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REPORTS OF ORIGINAL INVESTIGATIONS

Comparison of bupivacaine and 2-chloroprocaine for spinal anesthesia for outpatient surgery: a double-blind randomized trial

Comparaison de la bupivacaïne et de la 2-chloroprocaïne pour la rachianesthésie en chirurgie ambulatoire: une étude randomisée à double insu

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Abstract

Background *We have always been searching for the ideal local anesthetic for outpatient spinal anesthesia. Lidocaine has been associated with a high incidence of transient neurological symptoms, and bupivacaine produces sensory and motor blocks of long duration. Preservative-free 2-chloroprocaine (2-CP) seems to be a promising alternative, being a short-acting agent of increasing popularity in recent years. This study was designed to compare 2-CP with bupivacaine for spinal anesthesia in an elective ambulatory setting.*

Methods *A total of 106 patients were enrolled in this randomized double-blind study. Spinal anesthesia was achieved with 0.75% hyperbaric bupivacaine 7.5 mg (n = 53) or 2% preservative-free 2-CP 40 mg (n = 53). The primary endpoint for the study was the time until reaching eligibility for discharge. Secondary outcomes included the duration of the sensory and motor blocks, the length of stay in the postanesthesia care unit, the time until ambulation, and the time until micturition.*

Results *The average time to discharge readiness was 277 min in the 2-CP group and 353 min in the bupivacaine group, a difference of 76 min (95% confidence interval [CI]: 40 to 112 min; P < 0.001). The average time for complete regression of the sensory block was 146 min in the 2-CP group and 329 min in the bupivacaine group, a difference of 185 min (95% CI: 159 to 212 min; P < 0.001). Times to ambulation and micturition were also significantly lower in the 2-CP group.*

Conclusion *Spinal 2-chloroprocaine provides adequate duration and depth of surgical anesthesia for short procedures with the advantages of faster block resolution and earlier hospital discharge compared with spinal bupivacaine. (ClinicalTrials.gov number, NCT00845962).*

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Résumé

Contexte *Nous sommes depuis toujours à la recherche de l'anesthésique local idéal pour l'anesthésie rachidienne ambulatoire. La lidocaïne a été associée à une incidence élevée de symptômes neurologiques temporaires, et la bupivacaïne produit des blocs sensitifs et moteurs de longue durée. La 2-chloroprocaïne (2-CP) sans agent de conservation semble être une alternative prometteuse, étant donné qu'il s'agit d'un agent à courte action qui gagne en popularité depuis quelques années. Cette étude a été conçue afin de comparer la 2-CP à la bupivacaïne pour la rachianesthésie dans un contexte ambulatoire et non urgent.*

Méthode *Au total, 106 patients ont été recrutés dans cette étude randomisée à double insu. La rachianesthésie a été réalisée avec 7,5 mg de bupivacaïne hyperbare 0,75% (n = 53) ou 40 mg de 2-CP sans agent de conservation à 2% (n = 53). Le critère d'évaluation principal de l'étude était le délai jusqu'à l'éligibilité au congé. Les critères d'évaluation secondaires étaient la durée des blocs sensitifs et moteurs, la durée de séjour en salle de réveil, le temps jusqu'à ambulation et le temps jusqu'à miction.*

Résultats *Le délai moyen jusqu'à l'éligibilité au congé était de 277 min dans le groupe 2-CP et de 353 min dans le groupe bupivacaïne, soit une différence de 76 min (intervalle de confiance [IC] 95%: 40 à 112 min; P < 0,001). Le temps moyen jusqu'à régression du bloc sensitif était de 146 min dans le groupe 2-CP et de 329 min dans le groupe bupivacaïne, soit une différence de 185 min (intervalle de confiance [IC] 95%: 159 à 212 min; P < 0,001). Les temps jusqu'à ambulation et miction étaient également significativement plus bas dans le groupe 2-CP.*

Conclusion *La 2-chloroprocaïne rachidienne procure une durée et une profondeur adéquates de l'anesthésie chirurgicale pour les interventions courtes et offre l'avantage d'une régression plus rapide du bloc et d'un congé plus rapide de l'hôpital par rapport à la bupivacaïne rachidienne. (Numéro de ClinicalTrials.gov, NCT00845962).*

At present, more procedures are performed in an outpatient setting, and many of them are conducted under spinal anesthesia. Unfortunately, no local anesthetic can provide a block with rapid onset, predictable duration, good effectiveness and reliability, fast recovery, and lack of side effects.[1,2]

For many years, spinal lidocaine has been the local anesthetic of choice for outpatient surgery because of its profile of fast onset and short duration. However, transient neurological symptoms (TNS), described as back pain with irradiation to the lower extremities, have been reported.[3-7] This information has prompted many practitioners to abandon the use of lidocaine for spinal anesthesia.

As an alternative, attempts have been made to adapt hyperbaric bupivacaine, a long-acting local anesthetic, to the ambulatory setting by using smaller doses. However, the duration of the block remains prolonged with these smaller doses, and they may provide insufficient anesthesia.[8,9] Furthermore, urinary retention (or a prolonged interval to first voiding) is frequently encountered with bupivacaine, which delays the time until discharge for ambulatory patients.[10]

An amino-ester local anesthetic, 2-chloroprocaine (2-CP), is of short duration of action. Initially used mostly for obstetrical epidurals, its safety and reliability for spinal anesthesia has been reported since 1952.[11-14] Concerns about its use were raised in the 1980s following the description of nine cases of neurotoxicity. Multiple studies have suggested that the combination of a low pH (< 3) and the presence of sodium bisulfite, an antioxidant, may have been responsible for the neurotoxicity observed following the use of large doses of 2-CP.[15-37] In six of these cases, doses > 400 mg planned for epidural injection were inadvertently injected into the subarachnoid space. Subsequently, the pH of the solution has been adjusted, and a preservative-free formulation has been released. This new formulation has been used for spinal anesthesia in healthy volunteers without complication.[38-45] Despite a decade of worldwide use in thousands of patients, the anesthesia community remains reluctant to utilize 2-CP in routine practice.

Clinical research with spinal 2-CP has been limited mainly to dose comparisons and evaluation of block characteristics in patients undergoing short procedures.[46-51] In eight healthy volunteers, Yoos *et al*. compared 2-CP 40 mg with bupivacaine 7.5 mg. They concluded that spinal 2-CP provides adequate duration and density of block for ambulatory surgical procedures, and it has a significantly faster resolution of block and return to ambulation compared with bupivacaine.[44] This study was designed to compare 2-CP with bupivacaine for spinal anesthesia in elective ambulatory surgeries. We hypothesized that 2-CP can provide spinal anesthesia with a shorter recovery profile than bupivacaine, permitting earlier discharge from hospital after ambulatory surgery.

Methods

After receiving approval from the local ethics committee and Health Canada, written informed consent was obtained from each patient. All patients were informed about the cases of neurotoxicity in the 1980s that were related to the use of 2-CP (the preparation with a low pH and with sodium bisulfite as an antioxidant). A total of 106 patients were enrolled in this randomized double-blind study.

Patients included in the study were at least 18 yr old and scheduled for elective ambulatory surgery of short duration (< 60 min). The following surgeries were included: urologic surgeries (cystoscopy, circumcision, transurethral bladder tumour resection, varicocelectomy, and hydrocelectomy), general surgeries (hemorrhoidectomy, rectal biopsy, or any short anorectal surgery), and gynecologic surgeries (hysteroscopy, vulvar or vaginal biopsy, cystocele repair, dilatation, and curettage).

Exclusion criteria included patients with contraindications to spinal anesthesia (international normalized ratio > 1.3, platelets < 75,000, use of anticoagulant

drugs), neurologic disease (multiple sclerosis, symptomatic lumbar herniated disc, spinal stenosis), fluid restriction (cardiac or renal insufficiency), allergy or intolerance to local anesthetics or para-aminobenzoic acid, and atypical plasma cholinesterase.

The same blinded observer recruited all patients and assigned each patient a number that corresponded to their enrolment order (the first patient received the number 1; the second patient received the number 2, and so on). Afterwards, an unblinded anesthesiologist, the anesthesia provider, consulted a computer-generated randomized list where each number was linked to a local anesthetic, either 2-CP or bupivacaine, for each patient. The anesthesiologist then performed the spinal anesthesia using the local anesthetic randomly assigned to that patient. Both the patients and the observer who recruited the patients and collected the data were blinded.

All patients fasted for at least six hours before the procedure. After arrival in the operating room, a 20G peripheral intravenous catheter was inserted into the patient's forearm, and approximately 10 $mL \cdot kg^{-1}$ of crystalloid were infused. Standard monitoring was used throughout the procedure, including non-invasive arterial blood pressure, electrocardiogram (three leads), and pulse oximetry. Sedation was provided at the discretion of the anesthesiologist (midazolam 0.025 to 0.05 $mg \cdot kg^{-1}$ *iv* before or immediately after the spinal).

Spinal anesthesia was performed under sterile conditions after local infiltration of the skin with 1% lidocaine (Xylocaine, Astra Zeneca, Mississauga, ON, Canada). With the patient in the sitting position, the subarachnoid space was entered at the L2-3, L3-4, or L4-5 interspace via the midline approach using a 20G introducer and a 25 or 27G Sprotte spinal needle. According to their randomization, patients received an intrathecal injection of either 0.75% hyperbaric bupivacaine 7.5 mg (1 mL) (Marcaine®, Hospira Inc., Montreal, QC, Canada) ($n = 53$) or a preservative and bisulfite-free formulation of 2% 2-CP 40 mg (2 mL) (Nesacaine®-CE, AstraZeneca, Mississauga, ON, Canada) ($n = 53$). No adjuvant medication (fentanyl, epinephrine, etc.) was added to either local anesthetic.

After the completion of the spinal injection, the patients were immediately placed supine. The aforesaid independent blinded observer evaluated the sensory and motor blocks every three minutes for 15 min, then every five minutes for 45 min, and then every ten minutes for 60 min, and finally every 15 min until the sensory block had regressed to the S2 dermatome. During surgery, the patient's blood pressure (systolic and diastolic), electrocardiogram, and pulse oximetry were recorded.

The sensory level of the block was assessed in a caudal to cephalad direction using the loss of cold sensation to ice, and the C5-C6 dermatome was used as an unblocked reference point. The motor block was assessed using the modified Bromage scale (0 = no block, full straight leg raise possible; 1 = unable to straight leg raise, able to flex knee; 2 = unable to flex knee, able to flex ankle; 3 = no motor movement, complete motor block). Readiness for surgery was defined as loss of cold sensation $\geq$ T10.

During surgery, evaluation of the motor block was suspended until the end of the procedure. If the patient complained of pain, fentanyl 25 to 100 μg *iv* was administered. If additional sedation was needed, midazolam 0.025 to 0.05 $mg \cdot kg^{-1}$ *iv* or propofol 0 to 50 $\mu g \cdot kg^{-1} \cdot min^{-1}$ *iv* was administered. The total dose of any given medication was recorded. If the patient still felt pain, general anesthesia was provided and the protocol was stopped.

The occurrence of clinically relevant hypotension (defined as a decrease in systolic arterial blood pressure $\geq$ 25% from baseline values) was treated with ephedrine or phenylephrine. Clinically relevant bradycardia (defined as heart rate < 50 $beats \cdot min^{-1}$) was treated with atropine or ephedrine. The total dose of ephedrine, phenylephrine, or atropine needed was recorded.

Postoperative analgesia consisted of fentanyl 25 μg *iv* every five minutes if needed, supplemented by morphine 2 mg *sc* every 15 min if the pain was intense and difficult to treat. Ondansetron 4 mg *iv* was offered for nauseous patients. The cumulative dose on any of these medications was recorded. Patients were discharged from the postanesthesia care unit (PACU) when they had attained all of the following criteria: a minimum 60-min stay, stable vital signs, signs of regression of the motor block (Bromage 0 to 2), no analgesia within the previous 20 min, and normal consciousness.

After discharge from the PACU, the patients were transferred to the ambulatory surgical unit where the nurses responsible for patient care undertook directing further management so as to represent our real-life practice environment. The patients were offered a light snack just over an hour after their arrival in the ambulatory surgical unit, and once they could tolerate liquids by mouth and feel a light touch to their legs, they were asked to ambulate without assistance. Success at walking was followed by an attempt to void. Discharge from hospital was possible when the patients reached all of the following criteria: complete regression of the block to light touch, ability to void, ability to walk, stable vital signs, no nausea, pain controlled with oral medication (last dose given at least one hour before discharge), and ability to tolerate liquids by mouth. The primary outcome of this study, i.e., the time to eligibility for discharge from hospital, was measured from the time spinal anesthesia was performed to the time the patient attained all of the discharge criteria.

The following data were recorded: peak block height and time to reach peak block height, time for regression of

two segments, time for regression to L1, and time for complete regression. For the motor block, the Bromage score at the end of the surgery and the time to reach a score of 0/3 were also recorded. In addition, time to reach readiness for surgery, length of surgery, length of stay in the PACU, time to void, time to ambulate, and time to reach discharge readiness criteria were also recorded.

Patients were contacted by telephone 24 hr and seven days following surgery to assess potential complications related to the spinal anesthesia. A standardized questionnaire was used to check for the presence of headache, paresthesia or dysesthesia in the lower limbs, lower back pain, nausea or vomiting, and difficulty voiding. Also, during the first follow-up call, the patient's satisfaction with the anesthesia provided was assessed using a scale from 0 to 10 (0 = total dissatisfaction; 10 = total satisfaction).

Statistical analysis

In a pilot study of 20 patients having spinal anesthesia using hyperbaric bupivacaine 7.5 mg for urologic, gynecologic, and general procedures, the mean time to eligibility for discharge was 363 (95) min. The sample size was based on a two-sided test with an alpha of 0.05 and a power of 90%. To obtain a 60-min reduction, a minimum of 53 patients per group was required.

An integer was assigned to each dermatomal level (i.e., T1 = 1, T2 = 2, T3 = 3, T4 = 4, etc.) for statistical analysis of dermatomal height. To calculate the regression time of the block, the dermatomal height of the sensory block was compared for each patient in each group for each time interval. Comparison of block regression over time was made using a two-way analysis of variance for repeated measures. Incidence data (incidence of hypotension, bradycardia, pain requiring analgesia, postoperative nausea and vomiting (PONV), and postoperative complications) were compared using Chi square test or Fisher's exact test (when the expected values in any of the cells of a contingency table were < 5). Student's t test was used to compare the other variables, including the primary outcome (time to eligibility for discharge) and secondary outcomes (time for complete regression of the sensory and motor blocks, length of stay in the PACU, and time to ambulation and micturition).

Statistical analysis was performed using SPSS 13.0 for Windows (SPSS inc., Chicago, IL, USA). Continuous variables are presented as mean (standard deviation); categorical data are presented as number of cases recorded (percent). No adjustment was made to the comparison-wise P values to account for the multiple outcome variables.

Results

A total of 117 patients were approached for enrolment in this study, and 11 patients refused to participate after receiving the information about the project. No patient was excluded based on the exclusion criteria; no patient was withdrawn during the study, and no patient was lost during the follow-up period. This study was performed in a tertiary university centre, Centre Hospitalier de l'Université de Montréal (CHUM), St-Luc Hospital, Montreal, Canada. Patients were enrolled from February 2009 to June 2009.

The patients were similar in terms of baseline demographics and the type and length of surgery (Table 1). The average time to discharge readiness was 277 min in the 2-CP group and 353 min in the bupivacaine group, a difference of 76 min (95% confidence interval [CI]: 40 to 112 min; $P < 0.001$).

The onset characteristics of the block were similar between the groups, as was the time required to achieve readiness for surgery, the peak block height, and the time to reach peak block height. In both groups, the sensory block reached the T10 dermatome after a mean of six minutes, and the peak block height was T7 (Table 2). However, regression characteristics did show a different profile between the two groups. Regression of the block to L1 was almost 50% faster in the 2-CP group than in the bupivacaine group (82 min *vs* 160 min, respectively, a difference of 79 min; 95% CI: 61 to 97; $P < 0.001$). The time for complete regression to S2 in the 2-CP group was less than half that of the bupivacaine group (146 min *vs* 329 min, respectively, a difference of 185 min; 95% CI: 159 to 212; $P < 0.001$) (Figure). Similarly, the duration of the motor block was significantly shorter in the 2-CP group (Table 2). Successful spinal anesthesia was attained in all patients,

Table 1 Demographics and type and length of surgery

	2-Chloroprocaine ($n = 53$)	Bupivacaine ($n = 53$)
Age (yr)	53 (16)	54 (16)
Sex (male/female)	24/29	20/30
Weight (kg)	77 (15)	73 (17)
Height (cm)	165 (8)	165 (9)
ASA physical status (I/II/III)	19/32/2	23/29/1
Length of surgery (min)	19.3 (13)	21.5 (16)
Type of surgery		
Genitourinary	32	31
General	12	13
Gynecologic	9	9

Values are mean (standard deviation), otherwise absolute number of cases recorded. ASA = American Society of Anesthesiologists

Table 2 Clinical data

	2-Chloroprocaine ($n = 53$)	Bupivacaine ($n = 53$)	P value	Difference between groups (95% CI)
Primary outcome				
Time to eligibility for discharge from hospital (min)	277 (87)	353 (99)	< 0.001	75.9 (39.9 to 112.0)
Secondary outcomes				
Sensory				
Time to readiness for surgery (min)				
Mean (standard deviation)	6 (4)	6 (3)	0.50	−0.4 (−1.7 to 0.8)
Range	3 to 20	3 to 12		
Peak block height (mean, range)	T7 (T1 to T10)	T7 (T1 to T11)	1.00	T7 (T6 to T8)
Time to peak block height (min)	15 (8)	18 (11)	0.15	2.8 (−1.1 to 6.7)
Time for two-segment regression (min)	50 (18)	75 (37)	< 0.001	25.4 (14.2 to 36.6)
Time for regression to L1 (min)	82 (24)	160 (62)	< 0.001	78.8 (60.7 to 96.8)
Time for complete regression to S2 (min)	146 (38)	329 (82)	< 0.001	185.4 (158.5 to 212.4)
Motor				
Duration of the motor block (min) (time to Bromage = 0)	76 (25)	119 (93)	0.005	43.3 (16.4 to 70.2)
Discharge				
Length of stay in PACU (min)	67 (16)	68 (14)	0.66	1.3 (−4.6 to 7.2)
Time to ambulation (min)	225 (56)	265 (65)	0.001	40.0 (16.3 to 63.7)
Time to micturition (min)	271 (96)	338 (99)	0.001	67.7 (27.3 to 108.1)
Interval from first try to successful voiding (min)	9 (26)	29 (51)	0.02	20.6 (3.8 to 37.4)

Values are mean (standard deviation). CI = confidence interval; PACU = postanesthesia care unit

which was defined as the ability to complete the surgery without the need for general anesthesia.

Length of stay in the PACU was similar in both groups. However, in terms of discharge criteria, the time to ambulation, micturition, and eligibility for discharge were all significantly shorter in the 2-CP group (Table 2).

During surgery, the incidence of hypotension, bradycardia, pain requiring analgesia, and the total dose of fentanyl given were similar between groups (Table 3). In the PACU, the incidence of hypotension, bradycardia, and PONV were also similar between groups. However, patients in the 2-CP group experienced more pain in the PACU, with a 19% difference in the incidence of pain between groups ($P = 0.007$). Patients in the 2-CP group also received more fentanyl in the PACU than the bupivacaine group (a mean of 25 μg *vs* a mean of 4 μg, respectively, a difference of 21.4 μg; 95% CI: −36.3 to −6.6; $P = 0.01$) (Table 3).

The incidences of complications recorded during the follow-up phone calls (postdural puncture headache, transient neurological symptoms, and back pain) were all similar between groups (Table 4). One case of possible TNS was described in each group.

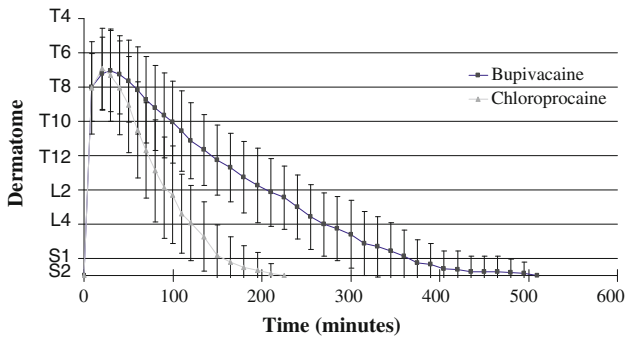

Figure Regression of the dermatomal level of the sensory block over time is mean (standard deviation): comparison of patients receiving an intrathecal injection of either bupivacaine 7.5 mg ($n = 53$) or 2-chloroprocaine 40 mg ($n = 53$). Analysis of variance repeated measures ANOVA: $P < 0.001$ (difference between the two groups over time)

Discussion

The purpose of this study was to compare 2-CP with bupivacaine for spinal anesthesia in an ambulatory surgery setting. Our principal finding was that spinal anesthesia with 2-CP can provide a satisfactory surgical block while permitting an earlier discharge from hospital than spinal bupivacaine. This advantage is due to a more rapid regression of the sensory and motor block, which helps patients ambulate and void faster.

The finding that shows the most significant advantage is the time for regression of the sensory block to S2, as 2-CP

Table 3 Hemodynamic changes and supplemental analgesia required during spinal anesthesia

	2-Chloroprocaine ($n = 53$)	Bupivacaine ($n = 53$)	*P* value	Difference between groups (95% CI)
During surgery				
Hypotension (≥ 25% baseline)	4 (8%)	2 (4%)	0.40	
Bradycardia (< 50 beats·min^{-1})	3 (6%)	4 (8%)	0.70	
Pain requiring analgesia	10 (19%)	5 (9%)	0.16	
Total dose of fentanyl (μg)	13 (32)	8 (28)	0.37	−5.2 (−16.7 to 6.3)
In the PACU				
Hypotension (≥ 25% baseline)	3 (6%)	1 (2%)	0.31	
Bradycardia (< 50 beats·min^{-1})	0 (0%)	2 (4%)	0.15	
PONV	2 (4%)	2 (4%)	1.00	
Pain requiring analgesia	13 (25%)	3 (6%)	0.007	
Total dose of fentanyl (μg)	25 (53)	4 (14)	0.01	−21.4 (−36.3 to −6.6)

Values are absolute number of cases recorded (percent). Differences between groups are mean (95% confidence interval [CI]). Total dose of fentanyl is mean dose per patient (standard deviation).
PACU = postanesthesia care unit; PONV = postoperative nausea and vomiting

Table 4 Postoperative complications and level of satisfaction

	2-Chloroprocaine ($n = 53$)	Bupivacaine ($n = 53$)	*P* value	Difference between groups (95% CI)
Postdural puncture headache	1 (2%)	1 (2%)	1.00	
Transient neurologic symptoms	1 (2%)	1 (2%)	1.00	
Back pain	24 (45%)	20 (38%)	0.43	
Satisfaction (/10)	9.2	9.1	0.59	−0.2 (−0.7 to 0.4)

Values are absolute number (percent). Difference between groups is mean (95% confidence interval [CI]). Satisfaction was assessed on a scale from 0 to 10 (0 = total dissatisfaction; 10 = total satisfaction)

was 2.3 times faster than bupivacaine. In a volunteer study of eight patients comparing equivalent doses of spinal 2-CP and bupivacaine, Yoos *et al.* demonstrated a 1.7 times faster regression of the sensory block with 2-CP (a difference of 78 min).[44] However, the data of Yoos *et al.* cannot be compared directly to ours as they used a different method to evaluate the sensory block. In our study, the level of sensory block was assessed using loss of cold sensation to ice, whereas Yoos *et al.* utilized loss of sensation to pinprick with a dermatome tester. Although the same nerve fibres transmit pain and cold information, there is a subtle distinction. Pinprick sensation is conducted by the A delta fibres, while cold sensation is transmitted by both the A delta fibres and the C fibres.[52]

The primary outcome of this study i.e., the time to eligibility for discharge from hospital, was measured from the time spinal anesthesia was performed to the moment the patient attained all of the discharge criteria. As to this outcome, a significant difference of 76 min was observed in favour of the 2-CP group due to faster regression of the block, resulting in earlier ambulation and earlier voiding. Delayed discharge due to urinary retention was particularly problematic in the bupivacaine group. Even with good block regression and successful ambulation, many patients who received bupivacaine experienced a longer delay between their first attempt and their eventual successful complete voiding. This delay may be explained by the need for a regression of the sensory block to at least the S3 dermatome in order to obtain normal detrusor function. Breebaart *et al.* also demonstrated a longer interval to first voiding in patients having spinal anesthesia with long-acting local anesthetics (levobupivacaine and ropivacaine) compared with those with shorter-acting agents (lidocaine).[10]

Although this study was not designed to measure health care costs, our results could be significant when considered from a cost savings perspective. As health care costs are determined, in part, by the length of hospital stay, achieving faster discharge from hospital through the utilization of 2-CP for spinal anesthesia could provide potential cost savings without compromising the quality of patient care.

The doses of local anesthetics used in this study can be considered clinically equivalent, since the minimum dose chosen for each medication (without additives) was believed to be clinically efficacious. Ben-David *et al.* showed that spinal hyperbaric bupivacaine 7.5 mg provided satisfactory anesthesia and rapid recovery for ambulatory arthroscopic knee surgery, but that further dilution resulted in failed blocks.[53] Prior studies of 2-CP suggested that 40 mg would be the minimum dose required to achieve the rapid onset of a reliable sensory and motor block of sufficient duration.[42,47]

After surgery, all of our patients were transferred to the PACU for routine observation, where they remained for a mean of 67 to 68 min. Although there was no difference between the groups in our study, there may be an opportunity to institute changes that could optimize the time spent in the PACU, e.g., permitting patients to be discharged earlier when they are stable and when the block has shown signs of regression. According to our results, this milestone would be achieved sooner in patients with 2-CP spinal anesthesia.

It is noteworthy to mention that more patients in the 2-CP group experienced pain in the PACU. Also, the total dose of fentanyl given in the PACU was higher in the 2-CP group. This may not necessarily represent a disadvantage of 2-CP administration. The patients in the 2-CP group experienced more pain in the PACU because their spinal anesthesia regressed more rapidly. Consequently, patients in the 2-CP group were treated with opioids earlier by nurses who were more familiar with pain control modalities. Thus, patients receiving 2-CP could be assured of optimal post-block pain control prior to being transferred to the ambulatory unit.

Telephone follow-up identified one possible case of TNS in each group, defined as pain and/or dysesthesia occurring in the legs and/or buttocks in the first 24 hr after recovery from an uneventful spinal anesthetic. According to a Cochrane review from 2009, the incidence of TNS after spinal anesthesia with lidocaine was 14% (102/719 cases).[54] In our study, both cases of possible TNS shared some important characteristics: both patients were 50 to 60-yr-old females undergoing transobturator tension-free urethral suspension (TVT-O) in the lithotomy position. Differential diagnosis includes the well-described neuropathies known to be associated with the lithotomy position. According to a review by Warner *et al*.,[55] there was a 1.5% incidence of lower extremity neuropathies in patients who underwent general anesthesia and surgery while in the lithotomy position. Positioning the thighs in extreme abduction with external rotation,[56] as is occasionally the case during TVT-O, is a well described risk factor. Another potential etiology could be surgical trauma, often entrapment of the obturator nerve during placement of the sling. In a review of the complications associated with transobturator sling procedure, Boyles *et al.*[57] found four cases of neuropathy out of a total of 173 complications described in an 18-month period. Therefore, we can't confirm the diagnosis of TNS in either of these patients.

One of the biggest limitations of this study is that it was not perfectly double-blinded. Since the block in the 2-CP group regressed earlier and faster, the blinded observer could guess the group to which the patient had been assigned. Although this limitation was identified prior to the enrolment of the first patient, no better alternative to the protocol was determined. An additional limitation of this study was determining the precision of the sensory level of the block within two dermatomal levels. This imprecision was minimized by having the same blinded observer responsible for collecting all data during the entire study. Also, our design could be criticized for not using opioids to supplement the local anesthetics, as is common clinical practice. In this study, opioids were not added to the spinal in order to reduce possible confounding factors.

In conclusion, intrathecal 2-CP 40 mg produces a satisfactory surgical block for procedures lasting < 60 min. When compared with hyperbaric spinal bupivacaine 7.5 mg, it resulted in a significantly faster regression of the block, shorter time to ambulation and micturition, and earlier discharge from hospital. Future work may confirm our predication that choosing 2-CP for spinal anesthesia in an ambulatory surgery setting may free up the PACU and ambulatory surgical unit resources with a corresponding decrease in total perioperative costs.

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Conflicts of interest None declared.

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