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Multiport Epidural Catheters

Does the Air Test Work?

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Background: **Multiport epidural catheters are popular; however, the reliability of the air test has not been evaluated with this catheter design. The authors determined the effectiveness of aspirating for blood and the air test in detecting intravascular multiorifice epidural catheters.**

Methods: **Three hundred women in labor underwent placement of a blunt-tip, three-hole, 20-gauge, lumbar epidural catheter. If there were no signs of spinal anesthesia, 3 ml lidocaine or bupivacaine was injected and the patient was observed for signs of spinal anesthesia. If there were no signs of spinal anesthesia, the authors injected 1 ml air through the epidural catheter while listening to the maternal precordium using a Doppler fetal heart rate monitor. Catheters through which blood was aspirated were air-tested and replaced. Patients with air–test-positive, blood–aspiration-negative catheters received 100 mg lidocaine through the catheter and were questioned about toxicity symptoms. The authors injected bupivacaine–fentanyl through aspiration-negative,air–test-negative catheters and recorded the sensory analgesic level 20 min later.**

Results: **The authors aspirated cerebrospinal fluid through one catheter and documented intravascular placement in 11 catheters. Results of the air test and blood aspiration were positive for eight catheters. Blood could not be aspirated from one air–test-positive catheter; perioral numbness developed in the patient after lidocaine injection. Blood was freely aspirated from two air–test-negative catheters. In the remaining 288 catheters, bupivacaine–fentanyl injection produced epidural analgesia in 279 patients and no effect in 9 patients.**

Conclusions: **The authors obtained false-negative results with both catheter aspiration and the air test. Fractionating the local anesthetic dose is important when using multiorifice epidural catheters. (Key words: Epidural test dose; obstetric anesthesia.)**

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THE most popular epidural catheter design in the United States has a blunt tip and three laterally placed holes (C. DiBase, B. Braun Medical, Inc., Bethlehem, PA; personal communication, December 9, 1997). However, most studies of epidural test-dose effectiveness have evaluated single-orifice catheters only.[1,2] We previously showed that the air test (listening for Doppler evidence of intracardiac air while injecting air 1 to 2 ml through the epidural catheter) reliably detects intravascular single-orifice epidural catheters in women in labor.[2] Because the sensitivity and specificity of the air test may change with catheter design, we performed the current study to determine whether the air-test reliably detects intravascular multiorifice epidural catheters.

Methods

Three hundred women in labor requesting epidural analgesia gave oral consent and participated in this study, which was approved by the Thomas Jefferson University Institutional Review Board. Patients sat while we used the air loss-of-resistance technique to identify the epidural space at the L2–L3 or L3–L4 interspace using an 18-gauge Hustead needle. The study was dis-

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Table 1. Catheter Testing Results

	n	Action Taken
No. enrolled patients	300	Lumbar epidural catheter inserted
+ CSF aspiration	1	Catheter replaced
+ Spinal anesthesia after 3 ml 2% lidocaine	0	—
No. catheters air and aspiration tested	299	
+ Air, + aspiration	8	Seven catheters were replaced; one catheter was withdrawn 2 cm; aspiration and air tests were then negative; bupivacaine/fentanyl produced epidural block
+ Air, − aspiration	1	Lidocaine 100 mg injected; patient developed perioral numbness; catheter replaced
− Air, + aspiration	2	Catheters replaced
− Air, − aspiration	288	Catheters injected with bupivacaine/fentanyl
No. catheters injected with bupivacaine/fentanyl	288	
Epidural anesthesia established	279	Catheters provided labor analgesia
No epidural anesthesia established	9	Catheters replaced

CSF = cerebrospinal fluid.

continued if cerebrospinal fluid flowed or could be aspirated through the epidural needle. We threaded a blunt-tip, three-orifice, 20-gauge, polyamide epidural catheter (B. Braun Medical) 5 cm into the epidural space and taped the catheter to the patient's back while she was sitting. We attempted to aspirate blood or cerebrospinal fluid from each catheter. If no fluid could be aspirated, we injected 3 ml lidocaine, 2%, or 3 ml bupivacaine, 0.25%, waited 3 min, and questioned the patient about changes in lower extremity sensation and motor strength. If we aspirated cerebrospinal fluid or obtained signs of spinal anesthesia with local anesthetic injection, we documented intrathecal placement, performed no further testing, and managed the catheter as clinically appropriate.

We performed an air test on all nonintrathecal catheters using a previously described technique.[2] Briefly, we placed the Doppler probe of a Hewlett Packard (Palo Alto, CA) HP8040A fetal heart rate monitor over the lower maternal sternum (*i.e.*, over the right ventricle) and positioned the probe so clear maternal heart sounds could be heard. We injected 1 ml air through the epidural catheter and listened for maternal heart sound changes for 15 s. We considered the air-test result to be positive if a loud swishing sound, lasting at least 5 s, was heard in addition to or in place of the normal "lub-dub" heart sounds. Because the increased circulating blood volume during a uterine contraction can change maternal heart sounds, we repeated the air test if the patient's uterus contracted during the observation period. If no blood was aspirated and no heart tone changes were heard, we injected 10 ml bupivacaine, 0.125%, with 50 μg fentanyl. We recorded whether a sensory analgesic band was present 20 min after epidural injection. If a sensory band was present, we continued epidural analgesia by continuously infusing 8–12 ml/h bupivacaine, 0.05%, with 1.45 μg/ml fentanyl and 1:700,000 epinephrine.

Epidural catheters through which blood initially was aspirated were air-tested. If the first air test was negative, the catheter was tested a second time, with the air injected as fast as possible. Then, at the discretion of the attending anesthesiologist, the catheter was either replaced immediately or withdrawn 2 cm and air-tested again. If blood was aspirated or the air test produced heart tone changes after catheter repositioning, the catheter was replaced. Otherwise, we injected the catheter with bupivacaine–fentanyl, as described previously.

If the air test was positive but blood could not be aspirated from the catheter, we injected 5 ml lidocaine, 2%, and questioned the patient about perioral numbness, tinnitus, and diplopia. If the patient reported symptoms of local anesthetic intravenous injection, we replaced the catheter. Otherwise, we injected the catheter with bupivacaine–fentanyl and used the catheter to provide analgesia if an appropriate sensory band developed.

Statistical Methods

If no positive results are obtained in a case series of 300 patients, one can state with 95% confidence that the true incidence of the phenomenon is less than 1%.[3] Therefore, we enrolled 300 patients.

Results

Testing results are summarized in table 1.

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Discussion

We found that neither the air test nor blood aspiration detected all cases of intravascularly placed multiorifice epidural catheters. We previously reported that the air test detected all intravascularly placed single-orifice catheters in a 313-patient case series, suggesting that the air test is more sensitive for detection of single- rather than multiorifice catheters.[2] However, a study showing a difference between 0 and 1% false-negative rates would necessitate approximately 770 patients per group (assuming $\alpha = 0.05$ and $1-\beta = 0.8$).[4]

Blood was aspirated more frequently from multiple- than from single-orifice epidural catheters in three large studies[5-7] and with equal frequency in two studies.[8,9] There may be a higher incidence of vascular cannulation with a multiport design. Alternatively, aspiration may detect a higher fraction of intravenous multiport catheters. Our aspiration results are similar to those of Norris *et al.*,[10] who reported that aspiration was 98% sensitive in detecting clinically evident intravascular multiorifice epidural catheters. However, Beck *et al.*[11] found that aspiration detected only 54% of the intravascular catheters.

One cannot assume that an aspiration-negative, multiorifice catheter lies completely outside the vascular system. Different holes of a multiorifice catheter can be in different body compartments. Beck *et al.*[11] obtained postoperative catheter epidurograms in 113 consecutive nonpregnant patients who underwent placement of multiorifice catheters. Fourteen catheters were located in two body compartments: 13 (12%) epidurovascular and 1 (1%) epidurointrathecal. The one epidurointrathecal and 3 of 13 epidurovascular catheters provided adequate anesthesia for surgery. Blood was never aspirated, no epidural anesthesia developed, and no symptoms of local anesthetic toxicity were elicited after administration of 112 mg bupivacaine and 100 mg etidocaine in 1 of 13 epidurovascular catheters. In the current study, nine catheters showed no signs of epidural, intrathecal, or intravascular placement. The results of Beck *et al.*[11] suggest that some of these catheters may have been at least partially intravascular rather than in an innocuous but ineffective location.

Patients with unrecognized epidurovascular or epidurointrathecal catheters are at risk if a large local anesthetic dose is rapidly injected through a catheter previously used only for low-speed injection. Ward *et al.*[12] reported a fatality during such conditions. In obstetric anesthesia, patients are at risk if a multiport catheter previously used only for continuous infusion labor analgesia is rapidly injected to provide anesthesia for an urgent cesarean delivery. The difficulty of testing multiport catheters underscores the need for careful local anesthetic dose fractionation, even if cesarean delivery is urgently needed.

Differential fluid flow through multiport orifices depends on catheter diameter and injection pressure. At low injection pressures, fluids preferentially exit the most proximal catheter orifice. Above a threshold pressure, flow is similar through all holes. This threshold pressure increases with increasing catheter diameter. Power and Thorburn[13] reported a threshold local anesthetic injection pressure of 133 kilopascals (kPa) for 16-gauge and 93.1 kPa for 18-gauge catheters from the same manufacturer. Because injection pressure increases with injection speed, a test dose is more likely to exit *via* all three ports the more rapidly it is injected.

Air may be an inappropriate multiport epidural catheter test dose. The minimum injection speed for flow through all three holes during air injection is fast (2-4 ml/s).[14] Much slower, and clinically much more practical, injection speeds permit fluid to flow through all three catheter holes (0.006-0.1 ml/s). Even if fluid is the appropriate state of matter, however, the correct fluid test dose must be determined. The effectiveness of epinephrine, local anesthetic, and other fluid test doses has not been adequately tested with multiorifice catheters.

In conclusion, we found that aspiration and the air test detected 91 and 82%, respectively, of clinically evident, intravascularly placed, multiorifice epidural catheters. No false-negative air-test results were obtained in a previous study[14] with single-orifice catheters. Air may be less reliable in multiport than in single-orifice catheters because gases, to a greater extent than liquids, preferentially exit the most proximal catheter hole. Our results underscore the importance of always fractionating the local anesthetic dose when injecting through multiorifice epidural catheters.

References

1. Colonna-Romano P, Nagaraj L: Tests to evaluate intravenous placement of epidural catheters in laboring women: A prospective clinical study. Anesth Analg 1998; 86:985-8

2. Leighton BL, Norris MC, DeSimone CA, Rosko T, Gross JB: The air test as a clinically useful indicator of intravenously placed epidural catheters. ANESTHESIOLOGY 1990; 73:610-3

3. Grayzel J: A statistic for inferences based upon negative results. ANESTHESIOLOGY 1989; 71:320-1

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4. Rosner B: Fundamentals of Biostatistics, 4th edition. Belmont, Duxbury Press, 1994, pp 384

5. Michael S, Richmond MN, Birks RJS: A comparison between open-end (single hole) and closed-end (three lateral holes) epidural catheters: Complications and quality of sensory blockade. Anaesthesia 1989; 44:578-80

6. Morrison LMM, Buchan AS: Comparison of complications associated with single-holed and multi-holed extradural catheters. Br J Anaesth 1990; 64:183-5

7. Dickson MAS, Moores C, McClure JH: Comparison of single, end-holed and multi-orifice extradural catheters when used for continuous infusion of local anaesthetic during labour. Br J Anaesth 1997; 79:297-300

8. D'Angelo R, Foss ML, Livesay CH: A comparison of multiport and uniport epidural catheters in laboring patients. Anesth Analg 1997; 84:1276-9

9. Segal S, Eappen S, Datta S: Superiority of multi-orifice over single-orifice epidural catheters for labor analgesia and cesarean delivery. J Clin Anesth 1997; 9:109-12

10. Norris MC, Ferrenbach D, Dalman H, Fogel ST, Borrenpohl S, Hoppe W, Riley A: Does epinephrine improve the diagnostic accuracy of aspiration during labor epidural analgesia? Anesth Analg 1999; 88: 1073-6

11. Beck H, Brassow F, Doehn M, Bause H, Dziadzka A, Schulte am Esch J: Epidural catheters of the multi-orifice type: Dangers and complications. Acta Anaesthesiol Scand 1986; 30:549-55

12. Ward CF, Osborne R, Benumof JL, Saidman LJ: A hazard of double-orifice epidural catheters. ANESTHESIOLOGY 1978; 48:362-4

13. Power I, Thorburn J: Differential flow from multihole epidural catheters. Anaesthesia 1988; 43:876-8

14. Leighton BL, Katsiris SE, Halpern SH, Wilson DB, Kronberg J: Multiport epidural catheters: Can orifice location be tested? ANESTHESIOLOGY 2000; 92:1840-2

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