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A comparison of selective and conventional spinal anaesthesia for ambulatory surgery

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Abstract

Background: Selective spinal anaesthesia is the practice of employing minimal doses of intrathecal agents so that only the nerve roots supplying a specific area and only the modalities that require to be anaesthetised are affected. . The study is based on the hypothesis that small dose lidocaine spinal anaesthesia may be adequate for elective surgical procedures, providing limited motor and sensory block, and thus enabling earlier patient's discharge. The aim of this study was the comparison of the low and the conventional dose of lidocaine spinal anaesthesia discharge time.

Methods: The study was a prospective, randomized controlled single-blind trial, with 84 patients enrolled. Patients in study group (SS-L, Selective Spinal Lidocaine) were administered 3 mL of a 0.8% lidocaine solution containing 24 mg of lidocaine and 15 µg of fentanyl into the subarachnoid space. Patients in the control group (CD-L, Conventional Dose Lidocaine) received 5 mL of a 1% lidocaine solution containing 50 mg of lidocaine and 25 µg of fentanyl into the subarachnoid space. Discharge time was evaluated.

Results: In the SS-L group time to discharge were shorter ($P < 0.01$) compared to the CD-L group.

Conclusion: Selective spinal anaesthesia with low dose of lidocaine decreases the time of patient discharge compared with conventional lidocaine dose spinal anaesthesia.

Key words: ambulatory surgery; anaesthesia; spinal anaesthesia; selective spinal anaesthesia; local anaesthetics; lidocaine; opioids; fentanyl

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The term of ambulatory surgery refers to any procedure when the patient is given anaesthesia, undergoes a surgical procedure, and is discharged home on the same day. i.e. the patient's stay in ambulatory center lasts several hours, without an overnight stay [1].

In the early days of day surgery a subarachnoid block was rarely used due to complications concern, predominantly post-puncture headaches. In the 1980s, 25–27 G Whitacre needles (pencil-point) and Sprotte (bullet-shaped) needles were introduced, and spinal anaesthesia became more common in outpatient settings. However, the delayed return of motor and sensory function, orthostatic hypotension, delayed micturition or other consequences of persistent blockade became limiting factors. Selective spinal anaesthesia (SSA) is suggested as one of these issues solution.

A selective spinal anaesthesia is the practice of employing minimal dodes of intrathecal agents so that only the nerve roots supplying a specific area and only the modalities that

require to be anaesthetised are affected. Both the patient and the operating team need to be aware of the selective character of this anaesthesia. Doses of anaesthetics should be adjusted according to type of the procedure (and its duration) as well as to the surgeon's experience, taking into consideration the assumed time of patient discharge [2, 3].

The presented study was based on the hypothesis that low dose of lidocaine used for subarachnoid block should provide adequate anaesthesia for elective procedures, with less pronounced motor and sensory block, thus facilitating earlier patient discharge.

The aim of the study was to the comparison of the low and the conventional dose of lidocaine spinal anaesthesia discharge time.

METHODS

The study protocol was approved by the ethical committee of the Medical University of Silesia in Katowice (NN-6501-145/07). The study included 84 persons of 18–70 years of age, with an ASA PS (American Society of Anesthesiologists Physical Status Classification) grade 1 or 2. All patients provided their informed written consent for participation in the study.

The study was a prospective randomised single-blind controlled trial. Patients were randomised into two groups, with 6 intervention assignments, according to randomisation plan created by the generator available at the randomisation.com website.

Included patients were already qualified for elective surgical procedures of short duration, with expected time of stay in ambulatory center of less than 4 hours. Subjects in the study group (SS-L, Selective Spinal-Lidocaine) were administered 3 mL 0.8% lidocaine solution into subarachnoid space. The solution contained 24 mg of lidocaine and 15 µg of fentanyl (Fentanyl, Polfa Warszawa, Poland).

In the control group (CD-L, Conventional Dose Lidocaine), patients received 5 mL a 1% lidocaine solution, containing 50 mg of lidocaine and 25 µg of fentanyl.

Anaesthesiological procedures were performed analogically in both groups.

All patients had to undergo obligatory anaesthesiological consultation for at least 7 days prior to the intervention. Fifteen minutes before the procedure, they were admitted to the outpatient surgery facility.

Following the principles of preventive analgesia, each patient took paracetamol by oral route 2 hours before the start of the procedure (at home), with doses calculated to body mass (paracetamol 1,500 mg for patients with body mass < 65 kg, and 2,000 mg when body mass was > 65 kg). Patients were positioned on the operation table, a 20G cannula was introduced in to a vein in the forearm, and infusion of 0.9% NaCl was commenced, alongside with monitoring of ECG tracing, heart rate, haemoglobin saturation (SpO_2), pletysmographic waveform , respiratory frequency (using ECG chest electrodes), and arterial blood pressure (non-invasive measurement). Spinal block was administered in patient in sitting position. Inroducer needle 22G (0.7 × 32 mm) was placed into the L2–L3 or L3–L4 space from midline, followed by introduction of the pencil-point pencil-point spinal needle 27G (0.4 × 90 mm), Whitacre type, with cranial directed opening. When cerebrospinal fluid was obtained, anaesthetic solution was injected slowly (1 mL 10 sec^{-1}) The patient was then placed in supine position, arterial blood pressure was measured, and end-expiratory CO_2 was measured using a CO_2/O_2 Oral-Nasal Cannula. Patients breathed air in the operation theatre (RASV, room air spontaneous ventilation). Haemodynamic parameters, respiratory variables and degree of patient sedation were monitored at regular time intervals, from patient arrival to operation theatre to the patient discharge. Extent of analgesia was measured using peripheral nerve stimulator (Ministim MS-IIIA, Professional Instruments, USA) with a bipolar electrode (tonic stimulation using direct current at 50 Hz for 5 seconds) at 3, 6, 9, 12 and 15 minutes from the spinal injection. Pain sensation was evaluated using 10 mA current, which was gradually increased to 60 mA. Pain stimulus induced thereby was equivalent to surgical skin incision. Testing was performed at the ankle level, laterally (S1), medially at the knee level (L3), in the midline at the level of pubic bone (T12), and around the umbilicus (T10), moving in a cranial direction (Fig. 1).

The degree of motor block was assessed using the modified Bromage scale, at 3, 6, 9, 12 and 15 minutes from onset of anaesthesia.

Level of sedation was evaluated using a Ramsay scale, together with haemodynamic and respiratory parameters. If prior to the start of surgery the patient status was not equivalent to at least a Ramsay score 2, midazolam was administered intravenously in fractionated doses of 1 mg each, so the desired effect was obtained (min. Ramsay score 2).

If the subarachnoid block was deemed inadequate, intravenous ketamine was administered, at a maximal dose of 0.3 mg kg^{-1}. Before ketamine administration, midazolam was given (if not already administered). An inadequate block was defined as patient claiming pain in the area to be operated on, when using the peripheral nerve stimulator 15 minutes after subarachnoid administration of anaesthetic. If the aforementioned procedure was still inadequate for pain elimination during the surgical procedure, conversion to laryngeal mask general anaesthesia was performed.

During the procedure, maximally 6–10 mL kg^{-1} 0.9% saline solution could be administered.

In cases of hypotension (decrease in arterial pressure by 20% or more from baseline) ephedrine was administered

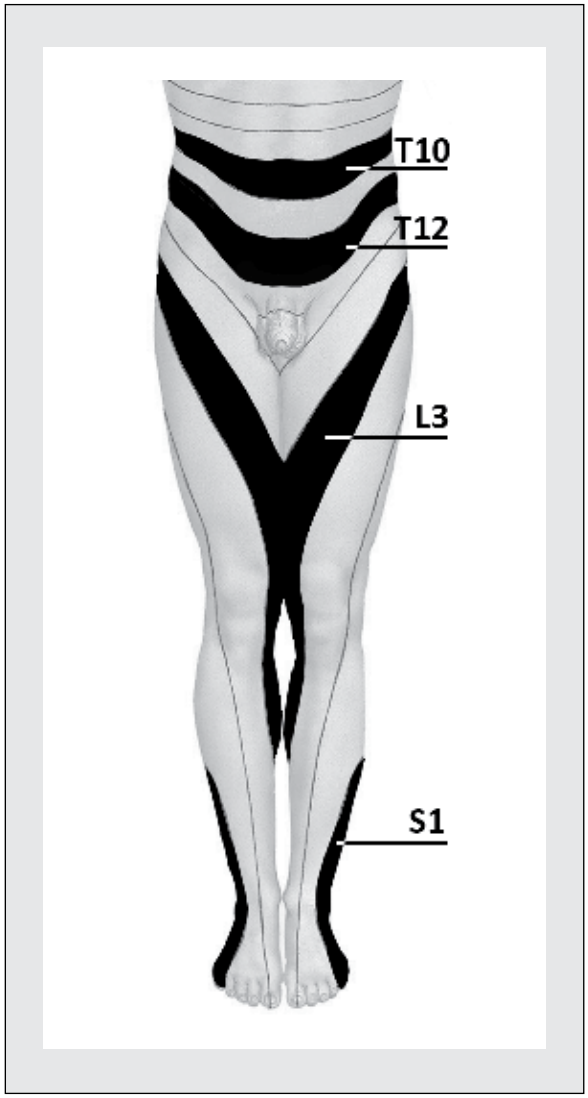

Figure 1. Pain stimuli application points

intravenously, in fractionated doses of 5 mg every 3 minutes, so long as the desired effect could be obtained (increase of arterial pressure). In cases of bradycardia (decrease of heart rate by 20% or more from baseline), 0.01 mg kg^{-1} atropine was administered intravenously until the desired effect (maximal dose of 3 mg).

During the procedure, 100 mg of ketoprofen was administered intravenously. When nausea/vomiting occurred, 4 mg of ondansetron was administered intravenously. In cases of pruritus following opioid administration, 0.1 mg kg^{-1} of ondansetron was administered intravenously. If no effect was observed, 0.05 mg of naloxone was given intravenously.

After the surgery, patient was moved to the recovery room (fast track, skipping the postoperative unit), if modified Aldrete score was at least 9. Monitoring of vital parameters was continued.

Patients were permitted to stand up unaided and ambulate after they had fulfilled the criteria, which included return of pinprick sensation in the perianal area (S4–S5), plantar flexion of the foot at preanaesthestic level of strength (S1–S2) and return of proprioception in the big toe (S2).

Patients were discharged home after they had achieved at least 9 points in Modified Post Anesthesia Discharge Scoring System (PADSS) and the escorts were present

At discharge, all patients were given detailed written information on administration of oral analgetics.

The study evaluated patient discharge time in both groups.

STATISTICAL ANALYSIS

Power analysis based on results of a pilot trial was performed to determine the necessary sizes of the two groups. Assuming a standard deviation of 23 minutes in time to discharge (taken from a pilot trial), an alfa value of 0.05 and a power of 95% it was estimated that a minimum of 38 patients per group would be required to show a 20 minutes difference in discharge times. Taking into consideration a possibility that some patients could drop out from the study 84 patients equally divided between groups were enrolled in the study. Distribution of variables was verified using W Shapiro-Wilk test. Comparisons were performed using Student's t-test for unrelated parameters and analysis of variance (ANOVA) with post-hoc Tukey test for repeated measurements. Analyses were performed using Statistica 6.0 software (StatSoft, Tulsa, USA). Statistical significance was accepted at *P*-value less than 0.05.

RESULTS

No differences in body mass or height were observed between the groups, but BMI values were significantly different (Table 1). The duration of surgical procedures and time to discharge were significantly longer in the CD-L group as compared to SS-L patients (Table 2).

There was no difference in the types of surgical procedures performed in both groups (Table 3).

Extent of sensory blockade at 3, 9, 12 and 15 minutes did not differ between the groups but at 6 minutes, significantly more patients from SS-L groups had block up to L3 level (92.86%) than in group II (69.05%), and fewer patients had blockade up to T12 (7.14% vs. 30.95%) (Table 4). Notably, at consecutive time points, more patients from group CD-L had a greater extent of motor block according to modified Bromage scale (Table 5).

No differences were observed in the intensity of postoperative pain between the groups (Table 6). Operating conditions did not differ either (Table 7), and patients' perceptions of anaesthesia during surgery was similar in both groups (Table 8).

Table 1. Demographic data

Variable		Group I (SS-L) (n = 42)		Group II (CD-L) (n = 42)		*P*-value
		Mean value	SD	Mean value	SD	
Age (years)		42.55	14.02	44.90	13.12	0.429
Height (cm)		173.48	7.40	170.31	7.76	0.059
Body mass (kg)		75.17	12.28	77.74	15.88	0.409
BMI (kg m^{-2})		24.89	3.27	26.70	4.65	0.043
		n	%	n	%	*P*
Sex	male	24	57.14	20	47.62	0.382
	female	18	42.86	22	52.38	
ASA score	1	29	69.05	17	40.48	0.008
	2	13	30.95	25	59.52	

BMI — body mass index; ASA — American Society of Anesthesiologists; SD — standard deviation

Table 2. Duration of the procedure and hospital stay in study and control group

Variable	Group I (SS-L) (n = 42)		Group II (CD-L) (n = 42)		*P*-value
	Mean value	SD	Mean value	SD	
Duration of stay (T_D-T_0) (= time to discharge)	11.31	21.33	174.76	22.87	< 0.001
Duration of procedure (T_E-T_B)	45.60	18.62	58.21	25.52	0.011

T_B — time point before anaesthesia; T_0 — time point directly after anaesthesia; T_E — time point directly after the end of surgical procedure; T_D — time point at patient discharge

Table 3. List of surgeries performed during the study

Type of surgery	Group I (SS-L) (n = 42)		Group II (CD-L) (n = 42)		*P*-value
	n	%	n	%	
Inguinal hernia repair	19	45.24	16	38.10	0.280
Hydrocele removal	1	2.38	1	2.38	
Removal of encysted hydrocele of the cord	1	2.38	0	0.00	
Removal of lower leg varices	21	50.00	16	38.10	
Epigastric hernia repair	0	0.00	1	2.38	
Umbilical hernia repair	0	0.00	1	2.38	
Repair of postoperative scar hernia	0	0.00	1	2.38	
Correction of phimosis	0	0.00	1	2.38	
Excision of pilonidal cyst	0	0.00	2	4.76	
Removal of spermatic cord varices	0	0.00	3	7.14	

Table 4. Extent of sensory block in the evaluated areas

Measurement time point	Extent of maximal sensory block in the investigated area	Group I (SS-L)		Group II (CD-L)		*P*-value
		n	%	n	%	
T3	S1	36	85.71	30	71.43	0.184
	L3	6	14.29	12	28.57	
T6	L3	39	92.86	29	69.05	0.012
	T12	3	7.14 13	30.95		
T9	L3	1	2.38	0	0.00	0.057
	T12	29	69.05	15	35.71	
	T10	12	28.57	17	40.48	
T12	T12	10	23.81	4	9.52	0.143
	T10	32	76.19	38	90.48	
T15	T12	6	14.29	1	2.38	0.114
	T10	36	85.71	41	97.62	

T_X — measurement time point; — x minutes from onset of anaesthesia

Table 5. Extent of motor block according to the modified Bromage scale

Measurement time point	Extent of motor block	Group I (SS-L)		Group II (CD-L)		*P*-value
		n	%	n	%	
T3	1	0	0.00	0	0.00	0.001
	2	0	0.00	0	0.00	
	3	0	0.00	1	2.38	
	4	4	9.52	20	47.62	
	5	38	90.48	22	52.38	
T6	1	0	0.00	0	0.00	0.000
	2	0	0.00	0	0.00	
	3	5	11.90	24	57.14	
	4	37	88.10	18	42.86	
	5	0	0.00	0	0.00	
T9	1	0	0.00	10	23.81	0.001
	2	12	28.57	19	45.24	
	3	29	69.05	13	30.95	
	4	1	2.38	0	0.00	
	5	0	0.00	0	0.00	
T12	1	0	0.00	19	45.24	0.000
	2	38	90.48	22	52.38	
	3	4	9.52	1	2.38	
	4	0	0.00	0	0.00	
	5	0	0.00	0	0.00	
T15	1	7	16.67	37	88.10	0.000
	2	35	83.33	5	11.90	
	3	0	0.00	0	0.00	
	4	0	0.00	0	0.00	
	5	0	0.00	0	0.00	

T_X — measurement time point; — x minutes from onset of anaesthesia

Table 6. Postoperative pain intensity at the time of discharge

Pain intensity (NRS)	Group I (SS-L)		Group II (CD-L)		*P*-value
	n	%	n	%	
0	40	95.2	41	97.6	
1	1	2.4	0	0.0	1.000
2	1	2.4	1	2.4	

Table 7. Operating conditions as assessed by the surgeons

Operating conditions	Group I (SS-L)		Group II (CD-L)		*P*-value
	n	%	n	%	
Good	40	95.24	41	97.62	
Average	2	4.76	1	2.38	1.000
Bad	0	0.00	0	0.00	

Table 8. Quality of anaesthesia as experienced by the patients

Quality of anaesthesia	Group I (SS-L)		Group II (CD-L)		*P*-value
	n	%	n	%	
Very good	35	83.33	37	88.10	0.755
Good	6	14.29	5	11.90	
Moderate	1	2.38	0	0.00	
Bad		0.00	0	0.00	
Willingness to choose the same type of anesthesia during another surgery	40	95.24	41	97.62	

DISCUSSION

The first reports concerning SSA were published in the mid-1990s [2, 4, 5]. The advantage of this variant of spinal block comparing with conventional dose spinal block is related to restricted haemodynamic effect (lower decrease of blood pressure), limited motor block, faster regression of sensory block , All this factors contribute to early patient discharge [2, 3, 6].

Several conditions must be fulfilled for the successful application of SSA. Both the patient and the operating team need to be aware of the selective character of the blockade. Drug doses need to be adjusted according to the procedure type (and its expected duration), to surgeon's experience and skill as well as to the expected time of discharge [2, 3, 6].

Patient preparation for selective subarachnoid block requires providing information and explaining the character of the procedure. During the intervention extero- and proprioception may be preserved in the operated area (sense of touch or pressure) but these stimuli are not painful. Particular characteristics of this type of anaesthesia and difficulty to discriminate various types of stimuli were considered when planning the presented study.

The authors elaborated their own method of stimulation so the patient could distinguish touch or pressure from pain stimuli. For that purpose, electrical stimulation was applied to a body area distant from the extent of blockade, and stimuli were increased up to the pain threshold and compared to stimulation in the area of blockade. With this comparison demonstrated, the patient could be assured of effective pain elimination by the blockade. Such procedure was carried out before the main intervention, which resulted in patient acceptance into the study group.

Tonic stimulation under 5 seconds using direct current of 60 mA and 50 Hz is equivalent to the surgical incision of the skin [7, 8]. This method was applied for the first time for assessment of the subarachnoid block extent by authors from Virginia Mason Medical Center [9] and is currently considered the most appropriate [10].

Patient home discharge is one of the main parameters used to evaluate efficacy of anaesthesia in ambulatory surgery. In the study group, mean home discharge time was 111 min in the SS-L group, and 175 min in the CD-L group. The difference (64 min) was statistically significant. These results are similar to the reports by Vaghadia *et al.* [5] and Casati *et al.* [11]. Female patients who received a subarachnoid block with 25 mg of lidocaine and 25 μg of fentanyl for gynaecological surgical procedures were ready for discharge after a mean time of 122 minutes. A slightly longer duration of this period might be related to the fact that in the study by Vaghadia *et al.* [5], patients were administered an additional 250–500 μg of alfentanyl intravenously before the initiation of CO_2 insuflation. Additionally, during the procedure, an additional 250–500 μg of alfentanyl and 10–20 mg of propofol were administered in the case of arm pain. Casati *et al.* [11] subarachnoideally administered 50 mg of lidocaine in patients prepared for knee arthroscopy and observed the restoration of their ability to walk by themselves after the mean time of 152 minutes. These authors did not specify if the patients qualified for discharge at that time as follow-up continued until the first miction. In the present study, 50 mg of lidocaine and 25 μg of fentanyl were administered to the CD-L group, and the time to discharge was 23 minutes longer (ca. 14%). However, some authors suggest that the subarachnoid administration of fentanyl does not prolong the time to discharge [9].

Duration of time from blockade to home discharge may depend on the discharge criteria specific for the institution. Widely accepted patient discharge qualification criteria include stable arterial pressure and heart rate, independent ambulation, lack of nausea or vomiting, accepted intensity of post-procedure pain and no signs of wound bleeding [12–17]. A more debatable feature is the first micturition after the procedure. Impaired function of detrusor muscle following both local and general anaesthesia may lead to postoperative urinary retention (POUR) [18]. Waiting for the first micturition may delay patient discharge by the mean of 75 min in 5–19% cases with no risk factors for POUR [19–21]. First micturition as an absolute requirement for patient discharge is currently debated [22, 23].

In the present study, waiting for micturition was not necessary before discharge, even in patients after inguinal hernia repair procedures, which are a risk factor for POUR [18, 20–22]. No cases of urine retention were observed after surgery. In all patients, the prevention of POUR was applied, with micturition before the procedure, decreased amount of administered crystalloids (500 mL) and adequate analgesia after the procedure. The first two measures prevented excessive filling and distention of bladder before the restoration of micturition. Adequate pain elimination reduced discomfort at micturition trial related to abdominal press, and thus prevented reflex urine retention, which occurs commonly after hernia repair procedures.

Currently, patients qualified for discharge before the first micturition are recommended to undergo ultrasound assessment of urine volume in the bladder [20, 22, 24]. Diagnostic criteria for POUR vary between institutions as to the accepted volume of residual urine. Some authors consider 400 mL of residual urine as an indication for bladder catheterisation, whereas others place the threshold at 500–600 mL [18, 20, 22, 24, 25]. In the present study, all patients had spontaneous micturition after the procedure.

The administration of local anaesthetics in glucose-free solutions for subarachnoid block permits dose reduction, and thus limits the extent of blockade to the area which needs to be anaesthetised for the procedure.

The addition of opioid adjuvant potentiates the effect of local anaesthetic and increases analgesic effect [26, 27]. The dose of local anaesthetic may be inadequate for the procedure by itself but in combination with the opioid, it becomes sufficient and may even be reduced. Ben-David *et al.* [28, 29] and Sethi *et al.* [30] successfully administered 20 mg of lidocaine with 20–25 µg of fentanyl for a subarachnoid block before arthroscopic knee surgeries [28–30]. In the presented study, 24 mg of lidocaine and 25 µg of fentanyl were also sufficient for a subarachnoid block in patients undergoing inguinal hernia repair.

Ben-David *et al.* [29] compared spinal anaesthesia using 50 mg of 1% lidocaine solution with 20 mg of 0.8% lidocaine solution combined with 25 µg fentanyl, using Whitacre needles. The median maximal extent of analgesia in both groups was similar (T10) but variable distribution in these groups was not normal. The lowest level of sensory block was T12 in both groups [29], which is similar to the present study.

The extent of motor block was assessed using a modified Bromage scale and was significantly smaller in patients in SS-L group at all time points, which was related to a low dose of local anaesthetic (24 mg of lidocaine). Low motor blockade is an important factor in outpatient surgery as it permits the carrying out of procedures with "walk-in–walk-out spinal anaesthesia". This idea is based on dosing the local anaesthetic to obtain a minimal motor block only for the duration of the procedure. The patient is thus able to walk in and walk out of the operating room by himself. Vaghadia *et al.* [5] reported similar results as our SS-L group, using even smaller lidocaine doses (10–20 mg) combined with 25µg of fentanyl for short (25–30 minutes) laparoscopic gynaecological procedures. However, these patients received additionally sedation or analgo-sedation with propofol and alfentanyl.

Adequate post-procedure analgesia is one of the most important criteria for discharge after ambulatory surgery (pain intensity at NRS 0–3), as the symptoms may be further controlled by oral analgetics [16]. Postoperative pain following subarachnoid block may be of less intensity than after general anaesthesia [31]. In the present study, patients about to be discharged had pain at NRS 0 to 2. That low pain intensity can be attributed to extensive perioperational preparations, including patient education at the time of preoperative visit, preventive analgesia and opioid addition to subarachnoid block [32].

CONCLUSION

Compared to standard dose of lidocaine, selective subarachnoid block with low dose lidocaine shortens the duration of time from onset of anaesthesia to patient discharge to home.

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