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Comparison of Air and Liquid for Use in Loss-of-Resistance Technique During Labor Epidurals: A Meta-analysis

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Abstract

Background: Air and saline are commonly used in the loss-of-resistance technique to identify the epidural space. However, it is unclear which method promotes more effective analgesic delivery after subsequent epidural catheter placement.

Methods: We conducted a meta-analysis to determine the efficacy of air and saline identification methods. We performed a systematic literature search of the National Library of Medicine's PubMed database using terms related to air, saline, epidural, and loss of resistance. Only randomized controlled trials that compared air with saline or local anesthetic were included for analysis. No restrictions were placed on the language of identified articles. Data on pertinent study characteristics and relevant outcomes were extracted from accepted articles. A random effects model was used..

Results: The literature search yielded six articles that met all inclusion criteria. A review of the articles reveal 515 subjects for whom air had been used to identify the epidural space and 522 for whom liquid had been used. We were able to obtain pooled estimates for unblocked segments, need for additional medications, and replaced catheters. Use of air was associated with an increased risk for unblocked segments [relative risk (RR) = 2.12, 95% confidence interval (CI): 1.07, 4.21; p = 0.03], but there was no difference with regard to replaced catheters [RR = 0.69, 95% CI: 0.26, 1.82; p = 0.45] or additional medication [RR = 1.59, 95% CI: 0.85, 2.41; p = 0.18]. .

Conclusion: Our pooled analysis revealed that use of air in the loss-of-resistance technique results in decreased analgesia in one parameter (unblocked segments) but not others (additional medications, replaced catheters). The results should be interpreted with caution, and additional examination with a larger randomized controlled trial is warranted, as the overall number of subjects was relatively small.

Introduction

Air and saline are commonly used for the loss-of-resistance (LOR) technique during identification of the epidural space. Despite the potential disadvantages of using air (including partial block, increased incidence of accidental dural puncture, greater difficulty of epidural catheter insertion, higher rate of intravascular catheter insertion paresthesia, and risk of pneumocephalus) [1,2], a recent meta-analysis found no difference between use of air and liquid in the incidence of these adverse outcomes[3]. However, whether one method leads to superior analgesic efficacy is unclear. We performed a meta-analysis to determine whether one method is more advantageous than the other.

Methods

This study qualified for exemption from the Johns Hopkins institutional review board. We conducted systematic literature searches of the National Library of Medicine's Medline database (1966-June 2011) using terms related to air, saline, epidural/extradural, and loss of resistance (see Appendix). Only randomized controlled trials that compared air with saline or local anesthetic in adult patients were included for analysis. We did not limit the included studies based on sample size or language. No attempts were made to contact the authors of original papers, and no quality assessments were used in our analysis.

For the purposes of this meta-analysis, the primary outcome for assessment was the analgesic efficacy (as defined by the original article) achieved after the use of air or liquid in the LOR technique to determine the epidural space for labor epidurals. Data on pertinent study characteristics and relevant outcomes were extracted from accepted articles. Meta-analysis was performed using the Review Manager 4.2.10 (The Cochrane Collaboration, 2004). A random effects model was used. The level of significance for all tests was set at an alpha level ≤0.05.

Results

The literature search yielded six articles that met all inclusion criteria (Table 1) [4-9]. A total of 1798 articles were rejected for the following reasons: 1380 articles did not study labor epidurals, 38 articles were not randomized controlled trials, and 380 articles did not compare use of air with use of liquid for the loss-of-resistance technique to identify the epidural space (Figure 1). In all articles, the patients studied were undergoing epidural catheterization for labor analgesia. Air (2–10 ml) was used in 515 subjects, and liquid was used in 522 subjects. We were able to obtain pooled estimates for unblocked segments, need for additional medications, and replaced catheters. We found that use of air was associated with an increased risk for unblocked segments [relative risk (RR) = 2.12; 95% confidence interval (CI): 1.07, 4.21; p = 0.03; Figure 2], but no significant difference was present with regard to additional medication [RR = 1.59; 95% CI: 0.85, 2.41; p = 0.18; Figure 3] or replaced catheters [RR = 0.69; 95% CI: 0.26, 1.82; p = 0.45; Figure 4]. No statistically significant heterogeneity was present in any of the pooled estimates presented.

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Study, Year	Number Enrolled	Liquid Group (n = 522)	Air Group (n = 515)	Endpoints Assessed and Additional Comments
Grondin, 2009 [4]	360	3 ml saline (n = 172)	3 ml air (n = 173)	Additional boluses: need for physician-administered boluses; need for epidural catheter replacement assessed at 4 hours
Norman, 2006 [5]	50	3 ml saline (n = 25)	3 ml air (n = 25)	Unblocked segments assessed by alcohol wipe; no difference in VAS pain up to 30 minutes
Evron, 2004 [6]	457	3 ml lidocaine (n = 185)	3 ml air (n = 180)	Unblocked segments assessed by blinded anesthesiologist; no difference in VAS pain at 1 hour
Beilin, 2000 [7]	Beilin, 2000 [7]	2 ml saline (n = 80)	2 ml air (n = 80)	No difference in overall pain score at 15 minutes; unblocked segment assessed by alcohol wipe; need for additional medication assessed at 15 minutes after last dose of LA; catheter replacement for inadequate analgesia as defined by the study
Valentine, 1991 [8]	50	4 ml saline (n = 25)	4 ml air (n = 25)	Unblocked segment defined as a segment sensitive to pinprick while the adjacent segments above and below were pain free
Sarna, 1990 [9]	67	10 ml saline (n = 35)	10 ml air (n = 32)	No definition for unblocked segment

*The patient population in all six studies consisted of patients undergoing labor analgesia. Either air or liquid was used during the loss-of-resistance technique for determining placement of the epidural catheter. LA = local anesthetic; VAS = visual analog scale

Table 1: Characteristics of Studies*

Discussion

We performed a meta-analysis of available randomized controlled trials that had compared analgesic efficacy after use of air and liquid for LOR during identification of the epidural space. We found that two of three endpoints (replaced catheters, need for additional medication) showed no difference when use of air was compared with use of liquid for LOR. However, the use of air was associated with an increased risk for unblocked segments when compared to use of liquid. Our study is one of the first to specifically address this question in a meta-analytical format.

Prior surveys and retrospective studies have shown that anesthesiologists are divided in their preference for using air or liquid (typically saline) for LOR. Although some surveys of epidural technique for labor analgesia seem to indicate a preference for saline (range: 23%–74%) over air (range: 29%–39%) [10-13], several recent large-scale cohort studies have revealed a more balanced distribution of preference for air (range: 44%–53%) and saline (range: 47%–56%) [14,15]. Although study results reveal ambiguity regarding the choice of air or liquid, some strong opinions are held on the matter [2,16].

Our finding that the risk for unblocked segments was greater after the use of air than after the use of liquid for LOR differs slightly from a previous meta-analysis that examined complications after LOR. That study found no statistical difference in risk for partial block between use of air and liquid [3]. The difference in findings may be attributed to the different studies that were incorporated into the respective meta-analyses, as we included only studies that specifically provided data on unblocked segments and excluded those that did not. Our findings of an increased risk for unblocked segments is also somewhat at odds with previously published observational data that showed no association between use of air for LOR and an increased risk (compared to saline) of unsatisfactory block or subsequent epidural failure [15,17-19]. Our other findings that air and liquid did not differ with regard to risk of replaced catheters or need for additional medication appears to be consistent with previously published data. A recent observational study also noted no significant differences between use of air and saline for subsequent catheter replacement or physician top-up doses [15].

Although our results are equivocal with regard to whether air or saline is superior as the medium for the LOR technique, use of air may be associated with some adverse events. Critics of using air in the LOR technique may list several shortcomings, including an increased incidence of accidental dural puncture, greater difficulty of epidural catheter insertion, higher rate of intravascular catheter insertion or paresthesia, and, rarely, pneumocephalus [2]. However, a recent meta-analysis found no statistical difference between air and liquid in the obstetric population for adverse outcomes such as difficult catheter insertion, intravascular catheter insertion, paresthesia, or accidental dural puncture [3]. Although the incidence of pneumocephalus associated with air during the LOR technique is unclear, a randomized controlled trial comparing air and saline during the LOR technique noted that, despite no difference in the incidence of accidental dural puncture, a higher incidence of postmeningeal puncture headache occurred with air and was associated with computed tomography evidence of intrathecal air bubbles [20]. It has been reported that air (presumably from the air in the LOR technique) may become trapped in the epidural space and potentially cause neurological symptoms [21]; however, the incidence of this presumably rare event is has not been quantified.

There are several limitations of this study. Because the endpoints that we assessed do not have widely accepted definitions, we used the

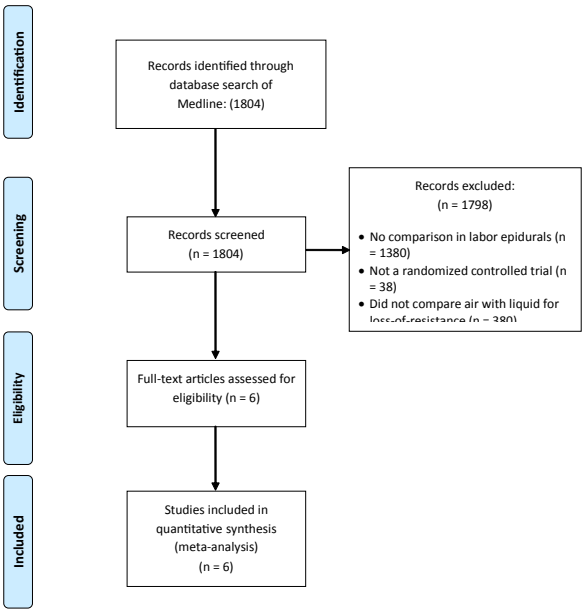

Figure 1: Literature search results. Six randomized controlled trials were ultimately used for the analysis.

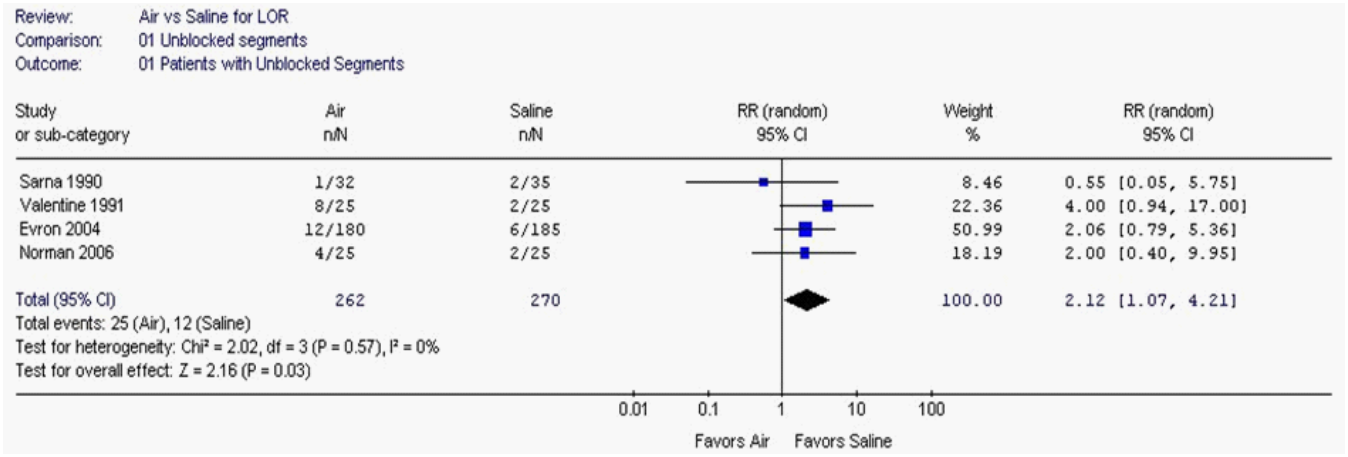

Figure 2: Pooled estimate for risk of unblocked segments during labor epidural analgesia after use of air or liquid in the loss-of-resistance (LOR) technique. Twenty-five of 262 patients in the air group and 12 of 270 patients in the liquid group had unblocked segments. The pooled estimate and 95% confidence interval (CI) are to the right of 1, suggesting that, compared to use of liquid, use of air for LOR is associated with a significantly higher risk of unblocked segments (p = 0.03); RR, relative risk.

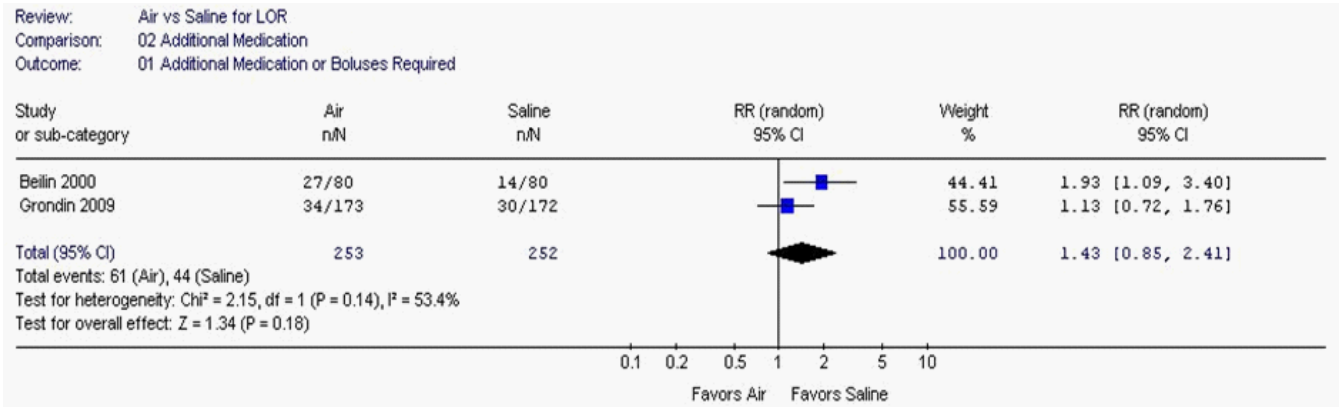

Figure 3: Pooled estimate for risk of needing additional medication during labor epidural analgesia after use of air or liquid in the loss-of-resistance (LOR) technique. Sixty-one of 253 patients in the air group and 44 of 252 patients in the liquid group needed additional medications. The pooled estimate and 95% confidence interval (CI) cross 1, suggesting no significant difference between use of air and saline (p = 0.18); RR, relative risk.

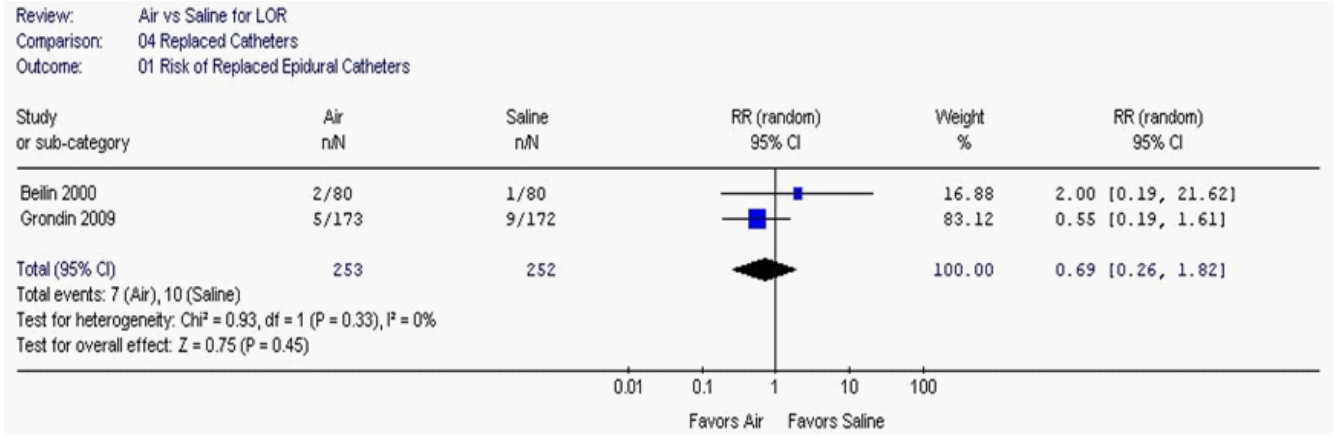

Figure 4: Pooled estimate for risk of needing a replacement epidural catheter during labor epidural analgesia after use of air or liquid for use in the loss-of-resistance (LOR) technique. Seven of 253 patients in the air group and 10 of 252 patients in the liquid group had their epidural catheters replaced. The pooled estimate and 95% confidence interval (CI) cross 1, suggesting no significant difference between use of air and saline (p = 0.45); RR, relative risk.

endpoints as defined by the original studies. Therefore, any changes to the outcome definitions may ultimately change our findings. Although one article reported visual analog scores for pain [5], we were unable to find any other meaningful pain scores to combine into a pooled estimate. In addition, we assessed only three endpoints (i.e., unblocked segments, additional medications, replaced epidural catheters) for analgesic efficacy of labor epidurals. Other measures of analgesic efficacy may produce different results. Finally, the meta-analytical technique has many well recognized limitations that have been discussed elsewhere [22,23]. In an attempt to reduce the presence of publication bias, we did not limit our search to the English language and used two databases to search for articles. We did not use methodologic quality assessments for the studies that were included in our meta-analysis, but some have questioned the usefulness of such assessments [24-26], which may not necessarily imply any inadequacy of a particular study.

In summary, our meta-analysis of randomized controlled trials comparing the use of air to the use of saline for the LOR technique for labor analgesia provided mixed results. No differences were found in rates of replaced catheters or need for additional medication but an increased risk for unblocked segments was observed with air use. The results should be interpreted with caution, however, as the overall number of subjects and studies were relatively small. Additional examination with larger randomized controlled trials is warranted.

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