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Pere, Pertti

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Original Contribution

Randomized comparison of the feasibility of three anesthetic techniques for day-case open inguinal hernia repair ☆,☆☆,★,★★,☆☆☆

Pertti Pere MD, PhD^{a,c,*}, Jukka Harju MD, PhD^{b,c}, Pekka Kairaluoma MD, PhD^{a,c},
Veikko Remes MD, PhD^{b,c}, Päivi Turunen RN^{a,c}, Per H. Rosenberg MD, PhD^a

^aDivision of Anesthesiology, Department of Anesthesiology, University of Helsinki and Helsinki University Hospital, Intensive Care and Pain Medicine

^bDivision of Gastrointestinal Surgery, Department of Surgery, University of Helsinki, 00014 University of Helsinki

^cDay-Surgery Center at Surgical Hospital, Helsinki University Central Hospital, PO Box 263, 00029, HUS, Helsinki, Finland

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Open inguinal hernia repair;
Spinal anesthesia

Abstract

Study objective: Comparison of local anesthetic infiltration (LAI), spinal anesthesia (SPIN) and total intravenous anesthesia (TIVA) for open inguinal herniorrhaphy. We hypothesized that patients receiving LAI could be discharged faster than SPIN and TIVA patients.

Design: Randomized, prospective trial.

Setting: University hospital day-surgery center.

Patients: 156 adult male patients (ASA 1–3) undergoing day-case open inguinal herniorrhaphy.

Interventions: Patients were randomized to either LAI (lidocaine + ropivacaine), SPIN (bupivacaine + fentanyl) or TIVA (propofol + remifentanyl). Perioperative Ringer infusion was 1.5 mL/h. Urinary bladder was scanned before and after surgery. Interviews were performed on postoperative days 1, 7 and 90.

Measurements: Duration of surgery, duration of the patients' stay in the operating room and time until their readiness for discharge home. Patient satisfaction and adverse effects were registered.

Main results: Surgery lasted longer in LAI group (median 40 min) than in SPIN group (35 min) ($P = .003$) and TIVA group (33 min) ($P < .001$). Although surgery was shortest in TIVA group, TIVA patients stayed longer in the operating room than LAI patients ($P = .001$). Time until readiness for discharge was shorter in LAI group (93 min) than in TIVA (147 min) and SPIN (190 min) groups ($P < .001$). Supplementary lidocaine infiltration was given to 32 LAI patients, and IV fentanyl to 29 LAI and 4 SPIN patients. Ephedrine was required in 34 TIVA, 5 LAI and 5 SPIN patients. One SPIN and three LAI patients had to be given TIVA and another SPIN patient LAI to complete the operations. Urinary retention was absent. Discomfort in the scar (26%) three months postoperatively was not anesthesia-related.

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☆☆☆ All authors contributed equally to the manuscript.

* Corresponding author at: Division of Anesthesiology, Department of Anesthesiology, Intensive Care Medicine and Pain Medicine, Academic Medical Center Helsinki, PO Box 340, 00029 Helsinki, Finland. Tel.: +358 50 4270064.

E-mail address: perti.pere@hus.fi (P. Pere).

Conclusions: Logistically, LAI was superior because of the fastest recovery postoperatively. The anesthetic techniques were adequate for surgery in all but a few LAI and SPIN patients. Lack of urinary retention was probably related to the small IV infusion volumes.

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1. Introduction

The choice of anesthesia for open inguinal herniorrhaphy may depend on the preference of the patient, the surgeon or on established routines in the health care unit.

Local anesthetic infiltration anesthesia is considered useful because the patient can ambulate soon after surgery [1–4] but its disadvantages include occasional pain from surgery and needle sticks for infiltration of acidic local anesthetic solution [5]. Both general and spinal anesthesia provide excellent anesthesia for surgery but they may be associated with intraoperative hemodynamic instability, nausea, and the occurrence of postoperative urinary retention [6–8]. Occurrence of postoperative urinary retention has been the main reason why the use of spinal anesthesia for inguinal hernia repair has fallen into disrepute [4,9,10]. Bupivacaine seems to have maintained its popularity as the spinal anesthetic for inguinal hernia repair but unnecessarily large doses have often been used [6,11] prolonging the motor block and increasing the risk for problems with urinary bladder function.

Recovery and readiness for discharge after day surgery may be shortened by using short-acting drugs for general anesthesia, low-dose spinal anesthesia, infusing small volumes of fluids, treating hypotension with vasoconstrictors instead of fluids, avoiding the use of atropine and other anticholinergic drugs and infiltrating the surgical wound with a long-acting local anesthetic. But in spite of these efforts to optimize the conditions, i.e., choice of drugs and reduced volumes of IV fluids, the benefits of local anesthetic infiltration may overwhelm those of the other techniques in the overall day-surgery process, particularly with regard to time until readiness for discharge. We hypothesized that the patients receiving local anesthetic infiltration (LAI) could be discharged earlier than those receiving spinal anesthesia (SPIN) or total intravenous anesthesia (TIVA). Secondary outcome parameters were the duration of the patients' stay in the operating room, the incidence of postoperative urinary retention, and the patients' subjective satisfaction with the anesthetic technique and care in the operating room.

2. Materials and methods

The study was approved by the Surgical Ethics Committee of the Hospital District of Helsinki and Uusimaa (29 February, 2012, diary number 313/13/03/02/11). We assessed 369 adult male patients, scheduled for open

unilateral inguinal herniorrhaphy in the day surgery center for eligibility to participate in the study. The most common refusal reason (76%) was the patient's own wish for a certain anesthetic technique, while some patients refused to have one of the presented three techniques. Other exclusion criteria were BMI > 40 kg/m², BMI < 15 kg/m², scrotal hernias, severe renal, cardiac or hepatic insufficiency, coagulation disorder, local anesthetic allergy, lack of co-operation due to cognitive impairment or inadequate ability to communicate because of linguistic problems.

Finally, 156 patients who gave written informed consent were randomized using the sealed envelope method into three anesthetic groups of 52 patients each. All included patients filled in a symptomatic index score sheet for benign prostatic hyperplasia [12] (IPSS, International Prostate Symptom Score).

The patients were premedicated with oral ibuprofen 600 mg, or acetaminophen 1000 mg if allergic to ibuprofen. They were asked to empty their urinary bladder before the transfer to the operating room. The postvoidal residual volume (PVR) was checked with an ultrasound bladder scanner (Bardscan II®, Mediwatch Ltd., Rugby, UK). If PVR was >200 mL, the patient was asked to void again.

In the operating room and postanesthesia care unit-1 (recovery room = PACU1) monitoring included ECG, noninvasive arterial blood pressure, heart rate, peripheral pulse oximetry, and supervision by an anesthesiologist intermittently and an anesthesia nurse continuously. The prescheduled rate of infusion of Ringer's acetate was 1.5 mL/kg/hour. The infusion was terminated when the patient was transferred to PACU2 ("easy chair resting area"). Patients operated in the afternoon received an extra hourly dose (1.5 mL/kg) of Ringer's acetate before induction of anesthesia. Midazolam 1–2 mg IV was administered to LAI and SPIN patients before anesthesia to relieve anxiety, as needed. For mean arterial pressure drop to ≤65 mmHg or by ≥20% from baseline, ephedrine 3–5 mg or phenylephrine 0.1 mg, and for heart rate < 40 beats/min, atropine 0.5 mg IV were administered.

2.1. Anesthesia

2.1.1. Local anesthetic infiltration (LAI)

First 15–18 mL of lidocaine 10 mg/mL with epinephrine 5 µg/mL was infiltrated in the skin and the subcutaneous layer of the incisional area. Then 15–18 mL of ropivacaine 7.5 mg/mL was injected into the deeper layers. The rest (left in both 20-mL syringes) of the local anesthetics was infiltrated under the fascia, around the

funiculus (spermatic cord) and into the tissues at the base of the hernia sac. Intraoperatively, supplemental lidocaine was infiltrated (maximum 200 mg), as required to anesthetize the deeper layers, and fentanyl (25 or 50 µg IV once or twice) was given as needed if pain was felt by the patient. If adequate analgesia could not be achieved with the supplementation of local infiltration anesthesia, total intravenous anesthesia with propofol and laryngeal mask airway (LMA) was induced.

2.1.2. Spinal anesthesia (SPIN)

With the patient in the lateral horizontal position and the side of operation dependent a 27 G needle with pencil-point tip was inserted in the midline through the L3–4 intervertebral space. The drug mixture was hyperbaric bupivacaine 6 mg (Bicain Pond Spinal®, Orion Pharma, Espoo, Finland) and 10 µg of fentanyl. After the injection the operating table was tilted head-down 10° and the lateral position maintained for 5 minutes. Then the patient was placed supine on the table, which was returned to its neutral horizontal position, except when the sensory block had not yet spread to the T10 dermatome level (tested by pin-prick).

If analgesia was inadequate during surgery, fentanyl 25 or 50 µg IV was administered. If surgical pain persisted after two doses of fentanyl, anesthesia was supplemented with lidocaine infiltration or total intravenous anesthesia (propofol, remifentanyl, LMA and mechanical ventilation). At the end of the operation, the surgeon infiltrated the tissue layers between the fascia and the skin with 20 mL of ropivacaine 7.5 mg/mL.

2.1.3. Total intravenous anesthesia (TIVA)

Fentanyl 1.5 µg/kg IV was administered followed by propofol 2–2.5 mg/kg, and an LMA was placed, following which the patient was mechanically ventilated. For maintenance propofol and remifentanyl were intravenously infused. No anticholinergics or neuromuscular blocking agents were used.

Anesthesia depth was maintained at 40–60 on the Entropy™ monitor (GE Healthcare, Helsinki, Finland), and adjusted as needed by changing the infusion rate of propofol. Similarly to the SPIN group, at the end of surgery the wound was infiltrated with 20 mL of ropivacaine 7.5 mg/mL.

2.2. Surgery

A tension-free mesh repair technique was used as described by Chastan [13]. As a rule, a self-gripping light-weight mesh (Parietene ProGrip™, TYCO Healthcare Pte, Ltd., Singapore, or Parietex ProGrip™, Covidien, New Haven, CT, USA) was chosen for the repair, and if needed, it could be additionally fixed in place by a medial absorbable suture. The duration of surgery as well as that of the patient's stay in the operating room were recorded.

2.3. Postoperative care

Postoperatively in the postanesthesia care unit (PACU1) acetaminophen 1 g was administered orally or intravenously when the patient reported pain in the wound area at an intensity of <3 on the numeral rating scale (NRS 0–10). For stronger pain fentanyl 25 or 50 µg IV was given. The patient was encouraged to try to sit up and stand up as soon as possible.

In PACU2 analgesic treatment with oral ibuprofen 600 mg x 3 or in patients allergic to ibuprofen, acetaminophen 1 g x 3 was started. When pain was stronger, NRS score ≥ 3, oral oxycodone (OxyNorm®, Mundipharma, Vienna, Austria) 5–15 mg, depending on bodyweight, was given once.

In PACU2 the patient was asked to walk to the bathroom and try voiding. If this did not succeed, he tried again at 30-min intervals and if the third attempt failed, the bladder was scanned with an ultrasound monitor. If the content exceeded 300 mL, the bladder was emptied by catheterization. Any other side-effects, such as nausea and pruritus were recorded and treated as needed. The discharge criteria are shown in [Appendix A](#).

For analgesia at home for the first 24 h, the patients were given a small labeled bag with three 600-mg tablets of ibuprofen to be taken three times a day independent of the intensity of pain, and another labeled bag with 4 tablets of the combination drug of acetaminophen 500 mg and codeine 30 mg (Panacod®, Sanofi Synthelabo Ltd., Newcastle upon Tyne, UK) to be taken one to three times a day as needed, in addition to ibuprofen. In case of allergy to nonsteroidal anti-inflammatory drugs, the discharge medication bag only contained the acetaminophen-codeine tablets.

After the first postoperative day, recommended and prescribed analgesia consisted of ibuprofen 600 mg three times a day to be taken for a week, when needed. It was left to the patient to decide when to reduce and terminate the analgesic therapy.

All patients were interviewed by telephone on the 1st and 7th postoperative day, as well three months after the operation. The interview questions are listed in [Appendix B](#).

2.4. Power analysis

According to the study by Song et al. [14] the patients who underwent open inguinal hernia repair under local anesthetic infiltration were eligible for discharge 39 min earlier than those who received general anesthesia, and 147 min earlier, on average, than those who received spinal anesthesia. Based on these differences, thirty-one patients per group would be required for proving the primary hypothesis of the present study ($\alpha = 0.05$, power = 80%).

2.5. Statistical analyses

The differences between the measured parameters of all three groups were calculated using the Kruskal Wallis test,

and $P < .05$ was regarded as significant. Dunn's multiple comparisons post hoc test was used to calculate the statistical difference between each two individual study groups if an overall significance had been shown by the Kruskal Wallis test. Results are presented as mean $\pm$ SD, where appropriate, or as median with interquartile ranges (IQR).

3. Results

The CONSORT diagram is presented in Figure. Four already randomized patients, i.e. three from the SPIN group and one from the TIVA group, dropped out before the start of anesthesia because of urgent changes in the operation schedules. The groups were comparable regarding the basic demographic characteristics and the preoperative volume of urine in the bladder (Table 1).

In four LAI patients IPSS was >20 (= severe symptoms) and in two of them the ultrasound bladder scan showed marked retention (210 and 225 mL) after spontaneous voiding before anesthesia. In one patient of the SPIN group IPSS was >20 , with clear retention (215 mL) after voiding. In the TIVA group four patients had an IPSS >20 , but none of them had marked retention (≥ 200 mL) after voiding preoperatively.

The largest preoperative PVR volume was 410 mL, with an IPSS of 9 (LAI group). All of the patients with high PVR in the ultrasound scan were able to void a second time before transfer to the operating room. One TIVA group patient (69 yr) with an IPSS of 15 had no need to void and could not pass urine before surgery. The scan showed a PVR of 305 mL requiring preoperative catheterization.

3.1. Anesthesia

Intravenous midazolam, 1–2 mg was given to 31 LAI and 23 SPIN patients before the anesthetic procedure. Intraoperatively fentanyl 25 or 50 μ g was given to 39 LAI patients. The intrathecal puncture was difficult, but eventually successful in eight patients, and in another two patients the spinal block was insufficient for surgery. In one of these two patients local anesthetic infiltration and fentanyl IV were needed, and the other was given general anesthesia, which was also required in three LAI group patients.

Intraoperatively, analgesia was supplemented with fentanyl IV together with additional lidocaine in 29 LAI and 4 SPIN patients because of surgical pain. Additionally 3 LAI patients received supplemental lidocaine infiltration without fentanyl IV.

Intraoperative ephedrine IV for arterial hypotension was needed in 5 LAI patients, 5 SPIN patients and in 34 TIVA patients. In the TIVA group ephedrine was given more than twice in 16 patients, and in 3 of them additionally phenylephrine (0.1–0.5 mg IV) was needed. Atropine IV for bradycardia was given to 3, 2 and 4 patients in the LAI, SPIN and TIVA group patients, respectively.

3.2. Surgery

The hernia sac was identified, reduced and dissected in a standardized fashion. The mesh, which was placed over the pubic tubercle and along the inguinal ligament, was a light-weight self-gripping polyester mesh (either Parietene ProGrip™ or Parietex ProGrip™), except in one LAI patient and in one TIVA patient in whom a light-weight titanized sutured polypropylene mesh (TiMESH™, pfmmmedical AG) was applied as judged by the surgeon. For surgical reasons

Figure CONSORT diagram.

Table 1 Demographic data of the three anesthesia groups. Values are mean $\pm$ SD, or median (interquartile range) or number of patients.

	Local anesthetic infiltration (LAI) (n = 52)	Spinal anesthesia (SPIN) (n = 49)	Total intravenous anesthesia (TIVA) (n = 51)
Age, yrs	51 $\pm$ 16	51 $\pm$ 15	54 $\pm$ 15
Weight, kg	78 $\pm$ 8	81 $\pm$ 9	79 $\pm$ 10
Length, cm	178 $\pm$ 6	180 $\pm$ 7	180 $\pm$ 7
ASA 1/2/3 (no.)	31/20/1	25/19/5	23/25/3
IPSS, mean $\pm$ SD	5.9 $\pm$ 7.2	5.9 $\pm$ 5.9	7.7 $\pm$ 7.3
IPSS, median (IQR)	4 (IQR 8)	4 (IQR 10)	5 (IQR 8)

IPSS = International Prostatic Symptoms Score.

the iliohypogastric nerve had to be manipulated in 7 patients and its branches cut in 5 patients.

The median duration of the operation and patients' stay in the operating room are shown in Table 2. The duration of surgery in the LAI group, including the time for local anesthetic infiltration and anesthesia to develop, was longer than in the other groups ($P < .001$). In the LAI group it varied from 28 to 65 minutes, in the SPIN group from 18 to 69 minutes, and in the TIVA group from 16 to 67 minutes. However, the duration of patients' stay in the operating room was in the LAI group shorter than in the TIVA group ($P = .001$) (Table 2).

In the LAI group and the TIVA group there were 24 patients who stayed in the operating room for ≥ 90 minutes because of unforeseen delays (e.g., prolonged surgery, change of the anesthetic technique, waiting for the anesthesiologist to come and wake the patient up).

The primary postoperative surgical result within the 3-month study time was good. Recurrence was noted in only one patient in whom about 1.5 months after the primary repair of a large medial hernia a new smaller medial hernia had developed in the same region, and it was successfully repaired laparoscopically.

Table 2 Duration of surgery, length of patients' stay in the operating room, time until ambulation and to readiness.

	Local anesthetic infiltration (LAI) (n = 52)	Spinal anesthesia (SPIN) (n = 49)	Total intravenous anesthesia (TIVA) (n = 51)	P-value Kruskal Wallis test
Duration of surgery, min	40 (IQR 13)	35 (IQR 13)	33 (IQR 9)	$P < 0.001$
				$P = 0.003$ (LAI vs SPIN), $P > 0.999$ (SPIN vs TIVA)
Duration of patients' stay in operating room, min	69 (IQR 13)	77 (IQR 20)	83 (IQR 19)	$P = 0.001$
				$P = 0.099$ (LAI vs SPIN), $P = 0.470$ (SPIN vs TIVA)
Time until ambulation unsupported, min *	72 (IQR 32)	154 (IQR 53)	132 (IQR 46)	$P < 0.001$
				$P < 0.001$ (LAI vs SPIN), $P = 0.071$ (SPIN vs TIVA)
Time until readiness for discharge, min *	93 (IQR 46)	190 (IQR 54)	142 (IQR 35)	$P < 0.001$
				$P < 0.001$ (LAI vs SPIN), $P = 0.001$ (SPIN vs TIVA)

* Time from start of anesthesia.

The differences between all three study groups with regard to the measured parameter were calculated using Kruskal Wallis test, following which Dunn's multiple comparisons post test was used to calculate the statistical significance between LAI and SPIN, SPIN and TIVA, and TIVA and LAI groups, respectively.

Table 3 Urinary bladder function, volumes of Ringer's acetate infused and time until postoperative spontaneous voiding. Values are medians with interquartile range (IQR) or IQR and range.

	Local anesthetic infiltration (LAI) (n = 52)	Spinal anesthesia (SPIN) (n = 49)	Total intravenous anesthesia (TIVA) (n = 51)	P-value Kruskal Wallis test
Preop. urinary bladder volume mL, median (IQR, range)	0 (29, 0–412)	0 (24, 0–220)	0 (26, 0–303)	$P=0.88$
Perioperative Ringer's acetate mL, median (IQR, range)	200 (100, 150–350)	300 (100, 125–500)	300 (100, 150–500*)	$P<0.001$
	$P<0.001$	$P>0.999$		
Time from start of anesthesia to first postop. spontaneous voiding, min, median (IQR)**	93 (IQR 46)	190 (IQR 54)	142 (IQR 35)	$P<0.001$
	$P<0.001$	$P=0.001$		

* one patient received 800 mL in total because the drip was given by mistake from a 1-liter bag instead of a 500-mL bag; this particular patient was able to void 176 min after the induction of anesthesia

** this time was also the time when the criteria for discharge were met.

The differences between all three study groups with regard to the measured parameter were calculated using Kruskal Wallis test, following which Dunn's multiple comparisons post test was used to calculate the statistical significance between LAI and SPIN, SPIN and TIVA, and TIVA and LAI groups, respectively.

3.3. Postanesthesia care

3.3.1. Analgesics

Only one patient in the LAI group needed any analgesic (acetaminophen IV) in PACU1 (none in PACU2). In the SPIN group none needed analgesics in PACU1 but two patients received oral oxycodone in PACU2. In the TIVA group 17 patients received oral or intravenous acetaminophen, five of whom also needed fentanyl IV in PACU1. One TIVA patient received only fentanyl IV in PACU1. All patients were given ibuprofen in PACU2 before discharge home, as scheduled, independent of the pain felt by the patient.

Thirteen patients in the SPIN group spontaneously reported mild itching in the face and on the chest. No therapy was needed.

3.3.2. Ambulation and postoperative voiding

All LAI patients were able to walk from the operating table to their bed and 76% could be taken directly to PACU2. One LAI patient developed temporary partial anesthesia and motor weakness of the thigh of the operative side, which delayed his discharge. The LAI group patients were able to stand up and ambulate without support in a median time of 72 min after the start of anesthesia, which was significantly earlier than the TIVA patients (132 min) and the SPIN patients (154 min) ($P < .001$).

None of the patients needed urinary bladder catheterization after surgery. The time from the start of anesthesia to first spontaneous voiding, i.e., the time when readiness for discharge was attained (Table 2), was clearly the shortest in the LAI group ($P < .001$) and associated with small volumes

of infused Ringer's acetate (median 200 mL) (Table 3). One TIVA patient fainted soon after an unsuccessful voiding attempt but regained consciousness rapidly without any sequelae. There was no correlation between the preoperative IPSS score and urinary retention volume after spontaneous preanesthetic voiding nor the time from the start of anesthesia to first spontaneous postoperative voiding in the three groups (Table 3). None of the patients required readmitting to the hospital because of inability to void.

3.3.3. Home readiness

The LAI group patients met the discharge criteria in a median time of 93 min after the start of anesthesia and significantly earlier than the TIVA patients (142 min) and SPIN patients (190 min) ($P < .001$) (Table 2). After attaining the discharge criteria (Appendix A), the patient was allowed to get dressed and stay in PACU2 area at his leisure until accompanied home by a relative or friend.

3.3.4. First postoperative day

All patients, except one of the TIVA group had taken analgesics as prescribed after discharge from the hospital. At the time of interview, the median NRS pain score in movement was 4 in all three groups. An NRS score in movement ≥ 8 was reported by 2, 3, and 2 patients in the LAI, SPIN and TIVA group, respectively. None of the patients experienced nausea in the PACU, nor at home during the first postoperative day, but 9 TIVA patients reported mild dizziness and nausea at the time of the

interview. Ninety-six percent of all patients were very satisfied with their care in the operating room and 81% very satisfied with their anesthesia with no statistically significant differences between the groups.

Three LAI patients were dissatisfied with their anesthetic because of pain they had felt intraoperatively. Four patients in the SPIN group reported dissatisfaction with their anesthetic, two because of multiple attempts needed to perform the intrathecal puncture and two (one of them very dissatisfied) because of an inadequate block.

3.3.5. Seventh postoperative day

All except two TIVA group patients could be reached for this interview. Median pain score (NRS) in motion in the operated area was 1 in all three groups (range 0–4 in the LAI group, 0–7 in the SPIN group and 0–4 in the TIVA group). None of the 12 patients, in whom nerves in the groin had been instrumentally manipulated or cut during surgery, reported pain or numbness in the operated area.

3.3.6. Three months postoperatively

Ninety-eight percent of the patients (all except one in TIVA group and two LAI group patients) were reached by telephone. In 26% of all patients interviewed temporary mild pain or discomfort in certain type of movement (no difference between the three different groups) was reported, including 3 of those patients in whom a nerve branch in the groin had been instrumentally manipulated (nerve branch cut 2 patients, nerve branches covered with mesh 1 patient) during surgery. Signs of mild movement-provoked neuropathic pain (sensory changes in the skin around the operated groin, hyperalgesia and allodynia) occurred in one patient.

Five patients (1 in LAI group, 1 in SPIN group, and 3 in TIVA group) had experienced an infection requiring medical attention in the operated area in the period between the postoperative days 7 and 90.

4. Discussion

Home readiness in the LAI patients was attained almost 100 min earlier than in the SPIN group and almost 50 min earlier than in the TIVA group. The slightly longer duration of surgery, which included the time for infiltration of the local anesthetic by the surgeon and the time for the analgesia to develop, in the LAI group in comparison with the other groups was compensated by a shorter overall stay in the operating room (Table 2). A few TIVA patients' stay in the operating room was markedly prolonged because the anesthesiologist was busy with another patient and could not come and wake the patient up immediately when the operation was finished.

Another clinically significant result was the lack of urinary retention. Interestingly, voiding difficulties were not

related with the IPSS, nor did the volume of urinary retention after the preoperative voiding correlate with the time to first postoperative voiding in any of the groups. We assume that our well controlled and restricted intravenous Ringer's acetate infusion (approximately 1.5 mL/kg/h) and treatment of intra-anesthetic arterial hypotension primarily with ephedrine IV rather than with intravenous fluid contributed to the avoidance of urinary retention and need for bladder catheterization.

In earlier reports [2,5,7,15] spinal anesthesia has been associated with postoperative urinary problems after open inguinal hernia repair. Details of the spinal anesthetics are lacking, or a relatively large dose of bupivacaine [6] or bupivacaine mixed with a large dose of fentanyl [15] had been used. An assumed benefit of the use of short-acting local anesthetics, such as articaine or 2-chloroprocaine, in spinal anesthesia for open inguinal hernia repair has still not been demonstrated. Use of a matching (regarding surgical anesthesia) dose of the short acting articaine for spinal anesthesia in open inguinal hernia repair resulted in a slightly shorter block, but urinary retention occurred in the articaine group (5%), and not in the bupivacaine group [16]. Studies comparing spinal anesthesia with low-dose bupivacaine and clinically comparable doses of 2-chloroprocaine in open inguinal hernia repair are still missing. However, studies in knee arthroscopy patients indicate that although the duration of the block is even slightly shorter than that caused by articaine [17] spontaneous voiding does not seem to occur significantly earlier after chloroprocaine (median 180 min) [18] than after low-dose bupivacaine in our present study (median 190 min).

Most late occurring problems after inguinal hernia repair such as discomfort in the scar are not related to anesthesia but to the surgical technique [8,19]. Such surgery-related problems have diminished albeit not completely disappeared after the introduction of a repair technique using self-gripping light-weight mesh [20,21].

Anesthesiologists can control postoperative pain in the immediate postoperative period by a multimodal approach, and thereby reduce the risk of chronic pain [22,23]. Regional anesthetic techniques, such as wound infiltration received by all our study patients, have been shown to be very beneficial [23,24].

In all groups in our study the degree patient of satisfaction was high, in general, despite the frequent perception of intraoperative pain in the LAI group and the need for additional lidocaine infiltration. The LAI patients' acceptance of occasional short intraoperative pain may be due to the fact that they had preoperatively been informed about this inconvenience and assured that it would be treated instantaneously should it occur.

Spinal anesthesia offers generally excellent analgesia but the intrathecal puncture may sometimes be difficult and even painful, as complained by two of our patients. There were no complaints about the performance of anesthesia in the TIVA group.

Our patients' high scores of satisfaction with their anesthesia experience may have been subject to bias by the fact the scores were obtained on the first postoperative day when the patients had realized that the surgery had been successful and performed as expected, i.e. the patients were satisfied with the whole surgical experience [25,26].

Even without stop-watch timing, the anesthesiologist's presence in the operating room was needed more in the TIVA group than in the other groups, i.e., always for both induction and recovery, but also during the maintenance of general anesthesia because of more frequent hemodynamic control and in PACU1 because of more pain than in the other anesthesia groups. In our university hospital day-surgery center, as a rule, the anesthesiologist assigned to the anesthesia care of a patient undergoing open inguinal hernia repair performed under any of these three anesthetic techniques, is simultaneously responsible for at least one other anesthesia in the same operating room area.

The majority of LAI group patients were able to stand up and walk, and were hemodynamically stable immediately after surgery whereby they could bypass PACU1 and be moved directly to PACU2. The fact that the postoperative burden on the nursing staff is thereby reduced may be considered an additional advantage of the LAI technique.

5. Conclusion

With regard to the day-surgery setting, LAI anesthesia was favorable since the patients could often ambulate immediately after surgery, thus bypassing PACU1, and the discharge criteria were met significantly earlier than in patients having had general or spinal anesthesia. There was no statistically significant difference in the high degree of patient satisfaction with their anesthesia in all three groups. Contrary to the situation in the LAI and SPIN groups with some anesthetic failures, and the frequent need for analgesia supplementation in the LAI group, in the TIVA group the anesthetics were always successful but needed frequently interventional attendance by the anesthesiologist. The lack of postoperative urinary retention in all our patients may be due to the small infused fluid volumes together with the routine bladder scan before and after surgery. Postoperative discomfort or pain in the groin in some patients was not associated with any particular anesthesia technique.

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Appendix A. Discharge criteria

The patient can be discharged home from PACU2 of the day-surgery center when the following criteria have been objectively attained:

- patient's general condition is good (normal cognition, breathing, circulation).
- patient is able to walk and dress without support.
- patient is pain-free, or almost pain-free (pain score below 3 on the NRS) when walking.
- there is no bleeding from the wound.
- patient has drunk at least 150 mL of water or juice without being nauseated.
- patient has been able to pass urine spontaneously, or the bladder has been emptied.
- using catheterization.
- the patient will be escorted home by a competent adult person.

Appendix B. Postoperative interviews

Days 1 and 7

Study patient no. _____

Patient's name: _____

Date of surgery: _____

Telephone numbers: _____

Date of interview: _____

1. What is your condition right now?
2. Have you needed to visit a health care unit (public or private) or a hospital after your operation?

If yes - what was the reason?

3. Have you taken any analgesics (pain medicines) for pain in the operated area?

If yes - when, which drugs, which doses?

4. What was the intensity of pain when you took the first dose of an analgesic drug?

Scoring on the Numeral Rating Scale (NRS 0–10), which was explained in the hospital and repeated now in the interview.

NRS score at rest: _____

NRS score when walking: _____

5. Have you had any problems with voiding? If yes - which kind?

6. Have you observed any fluid secretion in the wound? Yes/No.

7. Have you observed any redness or swelling around the wound? Yes/No.

8. Have you had any nausea and/or vomiting at home after the operation? Yes/No.

9. Have you noticed any strange and abnormal sensations in any part of the body after the operation? If yes - where and what kind?

10. Have you noticed muscle weakness in your arms or legs? If yes - where?

11. Have you taken any pain medicine for other than pain in the operated area after the operation? If yes, for which reason, which drugs and doses?

12. Have you had headache after the operation? If yes, did it disappear when you lie down in bed, and return when you stand up?

13. In addition to pain in the wound area and possible headache, have you had any other aches or pain in other parts of the body? If yes - where and which kind?

14. Please, give an estimate of your own (personal) degree of satisfaction of the treatment in the hospital, in general: Scores: 1. Very satisfied, 2. Satisfied, 3. Dissatisfied,

4. Very dissatisfied. If scores 3 or 4 - which were the reasons?

15. Please, give an estimate of your own (personal) degree of satisfaction of the anesthesia (anesthetic treatment): Score: 1. Very satisfied, 2. Satisfied,

3. Dissatisfied, 4. Very dissatisfied. If scores 3 and 4 - which were the reasons?

16. Any additional comments regarding your personal experiences and/or suggestions for.

improving the day-care organization?

3 months

1. What is your condition right now?

2. Has the surgical wound healed properly? If not - what has been the problem?

3. Have you needed to visit a health care unit (public or private) or a hospital after your operation? If yes - what was the reason?

4. Are you still (3 months after surgery) taking any analgesics for pain in the operated area? If yes - what has been the reason? What drugs and how often have you taken them? When was the last time you took medicine for pain in the wound area?

5. What is the intensity of pain right now? NRS score at rest: ____ NRS score when walking: ____.

6. Have you had any problems with voiding? If yes - what kind of problems?

7. When did you return to work?

When the patient is a retired person: When did you notice that you had the ability to accomplish normal activities without being hindered by pain in the operation scar area?

8. Any additional personal comments regarding your treatment or experiences with the inguinal hernia repair operation?

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