Epidural analgesia using loss of resistance with air versus saline: Does it make a difference? Should we reevaluate our practice?

CDR David Norman, CRNA, MSN, NC, USN
Chesapeake, Virginia

Introduction

Epidural analgesia is a very popular method of pain control for laboring parturients. The most common method for determining entry into the epidural space is the loss-of-resistance (LOR) technique. During the LOR technique, 2 to 5 mL of air or saline is drawn into the syringe, and continuous or intermittent pressure is applied to the plunger as the epidural needle is advanced toward the epidural space.1 On entry into the epidural space, the syringe contents are injected due to a loss in resistance. Air and saline are the most widely used substances in the LOR technique syringe.1 Both are used commonly; the decision derives mostly from personal preference.1 The purpose of this literature review is to examine our practice and determine whether both air and saline are equally safe and efficacious or whether anesthesia providers may need to consider changing the substance used in their practice.

The incidence of backache (approximately 30%) and postdural puncture headaches (up to 50% in parturients experiencing an inadvertent dural puncture) during an epidural insertion, are both considered common.2,3 Such complications as permanent nerve injury, systemic toxic effects of drugs, and spinal hematomas, fortunately, are rare.2,3 However, addi-
tional complications cited in the following case reports are attributed by the authors to the use of air injected during the LOR technique.

In an early case report, the author attributed a unilateral epidural block in a 64-year-old man undergoing left-sided inguinal herniorrhaphy to 2 mL of air injected during the LOR technique. In a second case, using air in the LOR technique during the epidural insertion in a laboring parturient resulted in inadequate analgesia and was cited by the author as a possible explanation for the patient having unblocked segments. The presence of peridural air was confirmed by radiography during the postpartum period.

Another case report describes a 58-year-old man with acute pancreatitis who was undergoing an epidural block for pain control. The LOR technique was performed with air. Six attempts at 3 intervertebral spaces were required before the successful identification of the epidural space and placement of the catheter. Subcutaneous emphysema along the vertebral column was confirmed by clinical assessment. A computed tomography (CT) scan obtained 4 days after the insertion confirmed the presence of peridural air bubbles. The authors stated that although there were no associated symptoms with the subcutaneous emphysema, it resolved slowly.

One of two patient positions generally is selected for the insertion of an epidural. The decision to use the lateral, or sitting, position usually is based on provider preference. When the sitting position is selected, it must be noted that air injected into the subarachnoid space will rise, resulting in a sudden and often severe headache. Before the invention of CT scans, pneumoencephalograms were used for radiographic examination of the spine and ventricles of the brain. During this procedure, air was injected intentionally into the subarachnoid space at the lumbar region, and radiographs were taken during the ascent of the air into the cerebral ventricles. This created a pneumocephalus, which resulted in a severe headache until the patient was positioned in a head-down position so the air would flow back through the subarachnoid space to the lumbar region, where it was aspirated.

A case report of a 17-year-old parturient receiving an epidural for labor, using the LOR technique with air, describes inadvertent dural puncture with 4 mL of air injected. The patient immediately reported a severe occipital headache. The epidural procedure was repeated with an LOR using saline at the same interspace and was successful. It took 7 days for this patient's headache to resolve.

Pneumocephalus was described in a 25-year-old parturient, “after many attempts” during an LOR technique using air. The epidural was placed for a cesarean section after multiple attempts, and approximately 20 mL of air were injected during these attempts. After injection of 16 mL of 0.5% bupivacaine with 1:200,000 epinephrine, the patient's respiration ceased, blood pressure dropped, and the patient was intubated. The patient remained stuporous postoperatively. A CT scan revealed approximately 25 mL of air in the parietofrontal cerebral cortex. This appeared to resolve within 24 hours, and the patient was discharged from the intensive care unit within 72 hours.

Another case report describes a 30-year-old parturient at term desiring epidural analgesia. The LOR technique with air was used during the insertion. The insertion process, with the patient in the sitting position, was described as uneventful with the “space entered easily.” Upon encountering the LOR, 5 mL of air was injected. The patient described an immediate sense of severe back pain at the needle site that moved up the spine, resulting in a severe neck ache and, finally, a severe bifrontal-temporal headache. The patient became very distressed (“became uncooperative and vociferously complaining that she was experiencing the worst headache of her life”), and an immediate CT scan was obtained to rule out cerebral bleeding. The CT scan revealed approximately 5 mL of air in the intracranial subarachnoid space and basal cisterns. Although no blood or cerebrospinal fluid was encountered during the LOR technique, the symptoms described are classic responses to pneumoencephalography air–related headaches. The patient was returned to the labor suite, and her analgesic needs were managed with intramuscular meperidine until her labor was deemed “failure to progress.” She then received a general anesthetic for a cesarean section. Her surgical and anesthetic courses were uneventful. Her headache resolved fully within 24 hours.

In a case describing the injection of an excessive amount of air during the LOR technique, the author attributed the resulting transient paraplegia to the air. In this case, a 52-year-old woman with chronic back pain was undergoing epidural analgesia. The insertion required 4 attempts, during which an estimated 40 mL of air was injected. After the injection of 20 mL of 0.25% bupivacaine with 80 mg of methylprednisolone plus 20 mL of normal saline, the needle was withdrawn. Eight hours after the injection, the patient complained of persistent left leg numbness and weakness. A CT scan revealed a large amount of extradural air. Her symptoms resolved within 24 hours, and a CT scan 72 hours after the injection revealed that a substantial quantity of the extradural air had been reabsorbed. The authors thought that her symptoms were a result of nerve root compression due to the air. However, it should be noted that 20 mL...
of the bupivacaine-methylprednisolone mixture also was injected into the same space. Since fluid is less compressible than air, might it also have contributed to her symptoms?

Nerve root compression also was described when an epidural pump was used for the management of cancer pain.12 This case is different from the preceding cases because the air was injected inadvertently into the narcotic reservoir by the patient during self-preparation. After a few days, the patient noted increasing back pain and bilateral hip flexor weakness. A CT scan revealed the presence of peridural air. The air was aspirated, and the patient experienced immediate relief.

Neurological damage was described in a case in which a patient received an epidural anesthetic for extracorporeal shock wave lithotripsy.13 An LOR technique with only 2 mL of air was used. Postoperatively, the patient experienced severe pain in the lower back and legs for 2 days that delayed her ambulation. She also experienced tenderness along the lumbar spine and bilateral limited leg mobility due to pain. A CT scan revealed air in the right lateral recesses of S1 and T12. Her pain and limited mobility improved during the next 6 weeks. At 6 weeks she was able to return to work but still experienced some backache and limited motion. The authors felt that the gas gradient between the air bubbles and the tissue may impede or disturb the shock waves. They further recommend that air not be used during the LOR technique during epidural insertion for extracorporeal shock wave lithotripsy.

An article reviewing the risks of air for the LOR technique describes one additional concern,14 the occurrence of a venous air embolism. In addition to citing all of the aforementioned events (back pain, headaches, paresthesias, and incomplete blocks) described in the case reports, the authors state that because the epidural anatomy is a rich plexus of veins, the risk of injecting air intravascularly is present. They cited 2 children and 1 man in whom air was injected and rapid cardiac deterioration followed. The authors stated that a patent foramen ovale may lead to a potentially lethal outcome if a venous air embolism is produced from the injection of air during the LOR technique.

Philip15 conducted a study in which she not only used air during the LOR technique, but also then injected 10 mL of air after confirmation of entry to the epidural space. The purpose of this study was to determine whether the injection of 10 mL of air before insertion of the epidural catheter might reduce the incidence of paresthesias encountered during the insertion of the catheter. She used a sample of 132 parturients, 63 who received 10 mL of air and 69 who did not. In contrast with the events described in the preceding case reports, she found that the incidence of paresthesias reduction was significant (from 49% to 29%) and that there were no complications.

One study found that the use of saline for the LOR technique resulted in the decrease of anesthetic effect.16 This dilutional effect on the local anesthetic injected also resulted in increasing spread of the drug.

Before the mid-to-late 1990s, many anesthesia textbooks described the use of “air or saline” during the LOR technique. Most did not cite a preference for one or the other. However, since the late 1990s many of the leading authors describe the use of saline alone or saline with an air bubble during the LOR technique.1,3 This transition likely is a result of the many case reports cited in the literature.

Only a few studies have compared the use of air and saline during the LOR technique. One study with a sample of 142 parturients in labor, 71 in each of 2 groups, sought to examine whether there was a difference between air and saline in the frequency of unacceptable analgesia.1 The investigators found a lower frequency of inadequate analgesia in the saline group than in the air group.

The aim of another study examining air vs saline for the LOR technique was to determine whether there was any difference in the onset, spread, or character of the epidural analgesia in laboring parturients.17 The sample consisted of 50 parturients, 25 in the air group and 25 in the saline group. The air group experienced an increased incidence of unblocked segments, but there was no difference in the spread of analgesia.

A third study examined air vs saline for the incidence of paresthesias during epidural catheter insertion.18 The sample consisted of 67 parturients, 32 in the air group and 35 in the saline group. The investigators used 10 mL of air or saline during the LOR technique. No significant difference was found between the groups in the incidence of paresthesias. The authors stated that they found no significant difference in analgesia between groups and concluded that the decision to use air or saline during the LOR technique remains a personal choice.

Summary
It is a conservative estimate that during the past 12 to 15 years, hundreds of thousands, if not more than a million epidurals have been placed. With these numbers, the reported cases of complications attributed to the injected substance are rare on a percentage basis. In the majority of the case reports cited, the authors attribute these side effects to air; the symptoms are transient and rarely life-threatening complications. The most current anesthesia literature seems to advocate the use of saline rather than air.

Despite reluctance to change practice based on case
reports, the case reports seem to share 3 common themes. The first is that the side effects reported seem to be related to the volume of air or saline injected. A second is that air remains in the peridural area for not just hours or a day or two as once thought; it often remains for many days. This was confirmed by radiography. In light of this fact, relatively few studies have been conducted to effectively determine whether there really is an increased risk with air or whether there exists a clinically significant scientific reason to advocate the use of one substance over the other. Even though there are just a few studies reported in the literature on this subject, it seems that multiple authors advocate the use of saline rather than air, based primarily on case reports. Finally, the common theory behind the possibility of air as the cause of inadequate or slow analgesia is that air actually impedes the absorption of the local anesthesia molecules.

A literature review on this topic would be incomplete without a review of what the leading anesthesia textbooks have taught during the past 10 to 15 years. A chronology with quotes from their description of the LOR technique is given in the Table.

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>Shnier et al</td>
<td>Loss-of-resistance technique with saline- (or air) filled syringe most commonly used.</td>
</tr>
<tr>
<td>1988</td>
<td>Cousins and Bromage</td>
<td>We prefer the technique of loss of resistance, using an air-filled syringe.</td>
</tr>
<tr>
<td>1990</td>
<td>Brown</td>
<td>The preferred method of carrying out the loss-of-resistance technique includes attaching a 3- to 5-mL glass syringe filled with 2 mL saline and a small (0.25 mL) air bubble.</td>
</tr>
<tr>
<td>1992</td>
<td>Covino and Lambert</td>
<td>The most common method to identify the epidural space is the loss of resistance technique... Usually, a syringe containing saline or air is attached...</td>
</tr>
<tr>
<td>1993</td>
<td>Shnier et al</td>
<td>Loss-of-resistance technique with saline- (or air) filled syringe most commonly used...</td>
</tr>
<tr>
<td>1994</td>
<td>Brown</td>
<td>A 3 to 5 mL low resistance glass or plastic syringe is filled with a small (0.25 mL) air bubble.</td>
</tr>
<tr>
<td>1996</td>
<td>Tetzlaff</td>
<td>Whether to inject saline or air with the loss of resistance technique depends on the preference of the practitioner.</td>
</tr>
<tr>
<td>1997</td>
<td>Bernards</td>
<td>A glass syringe filled with 2-3 mL saline and a small air bubble...</td>
</tr>
<tr>
<td>1998</td>
<td>Molnar and Pian-Smith</td>
<td>A glass or plastic loss-of-resistance syringe containing approximately 3 cc of air or 3 cc of saline...</td>
</tr>
<tr>
<td>1998</td>
<td>Cousins and Veering</td>
<td>We prefer the technique of loss of resistance, using an air-filled syringe.</td>
</tr>
<tr>
<td>1999</td>
<td>Brown</td>
<td>I prefer that the syringe contain both saline and a small (0.25 mL) compressible bubble of air.</td>
</tr>
<tr>
<td>1999</td>
<td>Brown</td>
<td>A 3-5 mL glass syringe is filled with 2 mL saline solution and a small (0.25 mL) air bubble is added.</td>
</tr>
<tr>
<td>2000</td>
<td>Brown</td>
<td>The preferred method of carrying out the loss-of-resistance technique includes attaching a 3- to 5-mL glass syringe filled with 2 mL saline and a small (0.25 mL) air bubble.</td>
</tr>
<tr>
<td>2001</td>
<td>Ellis</td>
<td>The syringe is filled with 3 to 4 mL of air or 3 mL saline and 1 mL of air to facilitate compression of the solution.</td>
</tr>
<tr>
<td>2001</td>
<td>Bernards</td>
<td>A glass syringe or a specially designed low resistance plastic syringe is filled with 2-3 mL saline and a small (0.1-0.3 mL) air bubble.</td>
</tr>
<tr>
<td>2002</td>
<td>Kleinman</td>
<td>A glass syringe filled with approximately 2 mL of fluid or air is attached to the hub of the needle.</td>
</tr>
<tr>
<td>2002</td>
<td>Rosen et al</td>
<td>Loss-of-resistance technique with saline- (or air-) filled syringe most commonly used.</td>
</tr>
</tbody>
</table>
might also be helpful to examine the insertion skills of the provider and the ease or difficulty of the insertion procedure. These 2 variables and others need to be studied and excluded before we can be certain that the injected substance is the cause of the aforementioned complications.

REFERENCES


AUTHOR

CDR David Norman, CRNA, MSN, NC, USN, is on active duty in the Navy, assigned to the Naval School of Health Sciences at Portsmouth Naval Medical Center, Portsmouth, Va. He recently served as the clinical coordinator for the Navy Nurse Corps Anesthesia Program, Portsmouth Va. Norman is a doctoral student at the Frances Payne Bolton School of Nursing, Case Western Reserve University, Cleveland, Ohio.

DISCLAIMER

The material contained in this article and the views of this author in no way represent the views of the US Naval Medical Center Portsmouth, the US Navy, or the US Government.