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Chloroprocaine vs. articaine as spinal anaesthetics for day-case knee arthroscopy

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Background: Chloroprocaine and articaine have recently gained interest as short-acting spinal anaesthetics. They have not, however, previously been compared in an ambulatory surgery setting.
Methods: In this double-blind, randomised, controlled trial, adult patients (≤ 65 years, ASA I–II, body mass index $<36\,kg/m^2$) underwent day-case knee arthroscopy under spinal anaesthesia with either 40 mg of plain chloroprocaine (20 mg/ml) (group C40; $n = 39$) or 60 mg of plain articaine (40 mg/ml) (group A60; $n = 39$). Study parameters included the onset, degree, and regression of both sensory and motor block. Standardised telephone interviews on the first and seventh post-operative day were aimed at detecting any untoward sequelae, e.g., transient neurologic symptoms (TNSs).
Results: The groups were comparable regarding demographic data, onset and maximal spread of spinal anaesthesia, and duration of surgery. All arthroscopies were performed successfully under spinal anaesthesia, except for one patient (C40, unforeseen delay in the start of surgery). The duration of sensory block $\geq$ dermatome L1 was significantly shorter in C40 vs. A60. Correspondingly, complete recovery was significantly faster ($P < 0.0001$, Mann–Whitney *U*-test) in C40 vs. A60 for both motor [75 (60/90) vs. 135 (105/150) min] and sensory [105 (105/135) vs. 165 (135/180) min] block, respectively [data are median (25th/75th percentiles)]. No TNSs were noted.
Conclusions: Both anaesthetics used provided a rapid onset of spinal anaesthesia of about 1 h and were satisfactory for day-case knee arthroscopy. Recovery, however, was significantly faster in group C40. The data add to earlier results that TNSs seem to be uncommon after spinal chloroprocaine and articaine.

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SPINAL anaesthesia with both rapid onset and a short duration of block is a sound alternative to general anaesthesia in day-case surgery. A short-acting spinal anaesthetic facilitates a smooth patient flow and contributes to good patient satisfaction as patients appreciate it when they quickly regain autonomy after surgery without unnecessarily prolonged (motor) block. For this purpose, lidocaine (e.g., 50 mg/ml) has been the drug of choice for decades. Spinal lidocaine, however, has been associated with an unacceptable number (20–30%) of transient neurologic symptoms (TNSs).[1–3] In recent years, both chloroprocaine[4–6] and articaine[7–10] have gained interest as short-acting spinal anaesthetics seemingly without the issue of TNSs. So far, these two drugs have not been compared as to whether one would be more preferable than the other in an ambulatory surgery setting. Therefore, the present study investigated, in patients undergoing knee arthroscopy, as to whether intrathecal chloroprocaine and articaine are comparable in terms of block onset, maximal spread, and recovery. Complete recovery from the motor blockade was the chief outcome parameter. The dosages of chloroprocaine (40 mg) and articaine (60 mg) (both drugs as plain solutions) were based on reports on the successful use of such doses in spinal anaesthesia for ambulatory surgery.[4,6–8]

The study was carried out at the Orthopaedic Hospital Orton, Invalid Foundation, Helsinki, Finland.
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Methods

Study design, patients, and randomisation

The study received approval from the Local Ethics Committee and the National Agency for Medicines,

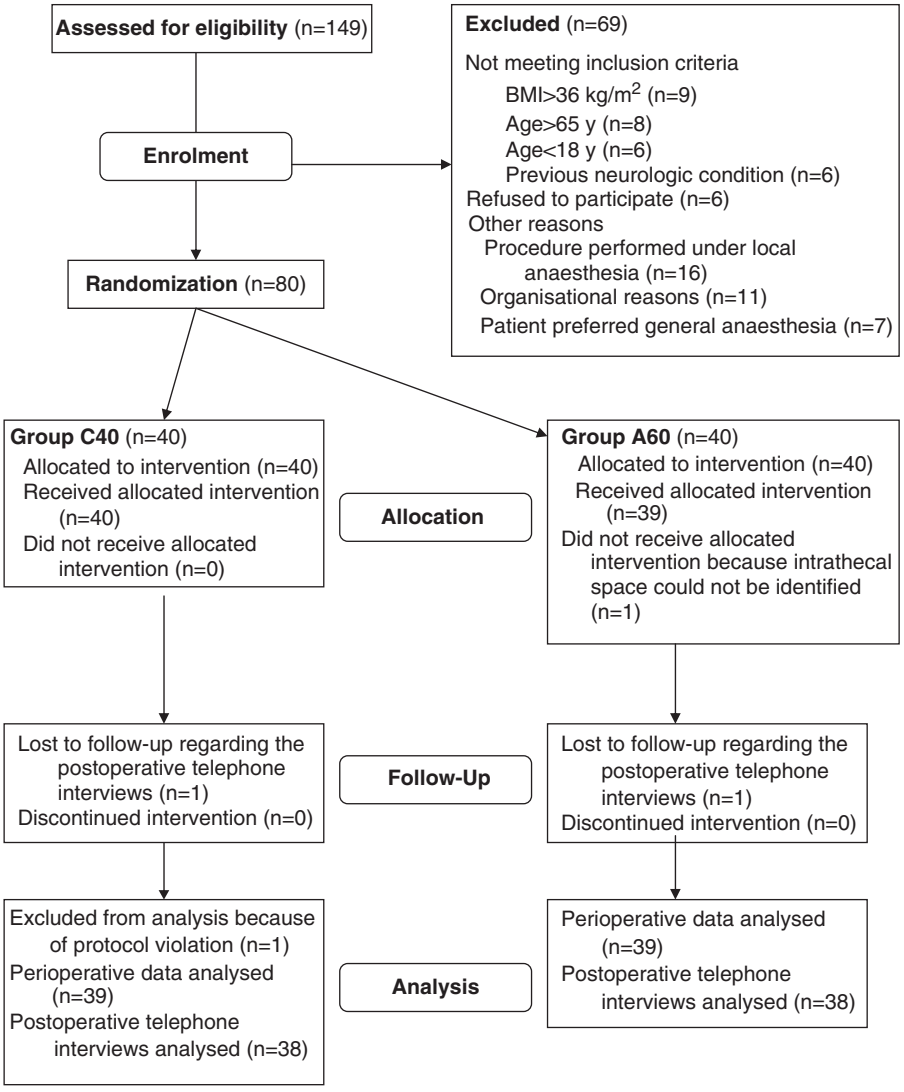

Fig. 1. CONSORT flow diagram.

and all patients gave written consent. Patients (40 per study group, Fig. 1) scheduled for ambulatory knee arthroscopy received either of the two spinal local anaesthetics in a prospective, randomised, and double-blind fashion. Inclusion criteria were age 18–65 years and ASA physical status I–II. Exclusion criteria were allergy to one of the study drugs, contraindications to neuraxial anaesthesia, previous neuropathy of the lower extremities, and a body mass index $>36\,kg/m^2$.

Treatment allocation to the two study groups was by blocked randomisation (closed envelope method, block size of 10 patients). One of the anaesthetists broke the seal of the randomisation envelope and administered the spinal anaesthesia according to the named drug without disclosing the group allocation to anybody. Then, this anaesthetist left the operating theatre and was not further involved in any part of the study. A second anaesthetist (J. F., P. R., M. P.) assumed responsibility for the case along with the specially trained nurse. The procedures were performed by one of the two orthopaedic surgeons (A. H., J. S.), and post-operative telephone interviews were carried out by one anaesthetist (H. K.). A thigh tourniquet was used during arthroscopy.

Pre-operative phase and spinal anaesthesia

According to routine guidelines here, patients were asked not to take their prescribed antihypertensive medication in the morning of their surgery. They were offered oral diazepam but combined with the information that generally oral premedication is not given in the day-case unit. Monitoring included pulse oximetry, ECG, and non-invasive blood pres-

sure measurement (recorded at 5-min intervals in the operating theatre and, thereafter, 10 min in the post-operative care unit). Before the spinal anaesthesia, 100–150 ml of Ringer's acetate solution was administered intravenously (i.v.).

During the lumbar puncture, the patients were in the lateral decubitus position with the side of intended surgery facing upwards. By inspection and with the help of a spirit level, we took care that the spine column was horizontal. After local anaesthesia of the skin at the puncture site (preferably midline at L3–L4), a lumbar puncture was made using a 27 G needle (preferably pencil point with guide needle). On obtaining a free flow of cerebrospinal fluid and with the orifice of the needle facing upwards, the study drug was injected at a rate of 1 ml/10 s. A stopwatch was then started (= time zero). Then, the patient was turned supine without delay and, if needed, the operating table was adjusted horizontally. We recorded technical difficulties and the occurrence of paraesthesia related to the lumbar puncture (Table 2).

Study drugs

The following two preservative- and glucose-free, plain local anaesthetics were compared. Patients received intrathecally either chloroprocaine hydrochloride 40 mg (group C40, $n = 40$), i.e., 2.0 ml Nesacaine®-CE 20 mg/ml, AstraZeneca, Mississauga, ON, Canada, or articaine hydrochloride 60 mg (group A60, $n = 40$), i.e., 1.5 ml Ultracain® D ohne Adrenalin 40 mg/ml, Aventis, Frankfurt am Main, Germany. The densities of the preparations were 1.0013 g/ml for chloroprocaine and 1.0035 g/ml for articaine. (As compared with the density of distilled water at 37 °C;[11] uncertainty of measurement 0.0002 g/ml; measured at 36.8 (± 0.2) °C; measurement protocol: M-09D025, 2009, the National Standards Laboratory, Centre for Metrology and Accreditation, Espoo, Finland.)

Additional drugs intraoperatively

Patients were given i.v. midazolam or fentanyl, as needed, at the time of lumbar puncture and during surgery. Hypotension (systolic blood pressure <90 mmHg or decrease in systolic blood pressure >30% of baseline measured on arrival in the operating theatre) was controlled with i.v. ephedrine 5 mg and bradycardia (pulse <50/min) with i.v. atropine 0.5 mg. The rescue anaesthetic procedure was sedation or general anaesthesia (the latter with a laryngeal mask) with i.v. propofol and fentanyl.

Assessment of sensory and motor block

Both the sensory and the motor block were assessed bilaterally. Concerning the sensory block, we recorded the highest dermatome level without a sharp sensation to a pin-prick needle at 2, 4, 6, 8, 10, 15, 20, 25, and 30 min, and then at 15-min intervals until the sensory blockade had regressed to dermatome S2 (normal sharp sensation at both calves). Motor blockade was evaluated using a modified Bromage scale (0 = able to raise entire leg; 1 = unable to raise whole leg but able to flex knee; 2 = unable to flex knee, only foot moving; 3 = unable to move knee or foot) at 5, 10, 15, 20, 25, and 30 min, and then every 15 min until both legs could be fully elevated.

Post-operative management and follow-up

In the post-operative care unit, when the sensory blockade had regressed to at least the dermatome L1 on one limb, and in the absence of nausea, the patient was permitted to drink fluid. At this time, the patient received first pain medicine, either paracetamol or a non-steroidal anti-inflammatory drug. In all, the post-operative pain treatment was tailored individually and included on-demand codeine or oxycodone. The urinary bladder of each individual was examined by ultra-sound (BladderScan® BVI 3000, Diagnostic Ultrasound, Bothell, WA): 0–400 ml of urine = no intervention and follow-up until spontaneous voiding; 400–500 ml of urine = patient asked to void and reassessment after 1 h as needed; and >500 ml of urine = single catheterisation of the bladder if spontaneous voiding was not possible. The time of first spontaneous voiding was registered as was the need for catheterisation. On arrival back to the surgical ward, the patient was offered a light meal. From here on, treatment was according to the hospital's standard procedure. Before being discharged home, all patients had to meet the usual discharge criteria for day-case surgery (mental alertness, stable vital signs, absence of nausea, adequate control of pain, ability to ambulate, and normal bladder function). There was no so-called simulated discharge or particular pressure towards accelerated home discharge; discharge times were noted retrospectively from the charts.

On the first and seventh post-operative days, the patients were interviewed by telephone for any possible side effects. Here, we used a standardised questionnaire that paid special attention to TNSs. The latter was defined as a bilateral mild to severe

pain occurring in the gluteal region and legs, appearing no more than 24 h after complete recovery from the spinal anaesthesia.[3] The patients were also asked to rate their satisfaction as to their spinal anaesthesia (see Table 4 for the grading scale).

Sample size and statistics

The chloroprocaine and articaine dosages were based on earlier studies.[4,6–8] With full recovery from motor block as the primary outcome, and assuming a clinically meaningful minimum difference of 30 min [standard deviation (SD) 40 min], we calculated that 38 patients per group would suffice to detect statistical significance ($\alpha = 0.05$, power = 90%). Forty patients were allocated to each group to allow for possible drop-outs.

Normally distributed, parametric data are presented as mean (SD) and the groups are compared using the *t*-test. Non-parametric data are given as median with percentiles or range, as appropriate, and the groups are analysed using the Mann–Whitney *U*-test (MW-*U*). Categorical data are presented in absolute numbers with percentages, and the differences between the groups are assessed using the χ^2-test or Fisher's exact test. *P*-values <0.05 are considered statistically significant. The StatView® for Windows® computer program (Version 5.0.1, SAS Institute Inc., Cary, NC) was used for the analysis. As appropriate, 95% confidence intervals (95% CI) were computed using the software Confidence Interval Analysis (Version 2.1.1, by Bryant TN, University of Southampton, UK, 2000).

Results

Data forwarded to analysis and demographics

The data were collected from October, 2008 to November, 2009. As shown in Fig. 1, one patient in group C40 dropped out due to protocol violation and one in group A60 because the intrathecal space could not be identified. In the remaining 39 patients per group, knee arthroscopy was successfully performed under spinal anaesthesia, except for one patient from C40, because the allocated surgeon was engaged in another operating theatre unexpectedly long; when the knee arthroscopy finally began 63 min from lumbar puncture, the spinal block was wearing off and thus the patient required sedation (i.v. propofol and fentanyl). The data of this particular person were, however, included in the analysis as regards the time until sedation was initiated and the telephone interviews. In each group, one patient was lost to follow-up as regards the telephone interviews, i.e., 38 patients per group contributed to these data. There were no statistically significant differences between the study groups regarding the demographic data, oral diazepam premedication, or surgery-related information (Table 1). Some patients required small doses of i.v. midazolam and fentanyl during application of the spinal block or surgery or both (Table 2). One patient from C40 received i.v. propofol 50 mg because of some dull sensation in the beginning of the procedure; after this, the patient was in comfort and awake throughout the arthroscopy.

Table 1

Data related to demographics, premedication, and surgery.

	Chloroprocaine (40 mg) ($n = 39$)	Articaine (60 mg) ($n = 39$)
Male/female	31/8	24/15*
ASA physical status I/II	30/9	29/10
Age (years)	45 (12.9)	48 (12.4)
Weight (kg)	81 (14.9)	81 (12.6)
Height (cm)	178 (8.0)	175 (10.3)
Body mass index (kg/m^2)	26 (3.6)	27 (3.5)
Premedication diazepam 10 or 15 mg p.o.		
Yes/No	0/39	5/34†
Average amount (mg)	0 (0/0)	0 (0/0)
Spinal anaesthesia to ready-to-cut (min)	18 (3.9)	18 (4.3)
Spinal anaesthesia to start of surgery (min)	31 (9.6)	30 (9.5)
Duration of surgery (min)	18 (13/23)	19 (15/25)
Type of arthroscopic knee surgery‡		
Diagnostic arthroscopy	1	3
Resection of meniscus	27	24
Refixation of meniscus	3	4
Arthroscopic synovectomy	6	5
Revision of osteochondritis lesion	2	3
Repair of joint cartilage	5	4

Data are numbers of patients, mean (SD), or median (25th/75th percentiles), unless stated otherwise.
*$P = 0.082$, χ^2 test.
†$P = 0.055$, Fisher's exact test.
‡Five patients in group C40 and four patients in group A60 with two codes.

Sensory and motor block

Table 2 shows the onset times of sensory block at dermatome L1 and T10, with no significant difference between the groups. The motor block developed significantly faster in A60 as compared with C40 ($P < 0.01$ at 5 and 10 min, MW-*U* test) (Fig. 2). Figure 2 presents the grades of sensory and motor block over time. The groups did not differ with regard to the maximum extension of the sensory

Table 2

Details related to the administration and progress of spinal anaesthesia.

	Chloroprocaine (40 mg) ($n = 39$)	Articaine (60 mg) ($n = 39$)	*P*-values, statistical test
Midazolam i.v.			
During administration of spinal anaesthesia	7	10	
During surgery	4	1	
Total amount (mg)	0 (0/1)	0 (0/1)	
Fentanyl i.v.			
During administration of spinal anaesthesia	2	3	
During surgery	3	1	
Total amount (μg) [additionally 10th/90th percentiles]	0 (0/0) [0/85]	0 (0/0) [0/30]	
Sensory block (pin-prick) at dermatome L1, number	36	39	
Time to onset (min)	6 (2/8)	4 (2/6)	0.38, MW-*U*
Duration (min)	54 (39/65)	71 (55/86)	0.0005, MW-*U*
Sensory block (pin prick) at dermatome T10, number	23	22	
Time to onset (min)	10 (4.5/15)	8 (4/10)	0.35, MW-*U*
Duration (min)	22 (15/41)	38 (30/58)	0.013, MW-*U*
Maximal extension of sensory block (dermatome)	T10 (T12/T6)	T10 (T11/T5)	
Time to onset (min)	20 (10/20)	20 (10/25)	
Time from start of spinal anaesthesia to two-dermatome regression from maximal sensory block level (min)	60 (45/75)	60 (45/75)	
Time to full motor block recovery (min)			
Median (25th/75th percentiles)	75 (60/90)	135 (105/150)	<0.0001, MW-*U**
Mean (SD)	78 (20.4)	130 (28.4)	
Time to full sensory block recovery (min)	105 (105/135)	165 (135/180)	<0.0001, MW-*U**
Needle 27G Pencil point/Quincke type†	36/3	36/3	
Level of puncture L III–IV/L II–III	37/2	37/2	
Median/Lateral approach	34/5	32/7	
Number of bone contacts (0/1/2/ $\geq$ 3)	26/9/3/1	28/5/3/3	
Paraesthesia during puncture (Yes/No)	3/ 36	7/ 32	
Pain on injection	0	1‡	
Needle slightly bent	1	2	

Data are numbers of patients, mean (SD), or median (25th/75th percentiles), unless stated otherwise.
*Median differences (95% CI) 45 (45–60) min and 45 (30–60) min for motor and sensory block, respectively.
†Pencan®, pencil point tip, B. Braun, Melsungen, Germany, or BD Spinal Needle, Quincke type tip, Becton Dickinson, Madrid, Spain.
‡Some indifferent sensation in the lower back during injection.

block (median dermatome T10) or the interval from spinal anaesthesia until the two-dermatome regression from the maximum sensory block (Table 2). However, the mean duration of the sensory block at levels T10 and L1 was significantly shorter in C40 vs. A60 (Table 2). Correspondingly, complete recovery was significantly faster ($P < 0.0001$, MW-*U* test) in C40 vs. A60 regarding both motor and sensory block (Table 2). The median differences (95% CI) were 45 (45–60) min and 45 (30–60) min for motor and sensory block regression, respectively.

Vital parameters and nausea intraoperatively

The vital parameters did not differ between the groups before spinal anaesthesia (data not shown). Intraoperatively, the maximum and minimum blood pressure, heart rate, and pulse oximetry between the groups were similar, e.g., the maximum intraoperative decrease in systolic blood pressure (difference between the baseline measured on arrival in the operating theatre and the minimum value registered intraoperatively) was [mean (SD)] 35 (23.3) vs. 30 (18.1) mmHg in C40 vs. A60, respectively ($P = 0.29$, *t*-test). In some patients, hypotension and bradycardia developed in the early phase of spinal anaesthesia and so they received i.v. ephedrine and atropine (Table 3) according to the protocol. Some of these persons complained of nausea (Table 3). In any case, hypotension, bradycardia, and nausea responded adequately to treatment.

Post-operative recovery and discharge to home

In C40, as compared with A60, there was a trend towards earlier first oral fluid intake whereas the volume of the urinary bladder at the initial ultrasound was significantly smaller (Table 3). However, there was no clear difference in the time to the first spontaneous voiding (Table 3). Two A60 patients

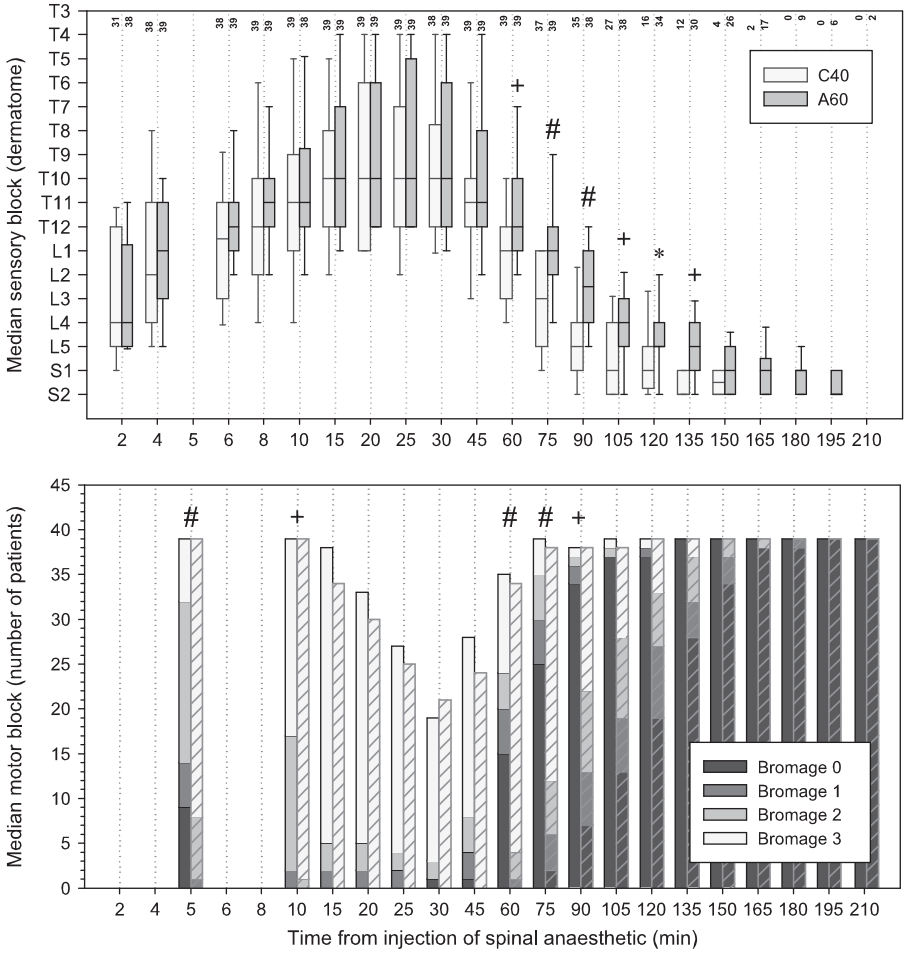

Fig. 2. Time-dependent course of sensory block (top) and motor block (bottom) on the side of arthroscopy for group C40 and group A60. Sensory block: Light box plots represent C40, dark box plots A60; the n*-numbers for every time point are given at the top of the figure. Motor block: Stacked bars filled with plain colour represent C40, bars with shading A60; grade of motor block according to colour scale (modified Bromage scale: 0 = able to raise entire leg; 1 = unable to raise whole leg but able to flex knee; 2 = unable to flex knee, only foot moving; 3 = unable to move knee or foot). Time points with statistically significant differences are marked with* $^{*}P<0.05$; $^{+}P<0.01$; $^{\#}P<0.0001$ *(MW-U test). As regards the ditch in* n*-numbers for motor block data, it should be noted that motor block was not necessarily measured during the procedure.*

required catheterisation. The proportion of patients who received weak or strong opioids on demand, post-operatively, was smaller in C40 as compared with A60, with borderline statistical significance (Table 3). Patients belonging to the C40 group left the hospital significantly earlier than those from group A60 (Table 3). Two patients (both A60) remained in hospital overnight for social reasons. Two patients belonging to A60 were kept under surveillance overnight because of post-operative bleeding, while one patient of C40 stayed in hospital because of nausea and vomiting while a second remained because of moderate pain.

Sequela from spinal anaesthesia and post-operative telephone interviews

The technical details related to the lumbar puncture are shown in Table 2. There were no significant differences between the study groups when considering post-dural puncture headache, posture-independent headache, backache, or post-operative nausea and vomiting (Table 4).

No TNSs were noted. One patient of the C40 group mentioned during the interview on the seventh post-operative day that she had experienced some pricking in three toes of the operated leg that lasted for 2 days after her surgery. She recalled that during the lumbar puncture, there had been paraesthesia radiating to the area where she experienced the pricking sensation later on.

Discussion

While the onset and quality of spinal anaesthesia were satisfactory and comparable between the study groups C40 and A60, the recovery of both motor and sensory block was significantly faster in C40 (median difference about 45 min).

There was no statistically significant difference in the onset or maximal spread of the sensory block, which proved sufficient for all arthroscopies even in the three patients of group C40 in whom the sensory block did not reach the dermatome L1 (Table 2) (one of these three patients received a single dose of i.v.

Table 3

Intra- and post-operative data related to hypotension, bradycardia, nausea, urinary bladder function, pain medication on day of surgery, and time to hospital discharge.

	Chloroprocaine (40 mg) ($n = 39$)	Articaine (60 mg) ($n = 39$)	*P*-values, statistical test
Patients receiving intraoperatively			
Ephedrine i.v. (Yes/No)	8/31	4/35	
Cumulative dosage of ephedrine given (mg) [range]	5–30	5–20	
Atropine i.v. (Yes/No)	4/35	6/33	
Cumulative dosage of atropine given (mg) [range]	0.5–1.0	0.5–1.0	
Patients with nausea related to the occurrence of hypotension or bradycardia (Yes/No)	4/35	1/38	
Time to first oral fluid intake (min)	81 (66/104)	91 (77/124)	0.09, MW-*U*
Urinary bladder volume at first ultrasound (ml)	199 (102/300)	302 (184/480)	0.0044, MW-*U*
Time to first spontaneous voiding (min)	204 (61.8)	219 (71.6)	NS, *t*-test
Urinary retention needing catheterisation	0	2	
Weak and strong opioids on demand post-operatively (no/codeine in combination with paracetamol/oxycodone)	28/7/4	19/7/13	0.039, χ^2-test
Time to hospital discharge (min)*	318 (74.2)	392 (93.2)	0.0004, *t*-test†

Data are numbers of patients, mean (SD), or median (25th/75th percentiles), unless stated otherwise. NS = Not significant.
*Data collected retrospectively; besides, particular pressure towards accelerated hospital discharge times was not part of the protocol.
†Mean difference (95% CI) 75 (34.8–114.9) min.

Table 4

Data gathered during post-operative telephone interviews.

	1st POD ($n = 38$)		7th POD ($n = 38$)	
	Chloroprocaine (40 mg)	Articaine (60 mg)	Chloroprocaine (40 mg)	Articaine (60 mg)
PDPH	0	1	0	0
Non-PDPH	7	7	2	7*
Non-radicular backache	6	7	0	3
Pricking in leg	0	0	1†	0
TNSs	0	0	0	0
PONV	2	4	2	0
Satisfaction with spinal anaesthesia technique (grade 0/1/2/3)			26/12/0/0	23/15/0/0

Data are number of patients.
*$P = 0.15$, Fisher's exact test.
†Patient experienced pricking in three toes of the operated leg for 2 days post-operatively, in an area where she had felt paraesthesia during lumbar puncture.
POD, post-operative day; PDPH, post-dural puncture headache, i.e., posture-dependent headache which is worsened on standing up and alleviated on lying down; Non-PDPH, posture-independent headache which does not worsen on standing up and is not alleviated on lying down; TNSs, transient neurologic symptoms; for definition, see "Methods"; PONV, post-operative nausea and vomiting. Grading for satisfaction with spinal anaesthesia: 0 = very satisfactory; 1 = satisfactory; 2 = unsatisfactory; 3 = very unsatisfactory.

fentanyl 50 μg). Altogether, the need for additional sedation or pain medication intraoperatively was small and did not vary from what can be seen with other regional anaesthesia techniques with an aim for fast recovery and early discharge.[4,7,12,13] The utilisation of short-acting spinal anaesthetics as in the study groups here has a smooth operating theatre scheduling as a prerequisite. But even with a good organisational level, it may happen sporadically that the effect of the spinal anaesthetic wears off prematurely, as seen on one occasion in C40. The faster onset of motor block in A60 hardly has any clinical significance considering the otherwise short ready-to-cut interval.

In both study groups, spinal anaesthesia was very well tolerated, with no haemodynamic deterioration and only little intraoperative nausea. The occasional nausea and vomiting observed post-operatively is at least partly due to the moderate use of opioids. Regarding sequelae from spinal anaesthesia, such as posture-independent headache and non-radicular backache, the present re-

sults are unspectacular and comparable.[7] No TNSs occurred, which adds to earlier results that TNSs seem to be uncommon after spinal chloroprocaine[4–6] and articaine.[7–10] So far, there are only a few described cases of possible TNSs after intrathecal articaine.[9,10] The pricking reported by one patient of C40 (Table 4) was most probably linked to the paraesthesia during lumbar puncture. It must be mentioned, however, that the described spinal application of chloroprocaine and articaine was off-label use. The small sample size here does not allow generalisations about the safety profile of these drugs when used intrathecally. Concerns about possible neurotoxicity with spinal chloroprocaine were recently rebutted[4–6], and also various clinical reports confirm spinal chloroprocaine to be free of apparent neurotoxicity [preliminary[14] and unpublished observations.*

The trend towards the earlier first oral fluid intake in group C40, as compared with that of A60, can be explained by the earlier regression of sensory blockade to dermatome L1, after which the patients were permitted to drink. It remains unclear, however, why the urinary bladder volume during the first ultrasound was significantly less in C40 (Table 3) but, on the other hand, there was no difference in the time to the first spontaneous voiding (Table 3). With only two patients requiring catheterisation (both group A60), no conclusion can be reached regarding this side effect of spinal anaesthesia. Interestingly, patients of group C40 needed fewer opioids on demand post-operatively (borderline statistical significance) and left the hospital significantly earlier (Table 3). However, all the results discussed in this paragraph need to be interpreted cautiously as the post-operative part of the study protocol was not rigorously standardised (e.g., the moment of urinary bladder ultrasound was not standardised, nor was there any particular pressure towards accelerated discharge) and the data were partly collected in a retrograde manner (time to discharge). The study protocol focused on the immediate recovery from spinal block but not on discharge times. Future investigations have to reveal whether the use of, e.g., chloroprocaine translates not only into higher patient satisfaction (presumably through a faster regaining of autonomy) but also into a shorter stay in hospital. Another issue will be to compare such short-acting spinal anaesthetics with other forms of anaesthesia, for example, total i.v. anaesthesia with propofol–remifentanil or light i.v. propofol anaesthesia combined with local anaesthesia.[15–17]

Both plain solutions of chloroprocaine 20 mg/ml and articaine 40 mg/ml were confirmed[18,19] to be slightly hyperbaric (defining the lower limit of hyperbaricity as 1.00119 g/ml when applying three SD above the mean density of the cerebrospinal fluid[20]). With hyperbaric local anaesthetics, it might have been more preferable to have the patients in the lateral decubitus position with the side of intended surgery facing downwards during lumbar puncture. However, this study did not aim at unilateral spinal anaesthesia, which usually requires keeping the patient in this position for 10–15 min after drug administration. Besides, turning the patients into the the supine position without delay after the injection of the spinal anaesthetic prevented any clear lateralisation in the spread of the blockade between the dependent and the non-dependent side (data not shown).

When inferring the dosages of the study drugs and the sample size, we could only partially apply data from earlier clinical studies[4–8,21–23] because of differences in methodology (e.g., use of hyperbaric vs. plain drug solutions) and data presentation [e.g., reporting means (SD) vs. medians (percentiles)]. The data by Hendriks et al.,[10] on the other hand, had not yet been available when the present study was planned. We estimated the mean duration of motor block to be some 100–125 min (40 mg of plain chloroprocaine 10 mg/ml,[4,6] 60 mg of articaine 30 mg/ml with glucose,[7] 84 mg of plain articaine 40 mg/ml[8]). Considering the distinct intergroup difference in motor block recovery observed here, a somewhat smaller sample size would have sufficed. Nevertheless, the good power of this study and the consequent measurement of motor block in short intervals until full recovery make the present data valuable when planning future trials. One such study might be to compare chloroprocaine 40 mg with, e.g., articaine 40 or 50 mg so as to determine whether the longer recovery time detected with articaine is more dependent on the dose–response curve rather than to pharmacokinetic properties.[24]

In conclusion, in the population studied (age 18–65, ASA I–II), both chloroprocaine 40 mg and articaine 60 mg in plain solutions provided rapid-onset spinal anaesthesia that was well tolerated (e.g., good haemodynamic stability) and deemed satisfactory by the patients. In both groups, anaesthesia

* *M. Mulroy, Seattle, WA, USA, >4000 patients (personal communication); E. Slock, Malle, Belgium, >1800 patients, presentation at BARA Congress 2009] http://www.bara2001.be/downloads/oct09_slock.pdf (accessed 18 August 2010).*

lasted about 1 h, which is suitable for day-case knee arthroscopy. Recovery, however, was significantly faster after chloroprocaine 40 mg. The data add to earlier results that TNSs seem to be uncommon after spinal articaine and chloroprocaine.

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References

1. Schneider M, Ettlin T, Kaufmann M, Schumacher P, Urwyler A, Hampl K, von Hochstetter A. Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. Anesth Analg 1993; 76: 1154–7.
2. Salmela L, Aromaa U. Transient radicular irritation after spinal anesthesia induced with hyperbaric solutions of cerebrospinal fluid-diluted lidocaine 50 mg/ml or mepivacaine 40 mg/ml or bupivacaine 5 mg/ml. Acta Anaesthesiol Scand 1998; 42: 765–9.
3. Zaric D, Christiansen C, Pace NL, Punjasawadwong Y. Transient neurologic symptoms (TNS) following spinal anaesthesia with lidocaine versus other local anaesthetics. Cochrane Database Syst Rev 2005; CD003006.
4. Casati A, Danelli G, Berti M, Fioro A, Fanelli A, Benassi C, Petronella G, Fanelli G. Intrathecal 2-chloroprocaine for lower limb outpatient surgery: a prospective, randomized, double-blind, clinical evaluation. Anesth Analg 2006; 103: 234–8.
5. Yoos JR, Kopacz DJ. Spinal 2-chloroprocaine for surgery: an initial 10-month experience. Anesth Analg 2005; 100: 553–8.
6. Sell A, Tein T, Pitkänen M. Spinal 2-chloroprocaine: effective dose for ambulatory surgery. Acta Anaesthesiol Scand 2008; 52: 695–9.
7. Kallio H, Snäll EV, Luode T, Rosenberg PH. Hyperbaric articaine for day-case spinal anaesthesia. Br J Anaesth 2006; 97: 704–9.
8. Bachmann M, Pere P, Kairaluoma P, Rosenberg PH, Kallio H. Comparison of hyperbaric and plain articaine in spinal anaesthesia for open inguinal hernia repair. Br J Anaesth 2008; 101: 848–54.
9. Dijkstra T, Reesink JA, Verdouw BC, Van der Pol WS, Feberwee T, Vulto AG. Spinal anaesthesia with articaine 5% vs bupivacaine 0.5% for day-case lower limb surgery: a double-blind randomized clinical trial. Br J Anaesth 2008; 100: 104–8.
10. Hendriks MP, de Weert CJ, Snoeck MM, Hu HP, Pluim MA, Gielen MJ. Plain articaine or prilocaine for spinal anaesthesia in day-case knee arthroscopy: a double-blind randomized trial. Br J Anaesth 2009; 102: 259–63.
11. Tanaka M, Girard G, Davis R, Peuto A, Bignell N. Recommended table for the density of water between 0 °C and 40 °C based on recent experimental reports. Metrologia 2001; 38: 301–9.
12. Korhonen AM, Valanne JV, Jokela RM, Ravaska P, Korttila K. Intrathecal hyperbaric bupivacaine 3 mg+fentanyl 10 microg for outpatient knee arthroscopy with tourniquet. Acta Anaesthesiol Scand 2003; 47: 342–6.
13. Korhonen AM, Valanne JV, Jokela RM, Ravaska P, Korttila KT. A comparison of selective spinal anesthesia with hyperbaric bupivacaine and general anesthesia with desflurane for outpatient knee arthroscopy. Anesth Analg 2004; 99: 1668–73.
14. Palas T. 1% chloroprocaine for spinal anesthesia: an ideal local anesthetic drug for short surgical procedures? Reg Anesth Pain Med 2007; 32 (Suppl. 1): S8.
15. Nora FS. Target-controlled total intravenous anesthesia associated with femoral nerve block for arthroscopic knee meniscectomy. Rev Bras Anestesiol 2009; 59: 131–41.
16. Maldini B, Miskulin M. Outpatient arthroscopic knee surgery under combined local and intravenous propofol anesthesia in children and adolescents. Paediatr Anaesth 2006; 16: 1125–32.
17. Dunn WR, Cordasco FA, Flynn E, Jules K, Gordon M, Liguori G. A prospective randomized comparison of spinal versus local anesthesia with propofol infusion for knee arthroscopy. Arthroscopy 2006; 22: 479–83.
18. Heller AR, Zimmermann K, Seele K, Rössel T, Koch T, Litz RJ. Modifying the baricity of local anesthetics for spinal anesthesia by temperature adjustment: model calculations. Anesthesiology 2006; 105: 346–53.
19. Na KB, Kopacz DJ. Spinal chloroprocaine solutions: density at 37 degrees C and pH titration. Anesth Analg 2004; 98: 70–4.
20. Pitkänen M. Spinal (subarachnoid) blockade. In: Cousins MJ, Carr DB, Horlocker TT, Bridenbaugh PO, eds. Neural blockade in clinical anesthesia and pain medicine, 4th edn. Philadelphia: Lippincott Williams & Wilkins, 2009:213–40.
21. Foldes FF, Mc NP. 2-Chloroprocaine: a new local anesthetic agent. Anesthesiology 1952; 13: 287–96.
22. Hauenschild E. Central nerve blocks 2000 spinal anaesthetics with carticaine 5%-'heavy' (author's transl). Anaesthesist 1977; 26: 398–402.
23. Kaukinen S, Eerola R, Eerola M, Kaukinen L. A comparison of carticaine and lidocaine in spinal anaesthesia. Ann Clin Res 1978; 10: 191–4.
24. Vree TB, Gielen MJ. Clinical pharmacology and the use of articaine for local and regional anaesthesia. Best Pract Res Clin Anaesthesiol 2005; 19: 293–308.

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