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Combined Spinal-Epidural Anesthesia for Outpatient Surgery

Dose-Response Characteristics of Intrathecal Isobaric Lidocaine Using a 27-Gauge Whitacre Spinal Needle

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Background: Combined spinal-epidural anesthesia (CSE) may offer theoretic advantages for outpatient surgery, because it produces the rapid onset of spinal anesthesia, with the option to extend the blockade with an epidural catheter. In this study, the authors attempted to determine an appropriate initial dose of a short-acting local anesthetic, 2% lidocaine, to administer for outpatient knee arthroscopy using CSE.

Methods: Data were collected from 90 patients undergoing outpatient knee arthroscopy. Using a double-blinded, prospective study design, patients were randomly assigned to receive CSE with an initial dose of intrathecal 2% lidocaine of 40, 60, or 80 mg. A 27-G $4^{11}/_{16}$ -inch Whitacre needle was placed through a 17-G Weiss needle. Onset and regression of sensory anesthesia and motor blockade were measured by a blinded observer at frequent intervals.

Results: All 90 patients had adequate anesthesia. Durations of thoracic and lumbar sensory and lower limb motor blockade were significantly shorter in the 40-mg group compared with the 60- or 80-mg groups ($P < 0.0002$ Mantel-Cox, Survivorship Analysis). Indices of neural blockade resolved 30-40 min more rapidly in the 40-mg group than in either the 60- or 80-mg group. Times to urinate, sit upright in a chair, take oral fluids, and be discharged were all significantly shorter (between 30 and 60 min) in the 40-mg group compared with the 60- and 80-mg groups ($P < 0.01$). Seven patients required intraoperative epidural supplementation: three in the 40-mg group, three in the 60-mg group, and one in the 80-mg group.

Conclusions: Combined spinal-epidural anesthesia with a 40-mg initial intrathecal dose of lidocaine provided reliable anesthesia for knee arthroscopy. Duration of spinal anesthesia with lidocaine was dose related. (Key words: Anesthesia: ambulatory. Anesthetics, local: lidocaine. Anesthetic technique: combined spinal-epidural anesthesia.)

REGIONAL anesthesia offers advantages and disadvantages for outpatient surgery. Advantages include lower incidences of postoperative nausea and vomiting, dizziness, disorientation, and somnolence, as well as a smoother transition to postoperative analgesia.¹⁻³ Disadvantages of regional techniques for lower extremity surgery include a potential delay in onset or prolongation in offset of neural blockade that may inhibit the efficiency of the ambulatory unit. Prolonged duration of anesthesia, beyond the necessary surgical time, may result in delayed mobilization, postural hypotension, and urinary retention, any of which may prevent timely discharge.

Combined spinal-epidural anesthesia (CSE) has previously been demonstrated to have properties that make it a useful technique for obstetric and inpatient anesthesia.⁴⁻⁸ With proper patient and needle selection, we believe that CSE may offer advantages over both spinal and epidural anesthesia for outpatient surgery, as well. Compared with spinal anesthesia, CSE offers increased flexibility, because the anesthetic duration can be extended using the epidural catheter. Combined spinal-epidural anesthesia may also provide a decreased duration of anesthesia by allowing administration of the minimal intrathecal dose required to establish the initial level of surgical anesthesia. This is made possible because of the confidence afforded by the continuous technique as a backup. Compared with epidural anesthesia alone, CSE has a shorter onset and virtually eliminates one of the most serious complications of epidural anesthesia, clinically relevant intravascular injection.

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We proposed that CSE, with an initial intrathecal dose of 40 mg, may provide short duration of anesthesia with the flexibility of a continuous technique. This study determined the dose-response characteristics of lidocaine, providing a basis for the initial intrathecal dose when

Materials and Methods

Data were collected from 90 patients using a randomized double-blind design. Patients were ASA physical status I-II, scheduled for ambulatory knee arthroscopy, and were recruited for the study without contraindications to spinal anesthesia. After Institutional Review Board approval, written informed consent was obtained from each patient using a computerized system.

Patients were randomly assigned to receive CSE with one of three initial intrathecal doses of 2% isobaric lidocaine: 40, 60, or 80 mg. The study was conducted at the Hospital for Special Surgery, North Chicago, IL.

For the original study of CSE, a dose-response table for 100 patients was developed. The study groups were 80, 60, and 40 mg. The initial intrathecal CSE dose was 40 mg. Patients were randomly assigned to one of the three groups. Each patient who received CSE was given an equivalent spinal anesthesia.

The 30-mg dose group was not included in the study because of a table limited to 40, 60, or 80 mg intrathecal doses and because of the

Patients received no premedication, limited to a maximum of 50 mg of propofol. No opioids or other sedatives were administered intraoperatively. All patients were monitored with standard monitors: electrocardiogram, pulse oximetry, and arterial blood pressure. (Critikon, Tampa, FL) pulse oximeter. Heart rate and arterial blood pressure were recorded for the duration of the procedure. Bradycardia was defined as a heart rate of less than 50 beats per minute and a systolic blood pressure of less than 90 mm Hg at any point in time.

After placement of an epidural catheter, 500 ml of lactated Ringer's solution was administered. Spinal-epidural anesthesia was maintained by intrathecal injection of 2% lidocaine into the interspace with patients in

DOSE-RESPONSE OF INTRATHECAL ISOBARIC LIDOCAINE

We proposed that CSE, with a small but effective initial intrathecal dose of short-acting local anesthetic, may provide short duration, fast onset, and the flexibility of a continuous technique for ambulatory surgery. This study determined the dose responses for 2% lidocaine, providing a basis to choose the initial dose to inject intrathecally when performing CSE.

Materials and Methods

Data were collected prospectively from 90 patients using a randomized, double-blinded study design. Patients were ASA physical status 1–3 who were scheduled for ambulatory knee arthroscopy. Patients recruited for the study were 18–60 yr of age and were without contraindication to spinal or epidural anesthesia. After Institutional Review Board approval and written informed consent, patients were randomly assigned using a computer-generated random sequence to receive CSE with one of three initial intrathecal injection doses of 2% isobaric plain lidocaine (Abbott, North Chicago, IL): 40, 60, or 80 mg (2, 3, or 4 ml).

For the original study design, we devised a randomization table for 100 patients randomly assigned to four study groups: 80, 60, 40, and 30 mg 2% lidocaine as the initial intrathecal CSE dose. A few patients were studied from this table, including two patients who were randomly assigned to receive 30 mg 2% lidocaine. Each patient who received 30 mg lidocaine had inadequate spinal anesthesia. As a result, we eliminated the 30-mg dose group. We created a new randomization table limited to 40-, 60-, or 80-mg lidocaine 2% initial intrathecal doses and began the study again.

Patients received no premedication and sedation was limited to a maximum of 10 mg intravenous midazolam. No opioids or other analgesics were administered intraoperatively. All patients had the following monitors: electrocardiogram, automated blood pressure cuff (Critikon, Tampa, FL) every 3 min, and finger pulse oximeter. Heart rate and blood pressure trends were recorded for the duration of the operative procedure. Bradycardia was defined before data collection as a heart rate of less than 50 beats/min and hypotension as a systolic blood pressure of less than 80 mmHg at any point in time.

After placement of an intravenous catheter, patients received 500 ml lactated Ringer's solution. Combined spinal-epidural anesthesia was performed and initial intrathecal injection was administered at the L3–L4 interspace with patients in the right lateral decubitus po-

sition using a midline approach. The L3–L4 interspace was operationally defined as the first palpable interspace that was cephalad to the iliac crest. A 17-G Weiss needle was inserted into the epidural space using loss of resistance. A 27-G, $4\frac{1}{16}$ -inch Whitacre point spinal needle (Becton-Dickinson, Franklin Lakes, NJ) was then placed through the 17-G, $3\frac{1}{2}$ -inch (patients 1–49) or 3-inch (patients 50–90) Weiss epidural needle. The Whitacre aperture was directed laterally, toward the operative knee, for the entire injection. Ability to aspirate CSF was assessed after each 1-ml increment of the intrathecal injection. The spinal needle was then removed and a 20-G (B. Braun Medical, Bethlehem, PA) epidural catheter was inserted 3 cm into the epidural space.

If the dural puncture attempt with the Whitacre needle through the Weiss needle at L3–L4 was unsuccessful (defined as no spontaneous CSF flow on removal of stylet), the Whitacre needle was removed and an epidural catheter was advanced through the Weiss needle. After this, spinal anesthesia using a separate 27-G Whitacre needle spinal was performed in the same interspace using a 20-G spinal introducer inserted just lateral to the epidural catheter.

Supplementation of the original spinal anesthetic by use of the epidural catheter was done by a separate anesthesiologist (blinded to the original intrathecal dose) according to strict criteria. Criteria for epidural supplementation were: (1) patient movement of the lower extremities, (2) surgeon complaint of inadequate muscle relaxation, or (3) patient discomfort. Reinforcement was with 5-ml increments of 2% lidocaine after a record of the patient's pain (0 = no pain to 10 = worst imaginable pain). This was repeated every 3 min, if required, to a maximum reinforcement dose of 15 ml.

After injection of intrathecal lidocaine, a single, blinded observer measured onset and regression of thoracic and lumbar sensory anesthesia by pinprick and motor blockade by use of the Bromage scale.⁹ For motor testing, a score of 0 = no paresis, full movement; 1 = partial paresis, ability to flex knee only; 2 = partial paresis, ability to flex foot only; and 3 = full paresis, no movement. Assessment of perirectal sensation was not performed. Measurements were made at 5, 10, 15, 20, 30, 40, 50, and 60 min and every 15 min thereafter until complete resolution of anesthesia. Measurements began preoperatively were continued intraoperatively and into the postoperative period.

Times were measured and recorded by postanesthesia care unit nurses (who were unaware of the original

intrathecal dose) for each of the following milestones: ability to sit unassisted in a chair, first spontaneous urination, initiation of oral intake, and ambulatory unit discharge. Strict criteria were used by these nurses in judging patients ready for discharge.³ These included all of the following requirements: complete resolution of thoracic and lumbar sensory anesthesia and motor blockade, return of vital signs and mental status to pre-anesthetic levels, ability to urinate, ability to ambulate, adequate analgesia, and absence of nausea and vomiting. Follow-up phone calls were done by ambulatory surgical nurses (who were blinded to treatment) to elicit symptoms consistent with postdural puncture headache or other complications in all patients on postoperative days 1 and 3, using a standardized questionnaire.

Statistical analysis was by ANOVA, chi-squared, or Kruskal-Wallis nonparametric analysis. To define differences in resolution of thoracic sensory, lumbar sensory, and lower extremity motor blockade, the time to full resolution of each of these was measured and survival analysis was performed with between-group comparisons using a Mantel Cox test. To account for multiple comparisons, α was set at 0.01.

Results

Patient Characteristics

Ninety-nine patients were randomized; two of these were excluded because of surgical reasons (changes in procedure from preoperative diagnosis). An additional seven patients who consented to be studied were excluded because it was difficult to perform the procedure while they were in the lateral decubitus position because of obesity or scoliosis. Subjectively, all 90 patients had high-quality spinal anesthesia, and epidural reinforcement was successful in each case in which it was required. Demographic data are displayed for each of the study groups in table 1. There were no dural punctures with the Weiss epidural needle and no patients had postdural puncture headaches at follow up.

Dose-Response Characteristics of Intrathecal Isobaric 2% Lidocaine

The original study design included a 30-mg lidocaine 2% group (see Materials and Methods section). Two patients received 30 mg lidocaine, and each had inadequate motor blockade and complained of pain in the knee. One had a duration of 38 min before com-

Table 1. Demographic Data

	Dose (mg)		
	40 (n = 29)	60 (n = 32)	80 (n = 29)
Age (yr)	38.7 ± 14.0	37.8 ± 10.8	38.8 ± 12.2
Height (cm)	172.1 ± 9.8	177.4 ± 9.4	174.7 ± 8.5
Weight (kg)	75.4 ± 14.6	82.0 ± 16.4	77.4 ± 14.4
Gender M/F	19/10	24/8	22/7
Physical status			
1	20	23	17
2	6	5	9
3	1	1	1
Midaolam (mg)	3.6 ± 2.1	4.9 ± 3.1	5.1 ± 2.9
Operating room time (min)	39 ± 11	43 ± 17	42 ± 17

Values are mean ± SD.

plaining of pain at the surgical site. The second complained of pain at less than 35 min and it was our impression that this patient's spinal was not complete before the 35-min point. While operating on both of these patients, the surgeon, who was blinded to dosage, complained of inadequate motor blockade that, he said, made arthroscopic examination of the knee very difficult. For this reason, the fourth group (30-mg dosage) was eliminated from the study design.

Table 2 shows mean spinal anesthetic durations for each of the three groups as well as those patients who required epidural reinforcement. Times to two-dermatome regression, resolution of thoracic sensory anesthesia, resolution of lumbar sensory anesthesia, and full return of motor blockade by Bromage scale were all approximately 30 min shorter for the 40-mg group than for the 60- or 80-mg groups ($P < 0.01$ for all variables). Thoracolumbar sensory level of anesthesia as a function of time from injection is shown in figure 1. Median Bromage score as a function of time from spinal anesthetic injection is plotted for each of the three groups in figure 2.

The results of survival analysis for resolution of sensory and motor blockade are shown in figure 3. This included patients who received epidural supplementation. Duration of thoracic sensory, lumbar sensory, and motor blockade were significantly longer in the 60- than in the 40-mg group ($P < 0.0002$) and longer in the 80- than in the 40-mg group ($P < 0.0001$).

Table 3 shows mean times from intrathecal injection to fulfillment of ambulatory milestones and discharge. The 40-mg dose significantly decreased all times com-

Table 2. Spinal Anesthetic Du

	Value
Peak thoracic dermatome	
2-Dermatome regression	
Thoracic anesthesia (T12-L1)	
Lumbar anesthesia (L1-L5)	
Motor blockade (Bromage)	
Times (min are from injection)	
Duration of motor blockade	
* $P < 0.01$, compared to 60-	
† $P < 0.01$, compared to 80-	
‡ $P < 0.01$, compared to epidural su	

pared with the 60- and 80-mg groups. There were no significant differences between the 60- and 80-mg groups. Seven patients (7.7%) required epidural supplementation intraoperatively, and three in the 40-mg group (3.4%), three in the 60-mg group (3.4%), and one in the 80-mg group (3.4%). The mean time to full resolution of motor blockade was similar in all groups and was approximately 30 min and was similar in all groups. The mean time to full resolution of 2% lidocaine administration (range 5-15 ml) in all patients was similar. Epidural supplementation tended to be required for thoracic sensory anesthesia, motor b

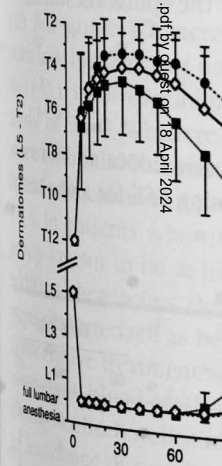


Fig. 1. Mean (±SD) sensory level of anesthesia by pinprick as a function of time for patients receiving intrathecal lidocaine.

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Table 2. Spinal Anesthetic Duration and Median Peak Thoracic Levels

	Dose (mg)			
	40 (n = 26)	60 (n = 29)	80 (n = 28)	Epidural Supplementation (n = 7)
Peak thoracic dermatome level (range)	T4 (T2-T10)	T3 (T2-T7)	T3 (T1-T7)	T3 (T1-T6)
2-Dermatome regression	50 ± 22*†	73 ± 27	70 ± 23	39 ± 25*†
Thoracic anesthesia (T12-T2)	101 ± 30*†‡	125 ± 26	137 ± 23	137 ± 29
Lumbar anesthesia (L1-L5)	130 ± 26*†	162 ± 32	170 ± 24	150 ± 23
Motor blockade (Bromage scale)	93 ± 24*†	128 ± 31	142 ± 32	111 ± 30†

Times (min) are from injection. Values are mean ± SD.

Duration of motor blockade is defined as the time required to return to a Bromage score of 0, with no paresis and full movement.

* $P < 0.01$, compared to 60.

† $P < 0.01$, compared to 80.

‡ $P < 0.01$, compared to epidural supplementation, by analysis of variance.

pared with the 60- and 80-mg dose groups ($P < 0.01$). There were no significant differences, however, between the 60- and 80-mg groups.

Seven patients (7.7%) required epidural supplementation intraoperatively, all for discomfort in the knee: three in the 40-mg lidocaine group (10.3%), three in the 60-mg group (9.4%), and one in the 80-mg group (3.4%). The mean time to reinforcement was 49 ± 11 min and was similar in all groups. The mean volume of 2% lidocaine administered epidurally was 9.3 ml (range 5–15 ml). Patients who received epidural supplementation tended to have a longer duration of sensory anesthesia, motor blockade, and delayed postop-

erative recovery in the postanesthesia care unit (tables 2 and 3).

Hemodynamic Changes During Spinal Anesthesia

There were no statistically significant differences in the incidence of bradycardia (heart rate < 50 beats/min), hypotension (systolic < 80 mmHg), or the need for intravenous atropine or ephedrine between groups (table 4). One patient developed asystole 15 min after onset of spinal anesthesia with 80 mg of 2% lidocaine. This patient was quickly and successfully treated with immediate precordial thump-pacing and concurrent administration of 8 μ g epinephrine and 1 mg atropine by intravenous route. This patient never lost consciousness and communicated with us throughout the

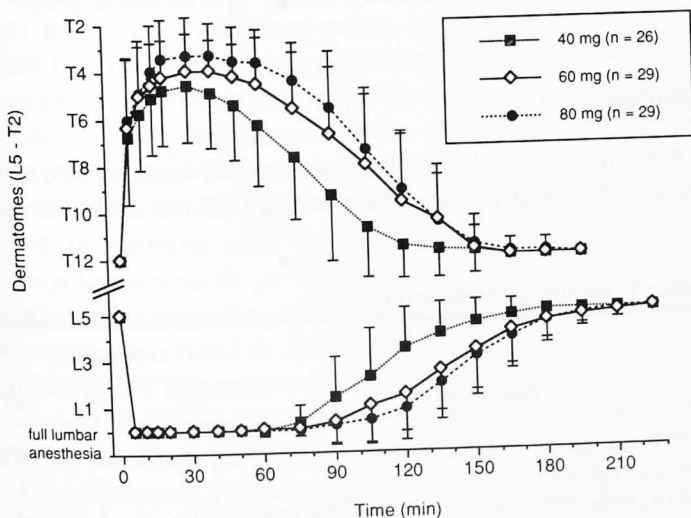


Fig. 1. Mean (\pm SD) sensory level of thoracic and lumbar anesthesia by pinprick as a function of the time from injection (0) for patients receiving intrathecal lidocaine only.

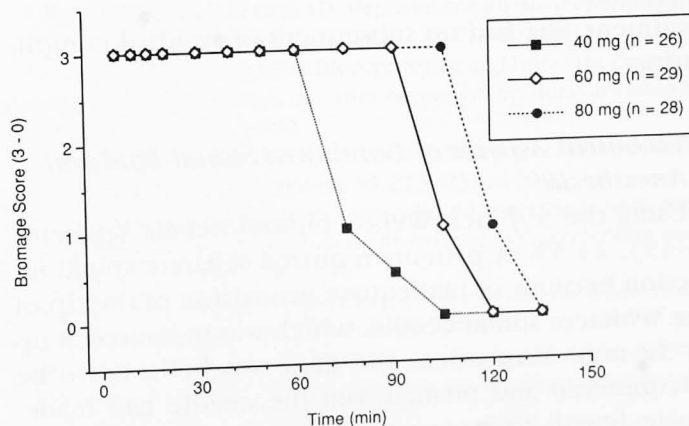


Fig. 2. Median motor anesthesia measured systematically by Bromage scores as a function of the time from injection (0) in patients receiving intrathecal lidocaine only.

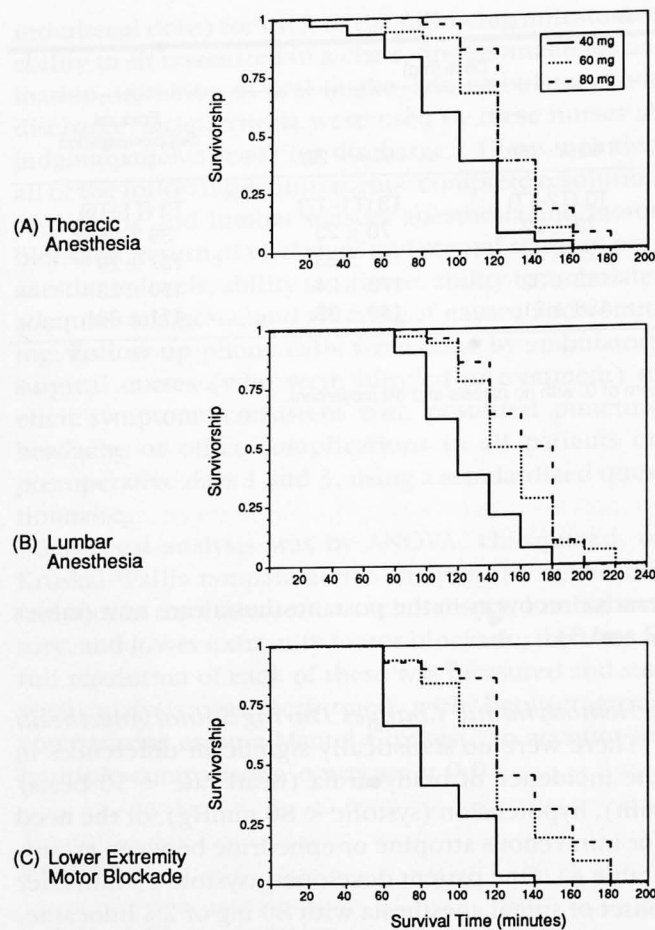


Fig. 3. Cumulative survival of thoracic sensory anesthesia (A), lumbar sensory anesthesia (B), and lower extremity motor blockade (C) after combined spinal epidural anesthesia in the 40-, 60-, and 80-mg groups (all 90 patients). Duration of sensory and motor blockade was significantly longer in the 60- and 80-mg groups than the 40-mg group ($P < 0.0002$).

treatment. She had no subsequent or residual complications.

Technical Aspects of Combined Spinal-Epidural Anesthesia

Using the 3 $\frac{1}{2}$ -inch Weiss epidural needle (patients 1-49), 24.5% of patients required separate spinal injection because of inadequate protrusion of the tip of the Whitacre spinal needle, which was measured at up to 12 mm. Most often, the dura was believed to be encountered and pushed, but the needle had inadequate length to penetrate. This caused a visible recoiling of the Whitacre needle out of the Weiss needle hub.

Table 3. Ambulatory Discharge Criteria

	Dose (mg)			
	40 (n = 26)	60 (n = 29)	80 (n = 28)	Epidural Supplementation (n = 7)
Chair	135 \pm 29*†‡	168 \pm 31	185 \pm 42	174 \pm 39
Per oral intake	122 \pm 34*†‡	152 \pm 28	158 \pm 35	157 \pm 50
Urination	159 \pm 36*†	193 \pm 30	215 \pm 73	193 \pm 56
Discharge	178 \pm 34*†‡	216 \pm 33	236 \pm 46	214 \pm 57

Times (min) are from injection. Values are mean \pm SD.

* $P < 0.01$, compared to 60.

† $P < 0.01$, compared to 80.

‡ $P < 0.01$, compared to epidural supplementation, by analysis of variance.

Subsequently, a 3-inch Weiss needle was used (patients 50-90), which allowed greater protrusion of the Whitacre needle tip. In spite of this, it was still necessary to give a separate spinal in 12.5% of these patients because of an inability to access cerebrospinal fluid (CSF; the Whitacre needle encountered bone or there was no free flow of CSF).

In the 33 patients in whom successful CSE was performed, the protrusion of the Whitacre needle beyond the tip of the Weiss needle was measured. This ranged from 5 to 15 mm, with a mean value of 8.5 mm.

Spontaneous flow of CSF through the Whitacre spinal needle was seen in all 90 patients before injection. However, it was not always possible to aspirate CSF via the Whitacre needle. In seven patients, CSF could not be aspirated at all, and in an additional four patients, aspiration of CSF was not possible after at least one of the 1-ml incremental doses of the spinal anesthetic.

Discussion

A reliable initial dose of isobaric lidocaine 2% to administer intrathecally when using CSE for ambulatory

Table 4. Hemodynamic Data

Patients (n)	Dose (mg)		
	40	60	80
With heart rate of <50 beats/min	4	6	4*
Given atropine	3	4	7
With systolic blood pressure of <80 mmHg	0	1	3
Given ephedrine	3	2	7

* One patient experienced asystole.

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knee arthroscopy is 40 mg. This dose provided excellent anesthesia, with a more rapid resolution of sensory and motor blockade than either 60 or 80 mg. We considered 30 mg as a potentially better initial dose, but because of our preliminary experience with two patients who received 30 mg and had inadequate anesthesia, we abandoned the 30-mg dose as being ineffective. The combined technique of CSE, using an initial dose of 40 mg 2% lidocaine, had qualities of rapid onset, short duration, and offered flexibility as provided by an epidural catheter.

Not only was the duration of sensory and motor blockade shortened in the 40-mg group, but all indices of recovery in the postanesthesia care unit were improved. Patients in the 40-mg group were able to sit in a chair, drink, and urinate before the 60- and 80-mg groups and were discharged on average almost 1 h earlier. Three patients of 29 in the 40-mg group developed pain in the surgical site intraoperatively, which was successfully treated using 2% lidocaine *via* the epidural catheter. Even when the three patients who required supplementation in the 40-mg group were considered, this had little impact on the recovery time.

Increasing the dose of anesthetic has been shown to prolong the duration of epidural anesthesia^{8,10-12} and spinal anesthesia with 0.5% bupivacaine.^{13,14} This is the first report showing a dose-response relationship between the dose of intrathecally administered isobaric lidocaine and duration of spinal anesthesia.

The CSE anesthetic that we chose to evaluate for ambulatory knee arthroscopy used a 27-G Whitacre needle-through-needle technique. This was deliberately chosen because: (1) it is technically easy to perform, (2) fine-gauge Whitacre-point needle are associated with low incidence of postdural puncture headache,¹⁵ and (3) it involves minimal patient discomfort. A recent study of 25-G Whitacre needle spinal anesthetics in more than 3,000 obstetric patients by Hurley *et al.*¹⁶ found an incidence of postdural puncture headache of 1.1% in patients who underwent cesarean section, a group known to be at high risk for this syndrome. In addition, headaches that occurred in these patients were characterized as being milder, and responded to conservative treatment without the necessity to resort to epidural blood patch. Thus, although the 27-G needle has not been well studied to date, one would expect an incidence of postdural puncture headache at least as low as, and possibly less than, that associated with the 25-G needle. An incidence in this range would certainly be acceptable in the ambulatory surgical center.

We observed no headaches in the ninety patients, but a study of much greater numbers would be necessary to define a postdural puncture headache incidence.

After changing to a 3-inch Weiss needle to enable greater protrusion of the tip of the 27-G Whitacre needle, there were still patients (12.5%) in whom it was not possible to perform a successful dural puncture using the CSE technique at the L3-L4 interspace that satisfied all study criteria. These criteria included a single midline insertion and spontaneous CSF flow without the aid of aspiration with the Whitacre needle aperture oriented toward the operative knee. In some patients, the Whitacre needle appeared to strike bone; in others, no CSF could be detected. Although this may appear to be a limitation of the 27-G Whitacre needle-through-needle technique, our clinical experience supports an approximate 100% success rate for CSE anesthesia in general.

In conclusion, CSE with a 40-mg initial dose of isobaric lidocaine provided reliable and significantly shorter-duration anesthesia for knee arthroscopy, allowing faster discharge than was possible with CSE using 60- or 80-mg initial doses. Duration of spinal anesthesia was indeed dose related. However, this dose dependence was not linear; rather, it presented as a step function with the 40-mg dose characterized by shorter duration. In contrast, the 60- and 80-mg doses were of approximately equal and significantly longer duration.

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References

1. Bridenbaugh LD: Regional anesthesia for outpatient surgery—A summary of 12 years' experience. *Can J Anaesth* 30:548-552, 1983
2. Mulroy M, Bridenbaugh LD: Regional anesthetic techniques for outpatient surgery. *Int Anesthesiol Clin* 20:71-80, 1982
3. Kopacz DJ, Mulroy MF: Chloroprocaine and lidocaine decrease hospital stay and admission rate after outpatient epidural anesthesia. *Reg Anesth* 15:19-25, 1990
4. Carrie LES: Extradural, spinal or combined block for obstetric surgical anaesthesia. *Br J Anaesth* 65:225-233, 1990
5. Curelaru I: Long duration subarachnoid anaesthesia with continuous epidural block. *Praktische Anästhesie Wiedererlebung und Intensivtherapie* 14:71-78, 1979
6. Lifschitz R, Jedeikin R: Spinal epidural anaesthesia. A new combination system. *Anaesthesia* 47:503-505, 1992
7. Lyons G, Macdonald R, Mikl B: Combined epidural/spinal anaesthesia for Caesarean section. Through the needle or in separate spaces? *Anaesthesia* 47:199-201, 1992
8. Littlewood DG, Buckley P, Covino BG, Scott DB, Wilson J: Comparative study of various local anaesthetic solutions in extradural block in labour. *Br J Anaesth* 51:47S-51S, 1979

9. Bromage PR: Epidural Analgesia. Philadelphia, WB Saunders, 1978, p 144
10. Crawford OB: Comparative evaluation in peridural anesthesia of lidocaine, mepivacaine and L-67, a new local anesthetic agent. ANESTHESIOLOGY 25:321-329, 1964
11. Scott DB, McClure JH, Giasi RM, Seo J, Covino BG: Effects of concentration of local anaesthetic drugs in extradural block. Br J Anaesth 52:1033-1037, 1980
12. Mikkada TA, Bridenbaugh PO, Singh P, Edström HH: Effects of dose, volume, and concentration of glucose-free bupivacaine in spinal anesthesia. Reg Anesth 11:98-101, 1986
13. Axelsson KH, Edström HH, Widman GB: Spinal anaesthesia

with glucose-free 0.5% bupivacaine: Effects of different volumes. Br J Anaesth 56:271-277, 1984

14. Sheskey MC, Rocco AG, Bizzarri-Schmid M, Francis DM, Edström H, Covino BG: A dose-response study of bupivacaine for spinal anesthesia. Anesth Analg 62:931-935, 1983

15. Shutt LE, Valentine SJ, Wee MYK, Page RJ, Prosser A, Thomas TA: Spinal anaesthesia for Caesarean section: Comparison of 22-gauge and 25-gauge Whitacre needles with 26-gauge Quincke needles. Br J Anaesth 69:589-594, 1992

16. Hurley RH, Hertwig LM, Lambert DH: Incidence of post dural puncture headache in the obstetric patient: 25 gauge Whitacre vs 26 and 27 gauge Quincke tip needles (abstract). Reg Anesth 17:33, 1992

Effect of Fentanyl Concentration

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Background: Fentanyl is used in swine, but there are no reports on its effect on the minimum alveolar concentration (MAC) in swine.

Methods: Sixteen swine were divided into four groups. For each group, two swine received two infusions: 50 $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ and 100 $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ (50 and 100 $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ followed by a loading dose of 200 $\mu\text{g}\cdot\text{kg}^{-1}$). A loading dose of 200 $\mu\text{g}\cdot\text{kg}^{-1}$ was maintained throughout the study. Minimum alveolar concentration determinations were obtained after 30 min of each infusion and hemodynamic parameters were obtained before stimulating swine for MAC. In the fourth group, control animals were used in determining MAC.

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