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Intrathecal Ropivacaine for Ambulatory Surgery

A Comparison between Intrathecal Bupivacaine and Intrathecal Ropivacaine for Knee Arthroscopy

Ph. E. Gautier, M.D., M. De Kock, M.D., Ph.D.,† A. Van Steenberge, M.D.,‡ N. Poth, M.D.,§ B. Lahaye-Goffart, M.D.,§ L. Fanard, M.D.,* J. L. Hody, M.D.**

Background: **The rationale of this study was to evaluate intrathecal ropivacaine for ambulatory surgery.**

Methods: **One hundred fifty patients with American Society of Anesthesiologists physical status 1 scheduled for knee arthroscopy were studied. Patients were randomly assigned to receive 4 ml of one of five isobaric intrathecal solutions: Patients in group 1 (n = 30) received 8 mg of bupivacaine; patients in group 2 (n = 30) received 8 mg ropivacaine; patients in group 3 (n = 30) received 10 mg ropivacaine; patients in group 4 (n = 30) received 12 mg ropivacaine; and patients in group 5 (n = 30) received 14 mg ropivacaine. The level and duration of sensory anesthesia were recorded along with the intensity and duration of motor block. Patients were interviewed to identify transient neurologic symptoms.**

Results: **Intrathecal ropivacaine 10 mg produced shorter sensory anesthesia and motor blockade than bupivacaine 8mg (152 ± 44 min and 135 ± 41 min *vs.* 181 ± 44 min and 169 ± 52 min, mean ± SD; $P < 0.05$). However, the quality of intraoperative analgesia was significantly lower in the 10-mg ropivacaine group ($P < 0.05$). Ropivacaine 12 mg produced sensory and motor block almost comparable to bupivacaine 8 mg. Ropivacaine 14 mg produced sensory and motor block comparable to ropivacaine 12 mg but significantly increased the time to void. No sign of transient radicular irritation were noted.**

Conclusion: **Intrathecal ropivacaine 12 mg is approximately equivalent to bupivacaine 8 mg. At this dose, ropivacaine offers no significant advantage compared with bupivacaine. (Key words: Local anesthetics; spinal anesthesia.)**

HYPERBARIC 5% lidocaine has recently been reported to be associated with transient radicular irritation following single-dose spinal anesthesia.[1,2] These observations prompted the search for alternative drugs, particularly for ambulatory surgery. Several investigators have reexamined the use of older short-acting local anesthetics such as prilocaine or mepivacaine.[3-8] Others have tested the efficacy of low dosages of bupivacaine.[9-12] The present study evaluated the use of intrathecal ropivacaine for ambulatory surgery. This new local anesthetic, administered by the epidural route, is reported to be 20% less potent than bupivacaine at equal dosage.[13] Nevertheless, it may produce less motor blockade and is of shorter duration.[14-16] Thus, ropivacaine may produce equivalent spinal anesthesia with a faster recovery period than bupivacaine.

Methods

The protocol was approved by the clinical research practices committee and informed consent was obtained from each patient at the preoperative visit. One hundred fifty patients with American Society of Anesthesiologists physical status 1 scheduled for knee arthroscopies were enrolled in the study. In each of these patients, a tourniquet with a pressure of 400 mmHg was used to provide a bloodless operative field to the surgeon. No premedication was given the day of surgery. Patients were placed in the lateral position (left or right to maintain the operative site up), and an intravenous bolus of at least 250 ml Ringer's lactate solution was given followed by an infusion of 100 ml/h. Heart rate and blood pressure were measured at 5-min intervals before and during induction, surgery, and recovery using an automated

* Staff Anesthesiologist, Department of Anesthesiology, Clinique Ste. Anne-St. Remi.

† Staff Anesthesiologist, Department of Anesthesiology, Cliniques Universitaires St. Luc.

‡ Professor of Anesthesiology, Department of Anesthesiology, Clinique Ste. Anne-St. Remi.

§ Resident in Anesthesiology, Department of Anesthesiology, Clinique Ste. Anne-St. Remi.

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Address reprint requests to Dr. De Kock: Department of Anesthesiology, Université Catholique de Louvain, St. Luc Hospital, av. Hippocrate 10-1821, 1200 Brussels, Belgium. Address electronic mail to: dekock@anes.ucl.ac.be

oscillometer. Arterial oxygen saturation was registered continuously by pulse oximetry.

A combined spinal epidural technique was performed at the L3-4 interspace using a midline approach. Dural puncture was performed using a 29-gauge pencil-point needle. Once a free flow of clear cerebrospinal fluid was obtained, 4 ml of one of the following intrathecal isobaric solutions was injected according to a computer-generated list of random numbers: Patients in group 1 (n = 30) received 8 mg bupivacaine (4 ml of 0.2%); patients in group 2 (n = 30) received 8 mg ropivacaine (4 ml of 0.20%); patients in group 3 (n = 30) received 10 mg ropivacaine (4 ml of 0.25%); patients in group 4 (n = 30) received 12 mg ropivacaine (4 ml of 0.30%); and patients in group 5 (n = 30) received 14 mg ropivacaine (4 ml of 0.35%). All the injections were made with the hole of the needle oriented to the upper side. The injection was made with a Luer-Lock syringe, which made it possible to inject the dose in 35 s. The anesthetic solution was injected without barbotage or aspiration in the beginning or at the end of the injection. The study solutions were prepared by a senior anesthesiologist not involved in the patients' care, and both the patient and the anesthesiologist who delivered analgesia were blinded to the study solutions. After the time spent in the lateral position for placement of the epidural catheter (approximately 5 min), the patients were turned supine and observed during 30 min in the induction room. If systolic arterial pressure decreased more than 50 mmHg from the initial value or below 70 mmHg, a vasopressor (ephedrine) was given intravenously. Bradycardia (heart rate < 50 beats/min) was treated with intravenous atropine.

The level and duration of sensory anesthesia—defined as the loss of sharp sensation by using a pinprick test (20-gauge hypodermic needle)—were recorded bilaterally at the midclavicular level. This assessment was performed at 6, 8, 10, 12, 14, 16, 18, 20, and 30 min after intrathecal injection and then every 15 min until regression to S2.

Motor block in the lower limb was assessed with a modified Bromage scale (1 = complete motor blockade; 2 = almost complete motor blockade: The patient is able only to move the feet; 3 = partial motor blockade: The patient is able to move the knees; 4 = detectable weakness of hip flexion: The patient is able to raise the leg but is unable to keep it raised; 5 = no detectable weakness of hip flexion: The patient is able to keep the leg raised during 10 s at least; 6 = no weakness at all: The patient is able to perform partial knee bend while supine).[17]

These measurements were performed at 10, 15, 20, and 30 min before surgery and every 15 min after surgery. When no motor blockade could be detected (modified Bromage scale score of 6) and the patients felt ready, they were asked to walk. The time elapsed between intrathecal injection and walking and the time elapsed between intrathecal injection and spontaneous micturition were recorded.

During surgery, the quality of motor blockade was assessed by the surgeon using a four-point scale (1 = excellent, 2 = good, 3 = fair, 4 = bad). The same surgeon performed all the procedures.

The quality of intraoperative analgesia was evaluated by the patient using a two-point scale (1 = adequate analgesia: no sensation at all from the surgical site or sensation of motion only; 2 = inadequate analgesia: discomfort but the patient declined additional analgesia, or major discomfort with additional analgesics required). In the latter situation, the patient received either an intravenous bolus of 5 μg sufentanil or 4 ml bupivacaine 0.5% by the epidural catheter if the patient felt pain and the surgeon complained of difficult operative conditions resulting from the lack of any motor blockade. Data collected from the patients after injection of additional epidural bupivacaine were not considered.

On postoperative days 1 and 15, patients were interviewed in person to identify transient neurologic symptoms using the standardized symptom checklist presented by Hampl *et al.*[1] Transient neurologic symptoms were defined as pain or dysesthesia or both in the buttocks, thighs, or lower limbs starting after recovery from spinal anesthesia.

Results are expressed as mean values ± SD, or median and range if appropriate. Continuous variables among groups were compared using analysis of variance and, if appropriate, followed by multiple comparisons with the Dunnett two-tailed t test, using bupivacaine 8 mg as the reference control group. Nominal categoric data among study groups were compared using chi-square analysis. For the comparison of ordinal categoric data among the five groups the Kruskall-Wallis test was applied followed by Wilcoxon's rank sum test for multiple comparisons, with the group receiving bupivacaine 8 mg used as the reference control group. In general, $P < 0.05$ was considered significant. However, significance at $P < 0.0125$ was determined using a Bonferroni correction (denominator = 4) for multiple comparison tests between bupivacaine 8 mg and each ropivacaine group. •

Table 1. Demographic Data and Details of the Surgical Techniques

	Group 1: Bupivacaine 8 mg (n = 30)	Group 2: Ropivacaine 8 mg (n = 30)	Group 3: Ropivacaine 10 mg (n = 30)	Group 4: Ropivacaine 12 mg (n = 30)	Group 5: Ropivacaine 14 mg (n = 30)
Age (yr)	43 ± 16	39 ± 15	38 ± 13	43 ± 15	42 ± 17
Gender (F/M)	18/12	13/17	21/9	17/13	13/17
Weight (kg)	70 ± 14	71 ± 16	69 ± 15	74 ± 15	71 ± 12
Height (cm)	168 ± 10	170 ± 8	169 ± 10	169 ± 10	170 ± 11
Time to incision (min)*	48 ± 17	45 ± 18	42 ± 11	39 ± 16	38 ± 13
Time to end of surgery (min)*	81 ± 23	78 ± 26	78 ± 20	74 ± 20	74 ± 16

* All times are calculated from the time of subarachnoid injection.

Results

Demographic data did not differ among study groups (table 1). The combined spinal epidural technique was easy and uneventful in all patients. The relevant aspects of the spinal block are presented in table 2. The duration of sensory and motor block was significantly shorter in patients treated with ropivacaine 8 and 10 mg (groups 2 and 3) compared with the three other groups. The evolution of the motor block with time, assessed by the modified Bromage scale, is shown in figure 1.

Intraoperative motor blockade was assessed as excellent by the surgeon in only 52% of patients in group 2 (ropivacaine 8 mg) (table 3). The great majority (>90%) of the patients in groups 1, 4, and 5 evaluated their intraoperative analgesia as adequate. In groups 2 and 3, this proportion was significantly lower (table 3). Five patients in group 2 (ropivacaine 8 mg) received supplemental analgesia.

Three patients, one in group 1, one in group 2, and one in group 5, received intravenous atropine for hypotension combined with bradycardia, and two patients, one in group 1 and one in group 4, received ephedrine for treatment of hypotension. None of the patients developed postdural puncture headache or reported any complaint suggestive of transient neurologic symptoms at the early and late postoperative interview. The postoperative course was uneventful for all the patients including those who received epidural bupivacaine.

Table 2. Characteristics of Spinal Block

	Group 1: Bupivacaine 8 mg (n = 30)	Group 2: Ropivacaine 8 mg (n = 30)	Group 3: Ropivacaine 10 mg (n = 30)	Group 4: Ropivacaine 12 mg (n = 30)	Group 5: Ropivacaine 14 mg (n = 30)
Median peak dermatomal level (range)	Th8 (Th4-L1)	Th9 (Th3-L1)	Th8 (Th4-L2)	Th8 (Th4-L1)	Th9 (Th3-L1)
Time to peak sensory level (min)	14 ± 6	15 ± 8	18 ± 5	18 ± 7	18 ± 6
Time to two segment regression (min)	89 ± 33	76 ± 21	86 ± 18	96 ± 32	98 ± 30
Time to sensory block to S2 (min)	181 ± 44	130 ± 27*	152 ± 44*	176 ± 42	192 ± 48
Maximum motor blockade (% of the population)					
mBs 1	73	26*	77	96*	93*
mBs 2	23	22	20	4	7
mBs ≥3	4	52	3	0	0
Time to maximum motor blockade (min)	15 ± 9	20 ± 11	20 ± 11	20 ± 11	19 ± 13
Duration of motor blockade (min)	169 ± 52	107 ± 25*	135 ± 31*	162 ± 37	189 ± 44
Time to walk (min)	192 ± 48	125 ± 23*	150 ± 28*	169 ± 38	195 ± 39
Time to void (min)	200 ± 50	165 ± 45*	174 ± 38	199 ± 52	233 ± 52*

All times are calculated from the time of subarachnoid injection.

mBs = modified Bromage scale.

* Significantly different from bupivacaine 8-mg group.

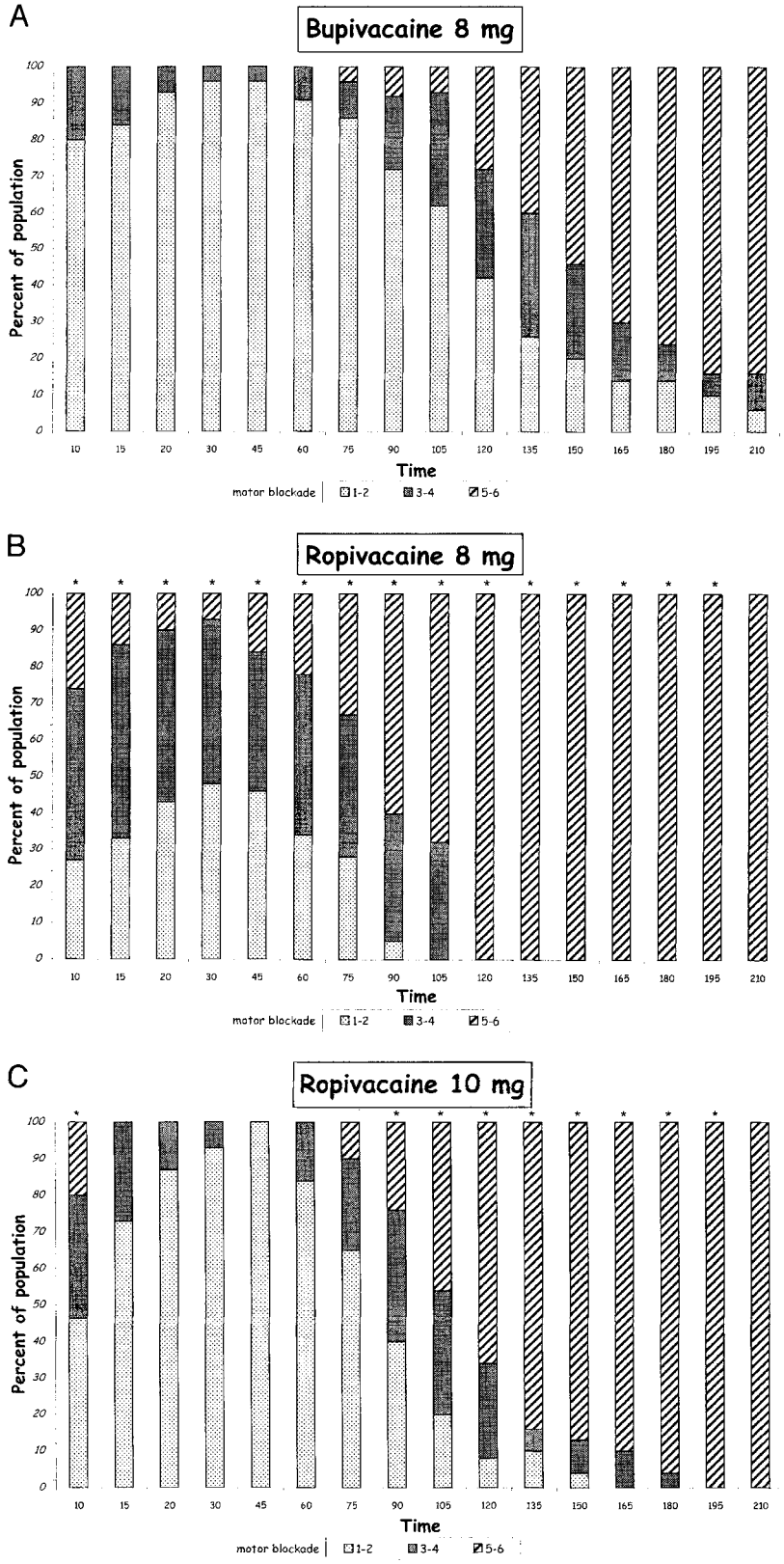
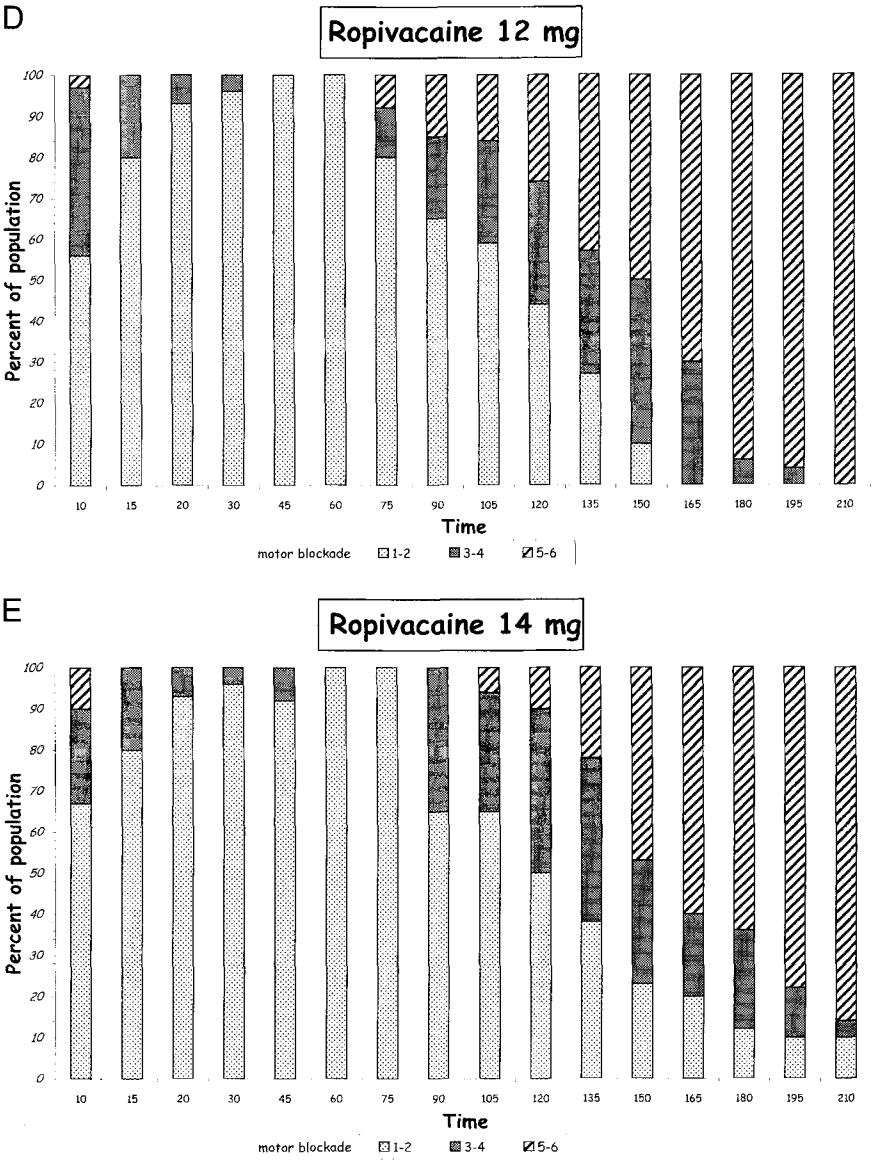


Fig. 1. Intensity of motor blockade expressed as percentage of the population presenting with a modified Bromage scale score of 1 (complete motor blockade), 2 (almost complete motor blockade: the patient is able only to move the feet), 3 (partial motor blockade: the patient is able to move the knees), 4 (the detectable weakness of hip flexion: the patient is able to raise the leg but is unable to keep it raised), 5 (no detectable weakness of hip flexion: the patient is able to keep the leg raised during 10 s at least); or 6 (no weakness at all: the patient is able to perform partial knee bend while supine) at different times in patients having received (*A*) bupivacaine 8 mg (n = 30; group 1), (*B*) ropivacaine 8 mg (n = 30; group 2), (*C*) ropivacaine 10 mg (n = 30; group 3), (*D*) ropivacaine 12 mg (n = 30; group 4), or (*E*) ropivacaine 14 mg (n = 30; group 5). *Significantly different from group 1, bupivacaine 8 mg.



Discussion

Our results clearly demonstrate that intrathecal ropivacaine 8 mg is insufficient to produce anesthesia for knee arthroscopies. Ropivacaine 10 mg produces a motor blockade of shorter duration than bupivacaine 8 mg intrathecally. Patients are able to walk but not to void sooner. Nevertheless, the quality of intraoperative analgesia appears significantly inferior to that obtained with 8 mg bupivacaine. Ropivacaine 12 mg produces sensory and motor blockade almost equivalent to bupivacaine 8 mg. Ropivacaine 14 mg produces sensory and motor blockade almost equivalent to ropivacaine 12 mg, but it significantly increase the time to void.

Ropivacaine is a new local anesthetic that was not initially marketed to be delivered by the intrathecal route. Nevertheless, the recent demonstration of intrathecal lidocaine-induced transient radicular irritation prompted the search for alternative drugs, particularly for ambulatory surgery.[1,2] Intrathecal ropivacaine may be considered as a possible alternative for the following reasons: First, an experimental study on spinal cord blood flow indicates that this drug did not markedly interfere with this parameter.[18] Moreover, although

Table 3. Quality of Anesthesia and Analgesia Evaluated by the Surgeon and the Patient

	Group 1: Bupivacaine 8 mg (n = 30)	Group 2: Ropivacaine 8 mg (n = 30)	Group 3: Ropivacaine 10 mg (n = 30)	Group 4: Ropivacaine 12 mg (n = 30)	Group 5: Ropivacaine 14 mg (n = 30)
Intraoperative motor blockade (surgeon) (% of the population)					
Excellent	87	52*	83	90	93
Good	7	11	13	7	7
Fair	3	22	9	0	0
Bad	3	15	4	3	0
Intraoperative analgesia (patient) (% of the population)					
Adequate	100	63*	83*	93	100
Inadequate	0	37	17	7	0

* Significantly different from bupivacaine 8-mg group.

there are no histologic or electrophysiologic studies available, the chemical structure of ropivacaine is very close to bupivacaine, a particularly nontoxic local anesthetic.[13] The observations made in the 80 patients included in the two first published studies on the intrathecal use of ropivacaine are in accordance with these arguments.[19,20] In our study, the total absence of any neurologic symptoms observed in the 120 patients who received ropivacaine suggests a lack of neurologic toxicity of this local anesthetic administered by the intrathecal route. Nevertheless, definitive conclusions can only be drawn after prospective studies including a large number of patients and evaluating more concentrated solutions of ropivacaine. The second reason for considering ropivacaine as an alternative is its pharmacological profile. This new local anesthetic, administered by the epidural route, appears to be approximately 20% less potent than bupivacaine at equal dose.[13] It is shorter-acting and may produce less motor blockade.[14-16]

Considering the relative analgesic potencies of intrathecal ropivacaine and bupivacaine, our data confirm the results obtained after epidural use.[15,21] Ropivacaine, administered by the intrathecal route, is clearly less potent than bupivacaine at equal dose. Epidural studies report a difference in potency of 20-40%.[15,16,21] Because the characteristics of the spinal block produced by 8 mg of bupivacaine are similar to those produced using 12 mg ropivacaine, our results argue for a difference of approximately 50% if the intrathecal route is considered. Several early reports on epidurally administered ropivacaine suggest that this drug may produce less motor impairment than bupivacaine. Our observations clearly argue against a specific drug effect and favor a potency-related effect. Ropivacaine produces less motor impairment at the same dose as bupivacaine because it is less potent.

In conclusion, the use of intrathecal ropivacaine 8, 10, 12, and 14 mg, in a limited number of patients, was not associated with symptoms of transient neurologic irritation. Compared with intrathecal bupivacaine 0.2%, ropivacaine at equal dosage is approximately 50% less potent. Moreover, the reduced effect of ropivacaine on muscle relaxation appears to be potency-related rather than a specific drug effect.

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