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The Recovery Profile of Hyperbaric Spinal Anesthesia With Lidocaine, Tetracaine, and Bupivacaine

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Background and Objectives. Surgical procedures previously considered too lengthy for the ambulatory surgery setting are now being performed during spinal anesthesia. The complete recovery profile of tetracaine and bupivacaine are now of interest but are not available in the literature. This study was conducted to compare times to ambulation, voiding, and complete block resolution, as well as the incidence of back and radicular pain, after spinal anesthesia with lidocaine, bupivacaine, and tetracaine. *Methods.* Twelve adult volunteers underwent spinal anesthesia on three separate occasions with three local anesthetics (lidocaine 100 mg, bupivacaine 15 mg, and tetracaine 15 mg in hyperbaric solutions) in random order and in a double-blind fashion. A 24-gauge Sprotte spinal needle was placed at the L2-3 interspace. The level of analgesia to pinprick was determined moving cephalad in the midclavicular line until a dermatome was reached at which the prick felt as sharp as over an unblocked dermatome. One dermatome caudad to this point was recorded every 5 minutes as the level of analgesia. We also recorded the times to voiding, unassisted ambulation, and complete resolution of sacral anesthesia. *Results.* There was no difference between tetracaine and bupivacaine in time taken for two- and four-segment regression of the analgesia level. However, times to ambulation and complete resolution of the block were significantly shorter with bupivacaine then with tetracaine. With lidocaine, times to four-segment regression, ambulation, voiding, and complete regression of the block were significantly shorter than with bupivacaine and tetracaine. Time to two-segment regression did not differ among local anesthetics. Back and radicular pain symptoms were reported by three subjects after lidocaine subarachnoid block but not after tetracaine or bupivacaine. *Conclusion.* Among individual subjects, lidocaine exhibited the shortest recovery profile. However, the recovery profiles of the three anesthetics were very variable between subjects. Time to meeting discharge criteria after bupivacaine or tetracaine was faster in a few subjects than that after lidocaine in other subjects. For ambulatory anesthesia, times to two- and four-segment regression do not accurately predict time to readiness for discharge after spinal anesthesia. *Reg Anesth Pain Med 1998: 23: 159–163.*

Key words: lidocaine, bupivacaine, tetracaine, spinal anesthesia, recovery profile, ambulatory surgery discharge criteria.

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Knowledge of the recovery profile from a spinal anesthetic is helpful in predicting time to meeting discharge criteria from an ambulatory surgery center. Surgical procedures of the lower extremity lasting 2 to 3 hours, such as anterior cruciate ligament repair, which were previously considered inappropriate for the ambulatory surgery setting, are now being performed on outpatients during spinal anesthesia. Therefore, it is important for anesthesiologists to know the recovery profile of bupivacaine and tetracaine. How the recovery profile of bupivacaine and tetracaine compare with the recovery profile of lidocaine, an anesthetic commonly used for ambulatory spinal anesthesia, would also be of interest.

Previous work has evaluated spinal local anesthetic duration and recovery in terms of sensory regression to a specific dermatome, (1,2) time to return of the micturition reflex, (3) or time to supplemental narcotic requirement for pain (4). The ability of a subject to flex at the hip, extend the knee and plantar flex the ankle/big toe have been used as an endpoint to analyze recovery from motor blockade (4,6). However, none of these criteria are used to determine eligibility for discharge from an ambulatory surgery center.

Information concerning the time it takes a patient to void, ambulate, and completely resolve sacral analgesia after spinal anesthesia with various local anesthetics is not available. We compared the times required for meeting usual ambulatory surgery discharge criteria after spinal anesthesia in healthy volunteers with lidocaine, bupivacaine, and tetracaine. We also compared the incidence of back and radicular pain after spinal anesthesia.

Methods

After approval from the Institutional Review Board of Loyola University Medical Center and written informed consent, 12 healthy (ASA physical status I) anesthesiologist and nurse anesthetist volunteers who were taking no medications underwent spinal anesthesia. Their mean age was 37 ± 1 years (range, 32-44), height 176 ± 2 cm (range, 165-185), and weight 72 ± 3 kg (range, 44-83). Ten of the volunteers were male and two were female.

Each subject was studied three times on different days after an overnight fast with a minimum of 48 hours between experiments. An intravenous catheter was placed prior to the start of spinal anesthesia. Intravenous fluid boluses were not given at any time during the study. In a randomized and double-blind fashion, each subject underwent spinal anesthesia using maximal clinically acceptable doses that historically have produced a similar sensory level of block. The agents used were tetracaine 15 mg in 10% dextrose (3 mL of a 1% solution), bupivacaine 15 mg in 8.25% dextrose (2 mL of a 0.75% solution), and lidocaine 100 mg in 7.5% dextrose (2 mL of a 5% solution), all without epinephrine. The local anesthetic solution was diluted in an equal volume of cerebrospinal fluid (CSF) and injected (over a 1-minute period) via a 24-gauge Sprotte needle inserted at the L2-3 interspace with the sideport directed cephalad. All injections were performed in the lateral decubitus position. Immediately after injection, the subjects were turned supine with their legs resting flat on the stretcher.

Blood pressure and the electrocardiogram were monitored for hemodynamic stability in each subject. For the purposes of this study, however, blood pressure and the electrocardiogram data are not recorded. An investigator that did not perform the spinal and therefore was blinded to the local anesthetic used, tested the level of analgesia to pinprick by using a safety pin. The level of analgesia was determined in the following manner. The investigator moved the safety pin from caudad to cephalad along the volunteer's trunk. When the subject reported that the sharpness of the pin was the same as over the shoulder (an unblocked dermatome), the level of analgesia was considered to be one dermatome caudad to that level.

The dermatomal level of analgesia was determined every 5 minutes after spinal injection. After the return of motor function to the hip flexors, subjects were assisted to a chair and were instructed to ambulate as soon as motor function and coordination of the lower extremities permitted. The ability to void spontaneously was accomplished as each volunteer regained bladder function. We recorded the times to unassisted ambulation, voiding, and complete resolution of sacral analgesia (to pinprick). Each subject completed a questionaire upon completion of the study regarding possible complications of the spinal anesthetic including headache, the presence or absence of postanesthetic back pain and radicular pain. Lower back and radicular leg pain were evaluated by a visual analog scale (VAS) (0–10 cm, with 0 = no pain and 10 = worst pain ever).

The Quade test was used to detect significant differences in median values among the three local anesthetic groups. Differences among local anesthetic recovery parameters and VAS pain scores were analyzed with Wilks' lambda test of multivariate analysis of variance (MANOVA). If there was a difference by MANOVA, the Bonferroni method

Table 1. Comparison of Recovery Parameters*

Parameter	Lidocaine (100 mg)	Tetracaine (15 mg)	Bupivacaine (15 mg)
Two-segment regression (min)	59 ± 11	70 ± 13	60 ± 15
Four-segment regression (min)	74 ± 14§	93 ± 18	84 ± 22
Unassisted ambulation (h)	2.9 ± 1.0‡	6.2 ± 2.0	4.8 ± 1.4†
	(0.8–4.3)	(3.0–9.0)	(2.4–7.0)
Void (h)	3.3 ± 1.0§	6.4 ± 2.0	5.9 ± 1.4
	(1.0–5.0)	(3.0–8.5)	(3.0–8.0)
Resolution of sacral analgesia (h)	3.9 ± 1.4‡	9.1 ± 3.5	7.3 ± 1.7†
	(1.5–6.0)	(3.0–14.0)	(3.0–9.5)

* Values are mean ± SD (range).
†$P < .05$ bupivacaine < tetracaine; ‡$P < .05$ lidocaine < tetracaine or bupivacaine; §$P < .05$ lidocaine < tetracaine.

was used to perform pairwise comparisons between local anesthetic groups. A P value < .05 was considered statistically significant.

A chi-square test was used to compare the incidence of radicular leg pain in each local anesthetic group.

Results

For each subject, the time to two-segment regression of analgesia was not significantly different for lidocaine, bupivacaine, or tetracaine (Table 1). As expected, time to four-segment regression was shorter for lidocaine than for bupivacaine or tetracaine with no significant difference found between the latter two. However, times to ambulation and complete resolution of sacral analgesia were significantly shorter with bupivacaine than with tetracaine. The time to voiding after bupivacaine or tetracaine spinal anesthesia was not significantly different. Lidocaine led to significantly shorter times to ambulation, voiding, and complete resolution of sacral block than the other two local anesthetics. Between subjects, there was wide variation of the recovery profiles of the three local anesthetics. Two subjects who received a lidocaine spinal anesthetic had times to ambulation (Table 2) that were similar to or longer than those experienced by other subjects who had received tetracaine (three subjects) or bupivacaine (five subjects).

At the described doses of local anesthetic, lidocaine reaches a comparatively higher analgesia level. Lidocaine attained a median maximal level of T_2 (range T_6-C_8), while tetracaine reached T_4 (range T_9-T_2), and bupivacaine achieved T_3 (range T_7-T_2). The course of regression of lidocaine is similar to those of tetracaine and bupivacaine until 110 minutes after subarachnoid injection (Fig. 1).

Three subjects, after recovery from lidocaine spinal anesthesia, reported symptoms of lower back soreness or stiffness accompanied by bilateral radicular burning leg pain. These three subjects reported VAS scores ranging from 3 to 8 within 2 hours after anesthesia dissipated and persisting for an additional 24–48 hours. Two of the three subjects required oral nonsteroidal antiinflammatory drugs

Table 2. Minutes to Ambulation, Voiding, and Complete Resolution

Subject	Height (cm)	Weight (kg)	Age	Sex	Lidocaine			Tetracaine			Bupivacaine		
					Amb	Void	Resol	Amb	Void	Resol	Amb	Void	Resol
1	183	72.7	38	M	255	300	330	315	465	685	200	405	500
2	178	77.0	38	M	180	180	180	420	420	540	420	420	480
3	175	82.7	36	M	128	130	137	220	220	270	300	390	405
4	170	65.9	32	M	240	300	360	540	480	840	420	405	540
5	185	79.5	34	M	225	240	330	480	485	836	348	373	510
6	165	48.0	39	F	210	210	300	420	420	720	330	330	420
7	180	82.0	36	M	150	210	240	290	290	420	180	254	434
8	170	65.9	41	M	150	180	180	510	510	600	240	250	280
9	170	68.2	33	M	160	170	210	240	240	420	310	400	460
10	180	77.3	35	M	50	60	130	180	180	180	145	180	180
11	180	79.5	33	M	180	180	240	420	450	540	330	390	450
12	173	69.0	44	F	180	240	240	420	420	570	240	480	570

Amb, ambulation; Void, voiding; Resol, complete resolution.

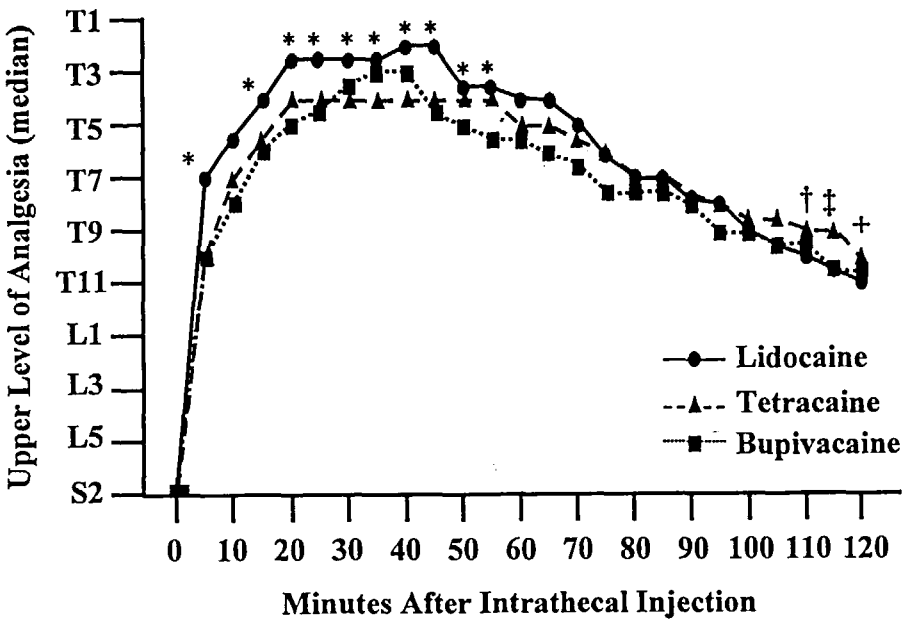

Fig. 1. Median levels of analgesia to pinprick during spinal anesthesia using lidocaine, tetracaine, and bupivacaine. *$P < .05$, lidocaine > tetracaine and bupivacaine; †$P < .05$, lidocaine < tetracaine; ‡$P < .05$, lidocaine < tetracaine, tetracaine > bupivacaine; +$P < .05$, lidocaine < tetracaine and bupivacaine.

(NSAIDs) to treat their radicular symptoms. The pain was significant enough to prevent normal activities such as sitting or jogging. Back pain localized to the needle insertion site after spinal anesthesia occurred occasionally with each of the local anesthetic agents studied. Back pain with a radicular component was observed only after lidocaine, but this difference did not reach statistical significance.

Back pain without radiation to the legs (VAS scores 1–4) after spinal anesthesia was present in each of the treatment groups (Table 3). The pain was localized to the lumbar region and described as either lower back stiffness or aching. The pain and aching was accompanied by 24–48 hours of paraspinal muscle spasm. One subject required oral NSAIDs for 72 hours. Most subjects reported minor discomfort localized to the site of needle insertion.

A post-dural puncture headache occured in one subject, requiring treatment with an epidural blood patch, but no signs of headache were experienced by other volunteers.

Table 3. Side Effect Profile

Effect	Lidocaine	Tetracaine	Bupivacaine
Visual Analog Scale back pain scores after spinal anesthesia	3.6 ± .8*	1.9 ± .5	2.3 ± .5
Subjects reporting radicular pain	3/12	0/12	0/12

Values are means ± SEM. *$P < .05$ lidocaine > tetracaine.

Discussion

This study demonstrated no significant differences between bupivacaine and tetracaine in terms of the usual measures of duration (i.e., time to two- and four-segment regression of analgesia). However, the time needed to meet standard ambulatory surgery discharge criteria (unassisted ambulation) was significantly shorter with bupivacaine than with tetracaine. Among individuals there was wide variation, such that some volunteers met the discharge criteria sooner after receiving tetracaine or bupivacaine than after lidocaine. This suggests that individual patient factors, such as the wide variability of cerebrospinal fluid volume among individuals (7) or other factors as yet undefined, may be of prime importance in determining the regression of the block during spinal anesthesia. Recognition that some patients, even those who are given a "short-acting" local anesthetic (lidocaine), may need more time than other patients to fully recover from a spinal anesthetic is particularly important for anesthesiologists working in outpatient surgical centers. Subarachnoid lidocaine given in large doses does not necessarily generate short recovery times. Further, our results underscore that the traditional measure of recovery from spinal anesthesia (i.e., times to two- and four-segment regression) do not predict time to ambulation, voiding, or complete resolution of block. Recovery of the ability to ambulate and void and resolution of sacral anesthesia are the important factors in determining whether a

patient may be discharged from an ambulatory surgery center.

Previous reports have shown motor block of the lower limbs persisting for a significantly longer time after tetracaine than after bupivacaine spinal anesthesia (4,5). In those reports, the ability of the patient to flex the knee and ankle was the criterion used to determine recovery of motor function in the lower extremities. Our results add to these findings by demonstrating that tetracaine, when compared with bupivacaine, significantly prolongs the times to ambulation and total resolution of the block. In individuals, our results confirm that lidocaine is the shortest-acting anesthetic, leading to the shortest recovery times. However, when comparisons are made between individuals, this is not necessarily so, and lidocaine can result in longer recovery times than tetracaine or bupivacaine.

We observed TRI in three subjects only after lidocaine but not after tetracaine or bupivacaine spinal anesthesia. This is significant, because all subjects received all three local anesthetics in a crossover fashion. Hampl et al. (8) reported a dramatically higher incidence of TRI in patients who had received lidocaine spinal anesthesia than in a patients receiving bupivacaine spinal anesthesia. Other authors also have reported TRI symptoms after lidocaine spinal anesthesia (9–11). Because of these concerns, we diluted the local anesthetic solutions with an equal volume of CSF oriented the sideport of the Sprotte needles cephalad, and injected the anesthetic over 1 minute in order to avoid sacral pooling of concentrated lidocaine solution. Despite these precautions, we observed clinically significant TRI in three individuals.

Bias may have been introduced into our results, since our study volunteers were all anesthesia care providers, who probably were aware of the relationship of TRI and lidocaine anesthesia. While we cannot exclude the possibility of bias, we did not discuss the issue of TRI with any volunteer prior to or during the study. The three individuals who reported TRI all had significant pain, requiring them to dramatically alter their activities of daily living. Specifically, these persons were not able to assume a sitting position for several hours because of severe pain. They all took NSAIDs to ameliorate their pain. Therefore, the appearance of TRI was not a subtle finding in these individuals.

In conclusion, among individual volunteers, lidocaine spinal anesthesia resulted in the quickest recovery times. However, there was significant variability in recovery times when the data were compared between individual volunteers. Some individual volunteers who had the "short-acting" lidocaine spinal anesthetic had longer recovery times than other subjects receiving the "longer-acting" agent, bupivacaine. The time to discharge after spinal anesthesia in an ambulatory setting cannot be accurately predicted by using times to two- and four-segment regression of sensory analgesia. Transient radicular irritation was observed after lidocaine but not bupivacaine or tetracaine spinal anesthesia in individuals undergoing spinal anesthesia with all three local anesthetics.

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