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Onset of spinal block is more rapid with isobaric than hyperbaric bupivacaine

Purpose: To compare isobaric with hyperbaric 9.75 mg bupivacaine injected intrathecally, and to evaluate the effects of subsequent injection of lidocaine 2% into the epidural space.

Methods: Patients in group 1 (n=30) received isobaric 9.75 mg bupivacaine and in group 2 (n=30) hyperbaric 9.75 mg bupivacaine injected into the subarachnoid space in a combined spinal-epidural technique. They were undergoing urological, gynecological, orthopedic, gastro-intestinal or vascular surgery. Using a double blind technique, the followings parameters were measured: cutaneous analgesia to pinprick, motor blockade, time for two segment regression, time for complete regression of the motor block, quality of anesthesia. In 12 patients the effect of epidural injections of 3 ml lidocaine 2% was observed.

Results: Motor and sensory block developed more rapidly (five minutes) in the isobaric group ($P < 0.05$). Maximum upper level ($T7 \pm 2$), two-segment regression (52 min in both groups), motor recovery (160 vs 157 min), and quality of anesthesia did not differ between the two groups. Thirty nine epidural injections of 3 ml lidocaine 2% were given in 12 patients 10 min after spinal injection, 28 were in the hyperbaric group ($P < 0.05$). Twenty six of the epidural injections produced an increase in sensory block of 0 or 1 dermatome, and 13, of 2 or more.

Conclusion: The block developed more rapidly in the isobaric group, but both isobaric and hyperbaric 9.75 mg bupivacaine produced adequate upper levels of analgesia for surgery. The effect of epidural injections of 3 ml lidocaine 2% was usually minimal.

Objectif : Comparer 9,75 mg de bupivacaine isobare et hyperbare injectés en sous-arachnoïdien, et évaluer l'effet, quand nécessaire, de la lidocaïne 2 % injectée subséquemment dans l'espace épidural.

Méthode : Les patients du groupe 1 (n=30) ont reçu 9,75 mg de bupivacaine isobare et ceux du groupe 2 (n=30) 9,75 mg de bupivacaine hyperbare en injection sous-arachnoïdienne selon une technique combinée rachi-épidurale. Des interventions chirurgicales urologiques, gynécologiques, orthopédiques, gastro-intestinales et vasculaires ont été faites. En utilisant une technique de double insu, on a mesuré les paramètres suivants : analgésie cutanée à la piqûre, bloc moteur, temps de régression de 2 niveaux, temps de régression complète du bloc moteur, qualité d'anesthésie. Chez 12 patients qui ont eu besoin d'injections épidurales de 3 ml de lidocaïne 2 %, l'effet de l'injection a été observé.

Résultats : Les blocs moteur et sensitif se sont développés plus rapidement (5 min) dans le groupe isobare ($P < 0,05$). Les niveaux supérieurs d'analgésie ($D7 \pm 2$), les temps de régression de 2 segments (52 min), la récupération motrice (160 vs 157 min), et la qualité de l'anesthésie ont été similaires. Trente-neuf injections épidurales de 3 ml de lidocaïne 2 % ont été faites chez 12 patients, 10 min après l'injection sous-arachnoïdienne. Vingt-huit des réinjections l'ont été dans le groupe hyperbare ($P < 0,05$); vingt-six ont produit une augmentation de 0 ou 1 dermatome, et 13 de 2 ou plus.

Conclusion : Le bloc s'est développé plus rapidement, de 5 min, dans le groupe bupivacaine isobare, mais 9,75 mg de bupivacaine isobare ou hyperbare ont produit des niveaux d'analgésie supérieurs adéquats pour l'opération. L'effet d'injections épidurales de 3 ml de lidocaïne 2 % est le plus souvent minime.

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TRANSIENT neurological symptoms associated with spinal lidocaine are an important factor for the popularity of bupivacaine in spinal anesthesia.¹ However, spinal bupivacaine has a longer duration of action than lidocaine. Thus, there is a reason for the interest in using small doses of bupivacaine in order to make this drug compatible with ambulatory surgery.² Less bupivacaine leads to less sensory and motor block,² but the flexibility of a combined spinal-epidural technique could compensate for this problem.³

However, even when used in small dosage in a combined spinal-epidural technique, isobaric bupivacaine is more appropriate than hyperbaric bupivacaine but the effect of subsequent injection of lidocaine 2% into the epidural space is not known.⁴ This led us to compare 9.75 mg of isobaric and hyperbaric bupivacaine used in a combined spinal-epidural technique, where lidocaine 2% could be injected in the epidural space when the block was inadequate for surgery, or has regressed before the end of surgery.

Methods

Following institutional approval and written informed consent, 60 patients scheduled for elective surgery were studied. The patients were randomized to two groups of 30 patients. Patients in group 1 received 9.75 mg isobaric bupivacaine and patients in group 2 received 9.75 mg hyperbaric bupivacaine. The study was double blind: the patient and the evaluator did not know what medication was injected. Bupivacaine 0.75% was used, and 1.3 ml of commercial hyperbaric and plain (isobaric) solutions were injected at L₃₋₄ or L₄₋₅ in a sitting position through a 27 g pencil point Whitacre needle with the aperture of the needle directed cephalad. A 19 g epidural catheter, inserted 3-4 cm cephalad, was left in place and the patients were placed supine with the operating table in a neutral position.

For the first 40 patients, upper cutaneous levels of analgesia and motor block were evaluated every five minutes for 20 min. The measurements were repeated 40 min later and every 15 min until complete recovery of the motor block. For the last 20 patients, to evaluate two segment regression time, measurements were repeated every five minutes throughout the study. The duration in sitting position after the spinal injection was also noted in these patients. Upper cutaneous levels of analgesia were evaluated with a Wartenberg pinwheel and motor block with the Bromage scale (3=complete paralysis, 2=movements of the foot only, 1=small motor block movement of the knee, 0=no paralysis). Ten minutes after the spinal

injection of bupivacaine, an epidural injection of 3 ml plain carbonated lidocaine was allowed if the attending anesthesiologist considered the level of analgesia inadequate for the planned surgery. The epidural injection could be repeated at five minutes intervals if the level of analgesia was still considered inadequate. Epidural injections of three milliliters lidocaine 2% could also be used if the spinal block had regressed before the end of surgery, also at five minute intervals. Patients who received the epidural injection were excluded from further analysis of cutaneous levels, motor block, and duration of motor block after spinal injection. The perioperative anesthesia was evaluated as complete, partial or inadequate. Vital signs were measured every 2.5 min and the patients received an infusion of 500 ml lactated Ringer's solution *iv* before the spinal injection. A decrease of systolic blood pressure below 100 mm Hg was treated with ephedrine. Sedation with midazolam and/or fentanyl was given when judged useful by the anesthesiologist. Patients were interviewed on the day after the surgery about their evaluation of the anesthesia for the surgery, on a 0-10 satisfaction scale.

A sample of 60 patients was based on an arbitrary difference of two cutaneous segments in the upper levels of analgesia between the two groups gives a power of 0.9 to the study. Student's *t* tests for unpaired data were used for comparison of quantitative data, and Chi square tests for nominal data. A *P* < 0.05 was considered significant.

Results

There were no differences between groups in age, sex, weight, height or in the type and duration of surgery (Table I). Upper levels of analgesia (Figure 1) and motor block (Figure 2) occurred more rapidly in the isobaric group (*P* < 0.05). However, at 15 min, maximum upper sensory levels (T7 ± 2) and motor block were not different. Two segment regression time, time in the sitting position after spinal injection, complete motor recovery and the use of ephedrine did not differ (Table II). The quality of anesthesia, need for intraoperative sedation and satisfaction of the patients were adequate in both groups (Table II). Finally, 39 epidural injections of lidocaine 2% were given to 12 patients (four in group 1 and eight in group 2) 10 min after spinal injection. Twenty eight of the reinjections were in the hyperbaric group (*P* < 0.05). Twenty six of the epidural injections produced an increase in sensory block of 0 or 1 dermatome, and 13, an increase of 2 or more (mode=0 segment, mean=1.3 in the isobaric group and 1.2 in the hyperbaric group five minutes after injection).

TABLE I Demographic and Surgical Data (Mean $\pm$ SD, or n)

Group	Isobaric (n=30)	Hyperbaric (n=30)
Age (year)	57 $\pm$ 18	55 $\pm$ 17
Gender (M/F)	M = 21 F = 9	M = 26 F = 6
Weight (kg)	71 $\pm$ 17	74 $\pm$ 11
Height (cm)	167 $\pm$ 9	169 $\pm$ 9
Type of surgery:		
Urologic	15	18
Gynecologic	6	3
Orthopedic	3	3
Gastro-Intestinal	2	2
Vascular	4	4
Duration of surgery (min)	40 $\pm$ 37	38 $\pm$ 35

TABLE II Perioperative and postoperative data (Mean $\pm$ SD, or n)

Group	Isobaric (n=30)	Hyperbaric (n=30)
Duration of sitting position (min)*	2.7 $\pm$ 0.9	2.9 $\pm$ 1.4
Time for 2 segments regression (min)*	52 $\pm$ 19	52 $\pm$ 28
Time for motor recovery (min)	161 $\pm$ 60	157 $\pm$ 60
Ephedrine use (n)	2	5
Quality of anesthesia		
Complete	28	25
Partial	2	5
Incomplete	0	0
Perioperative sedation (n)	8	8
Patient satisfaction of anesthesia (0-10)	9.6 $\pm$ 0.6	9.2 $\pm$ 1

* Based on data from 20 patients

Discussion

In the present study the onset of spinal block is more rapid with isobaric than with hyperbaric bupivacaine and 1.3 ml of either isobaric or hyperbaric bupivacaine 0.75% produce upper levels of analgesia at about T7 $\pm$ 2 which are adequate for many procedures. Complete recovery of the motor block took about 2.5 hr with either form of bupivacaine and the effect of epidural injections of 3 ml lidocaine 2 % usually has a minimal effect in the present combined spinal-epidural technique.

Isobaric bupivacaine, 15 mg, was reported to produce a more rapid block than the hyperbaric form in one study.⁴ We observed the same trend with 9.75 mg, the isobaric form being five minutes faster. Fifteen min after the spinal injection, both forms of bupivacaine produced a maximum T7 $\pm$ 2 upper levels. Factors that have been demonstrated to affect the distribution of local anesthetic solutions in CSF include age, height, anatomy of the spinal column, injection site, volume of CSF, density of CSF, baricity of anesthetic solution, position of the patient, dose and vol-

FIGURE 1 Upper levels of analgesia at different times after spinal injection of bupivacaine. Means $\pm$ SD.

FIGURE 2 Degree of motor block at different times after spinal injection of bupivacaine. Means $\pm$ SD.

ume solution injected.⁵ In the present study, we retain the baricity of the anesthetic solution and position of the patient. The density of the "isobaric" solution is 0.99964 g·ml⁻¹, i. e. slightly hypobaric.⁶ The density

of the hyperbaric solution is $1.0247 \text{ g}\cdot\text{ml}^{-1}$.⁷ We expected posture to have no influence on cephalad spread of the isobaric solution⁴ but, in one study, the spread of analgesia was significantly greater in patients who sat for 2.5 min or more.⁸ The patients in the isobaric group sat 2.7 min after the spinal injection. This may explain why the upper levels were the same in both groups, even though the hyperbaric solutions are expected to produce higher levels in supine position on a horizontal table.⁹

Complete recovery of the motor block occurred in 2.5 hr with either form of bupivacaine. This is not very different from the recovery which follows the injection of 2.5 ml lidocaine (50 mg) in the subarachnoid space,¹ and make 9.75 mg of either isobaric or hyperbaric bupivacaine compatible with ambulatory surgery.

Finally, 3 ml lidocaine 2% injected into the epidural space 10 min after the spinal did not increase the levels of analgesia in most patients and more patients in the hyperbaric groups had such injections. The explanation for the more frequent epidural injections in the hyperbaric group is that, in the sitting position, anesthesia developed more slowly. Consequently, the cutaneous levels were lower at 10 min and they had more ($\times 2$) frequent injections of epidural lidocaine. Concerning the mechanism of extension of spinal anesthesia by extradural injection of local anesthetic, it is partly a volume effect and partly an effect of local anesthetic itself.^{10,11} Thus, extradural saline would extend the sensory block, but less than that by a local anesthetic. An increased spread of 4 to 5 segments is expected over 15 min after a 10 ml bupivacaine 0.5% epidural injection in a combined spinal-epidural anesthesia.¹¹ Thus, after 3 ml, observation of only a 1.5 segment increase at five minutes following the injection is expected. However, the injection was made only 10 min after the spinal injection. Increase may have been due to the spinal injection itself.

In conclusion, the block developed more rapidly with the isobaric form of bupivacaine. However, 9.75 mg of either isobaric or hyperbaric bupivacaine injected intrathecally produced adequate levels of anesthesia for surgery, and is a dosage compatible with ambulatory surgery.

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