RADIOLOGICAL EXAMINATION OF THE INTRATHECAL POSITION OF MICROCATHERETERS IN CONTINUOUS SPINAL ANAESTHESIA

T. STANDL AND H. BECK

SUMMARY
There have been few studies of the intrathecal position of spinal catheters in continuous spinal anaesthesia. This prospective study was designed to examine radiologically the intrathecal position of 28-gauge spinal catheters. We studied the entry into the subarachnoid space and the intrathecal position of 68 spinal catheters. In 50%, the catheters passed in a cranial direction, in 34% the catheters remained at the level of the puncture site and in 16% the catheters were directed caudally. The intrathecal position of the catheters did not depend on the level of the lumbar puncture (P = 0.6246), but was dependent on the position of the patient during insertion of the catheter (P = 0.0093), and on the depth of insertion (P = 0.0099). Our study suggests that patients should be in a sitting position during insertion of a subarachnoid microcatheter and that the depth of insertion should not exceed 4 cm. (Br. J. Anaesth. 1993; 71 : 803-806)

KEY WORDS
Anaesthetic techniques: subarachnoid.

Tuohy, in 1944, was the first to describe the technique of continuous spinal anaesthesia using a 15-gauge needle and a urethral catheter placed into the subarachnoid space [1, 2]. In 1947, Courbelo modified Tuohy's technique and inserted a urethral catheter into the extradural space [3]. Since that time, continuous extradural anaesthesia has become more popular than continuous spinal anaesthesia because of its smaller incidence of postdural puncture headache [4]. However, with the availability of spinal microcatheters, continuous spinal anaesthesia is enjoying a renaissance [5-9]. There are several studies on the position of extradural catheters during continuous extradural anaesthesia [10-13], but only a few studies have investigated the position of large-gauge spinal catheters [11, 14]. Recent publications suggest that the intrathecal position of spinal catheters affects the clinical outcome of continuous spinal anaesthesia [15, 16]. The present prospective study was designed to investigate the intrathecal position of spinal catheters using conventional radiography.

 PATIENTS AND METHODS
We studied 68 patients who received continuous spinal anaesthesia for elective orthopaedic operations on the lower extremities (table I). None of the patients had abnormality of the vertebral column or vertebral surgery before the study. The study was approved by the hospital's Ethics Committee and informed consent was obtained from all patients. After oral premedication with midazolam 7.5 mg 1 h before anaesthesia, the patients were allocated randomly to two groups: in group A (32 patients), lumbar puncture and intrathecal insertion of the catheter were performed with the patient in the sitting position; in group B (36 patients), the lumbar puncture and intrathecal insertion of the catheter were performed with the patient in the right lateral position. In all patients, a 22-gauge Quincke needle was inserted at an angle of 45° through the anaesthetized skin using the midline approach at the L2-3, L3-4 or L4-5 interspace. When piercing the dura, the needle bevel was directed parallel to the dural fibres [17]. After aspiration of clear CSF, the needle was turned cephalad in order to direct the catheter into a cranial position. A 28-gauge spinal catheter (Cospan Kendall, Mansfield, Mass.) was inserted 2 cm (minimum) to 5 cm (maximum) into the subarachnoid space by the same anaesthetists. After removal of the needle, the stylet was withdrawn from the catheter and the catheter was secured in the

TABLE I. Characteristics and classification of 68 patients allocated randomly to group A (sitting) and group B (right lateral) (number or mean (SD) [range])

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. patients</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>16:16</td>
<td>18:18</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>63 [23-83]</td>
<td>61 [26-84]</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72 (2) [54-95]</td>
<td>75 (2) [49-93]</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166 (1) [150-181]</td>
<td>170 (2) [150-188]</td>
</tr>
<tr>
<td>Interspace</td>
<td>L2-3 4</td>
<td>4 5</td>
</tr>
<tr>
<td></td>
<td>L3-4 21</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>L4-5 7</td>
<td>7</td>
</tr>
<tr>
<td>Insertion depth (cm)</td>
<td>2.0-3.0 10</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>3.1-4.0 15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>4.1-5.0 7</td>
<td>6</td>
</tr>
</tbody>
</table>

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form of a loop at the level of the puncture site. The catheter level at the patient's skin was marked and a tape fixed on the patient's back before the patient was placed in a horizontal position. Then plain 0.5% bupivacaine 2.5 ml was injected into the catheter. If required, additional doses of 0.5% bupivacaine were injected to produce an analgesic level of T10. After completion of surgery, the catheter remained in situ for postoperative pain relief.

On the first day after operation, the position of the catheter was compared with the preoperative level. For radiological control of the intrathecal position of the catheter, a dose of Iopamidol 1 ml (= 200 mg of iodine) (Solutrast 200 M, Byk Gulden, FRG) was injected into the catheter to increase the contrast of the intrathecal part of the catheter and a conventional antero–posterior x-ray of the lumbar spine was performed. Entry of the spinal catheter into the subarachnoid space and the intrathecal position of the catheter were evaluated as "cranial" (tip of the catheter above the lower edge of the cranial lumbar vertebral body), "caudal" (tip of the catheter below the upper edge of the caudal lumbar vertebral body) or "at the level of the puncture site" (tip of the catheter between lower edge of the cranial and upper edge of the caudal lumbar vertebral body). The results were assessed by Freemann–Halton test [18].

The intrathecal position of the microcatheter was tested statistically in respect of the point of entrance of the catheter into the subarachnoid space (lumbar interspace), the position of the patient during insertion of the catheter (sitting or right lateral) and intrathecal advancement of the catheter (insertion depth). Results were considered significant at \( P < 0.01 \).

### RESULTS

Adequate analgesia was produced in all 68 patients and there was no significant difference between the two groups of patients. In all patients, there was no change of the marked catheter level at the skin on the first day after operation compared with the level noted immediately after catheter insertion.

Radiological evaluation of the intrathecal position of the spinal catheters revealed nine catheters penetrating the dura at the L2–3 interspace, 45 catheters penetrating the dura at L3–4 and 14 catheters penetrating it at L4–5. Thirty-four spinal catheters were in a cranial position, 11 catheters were in a caudal position and 23 catheters remained at the level of the puncture site.

The intrathecal position of the 68 spinal catheters in relation to the interspace at which the catheters were threaded into the subarachnoid space is shown in table II. There was no statistically significant dependence of the intrathecal position of the catheters on the lumbar interspace at which catheter insertion had been performed \( (P = 0.63) \).

The intrathecal position of the 68 spinal catheters in relation to the position of the patients during insertion of the catheters into the subarachnoid space was significantly different between the groups (table II). In group A (sitting patients), 69% of the catheters were directed cephalad, while in group B (patients in right lateral position) only 33% of the catheters were cephalad. In group A, 6% of the catheters and in group B 25% of the catheters were directed caudally. There was a greater number of catheters at the level of the puncture site in group B (42%) than in group A (25%). The differences between groups A and B in intrathecal positions of the spinal catheters were statistically significant \( (P = 0.0093) \).

The intrathecal position of the 68 spinal catheters in relation to the intrathecal depth of insertion of the catheters also revealed significant differences between all three insertion depths. Spinal catheters inserted more than 4 cm were more caudal (31%), while those inserted 2–3 cm or 3.1–4 cm had fewer caudal positions (10% and 15%). The majority of catheters inserted only 2–3 cm remained at the level of the puncture site (62%). The number of catheters that remained at the level of the puncture site decreased with increasing depth of insertion (table II). The differences in intrathecal positions of the spinal catheters between the three different intrathecal insertion depths were significant \( (P = 0.0099) \).

### DISCUSSION

Most anaesthetists intend to introduce extradural or spinal catheters in a cranial direction [11]. Correct position of the catheter tip at the intended level may reduce the required dose of local anaesthetics needed for block of a specific area. Therefore, special needle shapes (such as Tuohy's needle) have been designed to guide the catheters towards an intended direction within the extradural or subarachnoid space [4]. Several studies have investigated the position of extradural catheters within the vertebral column [10–13]. However, few investigations deal with the intrathecal position of spinal catheters [11, 14]. Bridenbaugh and colleagues [11] observed that 56–69% of catheters placed into the subarachnoid space were passed cranially, but they gave no information on the type of the catheter used. Van Gessel, Forster and Gamulin [14] observed that all of 30 spinal catheters (20-gauge) inserted 3–4 cm into the subarachnoid space were directed cranially. In contrast, studies on the position of extradural catheters have shown that a cranial direction occurs only

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### Table II. Intrathecal position of 68 microspinal catheters dependent on interspace of lumbar puncture, patient's position during catheter insertion and intrathecal insertion depth

<table>
<thead>
<tr>
<th>Interspace</th>
<th>Cranial</th>
<th>Puncture site</th>
<th>Caudal</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2–3</td>
<td>3 (33%)</td>
<td>3 (33%)</td>
<td>3 (33%)</td>
</tr>
<tr>
<td>L3–4</td>
<td>24 (33%)</td>
<td>15 (33%)</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>L4–5</td>
<td>7 (50%)</td>
<td>5 (36%)</td>
<td>2 (14%)</td>
</tr>
<tr>
<td>Patient's position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting (group A)</td>
<td>22 (69%)</td>
<td>8 (25%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>Right lateral (group B)</td>
<td>12 (33%)</td>
<td>15 (42%)</td>
<td>9 (25%)</td>
</tr>
<tr>
<td>Insertion depth (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0–3.0</td>
<td>6 (28%)</td>
<td>13 (62%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>3.1–4.0</td>
<td>20 (59%)</td>
<td>9 (26%)</td>
<td>5 (15%)</td>
</tr>
<tr>
<td>&gt; 4</td>
<td>8 (61%)</td>
<td>1 (8%)</td>
<td>4 (31%)</td>
</tr>
</tbody>
</table>
in 14–65% [10–13]. Because of anatomical differences between the extradural and subarachnoid space, we expected a greater number of cranially directed spinal catheters in our study. However, our results with the 28-gauge spinal catheters are consistent with previous results obtained with extradural catheters [10–13]. The difference between our data and those of van Gessel’s group [14] suggests that the rigidity of the larger-bore 20-gauge spinal catheters may allow better control of the direction of spinal catheters. However, the risk of secondary perforation of the dura, neurological damage or postdural puncture headache is greater for spinal catheters with larger diameters [7, 19–22].

In the study by van Gessel, Forster and Gamulin [14], the patients were examined at the end of the operation. In the present study, the patients were examined on the first day after operation. There was no change in the position of the marked catheters at the skin, but we cannot exclude totally changes in the intrathecal position of the catheters during this period of 24 h. However, because of strict immobilization of all patients, it is unlikely that the catheters changed their intrathecal position.

The shape of the needle and the design of the tip may help to guide the catheter into the intended intrathecal direction. In the present study, we used a needle with a Quincke tip. This produced unpredictable intrathecal positions of the catheters. It is possible that needles with a special tip or a ramped opening on their side (Whitacre or Sprotte needle [23, 24]) may facilitate achievement of the intended direction of a spinal microcatheter.

In contrast with our intention to direct all 68 spinal catheters cranially, only 50% of the catheters passed cephalad, 34% of the catheters remained at the level of the puncture site and 16% were passed caudally. These results are consistent with the findings of Swayze and Skerman [25], who used the same spinal catheters in a spinal canal model.

The clinical consequences of the different intrathecal catheter positions have not been investigated systematically. There may be a greater risk of neurological sequelae associated with the use of caudally directed spinal microcatheters in combination with large doses of hyperbaric local anaesthetics in continuous spinal anaesthesia. Rigler and Drasner [15] demonstrated in a model of the subarachnoid space, that this combination resulted in maldistribution and a large local concentration of local anaesthetic. Maldistribution of local anaesthetic with caudally directed spinal catheters may also explain the restricted sacral block described by Chan and Smyth [16] or neurological damage (cauda equina syndrome) observed by Lambert and Hurley [26] and Rigler and colleagues [27]. Therefore, cranial direction of the spinal catheter or a position at the level of the puncture site may be associated with a smaller incidence of complications.

Our study showed that the level of the lumbar interspace selected for insertion of the spinal catheter had no effect on the intrathecal catheter position. In contrast, our data suggest a greater rate of cranially directed catheters in patients who were sitting during insertion of the catheter. It is possible that the sitting position increases the lumbar subarachnoid space (because of increased hydrostatic pressure). This may reduce the incidence of contact between the dura on the opposite side or with intrathecal spinal nerves. This contact may help to guide the intrathecal direction of a spinal catheter [28]. In contrast with our findings, Swayze and Skerman [25] obtained a greater number of catheters directed cephalad and no caudally directed catheter in their model simulating the right lateral decubitus position compared with the model simulating the sitting position. The present study also showed that catheters inserted deeper are more likely to be directed cranially or caudally. Thus an insertion depth of 2–4 cm seems to be the optimum and is consistent with the results of Swayze and Skerman [25]. Mollmann and colleagues [28] found that malposition of spinal catheters could be avoided by inserting the catheters only 2 cm into the subarachnoid space. Catheters inserted more than 3 cm can also produce intrathecal loops or coils and this may lead to inadequate block or even neurological damage [16, 26, 27].

The intrathecal position of spinal catheters is certainly not the only factor influencing the clinical outcome of continuous spinal anaesthesia. Other variables such as size of the spinal catheter and injection rate may also influence the effect of a local anaesthetic in continuous spinal anaesthesia [15]. The characteristics of the local anaesthetic used, such as baricity and concentration, are important [29]. Most of the reports of neurological problems after continuous spinal anaesthesia describe patients in whom hyperbaric 5% lignocaine was used [16, 26, 27].

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REFERENCES


