Rapid injection of epidural mepivacaine speeds the onset of nerve blockade

[L'injection péridurale rapide de mépivacaïne accélère l'installation du bloc nerveux]

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Purpose: When used intraoperatively, mepivacaine can produce a satisfactory sensory block. However, insufficient information is available concerning the factors that affect the speed of nerve blockade with epidural analgesia. The optimal rate of injection of mepivacaine has not been determined. We examined whether the speed of epidural infusion of mepivacaine affects the speed of nerve blockade.

Methods: Forty patients, physical status ASA I–II, scheduled for gynecological abdominal surgery, were enrolled in this double blind randomized trial. A catheter was inserted 4 cm in the epidural space in the midline at L1–L2. Three minutes after a test dose of 2 mL plain 1% mepivacaine over four seconds, 8 mL were injected epidurally at a rate of 1 mL·sec^{-1} (fast group) or 0.05 mL·sec^{-1} (slow group). Sensory and motor blockade, blood pressure, and heart rate were assessed at five, ten, and 15 min after the epidural injection.

Results: There was a significant difference in the spread of sensory blockade at five minutes after the epidural injection between the two groups, but not at ten and 15 min. Blood pressure decreased at five and ten minutes, recovered at 15 min in the fast group, and remained stable in the slow group.

Conclusion: Rapid injection of mepivacaine in the epidural space produced a more rapid onset of epidural block than slow injection, but there was no difference in the final extent of the block.

Objectif : *Utilisée pendant l'opération, la mépivacaïne peut produire un bloc sensitif satisfaisant. Cependant, il y a peu d'information sur les facteurs qui modifient la vitesse d'installation du blocage nerveux avec l'analgésie péridurale. La vitesse optimale de l'injection de mépivacaïne n'est pas connue. Nous avons vérifié si la vitesse de perfusion péridurale de la mépivacaïne modifiait la vitesse du d'installation-blocage nerveux.*

Méthode : *Quarante patientes, d'état physique ASA I–II, devant subir une intervention gynécologique abdominale ont participé à l'étude randomisée et à double insu. Un cathéter a été inséré à 4 cm dans l'espace péridural interépineux de L1–L2. Trois minutes après l'injection d'une dose test de 2 mL de mépivacaïne simple à 1 % pendant quatre secondes, 8 mL ont été injectés dans l'espace péridural à 1 mL·sec^{-1} (groupe rapide) ou 0,05 mL·sec^{-1} (groupe lent). Le blocage sensitif et moteur, la tension artérielle et la fréquence cardiaque ont été évalués à cinq, dix et 15 min après l'injection péridurale.*

Résultats : *La diffusion du blocage sensitif était significativement différente entre les groupes cinq minutes après l'injection, mais non 10 et 15 min après. La tension artérielle a baissé à cinq et dix minutes, s'est rétablie à 15 min dans le groupe rapide et est demeurée stable dans le groupe lent.*

Conclusion : *L'injection rapide de mépivacaïne dans l'espace péridural a produit une installation plus rapide du bloc péridural que l'injection lente, mais il n'y a pas eu de différence dans l'étendue finale du bloc.*

SEVERAL reports describe the factors that affect the speed of sensory blockade in epidural anesthesia.[1–5] However, the influence of the speed of epidural infusion remains unclear and the optimal rate of injection of mepivacaine has not been determined.

A time sequence is apparent during blockade of peripheral nerve action potentials by local anesthetics.[6] Sympathetic precedes sensory blockade, and leads to hypotension, tachycardia, and cutaneous warmth through extensive vasodilatation. The decrease in blood pressure can be used as an indicator of the spread of sympathetic nerve blockade. Sensory and motor nerve blockade can be evaluated by cutaneous coolness and skeletal muscle weakness, respectively.

We designed the current study to compare two rates of injection of mepivacaine into the epidural space to determine whether rate of injection affects the speed of nerve blockade.

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Methods

After giving informed consent, 40 female patients, ASA physical status I and II, scheduled for gynecological abdominal surgery were enrolled in this double blind randomized trial. They represented all consecutive in-patients scheduled for gynecological surgery during the latter six months of 2003. Patients were excluded if there was any contraindication to epidural anesthesia or communication difficulties that would influence postoperative assessment. Also excluded were pregnant women or women with childbearing potential, individuals with ongoing alcohol or drug abuse, or who had been administered drugs known to interfere with drug metabolism. Each patient was randomly allocated to one of two groups; those in group F received a fast injection of mepivacaine and those in group S a slow injection.

All patients received lactated Ringer's solution at a rate of 1 $mL \cdot kg^{-1}$ for one hour before arrival in the operating room and at 10 $mL \cdot kg^{-1} \cdot hr^{-1}$ during the subsequent observation period. Operating room temperature was kept at 25° centigrade. The epidural puncture was performed at the L1–L2 interspace with a 17-gauge Tuohy needle using the midline approach, with patients remaining in the lateral decubitus position. The epidural space was identified using a loss of resistance to saline technique. Less than 1 mL of saline was injected after the needle had entered the epidural space. A 19-gauge epidural catheter was passed through the needle with the bevel directed cephalad. Following withdrawal of the needle, 4 cm of catheter were left in the epidural space. An injection of mepivacaine 1% at room temperature was given through the epidural catheter. Three minutes after the test dose of 2 mL over four seconds, 8 mL were injected at either rate of 1 $mL \cdot sec^{-1}$ (group F) or 0.05 $mL \cdot sec^{-1}$ (group S) with the patient in the supine position.

Sensory and motor blockade, blood pressure, and heart rate were assessed at five, ten, and 15 min after the end of injection of the main dose of mepivacaine. The sensory assessment was started in the block zone and moved towards the no block zone. Sensory block was considered to have occurred when the sensation of cold was markedly reduced or abolished. A dermatome was considered blocked only if the block could be demonstrated bilaterally. Motor blockade was assessed by recording motor function of the lower limbs (modified Bromage scale) immediately after each evaluation of sensory block: 0 = no paralysis (full flexion of knees and feet); 1 = inability to raise extended legs (able to move knees); 2 = inability to flex knees (able to flex ankle joints); 3 = inability to flex ankle joints (unable to flex ankle joints and knees). The assessments were performed by an anesthesiologist who was unaware of group assignment.

Within group comparisons were made by analysis of variance with repeated measures, and between group comparisons were made by analysis of variance with non-repeated measures. If significant differences were detected by analysis of variance, individual means were compared by using the Student-Newman-Keuls test. Differences were considered statistically significant if $P < 0.05$. Expecting that a clinically significant difference in the number of bilaterally blocked dermatomes is four segments and that the standard deviation of the data is 4, sample size calculation indicated that 16 patients in each group would be required to detect a difference with an $\alpha = 0.05$ and ß = 0.20.

Results

A total of 40 patients were included in this double-blind study. The epidural technique was well accepted by all patients. Demographic characteristics were similar in the two groups (Table I).

Mean blood pressures are shown in Table II. Although time was measured from the point at which the epidural injection was finished, no differences were found at each assessment time between the two groups. However, mean blood pressure decreased slightly at five and ten minutes, recovered at 15 min in the fast group, whereas it remained stable in the slow group. Heart rate did not change during the observation period in the two groups.

The number of dermatomes blocked at each assessment time is shown in Table III. The spread of sensory blockade in the fast group was rapid, showing no difference between the ten and 15 min time points. In the slow group, the spread increased gradually, resulting in a significant difference between any two assessment times. At five minutes, significantly more dermatomes were blocked in the fast injection group compared with the slow group ($P < 0.01$), but at ten and 15 min there were no significant differences between the groups. Table IV shows the number of patients in whom perineal blockade was present at five, ten and 15 min. At the five-minute assessment time, perineal blockade with bilateral block of the second to fourth sacral dermatomes occurred in 13 patients in group F and three patients in group S ($P < 0.05$, Chi squared test).

No difference was found in motor blockade between both groups. All patients had either bilateral grade 0 or 1 block throughout the investigation. Nine patients in group F and ten patients in group S had a bilateral Bromge grade 1 blockade by 15 min after epidural injection of the main dose of mepivacaine.

TABLE I Demographic characteristics of the patients

	Group F (fast injection)	*Group S (slow injection)*	
Age (yr)	51.6 ± 12.3	51.4 ± 10.3	NS
Height (cm)	156.1 ± 4.5	156.4 ± 5.7	NS
Weight (kg)	55.0 ± 7.3	55.1 ± 7.9	NS
Depth to epidural space (cm)	3.9 ± 0.6	3.8 ± 0.7	NS

Data expressed as mean ± SD. NS = no significant difference between groups.

TABLE II Mean blood pressure

	Mean blood pressure (mmHg)		
Time after injection (min)	*Group F (fast injection)*	*Group S (slow injection)*	
0	82.1 ± 9.7	80.8 ± 12.1	NS
5	77.5 ± 11.2*	80.0 ± 12.2	NS
10	76.0 ± 10.5*	79.4 ± 10.0	NS
15	79.1 ± 14.1	78.9 ± 8.6	NS

Data are expressed as mean ± SD. NS = no significant difference between groups. *$P < 0.05$ *vs* baseline.

TABLE III Number of dermatomes blocked

	Number of bilaterally blocked dermatomes		
Time after injection (min)	*Group F (fast injection)*	*Group S (slow injection)*	
5	13.6 ± 3.2	7.6 ± 3.1	$P < 0.01$
10	15.2 ± 3.7*	14.2 ± 3.4*	NS
15	16.4 ± 3.1*	16.7 ± 3.3*†	NS

Data are expressed as mean ± SD. NS = no significant difference between groups. *$P < 0.01$ *vs* five minutes. †$P < 0.01$ *vs* ten minutes.

TABLE IV Number of patients with perineal blockade

	Number of patients with perineal blockade		
Time after injection (min)	*Group F (fast injection)*	*Group S (slow injection)*	
5	13	3	$P < 0.05$
10	16	14	NS
15	17	18	NS

NS = no significant difference between groups.

Discussion

The influence of epidural infusion speed on the speed of onset of epidural anesthesia remains controversial. The disagreement among authors describing its influence may be, partially, explained by differences in study design such as comparing spread of sensory blockade at different moments after local anesthetic injection, using different local anesthetic solutions, adapting different rates of epidural injection, and performing epidural puncture at a different interspace. Cardoso *et al.* described that there were no differences between epidural infusion rate and the speed of sensory blockade, when infusing 15 mL of 2% lidocaine over 30 sec or three minutes.[7] They compared spread of sensory blockade ten and 15 min after the injection of the solution. The intrinsic potency of lidocaine is similar to that of mepivacaine.[8] Also, the speed of onset of sensory blockade is enhanced by an increase in dose achieved by either an increase in concentration or in the volume of local anesthetic solution.[1,9] Therefore, the 15 mL of 2% lidocaine used by Cardoso *et al.* may have produced more rapid blockade than the 8 mL of 1% mepivacaine used in our study. Also, there may have been an undetected but significant difference in the spread of sensory blockade at five minutes after the injection. Rosenberg *et al.* reported that the decrease of blood pressure during the first 30 min did not differ between two injection rates with bupivacaine.[10] In the present study, a significant difference was shown in the decrease of mean blood pressure between the two injection rates, possibly due to the injection of a low volume of lactated Ringer's solution before epidural injection and a more rapid onset of block with mepivacaine compared with bupivacaine. In general, vasodilatation leads to tachycardia following hypotension. However, heart rate did not change until the end of the observation period. The number of patients with dermatomes blocked above T4 was four in the fast group and five in the slow group and the suppression of cardiac sympathetic innervation may, partly, explain the decrease in heart rate. In the caudal epidural space Blanco *et al.* found no correlation between the speed of injection and the speed of onset of sensory blockade.[11] Stabilization and onset are slower and drug requirements larger for caudal than for lumbar epidural anesthesia.[2]

Injecting a constant volume of anesthetic solution epidurally produces an instantaneous increase in epidural pressure with a subsequent return toward preinjection values. Characteristically, the curve of epidural pressure *vs* time exhibits three successive components: the peak, the descent, and the residual values.[12] The first part of the epidural pressure curve has been known as the forced response curve, derived from expansion of the epidural space induced by the administration of a given volume of anesthetic. The second part of the curve constitutes the free response curve, based on intrinsic properties of the epidural space such as compliance and resistance. Finally, the

higher the residual epidural pressure, the more extensive the anesthetic blockade, but higher peak epidural pressures do not change the extent of blockade. The peak epidural pressure correlates directly with the speed of injection of anesthetic solution, not with its volume, whereas the residual epidural pressure correlates directly with its volume and not with the speed of injection.[7] Therefore, the speed of epidural injection does not influence the final extent of sensory blockade. Although in the present study the observation period was only 15 min, the two groups studied showed similar spread of anesthesia at 15 min. However, our results suggest a more rapid spread of mepivacaine in the epidural space and earlier establishment of block following a fast injection. A rapid epidural injection of mepivacaine will more reliably produce perineal blockade at five minutes. When early onset of analgesia and sacral blockade are required for intra- and postoperative pain control, our results suggest that a rapid injection of local anesthetic is indicated. A larger dose injected slowly might be expected to produce a similar result in the short term,[1,9] but the epidural blockade will progress to include more segments than necessary, possibly resulting in severe hypotension and skeletal muscle relaxation.

In conclusion, a faster lumbar epidural infusion of mepivacaine leads to more rapid spread of sensory blockade, in the absence of clinically significant hypotension. Although no difference could be found in the final level of the block, the speed of the epidural infusion of mepivacaine is considered important when rapid analgesia is required.

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