COMPARATIVE STUDY OF THE EFFECTS OF AIR OR SALINE TO IDENTIFY THE EXTRADURAL SPACE

S. J. VALENTINE, A. P. JARVIS AND L. E. SHUTT

SUMMARY

Fifty women in labour were allocated randomly to receive either air or saline to assist in the identification of the extradural space by the loss of resistance technique. A study volume of 4 ml of air or saline was used before 0.5% bupivacaine 8 ml and the spread of analgesia was followed for 30 min. The first segment blocked, time of onset, number of blocked segments and height of block were comparable in the two groups. At 30 min, there were eight patients with an unblocked segment in the air group, compared with two in the saline group (P < 0.01). All unblocked segments were blocked subsequently by further doses of bupivacaine. We conclude that air is more likely than saline to produce unblocked segments in the initiation of extradural analgesia in labour.

KEY WORDS

Since extradural analgesia was popularized by Dogliotti in the 1930s, a variety of techniques have been used to identify the extradural space. Today, the loss of resistance technique using either an air- or saline-filled syringe is the most popular method. The proponents of these two methods disagree about the relative advantages and disadvantages of each medium. However, there have been no prospective comparative studies on the possible effects of the injected air or saline on the subsequent analgesia.

The aim of this study was to determine if the choice of either air or saline in the loss of resistance technique would affect the onset, spread or character of the initial extradural injection of local anaesthetic in the patient in labour.

PATIENTS AND METHODS

Fifty primiparous patients in early labour who had requested extradural analgesia gave informed verbal consent to the study, which was approved by the local Ethics Committee. Patients who had previously experienced an extradural or spinal procedure, patients in whom urgent delivery was anticipated and those who had a contraindication to extradural analgesia were excluded from the study. The patients were allocated randomly to one of two groups to receive either air or 0.9% sodium chloride (saline) in equivalent volumes (4 ml) as part of the loss of resistance method of locating the extradural space. The blocks were undertaken by a group of five anaesthetists, including the investigators, all of whom had more than 3 years experience of extradural technique.

Under aseptic conditions and following local infiltration with 1% lignocaine 2–4 ml, extradural puncture was performed with a 16-gauge Tuohy needle (Portex) at either the L2–3 or the L3–4 interspace, with the patient lying in the left lateral position. Following puncture of the ligamentum flavum and satisfactory loss of resistance, 4 ml of the study medium was injected slowly into the space. A catheter was threaded through the Tuohy needle, leaving 2–4 cm in the extradural space. Before the extradural filter was attached, it was flushed with 0.5% bupivacaine in order to avoid (apart from the small deadspace of the catheter) injection of air on subsequent dosing.

As soon as the extradural catheter had been secured, a test dose of 0.5% bupivacaine 4 ml was
given (time $t = 0$) and, in the absence of any complications, a further 4 ml was given after 5 min ($t + 5$). All patients remained in the left lateral position for the 30-min duration of the study. An investigator who had no knowledge of the medium used to identify the extradural space assessed onset of sensory loss and dermatomal spread, using sterile 21-gauge needles to test pinprick at 5-min intervals up to 30 min ($t + 30$). At this time, patients were asked if they felt any discomfort and unblocked dermatomal segments were noted. An unblocked segment was defined as one remaining sensitive to pinprick whilst adjacent segments above and below were pain free. Maternal heart rate and arterial pressure were recorded at 5-min intervals throughout the study.

After the 30-min study period, routine management was resumed. In patients with unblocked segments, measures were taken to ensure adequate extradural analgesia (vide infra).

Data on the onset and extent of sensory block between and within the two groups were analysed for statistical significance using Student's $t$ test. The incidence of unblocked segments was assessed using chi-square tables with Yates' correction. Data on height of the block between groups were compared using the Wilcoxon rank sum test. $P < 0.05$ was taken as statistically significant.

**RESULTS**

Twenty-five patients received an injection of air and 25 saline, in the loss of resistance technique. There was no difference between the two groups in age, weight and height (table I).

There were no untoward cardiovascular side effects in either group, and no dural taps or other complications of extradural insertion.

There were a total of eight unblocked dermatomal segments in eight patients in the air group and two unblocked segments in two patients in the saline group ($P < 0.01$) (table II). All unblocked segments occupied either the T12 or L1 dermatome. Three unblocked segments occurred on the patient's left (dependent) side and seven unblocked segments on the right (uppermost) side.

Two patients in the air group had blocks which did not extend above L1 on one side (one right, one left). All unblocked segments were relieved after the 30-min study period by the injection of 0.5% bupivacaine 4 ml with the patient lying on the unblocked side.

**DISCUSSION**

Since the advent of extradural analgesia, many methods have been proposed to identify the extradural space. The majority of methods rely on
the identification of the negative pressure in the extradural space or the loss of resistance encountered on entering the space. The technique used most widely today involves loss of resistance detection with either a saline or air filled syringe. There are advantages and disadvantages to each technique.

The advantages of using saline include the fact that a rigid liquid-filled system is ideal for providing a crisp and unequivocal end-point to the loss of resistance test. Liquid is incompressible and so the transition from complete resistance to loss of resistance is immediate and convincing. The distension of the extradural space with saline may aid the passage of a catheter, but an excess of saline may also dilute the local anaesthetic solution and result in inadequate block [1]. The other potential disadvantages of using saline include inability to detect a sticky plunger [2] and difficulty and delay in detecting a dural puncture [3].

Air is compressible, so that detection of the extradural space is more difficult and false positives are possible [4]. In practised hands, however, it does provide an easy and reliable technique, particularly if glass syringes are used [5], and there is no delay or difficulty in detecting dural puncture. Disadvantages of using air include the possibility of missed segments [6], venous air embolism [7] or cervical subcutaneous emphysema if large volumes of air are injected into the extradural space [8].

The frequency of missed or unblocked dermatomal segments during established extradural analgesia for obstetric patients is thought to be about 6–8% [9]. This is similar to the frequency of missed segments in our saline group. There was a much greater incidence in our air group (32%) following the initial dose of bupivacaine. In every subject in our study, the unanaesthetized dermatome was blocked by additional doses of bupivacaine. The mechanism of unblocked segments is unknown, but thought to be caused by either failure of the local anaesthetic solution to reach a given segment in an adequate concentration, or a quantitative increase in afferent input through one or more segmental nerves, possibly by stretching of the round ligament [6]. There are several potential factors to impede the local anaesthetic solution reaching segmental nerves, including malposition of the extradural catheter tip [10], the type of catheter used [11], the presence of extradural membranes and adhesions [12] and distended extradural veins [6].

In this prospective study, our technique was standardized; closed-end (three lateral holes) extradural catheters were used and the patient was maintained in the left lateral position throughout so as to minimize the known experimental variables. A volume of 4 ml of air or saline was chosen following a consensus view amongst local obstetric anaesthetists that 4 ml may be injected easily during identification of the extradural space although this volume was unlikely to be exceeded in experienced hands.

The results of this study indicate that air introduced into the extradural space may significantly increase the incidence of local anaesthetic failing to reach the nerve roots, presumably by the formation of bubbles. The range of first segment to be blocked was wider in the group of

### TABLE V. Number of segments blocked at times t + 15, t + 25 and t + 30 min (mean (SD)). *P < 0.05; **P < 0.01 within groups

<table>
<thead>
<tr>
<th>Time</th>
<th>Air group</th>
<th>Saline group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>5.7 (3.2)</td>
<td>4.9 (2.5)</td>
</tr>
<tr>
<td>Left</td>
<td>7.3 (3.7)</td>
<td>8.1 (3.7)*</td>
</tr>
<tr>
<td>t + 20</td>
<td>Right</td>
<td>7.3 (2.7)</td>
</tr>
<tr>
<td>Left</td>
<td>9.4 (3.2)</td>
<td>9.8 (3.7)</td>
</tr>
<tr>
<td>t + 25</td>
<td>Right</td>
<td>8.6 (2.5)</td>
</tr>
<tr>
<td>Left</td>
<td>10.6 (3.2)**</td>
<td>10.9 (3.5)**</td>
</tr>
<tr>
<td>t + 30</td>
<td>Right</td>
<td>9.4 (2.6)</td>
</tr>
<tr>
<td>Left</td>
<td>10.9 (3.3)</td>
<td>11.5 (3.4)</td>
</tr>
</tbody>
</table>

### TABLE VI. Height of block established at times t + 15, t + 20, t + 25 and t + 30 min (median (range))

<table>
<thead>
<tr>
<th>Time</th>
<th>Air group</th>
<th>Saline group</th>
</tr>
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<tbody>
<tr>
<td>Right</td>
<td>T10 (T6-L2)</td>
<td>T10 (T6-T12)</td>
</tr>
<tr>
<td>Left</td>
<td>T9 (T6-L2)</td>
<td>T9 (T6-T12)</td>
</tr>
<tr>
<td>t + 20</td>
<td>Right</td>
<td>T8 (T5-L2)</td>
</tr>
<tr>
<td>Left</td>
<td>T8 (T4-L1)</td>
<td>T8 (T5-T12)</td>
</tr>
<tr>
<td>t + 25</td>
<td>Right</td>
<td>T8 (T4-L2)</td>
</tr>
<tr>
<td>Left</td>
<td>T8 (T4-L1)</td>
<td>T8 (T4-T12)</td>
</tr>
<tr>
<td>t + 30</td>
<td>Right</td>
<td>T8 (T4-L2)</td>
</tr>
<tr>
<td>Left</td>
<td>T8 (T4-L1)</td>
<td>T8 (T4-T12)</td>
</tr>
</tbody>
</table>
patients in which air was used. It is also interesting to note the effect of gravity, with more unblocked segments occurring on the right (uppermost) side. The possibility of bubbles of air collecting within the extradural space following use of air with the loss of resistance technique was realized by Macintosh [5] and confirmed recently by Dalens, Bazin and Haberer [13]. They correlated the formation of air bubbles (as seen in peri-durograms) with unanaesthetized segments in extradural block in children. It is debatable if this is relevant to obstetric analgesia, as the extradural space in children extends along spinal nerves which may facilitate significant bubble trapping and, while the volume of air used was unspecified, it is likely that relatively more air was used compared with the size of the infant extradural space.

A study in which 12 ml of air was injected into the extradural space of patients in labour reported no segmental defect in subsequent analgesia, but no details were given [14]. The results of our study are not in disagreement, as they do not show that using air in the loss of resistance technique leads to persistently unblocked segments. We have demonstrated that use of 4 ml of air rather than of saline leads to a greater incidence of patchy analgesia following initial injection of local anaesthetic.

It may be argued that the addition of saline 4 ml had the effect of increasing the volume of local anaesthetic by 50% whilst maintaining the concentration greater than that required to provide sensory block (0.33%), and that this was the cause of the smaller incidence of unblocked segments in this group. However, the fact that the characteristics of the spread of the block in the two groups did not differ significantly militates against this. The first segment blocked, the time of onset, the total number of blocked segments and the height of the block were the same. This supports the long held view [15, 16], corroborated recently [17], that the dose of local anaesthetic injected, rather than the volume or concentration, is the important determinant of the subsequent spread of extradural block.

In conclusion, we have demonstrated that the use of air rather than saline to identify the extradural space in labouring patients increased the incidence of unblocked segments following the initial injection of local anaesthetic, but that there was no significant difference in the spread of analgesia.

REFERENCES