A directional needle improves effectiveness and reduces complications of microcatheter continuous spinal anaesthesia

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The present prospective randomized study compares the impact of two different spinal needle designs – non-directional versus directional – on the effectiveness of continuous spinal anaesthesia provided via a microcatheter in orthopaedic patients. Using the midline approach, a 28-gauge spinal catheter was inserted either through a 22-gauge Quincke needle (non-directional, Group 1, n = 21) or a 22-gauge Sprotte needle (directional, Group 2, n = 21) under standardized conditions. The incidence of technical difficulties and postoperative complaints, onset time of analgesia at the level of T₁₀ and dose requirement of plain bupivacaine 0.5% were recorded. Postoperatively, the subarachnoid position of the catheters was radiographically evaluated. There was a higher incidence of technical problems during catheter insertion in Group 1 compared with Group 2 (71% vs 19%, $P < 0.05$). Onset time of analgesia was shorter ($P < 0.05$) and anaesthetic dose requirement was lower in patients in Group 2 than in Group 1. While 40% of the catheters were found in a caudal position in Group 1, all catheters were in a cranial position or at the level of the puncture site in Group 2 ($P < 0.05$). There was no difference in the incidence of postoperative complaints between the groups. The faster onset of analgesia and lower dose requirement of local anaesthetics associated with a lower incidence of technical problems suggest that there is greater effectiveness and safety when microcatheters are inserted using directional needles rather than non-directional needles.

Cette étude randomisée compare en chirurgie orthopédique l'impact de deux modèles d'aiguille rachidienne – non directionnel versus directionnel – au regard de l'efficacité de la rachianesthésie continue réalisée avec un microcathéter. Par approche médiane, un cathéter rachidien 28G est inséré à travers une aiguille Quincke 22G (modèle non-directionnel, Groupe 1, n = 21) ou Sprotte 22G (modèle directionnel, Groupe 2, n = 21) sous des conditions standardisées. On enregistre l'incidence des difficultés d'ordre technique et des doléances post-opératoires, le délai de l'installation de l'analgesie au niveau T₁₀ et la dose requise de bupivacaine 0,5%. Après la chirurgie, la position sous-arachnoïdienne du cathéter est déterminée par radiographie. L'incidence des problèmes d'ordre technique au moment de l'insertion du cathéter est plus élevée dans le Groupe 1 que dans le Groupe 2 (71% vs 19%, $P < 0,05$). L'installation de l'analgesie est plus courte ($P < 0,05$) et la dose anesthésique requise est plus basse dans le Groupe 2 que dans le Groupe 1. Alors que 40% des cathéters se retrouvent en position caudale dans le Groupe 1, tous les cathéters du Groupe 2 se retrouvent en position céphalique ou au niveau de la ponction dans le Groupe 2 ($P < 0,05$). L'incidence des doléances post-opératoires est la même pour les deux groupes. Le plus court délai d'installation de l'analgesie et la diminution de la dose nécessaire d'anesthésique local associés à l'incidence moindre de problèmes techniques suggèrent que la sécurité et l'efficacité sont supérieures quand des microcathéters sont insérés à l'aide d'aiguilles directionnelles plutôt que non directionnelles.

Key words

ANESTHETIC TECHNIQUES: spinal continuous;
EQUIPMENT: needles, spinal.

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Continuous spinal anaesthesia (CSA) using microcatheters (<27-gauge) allows adjustment of intraoperative analgesia according to the status of the patient.^{1,2} A lower incidence of postoperative complaints, especially postdural puncture headache, after continuous microspinal anaesthesia in comparison with commonly used large-bore needles and catheters has been documented.³⁻⁵ However, this progress has been associated with a higher incidence of technical difficulties with the use of micro-

catheters.^{6,7} Kinking of the catheters during insertion provided a higher failure rate than with large-bore spinal catheters⁸ and made microcatheter CSA sometimes a time-consuming and frustrating procedure. In addition, severe neurological deficits such as cauda equina syndrome have been reported after CSA using microcatheters in combination with hyperbaric local anaesthetics.⁹ There is some evidence that the subarachnoid position of the microcatheter has an influence on the incidence of postoperative complications as well as on the effectiveness of CSA.^{10,11} While caudally directed catheters may cause maldistribution of hyperbaric local anaesthetics, cranially directed catheters seem to be advantageous in terms of subarachnoid distribution of anaesthetics.¹² As a consequence, cranial catheter positions should be preferred to caudal positions in CSA. A previous study has shown that both the position of the patient during catheter insertion and the intrathecal insertion depth may influence the subarachnoid position of microcatheters.¹³ However, no study has examined the influence of the type of spinal needle on microcatheter CSA.

The present study was designed to evaluate the impact of two different types of spinal needles – a non-directional Quincke needle and a directional Sprotte needle – on the time of onset of analgesia, dose requirement of local anaesthetics and on the subarachnoid position of microcatheters in CSA. A second goal of the study was to determine the incidences of technical difficulties during insertion and of postoperative complaints after CSA using different spinal needles.

Methods

After ethics committee approval and written informed consent, 42 orthopaedic patients were scheduled for elective lower limb surgery with microcatheter CSA. The lumbar puncture was performed through the anaesthetized skin at the L₃/L₄ interspace using a midline approach. All patients were placed in the sitting position and randomly assigned to receive the lumbar puncture using either a non-directional 22-gauge Quincke needle (Group 1) or a directional 22-gauge Sprotte needle (Group 2). In Group 1, the bevel of the Quincke needle (B. Braun, FRG) was in parallel to the dural fibres when piercing the dura. After free flow of cerebrospinal fluid (CSF) was obtained, the needle bevel was turned in a cranial direction. In Group 2, the Sprotte needle (Kendall, Mass., USA) was inserted with the orifice directed cranially. When free flow of CSF was obtained, the needle was advanced an additional 2 mm intrathecally. In both groups, a 28-gauge nylon catheter (Cospan, Kendall, Mass., USA) was inserted 2–4 cm into the subarachnoid space by one of two anaesthetists. Technical problems such as difficulties in catheter advancement or paraes-

thesia during catheter insertion were documented. With the patients in the supine position, 2 ml plain bupivacaine 0.5% (Carbostesin, Astra Chemicals, FRG) were injected into the catheter with an injection speed of 1 ml · 30 sec⁻¹ to obtain an analgesic level of T₁₀. The analgesic level was tested using the pin-prick method. If analgesia did not achieve a level of T₁₀ within 20 min, additional doses of 1 ml bupivacaine were given until the level of T₁₀ or a maximal anaesthetic dose of 5 ml were reached. Onset time of analgesia at T₁₀ and the dose of bupivacaine required for the block at T₁₀ were documented. An indwelling urinary catheter was placed before operation and withdrawn when the patient reached the recovery room. After completion of surgery, the subarachnoid position of the catheters was evaluated by an A-P x-ray of the lumbar spine following injection of 1 ml (200 mg of iodine) of Jopamidol (Solutrast 200 M, Byk Gulden, FRG) into the catheter. A *cranial* position was identified if the catheter was situated above the lower edge of the cranial vertebral body. Positions below the upper edge of the caudal lumbar vertebra were defined as *caudal*. A position at the level of the puncture site was assessed when the tip of the catheter was localized between the upper edge of the caudal and the lower edge of the cranial vertebra.

On day four after surgery, the patients were interviewed for postoperative complaints by an anaesthetist blinded to the intraoperative treatment conditions, using a standardized questionnaire.

Demographic data of both groups were tested by the Mann-Whitney-U-test for independent samples. Dependence of variables on type of spinal needle were tested using the Chi-square test with Fisher's exact test where appropriate. The results were considered significant at $P < 0.05$.

Results

Patients did not differ with respect to demographic data and type or duration of surgery (Table I). All microcatheters were successfully placed into the subarachnoid space. In Group 1, there was a higher incidence of paraesthesia and difficulties in catheter position than in Group 2 ($P < 0.05$, Table II). In 15% of patients, a second lumbar puncture at the L₂/L₃ or L₄/L₅ interspace was necessary due to difficulties in microcatheter placement. In Group 1, one patient was excluded from further evaluation because of allergic disposition to the dye that made a radiological examination impossible.

Sufficient intraoperative analgesia could be achieved in all patients. While hip arthroplasties were performed in a lateral position (69%), patients were in supine position during knee replacement (31%). Fifty percent of the patients in Group 1 presented a prolonged time of

TABLE I Demographic data, type and duration of surgery of 42 patients randomly allocated to Group 1 (Quincke) and Group 2 (Sprotte)

Characteristics	Group 1	Group 2
<i>n</i>	21	21
Sex (M:F)	5:16	4:17
Age (yr)	73 ± 6 (6–83)	74 ± 6 (56–83)
Weight (kg)	74 ± 15 (56–120)	68 ± 15 (48–100)
Height (cm)	167 ± 9 (152–190)	165 ± 10 (152–188)
<i>Operation</i>		
Hip replacement	14	15
Knee replacement	7	6
Duration (min)	144 ± 60	190 ± 105
Range	70–300	40–520

TABLE II Incidence of technical problems and postoperative complaints after CSA using a Quincke needle (Group 1) or a Sprotte needle (Group 2)

Variables	Group 1 (<i>n</i> = 21)	Group 2 (<i>n</i> = 21)
<i>Technical (total)</i>	15 (71%)	4 (19%)*
Paraesthesia	4 (19%)	2 (9%)*
Difficult insertion	3 (14%)	1 (5%)*
Both	5 (24%)	1 (5%)*
Second puncture	3 (14%)	0 (0%)*
<i>Complaints (total)</i>	5 (24%)	4 (19%)
Headache	0	0
Backache	4 (19%)	4 (19%)
Urinary dysfunction	0	0
Nerve irritation	1 (5%)	0

**P* < 0.05 vs Group 1.

onset of analgesia >30 min compared with 14% of the patients in Group 2 (*P* < 0.05, Table III). In Group 1, 40% of the patients required a dose of >3 ml for adequate analgesia compared with 19% in Group 2, but this difference was not statistically significant.

There were more catheters running in a cranial direction in Group 2 than in Group 1 (Figure). In contrast to Group 1, no caudal catheter position was seen in Group 2 (*P* < 0.05).

No differences in the incidences of postoperative complaints could be revealed at the postoperative interview on day four after surgery between groups. Backache was the most frequent complaint. There was one patient in Group 1 who noticed paraesthesia during catheter insertion followed by postoperative nerve irritation in the L₃ area. However, this irritation disappeared within 24 hr and no neurological deficit could be detected on the day of discharge from hospital. No headache or urinary dysfunction was seen during the postoperative period in either group.

TABLE III Dependence of onset time of analgesia (Time) and dose requirement of local anaesthetic (Dose) on type of spinal needle in microcatheter CSA

Time (min)	10–20	21–30	>30
Group 1 (Quincke)	8 (40%)	2 (10%)	10 (50%)
Group 2 (Sprotte)	15 (72%)	3 (14%)	3 (14%)*
Dose (ml)	2.5–3.0	3.1–4.0	>4
Group 1 (Quincke)	12 (60%)	5 (25%)	3 (15%)
Group 2 (Sprotte)	17 (81%)	3 (14%)	1 (5%)

**P* < 0.05 vs Group 1.

FIGURE Subarachnoid microcatheter position dependent on the needle type used for catheter insertion: Group 1 (Quincke), Group 2 (Sprotte).

Discussion

The incidence of technical problems and the risk of severe neurological complications is one of the most important concerns about microcatheter CSA.¹⁴ Studies have stressed the importance of the baricity of the administered drug and of the subarachnoid position of the microcatheter as determinants of the intrathecal local anaesthetic distribution.^{11,12} Cranially directed catheters reduce the risk of maldistribution, thus producing more effective and predictable CSA.¹¹ This is consistent with radiographical data, where cranial catheter positions were associated with faster onset of analgesia and lower dose requirement of local anaesthetics compared to caudally-directed catheters.¹⁵ The data of the present study suggest that the subarachnoid microcatheter position is a function of needle design. The ramped and cranial orifice beyond the blunt needle tip of the Sprotte needle¹⁶ directed most of the catheters upward. In contrast, in Group 1 the microcatheter probably did not follow this intended direction despite a cranially-directed needle bevel. Because the Quincke needle is non-directional, the catheter will leave the needle in a straight direction towards the ventral part

of the dura. Any contact with the dura or with spinal nerves may guide the catheter into a cranial or caudal position.¹⁷ This assumption is consistent with the results of the radiographically controlled positions of the microcatheters. However, it is possible that a paramedian approach which is known to provide easy catheter insertion in spinal and epidural anaesthesia may produce more cranially-directed catheter positions using a non-directional needle.

Due to the long orifice of the Sprotte needle,¹⁸ one would expect a higher rate of difficulties in catheter insertion if the whole orifice of the needle is not placed within the subarachnoid space. In these situations, parts of the dura or arachnoid could obstruct the orifice thus making catheter insertion impossible and increasing the failure rate in CSA. However, the technique performed in this study encouraged a free passage of the catheter by advancing the needle another 2 mm intrathecally after CSF was obtained. In contrast, the higher incidence of difficulty in catheter placement in the Quincke group suggest closer contact of the catheter with intrathecal structures producing an unpredictable subarachnoid catheter position. It is unclear whether paraesthesia, which is unpleasant for the patient, is harmless or an indicator of potential neurological complications. One patient with severe paraesthesia in the L₃ dermatome during catheter insertion through a Quincke needle complained of post-operative nerve irritation. This irritation was probably caused by the catheter which touched the respective spinal nerve. As a consequence, the spinal needle should be withdrawn and a second puncture at a different lumbar interspace be performed when severe paraesthesias occur during the insertion manoeuvre. Our data suggest that directional needles such as the Sprotte needle should be preferred to non-directional spinal needles in CSA because of a lower incidence of paraesthesia. This may provide not only more effectiveness with respect to faster onset of analgesia but also more safety by reducing the risk of neurological damage.

The two anaesthetists who were involved in the performance of CSA were not blinded to the type of needle because the needle can easily be identified by its design. In addition, the different techniques of dural puncture (Group 1: parallel vs Group 2: perpendicular) can only be performed knowing the respective type of puncture needle which is actually used.

Concerning the incidence of postoperative complaints, the directional needle has no advantage over the non-directional needle. However, differences in frequency of postdural puncture headache (PDPH) can only be revealed in a large number of younger patients. Due to the demographic characteristics of the patients, the present study allows no conclusion as to the incidence of PDPH

in relation to different spinal needles. Studies using single-dose anaesthesia have shown a reduction of PDPH using Whitacre or Sprotte needles compared with Quincke needles.¹⁹⁻²¹ However, the incidence of PDPH was also low (1%) in a group of 100 patients receiving CSA using a 22-gauge Quincke needle.⁵ The present data suggest that a potentially atraumatic lumbar puncture with blunt Sprotte needles does not reduce the incidence of post-operative backache. The relatively high incidence of backache in both groups may be caused by elimination of the lumbar curvature during the prolonged operations with a high percentage of lateral positions.²² Urinary dysfunction after spinal or epidural anaesthesia is often caused by a full urinary bladder associated with a long-lasting blockade of sacral nerves. In the present study, the use of urinary catheters may have prevented this complication.

In conclusion, the study demonstrated fewer technical problems and more cranially directed catheters using a directional needle for microcatheter insertion by the mid-line approach. These results were associated with faster onset of analgesia and lower dose requirement of local anaesthetics in patients who received microcatheter insertion through a Sprotte needle. The results suggest greater effectiveness and safety when microcatheters are inserted using directional needles rather than non-directional needles.

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