Original Article

The correlation of antepartum upper extremity cuff algometry with epidural analgesic requirements for labor

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Abstract

Background: Individual parturients experience pain differently, and it is unknown how these differences affect their requirements for labor analgesics.

Materials and Methods: Cuff algometry of the upper limb was used to determine the pain thresholds and temporal summation of pain scores in nulliparous women about to undergo induction of labor. Analgesia was provided, upon request, with a patient controlled epidural analgesia infusion of bupivacaine and fentanyl. Nurse-administered epidural boluses of bupivacaine or lidocaine were given for breakthrough pain. Partial Spearman correlations were used to correlate the cuff algometry measurements with the amount of analgesic medication required by the patient.

Results: There was no significant correlation between any of the algometry measurements and the number of patient or nurse administered bupivacaine boluses. There was a correlation of 0.7 ($P = 0.001$) between the temporal summation scores and the hourly number of nurse-administered epidural lidocaine boluses; however, this was based on only 3 patients who required lidocaine boluses.

Conclusions: The use of pre-labor cuff algometry of the upper limb does not correlate with the patient epidural analgesic requirements and subsequent analgesia administration.

Key words: Cuff algometry, epidural analgesia, pain tolerance

Introduction

Pain is a fundamental part of the labor experience, and individuals have different pain tolerances. It is possible that a patient with lower pain tolerance will have higher labor analgesic requirements; however, this is yet unknown. A simple, easily accepted, quantitative sensory test that could be used to predict labor analgesia requirements would be useful in the stratification and management of patients at higher risk. There are multiple quantitative sensory tests that are available; however, many are complicated, expensive, or would have a low acceptance in the pregnant population. Cuff algometry is a described method of quantitative sensory testing.[1] A cuff with an inflatable bladder is placed circumferentially around a limb, and is progressively inflated to determine the pain threshold and tolerance of an individual. We wished to explore if the pain thresholds as measured with cuff algometry could predict analgesic medication requirements for labor.

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Materials and Methods

Institutional research ethics board approval and written informed consent was obtained. Included patients were nulliparous women presenting for induction of labor with a gestational age of 38 weeks or greater. We excluded women in whom contractions had already commenced, who had received any pain medication in the previous 48 hours, who carried multiple gestations, who had known fetal or placental abnormalities, with pregnancy induced hypertension requiring magnesium treatment, who had an American Society of Anesthesiologist's classification greater than 2, and who were diagnosed with any chronic pain syndrome.

Before induction of labor was commenced, the patients underwent the cuff algometry pain assessment. All the tests

were performed by either the principal author or by a research assistant, who had both performed the initial tests together to ensure the uniformity of the procedures. A 61 x 10 cm single bladder dual port tourniquet cuff (Zimmer Inc. Warsaw, IN) was attached to the bulb and manometer of a standard sphygmomanometer (AMG Medical, Montreal, QC). After explaining the procedure to the patient, the pain threshold was measured by placing the cuff on the bicep of the patient's dominant arm, rapidly inflating it to a pressure of 60 mm Hg, and then inflating at a rate of 5 mm Hg per second until the patient felt the sensation as starting to be painful. This pressure was recorded, the cuff was deflated, and the patient was given a two minute rest period. This was repeated for a total of three measurements. To allow the patient to use their dominant arm to place marks on a 100 mm visual analogue scale (VAS), the cuff was then placed on the bicep of the patient's non dominant arm, and rapidly inflated to a pressure of 180 mm Hg for 90 seconds. The patient was asked to mark the level of her pain at the start and at the end of the 90 seconds. The difference between these two values was considered the patient's temporal summation score.

All the staff caring for the patients remained uninformed of the results of the pain assessment. Labor and induction was managed as seen fit by the attending obstetrician. Cervical ripening, if performed, was achieved with vaginal dinoprostone. Uterine contractions were maintained and augmented with intravenous oxytocin, starting at 2 milliunits/hour, and increasing by 2 milliunits/hour every 30 minutes as required.

Labor analgesia was managed according to our institutional practice. Epidurals were placed at the request of the patient. Twenty gauge multi orifice epidural catheters were placed in the lumbar epidural space using a 16G Tuohy needle. Epidurals were initially bolused with either 10 ml of 0.125% bupivacaine and 50 mcg of fentanyl, or with 15 ml of 0.125% bupivacaine with no fentanyl, according to the routine practice of the attending anesthesiologist. The catheters were connected to a patient controlled epidural analgesia (PCEA) pump, which infused a 0.06% bupivacaine solution containing 2 mcg/ml of fentanyl at 10 ml/hour, and was programmed to deliver a 5 ml demand dose with a lockout of 10 minutes. If at any point the patient requested additional analgesia, and the patient had received more than 2 PCEA boluses in the preceding hour, nurses used ice to verify the dermatomes that were anesthetized. Epidural catheters with evidence of unilateral blockade where pulled back 1 to 2 cm, and 5 ml of 0.125% bupivacaine was administered to the patient. This bolus was not included in the analysis of medication requirements. Epidural catheters with no evidence of blockade, with a unilateral blockade of less than 2 dermatomes, or those that remained unilateral after 30 minutes of being pulled back, were considered non-functional, and replaced. All replaced epidural catheters were excluded from the analysis. If the ice test revealed bilateral epidural blockade, nurses administered a 10 ml epidural bolus of 0.125% bupivacaine containing 2 μg/ml of fentanyl. If 30 minutes after this bolus the patient did not feel her pain was adequately relieved, she was given a nurse administered epidural bolus of 8 ml of 2% lidocaine. The nurse could give bupivacaine or lidocaine boluses every 2 hours if the pain had been relieved by the lidocaine bolus but remained unrelieved by the PCEA pump solution. The patients' demographic data and obstetrical histories were recorded, together with methods of induction and medical management. Labor and neonatal outcomes were also recorded. After delivery, the total number of PCEA, bupivacaine and lidocaine boluses the patient had received were recorded. These were then divided by the number of hours the epidural was utilized, to give an hourly rate of medication usage. The day after delivery, the patients were asked to rate their satisfaction with the management of their labor pain using an 11 point verbal scale, with 0 being not satisfied and 10 being completely satisfied. Our sample size was calculated using StatsDirect version 2.7.8 (StatsDirect Ltd, England). Our primary outcome measure was the correlation of the temporal summation scores with the hourly number of PCEA bupivacaine boluses used. To achieve a correlation coefficient of at least 0.5, with α of 0.05 and β of 0.8, we calculated that 30 patients would be required. Descriptive characteristics of the patients were summarized, and partial Spearman correlations, controlling for maternal age, height, weight, gestational age, neonatal weight, cervical dilation at epidural request, and the maximum oxytocin dosage, were performed. We used Statistical Package for Social Sciences (SPSS) statistics version 19 (SPSS Inc., Chicago, IL) for the data analysis.

Results

From April 2010 until November 2011, we recruited 30 nulliparous patients. Demographic, obstetrical, and neonatal data are presented in Table 1. The mean (standard deviation) pain threshold and temporal summation scores were 199 (60) mm Hg and 15 (11) respectively. All patients requested and received an epidural. One epidural provided a unilateral block, which did not improve after being pulled back, and was excluded. One epidural catheter stopped providing a blockade several hours after placement, was found to be dislodged, and was excluded. One epidural catheter, for unknown reasons, did not provide adequate dermatome blockade one hour after placement, and was excluded. The correlations between mean the pain threshold and the temporal summation score with epidural analgesic medication usage and with patient satisfaction are presented in table 2. There

was no correlation of pain threshold or temporal summation with our primary outcome, which is the number of PCEA boluses. However, there was a significant correlation found between the temporal summation score and the hourly number of nurse administered lidocaine boluses, even after controlling for maternal age, height, weight, parity, gestational age, neonatal weight, maximum oxytocin dose, and the cervical dilation at which the patient received the epidural. This relation was based on only 3 patients who required lidocaine boluses [Figure 1].

Discussion

Pain sensation in the pregnant population has been previously studied. Pressure pain tolerance in pregnancy has been shown to increase during labor, and remain elevated until after birth. [2] Term pregnant women are more likely to have an increased tolerance to heat induced pain as compared to controls.[3] However, little is known about how individual pain tolerances affect labor analgesia. We devised this present study to assess methods that could be used to explore the relationship between pain tolerance and the requirements for analgesic medications in epidural labor analgesia.

Table 1: Demographic, Obstetrical and Neonatal Data for the Patients (n=30) included in the study

Age (years)	32 (5)
Body Mass Index (kg/m^2)	29 (5)
Gestational Age (days)	284 (8)
Gravidity	1 (0[3])
Induction Reason	
Post dates	18(60%)
Decreased amniotic fluid	3 (10%)
Decreased fetal movements	2 (6%)
Diabetes	2 (6%)
Hypertension	2(6%)
Other	3 (10%)
Received dinoprostone	16 (53%)
Maximum oxytocin dose (milliunits/min)	14 (7)
Cesarean delivery	4 (13%)
Neonatal weight (g)	3424 (416)
Cervical dilation at epidural	3(2[8])
Pain Score before epidural	7(4[10])

Results presented as mean (standard deviation), median (interquartile range[range]), or number (%).

There are multiple methods to test for pain tolerance, including stimulation with electricity, pressure, heat, ice water, or Von Frey hairs. All tests have their limitations.[4] Heat pain threshold testing requires the use of an electric thermode apparatus, which is expensive to acquire. The use of von frey hairs are more appropriate for measuring the abnormal pain sensation, including areas of hyperalgesia. The use of a cold pressor test, where an extremity is placed in an ice water bath, may not be readily accepted by the pregnant population. We chose to test cuff algometry because it is easy to use, inexpensive, and readily accepted by patients. Previous studies of cuff algometry have placed the cuff on the calf of the patients.[1,5] For the ease of testing, and for acceptance by the patient, we chose to place the cuff on the arm. To test temporal summation we chose 180 mm Hg because it was thought that this pressure would provide a painful stimulus without posing undue risk to the pregnant patient. We chose to keep this pressure for 90 seconds because it has been shown that the pain score at this point is often higher than the initial pain score.[5]

Cuff algometry as utilized in this study does not predict the number of PCEA boluses required by patients, which was our primary outcome. A relationship was found between the temporal summation scores and hourly number of lidocaine boluses, but this was based on 3 patients, and

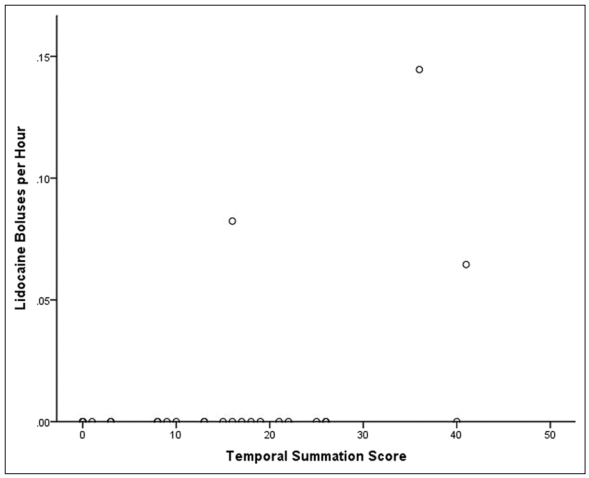

Figure 1: Scatterplot of temporal summation scores and the number of nurse administered Lidocaine boluses per hour as seen in the study

Table 2: Partial spearman correlations between mean pain threshold, temporal summation pain score, and epidural analgesic requirements, controlling for maternal age, maternal height, maternal weight, neonatal weight, cervical dilation at epidural, total days gestation and maximum oxytocin dose as seen in the study

	Mean pain threshold	Temporal pain summation score
Patient controlled epidural boluses per hour	-0.07 (P = 0.8)	-0.082 (P = 0.7)
Nurse bupivacaine bolus per hour	0.30 (P = 0.2)	-0.12 (P = 0.6)
Nurse lidocaine boluses per hour	0.02 (P = 0.9)	0.706 (P = 0.001)
Patient satisfaction with pain management	0.88 (P = 0.32)	-0.32 (P = 0.2)

must be interpreted with caution. There are limitations to this study. We chose a test that has been validated for the leg; however, we used it on the arm, mainly for simplicity and acceptance by the pregnant population. Cuff algometry was also originally described using a computer system for inflation, which we did not use. These modifications used in this study may have weakened the test's ability to predict the analgesic requirements. The continuous PCEA infusion of 10 ml per hour may also be a limitation of this study. A lower infusion rate may have increased the number of PCEA boluses required in all the patients, and led to a larger difference in the patients with higher pain scores. We chose to use an infusion rate of 10 ml per hour as this is our current clinical practice.

Even taking these limitations into account, it seems that the use of cuff algometry, in this form, is not helpful in studying the relationship between the pain tolerance and the labor pain requirements. It may be that this test might predict the requirement for stronger local analgesic medications, like 2% lidocaine; however, this study was not powered to make that conclusion. The study of the interaction of pain tolerance and labor analgesic requirements is important, and further methods of pain sensation assessment should be examined.

References

1. Polianskis R, Graven-Nielsen T, Arendt-Nielsen L. Computer-controlled pneumatic pressure algometry--A new technique for quantitative sensory testing. Eur J Pain 2001;5:267-77.
2. Ohel I, Walfisch A, Shitenberg D, Sheiner E, Hallak M. A rise in pain threshold during labor: a prospective clinical trial. Pain 2007;132 Suppl 1:S104-8.
3. Carvalho B, Angst MS, Fuller AJ, Lin E, Mathusamy AD, Riley ET. Experimental heat pain for detecting pregnancy-induced analgesia in humans. Anesth Analg 2006;103:1283-7.
4. Staahl C, Drewes AM. Experimental human pain models: A review of standardised methods for preclinical testing of analgesics. Basic Clin Pharmacol Toxicol 2004;95:97-111.
5. Polianskis R, Graven-Nielsen T, Arendt-Nielsen L. Spatial and temporal aspects of deep tissue pain assessed by cuff algometry. Pain 2002;100:19-26.

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