Anesthesiology
2000; 92:1588-93


# *Ropivacaine, 0.1%, Plus Sufentanil, 0.5 μg/ml,* versus *Bupivacaine, 0.1%, Plus Sufentanil, 0.5 μg/ml, Using Patient-controlled Epidural Analgesia for Labor*

## *A Double-blind Comparison*

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***Background:*** **This study compared the administration of 0.1% ropivacaine and 0.5 μg/ml sufentanil with that of 0.1% bupivacaine and 0.5 μg/ml sufentanil via patient-controlled epidural analgesia route during labor.**

***Methods:*** **Two hundred healthy pregnant women at term with a single fetus with a vertex fetal presentation were randomized in a double-blind fashion to receive either 0.1% ropivacaine and 0.5 μg/ml sufentanil or 0.1% bupivacaine and 0.5 μg/ml sufentanil using a patient-controlled epidural analgesia pump (5-ml bolus dose, 10-min locked-out period, no basal infusion). Pain score on a visual analog scale, Bromage score (0–3), level of sensory block, patient-controlled epidural analgesia ratio, drug use, supplemental boluses, and side effects were recorded at 30 min and then hourly. Mode of delivery, duration of first and second stages of labor, umbilical cord pH, Apgar scores of the newborn, and a measure of maternal satisfaction were recorded after delivery.**

***Results:*** **No differences were seen between the two groups for pain scores on a visual analog scale during labor, volume of anesthetic solution used, mode of delivery, or side effects. Motor block during the first stage of labor was significantly less in the ropivacaine group than in the bupivacaine group (no motor block in 97.8 of patients *vs.* 88.3%, respectively; $P < 0.01$). Duration of the second stage of labor was shorter in the ropivacaine group (1.3 ± 1.0 *vs.* 1.5 ± 1.2 h [mean ± SD]; $P < 0.05$). Maternal satisfaction was greater in the bupivacaine group (91 ± 13 mm for contraction, 89 ± 19 mm for delivery on a visual scale: 0 = not satisfied at all, 100 = fully satisfied) than in the ropivacaine group (84 ± 21 and 80 ± 25 mm; $P < 0.0001$). Patients in the ropivacaine group requested more supplemental boluses to achieve analgesia during the second stage of labor than those in the bupivacaine group (29.7 *vs.* 19.8%, respectively, requested one or more supplemental boluses; $P < 0.05$).**

***Conclusions:*** **Delivered as patient-controlled epidural analgesia, 0.1% ropivacaine and 0.5 μg/ml sufentanil produce less motor block but are clinically less potent than 0.1% bupivacaine and 0.5 μg/ml sufentanil. (Key words: Analgesia for labor pain; obstetric anesthesia.)**

BUPIVACAINE is the most commonly used local anesthetic for epidural analgesia in labor. Significant motor block and systemic toxicity may occur with its use. Ropivacaine is a single *S*-enantiomer with pharmacologic properties similar to those of bupivacaine; it has been found to be less toxic than bupivacaine in preclinical studies.[1] Epidural ropivacaine has been claimed to be superior to bupivacaine as an agent for labor analgesia, with decreased motor blockade.[2,3] Studies also have found that the depth and duration of motor block are less pronounced with ropivacaine than with bupivacaine in equal concentrations.[4,5] Comparisons between ropivacaine and bupivacaine, 0.25 or 0.125%, given as intermittent bolus doses or continuous infusion or using a patient-controlled epidural analgesia (PCEA) system have failed to show any significant difference in onset, duration, and quality of analgesia.[6-9] Recent studies suggest that ropivacaine may be less potent than bupivacaine and question the validity of potential benefits in toxicity and motor block until the relative therapeutic ratios are established.[10,11]

The current study compared the administration of 0.1% ropivacaine and 0.5 μg/ml sufentanil compared with that of 0.1% bupivacaine and 0.5 μg/ml sufentanil for labor analgesia using PCEA.

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Received from the Departments of Anesthesia and Gynecology and Obstetrics, Poissy Hospital, Poissy, France. Submitted for publication August 31, 1999. Accepted for publication January 3, 2000. Supported by a grant from Laboratoires Astra France, Groupe Pharmaceutique Astra Suède, Rueil-Malmaison, France, for insurance legally required to conduct the study.

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## Materials and Methods

The investigation, which was approved by the local ethics committee, CCPRB, St. Germain en Laye Hospital 7B, France, was explained fully to the patients, and written consent was obtained. Two hundred women in labor classified as American Society of Anesthesiologists physical status I or II who requested epidural analgesia were enrolled. All patients carried a single healthy fetus (36–41 weeks' gestation) in a vertex presentation with a normal fetal heart rate pattern. None received any analgesic agent before participation in the study. Patients were allocated randomly to one of two groups: Group A received 0.1% ropivacaine and 0.5 μg/ml sufentanil, and group B received 0.1% bupivacaine and 0.5 μg/ml sufentanil. Trial medications were supplied in coded ampules of identical appearance prepared by the Poissy Hospital pharmacy, and investigators were blind to the contents.

An intravenous infusion was established, and at least 500 ml Ringer's lactate solution was administered before epidural block was set. With the mother in the sitting position, an open-tip, single-orifice epidural catheter was inserted in the lumbar region using the loss-of-resistance technique; 3 cm of catheter was left in the epidural space. The catheter was connected to an Abbott Pain Manager pump (Abbott, San Diego, CA). A test dose of 5 ml study solution was administered, followed by a loading dose 5 min later: Incremental doses of 5 ml were injected *via* the PCEA pump until the patient felt comfortable (visual analog pain score [VAS] < 30 mm). Each patient was given a demand button and was instructed to press the button whenever she began to feel discomfort. Afterward, patients were able to self-administer a demand dose of 5 ml every 10 min as needed without basal infusion. No 1- or 4-h dose restriction was set. If the patient requested additional analgesia, 5 ml of the study solution was given *via* the PCEA pump by the nurse anesthesiologist in charge. No local anesthetic solutions other than the study solution were administered before delivery. Maternal and fetal monitoring followed hospital protocol (maternal blood pressure was recorded using a noninvasive monitor at 15-min intervals, and at 5-min intervals for 20 min after any staff-administered bolus). Obstetric treatment was undertaken according to the clinical protocols in use, and participants received oxytocin for induction or augmentation of labor accordingly.

Data recorded included demographics, 30-min and then hourly pain score on a VAS, maximum VAS score during the previous hour, and a measure of motor block (modified Bromage scale: 0 = bilateral sustained straightening of leg, 1 = unable to straighten leg, 2 = just able to flex knees, 3 = foot movement only). The upper and lower levels of sensory block were assessed hourly as loss of sensation to ice. Analgesic consumption was calculated for both the first and the second stages of labor. All subsequent physician-administered boluses were included in the cumulative totals for the first and second stages. PCEA ratio (*i.e.*, number of pump doses received ×:× number of patient-directed pump demands) was recorded hourly. The study ended 2 h after delivery, and patients were asked to rate satisfaction regarding epidural analgesia on a visual scale (0 = not satisfied at all, 100 = fully satisfied) for labor pain and for delivery separately. Any supplemental analgesia requested for repair of perineum laceration or revision of the uterine cavity was recorded. Postpartum hemorrhage greater than 500 ml also was recorded. Mode of delivery was recorded as normal (spontaneous vertex), forceps, vacuum extraction, or cesarean. The duration of the first and second stages of labor and the birth weight were recorded. In addition, Apgar scores of the newborn at 1–5 and 10 min and umbilical arterial blood gas measurements obtained at delivery from a clamped cord were recorded.

### *Statistical Analyses*

Data are presented as the mean ± SD (or range). Statistical analysis of demographic data, anesthetic solution used, duration of labor, and maternal satisfaction was performed using the Student *t* test or Wilcoxon–Mann–Whitney test as appropriate. The incidence of

**Table 1. Patient Demographics**

| | Ropivacaine (n = 95) | Bupivacaine (n = 94) |
|---|---|---|
| Age (yr) | 29 ± 5 | 30 ± 4 |
| Height (cm) | 164 ± 5 | 164 ± 6 |
| Weight (kg) | 71 ± 10 | 72 ± 11 |
| Primiparous (%) | 45.3 | 38.3 |
| Gestation (weeks) | 40 ± 1 | 40 ± 1 |
| Oxytocin induction (%) | 30.5 | 31.9 |
| Cervical dilatation (cm) | 3 ± 1 | 3 ± 1 |
| Baseline VAS (mm) | 55 ± 30 | 60 ± 30 |
| Time from epidural administration until delivery (h) | 5.64 ± 3.4 | 5.49 ± 2.81 |
| Instrumental delivery (%) | 20.9 | 15.2 |
| Cesarean section (%) | 4.21 | 2.13 |
| Infant birthweight (g) | 3372 ± 404 | 3372 ± 412 |

Values are mean ± SD unless otherwise indicated. There were no significant differences between groups.

VAS = visual analog pain score.

**Table 2. Local Anesthetic Requirements**

| | | |
|---|---|---|
| Total local anesthetic solution used (ml)* | 72.8 (20–295) | 67.5 (20–190) |
| Anesthetic solution used during the first stage (ml)* | 39.3 (0–285) | 33.4 (0–145) |
| Anesthetic solution used during the second stage (ml)* | 21.6 (0–75) | 20.7 (0–70) |
| Loading dose (ml)* | 13.7 (0–30) | 14.6 (0–30) |
| Total PCEA ratio† (%)‡ | 63 ± 24 | 65 ± 25 |
| PCEA ratio† during the first stage (%)‡ | 71 ± 27 | 72 ± 26 |
| PCEA ratio‡ during the second stage (%)‡ | 65 ± 28 | 71 ± 30 |

There were no significant difference between groups (Wilcoxon-Mann-Whitney test or chi-square test).

* Median with (range).

† No. of pump doses received/no. of patient-directed pump demands (%).

‡ Values are mean ± SD.

PCEA = patient-controlled epidural analgesia.

motor block, side effects, and mode of delivery were analyzed using the chi-square test. VAS score during labor was analyzed using analysis of variance and the Newman-Keuls test. $P < 0.05$ was considered to be significant.

## Results

Two hundred patients were enrolled in the study; 11 were excluded from data analysis for the following reasons: inadequate analgesia with protocol deviation (4 in ropivacaine group, 4 in bupivacaine group), accidental epidural catheter removal (1 in ropivacaine group), or incomplete data collection (1 in each group). One-hundred eighty-nine patients completed the study: 95 received ropivacaine and 94 received bupivacaine. Demographic data and labor characteristics are presented in table 1 and did not differ between the two groups.

There was no difference between the two groups for the total use of local anesthetic solution (table 2). The total study periods were similar in the two groups. The duration of the first stage of labor (defined as the time between epidural blockade and full cervical dilatation) was comparable for the two groups. The duration of the second stage (defined as the time between full cervical dilatation and the completion of vaginal delivery or the decision to proceed with cesarean delivery) was shorter in the ropivacaine group (table 3). There was no difference in the hourly dose of anesthetic solution used during the overall study period (ropivacaine: 14.4 ± 6 ml/h; bupivacaine: 13.7 ± 7 ml/h) or during the first stage of labor (ropivacaine: 9.5 ± 9.0 and bupivacaine: 8.9 ± 7.3 ml/h). This hourly dose of anesthetic solution does not include the initial bolus given at epidural insertion (the loading dose). During the second stage, drug consumption was significantly greater with ropivacaine than with bupivacaine (30.4 ml/h, range 0–187, *vs.* 22.2 ml/h, range 0–312; $P < 0.0001$). The mean total volumes of study drug administered were similar in the two groups (table 2).

Mean VAS scores at baseline and throughout labor for ropivacaine showed no difference compared with bupivacaine (fig. 1). The median VAS score before institution of epidural analgesia was 57.4 ± 27.5 mm in the ropivacaine group and 57.9 ± 28.5 mm in the bupivacaine group. Median average VAS score during treatment (*i.e.*, from the time of the epidural loading dose until delivery) was 19.7 ± 17.1 mm in the ropivacaine group and 16.9 ± 13.4 mm in the bupivacaine group. As shown in figure 2, the VAS pain score increased as cervical dilation

**Table 3. Labor and Delivery**

| | Group Ropivacaine (n = 91) | Group Bupivacaine (n = 92) | *P* |
|---|---|---|---|
| Duration of labor* (h) | 5.64 (0.7–22.8) | 5.49 (0.8–14) | NS† |
| First stage‡ (h) | 4.16 (0.25–21) | 3.78 (0.7–11.7) | NS† |
| Second stage§ (h) | 1.28 (0.08–4.33) | 1.54 (0.08–5.5) | 0.03† |
| Spontaneous vaginal delivery | 72 (75.8%) | 78 (82.9%) | NS |
| Instrumental delivery | 19 (20%) | 14 (14.9%) | NS |
| Cesarean delivery | 4 (4.2%) | 2 (2.1%) | NS |

Values are mean (range).

* From epidural placement until delivery.

† Analysis by Wilcoxon-Mann-Whitney test.

‡ From epidural placement until full cervical dilatation.

§ From full dilatation until delivery.

NS = not significant.

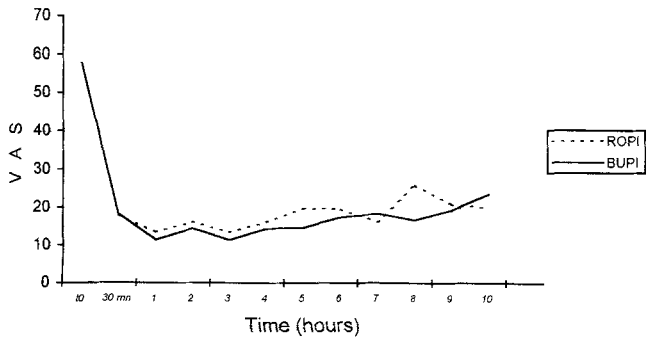


**Fig. 1. Mean visual analog pain score (VAS) during labor. There was no difference between groups (analysis of variance and Newman-Keuls tests).**

progressed throughout labor in the two groups, despite patient-controlled administration of drugs and supplemental boluses.

Satisfaction with the relief of contraction pain was greater in the bupivacaine group (90.5 ± 12.9 mm) than in the ropivacaine group (84.4 ± 21.5 mm, $P < 0.0001$), as was satisfaction with the relief of delivery pain (88.7 ± 19.1 and 80.4 ± 25.6 mm, respectively; $P < 0.0001$). In the ropivacaine group, 10.7% of patients had an asymmetric upper level of sensory block, *versus* 6.4% in the bupivacaine group ($P = 0.08$).

Patients in the ropivacaine group requested more supplemental boluses than did patients in the bupivacaine group in the second stage of labor and after delivery (table 4).

The incidence of motor block was lower in the ropivacaine group than in the bupivacaine group during the first stage of labor (table 5). There was no difference between the two groups in the incidence of instrumental or cesarean delivery (table 3).

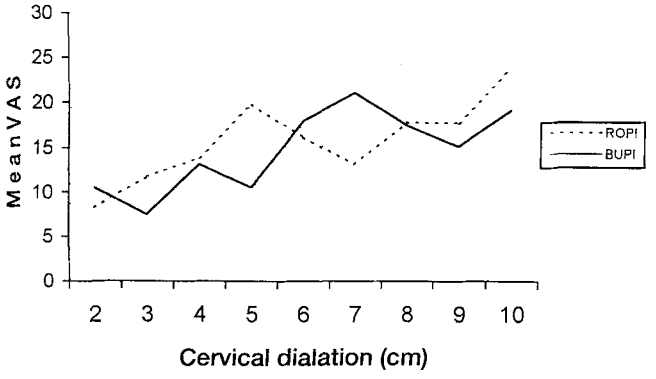


**Fig. 2. Mean visual analog pain score (VAS) and cervical dilatation. There was no difference between groups (analysis of variance and Newman-Keuls tests).**

**Table 4. Supplemental Analgesic Requirements**

| | Ropivacaine | Bupivacaine | *P* |
|---|---|---|---|
| 0–1 supplemental bolus during first stage | 71 (74.7%) | 77 (81.9%) | 0.06* |
| ≥2 supplemental bolus during first stage | 24 (25.3%) | 17 (18.1%) | |
| Any supplemental bolus during second stage | 68 (71.6%) | 76 (80.8%) | 0.02* |
| ≥1 supplemental bolus during second stage | 27 (28.4%) | 18 (19.2%) | |
| Need for supplemental anesthesia after delivery† | 15 (16.5%) | 7 (7.6%) | 0.001* |

* Analysis by chi-square test.

† Concern only vaginal delivery for both groups.

Apgar scores of the newborns were similar in both groups. Eight infants in the ropivacaine group and seven in the bupivacaine group had Apgar scores less than 7 at 1 min; one infant in the ropivacaine group had an Apgar score of 6 at 5 min. No infants in the bupivacaine group had 5-min scores less than 7. There were no difference between groups in umbilical cord pH: 7.37 ± 0.09 in the ropivacaine group *versus* 7.35 ± 0.09 in the bupivacaine group. Three infants in each group had a neonatal umbilical cord pH less than 7.2.

No significant complications resulted from this study. No prolonged hypotension or respiratory depression was seen in either study group. Postpartum hemorrhage greater than 500 ml occurred in five patients in the ropivacaine group and in four in the bupivacaine group.

## Discussion

Our results show that 0.1% ropivacaine and 0.5 μg/ml sufentanil or 0.1% bupivacaine and 0.5 μg/ml sufentanil given *via* a PCEA device produce effective pain relief in labor. No significant differences were seen between the two groups in VAS pain scores during labor, total amount of local anesthetic used, or level of sensory block. Patients in the ropivacaine group, however, requested more supplemental boluses to achieve analgesia during the second stage of labor and after delivery than those in the bupivacaine group, and maternal satisfaction was significantly greater in the bupivacaine group regarding analgesia during labor and delivery. The overall drug consumption was not significantly different between the two groups, although patients in the ropivacaine group used more drug than those in the bupivacaine group during the second stage.

**Table 5. Motor Block**

| | Ropivacaine | Bupivacaine | *P* |
|---|---|---|---|
| First stage | | | |
| Bromage score = 0 | 93 (n = 95) | 83 (n = 94) | <0.005 |
| Bromage score ≥ 1 | 2 (n = 95) | 11 (n = 94) | |
| Second stage | | | |
| Bromage score = 0 | 75 (n = 93) | 75 (n = 87) | NS |
| Bromage score ≥ 1 | 8 (n = 93) | 12 (n = 87) | |
| Whole study | | | |
| Maximal Bromage score = 0 | 85 (n = 95) | 75 (n = 94) | <0.05 |
| Maximal Bromage score ≥ 1 | 10 (n = 95) | 19 (n = 94) | |

NS = not significant.

The increase in mean VAS score throughout labor, as shown in figure 2, suggests that the PCEA regimen could be improved in permitting consumption to increase (through an increased bolus dose or reduced lockout period) during cervical dilation. In the same way, the fact that almost 30% of the drug had to be given as a supplemental bolus suggests that PCEA administration limitations could be liberalized.

Motor block was significantly less pronounced in the ropivacaine group during the first stage of labor. These results confirm the observation that the reduced motor impairment observed after administration of ropivacaine occurs only if low doses are used.[12] In the current study, the difference is significant during the first stage of labor but disappears during the second stage; drug consumption is actually higher during the second stage, which may attenuate the difference in motor block, as reported by Russel and Reynolds,[13] who demonstrated that motor blockade is dependent on the cumulative dose of local anesthetic agent.

Until recently, it was assumed that ropivacaine and bupivacaine were equipotent, but Polley *et al.*[10] and Capogna *et al.*[11] suggest that ropivacaine could be 40% less potent than bupivacaine. This reduction of motor impairment may be a result of a lower potency of ropivacaine compared with bupivacaine, rather than a specific drug-related effect, particularly if used at low concentrations. Owen *et al.*[7] did not detect any significant difference in the degree of motor block using 0.125% ropivacaine or 0.125% bupivacaine *via* a PCEA route, but drug consumption was higher than in the current study (18–19 *vs.* 13–14 ml/h) probably because no opioid was added. Conversely, if local anesthetic solution is used at a 0.125% concentration but with a lipid soluble opioid, a difference in the severity of motor block becomes apparent.[3]

Although there was no statistically significant difference in mode of delivery in the current study, there was a greater proportion of instrumental deliveries in the ropivacaine group; this finding is in contradiction with previous studies,[5,12] possibly because of an unexpected (but not significant) difference in the proportion of nulliparous women in this group. The difference observed in duration of the second stage may be related to specific properties of ropivacaine, which also could explain the lower incidence of motor block during the first part of labor. Alternatively, and more probably, this difference may be related to the finding that the variables affecting delivery outcome were neither controlled nor monitored in this study.

In summary, a low concentration of ropivacaine with sufentanil produces less motor block than does bupivacaine with sufentanil. This benefit is not associated with a decrease in the incidence of instrumental deliveries. The reduction of motor impairment could be a result of a lower potency of ropivacaine, as shown by lower maternal satisfaction scores and a greater need for supplemental boluses; or it could be related to a fundamental difference between the drugs, which could explain the difference observed in the duration of the second stage of labor. This finding applies for further studies using a higher concentration of ropivacaine *versus* the same 0.1% bupivacaine.

The authors thank Dan Benhamou, M.D., Hopital A. Beclere, Clamart; Luc-Olivier Sauvêtre, Hopital Poissy, Poissy; and Eric Stoll, Hopital Poissy, Poissy, France.

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