Efficacy of three test doses to detect epidural catheter misplacement

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Purpose: To determine among three currently used epidural test doses which is the most reliable for the detection of accidental intrathecal misplacement of an epidural catheter, and which clinical sign is to be used as a marker.

Methods: Ninety orthopedic patients were allocated to either the continuous epidural or the continuous spinal group according to age, $<$ or $>$ 70 yr. They received, in a randomised, double-blind fashion, one of the three solutions: 60 mg lidocaine 2% (L2%), 7.5 mg bupivacaine 0.25% (B0.25%), or 15 mg bupivacaine 0.5% (B0.5%); all three solutions contained epinephrine. Objective variables studied every two minutes over the first ten minutes after injection included: presence of a sensory level $\geq T_{12}$, presence of a motor block ≥ 1 , and anesthesia of segments L_1 , L_2 , S_2 and S_5 . Subjective variables studied over the same period included paresthesias, sensation of warmth or cold, and muscle weakness.

Results: When using presence of motor block ≥ 1 on the Bromage scale, the administration of 60 mg L2% with epinephrine identified all patients having an intrathecal catheter six minutes after injection, whereas none of the patients receiving the same solution through the epidural catheter presented a motor block. This was not the case for the other two solutions studied.

Conclusion: Lidocaine 2% with epinephrine at a dose of 60 mg is the test dose of choice to detect the intrathecal misplacement of an epidural catheter. The presence of motor block ≥ 1 is the only reliable clinical sign.

Objectif : Déterminer, parmi trois dose-tests couramment utilisées en anesthésie péridurale, laquelle est la plus fiable dans la détection d'une position intrathécale accidentelle d'un cathéter péridural, et quel signe clinique doit être utilisé comme marqueur.

Méthode : Quatre-vingt-dix patients orthopédiques ont été attribués en fonction de leur âge, $<$ ou $>$ 70 ans, soit au groupe d'anesthésie péridurale continue soit au groupe d'anesthésie spinale continue ; ils ont ensuite été randomisés pour recevoir en double-aveugle l'une des trois solutions suivantes : 60 mg de lidocaine 2 % (L 2 %), 7,5 mg de bupivacaine 0,25 % (B 0,25 %), et 15 mg de bupivacaine 0,5 % (B 0,5 %) ; les 3 solutions étaient adrénalinées. Les variables objectives étudiées toutes les deux minutes pendant les deux premières minutes après l'injection comprenaient : la présence d'un bloc sensitif $\geq T_{12}$, la présence d'un bloc moteur ≥ 1 sur l'échelle de Bromage, et la perte de sensation à la piqûre dans les segments L_1 , L_2 , S_2 and S_5 . Les variables subjectives étudiées pendant la même période comprenaient : la présence de paresthésies, de sensation de chaud ou de froid, et de faiblesse musculaire.

Résultats : En utilisant la présence d'un bloc moteur ≥ 1 , l'administration de 60 mg de L 2 % adrénalinée a permis d'identifier tous les patients avec un cathéter intrathécal, six minutes après l'injection, alors qu'aucun des patients recevant la même solution au travers du cathéter péridural n'a présenté de bloc moteur. Ceci n'a pas été le cas avec les 2 autres solutions étudiées.

Conclusion : La L 2 % adrénalinée à une dose de 60 mg semble être la dose-test la plus fiable pour détecter une position intrathécale accidentelle d'un cathéter péridural. Le seul signe clinique à utiliser est la présence d'un bloc moteur.

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EPIDURAL catheters may be accidentally misplaced either intravascularly or intrathecally. The incidence of accidental perforation of an epidural vein ranges from 1 to 10% and the incidence of unintentional intrathecal catheterization may be as high as 2%.¹ Normally, aspiration of blood or cerebrospinal fluid (CSF) is observed in the case of a misplacement; however aspiration can be negative and this is one of the reasons the epidural test dose was introduced. There is a consensus about the use of 15 µg epinephrine for the detection of intravascular misplacement of an epidural catheter.²⁻³ In contrast, the type of epidural test dose used to detect intrathecal misplacement is not clearly defined. Some studies have attempted to define the ideal epidural test dose,⁴⁻⁹ but were either unblinded and non-randomised,⁵ lacked a control group⁴ or the time needed to discriminate between an epidural or a subarachnoid position was too long.⁶

The aim of our study was to compare three currently used epidural test doses and to determine:

- which solution reliably detected the accidental intrathecal misplacement of an epidural catheter within ten minutes of injection;
- which clinical sign should be used as a marker.

Methods

After institutional approval and informed consent, 90 orthopedic patients, ASA 1-3, were recruited into the study. No premedication was administered. According to age, patients were prospectively admitted to the following two groups: continuous epidural anesthesia (CEA) included patients < 70 yr of age and continuous spinal anesthesia (CSA) for those > 70 yr. The rational

for this age difference resides in the use of large bore equipment for CSA in our institution. In each group, patients were randomised to receive either 3 ml (60 mg) lidocaine 2%, 3 ml (7.5 mg) bupivacaine 0.25% or 3 ml (15 mg) bupivacaine 0.5% through the catheter. All test dose solutions contained 15 µg of epinephrine.

All patients received 10 ml.kg⁻¹ of a crystalloid solution before the injection of the test dose solution. Monitoring was with continuous ECG, a non-invasive arterial pressure device and a pulse oxymeter. A 20 gauge catheter was introduced at the L₃₋₄ level, via an 18 gauge Tuohy needle, in the epidural or subarachnoid space by 3 to 4 cm in a cephalic direction. The epidural space was identified using the loss of resistance technique, the subarachnoid space was identified by observing free flow of CSF. Injection of the test dose solutions was made with the patient in the supine position and in a double blind manner. Speed of injection was identical for all patients, i.e. 3 ml. min⁻¹.

The following variables were recorded every two minutes for ten minutes, starting at T0 (end of injection):

1 Objective variables were defined as all signs measured and scored by a blinded anesthesiologist and included:

- presence or not of a sensory level $\geq T_{12}$ (loss of sensation to pin- prick, 24 gauge needle)
- presence or not of a motor blockade ≥ 1 on the Bromage scale¹⁰ (ranging from 0 = no motor block, 1 = inability to raise leg, 2 = inability to raise leg and flex knee, to 3 = complete motor block)
- anesthesia of the L₁, L₂, S₂ and S₅ segments (loss of sensation to pin- prick, 24 gauge needle).

2 Subjective variables were defined as signs and

TABLE I Demographic data of patients in both epidural and spinal groups. Data as mean $\pm$ sd or n.

Continuous Epidural Anesthesia:						
Drug	Age (yr.)	Height (cm)	Weight (kg)	No. of ASA I	No. of ASA II	No. of ASA III
Lidocaine 2%	54 $\pm$ 19	170 6	78 $\pm$ 11	14	0	1
Bupivacaine 0.25%	52 $\pm$ 18	159 26	72 $\pm$ 10	7	8	0
Bupivacaine 0.5%	57 $\pm$ 13	169 9	75 $\pm$ 13	3	12	0
Mean / Total	55 $\pm$ 17	166 17	75 $\pm$ 11	24	20	1
Continuous Spinal Anesthesia:						
Drug	No. of Age (yr.)	No. of Height (cm)	No. of Weight (kg)	ASA I	ASA II	ASA III
Lidocaine 2%	82 $\pm$ 4	161 $\pm$ 10	65 15	0	3	12
Bupivacaine 0.25%	81 $\pm$ 4	160 $\pm$ 10	67 8	0	4	11
Bupivacaine 0.5%	80 $\pm$ 5	167 $\pm$ 8	73 16	0	7	8
Mean / Total	81 $\pm$ 4*	163 $\pm$ 9	68 14*	0*	14	31*

ASA: American Society of Anesthesiologists

* $P < 0.05$ between epidural and spinal groups

TABLE II Number of patients in continuous spinal anesthesia (CSA) and continuous epidural anaesthesia (CEA) groups presenting anesthesia of specific roots as defined in methodology.

		<i>Lidocaine 2% + Epi</i> CSA/CEA							<i>Bupivacaine 0.25% + Epi</i> CSA/CEA							<i>Bupivacaine 0.5% + Epi</i> CSA/CEA						
Roots:	L1	0/0	10/0	11/2	13/4	13/6	14/9	3/1	10/1	11/1	13/1	14/1	14/1	2/0	8/0	9/1	10/2	11/4	11/4			
	L2	7/0	12/0	14/0	14/4	15/6	15/10	4/1	10/1	11/1	12/1	13/1	14/1	3/0	11/0	11/2	11/2	11/3	11/4			
	S2	3/1	7/1	12/1	14/3	14/3	14/4	1/1	4/1	6/1	10/1	11/1	11/2	2/0	8/0	10/0	13/1	14/1	14/1			
	S5	4/1	8/1	11/1	13/2	13/2	13/2	0/1	4/1	7/2	11/2	12/2	13/2	3/0	9/0	11/0	12/2	15/5	15/5			
Time (min)		0	2	4	6	8	10	0	2	4	6	8	10	0	2	4	6	8	10			

Epi : Epinephrine

TABLE III Number of patients in continuous spinal anesthesia (CSA) and continuous epidural anaesthesia (CEA) groups describing subjective variables as defined in methodology.

		<i>Lidocaine 2% + Epi</i> CSA/CEA							<i>Bupivacaine 0.25% + Epi</i> CSA/CEA							<i>Bupivacaine 0.5% + Epi</i> CSA/CEA						
Paresthesias		4/0	8/1	10/4	11/8	11/10	11/10	2/1	2/2	4/2	4/3	4/4	4/4	4/0	7/0	7/2	7/2	7/2	7/5			
Sensation of warmth		6/0	8/1	9/5	12/8	12/8	12/9	5/0	6/1	7/2	8/4	8/4	8/4	9/0	11/2	12/3	12/4	12/5	12/5			
Sensation of cold		1/1	1/1	2/1	2/1	2/2	2/2	0/0	0/1	1/1	2/1	2/1	2/1	1/1	2/1	2/1	2/3	2/3	2/3			
Muscle weakness		3/0	8/1	9/2	9/5	9/7	9/9	4/0	8/0	10/0	10/1	11/1	11/2	4/0	12/1	12/2	12/2	12/5	12/5			
Time (min)		0	2	4	6	8	10	0	2	4	6	8	10	0	2	4	6	8	10			

Epi : Epinephrine

sensations which were communicated by the patient if present and which were not clinically measurable or quantifiable. These were categorised as paresthesias, sensation of warmth, cold or muscle weakness.

Data are presented as mean $\pm$ SD, or number of patients. Variables from the demographic data were compared using analysis of variance (ANOVA) or Chi-square as required. A $P < 0.05$ was considered significant.

Results

At the end of the study, patients with a spinal catheter presented adequate surgical anesthesia except for 18/45 who required a 1 ml supplemental dose of isobaric bupivacaine 0.5% (5 mg). All patients with an epidural catheter developed, after a titrated supplementation of 10 to 12 ml lidocaine 2%, the typical onset and distribution of an epidural anesthesia. In all cases, surgery took place under regional anesthesia and no failure of the technique was observed.

Demographic data are shown in Table I. Though the CEA and CSA groups were different in terms of mean age, weight, and ASA status, distribution of patients among the three subgroups in each group was homogenous.

Figures 1 and 2 show the number of patients in each group presenting a motor block or a sensory level as defined, after the injection of one of the three test

dose solutions.

All patients with a spinal catheter who received 60 mg L2% showed, six minutes after injection of the test dose, motor block ≥ 1 on the Bromage scale while none of the patients receiving the same test dose epidurally did so (Figure 1). In the B0.25% and B0.5% groups 11/15 and 13/15 patients with a spinal catheter developed motor block, none of the patients receiving B0.25% and 1/15 patients receiving B0.5% epidurally had a motor block (Figure 1).

Sensory block (level $\geq T_{12}$) was observed after ten minutes in 14/15 patients receiving L2% or B0.25%, and in 11/15 patients receiving B0.5% spinally (Figure 2). In contrast, 6/15 patients in the L2% group, 0/15 patients in the B0.25% group and 1/15 patients in the B0.5% group with an epidural catheter presented a sensory level $\geq T_{12}$.

Results of both anesthesia of specific roots and subjective signs are presented in Tables II and III. A highly variable number of patients in both groups presented anesthesia or subjective signs after both epidural and spinal administration of test doses.

Discussion

Our results show that 60 mg (3ml) L2% with epinephrine is a better choice than B0.25% or B0.5% for the detection of an accidental intrathecal misplacement of an epidural

FIGURE 1 Evolution throughout study time of the number of patients presenting a motor block grade 1 on Bromage scale, in both continuous spinal anesthesia (CSA) and continuous epidural anesthesia (CEA) groups, and for all three test dose solutions. Epi: epinephrine

FIGURE 2 Evolution throughout study time of the number of patients presenting a sensory level T_{12} , in both continuous spinal anesthesia (CSA) and continuous epidural anesthesia (CEA) groups, and for all three test dose solutions. Epi: epinephrine

catheter, when the presence of a motor block ≥ 1 , at six minutes after injection is used as the clinical marker.

Abraham⁵ injected 30 mg (2 ml) hyperbaric lidocaine 1.5% with epinephrine either epidurally in 100 patients in

labour or intrathecally in 15 patients undergoing minor obstetric procedures. He concluded that, within two minutes, all patients in the spinal group developed loss of sensation to pinprick at the S_2 segment whereas only one

patient in the epidural group had evidence of objective sensory loss, but at the L₂ segment, three minutes after injection. When considering our results on anesthesia of specific roots which included S₂, the loss of sensation to pin-prick was apparent in 14/15 patients receiving either L2% or B0.5% spinally after six to eight minutes. However after six minutes respectively 3/15 and 1/15 patients in the CEA groups receiving the same solutions showed loss of sensation to pin-prick at S₂. The results of Abraham's unblinded and non-randomised study are thus difficult to transpose to non-obstetrical patients, since the subarachnoid distribution of hyperbaric solutions has been shown to be different in pregnancy.¹¹

Prince,⁶ also studying pregnant patients, injected 8 mg bupivacaine 0.5% without epinephrine either intrathecally or epidurally. Motor block (inability to raise a straight leg in at least one leg) allowed differentiation between subarachnoid and extradural injections. However, he achieved these results only ten minutes after the injection because of slow and patchy onset of spinal block in some patients in the subarachnoid group. In our study, 7.5 mg B0.25% or 15 mg B0.5% did not allow such a clear differentiation compared with lidocaine. These results should be interpreted with caution because of the different population selection.

Colonna-Romano⁴ compared the effects of the intrathecal injection of an epidural test dose of 45 mg (3 ml) lidocaine with epinephrine *vs* 3 ml saline. He concluded that motor block four minutes after the injection had a sensitivity of 100% and a specificity of 93%. This confirms the importance of motor block as a reliable marker of accidental intrathecal injection of an epidural test dose. However, the specificity was low (93%), implying one false positive test, i.e., one patient receiving saline intrathecally was unable to raise his legs. The lack of a true control (or epidural) group makes further comparisons difficult.

Our study could be criticised because the CEA and CSA groups were different in age and weight. The patients were not randomised but admitted to one of two groups according to age. The reason for this study design is that, in our department, we use large bore equipment for CSA, i.e. 18 gauge Tuohy needles and 20 gauge catheters. Consequently, the incidence of postspinal headache, especially in young patients, would be high.¹²⁻¹³ However, other studies have demonstrated that age has a controversial influence on onset and distribution of spinal anesthesia.¹²⁻¹⁶ In a review on subarachnoid anesthesia, Greene¹⁴ stated that the only correlation was between age and the cephalic spread of sensory block. Veering *et al.*¹⁵ could not confirm this and, furthermore, did not find any correlation between age and initial onset,

intensity or recovery of motor block. The only difference was in a quicker time to maximal motor block in elderly patients, which is not relevant to the present study since only the first ten minutes of initial spread were studied. Other studies¹⁶⁻¹⁸ have shown some correlation between age and intrathecal spread of isobaric anesthetic solutions, but the clinical importance of these results only emphasises the unpredictability of the spread of these plain or isobaric solutions.

Likewise, influence of age on the spread of epidural anesthesia is controversial.¹⁹⁻²¹ These studies used either higher doses and volumes or started measurements 15 min after injection. We feel that their conclusions are not applicable to small test doses and the short study time used in our study, particularly when no correlation has been found between age and onset, intensity, or duration of motor block with higher doses and volumes.¹⁹⁻²⁰ The difference in weight observed between the two groups of the present study was around a mean of 7 kg. A more extensive cephalic spread of sensory block during spinal anesthesia was found in patients with increased body mass index;²² again interindividual variability in sensory level achieved was great and questioned the clinical importance of this finding. In the same study, no difference in intensity and duration of motor block was observed for patients with increased body mass, however onset times were not reported.

Although 60 mg L2% with epinephrine as a test dose seems a better choice for the detection of the accidental intrathecal misplacement of an epidural catheter when using motor block ≥ 1 as a clinical marker, there may be clinical implications in waiting six minutes in a busy practice. Unfortunately, none of the bupivacaine solutions offer a quicker or more reliable alternative. A test dose of 7.5 mg B0.25% along with the observation of the appearance of a sensory level $\geq T_{12}$ yielded results only after 8 min., i.e., 14/15 patients in the CSA group *vs* 0/15 in the CEA group presented a sensory level $\geq T_{12}$. Using a higher dose of 15 mg B0.5% decreased reliability, i.e., a few patients in the epidural group already showed signs of anesthesia 2 to four minutes after injection and thus did not allow to clearly differentiate between an epidural or a spinal injection.

In conclusion, among the three test doses currently used at our institution, L2% clearly detects the intrathecal misplacement of epidural catheter. Six minutes after injection, motor block was present in all patients in the spinal group and in none of the patients in the epidural group.

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