The effect of Pencan needle orientation on spinal anesthesia outcomes

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Slow resolution of block and incidence of side effects deter many practitioners from choosing spinal anesthesia for outpatient surgical procedures. Some studies suggest that controlling bevel or side port orientation of a spinal needle during anesthetic injection can affect occurrence of side effects and time to block resolution. The objective of this study was to determine the effects of varying Pencan spinal needle (B-Braun, Bethlehem, Pa) side port orientations on duration of block and incidence of side effects in groups of patients receiving spinal anesthesia.

We randomized 87 subjects scheduled for spinal anesthesia to receive a spinal anesthesia injection using a cephalad, lateral, or caudad side port orientation. Onset, duration, block height, incidence of side effects, and analgesic requirements were among the variables measured.

No difference in onset, duration, or analgesic requirements was noted among groups. Differences were noted in time to discharge from the hospital (P = .027) and time to first voiding (P = .023) in the lateral compared with the cephalad and caudad orientation groups.

Patients in whom the lateral needle side port orientation was used for injection were discharged earlier and had fewer side effects. This could translate into significant savings, financially and in terms of staff requirements.

Key words: **Bevel orientation, bupivacaine, fentanyl, Pencan spinal needle, spinal anesthesia.**

Outpatient surgery relies on the rapid induction, recovery, and discharge of the patient as a means of controlling costs. In studies comparing spinal anesthesia with general anesthesia, no unequivocal, compelling data have clearly distinguished the safety and efficacy of general anesthesia vs spinal block.[1-4] Therefore, cost may be an influential factor when choosing an anesthetic technique.

The cost of an anesthetic not only includes the cost of the individual medications administered, but also factors in the relative cost of the care required following the surgical procedure. This postsurgical care includes time required in the postanesthesia care unit (PACU) and same-day surgery units (SDSU), and this time can account for a significant portion of the overall cost.[5] Patients must remain in the PACU and SDSU until anesthesia has resolved sufficiently to allow for discharge and side effects of anesthesia such as nausea, vomiting, and pain are controlled. Of these, resolution of the anesthetic is the most difficult aspect to control and is largely a reflection of the anesthetic technique.

Two of the most common anesthetic techniques used for surgical procedures are general and spinal anesthesia. Both techniques have advantages and disadvantages. A patient in whom a spinal technique was used typically reports less postoperative nausea than a patient undergoing general anesthesia but has a higher incidence of urinary retention, often resulting in a delay in time to discharge.[5] There have been studies that have analyzed the impact of the method of anesthesia as it relates to inpatient hospital times and overall institutional cost. For example, Song et al[5] reported that patients who had undergone a spinal anesthetic were discharged from the PACU an average of 5 minutes earlier than those who had general anesthesia but remained in the SDSU an average of 108 minutes longer. This longer duration translated into an additional cost of $40.00 per patient.[5]

To produce effective surgical anesthesia while reducing the postoperative duration of spinal blockade, the anesthetist must have a strong understanding of the variables influencing the distribution, onset, and duration of spinal anesthesia. In a pair of significant meta-analyses, Greene[6,7] reviewed the published literature on spinal anesthesia and developed a frame-

work describing these variables by their controllability: uncontrollable or intrinsic, such as vertebral column abnormalities and height, and controllable or extrinsic, such as spinal technique and pharmacology. Controllable features of the spinal technique included needle approach (paramedian or midline), needle angle, needle insertion level, side port orientation (in the case of side-aperture needles), and the patient's position during and after injection of the spinal medication. Aspects of pharmacology that affected the characteristics of the resulting spinal block included local anesthetic baricity, concentration, volume, and vasoconstrictor content.[6,7] Clinical studies typically focus on measuring the effects of manipulating one or more of the extrinsic variables while attempting to control the intrinsic variables as much as is feasible.

Although they are used clinically for their efficacy in reducing the incidence of postdural puncture cephalgia,[8] pencil-point, side-aperture needles such as the Sprotte, Whitacre, and Pencan (product code P25BK, B-Braun, Bethlehem, Pa) also allow for controlled variance of the stream of anesthetic solution during injection, and numerous studies have been performed to examine the relationship between varying side port orientation and the characteristics of the ensuing anesthetic. However, the focus of previous research has been on block onset and distribution rather than on duration,[9-12] with two exceptions.[13,14] The results of previous studies are inconsistent due to the variety of techniques and small samples used, limiting their applicability to current practice. In addition, these previous studies did not assess the impact of the inclusion of an opioid, as part of the spinal anesthetic admixture, on onset, distribution, and duration of spinal anesthesia when a pencil-point needle was used.

The purpose of this study was to determine whether manipulation of the side port of a 25-gauge pencil-point needle during injection of a hyperbaric bupivacaine-fentanyl admixture would have an impact on the onset, block height, and duration of a spinal anesthetic. More specifically, we wanted to determine the influence of spinal needle side port orientation on length of times to discharge from the PACU, SDSU, and hospital and the length of time to first voiding.

Methods

A convenience sample of 92 patients undergoing lower extremity and inguinal hernia surgery and requesting spinal anesthesia were enrolled in this investigational review board–approved study. Exclusion criteria included contraindications to receiving a spinal anesthetic; documented allergy to fentanyl or bupivacaine; pregnancy; obesity (body weight ≥ 40% over ideal); lordosis, kyphosis, or scoliosis deemed excessive by clinical judgement of the anesthesia provider; history of chronic back pain; patients younger than 18 years or older than 65 years, and an ASA physical status of III or more.

All patients requesting a spinal anesthetic in the preoperative anesthesia area for lower extremity or inguinal hernia surgery were identified as potential candidates for inclusion in this study. During the preoperative interview, potential subjects were provided an information sheet that described the objectives and parameters of the study. All potential subjects were informed that participation was voluntary and that informed consent would take place in the preanesthetic clinic the morning of surgery by one of the investigators. Once informed consent was obtained, a random numbers table was used to assign subjects to 1 of 3 groups by side port orientation for the injection: group 1, caudad; group 2, lateral; or group 3, cephalad.

After informed consent was obtained, demographic data, which included age, height, weight, sex, and ASA physical class, were collected and recorded on the data collection sheet. An intravenous (IV) catheter was inserted, and each subject was prehydrated with 1 L of lactated Ringer's solution before placement of the spinal anesthetic. Preoperative anxiety was treated with 0 to 5 mg of IV midazolam and/or 0 to 100 µg of IV fentanyl titrated as needed in the preoperative holding area and during spinal anesthetic placement. All opioids and anxiolytics administered were noted and recorded on the data collection sheet. In the operating room, the subject was moved to the operative table and a noninvasive blood pressure cuff, a continuous electrocardiographic monitor, and a continuous pulse oximeter were applied. Baseline vital signs were taken and recorded on the anesthesia record and data collection sheet.

After baseline vital signs were obtained, all subjects were placed in a sitting position and the subject's back was examined and the skin cleansed with povidone iodine or Techni-Care (Care-Tech Laboratories, Inc, St Louis, Mo) solution from lumbar section 1 (L1) to sacral section 1 (S1). A sterile drape was applied, and the skin was infiltrated with 2 to 3 mL of a 1% lidocaine solution to provide dermal anesthesia over the chosen interspace (L2-L3, L3-L4, or L4-L5).

Once dermal anesthesia was established, a 20-gauge introducer needle was inserted through the anesthetized area. A 25-gauge Pencan spinal needle was inserted through the introducer needle and advanced until a free flow of cerebrospinal fluid was obtained. All subjects were observed for the presence

of paresthesia, blood in the cerebrospinal fluid, or both. If no paresthesia or blood was noted and free flow of cerebrospinal fluid was observed, it was determined that the spinal needle was in the correct position within the subarachnoid space and the side port was oriented to a cephalad, caudad, or lateral orientation as determined by the random group assignment. A spinal anesthetic dose containing 7.5 to 15 mg of 0.75% bupivacaine (methylparaben free) in 8.25% dextrose with 25 µg of fentanyl was injected. The spinal needle and syringe then were removed as a single unit, and the subject was placed in a supine position on the table.

The time of injection and the total doses of bupivacaine and fentanyl given were recorded on the data collection sheet. Blood pressure, electrocardiographic, and pulse oximeter readings were obtained and recorded on the anesthesia record immediately following injection and every 2 to 3 minutes thereafter for the next 20 minutes. Vital signs were obtained and recorded every 5 minutes for the duration of the operation until transfer to the PACU.

Sensory anesthesia was determined by using a Semmes-Weinstein Monofilament (Sammons Preston Rolyan, Bollingbrook, Ill). This device permits application of a 6.65 monofilament thread to the skin at a fixed pressure of 279.4 g of force. Neurologists use this device to assess deep pressure sensation because it applies an accurately reproducible force. These assessments were performed immediately after injection and every 2 minutes thereafter for 10 minutes and recorded on the data collection sheet. Sensory levels for each dermatome were recorded for each side to determine whether unilateral blockade occurred.

All subjects were monitored for hypotension, nausea, pain, and anxiety throughout the surgery. Hypotension was treated with additional infusions of lactated Ringer's solution and 5 to 10 mg of IV ephedrine repeated every 5 minutes as necessary up to a total of 30 mg. Nausea was treated with 4 mg of IV ondansetron every 5 minutes as necessary, up to a total of 8 mg. Pain was treated as necessary with 0 to 250 µg of IV fentanyl. Anxiety was treated with 0 to 10 mg of midazolam or 0 to 100 mg of IV propofol at the discretion of the anesthetist. All antihypotensives, intravenous fluids, antiemetics, analgesics, and anxiolytics administered intraoperatively were recorded on the anesthesia record and the data collection sheet.

Following surgery, subjects were transported to the PACU. The admission Aldrete score was documented on the PACU data collection sheet. The sensory anesthesia level again was assessed using the Semmes-Weinstein monofilament on arrival and every 15 minutes thereafter until discharge from the PACU. The time to return of motor function was determined as the time from admission to the PACU to the time in which subjects could independently lift their hips and slide onto a transport gurney. Sensory and motor block assessments were recorded on the PACU data collection sheet.

Pain was assessed by asking subjects to rate their pain using a verbal analog scale (VAS) from 0 to 10, with 0 indicating "no pain" and 10 indicating "the worst pain imaginable." Pain assessments were made on admission and discharge from PACU and immediately before and every 30 minutes following administration of analgesics until discharge from PACU. All VAS scores and analgesics administered were recorded on the data collection sheet. Any incidence of nausea was treated with 4 mg of IV ondansetron, which was repeated once after 5 minutes, up to a total dose of 8 mg, as necessary and recorded on the data collection sheet. Subjects were discharged when standard PACU discharge criteria were met, and the time of discharge and the discharge Aldrete score were recorded.

Following discharge from the PACU, all subjects were transported to the SDSU. Pain was treated with analgesics according to the attending surgeon's orders and the treatment provided recorded on the SDSU data collection sheet. If any analgesics were administered, subjects were reassessed for pain using the VAS every 30 minutes after administration. Nausea was treated with 4 mg of IV ondansetron repeated every 5 minutes to a maximum of 8 mg. Any incidence of nausea was recorded on the data collection sheet. Subjects were released to home when standard discharge criteria were met, and the time of discharge was documented on the SDSU data collection sheet.

Before discharge, the subject's attending surgeon prescribed an analgesic for treatment of pain following discharge to home. All subjects were provided with a take-home data collection form and instructed to record the time and amount of any analgesic medications taken and any nausea, vomiting, or headache within 24 hours of discharge. To obtain data recorded at home, we contacted patients by telephone 16 to 24 hours after discharge. All analgesic doses were converted to morphine equivalents for data analysis and recorded on the postdischarge data collection sheet.

Before initiation of this study, a power analysis was calculated in which a mean ± SD difference of 20 ± 25 minutes in time to discharge from the hospital would be noted among the groups. By using an α of .05 and a β of .2 ($1 - \beta$ of 0.08), we determined in our initial investigational review board–approved study design that a sample size of 35 subjects per group was needed

with 5 additional subjects per group for attrition, for a total of 120 subjects. While conducting the research, an interim data analysis showed significance after accrual of 75 subjects (25 subjects per group). This data analysis was performed by an investigator not involved in data collection (J.E.P.), and the decision was made to continue to enroll subjects until approximately 30 per group (90 total subjects) were enrolled. All investigators involved in data collection remained blinded from the final data analysis until the data collection was completed.

Statistical analysis was performed using SPSS software, version 12.0 (SPSS Inc, Chicago, Ill). Results are expressed as mean ± SD. All normally distributed continuous variables were analyzed by 1-way analysis of variance adjusted for unequal groups and the Scheffe correction for multiple comparisons. Block heights and the number of dermatomes blocked in the 3 groups were assessed with the Kruskal-Wallis test. If there were significant differences, the analysis was continued with post hoc comparisons of differences among the groups using the Mann-Whitney *U* test. Differences in nominal categorical data among the study groups were tested by using the χ^2 test. A *P* value of less than .05 was considered significant.

Results

Data were collected from 92 subjects; 5 subjects were withdrawn from the study: medical complications unrelated to anesthesia or surgery, 1; inability to place the spinal anesthetic, 2; administrative reasons, 1; and complete failure of the spinal anesthetic to take effect, necessitating conversion to general anesthesia, 1. Of the remaining 87 patients, analysis of the data yielded no statistically significant differences in demographic variables, surgical or anesthesia times, amount of spinal bupivacaine given, or intraoperative analgesic and sedative medication requirements among the groups (Table 1). No statistically significant differences in relation to time to block setup, number of attempts required to place the spinal anesthetic, incidence of side effects, or VAS pain scores were noted among the groups. In addition, no differences in sensory dermatome levels were noted among groups at any of the timed intervals (Table 2).

No statistically significant differences in time to discharge were noted among groups in relation to total time in PACU or SDSU, although SDSU time approached significance (*P* = .06) in the lateral group compared with the other groups. When total time in the hospital was analyzed, defined from the time of spinal injection until the patient met hospital discharge criteria, significant differences were noted among group 1, caudad (372 ± 102 minutes); group 2, lateral (308 ± 57 minutes); and group 3, cephalad (388 ± 155 minutes) (*P* = .027). A difference in time to first voiding also was noted among groups; group 2 voided sooner (280 ± 67 minutes) than groups 3 (332 ± 93 minutes) and 1 (342 ± 94 minutes) (*P* = .02) (Figure). Analysis of postdischarge analgesic requirements revealed no differences among groups 3 (6.93 ± 4.5 mg), 1 (5.53 ± 4.8 mg), and 2 (5.01 ± 3.0 mg) (*P* = .28). Headache was reported by 3 patients after discharge, 2 from group 3 and 1 from group 1. In all 3 cases, the headache responded to the analgesics prescribed for the surgical pain and no further treatment was required. No incidences of postdischarge nausea or neurological complications were reported.

Table 1. Demographic and independent variables*

	Group 1 Caudad (n = 31)	Group 2 Lateral (n = 26)	Group 3 Cephalad (n = 30)
Age (y)	35.0 ± 10.0	36.5 ± 10.5	31.1 ± 7.9
Weight (kg)	87.6 ± 12.8	92.5 ± 14.9	90.0 ± 14.6
Height (in)	70.2 ± 3.4	70.3 ± 2.1	70.4 ± 3.2
Median (range) dose of spinal bupivacaine (mg)	12 (9-15)	12 (9-15)	12 (9-15)
Sex (n)			
Male	27	25	27
Female	4	1	3
Surgical time (min)	49.9 ± 24.5	49.5 ± 22.9	62.9 ± 46.0
Intraoperative fentanyl requirements (μg)	27.0 ± 44.5	21.2 ± 48.0	29.2 ± 33.0

* Data are given as mean ± SD unless otherwise indicated.

Discussion

The absence of statistically significant differences among groups in relation to time to block setup, differential block dermatomal levels, duration of motor blockade, number of attempts to perform the block, VAS pain scores, and the incidence of side effects is not surprising, given the findings of previous studies. Some previous studies reported higher levels of anesthesia when the side port was oriented cephalad,[9,10,13] whereas others reported a faster onset of block with the same intervention.[8,13] Only 1 study found no significant difference in block development with cephalad vs caudad orientation.[11]

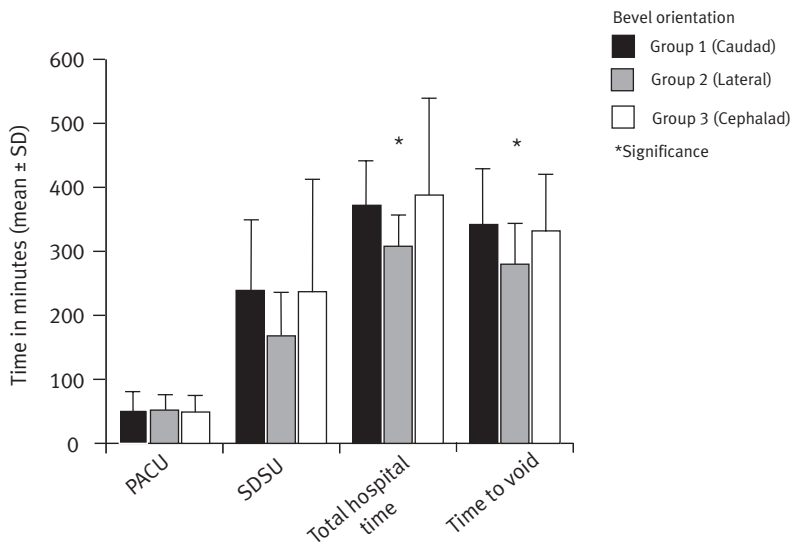
The only studies conducted thus far examining the relationship between pencil-point needle orientation and anesthesia duration are those of Neigh et al[10] and Urmey et al.[14] In 1970, Neigh et al[10] reported the

Table 2. Average sensory levels at 0, 2, 4, 6, 8, and 10 minutes following spinal anesthetic placement*

Time measurements (min)	Side port orientation					
	Group 1 (Caudad)		Group 2 (Lateral)		Group 3 (Cephalad)	
	R side	L side	R side	L side	R side	L side
0 (baseline)	L2 (± 3.8)	L2 (± 3.5)	L3 (± 3.4)	L3 (± 3.2)	L2 (± 3.8)	L3 (± 3.5)
2	T10 (± 2.9)	T10 (± 2.8)	T11 (± 2.6)	T11 (± 2.7)	T10 (± 1.9)	T10 (± 2.0)
4	T9 (± 2.7)	T8 (± 2.9)	T9 (± 2.5)	T9 (± 2.5)	T8 (± 1.9)	T8 (± 2.1)
6	T8 (± 2.7)	T7 (± 2.7)	T7 (± 2.1)	T8 (± 2.3)	T7 (± 2.3)	T7 (± 2.3)
8	T7 (± 3.0)	T7 (± 2.8)	T7 (± 2.0)	T7 (± 2.3)	T7 (± 2.1)	T7 (± 2.3)
10	T6 (± 3.0)	T6 (± 2.8)	T6 (± 2.3)	T6 (± 2.4)	T6 (± 2.3)	T6 (± 2.5)

* Numbers in parentheses are the SDs expressed in dermatomes. No differences among groups were noted in sensory dermatome block height noted at any time interval.

Figure. Time in the postanesthesia care unit (PACU) and same-day surgery unit (SDSU), total hospital time, and time to first voiding



Significant differences were noted between the lateral orientation group and the cephalad and caudad groups in total hospital time and time to voiding.

effects of needle type (22-gauge Quinke vs 22-gauge Whitacre), side port orientation (cephalad vs caudad), and injection speed (1 mL/s vs 0.2 mL/s) on the characteristics of hyperbaric tetracaine spinal administered with the patient in the sitting position. The data were limited to an initial sensory level after injection, a sensory level 10 minutes after injection, and time to resolution of motor block as indicated by the ability to dorsiflex either great toe. They concluded that injection performed with the Whitacre needle with a cephalad side port orientation produced significantly higher levels of anesthesia compared with a caudad orientation but found no significant difference in anesthesia duration with varying side port orientations. Major differences in methods between our study and that of Neigh et al[10] include their use of tetracaine and 22-gauge Whitacre and Quinke needles as compared to our use of bupivacaine, 25-gauge Pencan needle, and the addition of 25 µg of fentanyl to the anesthetic admixture in our study.

More recently, Urmey et al[14] compared the effects of caudad and cephalad side port orientation using an isobaric lidocaine spinal injection solution administered via a 27-gauge Whitacre needle with the patient in the right lateral decubitus position. Variables assessed included the distribution and duration of block, the return of motor function, and the time to spontaneous urination and discharge. In addition to having significantly lower levels of anesthesia, subjects in the caudad orientation group required approximately 30 minutes longer to urination and hospital discharge than patients in the cephalad group.[14] While those results are mirrored in our study, the significant difference noted among groups in our study was that injection with a lateral side port needle orientation correlated with a significant difference in time to discharge and spontaneous urination.

Based on these results, we conclude that a lateral needle orientation leads to earlier return of motor function, earlier time to first urination, and faster time to discharge from the hospital. When compared with the results of previous studies,[6,9-13] differences that could account for this observation may be the position of the patient, baricity of the solution, the inclusion of fentanyl, or the use of the Pencan needle as opposed to the Whitacre needle used in the study by Urmey et al.[14] It is unlikely that these differences account for the variations observed because of the similarity in results reported when the cephalad and caudad orientations are used. It would be interesting to repeat this study using Pencan and Whitacre needles and an isobaric solution to determine whether similar results could be obtained. Although the direction of lateral orientation (right vs left) was not predetermined, it was noted that right and left lateral orientations were used in equal distributions; when analyzed separately, similar results were found. Therefore, based on this finding, the data for right and left lateral orientations were combined into a single group for analysis.

Conclusion

To our knowledge, this is the first study of the effects of varying side port orientations in combination with an intrathecal opioid on discharge criteria for ambulatory surgery patients. The addition of fentanyl to intrathecal local anesthetics has been found to improve analgesia and anesthesia without prolonging motor blockade, sympathetic blockade, or time to voiding after surgery.[15,16] The significantly shorter time to first postoperative voiding and to hospital discharge observed in group 2 (lateral) was unexpected. Our initial hypothesis was that our findings would parallel those of Urmey et al,[14] with patients in group 2 displaying characteristics intermediate to those of patients in groups 1 (caudad) and 3 (cephalad). Further study is needed to evaluate the significance of this phenomenon.

Improvements addressing the weaknesses of this study would include the administration of a fixed dose of bupivacaine to all patients and measuring Bromage scores and temperature differentiation postoperatively to assess for possible differences in time to complete resolution of motor and sympathetic blockade. Of the utmost importance to any future study of this phenomenon is the need to use the same intrathecal agents and the sitting position during injection; otherwise it will be difficult to draw any salient conclusions.

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