Reports of Investigation

Differential sensory block: spinal vs epidural with lidocaine

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Purpose: In this study we sought to determine if and when a difference exists with regards to differential sensory blockade between spinal and epidural anaesthesia using lidocaine.

Methods: Ten healthy volunteers were randomly assigned to receive both spinal and epidural anaesthesia. Non-epinephrine containing solutions of lidocaine, 100 mg lidocaine 5% with 7.5% dextrose (spinal) and 600 mg lidocaine 2% (epidural), were used to establish sensory blockade. At five minute intervals, for a total of 65 min, the following sensory modalities were tested: anaesthesia (complete loss of sensation to pinprick), analgesia (loss of an equally sharp sensation to pinprick compared with that at an unblocked dermatome), cold sensation (complete loss of cold temperature discrimination).

Results: At all times, except at time = 0 during spinal anaesthesia, the levels of analgesia and cold sensation were more cephalad than the level of anaesthesia for both spinal and epidural anaesthesia. Multiple comparison testing among the three dermatomal response levels showed that, during epidural anaesthesia, the level of analgesia was more cephalad than the level of cold sensation at the following times: 25 min, 30 min, and from 40 to 60 min. In contrast, the level of analgesia was not different from the level of cold sensation during spinal anaesthesia.

Conclusions: Spinal and epidural anaesthesia with lidocaine produce a similar degree of differential sensory blockade. Epidural anaesthesia produces a detectable difference between the level of analgesia and cold sensation at various times, whereas spinal anaesthesia did not reliably do so in this study.

Objectif : Nous avons tenté de déterminer dans cette étude si une différence existe, et à quel moment elle se manifeste, entre une anesthésie rachidienne et une anesthésie péridurale avec de la lidocaïne, en ce qui concerne le blocage sensitif différentiel.

Méthode : Dix volontaires, en bonne santé, ont été désignés de façon aléatoire pour recevoir une anesthésie rachidienne et péridurale. Des solutions de lidocaïne sans épinéphrine, 100 mg de lidocaïne 5 % avec 7,5 % de dextrose (rachidienne) et 600 mg le lidocaïne 2 % (péridurale), ont été utilisées pour provoquer le blocage sensitif. À des intervalles de cinq minutes, pendant 60 min, les modalités sensitives suivantes ont été étudiées : anesthésie (perte de sensibilité complète à la piqure), analgésie (perte de sensibilité équivalente à la piqure à partir d'une comparaison avec celle d'un dermatome non touché), sensibilité au froid (perte complète de la discrimination de la température froide).

Résultats : Pendant l'anesthésie, les degrés d'analgésie et de sensibilité au froid étaient toujours, sauf au temps = 0 de l'anesthésie rachidienne, plus grands que le degré d'anesthésie autant pour une anesthésie rachidienne que péridurale. Les épreuves de comparaisons multiples parmi les trois niveaux de réponses segmentaires ont montré que, pendant l'anesthésie péridurale, le degré d'analgésie était plus grand que le degré de sensibilité au froid aux temps suivants : 25 min, 30 min, et de 40 à 60 min. En comparaison, le degré d'analgésie n'était pas différent de celui de la sensibilité au froid pendant l'anesthésie rachidienne.

Conclusion : L'anesthésie rachidienne et péridurale avec de la lidocaïne produit un degré similaire de blocage sensitif différentiel. Selon cette étude, l'anesthésie péridurale produit une différence détectable entre le degré d'analgésie et de sensibilité au froid à différents moments, pendant que l'anesthésie rachidienne ne fournit pas de données prévisibles en ce sens.

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DURING tetracaine spinal anaesthesia a zone of differential block exists for the sensations of pinprick and cold temperature discrimination.¹⁻³ Similar zones of sensory blockade exist for epidural anaesthesia, although this has been the subject of debate.⁴⁻⁸ Bigler *et al.* showed a difference between the dermatomal levels of cold sensation and analgesia to pinprick during epidural anaesthesia using bupivacaine.⁶ Brull and Greene⁷ and Stevens *et al.*⁸ demonstrated a zone of differential sensory blockade between pinprick and cold temperature discrimination using lidocaine 2% with epinephrine and chloroprocaine 3% respectively. Recently, White *et al.* - testing lidocaine 2%, chloroprocaine 3% and bupivacaine 0.75% - showed that the levels of anaesthesia, analgesia, and cold temperature discrimination were independent of the local anaesthetic used during epidural anaesthesia.⁹

Now that it has been established that both spinal and epidural anaesthesia produce a differential sensory block, the question arises as to whether there is a difference between the two techniques. Thus, the purpose of this study was to determine if there was a difference in the differential sensory blockade that develops during spinal and epidural anaesthesia.

Materials and methods

The study was approved by the Institutional Review Board of the Naval National Medical Center, Bethesda, Maryland. After obtaining informed written consent, we studied 10 healthy volunteer subjects (seven male and three female) ranging in age from 33 to 39 yr. Each was randomly assigned to receive both spinal and epidural anaesthesia. Spinal anaesthesia was achieved with 2 ml lidocaine 5% (100 mg) in 7.5% dextrose injected over a two minute period through a 25 gauge or 27 gauge Whitacre needle (Becton Dickson and Company, Franklin Lake, NJ) at the 2nd or 3rd lumbar interspace. Epidural anaesthesia was established with 30 ml lidocaine 2% (600 mg) injected incrementally, after negative aspiration, over five minutes through a 17 gauge epidural needle (Buron Medical, Bethlehem, PA) placed at the 2nd or 3rd lumbar interspace. After the local anaesthetic was injected, the subject was immediately turned supine from the left lateral decubitus position. Complete recovery of sensory and motor function, including the ability to ambulate and void, occurred between interventions. Monitoring consisted of an automated blood pressure device and a three lead electrocardiogram.

A safety pin was used to test for anaesthesia and analgesia. Cold sensation was assessed by spraying a volatile

mixture of dichlorofluoromethane and trichloromono-fluoromethane (Fluriomethane, Gebauer, Cleveland, OH) on the skin. After the institution of central neuraxis blockade, sensory testing was performed at five minute intervals for 65 min. This was done bilaterally in the midclavicular line moving caudad to cephalad. The most caudad level was recorded if there was a difference between the right and left sides. The level of anaesthesia was defined as one dermatomal level below where subjects first reported sensation when tested with a safety pin; the level of analgesia was one dermatomal level below where subjects first reported an equally sharp sensation to pinprick when compared to an unblocked dermatome (shoulder); loss-of-cold sensation was recorded one dermatomal level below where the subjects first experienced a cold sensation, equal to that of an unblocked dermatome (shoulder), to the volatile mixture sprayed on their skin.

Data are presented as median dermatome levels with minimum-maximum values for discrete variables and, otherwise, as mean $\pm$ standard error (SEM). To determine if a significant difference existed among the three response levels: anaesthesia, analgesia and loss-of-cold sensation during spinal and epidural anaesthesia, the Quade test was used because dermatome levels are ordinal and not normally distributed. Bonferroni's correction was used to adjust for 14 separate Quade tests for each treatment (i.e. there is a significant difference if $P < 0.05/14$ or 0.0036). If a significant difference was found, the data were further analyzed with a multiple comparison test.¹⁰ The Wilcoxon signed rank test was used to determine if a significant difference existed between epidural and spinal anaesthesia at a given response level. Again, Bonferroni's correction was used to adjust for the 14 tests for each response level. Dermatome levels ($< S_1, S_1, L_5, \dots, L_1, T_{12} \dots T_1, C_8, C_7, C_6$) were coded as 0, 1 to 21. Statistical analysis was performed using SAS statistical software.¹¹ The Quade test was performed by writing a program using SAS language.¹² Statistical significance was set at a $P < 0.05$.

Results

The mean $\pm$ SEM age, height, and weight of our subjects were 35.2 ± 0.9 yr, 172.8 ± 2.5 cm, and 72.5 ± 3.3 kg respectively. No difference existed between spinal and epidural anaesthesia among the median levels attained for anaesthesia, analgesia and cold sensation (Table). For each subject, there were distinct dermatomal levels for the sensory modalities tested during both spinal and epidural anaesthesia at all times. (Figures 1, 2) Throughout the study, the dermatomal levels of analgesia and cold sensation were

TABLE Dermatome levels of analgesia, cold sensation and anaesthesia from 0 to 65 min after epidural and spinal anaesthetic injection.

	Time	Analgesia			Cold			Anaesthesia			Quade test P-value
		Min	Med	Max	Min	Med	Max	Min	Med	Max	
Epidural	0	4	8	10	0	7	9	0	0	9	0.0002
	5	7	10	13	8	10	12	0	2.5	10	0.0006
	10	8	12	17	9	11.5	15	0	8	10	0.0001
	15	11	14	21	9	13	15	6	9	11	0.0001
	20	12	15	19	10	13	17	8	9.5	11	0.0001
	25	13	15	19	9	13.5	17	9	10.5	12	0.0001
	30	14	15	17	9	13	17	9	10.5	13	<0.0001
	35	13	15	16	7	13	17	8	10	13	0.0020
	40	12	14.5	17	9	13	16	7	9	13	<0.0001
	45	11	14	16	9	12	16	7	8	12	<0.0001
	50	10	13	16	8	11	15	7	8	12	<0.0001
	55	10	12	15	8	11	15	7	8	11	<0.0001
	60	9	11.5	15	4	11	15	0	7	11	<0.0001
	65	0	10	15	0	9	16	0	6.5	10	<0.0001
Spinal	0	0	8	11	0	8	12	0	5	9	0.0086
	5	7	11	14	7	10	13	6	8	11	0.0008
	10	9	12	15	10	12	16	7	9	12	0.0003
	15	11	14	17	11	13.5	18	8	10	14	0.0001
	20	12	14.5	19	12	14	18	8	11	15	0.0001
	25	12	15	19	12	14.5	18	8	11.5	17	0.0001
	30	12	16	19	12	15	17	8	12.5	17	0.0002
	35	11	16	19	9	15	17	8	12.5	16	0.0002
	40	10	15.5	20	8	14	19	7	11	15	0.0001
	45	9	14	20	8	13.5	20	5	9.5	16	0.0001
	50	7	12.5	20	7	12.5	18	3	8	15	0.0001
	55	0	12	20	6	12	19	0	8	16	0.0009
	60	0	10.5	18	3	10	17	0	7	14	0.0005
	65	0	10.5	18	0	9	17	0	6.5	14	0.0008

Min = minimum, Med = median, Max = maximum (coded as 0, 1, 1 to 21 for the following dermatomal levels: less than S1, S1, L5...L1, T12...T1, C8, C7, C6). Except for spinal anaesthesia at 5 min, there was difference among the 3 response levels using the Bonferroni correction for the 14 separate Quade tests for each given anaesthetic treatment (i.e. $P < 0.05/14$ or 0.0036).

more cephalad than the level of anaesthesia for both groups. Multiple comparisons among the three modalities tested showed that during epidural anaesthesia the level of analgesia was higher than the level of cold sensation at the following times: 25 min, 30 min, and from 40 to 60 min; and that the level of analgesia was not different from the level of cold sensation at any time during spinal anaesthesia.

Discussion

This study examined the differential block that develops in unmedicated volunteers during epidural and spinal anaesthesia. Separate analysis of the two anaesthetic techniques showed distinct dermatomal levels for the three sensory modalities tested. Comparative analysis between the two groups, however, showed that during spinal anaesthesia there was no statistical difference between the levels of analgesia and cold sensation. This difference was demonstrable at various times during epidural anaesthesia.

Previous studies have shown that the level of cold sensation is two dermatomes above the level of analgesia during spinal anaesthesia.^{1,3} More than 40 yr ago Greene established the existence of a differential sensory block during spinal anaesthesia with hyperbaric tetracaine.¹ He observed a consistent relationship between the dermatomal levels-caudad moving cephalad-to the sensations of pinprick and cold sensation. Brull and Greene conducted a similar study in 1989 with hyperbaric tetracaine and bupivacaine during spinal anaesthesia.³ They found distinct sensory levels for light touch (anaesthesia), pinprick (analgesia), and temperature (cold sensation). However, not all investigators have observed this difference between analgesia and cold sensation as shown by Rocco in a study of spinal anaesthesia using tetracaine and lidocaine.² Could these findings have been due to variations in methodology? For example, Greene, and Greene and Brull did not use a standardized local anaesthetic dose.^{1,3} In addition, they used both epinephrine

FIGURE 1 Median dermatome levels of Anesthesia, Analgesia and Cold sensation during epidural block. A significant difference existed among the 3 median dermatomal levels at any given time ($P < 0.05/14$ or 0.0036) with the Bonferroni correction for the 14 Quade tests.

and non-epinephrine containing local anaesthetic and did not control such variables as patient positioning and the administration of systemic opioids and benzodiazepines. Greene used an ether soaked sponge to test for cold sensation, raising the possibility of two different simultaneously applied stimuli (touch and cold) interfering with what was originally intended to be measured - cold sensation. The intensity of the stimulus may vary among investigators despite their using the same apparatus to apply the stimulus, for example, a safety-pin used to test for pinprick and light touch. This in turn can influence sensory testing as the time of disappearance of a given sensory modality can be influenced by the intensity of the stimulus.¹³ Finally, comparisons of different studies are made difficult when different statistical measures are used (mean *versus* median) the latter being preferred when reporting and analyzing non-parametric data such as dermatome levels.¹⁴

Inherent in our own study are some potential biases. The study population, comprised of anesthesiologists, anaesthesia residents and nurse anaesthetists, may have been a source of potential error due to their knowledge of regional anaesthetic techniques. It was impossible to blind them to the technique used. The assessors, however, were blinded to the technique. In addition, although some of the subjects may have been aware of the issues involved with differential block, this was not discussed with them before or during the study.

Inaccuracies may arise in crossover studies from the potential interaction between the initial experiment and subsequent scientific interventions during the course of the investigation. We sought to avoid this in two ways:

FIGURE 2 Median dermatome levels of Anesthesia, Analgesia and Cold sensation during spinal block. A significant difference was found among the 3 dermatomal levels at any given time except at time = 0 (since $P = 0.0086 > 0.0036$) if Bonferroni correction was used for the 14 Quade tests.

First, there was at least a two hour interval between the dissipation of the spinal (or epidural) anaesthetic. This should have been sufficient time to ensure that clinically significant amounts of lidocaine did not exist in cerebrospinal fluid or in the epidural space. Secondly, the order of anaesthetic administration was randomized which would tend to cancel out any effects - if present - of the previous intervention.

In conclusion, during spinal and epidural anaesthesia in subjects with high thoracic sensory levels we were able to detect a slight difference between the two techniques for the sensory levels of analgesia and cold sensation; analgesia was found to be more cephalad than the level of cold sensation during most of the epidural anaesthetics and the levels of analgesia and cold sensation were equal during spinal anaesthesia. These findings may assist clinicians in more accurately assessing the level of sensory blockade during spinal and epidural anaesthesia in the perioperative period.

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