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ORIGINAL ARTICLE

Comparison of two spinal needle types to achieve a unilateral spinal block

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Abstract
Purpose Unilateral spinal anesthesia is beneficial in patients undergoing unilateral leg surgery. The direction and the shape of the spinal needle are thought to influence the unilateral distribution of the local anesthetic in the intrathecal space. Therefore, to study the effects of different spinal needles we compared the effects of the Whitacre and Quincke spinal needles.
Methods This was a prospective, randomized, double-blind study of 60 consecutive outpatients scheduled for unilateral lower-limb surgery. The patients were randomized to receive spinal anesthesia with 1.2 ml of 0.5 % plain bupivacaine using either a 27-G Whitacre or a Quincke needle. One half of the local anesthetic was injected towards the nondependent side and the other half was directed cranially. The spread of spinal anesthesia, both sensory and motor blocks, was defined as the primary endpoint and was recorded at 10, 20, and 30 min after the spinal injection, at the end of the operation, 2 h after the spinal injection, and every 30 min thereafter until there was no motor block. Secondary endpoints included patient satisfaction and adverse effects.
Results There was no difference in the spread of sensory or motor blocks between the Whitacre and the Quincke groups. However, the sensory and motor blocks on the operated and the nonoperated sides were significantly different at all testing times, as expected. There was no difference in the incidence of adverse effects or patient satisfaction scores between the Whitacre and the Quincke groups.
Conclusion Unilateral spinal block for outpatient surgery can be achieved with both pencil-point (Whitacre) and Quincke needles using 6.0 mg of plain bupivacaine. Neither the spread of sensory and motor blocks nor the corresponding recovery times appeared to be different between the groups. Nor was there any difference in patient satisfaction.

Keywords Spinal anesthesia · Unilateral · Bupivacaine · Needle type · Outpatient

Introduction

When surgery involves only one lower limb the possibility of obtaining a unilateral distribution of spinal anaesthesia is beneficial. A lateral position, a small dose of the local anesthetic, a slow speed of injection, and the choice of a directional spinal needle have been suggested to improve the unilateral distribution of spinal anesthesia [1–3]. The use of a unilateral technique also results in a higher concentration of the drug on the affected side and hence a reduced dose is needed. Very low doses, however, have been associated with an increasing incidence of failed spinal anesthesias [4, 5]. In order to direct the low dose of the anesthetic solution to the desired side as accurately as possible, the effect of different spinal needles should also be studied more precisely. A directional spinal needle has earlier been shown to facilitate the deposition of the spinal

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anesthetic solution at the desired site, at least when using hyperbaric bupivacaine [3]. On the other hand, the Whitacre needle orientation exerted a major influence on the sensory level and the duration of spinal anesthesia when isobaric spinal lidocaine was injected cranially or caudally [6].

The purpose of this prospective, randomized, double-blind study was to compare the effects of the Whitacre and Quincke spinal needles in achieving unilateral spinal anesthesia, when 1.2 ml of 0.5 % plain bupivacaine and a precisely defined orientation of the needle aperture were used for outpatient lower-limb surgery. The spread of spinal anesthesia, including both sensory and motor blocks, was defined as the primary endpoint. We hypothesized that the spread of the spinal block, both sensory and motor blocks, would be more unilateral using the Whitacre needle compared with the Quincke needle.

Subjects, materials, and methods

The study was approved by the Ethics Committee of Turku City Hospital, Turku, Finland (Chairperson P. Leppänen). Written informed consent was obtained from all patients prior to enrolment.

The study population was selected among outpatients. We enrolled 60 consecutive unpremedicated patients with American Society of Anesthesiologists (ASA) physical status I–III, ages ranging between 18 and 60 years, scheduled for unilateral lower-limb surgery, with spinal block being used as the sole anesthetic without any intraoperative sedation. A thigh tourniquet was used and inflated to 250–300 mmHg to provide a bloodless surgical site. Exclusion criteria were a previous history of intolerance to the study drug or related compounds and existing contraindications for spinal anesthesia. In addition, patients with a body mass index (BMI) of >30 kg/m^2 [7], and those with a history of alcoholism, drug abuse, or psychological or other emotional problems that were likely to invalidate informed consent were excluded. We did not enrol any patients who were pregnant or lactating, either.

The spinal anesthesias were performed in a separate induction area. Upon their arrival in this area, an intravenous cannula was placed in each patient, but no intravenous fluids or vasoactive drugs were given at this stage. Electrocardiograph and pulse oximetry were used as standard monitoring and the blood pressure was measured at 5-min intervals before and during the phases of induction, surgery, and recovery. Systolic pressure of <85 mmHg was defined as hypotension and was treated with etilefrine (Effortil® 10 mg/ml, Boehringer Ingelheim, Ingelheim, Germany) 3 mg. A decrease in heart rate below 40 beats per min was treated with atropine (Atropin 1 mg/ml; Leiras, Helsinki, Finland) 0.5 mg.

Using a sealed envelope technique, the patients were randomized to two groups. In the Whitacre group the spinal anesthesia was performed by using a 27-G Whitacre needle (Whitacre®; Becton–Dickinson, Madrid, Spain) and in the Quincke group a 27-G Quincke needle (Yale®; Becton–Dickinson) was used. In both groups a 20-G introducer was applied.

Patients were placed in the lateral position with the limb to be operated uppermost. The vertebral column was positioned as horizontally as possible, tilting the bed if needed. Dural puncture was performed in the midline at the L2-3 interspace. After a free flow of cerebrospinal fluid (CSF) had been observed, the needle opening was turned towards the nondependent side and half of the local anesthetic solution was injected. Thereafter the needle opening was turned cranially and the remaining half of the solution was administered. The local anesthetic was injected in 30 s without barbotage or aspiration. Both groups received 1.2 ml of 0.5 % plain bupivacaine (Bicain® spinal 5 mg/ml; Orion, Espoo, Finland) as anesthetic solution. The density of the plain solution is 1.000 g/ml at 20 °C, being slightly hypobaric. The lateral position was maintained for 30 min after the injection before the patient was turned supine for the operation. The patients, the nurses, and the anesthetist performing the motor and sensory block assessments were blinded for the spinal needle type used.

The motor block in the lower limbs was assessed using a scale with reference to specific myotomes by the anesthetist, who was unaware of the patient's treatment group. Myotomes from L2 to S1 were tested: L2 by hip flexion, L3 by knee extension, L4 by ankle dorsiflexion, L5 by great toe dorsiflexion, and S1 by ankle plantar flexion. The normal movement (no block) was scored as 0 and a complete block or an uncoordinated movement was 1 point. The total score was calculated for each side, the maximum score on each side being 5 out of 5 points. Both sides were tested separately. The sensory block, defined as a loss of sharp sensation, was tested bilaterally in the midclavicular line by using a pinprick test. Both sensory and motor blocks were tested at 10, 20, and 30 min after the spinal injection, immediately after the operation, 2 h after the

Table 1 Patient characteristics and duration of surgery

	Whitacre group	Quincke group	*p* Value
Women/men	19/11	22/8	
Age (years)	42 ± 11.4	45 ± 9.1	0.171
Height (cm)	169 ± 7.1	168 ± 8.1	0.543
Weight (kg)	70 ± 11.2	70 ± 11.6	0.884
Duration of surgery (min)	25 ± 14.7	31 ± 13.4	0.097

Values are means ± SD

spinal injection, and every 30 min thereafter until there was no motor block.

Returning from the operating room, the patients were asked about their opinion of the anesthesia, on a 3-point scale: 1 = good; 2 = satisfactory; 3 = poor. The operating surgeon was asked the same question. The patients were also asked to indicate the time when they believed that the anesthesia had completely worn off. The nurse in the day-surgery unit recorded the time when the patient drank, voided, and walked for the first time after the operation. The time of discharge from the day-surgery unit was recorded as well.

The patients were allowed to drink postoperatively and they received 100 mg of diclofenac orally. If this was not effective enough, per oral oxycodone 5–10 mg was given in accordance with the patient's age and weight. Postoperatively the patients were mobilized as soon as all signs of motor blockade had disappeared. The home discharge criteria consisted of stable vital signs, the absence of postoperative nausea or vomiting, no pain or minimal pain, no bleeding, and the ability to walk and void.

On the third postoperative day the patients were interviewed by telephone. They were inquired about a possible headache or backache and whether they would choose the same anesthesia next time for a similar operation. Once again the patients were also asked about their opinion of the anesthesia, on a 3-point scale: 1 = good; 2 = satisfactory; 3 = poor. Headache was classified as a postural puncture-type if it was aggravated by the erect or sitting position, was mainly occipital or frontal, and increased on coughing, sneezing, or straining. Backache was considered to represent transient neurological symptoms (TNS) if

Table 2 Recovery times

	Whitacre group	Quincke group	*p* Value
Time to drinking (min)	90 ± 25.8	95 ± 17.8	0.371
Time to walking (min)	213 ± 40.1	214 ± 50.8	0.946
Time to voiding (min)	245 ± 73.3	240 ± 62.4	0.776
Time to home-readiness (min)	285 ± 63.7	288 ± 78.7	0.873
Time to the subjective feeling that the anesthesia had completely worn off	315 ± 119.3	258 ± 65.8	0.026*

Values are means ± SD

* Significant difference between the groups

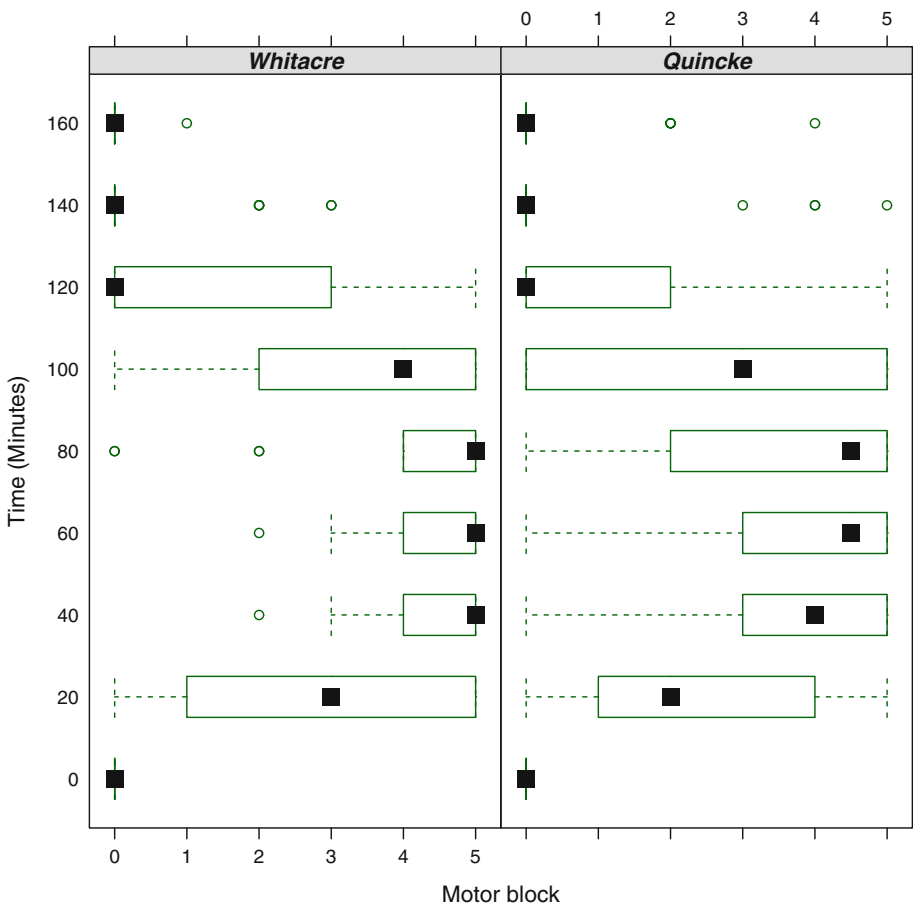

Fig. 1 Motor block score, operated sides. The sensory and motor blocks on the operated and nonoperated sides as the function of time from the injection of the local anesthetic solution (onset and offset). *Medians* are presented as *solid squares,* and *boxes* are the interquartile ranges (median ± 25 %). The *left whisker* ends at the observation, which is greater than or equal to the lower quartile minus 1.5 times the interquartile range. The *right whisker* ends at the observation, which is smaller than or equal to the upper quartile plus 1.5 times the interquartile range

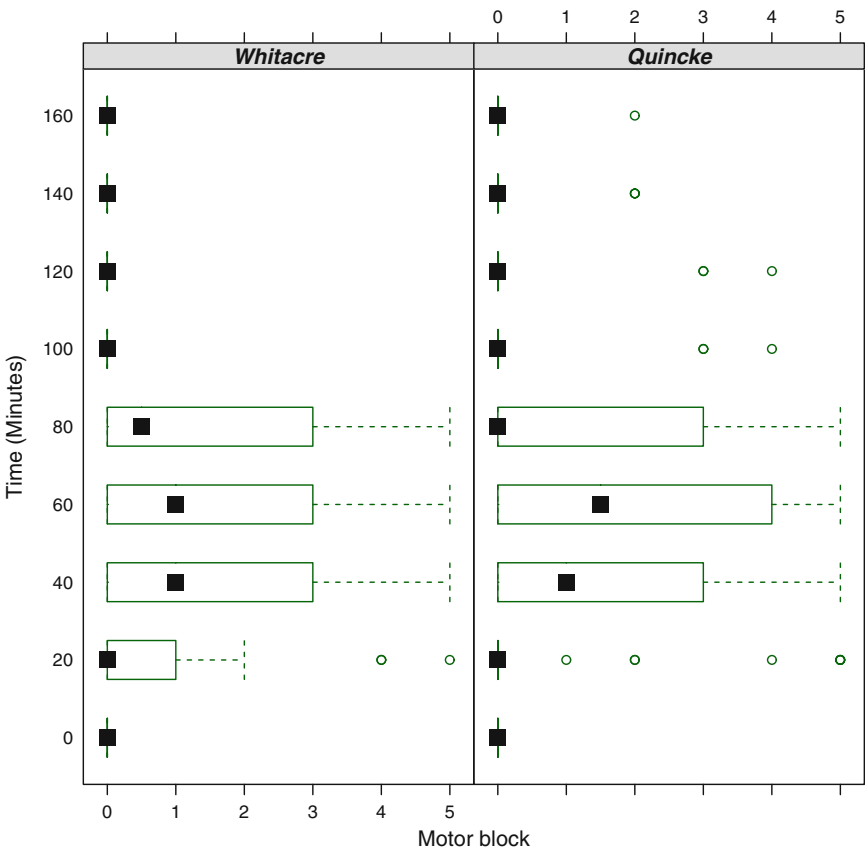

Fig. 2 Motor block scores, nonoperated sides. The sensory and motor blocks on the operated and nonoperated sides as the function of time from the injection of the local anesthetic solution (onset and offset). *Medians* are presented as *solid squares,* and *boxes* are the interquartile ranges (median ± 25 %). The *left whisker* ends at the observation, which is greater than or equal to the lower quartile minus 1.5 times the interquartile range. The *right whisker* ends at the observation, which is smaller than or equal to the upper quartile plus 1.5 times the interquartile range

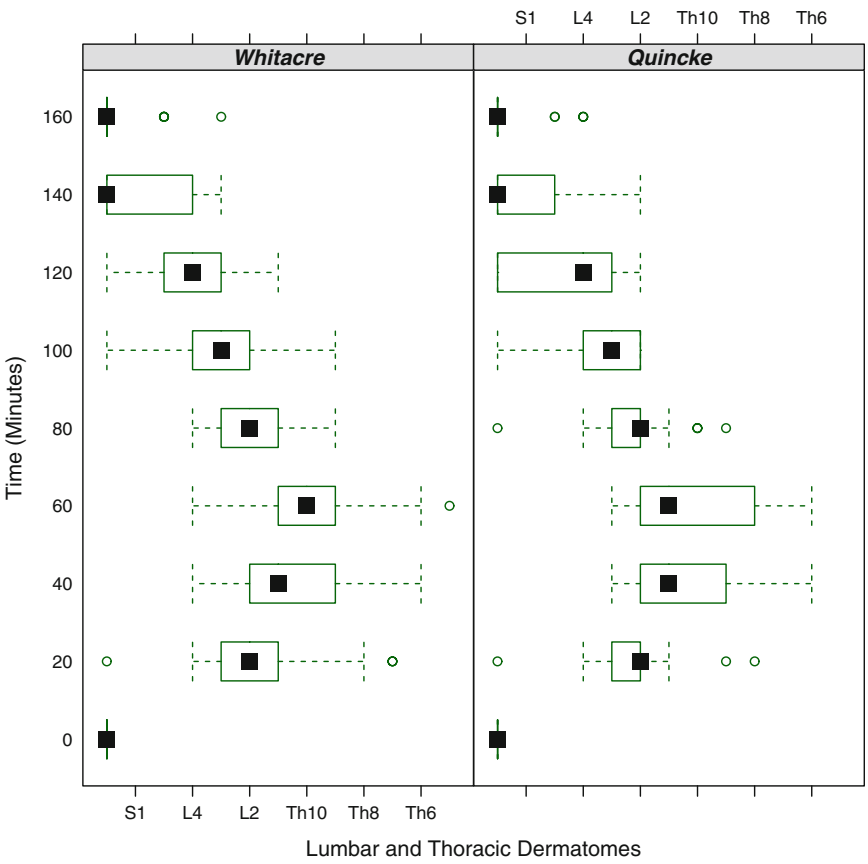

Fig. 3 Sensory block, operated sides. The sensory and motor blocks on the operated and nonoperated sides as the function of time from the injection of the local anesthetic solution (onset and offset). *Medians* are presented as *solid squares,* and *boxes* are the interquartile ranges (median ± 25 %). The *left whisker* ends at the observation, which is greater than or equal to the lower quartile minus 1.5 times the interquartile range. The *right whisker* ends at the observation, which is smaller than or equal to the upper quartile plus 1.5 times the interquartile range

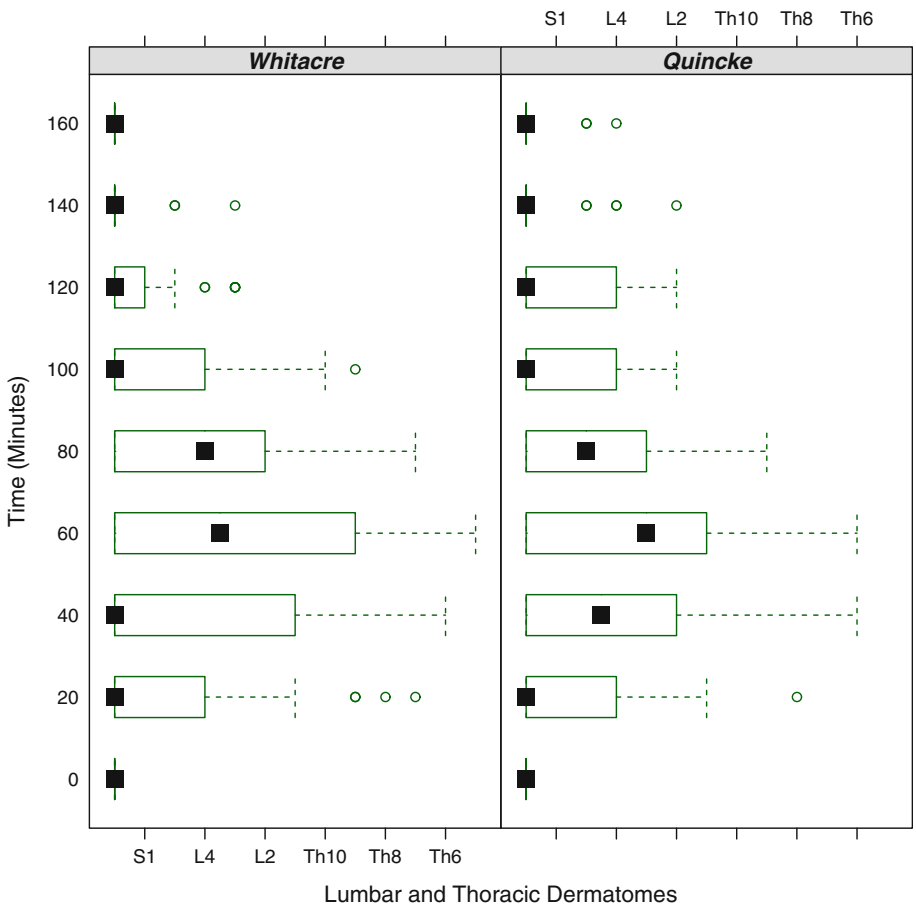

Fig. 4 Sensory block, nonoperated sides. The sensory and motor blocks on the operated and nonoperated sides as the function of time from the injection of the local anesthetic solution (onset and offset). *Medians* are presented as *solid squares,* and *boxes* are the interquartile ranges (median ± 25 %). The *left whisker* ends at the observation, which is greater than or equal to the lower quartile minus 1.5 times the interquartile range. The *right whisker* ends at the observation, which is smaller than or equal to the upper quartile plus 1.5 times the interquartile range

there was pain and/or dysesthesia in the back, buttocks, or legs after recovery, resolving within 72 h.

Statistical analysis

The calculation of the required number of patients was based on the difference of the motor block magnitude. Thirty patients in each group would provide a 0.80 power for the detection of a difference of 1 point between the groups in the motor block scale, which was considered clinically relevant. Statistical analysis was carried out using SAS version 9.2 TS2M3 (SAS Institute, Cary, NC, USA) software. Based on the design of the study the repeated measurements model was analyzed. Owing to the form of the distribution of response at different points of time, SAS-macro F1-LD-F1 for nonparametric repeated measurements (Abteilung Medizinische Statistik, Göttingen, Germany) was used for the analysis. Two separate test statistics were calculated to test needle and time effect [8]. Both tests gave the result, that time was the only significant factor ($p < 0.0001$). Needle and interaction with the time were always insignificant ($p > 0.1$).

For the analysis of patients' characteristics and the duration of surgery a simple ANOVA model (with the F test) was used. Values of p smaller than 0.05 were considered statistically significant.

Results

There was no difference between the two groups at baseline in the patients' characteristics or in the duration of surgery; these features are listed in Table 1. The times measured from the injection to the first drinking, walking, voiding, subjective feeling of total recovery from the sensory block, and the time to discharge are listed in Table 2. No patient suffered from urinary retention. Hypotension was observed in 3.3 % of the patients. The time to the subjective feeling that the anesthesia had completely worn off was longer in the Whitacre group ($p = 0.026$), but statistical significance between the groups was not reached in regard to the motor or sensory blocks.

The sensory block and the motor block assessments are shown in Figs. 1, 2, 3, and 4. There was no statistically significant difference between the groups. However, the sensory and motor blocks were significantly different between the operated and the nonoperated sides at all testing times, as expected. This means that the blocks were

unilateral in both groups. The motor block was completely unilateral in 27 % of the patients in the Whitacre group and in 30 % of the patients in the Quincke group (not significant; NS). The sensory block was completely unilateral in 27 % of the patients in the Whitacre group and in 23 % in the Quincke group (NS).

The incidence of postoperative headache was 8.3 % (5/60). One patient in the Quincke group (female, age 53 years) developed a post-dural puncture headache (PDPH) and two patients in each group suffered from a non-PDPH. Backache in one patient in the Quincke group was classified as TNS.

There was no difference in the patients' or surgeons' opinions of anesthesia between the groups. The patients and the surgeons classified the anesthesia to be good in all but one case in each group. All the patients, except for one in the Whitacre group, would choose the same type of anesthesia in the future, should a similar situation occur. No patient required general anesthesia for the surgery, but one patient in each group felt discomfort in the operation area. We note that the Quincke group lacked one patient's pain data. The other adverse effects are listed in Table 3.

Table 3 Adverse effects and pain

	Whitacre group	Quincke group	*p* Value
Pain in the operation area	1	1	0.496
Hypotension	0	2	0.116
Shivering	3	2	0.639
Itching	0	0	
Blood in the spinal needle	1	5	0.073
Paresthesia during the puncture	3	3	0.495
One attempted puncture	25	24	Needle and attempt $p = 0.896$
Two attempted punctures	2	3	
Three attempted punctures	3	3	
Nausea	2	4	0.667
Vomiting	0	0	
non-PDPH	2	2	
PDPH	0	1	
TNS	0	1	

TNS transient neurological symptoms, *PDPH* post-dural puncture headache

Discussion

Our study shows that a unilateral spinal block for outpatient surgery can be achieved with both the Whitacre and the Quincke needles. In this respect the use of a Whitacre needle combined with careful direction of the local anesthetic solution confers no additional advantage over a Quincke needle.

Compared with the Quincke spinal needle, at least when using hyperbaric bupivacaine, a directional spinal needle has been shown to facilitate the deposition of the spinal anesthetic solution to the desired site and to provide a more marked differential block of sensory nerve roots between the dependent and the nondependent sides. The observed differences in the motor block did not, however, reach statistical significance [3].

In our study, using plain bupivacaine, no marked difference could be found between the groups in the unilaterality of the spinal anesthesia, with both needles providing highly unilateral spinal anesthesia. The time to the subjective feeling that the anesthesia had completely worn off was longer in the Whitacre group, indicating that the block was more pronounced on the operation side in the Whitacre group. However, there was no statistically significant difference in the sensory and motor blocks. These differences (i.e., ?) have been observed when hyperbaric bupivacaine has been used [3, 9]. Hyperbaric solutions may be more easily directed to the operation side, because the baricity of the CSF and a clearly hyperbaric solution differ from each other distinctly more, compared with the difference between the CSF and plain bupivacaine used in our study.

The importance of the needle bevel on the path of the needle, when traversing the tissues, is emphasized when aiming at a unilateral spinal anesthesia with a low dose of local anesthetic. In an in vitro study, the Whitacre and Sprotte straight pencil-point needles have been found to deflect from the axis of insertion significantly less than Quincke needles do [10]. It has also been found that the Whitacre needle orientation exerts a major influence on the sensory level and the duration of spinal anesthesia when isobaric spinal lidocaine is used. The cephalad orientation of the needle aperture on injection resulted in significantly greater numbers of thoracic dermatomes being anesthetized compared with the caudad orientation of the needle aperture [6]. We used a 6.0-mg dose of plain bupivacaine and also made an attempt to direct the dose to the cephalad direction in order to prevent the patients from feeling tourniquet pain. In our study there was only one patient in each group who felt discomfort in the operation area and none who needed general anesthesia, this fact implying that the method was functioning.

In our study one patient in the Quincke group unfortunately suffered from PDPH for 3 days. In addition two

patients in each group had a non-specific postoperative headache. In general, true PDPH seldom occurs when a 27-G spinal needle is used, but postoperatively a non-specific headache is quite common [11, 12]. However, our study was not designed to evaluate the incidence of PDPH or the technical properties of the needles. Furthermore, the number of patients was far too small to reach any such conclusions. In addition, there was no difference between the groups regarding the number of attempted spinal punctures or paresthesias felt during the puncture. In the study by Eriksson et al. [13], the use of Whitacre spinal needles was associated with fewer technical difficulties, fewer multiple punctures of both the skin and the dura, and fewer failed blocks compared with the use of cutting spinal needles. However, a better performance with the Whitacre needle compared with the Quincke-type needle could not be found here. An optimal spinal needle should allow the clinician to identify the intrathecal space with ease and accuracy and to inject the local anesthetic in the subarachnoid space safely and accurately, causing PDPH as seldom as possible.

One limitation of this unilateral spinal anesthetic technique in a hectically functioning outpatient clinic is the extra time needed for the unilateral spinal block to develop. The main advantages of unilateral spinal anesthesia; for example, a reduced incidence of adverse effects such as bradycardia, hypotension, and urinary retention, will outweigh the possible time delay [1, 14–17]. The L2-3 interspace used in the present study can also be criticized in the light of current medical literature, because an anesthetist's ability to identify accurately the actual vertebral interspace is found to fluctuate and the vertebral interspace selected tends to be higher than the one intended [18]. In the future the L3-4 lumbar interspace should be preferred, combined with adjusting the posture of the vertebral column in order to ensure an adequate spread of the sensory and motor blocks [19].

In conclusion, a high-quality unilateral spinal block for outpatient surgery can be achieved with both the Whitacre and the Quincke needles using 1.2 ml of 0.5 % plain bupivacaine. Both the spread of the motor and sensory blocks and the corresponding recovery times appear to be no different between the groups. Furthermore, there is no difference in patient satisfaction.

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Conflict of interest The authors declare that they have no competing interests.

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