



Assessment of sensory block during labour epidural analgesia: a prospective cohort study to determine the influence of the direction of testing

Évaluation du bloc sensoriel pendant l'analgésie péridurale obstétricale : une étude de cohorte prospective pour déterminer l'influence de la direction des tests

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Abstract

Purpose Assessment of sensory block level during labour epidural analgesia is an essential component of clinical practice and patient safety. Nevertheless, the methods and direction of testing are not standardized. In our hospital, sensory block testing to ice is routinely used, but while some anesthesiologists test the block from a nonanesthetized to an anesthetized area, some do it in the opposite direction. It is unknown how these two different practices affect identification of the sensory block level. The objective of this study was to determine the agreement between these two practices.

Methods We enrolled 31 patients admitted to the labour and delivery unit in a prospective cohort study. At their request, labour epidural analgesia was performed as per institutional routine. Sensory block level to ice was assessed using opposite directions by two randomly assigned independent investigators, one and two hours after the loading dose was administered.

Results Sensory block levels to ice assessed from an anesthetized area to a nonanesthetized area were lower

than those when assessed with the stimulus applied in the opposite direction, typically one segment lower.

Discussion Given the small difference detected with both methods, it may be acceptable to use either in clinical practice. Nevertheless, the lack of standardization may have a significant impact when comparing studies involving assessment of sensory block to ice.

Study registration www.ClinicalTrials.gov (NCT03572439); registered 28 June 2018.

Résumé

Objectif L'évaluation du niveau de bloc sensoriel pendant l'analgésie péridurale obstétricale est une composante essentielle de la pratique clinique et de la sécurité des patientes. Néanmoins, les méthodes et l'orientation des tests ne sont pas standardisées. Dans notre hôpital, les tests à la glace des blocs sensoriels sont couramment utilisés, mais alors que certains anesthésiologistes testent le bloc d'une zone non anesthésiée à une zone anesthésiée, certains le font dans la direction opposée. Nous ne savons pas dans quelle mesure ces deux pratiques différentes affectent l'identification du niveau du bloc sensoriel. L'objectif de cette étude était de déterminer la concordance entre ces deux pratiques.

Méthode Nous avons recruté 31 patientes admises à l'unité obstétricale dans une étude de cohorte prospective. À leur demande, l'analgésie péridurale obstétricale a été réalisée conformément à la routine institutionnelle. Le niveau du bloc sensoriel tel que mesuré par un test à la glace a été évalué dans les deux directions par deux chercheurs indépendants assignés au hasard, une et deux heures après l'administration de la dose de charge.

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Résultats *Les niveaux de blocs sensoriels tels que mesurés par un test à la glace évalués d'une zone anesthésiée à une zone non anesthésiée étaient inférieurs à ceux évalués lorsque le stimulus était appliqué dans la direction opposée, habituellement un segment plus bas.*

Discussion *Compte tenu de la petite différence détectée entre les deux méthodes, il peut être acceptable d'utiliser l'une ou l'autre dans la pratique clinique. Néanmoins, le manque de standardisation peut avoir un impact significatif lors de la comparaison d'études impliquant l'évaluation du bloc sensoriel à l'aide d'un test à la glace.*

Enregistrement de l'étude www.ClinicalTrials.gov (NCT03572439); enregistrée le 28 juin 2018.

Keywords anesthesia · labour epidural · obstetric analgesia · sensory testing

Assessment of sensory block level during neuraxial analgesia for labour and delivery is an essential component of clinical management and patient safety.¹ Patients undergoing neuraxial analgesia for labour should have their sensory block levels assessed frequently.² These assessments detect suboptimal and failed epidural catheters, thus preventing general anesthesia in case of an intrapartum Cesarean delivery; facilitate optimization of the analgesic regimen to minimize breakthrough pain; prevent unwanted side-effects associated with a high block, such as respiratory compromise and hypotension; and may detect unintentional intrathecal injection of local anesthetic.³

A variety of stimuli have been used to assess sensory block level, including cold, light touch, sharp touch, prick, and transcutaneous electrical stimulation.^{2,4,5} In addition to a wide variety of stimuli, the endpoints used by investigators also vary widely. Not surprisingly, at one given assessment, the examiner may identify different sensory block levels in response to different types of stimuli.⁶

Another complicating factor of sensory block assessment following neuraxial analgesia is the lack of standardization of the direction of the testing as it relates to anesthetized and nonanesthetized areas. The lack of standardization of sensory block assessment may result in a difference of several dermatomes in the level that two different assessors might record for the same patient.⁷ Consequently, it may be difficult to replicate results from previous studies and implement clinical practices.

Many studies have addressed the assessment of sensory block levels after spinal and epidural anesthesia for Cesarean delivery.^{1,4,6-8} Nevertheless, studies addressing this very practical issue in labouring patients under

epidural analgesia are rare.^{2,3} Based on our review of the literature and an informal survey, we believe that there is a wide variation in practice among clinicians and researchers, with no clear “gold standard” for assessing sensory block levels during epidural analgesia for labour and delivery. This may have clinical and medicolegal relevance. This is a significant knowledge gap in our practice and one that limits the interpretation and planning of research in this area.¹

The objective of this study was to determine the degree of agreement between two methods of assessment of sensory block level to cold in patients receiving epidural analgesia for labour (anesthetized to nonanesthetized segments vs nonanesthetized to anesthetized segments). We hypothesized that the two methods would present a high degree of agreement.

Methods

This prospective cohort study was approved by the Ethics Review Board at Mount Sinai Hospital, Toronto, Canada (REB 18-0119-E, 12 June 2018) and registered at ClinicalTrials.gov (trial number, NCT03572439; registered 28 June 2018).

We recruited patients admitted to the labour and delivery unit at our institution who requested and had no contraindications to receiving epidural analgesia and were capable of understanding and signing the written informed consent. We excluded patients with neurologic conditions that could compromise the body's sensitivity to cold. Patients were recruited once they were admitted to the labour and delivery unit and before they experienced significant pain. Written informed consent was obtained from all participants.

Upon patient request, labour epidural analgesia was performed as per institutional routine. An ultrasound assessment of the lumbar spine was used to determine the L2/L3 or L3/L4 interspace, with the patient in the sitting position. The epidural space was identified with a 17G Tuohy needle using loss of resistance to saline or air, and a 19G multiport wire-reinforced epidural catheter (Arrow FlexTip plus; Arrow International Inc, Reading, PA, USA) was inserted 5 cm into the epidural space. After negative aspiration of the epidural catheter, a test dose of bupivacaine 0.125% 3 mL plus fentanyl 3.3 µg·mL⁻¹ was administered, followed by a loading dose consisting of two aliquots of 6 mL of the same solution at an interval of three minutes. Upon completion of the test dose and loading dose (total volume 15 mL), patients were positioned in a semi-recumbent position with a wedge under their right hip to alleviate aortocaval compression.

Patients were assessed for pain at 20 min after administration of the test/loading dose, using a numerical rating score (NRS) from 0 to 10, where 0 means no pain and 10 means the worst pain imaginable. If the NRS pain score was greater than 1, the patient received 5 mL of bupivacaine 0.25%. If necessary, another 5 mL was given after ten minutes to achieve an NRS equal or lower than 1. Epidural maintenance with bupivacaine 0.0625% with fentanyl $2 \mu\text{g}\cdot\text{mL}^{-1}$ was started one hour after the end of the loading dose. The institutional routine epidural maintenance is a combination of programmed intermittent epidural bolus (PIEB) and patient-controlled epidural analgesia (PCEA) (PIEB 10 mL, PIEB interval 40 min, PCEA 5 mL, lockout ten minutes, maximum $30 \text{ mL}\cdot\text{hr}^{-1}$).

The sensory block levels were assessed by two independent investigators at one and two hours after the loading dose was administered. The patients' eyes were covered to ensure that they could not see where the stimulus was being applied to their skin. The sensory block level to cold was tested with an ice bag (10 cm \times 20 cm plastic bag half-filled with ice chips). The control areas were defined as those just above the clavicle and just lateral to the sternocleidomastoid muscle on each side, which corresponds to the C3–C5 dermatome. We assessed the sensory block level using two different starting points and directions of assessment. The starting point for testing from an anesthetized to a nonanesthetized area (*up* method) was at L1. The starting point for testing from a nonanesthetized to an anesthetized area (*down* method) was at T1. The assessments were performed on both sides (left and right), on the midclavicular line.

In each direction, two levels of block were determined: (a) the lower sensory block level to cold, defined as the dermatome at which and below which there was complete loss of sensation to cold and (b) the upper sensory block level to cold, defined as the dermatome at which and below which the cold sensation was present but not as cold as the control areas.

Two independent assessors were randomized as to who would perform the assessment first and in which direction. Each assessor performed the assessment bilaterally in only one direction in each participant, either *up* or *down*, as per randomization. Participants were randomized according to a table of random numbers and the investigators were blinded to each other's assessment. The Keegan's dermatome map was used as a reference during the assessment. The patient's response to the assessments was marked by the two different assessors on a printout of the Keegan's map of dermatomes.

Upon completion of the assessments by each individual assessor, the patients were asked about their comfort with

the assessment on a numeric scale of 0–10, 0 meaning not comfortable at all and 10 meaning completely comfortable.

The primary outcomes of this study were 1) the lower sensory block level to cold and 2) the upper sensory block level to cold. The secondary outcome was patient satisfaction with the assessment.

Since there was no preliminary information available on the degree of agreement between these two practices/methods for sample size estimation, we planned to recruit 30 patients based on the expected availability of patients during the planned study period. This sample size would allow a margin of error < 0.10 if the percent agreement was no less than 90%.

We summarized the study population using descriptive statistical methods. The degree of agreement in sensory block levels between the two methods was assessed using kappa statistics and the percentage agreement. The association in the sensory block levels between the two methods was assessed using Spearman correlation coefficient. We also examined the possible bias of the methods: whether one method is consistently associated with higher or lower levels than the other. Data management and statistical analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, NC, USA). A two-sided *P* value of 0.05 was used to determine statistical significance.

Results

Thirty-one patients were enrolled in the study. One patient required Cesarean delivery before any data were collected and therefore was not included in the analysis. Four patients had just one assessment because they delivered before the second hour of labour. For those patients, data from the one-hour assessment were included in the analysis. Patient characteristics are shown in Table 1.

No patient required supplementation of the loading dose or PCEA before the sensory block assessments at one and two hours.

Table 2 shows the upper and lower sensory block levels at one hour and two hours using the *up* and *down* methods, as well as kappa statistics and the Spearman correlation coefficients. The *down* method showed higher sensory block levels than the *up* method did, most often with one-segment difference observed in both the upper and lower sensory block levels. The upper and lower sensory blocks were 2–4 dermatomes apart, as assessed by both methods.

Patient satisfaction was high and similar with both methods. At one hour, 97% of patients scored comfort during the test as 8/10 or more; at two hours this score lowered to 92%. No patients classified comfort below 7 in any assessment.

Table 1 Patient characteristics

Characteristic	LEA cohort included in analysis N = 30
Age (yr), median [IQR]	33 [30–37]
Height (cm), mean (SD)	164 (7)
Weight (kg), mean (SD)	76.2 (11.7)
BMI (kg·m ⁻²), mean (SD)	28.1 (4.0)
Gestational age (weeks), median [IQR]	39.8 [39.0–40.3]
Pain score (VAS) at epidural request, median [IQR]	8 [7–9]
Primipara, n/total N (%)	17/30 (57%)
Primigravida, n/total N (%)	11/30 (37%)

Continuous variables were examined for normality of distribution using the Shapiro–Wilk test. Normally distributed continuous variables are reported as mean (SD) and non-normally distributed continuous variables are reported as median [IQR]. Categorical variables are reported as number (percentage) of patients.

BMI = body mass index; IQR = interquartile range; LEA = labour epidural analgesia; SD = standard deviation; VAS = visual analogue scale

Table 2 Comparison between upper and lower sensory block levels, degree of agreement, and correlation between *up* and *down* testing

	Upper sensory block		Lower sensory block	
	<i>Up</i> method	<i>Down</i> method	<i>Up</i> method	<i>Down</i> method
1 hr				
right side				
Sensory level, median [IQR]	T9 [T6–T11]	T8 [T5–T10]	L1 [T11–L3]	T11 [T10–L2]
Kappa (concordance) ^a	0.13* (23.3%)		0.17* (26.7%)	
Correlation coefficient ^b	0.79*		0.86*	
1 hr				
left side				
Sensory level, median [IQR]	T9 [T6–T10]	T7 [T6–T8]**	T11 [T10–L2]	T10 [T9–T11]**
Kappa (concordance)	0.13* (23.3%)		0.02 (16.7%)	
Correlation coefficient	0.86*		0.68*	
2 hr				
right side				
Sensory level, median [IQR]	T8 [T5–T9]	T7 [T5–T9]	T11 [T10–L2]	T10 [T9–T12]
Kappa (concordance)	0.24* (38.5%)		0.09 (19.2%)	
Correlation coefficient	0.85*		0.71*	
2 hr				
left side				
Sensory level, median [IQR]	T8 [T5–T9]	T8 [T5–T9]	T10 [T9–T12]	T10 [T8–T11]
Kappa (concordance)	0.16* (26.9%)		0.07 (19.2%)	
Correlation coefficient	0.80*		0.74*	

Up method = anesthetized to nonanesthetized direction (caudad-cephalad direction); *down* method = nonanesthetized to anesthetized direction (cephalad-caudad direction)

* $P < 0.05$; ** statistical significance was observed in the comparisons of outcomes (sensory block level) between *up* and *down* methods (Wilcoxon Rank Sum test, $P < 0.05$)

^a Concordance: percentage of the agreement

^b Correlation coefficient: Spearman correlation coefficient

IQR = interquartile range

Discussion

Our results show that the direction of sensory block assessment affected the results of the assessment. Sensory block levels to ice assessed with the stimulus applied from an anesthetized area to a nonanesthetized area were lower than when assessed with the stimulus applied in the opposite direction. The sensory block levels to cold assessed from an anesthetized to a nonanesthetized area were strongly correlated with the levels assessed from a nonanesthetized to an anesthetized area; however, the agreement between the levels was poor/fair. At this time, we cannot offer a physiologic pathway to explain the differences observed with both methods.

We have also identified two different gradations or depths of perception to cold, one indicating some change in perception to cold (upper sensory block level), the other indicating complete block to cold sensation (lower sensory block level). It is very likely that these different sensory block levels translate to different densities or intensities of sensory block. Mowat *et al.* have shown that the spread of the local anesthetic mixture tends to be more circumferential closer to the injection point, and more erratic and noncircumferential as the epidural mixture travels away from the injection point.⁹ It is possible that the upper and lower sensory block levels correspond to these different patterns of spread of the local anesthetic, with different implications for analgesia and sympathetic block. The difference between the upper and lower sensory block in our study ranged from two to four segments. It is very important that clinical and research protocols clearly define the sensory block assessment, as they might have different clinical implications. Further studies are warranted to understand such clinical implications.

Our findings provide an important step towards standardizing the assessment of sensory block levels during epidural analgesia for labour. The literature clearly indicates the need for standardization of methods, including stimuli and endpoints. If a study, for example, states that sharp pinprick was used to assess the block, there could be four possible endpoints: 1) total loss of all sensation to the pinprick; 2) the pinprick is recognized as a touch sensation but is not recognized as being sharp; 3) the pinprick is recognized as being sharp but is less sharp than normal; and 4) the pinprick feels normal. Considering these four possibilities, a wide number of dermatomes could be obtained and documented as sensory block level.⁶ Furthermore, even if there was agreement on where a block spreads, not everyone may record it in the same way. Russell has suggested that a block is best described as “up to and including a certain dermatome”, but this concept is not usually applied in daily practice. This lack of standardization may result in a difference of several

dermatomes in the level that two different assessors might record for the same block in the same patient.¹⁰ Russell has also emphasized the importance of investigators describing in detail the exact method used to determine sensory block levels to facilitate comparisons between results from different publications.¹⁰ Our study further emphasizes this recommendation.

Our study has some limitations. First, our sample size was small. Nevertheless, the fact that the two methods were tested on the same patient with blinded observers reduces the chance of bias due to a small sample size. Second, we tested sensory block to ice in a plastic bag, which may introduce some confounder in the assessment, given that we are also producing touch and pressure; these confounders may limit the precision with which our study may be reproduced.

We conclude that, while assessing the sensory block level to ice in patients undergoing epidural analgesia during labour, the direction of the assessment should be standardized, as assessment in opposite directions results in different sensory levels. Given the small difference detected with both methods, it may be acceptable to use either in clinical practice. Nevertheless, the lack of standardization may have a significant impact when comparing studies involving assessment of sensory block.

Author contributions Eliane Soares, Mrinalini Balki, Kristi Downey, and Jose Carlos A. Carvalho contributed to all aspects of this manuscript, including study conception and design; acquisition, analysis, and interpretation of data; and writing the manuscript. Xiang Y. Ye contributed to study conception and design, analysis of data, and writing the manuscript.

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