Lumbar plexus and sciatic nerve block for knee arthroplasty: comparison of ropivacaine and bupivacaine

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Purpose: Information about the onset time and duration of action of ropivacaine during a combined lumbar plexus and sciatic nerve block is not available. This study compares bupivacaine and ropivacaine to determine the optimal long-acting local anaesthetic for lumbar plexus and sciatic nerve block in patients undergoing total knee arthroplasty.

Methods: Forty adult patients scheduled for unilateral total knee arthroplasty, under lumbar plexus and sciatic block were entered into this double-blind randomized study. Patients were assigned (20 per group) to receive lumbar plexus block using 30 ml of local anaesthetic and a sciatic nerve block using 15 ml of local anaesthetic with either bupivacaine 0.5% or ropivacaine 0.5%. All solutions contained fresh epinephrine in a 1:400,000 concentration. Every one minute after local anaesthetic injection, patients were assessed to determine loss of motor function and loss of pinprick sensation in the L₁-S₁ dermatomes. The time to request first analgesic was documented from the PCA pump. This time was used as evidence of block regression.

Results: Blocks failed in four patients in each group. The mean onset time of both motor and sensory blockade was between 14 and 18 min in both groups. Duration of sensory blockade was longer in the bupivacaine group, 17 ± 3 hr, than in the ropivacaine group, 13 ± 2 hr ($P < 0.0001$).

Conclusion: We conclude that bupivacaine 0.5% and ropivacaine 0.5% have a similar onset of motor and sensory blockade when used for lumbar plexus and sciatic nerve block. Analgesic duration from bupivacaine 0.5% was prolonged by four hours compared with an equal volume of ropivacaine 0.5%.

Objectif : Il n'existe pas d'informations concernant le début et la durée de l'action de la ropivacaine pendant une anesthésie par blocage combiné du plexus lombaire et du nerf sciatique. La présente étude compare la bupivacaine et la ropivacaine dans le but de déterminer l'anesthésique local ayant l'action prolongée optimale lors de l'anesthésie du plexus lombaire et du nerf sciatique chez des patients devant subir une arthroplastie totale du genou.

Méthode : Quarante patients adultes, devant subir une arthroplastie totale et unilatérale du genou sous anesthésie par blocage du plexus lombaire et du nerf sciatique, ont été admis dans cette étude randomisée et en double aveugle. Les patients ont été répartis (20 par groupe) afin de recevoir un blocage du plexus lombaire utilisant 30 ml d'anesthésique local et un blocage du nerf sciatique utilisant 15 ml d'anesthésique local avec, soit de la bupivacaine 0,5 %, soit de la ropivacaine 0,5 %. Toutes les solutions contenaient de l'adrénaline fraîche selon une concentration de 1:400 000. À chaque minute après l'injection de l'anesthésique local, les patients ont été évalués pour déterminer la perte de la fonction motrice et de la sensibilité à la piqure dans les dermatomes L₁-S₁. Le temps nécessaire avant la première demande d'analgesique a été enregistré à partir d'une pompe ACP. Ce temps a été utilisé comme une évidence de régression du blocage.

Résultats : Les blocages n'ont pas réussi chez quatre patients dans chaque groupe. Le temps moyen nécessaire pour que s'installe le blocage moteur et sensitif se situait entre 14 et 18 min chez les patients des deux groupes. La durée du blocage sensitif a été plus longue dans le groupe bupivacaine, 17 ± 3 h, que dans le groupe ropivacaine, 13 ± 2 h ($P < 0,0001$).

Conclusion : Nous concluons que la bupivacaine 0,5 % et la ropivacaine 0,5 % installent de façon similaire le blocage moteur et sensitif quand elles sont utilisées pour le blocage du plexus lombaire et du nerf sciatique. La durée de l'analgesie à partir de bupivacaine 0,5 % a été prolongée de quatre heures en comparaison avec un volume égal de ropivacaine 0,5 %.

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Accepted for Publication September 4, 1998

TOTAL knee arthroplasty is frequently performed under regional anaesthesia. Spinal and epidural anaesthesia are used for lower extremity surgery because of the reliable operative conditions and postoperative analgesia. However, central neuraxial anaesthesia may also be associated with iatrogenic complications including hypotension and urinary retention. More recently, reports of epidural haematoma associated with low molecular weight heparin have prompted rigid safety guidelines which may curtail spinal and epidural use in these patients.¹

In an effort to avoid these complications, lower extremity nerve blocks have been utilized as a substitute for operative and postoperative analgesia. In order to provide adequate anaesthesia, separate injections of the lumbar plexus and sciatic nerve are necessary. This requires large volumes, 40-60 ml, of long acting local anaesthetic.^{2,3} Bupivacaine has been used because it provides long-lasting analgesia but intravascular injection of large volumes can result in severe cardiac and central nervous system toxicity.⁴

Ropivacaine is a long-acting amide local anaesthetic with a potentially improved safety profile when contrasted to bupivacaine.^{5,6} Human trials have demonstrated less cardiac depression and fewer central nervous system effects when ropivacaine is injected intravenously. These are potential clinical advantages during neural blockade when large volumes of local anaesthetic are required. However, if onset time and duration of neural blockade are not adequate, substitution for bupivacaine may not be appropriate.

The aim of this study was to compare bupivacaine 0.5% and ropivacaine 0.5% for lumbar plexus and sciatic nerve blocks during total knee arthroplasty.

Methods

After Institutional Review Board approval and written informed consent, 40 ASA I-III patients, aged 18 yr participated in this randomized, double-blind trial. All were scheduled for unilateral total knee arthroplasty, under lumbar plexus and sciatic block. Exclusion criteria included coagulopathy, infection at the site of block, neurological injury involving the operative extremity or concurrent opioid use.

Patients were assigned by pre-randomized envelopes to receive a lumbar plexus block with 30 ml and a sciatic nerve block with 15 ml of one of two different solutions ($n = 20$ per group). Each solution contained fresh epinephrine (1:400,000 concentration).

Group 1: bupivacaine 0.5%

Group 2: ropivacaine 0.5%

Standard monitors were applied. Patients were sedated with 1-5 mg midazolam and 50-200 µg fentanyl

iv titrated to moderate sedation (arousable on command). Lumbar plexus blocks were performed using the approach described by Chayen.⁷ With the neck, back and hips flexed in the lateral decubitus position a point was identified 4 cm lateral from midline along the intercostal line. Using a nerve stimulator, a 21 g, 100 cm, blunt tip insulated needle (Braun Medical, Bethlehem, Pennsylvania), was advanced perpendicular to the back in all planes and a motor stimulus was sought in the quadriceps distribution. After an appropriate stimulus was localized with a current < 0.5 mA, 30 ml of study drug were injected in 3 ml increments. Using the same technique and needle, a sciatic nerve block was performed using the classic approach described by Labat.⁸ With the patient in the Sims position the needle was inserted 5 cm below the midpoint of a line connecting the posterior superior iliac spine and the greater trochanter. After an appropriate stimulus was localized in the sciatic distribution, 15 ml of the study drug were injected in 3 ml increments.

Immediately following block placement patients were evaluated every minute, by a clinician unaware of the identity of the injected solution. To determine loss of motor function a scale from 1 to 3 (1 = lack of hip flexion, 2 = loss of knee extension, 3 = loss of ankle dorsiflexion) was used, similar to that of Bromage.⁹ Sensory block was assessed by pinprick (using a 25 gauge hollow needle) every minute in the L₁-S₁ dermatomes. Failure to achieve motor or sensory loss after 30 min was considered block failure. These patients were reblocked at the discretion of the attending anesthesiologist and omitted from statistical analysis. All episodes of local anaesthetic toxicity or haemodynamic change requiring anesthesiologist intervention (increased intravenous fluids or inotropes) were recorded as adverse events. Patients were sedated using a propofol infusion of 10-50 µg·kg⁻¹·min⁻¹; titrated so patients were able to follow commands. During surgery, additional infiltration of local anaesthetic was not performed. Patients requiring additional analgesics for pain were considered block failures and omitted from subsequent analysis.

After surgery, patients were instructed to use a patient controlled anaesthesia (PCA) pump when they first experienced pain. The patient and evaluator were unaware of the injected solution identity. Time to request first analgesic, evidence of block regression, was documented from the PCA pump.

Data were analyzed using two sample *t* tests. There was no indication of departure from normality or of heteroscedasticity. Because of baseline imbalances in gender, race, height and weight, these factors were controlled for in a linear regression analysis used to investigate the analgesic difference between the two drugs.

Results

There were no differences in age, weight, gender or ASA classification among groups (Table I). There were eight failed blocks. Two patients in each group required re-injection of the sciatic nerve. Two patients in each group required supplemental analgesics for pain during surgery. These eight patients were not included in subsequent analysis.

In both groups, mean onset time of sensory block was between 14 and 18 min. The onset of motor and sensory block was not different among groups. The time from block placement until first request for analgesia was 17 ± 3 hr for the bupivacaine 0.5% group and 13 ± 2 hr for the ropivacaine group 0.5% ($P < 0.0001$) (Table II). The results of the linear regression analysis were consistent with an estimated difference of four hours duration between the two drugs. There were no adverse events in the two groups.

Discussion

Both bupivacaine 0.5% and ropivacaine 0.5% provide a fast onset time when evaluating loss of motor function and loss of sensation in the L₁ to S₁ dermatomes. Both groups had a mean onset time for sensory block between 14 and 18 min. There appears to be little clin-

ical advantage for selection of either anaesthetic based on the time to onset of neural blockade.

Mean duration of analgesia was approximately four hours longer in the bupivacaine 0.5% group than in the ropivacaine 0.5% group ($P < 0.0001$). This increase in duration may prove clinically useful when prolonged analgesia is essential. However, selection of the optimal long acting local anaesthetic must take this fact into consideration as well as the available anaesthetic agents, the time to onset, and the side effects of each drug and dose.

In conclusion, there was no clinical difference in onset of neural blockade between bupivacaine 0.5% and ropivacaine 0.5% when injected in equal volumes for combined lumbar plexus and sciatic nerve block. The analgesic duration of bupivacaine 0.5% was prolonged by four hours compared with ropivacaine 0.5%.

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TABLE I Patient characteristics

Characteristic	Bupivacaine 0.5% (n = 16)	Ropivacaine 0.5% (n = 16)
Age (yr)	68 ± 8	68 ± 8
Height (cm)	163 ± 10	166 ± 11
Weight (kg)	80 ± 20	88 ± 15
Sex (m/f)	4/12	7/9

Means ± SD

TABLE II Time to loss of sensory and motor function (min)

Sensory	Bupivacaine 0.5%	Ropivacaine 0.5%
L ₁	15 ± 6	17 ± 8
L ₂	14 ± 6	16 ± 7
L ₃	14 ± 7	15 ± 8
L ₄	15 ± 7	14 ± 8
L ₅	17 ± 7	15 ± 6
S ₁	18 ± 8	17 ± 7
Motor		
1	6 ± 2	6 ± 3
2	12 ± 6	11 ± 5
3	20 ± 9	18 ± 7

mean ± SD

Time to onset of lumbar plexus and sciatic nerve block in total knee arthroplasty patients treated with bupivacaine 0.5% or ropivacaine 0.5%.