Identification of the Lumbar Interspinous Spaces: Palpation Versus Ultrasound

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BACKGROUND: Palpation has been shown to be inaccurate at identifying lumbar interspinous spaces. Our goal in this study was to compare ultrasound imaging of the region to palpation.

METHODS: Using ultrasound in the postpartum period, we estimated the interspinous level used for obstetric neuraxial anesthesia in 121 women and compared this estimation with the level estimated by palpation and documented in the chart by the anesthesiologist.

RESULTS: In 67 of 121 (55%) patients, the vertebral level of the puncture mark documented by the treating anesthesiologist was in agreement with vertebral level as assessed using ultrasound, and in 39 (32%) women, the skin puncture level was estimated by ultrasound to be at least one interspace higher. The unweighted kappa was 0.08 (95% confidence interval: 0.02, 0.14).

CONCLUSIONS: There was poor agreement between palpation and ultrasound estimation of the specific lumbar interspace, and when there was disagreement, the ultrasound estimate was more often higher than the palpitation estimate. (Anesth Analg 2008;106:538-40)

Cesarean deliveries are primarily performed under neuraxial anesthesia,¹ however, neuraxial anesthesia is not without risk. Transient and permanent neurological deficits may occur as a result of direct trauma from a spinal or epidural needle to a low-lying spinal cord, or as a result of an inadvertent high needle placement.^{2–4} Palpation, using anatomical landmarks, has repeatedly been shown to be inaccurate at identifying lumbar vertebrae and their corresponding interspaces.^{5–7} The aim of this study was to compare the level of the vertebral interspace estimated by palpation to that estimated using ultrasound.

METHODS

The study was approved by the local research ethics board. All postpartum women at Mount Sinai Hospital, Toronto, Canada who had received epidural or spinal analgesia or anesthesia were eligible to participate in the study. Subjects were enrolled on the day of delivery or the first day postpartum from March to June 2006. After giving informed written

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consent, the backs of subjects were examined to identify the puncture site of the spinal or epidural needle. Subjects with more than one skin marking were excluded from further analysis, as we were unsure which puncture mark corresponded with the interspinous level documented in the medical record. All subjects had the neuraxial procedure and the lumbar ultrasound performed in the sitting position. A Sonosite Titan 2-5 MHz (Sonosite Canada) curved ultrasound probe was placed over the sacral area in the transverse axis. Using the top of the buttock crease as a starting point, the probe was moved in a cephalad direction to identify the cephalic or upper end of the sacrum, and the spinous process of each lumbar vertebra. If the interspace could not be conclusively identified, the probe was moved in a caudal direction from the 12th vertebral body (T12). A single anesthesiologist (R.W.), blinded to the interspace documented in the anesthetic record, performed the ultrasound examinations and estimated the interspinous space beneath the needle puncture site.

The interspinous space identified by palpation by the clinician who performed the neuraxial procedure was recorded from the anesthetic record. The primary outcome was the level of agreement between the lumbar interspinous space identified by ultrasound and that identified by palpation using the puncture mark as a reference point. Secondary outcomes included the duration of the ultrasound examination and pain experienced by the subject during the ultrasound examination (none, mild, moderate, or severe). Additional recorded information included the clinical experience of the anesthesiologist (resident, fellow, or attending physician), the subject's Body Mass Index, type of neuraxial anesthetic technique (spinal or epidural), and time of day the neuraxial procedure was performed (0001–0800, 0801– 1600, 1601–2400 h).

Data were examined using STATA (version 8.0, STATA Corporation, TX) with the primary outcome, measure of agreement between palpation and ultrasound estimation of the lumbar interspinous space, estimated using the kappa statistic. Weightings were assigned to indicate the importance of disagreements between the two methods, with increasing weights given to levels separated by more than one interspace.8 Simple descriptive statistics were used to summarize continuous and categorical variables. Identification of variables associated with agreement between clinical palpation and ultrasound determination were assessed by logistic regression analysis. Individual variables were first modeled with agreement as the dependent variable. Multivariate analysis was done to adjust for the effect of individual variables and assess the predictive ability of the full model to predict agreement between the ultrasound and palpation techniques.

Statistical significance for kappa measurement was defined as P < 0.05, and the Bonferroni correction was used to determine significance in secondary outcomes. Sample size estimation was calculated around the assumptions that ultrasound determination of the correct level was 70% accurate⁹ and that clinical palpation was 30% accurate,⁵ with type I and type II errors of 5% and 20%, respectively.¹⁰ The sample size estimation required 122 patients and 143 were enrolled to account for subject dropout.

RESULTS

One hundred forty-three women consented to participate in the study; however, three women were excluded because their medical records were incomplete, and 19 subjects had multiple insertion needle marks on their back. One hundred twenty-one subjects whose records were complete were included in the study. Most study participants (68%) received epidural analgesia for labor, with the remainder receiving spinal anesthesia for elective cesarean delivery. Table 1 describes the demographic details of the study population and anesthesia providers.

The level of the puncture mark documented by the anesthesiologist was in agreement with the level estimated by postpartum ultrasound in 67 (55%) subjects (Fig. 1). The expected level of agreement by chance was 52% resulting in an unweighted kappa of 0.08 (95% confidence interval: 0.02, 0.14). In 39 women (32%), the skin puncture level was estimated by ultrasound to be at least one interspace higher than the level documented in the anesthetic record, and in 15 women (12%), the ultrasound interspace estimation

Table 1. Demographic Data

	Summary
Variable	measure
Body Mass Index (kg/m ²)	28 (±5)
Level of anesthesiologist's experience*	
Resident	49/118 (42%)
Fellow	37/118 (31%)
Attending	32/118 (27%)
Timing of regional administration	. ,
0001–0800	28/121 (23%)
0801–1600	65/121 (54%)
1601–2400	28/121 (23%)
Type of regional anesthetic	
Épidural	82/121 (68%)
Spinal	39/121 (32%)

Values are mean (\pm sd) or number (%).

* Level of experience of the anesthesia provider was unclear from three anesthetic records.



Figure 1. Comparison of interspinous levels estimated by palpation and by ultrasound examination. The numbers in the circles describe the number of subjects and the dotted line is the line of agreement between the two techniques.

was lower than the documented level. Variables evaluated by univariate and multivariate logistic regression were not associated with agreement between the two techniques. These included Body Mass Index (P = 0.33), time of day (P = 0.14), epidural versus spinal technique (P = 0.47), or level of experience of the anesthesiologist (P = 0.11). The mean (\pm sD) time to perform the ultrasound was 192 \pm 60 s. Most women described no pain (79%) or mild pain (17%) during the ultrasound examination.

DISCUSSION

In this study, the vertebral level identified by ultrasound agreed with the anesthesiologist's recorded level in just over 55% of the cases. If there was disagreement, the ultrasound level was usually higher than the level described by palpation. Although we did not compare palpation and ultrasound to a "gold standard" imaging technique (e.g., radiograph), our findings agree with other studies which have found that clinicians select interspaces that are one or two spaces higher than their intended selected space.^{5,11,12}

There is appropriate concern of neurological injury with using interspaces above L3/4, as magnetic resonance imaging studies have demonstrated that the conus medullaris may extend as low as the upper body of L3.^{3,13–15} Ultrasonography may be more accurate than palpation in correctly identifying lumbar interspaces. Watson et al.⁹ performed a study to determine the accuracy with which a single anesthesiologist could identify the L3/4 interspace using ultrasonography in nonpregnant subjects in the sitting position. Using ultrasound, the anesthesiologist who had received minimal instruction correctly identified the L3/4 interspace in 13 of 17 (76%) cases. With lumbar radiograph as the standard, Furness et al.¹⁶ showed that the correct intervertebral level was identified in 71% of 50 cases using ultrasound in nonpregnant subjects compared with a 30% success rate with palpation.

Limitations of this study include the fact that the ultrasound examination was performed in the postpartum period. It is possible that the puncture mark may have moved relative to the interspinous space. In addition, the ultrasound technique did not account for the possibility of fused or extra vertebrae. In future studies, both the longitudinal and transverse ultrasound approaches should be assessed. Although the results of our study, together with previous studies in nonobstetric subjects,^{9,16} suggest that ultrasonography may improve the accuracy of interspinous space estimation, a study comparing ultrasonography to a gold standard imaging technique is necessary to confirm the utility of ultrasonography for interspinous space estimation in the obstetric setting.

REFERENCES

1. Gaiser RR. Changes in the provision of anesthesia for the parturient undergoing cesarean section. Clin Obstet Gynecol 2003;46:646–56

- Hamandi K, Mottershead J, Lewis T, Ormerod IC, Ferguson IT. Irreversible damage to the spinal cord following spinal anesthesia. Neurology 2002;59:624–6
- 3. Reynolds F. Damage to the conus medullaris following spinal anaesthesia. Anaesthesia 2001;56:238–47
- 4. Ahmad FU, Pandey P, Sharma BS, Garg A. Foot drop after spinal anesthesia in a patient with a low-lying cord. Int J Obstet Anesth 2006;15:233–6
- 5. Broadbent CR, Maxwell WB, Ferrie R, Wilson DJ, Gawne-Cain M, Russell R. Ability of anaesthetists to identify a marked lumbar interspace. Anaesthesia 2000;55:1122–6
- 6. Ievins FA. Accuracy of placement of extradural needles in the L3–4 interspace: comparison of two methods of identifying L4. Br J Anaesth 1991;66:381–2
- 7. Van Gessel EF, Forster A, Gamulin Z. Continuous spinal anesthesia: where do spinal catheters go? Anesth Analg 1993;76:1004–7
- 8. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159–74
- 9. Watson MJ, Evans S, Thorp JM. Could ultrasonography be used by an anaesthetist to identify a specified lumbar interspace before spinal anaesthesia? Br J Anaesth 2003;90:509–11
- Cantor AB. Sample-size calculations for Cohen's Kappa. Psychol Methods 1996;1:150–3
- Schlotterbeck H, Schaeffer R, Touret Y, Diemunsch PA. Ultrasonographic control of the puncture level of spinal anesthesia in obstetrics. ASA Abstract, A579. 2005
- Lirk P, Messner H, Deibl M, Mitterschiffthaler G, Colvin J, Steger B, Rieder J, Keller C. Accuracy in estimating the correct intervertebral space level during lumbar, thoracic and cervical epidural anaesthesia. Acta Anaesthesiol Scand 2004;48:347–9
- Rajakulendran Y, Rahman S, Venkat N. Long-term neurological complication following traumatic damage to the spinal cord with a 25 gauge whitacre spinal needle. Int J Obstet Anesth 1999;8:62–6
- Saifuddin A, Burnett SJ, White J. The variation of position of the conus medullaris in an adult population. A magnetic resonance imaging study. Spine 1998;23:1452–6
- Soleiman J, Demaerel P, Rocher S, Maes F, Marchal G. Magnetic resonance imaging study of the level of termination of the conus medullaris and the thecal sac: influence of age and gender. Spine 2005;30:1875–80
- Furness G, Reilly MP, Kuchi S. An evaluation of ultrasound imaging for identification of lumbar intervertebral level. Anaesthesia 2002;57:277–80