mg atropine *iv*.

Patients were placed in the lateral position with the limb to be operated on in the dependent position. The vertebral column position was accurately visualized before dural puncture, and was maintained as horizontal as possible by tilting the operating table or by putting a pillow under the shoulder. Dural puncture was performed at the L_3-$_4$ interspace using a 25-Gauge Whitacre spinal needle (Becton-Dickinson, New Jersey, USA) with the midline approach. Using sealed envelopes prepared according to a computer generated randomization table, patients were randomly allocated to one of two groups. In the first group (Unilateral, n = 50), after free flow of cerebrospinal fluid (CSF) had been observed, the needle orifice was turned toward the dependent side and 8 mg hyperbaric bupivacaine 0.5% (Marcaine Spinal Heavy, Astra, Sweden) was injected over 30 sec without further CSF aspiration (speed of intrathecal injection approximately 0.05 ml·sec^{-1}); the lateral position was then maintained for 15 min, before patients were turned supine. In the second group (Conventional, n = 50) after free CSF flow had been observed, the same dose of hyperbaric bupivacaine 0.5% was injected with three further CSF aspirations (barbotage) through a cranially directed needle orifice. Then, patients were immediately turned to supine.

Standard monitoring was used throughout the study, including continuous ECG (Lead II), heart rate, non-invasive arterial blood pressure measured every five minutes, and continuous pulse oximetry. The sensory block was evaluated using the pinprick test (22-gauge hypodermic needle), whereas motor blockade was evaluated using a modified Bromage scale (0 = no motor block; 1 = hip blocked; 2 = hip and knee blocked; 3 = hip, knee and ankle blocked). Sensory and motor blocks were evaluated bilaterally by an unblinded observer every five minutes from the end of spinal injection until adequate surgical anesthesia was observed on the operated side. Surgical anesthesia was defined as the loss of pinprick sensation at T_{12} on the operated side with a modified Bromage score $\geq$ 2 on the operated limb.

After adequate spinal block had been achieved, the time from the end of intrathecal injection to readiness for surgery was recorded. Then, the patient was positioned on the operating table and surgery started. Further assessments of sensory and motor blocks were performed by a blinded observer every 15 min until two-segment regression of sensory level was observed on the operated side, and then every 30 min until complete resolution of spinal block. Hemodynamic variables were recorded every five minutes during the first 30 min after block placement, then every 15 min until the end of surgery. Further cardiovascular assessments were performed during sensory and motor blocks assessments.

The quality of spinal anesthesia was evaluated by the blinded observer according to the need for sup-

TABLE I Demographic data.

	Conventional (n = 50)	*Unilateral (n = 50)*
Age (yr)	38 ± 12	40 ± 14
Weight (kg)	67 ± 17	70 ± 12
Height (cm)	169 ± 9	169 ± 8
Male/Female	28 / 22	31 / 19

Results are presented as mean (± SD), with the exception of the Male/Female ratio (number)

TABLE II Distribution of the modified Bromage score in both the operated and nonoperated sides in patients receiving conventional bilateral spinal anesthesia (Conventional group, n = 47) or unilateral spinal anesthesia (Unilateral group, n = 47).

Group Unilateral (n = 47)					
		Operated side			
Bromage score		0	1	2	3
Nonoperated side					
	0	0	2	0	35
	1	0	0	0	3
	2	0	0	0	2
	3	0	0	0	5
r = 0.1; P = 0.503					
Group Conventional (n = 47)					
		Operated side			
Bromage score		0	1	2	3
Nonoperated side					
	0	4	0	1	7
	1	0	1	0	0
	2	0	0	4	9
	3	0	0	0	20
r = 0.50; P = 0.0005					

plementary *iv* analgesics: adequate spinal anesthesia = no analgesic required to complete surgery; inadequate spinal anesthesia = 0.1 mg fentanyl required to complete surgery; failed spinal anesthesia = general anesthesia (0.1 mg fentanyl and 4 $mg \cdot kg^{-1} \cdot hr^{-1}$ infusion of propofol) required to complete surgery.

Postoperative analgesia consisted of 50 mg ketoprofen *po* every eight hours on the operation day, starting eight hours after surgery. Rescue analgesia was given with 50 mg tramadol *po*, if the patient asked for more analgesics. Postoperatively, patients were evaluated every 30 min by the blinded observer until patients were judged ready for home discharge. Standardized home discharge criteria were: patient alert with stable vital signs, complete resolution of spinal block, able to void and ambulate, nausea and pain controlled with oral medication. If spontaneous urination had not recovered six hours after spinal block placement, a catheter was placed to empty the bladder, and two hours were allowed for spontaneous micturition to resume. If this did not occur the patient was hospitalized for the night. Data regarding the time from the end of local anesthetic injection to complete resolution of sensory and motor blocks, urination, unassisted ambulation and readiness to discharge, as well as occurrence of untoward events or complications, and pain treatment were also recorded.

Postoperative follow-up was carried out the day after surgery by phone and one week after surgery during a routine postoperative visit by asking the patient about postoperative pain, post-dural puncture headache, and dysesthesia in the buttocks, thighs, or lower limbs. The need for rescue tramadol during the first 24 hr after surgery was also recorded.

Statistical analysis was performed using Systat 7.0 (SPSS Inc, Chicago, IL). The two-sample Student's t test was used to compare demographic data, and times for readiness to surgery, block resolution, and home discharge. The Mann-Whitney u-test was also used when data were not normally distributed. Analysis of variance for repeated measures was used to analyze changes over time. Ordinal data were analyzed using the contingency table analysis with the chi-square test. The time required from completion of spinal anesthesia to fulfillment of standardized discharge criteria was also evaluated using the Kaplan-Meier's survival analysis. A value of $P < 0.05$ was considered significant. Unless otherwise indicated, continuous variables are presented as mean (±SD), while ordinal data are presented as number (%).

Results

No differences in demographic variables were observed between the two groups (Table I). The median time from the end of intrathecal injection of local anesthetic solution to achieving surgical anesthesia was 13 min (range: 5 – 25 min) in the Conventional group and 16 min (range: 15 – 30) in the Unilateral group (P = 0.0005). Three patients in each group (6%) required general anesthesia to perform surgery due to inadequate spinal block. In five (three Conventional and two Unilateral) the sensory level on the operated side was less than T_{12} 30 min after spinal injection. In one Unilateral group patient, even though nerve block achieved the criteria for adequate surgical anesthesia, the patient complained of pain due to regression of sensory block before the end of surgery. These patients were excluded from discharge analysis. None of the other patients required additional analgesia, and no fentanyl supplementation was provided during surgery.

The maximum sensory level on the operated side was T_9 ($T_{12} - T_2$) in the Unilateral and T_7 ($T_{12} - T_1$) in the Conventional group (P = 0.026), while the maximum

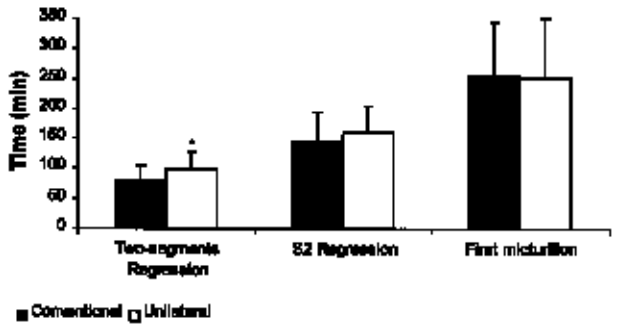

FIGURE 1 Times from spinal injection to two segment and S_2 regression of sensory block on the operated side, and first micturition in outpatients receiving knee arthroscopy with either conventional bilateral (Conventional group, n = 47) or unilateral spinal anesthesia (Unilateral group, n = 47). Results are presented as mean (± SD).
* $P = 0.002$ *vs* Group Conventional

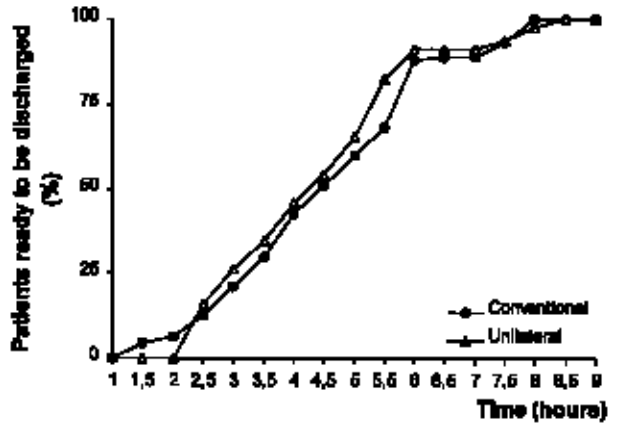

FIGURE 2 Percentage of patients ready to be discharged from the hospital after either conventional bilateral (Conventional group, n = 47) or unilateral (Unilateral group, n = 47) spinal anesthesia. Patient alert, with stable vital signs, complete resolution of spinal anesthesia, able to void and ambulate, with nausea and pain controlled with oral medication constituted the endpoint of the study for the patient concerned. The log-rank curves representing the two groups studied are not significantly different ($P = 0.38$).

sensory level on the nonoperated side was S_2 ($S_2 - T_5$) in the Unilateral compared with T_8 ($S_2 - T_1$) in the Conventional group ($P = 0.0005$). Motor blockade of the operated limb was more profound in patients receiving unilateral spinal anesthesia (Bromage score 0/1/2/3: 0/2/0/45) than in patients in the Conventional group (Bromage score 0/1/2/3: 4/1/6/36) ($P = 0.016$), while the nonoperated limb was more markedly blocked in patients in the Conventional (Bromage score 0/1/2/3: 12/1/14/20) than in the Unilateral group (Bromage score 0/1/2/3: 37/3/2/5) ($P = 0.0005$). Five patients in the Conventional group (10%) and two patients in the Unilateral group (4.2%) had a Bromage score < 2 on the operated limb with a sensory level (T_{12} ($P = 0.25$). However, these patients were successfully operated upon without the need for supplemental analgesics or sedation. Patients in the Conventional group showed a correlation between the motor block measured on the operated and nonoperated sides (Table II). Patients with a low Bromage score on the nonoperated side also had poor motor blockade on the operated side. On the contrary, most Unilateral group patients had complete motor block on the operated side with no motor block on the nonoperated side. Twenty-six patients (55%) in the Unilateral group only showed unilateral sensory block ($P = 0.0005$); while unilateral motor block was observed in 37 patients in the Unilateral group (78%) and 10 patients in Conventional group (21%) ($P = 0.0005$).

Hypotension was treated with *iv* fluid in eight patients (17%) of the Conventional group and three patients (6%) in the Unilateral group ($P = 0.10$), while vasopressor was required in five patients of the Conventional group only (11%) ($P = 0.02$). Clinically relevant hypotension occurred always after surgery had started. Bradycardia occurred in four and five patients in Unilateral and Conventional groups, respectively ($P = 0.72$).

Figure 1 shows the time from completion of intrathecal injection to two-segment and S_2 regression of sensory level, as well as the time to first micturition. Five patients required temporary bladder catheterization due to delay in recovery of spontaneous urination (1 in Unilateral group [2%] and 4 in Conventional group [8.5%], $P = 0.16$); however, no patient required overnight hospitalization due to urinary retention, and all patients were successfully discharged from the hospital. Figure 2 shows the survival analysis of the time from spinal block to fulfillment of discharge criteria.

Postoperative pain relief was adequate in all studied patients. Five patients in the Unilateral group (10%) and nine patients in the Conventional group (19%) required tramadol during the first 24 hr after surgery ($P = 0.24$). No differences in patient acceptance were reported between the two groups. Three patients in the Unilateral group (6%) and four patients in the Conventional group (8%) would prefer a different anesthetic technique if operated upon again in the future ($P = 0.69$). No case of post-dural puncture headache or other neurological complication were reported at the 24 hr and seven day postoperative follow-up.

Discussion

This prospective, randomized, blind study demonstrated that, when spinal anesthesia is performed in outpatients with 8 mg hyperbaric bupivacaine 0.5%, attempting to achieve unilateral spinal block produced a slight delay in onset of surgical block, but produced a deeper motor blockade on the operated side with a 22% delay in the two segment regression of spinal block on the surgical side compared with conventional bilateral spinal anesthesia. Even though motor block was more profound on the surgical side in the Unilateral than in the Conventional group patients, no delay in resolution of spinal anesthesia and home discharge were observed.

According to the anesthetic protocol, patients in the Unilateral group had to maintain the lateral decubitus position for 15 min after intrathecal injection of local anesthetic solution, and this may explain the longer time required to achieve readiness to surgery observed in this group. However, although statistically significant, the clinical relevance of such a small difference in the time from anesthetic injection to be ready to surgery may have minor clinical relevance.

In agreement with previous investigations[6–9] attempting unilateral spinal block produced a more restricted spinal anesthesia, with unilateral sensory and motor blocks in up to 55% and 78% of Unilateral group patients, respectively. Moreover, the maximum sensory level recorded on the operated side was nearly one dermatome lower than that measured in patients receiving conventional bilateral spinal anesthesia, with a deeper motor blockade. This was probably due to the higher anesthetic concentration achieved near the nerve roots of the operated limb than in the Conventional group patients, and could also account for the slower regression of sensory block, probably due to the reduced surface available for absorption and elimination from the subarachnoid space of the local anesthetic molecules.[9]

The slower and more restricted spinal block also produced a more stable cardiovascular profile in Unilateral group patients, with a decrease in the need for vasopressor to treat hypotension. Similar results have been reported in previous investigations, which demonstrated that unilateral spinal block reduced the hemodynamic effects of spinal anesthesia when small doses of hyperbaric bupivacaine 0.5% were used.[9,10]

The recovery profile observed after intrathecal injection of 8 mg hyperbaric bupivacaine is consistent with that reported in previous investigations with similar doses of bupivacaine,[3–4] and is only slightly prolonged compared with that reported after using a lower dose of hypobaric bupivacaine.[5,11] When producing spinal anesthesia with 5 mg hypobaric bupivacaine, Ben-David and colleagues[5] reported two segment regression after 53 min and discharge after 180 – 190 min. However, with such a small dose of bupivacaine spinal anesthesia failed in up to 24% of cases. In the present investigation, spinal block resolution was only slightly delayed compared with Ben-David *et al's* results, but using 8 mg hyperbaric bupivacaine resulted in a four fold reduction in failure rate of spinal anesthesia, with very good patient acceptance. Interestingly, recovery from anesthesia was also similar to that reported after lidocaine spinal block. Liu and colleagues[12] reported sensory block resolution within 144 min after intrathecal injection of 50 mg lidocaine; while Urmey and colleagues[13] studied 60 mg plain lidocaine 2% for outpatient knee arthroscopy and observed spontaneous micturition 170 - 198 min after spinal injection.

Temporary bladder catheterization was more frequently reported in the Conventional than in the Unilateral group patients. This could be related both to the more frequent use of volume expansion to treat hypotension (17% *vs* 6%), and different recovery of bladder function due to the different extent of spinal block. Although the difference in bladder catheterization was not statistically significant, it should be considered that a type two error cannot be excluded, and further sufficiently powered studies should be advocated to evaluate this point. However, spontaneous micturition recovered in all patients, and in no case was overnight hospitalization required due to urinary retention.

Patient discharge after day-case surgery is influenced by several factors not directly related to the anesthetic procedure, such as the availability of personnel effecting the patient discharge, or family members to accompany the patient home. However, these factors should have been randomly distributed between the two groups, excluding the risk for a systematic error which would have altered the findings of no significant differences between the two anesthetic techniques.

In conclusion, this study demonstrated that, attempting unilateral spinal block in outpatient knee arthroscopy resulted in more intense motor block and delayed regression of sensory level on the operated side, with more stable cardiovascular homeostasis and no differences in the recovery profile or home discharge compared with conventional bilateral spinal anesthesia. These advantages had a cost of three minutes increase in the time from spinal injection to achievement of surgical block.

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