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Identification of the epidural space : Stop using the loss of resistance to air technique !

M. VAN DE VELDE

Epidural anesthesia is a well established technique which is in use for over a century. Identification of the epidural space is of crucial importance. Several techniques have been proposed such as the “hanging drop” method. With the development of modern loss of resistance (LOR) syringes (glass or more recently plastic) the loss of resistance technique is now by far the most commonly used technique. The 2 most commonly used media are air and saline. The purpose of this text is to review the available literature and evaluate the advantages and shortcomings of both media and determine whether one is superior.

HOW POPULAR ARE AIR AND SALINE ?

In 1993 in the UK, 37% of anesthetists preferred saline as their agent of choice to perform the LOR technique to identify the epidural space (12). In 1998, 500 obstetric anesthetists, all members of the Obstetric Anaesthetists Association, were surveyed regarding their preferred medium for LOR (22). More then 80% of anesthetists responded. A majority first learned a LOR to air technique (59.1%). However, only 37.1% of respondents were still using air, while 52.7% were using saline as their medium of choice for LOR. Most anesthetists preferred to teach a LOR to saline technique to junior colleagues (70.1%). A more recent survey noted that up to 70% were using saline (9). So it seems that more and more anesthetists prefer the LOR to saline technique. Are they right and why ? Let us now evaluate whether various complications associated with epidural anesthesia are more frequent when one or the other medium is used for the LOR technique.

ACCIDENTAL DURAL PUNCTURE

Several investigations demonstrated that the accidental dural puncture rate is significantly higher when air is used to access the epidural space (9, 15, 13, 47, 38, Table 1). Aida *et al*. however could not confirm this (3). Furthermore, Paech *et al*. demonstrated that symptoms of post dural puncture headache developed earlier when air was used (38).

Table 1

Accidental dural puncture rates according to the medium used for LOR

Study and year	ADP rate with air	ADP rate with saline
Stride *et al*. 1993	1.00 %	0.60 %
Gleeson *et al*. 1998	1.11 %	0.69 %
Cowan *et al*. 2001	1.70 %	0.00 %
Paech *et al*. 2001	2.30 %	0.30 %
Evron *et al*. 2004	0.33 %	0.25 %

ADP : accidental dural puncture. * $p < 0.05$ versus air.

DIFFICULTIES UPON INSERTION OF THE EPIDURAL CATHETER/PARESTHESIA

In a prospective trial involving 547 women, Evron et al. reported a 16% incidence of difficult epidural catheter insertion following a LOR with air technique, while in those patients treated with fluid for the LOR only 4% had a difficult catheter insertion (13). Evron *et al.* also showed that with air more inadvertent intravascular insertions of the epidural catheter occurred (13). This was however not confirmed by Beilin *et al*. and Sarna *et al*. who reported a similar incidence of intravascular catheters (43, 6). Beilin *et al*. and Sarna *et al*. were also unable to find a difference in the incidence of paresthesias during epidural catheter insertion between patients treated with saline or patients treated with air (43, 6).

M. VAN DE VELDE, MD, PhD., Department of Anesthesiology, University Hospitals Gasthuisberg
Katholieke Universiteit Leuven, Herestraat 49, B-3000 Leuven, Belgium.
Correspondence address : Marc Van de Velde, MD, PhD., Director Obstetric Anesthesia and Extra Muros Anesthesia, Associate Professor of Anesthesia, Department of Anesthesiology, University Hospitals Gasthuisberg, Herestraat 49, B - 3000 Leuven, Belgium.
Phone : 0032-16 34 42 70. Fax : 0032-16 34 42 45.
E-mail : marc.vandevelde@uz.kuleuven.ac.be

Nerve root compression

Several case reports have described neurologic injury secondary to nerve root compression following identification of the epidural space using LOR to air. Saberski *et al*. performed a literature search and identified a series of case reports, between 1966 and 1995, in which air compressed the spinal cord or nerve roots resulting in prolonged neurologic deficit (42, 8, 10, 20, 26, 33, 35). Fortunately, in only one non-obstetric patient the neurologic injure did not resolve (8). Since this comprehensive report by Saberski *et al*. two further cases of neurologic injury following deliberate or inadvertent injection of air in the epidural space have been reported (17, 39). Again both patients recovered fully. To this author's knowledge no cases of neurologic injury have been reported in which saline was the causative agent.

Incomplete anesthesia

A most irritating complication of epidural anesthesia or analgesia is an incomplete block or patchy pain relief. Dalens et al. and Boezaart et al. reported on several cases of incomplete anesthesia resulting from epidural air bubbles preventing adequate spread of epidural local anesthetic to all nerve roots (7, 11). Stevens *et al*. injected air in the epidural space of chronically instrumented dogs and noted that air bubbles remained for 2 to 3 days in the epidural space often located near the intervertebral spaces (44). Several studies in pregnant women have demonstrated that the LOR with air technique to identify the epidural space produces analgesia of an inferior quality as compared to the LOR to saline technique (6, 13, 49). Valentine *et al*. published the first randomized, double-blind trial comparing analgesia following LOR with air or saline (49). Air led to a greater number of unblocked dermatomes. Beilin et al. noted that with air significantly more patients requested additional analgesia as compared to the use of saline (6). In a large trial Evron *et al*. confirmed the superiority of saline with respect to the quality of analgesia (13). Interestingly, Okutomi and Hoka reported that using large volumes of saline (>10 ml) resulted in less dermatomes blocked as opposed to smaller volumes of saline (36, 37). The authors hypothesized that this was due to a dilutional effect.

Venous air embolism

Venous air embolism following identification of the epidural space using LOR to air can occur whenever a tear occurs in the epidural venous plexus or when the pressure from the air source is higher than the venous pressure. Naulty *et al*. studied in 1982, using trans-thoracic Doppler measurements, 17 ASA I pregnant patients who underwent a rapid injection of 5 ml of air in the epidural space (34). The characteristic Doppler sounds of venous air embolism were heard in 8 out of 17 parturients. In only three patients short-lived mild symptoms of hemodynamic compromise were observed during the episode of embolization.

More serious episodes of cardiovascular compromise following the injection of small volumes of air were reported in three different case reports, two of whom were in children (18, 23, 44).

Headache

Headache following epidural anesthesia can occur as a result of dural puncture. Onset of post dural puncture headache is usually after 1 to 3 days. Since accidental dural puncture occurs more frequently with air as medium for LOR, also PDPH is more frequent with air. However in 1979, Abram reported on a headache with different character (1). Following accidental dural puncture and injection of air in the spinal space, pneumocephalus develops resulting in severe headache with almost immediate onset. Since then numerous case reports have described pneumocephalus and severe headache following LOR with air (2, 4, 5, 14, 16, 19, 21, 24, 25, 27, 28, 29, 30, 31, 32, 41, 45, 48). Several of these reports were in obstetric patients (2, 16, 28, 29, 31, 41). Some of these patients suffered from serious neurologic injury as a result of intrathecal air such as hemiparesis, generalized convulsions, nausea and delayed recovery from general anesthesia. Aida et al. confirmed the role of intrathecal air in a prospective trial comparing air with saline (3). Although dural puncture occurred with a similar incidence in patients treated with air or saline, the incidence of headache was much higher in those patients treated with air (3).

Effect of association of general anesthesia with nitrous oxide

Petty showed that the inhalation of nitrous oxide, as part of general anesthesia, may enlarge epidural air bubbles and thus accentuate their deleterious effects (40).

Reasons not to change

Air-users have various arguments not to change their practice (50s). Air aids with the diag-

nosis of inadvertent dural puncture. This claim does not hold since simple bedside testing can distinguish saline from cerebrospinal fluid. The second argument is that air-users have used air for many years. Changing to saline might increase the dural tap rate during the initial phase of re-training. Whilst this is a valid argument for experienced operators (provided they have low complication rates), surely we should not be teaching trainees the air technique. A final argument comes from those air-users that employ combined spinal epidural anesthesia. They are worried that using saline will complicate identification of the subarachnoid space following deliberate spinal puncture with a pencil point needle. However, this is not a problem as long as small volumes of saline are used for LOR.

Conclusion

The anaesthetic literature abounds with small series, studies and case reports indicating that the LOR to air technique is associated with various complications including incomplete anesthesia, venous air embolism, difficult epidural catheter insertion, inadvertent intravascular position of the catheter, pneumocephalus, headache, neurologic injury, and accidental dural taps. This reviewer is not aware of complications related to the use of saline. It is clear that we should stop training residents to use air as their medium of choice for LOR. Furthermore, experienced anesthesia providers should change their practice to a saline based technique, especially if they perform adequate numbers of epidural blocks each year. The period of retraining perhaps is associated with more dural taps but this should not be a reason not to change.

References

1. Abram S. E., Cherwenka R. W. *Transient headache immediately following epidural steroid injection*. Anesthesiology, **50**, 461-462, 1979.
2. Ahlering J. R., Brodsky J. B. *Headache immediately following attempted epidural analgesia in obstetrics*. Anesthesiology, **52**, 100-101, 1980.
3. Aida S., Taga K., Yamakura T., Endoh H., Shimoji K. *Headache after attempted epidural bloc*k. Anesthesiology, **88**, 76-81, 1998.
4. Ash K. M., Cannon J. E., Biehle D. R. *Pneumocephalus following attempted epidural anesthesia*. Can J Anaesth, **38**, 772-774, 1991.
5. Becker W. J. *Pneumocephalus as a cause for headache*. Can J Neurol Sci, **29**, 278-281, 2002.
6. Beilin Y., Arnold I., Telfeyan C., Bernstein H. H., Hossain S. *Quality of analgesia when air versus saline is used for identification of the epidural space in the parturient*. Reg Anesth Pain Med, **25**, 596-599, 2000.
7. Boezaart A. P., Levendig B. J. *Epidural air-filled bubbles and unblocked segment*s. Can J Anaesth, **36**, 603-604, 1989.
8. Cheng A. C. K. *Intended epidural anesthesia as possible cause of cauda equina syndrome*. Anesth Analg ,**78**, 157-159, 1994.
9. Cowan C. M., Moore E. W. *A survey of epidural technique and accidental dural puncture rates among obstetric anaesthetists*. Int J Obstet Anesth**, 10**, 11-16, 2001.
10. Cuerden C., Buley R., Downing J. W. *Delayed recovery after epidural block in labor. A report of four cases*. Anaesthesia, **32**, 773-776, 1977.
11. Dalens B., Bazin J. E., Haberer J. P. *Epidural bubbles as a cause of incomplete analgesia during epidural anesthesia*. Anesth Analg, **66**, 670-683, 1987.
12. Davies M. W., Harrison J. C., Ryan T. D. R. *Current practice of epidural analgesia during normal labour. A survey of maternity units in the United Kingdom*. Anaesthesia, **48**, 63-66, 1993.
13. Evron S., Sessler D., Sadan O., Boaz M., Glezerman M., Ezri T. *Identification of the epidural space : loss of resistance with air, lidocaine, or the combination of air and lidocaine*. Anesth Analg, **99**, 245-250, 2004.
14. Fedder S. L. *Air ventriculogram serendipitously discovered after epidural anesthesia*. Surg Neurol, **30**, 242-244, 1988.
15. Gleeson C. M., Reynolds F. *Accidental dural puncture rates in UK obstetric practice*. Int J Obstet Anesth, **7**, 242-246, 1998.
16. Gonzalez-Carrasco F. J., Aguilar J. L., Llubia C., Nogues S., Vidal-Lopez F. Pneumocephalus after accidental dural puncture during epidural anesthesia. Reg Anesth, **18**, 193-195, 1993.
17. Gracia J., Gomar C., Riambau V., Cardenal C. *Radicular acute pain after epidural anaesthesia with the technique of loss of resistance with normal saline solution*. Anaesthesia**, 53**, 166-171, 1993.
18. Guinard J. P., Borboen M. *Probable venous air embolism during caudal anesthesia in a child*. Anesth Analg ,**76**, 1134-1135, 1993.
19. Harrel A. E., Draker M. E., Massey E. W. *Pneumocephaly from epidural anesthesia*. South Med J, **76**, 399-400, 1983.
20. Hirsch M., Katz Y., Sasson A. *Spinal cord compression by unusual epidural air accumulation after continuous epidural anesthesia*. Am J Roentgenol, **153**, 887, 1989.
21. Hogan Q. H, Haddox J. D. *Headache from intracranial air after a lumbar epidural injection : subarachnoid or subdural ?* Reg Anesth, **17**, 303-305, 1992.
22. Howell T. K., Prosser D. P., Harmer M. *A change in resistance ? A survey of epidural practice amongst obstetric anaesthetists*. Anaesthesia, **53**, 238-243, 1998.
23. Jackson K. E., Rauck R. L. *Suspected venous air embolism during epidural anesthesia*. Anesthesiology, **74**, 190-191, 1991.
24. Katz J. A., Lukin R., Bridenbaugh P. O., Gunzenhauser L. *Subdural intracranial air : an unusual cause of headache after epidural steroid injection.* Anesthesiology, **74**, 615-618, 1991.
25. Katz Y., Markovits R., Rosenberg B. *Pneumocephalus after inadvertent intrathecal air injection during epidural block.* Anesthesiology, **73**, 1277-1279, 1990.
26. Kennedy T. M., Ullman D. A., Harte F. A., Saberski L. R., *Greenhouse B. B. Lumbar root compression secondary to epidural air.* Anesth Analg**, 67**, 1184-1186, 1988.
27. Kreitzer J. M., Reed A. P., Damo A. T., Brodman M. L., Bronster D. J. *Ascending back pain and headache during attempted epidural catheter placement*. J Clin Anesth, **3**, 414-417, 1991.
28. Kuczkowski K. M. *Post-dural puncture headache, intracranial air and obstetric anesthesia*. Anaesthesist, **52**, 798-800, 2003.

29. Kuczkowski K. M., Benumof J. L. *Headache caused by pneumocephalus following inadvertent dural puncture during epidural space identification : is it time to abandon the loss of resitance to air technique ?* CAN J ANAESTH, **50**, 159-160, 2003.
30. Lin H. Y., Wu H. S., Peng T. H., Yeh Y. J., Cheng I. C., Lin I. S., Liu C. H. *Pneumocephalus and respiratory depression after accidental dural puncture during epidural anesthesia – a case repor*t. ACTA ANAESTHESIOL SIN, **35**, 119-123, 1997.
31. Lucas D. N., Kennedy A., Dob D. P. *Dural puncture and iatrogenic pneum ocephalus with subsequent transverse myelitis in a parturien*t. CAN J ANAESTH, **47**, 1103-1106, 2000.
32. Mateo E., Lopez-Alarcon D., Moliner S., Calabuig E., Vivo M., De Andres J., Grau F. *Epidural and subarachnoid pneumocephalus after epidural technique*. EUR J ANAESTHESIOL, **16**, 413-417, 1999.
33. Miguel R., Morse S., Murtagh R. *Epidural air associated with multiradicular syndrome*. ANESTH ANALG, **73**, 92-94, 1991.
34. Naulty J. S., Ostheimer G. W., Datta S., Knapp R., Weiss J. B. *Incidence of venous air embolism during epidural catheter insertion*. ANESTHESIOLOGY, **57**, 410-412, 1982.
35. Nay P. G., Milaszkiewicz R., Jothlingam S.. *Extradural air as a cause of paraplegia following lumbar analgesia*. ANAESTHESIA, **48**, 402-408, 1993.
36. Okutomi T., Hoka S. *Epidural saline solution prior to local anaesthetic produces differential nerve block*. CAN J ANAESTH, **45**, 1091-1093, 1998.
37. Okutomi T., Hoka S. *Saline – anesthetic interval and the spread of epidural anesthesi*a. CAN J ANAESTH, **46**, 935-938, 1999.
38. Paech M., Banks S., Gurrin L. *An audit of accidental dural puncture during epidural insertion of a Tuohy needle in obstetric patients*. INT J OBSTET ANESTH, **10**, 162-167, 2001.
39. Panni M. K., Camann W., Bhavani Shankar K. *Hyperbaric therapy for a postpartum patient with prolonged epidural blockade and tomographic evidence of epidural air*. ANESTH ANALG**, 97**, 1810-1811, 2003.
40. Petty R. *Inhalation of nitrous oxide expands epidural air bubbles*. REG ANESTH**, 21**, 144-148, 1996.
41. Rodrigo P., Garcia J. M., Ailagas J. *Crisis convulsive generalizada relacionada con neumoencefalo tras punction dural inadvertida en una paciente obstetrica*. REV ESP ANESTHESIOL REANIM**, 44**, 247-249, 1997.
42. Saberski L. R., Kondamuri S., Osinubi O. Y. O., REG ANESTH, **22**, 3-15, 1997.
43. Sarna M. C., Smith I., James J. M. *Paraesthesia with lumbar epidural catheters*. ANAESTHESIA, **45**, 1077-1079, 1990.
44. Schwartz N., Eisenkraft J. B. *Probable venous air embolism during epidural placement in an infant*. ANESTH ANALG, **76**, 1136-1138, 1993.
45. Sherer D. M., Onyeije C. I., Yun E. *Pneumocephalus following inadvertent intrathecal puncture during epidural anesthesia : a case report and review of the literature*. J MAT FET MED**, 8**, 138-140, 1999.
46. Stevens R., Mikat-Stevens M., Van Clief M., Schubert A., Weinstein Z. *Deliberate epidural air injection in dogs : a radiographic study*. REG ANESTH, **14**, 180-182, 1989.
47. Stride P. C., Cooper G. M. *Dural taps revisited*. ANAESTHESIA, **48**, 247-255, 1993.
48. Vasdev G. M., Chantigian R. C. *Pneumocephalus following the treatment of a postdural puncture headache with an epidural saline infusion*. J CLIN ANESTH, **6**, 508-511, 1994.
49. Valentine S. J., Jarvis A. P., Shutt L. E. *Comparative study of the effects of air or saline to identify the extradural spac*e. BRIT J ANAESTH**, 66**, 224-227, 1991.
50. Yentis S. M. *Time to abandon loss of resistance to air*. ANAESTHESIA, 5**2**, 184, 1997.