COMPARISON OF INCREMENTAL SPINAL ANAESTHESIA USING A 32-GAUGE CATHETER WITH EXTRADURAL ANAESTHESIA FOR ELECTIVE CAESAREAN SECTION

I. G. KESTIN, A. P. MADDEN, J. T. MULVEIN AND N. W. GOODMAN

SUMMARY

Forty-three mothers who had requested regional anaesthesia for elective Caesarean section were allocated randomly to receive either extradural anaesthesia with pH-adjusted 2% lignocaine with 1/200 000 adrenaline, or incremental spinal anaesthesia using a 32-gauge catheter with 0.5% plain bupivacaine. Increments of lignocaine or bupivacaine were given with the aim of achieving a block from T4 to S5. The spinal catheter was quicker to place (median 3 min, range 1-45 min, compared with median 10 min, range 1.5-50 min) and spinal anaesthesia was quicker to establish (median 20 min, range 10-46 min compared with median 48 min, range 15-59 min) compared with the extradural technique. The maximum height of the spinal block was significantly higher (median T3-4, range T5-T3) than the extradural group (median T5, range T6-T3). The total dose of intrathecal 0.5% bupivacaine was unpredictable, with a mean dose of 2.7 ml and a range between 1.5 ml and 7.4 ml. Haemodynamic stability and the quality of the block were similar between the groups. There were two mild spinal headaches in the spinal group. All the spinal catheters were removed intact.

KEY WORDS


Spinal anaesthesia has some advantages over extradural anaesthesia for Caesarean section. It is technically easier to perform and can be performed more quickly; the block is more rapid in onset and is more reliable. Only small doses of local anaesthetics are used, so there is little systemic absorption by mother and fetus and no risk of large doses of local anaesthetic being administered into a vein or the subarachnoid space.

The disadvantages of spinal anaesthesia by single injection are unpredictable spread (with no chance, unless a combined extradural–spinal technique is used, of giving more injections to extend an inadequate block or for postoperative analgesia), the rapid onset of hypotension and the risk of spinal headache.

An incremental technique through a spinal catheter may overcome some of these disadvantages while retaining the advantages, and the incidence of spinal headache may be lower if a spinal catheter has been used [1]. This study was a single-blinded (patient) stratified randomized trial of two regional techniques for elective Caesarean section: extradural anaesthesia, and spinal anaesthesia using a 32-gauge catheter (TFX Medical).

PATIENTS AND METHODS

The study was approved by the local Ethics Committee. Forty-three consecutive mothers who had requested regional anaesthesia for elective Caesarean section gave written informed consent, and they were allocated randomly to receive either extradural anaesthesia, or spinal anaesthesia using a 32-gauge catheter. Randomization was stratified: mothers who had had a previous Caesarean section under regional anaesthesia were randomized separately. We excluded from the study...
mothers with a multiple pregnancy, diabetes, cardiorespiratory disease or a fetus of less than 38 weeks of gestational age. All mothers were visited before operation by one of the authors (I.G.K.) and received a standard explanation of the study and anaesthesia. The mothers were given oral ranitidine 150 mg the night before and 2 h before surgery. All the anaesthetics and assessments were made by I.G.K. or A.P.M. In the anaesthetic room, a 14-gauge i.v. cannula was inserted using local anaesthesia, and the mother turned onto her left side.

Extradural anaesthesia

A 16-gauge Tuohy needle was inserted at L3–4 in the midline and the extradural space identified by loss of resistance to air. Approximately 3 cm of catheter was inserted into the extradural space. The mother was then turned onto her back, sitting semi-upright with 20° of left lateral tilt. I.v. crystalloid 15 ml kg\(^{-1}\) was given before the test dose of 2 ml of pH-adjusted 2% lignocaine with 1/200 000 adrenaline (preservative-free 8.4% sodium bicarbonate 2 ml and 1/1000 adrenaline 0.1 ml were added to 2% lignocaine 20 ml just before use). This lignocaine solution was used for the main dose and all subsequent doses. The initial dose of 10–13 ml of solution was given 5 min after the test dose. After 15 min, the mother was placed supine with 20° of left tilt, and the block assessed by loss of segmental sensation to cold. The block was reassessed at 3–5-min intervals until surgery. Increments were given of 1–1.5 ml of solution for each unblocked segment below T4 if two successive measurements were at the same segmental level. The aim was a bilateral block from T4 to S5.

Spinal anaesthesia

We checked that each spinal catheter would pass through the spinal needle before performing the lumbar puncture. The 32-gauge catheter passed easily down all 26-gauge Becton Dickinson needles. An oblique paraspinous approach was used, with a 26-gauge or 27-gauge needle at L3–4 with the bevel facing laterally. Three centimetre of catheter was threaded into the subarachnoid space. The mother was then turned supine with 20° of left lateral tilt, and i.v. crystalloid 20 ml kg\(^{-1}\) given before the first injection of plain 0.5% bupivacaine 1.5 ml. A larger loading volume was given to the patients having spinal anaesthesia because of the more rapid onset of hypotension.

The block was assessed after 10 min by loss of segmental sensation to cold, and reassessed at 3-min intervals until surgery. Increments of 0.2–2 ml of 0.5% bupivacaine were given if two successive measurements were at the same segmental level, with the aim of achieving a bilateral block from T4 to S5.

Monitoring

The time to place the catheter (time from first insertion of the Tuohy needle or spinal needle to time of removing the needle over the catheter) and the time to establish a block sufficient for surgery (from the time of the first injection of local anaesthetic) were recorded by an independent observer. Arterial pressure and heart rate were measured with a non-invasive automated recorder (Critikon Dinamap) at 3-min intervals during the onset of the block. I.v. ephedrine was given if the systolic pressure was less than 100 mm Hg or had decreased by more than 20 mm Hg between successive readings. The mothers were asked immediately after surgery, and again at 24 h, to rate their discomfort during surgery as none, mild, moderate or severe. The presence of nausea and vomiting and concurrent hypotension or surgical stimuli were noted. Daily postoperative visits were made for 4 days, to enquire about headache, backache and neurological sequelae. All the spinal catheters were removed in the recovery ward by the investigators.

Data were analysed by Mann–Whitney U test (time to place catheter and establish block, maximum height of the block and Apgar scores), unpaired \( t \) test (age, weight, height and dose of ephedrine) and chi-square contingency table with Yates’ continuity correction (incidence of nausea and vomiting, motor block, hypotension, discomfort during surgery and use of ephedrine). A probability of less than 5% was taken as statistically significant.

RESULTS

There were no significant differences between the groups in age, height, or weight \((P = 0.07)\) (table I). Two mothers in the spinal group were withdrawn from the study: the subarachnoid space could not be identified in one patient, and the catheter could not be threaded in the other. One of the mothers in the extradural group had a catheter resited at L2–3 because an extradural vein was entered at L3–4. Another mother in the
TABLE I. Patient characteristics (mean (range or SD)) and anaesthetic data (median (range)).

<table>
<thead>
<tr>
<th></th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>Time to place catheter (min)</th>
<th>Time to establish block (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extradural</td>
<td>28.2</td>
<td>77.9</td>
<td>162</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>(n = 20)</td>
<td>(23-35)</td>
<td>(12.6)</td>
<td>(8.9)</td>
<td>(1.5-50)</td>
<td>(15-59)</td>
</tr>
<tr>
<td>Spinal</td>
<td>28.4</td>
<td>71.2</td>
<td>160</td>
<td>3*</td>
<td>20**</td>
</tr>
<tr>
<td>(n = 20)</td>
<td>(18-36)</td>
<td>(11.0)</td>
<td>(7.2)</td>
<td>(1-45)</td>
<td>(10-46)</td>
</tr>
</tbody>
</table>

*P < 0.05; **P < 0.01

The extradural group was withdrawn from the study and given a general anaesthetic soon after skin incision because of severe discomfort.

The block could not be extended to T4 in all the mothers in the extradural group; for 10 of the 20 patients the maximum dose of local anaesthetic had been given. The maximum height of the block in the spinal group (median T3–4, range T5–T3) was significantly higher (P < 0.002) than the maximum height in the extradural group (median T5, range T6–T3). Two of the extradural blocks were only just satisfactory for surgery—these two patients were given i.v. fentanyl after delivery. All the other extradural and spinal blocks were satisfactory for surgery without supplementation.

Two patients in the spinal group complained of pain at the site of surgery soon after skin closure, and were given an increment of 1 ml of intrathecal bupivacaine before the catheter was removed. The mean dose of lignocaine solution used for extradural block was 22.7 (range 12-34) ml (fig. 1).

The spinal technique was quicker to perform and a satisfactory block was achieved significantly faster (table I). Haemodynamic stability and the quality of the block were similar in the two groups (tables II, III). There was no difference in fetal outcome measured by the 5-min Apgar score. The ratings of discomfort by the patients were the same immediately after surgery and at 24 h.

The mean dose of intrathecal bupivacaine was 2.7 (range 1.5–7.4) ml (fig. 2). The maximum height of the block was from T3 to T5 with the incremental technique. There was no relationship between the dose of intrathecal bupivacaine and the patient's experience of pain during surgery. The mean dose of intrathecal bupivacaine in the

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TABLE II. Adverse effects of incremental spinal anaesthesia compared with extradural anaesthesia for Caesarean section.

<table>
<thead>
<tr>
<th>Number of patients with</th>
<th>Extradural (n = 20)</th>
<th>Spinal (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild discomfort during surgery</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Moderate discomfort during surgery</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>I.v. supplementation of analgesia during surgery</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Nausea/vomiting with surgical stimuli</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Complete motor block</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

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FIG. 1. Individual dose–response curves: segmental height of block vs dose of pH-adjusted 2% lignocaine + adrenaline 1/200000, for extradural anaesthesia for Caesarean section.
Table III. Haemodynamic stability of incremental spinal anaesthesia compared with extradural anaesthesia for elective Caesarean section: systolic arterial pressure (SAP) and requirement for ephedrine (mean (range))

<table>
<thead>
<tr>
<th></th>
<th>Extradural (n = 20)</th>
<th>Spinal (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with SAP &lt; 100 mm Hg</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Number of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with SAP &lt; 80 mm Hg</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Number of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>given ephedrine</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Dose of ephedrine</td>
<td>16.4 (6–30)</td>
<td>16.8 (6–45)</td>
</tr>
</tbody>
</table>

seven patients who experienced some pain during the operation was 2.3 (range 1.5–3.3) ml, and two patients had a complete motor block.

Four patients in the spinal group complained of headache at some time during the first 4 days after operation and two patients described symptoms typical of dural puncture. The onset of headache in these two mothers was 24–48 h after operation, and they lasted 2 and 3 days. Both mothers described the headaches as mild; they did not have to restrict movements and they required only oral analgesics.

Three patients who had an extradural block complained of headache at some time in the first 4 days after operation, but none was typical of dural puncture. Five patients who had had a spinal block and four patients who had had an extradural block had non-specific backache at some time after operation. There were no neurological sequelae in any of the patients when last questioned at 4 days. All the spinal catheters were removed intact.

Discussion

The incremental technique of spinal anaesthesia was quicker, and produced a satisfactory block more quickly, than extradural anaesthesia. However, in this study there were some patients in whom the subarachnoid space was difficult to find, and some patients who needed several increments of intrathecal bupivacaine and in whom the block was relatively slow in onset. Otherwise, the two techniques were similar. In their textbook, Moir and Thorburn wrote “The quality of analgesia may be rather greater with subarachnoid block” [2]. In this study, the quality of the incremental spinal block was not better than that of the extradural block; there was no difference in the patients’ rating of discomfort during surgery, nausea and vomiting with surgical stimuli, or the incidence of complete motor block.

Two of the 20 patients had spinal headaches—the expected incidence in obstetric patients after a 26-gauge spinal puncture [3]. Denny and colleagues reported an unexpectedly low incidence of headache, even after using a 20-gauge intrathecal catheter [1]. A study of the true incidence of headache with 32-gauge catheters would require a large number of patients but, if confirmed, would be a worthwhile additional clinical advantage of using an intrathecal catheter.

In spinal anaesthesia by single injection, the height of the block is variable in pregnant patients [4]. In our study, the dose was variable, but the height of the block was well controlled within a narrow range of segments by the incremental technique. There is one important difference between spinal anaesthesia by single injection and this technique of incremental spinal anaesthesia. After single-injection spinal anaesthesia, moving

**Fig. 2. Individual dose–response curves: segmental height of block vs dose of 0.5 % bupivacaine, for incremental spinal anaesthesia through a 32-gauge catheter for Caesarean section.**
the patient from lateral to supine causes cephalad extension of the block [5]; with the incremental technique, all doses of intrathecal bupivacaine can be given through the catheter after the patient has been positioned for surgery. The only subsequent movement of the patient, during insertion of the urinary catheter, did not cause cephalad extension of the block in our study. If the incremental technique is used with the patient already supine and there is need for subsequent movement of the patient (for example, to treat aortocaval compression), this might cause further unpredictable extension of the block.

We found 1.5 ml of 0.5% plain bupivacaine was too large as an initial dose: three patients had a sensory level at T3 after this dose. Once the block is established, we suggest an increment of 1.5 ml of 0.5% plain bupivacaine if the sensory level is in the sacral segments; 1 ml if the sensory level is still in the lumbar segments; and 0.25-0.5 ml if the sensory level is in the low thoracic segments. From our results, we should surmise that these increments should not extend the analgesia to dangerously high levels. The spread of spinal anaesthesia after a single injection is more variable in pregnant patients than in general surgical patients [6], and the reason for this is not fully understood. This seems to be true also of incremental spinal anaesthesia; there was less variability in a group of general surgical and urological patients [7].

Hurley and Lambert reported technical difficulties with the prototype 32-gauge spinal catheter [8]. These were mainly difficulty in threading the catheter (30%) or breakage. In our study, we had difficulty with the catheter in only one of 22 patients. However, there had been more failures in an earlier pilot study [7]. We recommend that anaesthetists learn to use the 32-gauge catheters in elderly patients, who are less likely to suffer spinal headache after dural puncture.

In our study, the assessor of the heights of the blocks was not blinded to the anaesthetic method. It would be difficult to organize a truly double-blind trial because of the different time intervals and speed of onset between the two techniques.

Within the constraints of not being a double-blind trial, we have shown that an incremental technique of spinal anaesthesia using a 32-gauge catheter is easier and quicker than extradural anaesthesia for elective Caesarean section. Once experience in the technique has been gained, the 32-gauge catheter is usually easy and quick to insert. Although the total dose of intrathecal bupivacaine is variable, the maximum height of the block may be controlled within a narrow range of segments. The height of the block may always be extended with the spinal technique; with extradural anaesthesia 50% of patients in our study had to be given their maximum dose of local anaesthetic. Haemodynamic stability and the quality of block were similar in the two groups. The only adverse effect of the technique was mild spinal headache in two patients, although further studies with larger numbers of patients will be needed to determine if spinal headaches are an important clinical problem with the 32-gauge catheter.

ACKNOWLEDGEMENT

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REFERENCES