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Original Research

Spinal Anesthesia Using Chloroprocaine is Safe, Effective, and Facilitates Earlier Discharge in Selected Fast-track Total Hip Arthroplasty

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ABSTRACT

Background: Spinal anesthetic choice plays an underappreciated role in total hip arthroplasty (THA). Chloroprocaine, a short-acting local anesthetic, has been limited to short-duration ambulatory procedures and has not been studied in THA. We compare perioperative outcomes of patients undergoing fast-track THA using chloroprocaine spinal anesthesia with those who have surgery with a longer-acting agent (bupivacaine).

Methods: A total of 143 THAs performed under spinal anesthesia by 3 arthroplasty surgeons between November 2018 and July 2019 were retrospectively reviewed. Patients receiving chloroprocaine were matched 1:1 by demographics to patients receiving bupivacaine. Ultimately, 74 patients were included (37 chloroprocaine and 37 bupivacaine). The primary outcome was hospital length of stay (LOS). Other perioperative outcomes were also evaluated.

Results: A total of 37 patients (50%) received chloroprocaine (60 mg), whereas 37 (50%) received bupivacaine (median 10 mg, range 8-15 mg). Among the matched groups, chloroprocaine use was associated with shorter hospital LOS (0.9 vs 1.2 days; $P = .03$), shorter operative time (68.2 vs 83.6 minutes, $P = .03$), lower estimated blood loss (184.7 vs 218.9 mL, $P = .02$), shorter postanesthesia care unit LOS (139.4 vs 194.9 minutes; $P = .04$), and less intraoperative hypotension (59.5% vs 83.8%, $P = .02$). Patients receiving chloroprocaine were also more commonly discharged home (100% vs 89.2%; $P = .04$).

Conclusion: Chloroprocaine is a safe and reliable option for patients to mobilize rapidly and leave the hospital sooner after THA. Compared with bupivacaine, it is associated with shorter hospital LOS and higher likelihood for discharge to home.

Introduction

Fast-track total hip arthroplasty (THA) has consistently been shown to reduce hospitalization costs and improve patient care in select patient populations [1-5]. Many perioperative factors affect the success of fast-track THA protocols, yet the choice of spinal anesthetic and dosing have not been well studied. A variety of options are available, each offering different trade-offs between duration of intraoperative anesthesia and side effects such as hypotension and urinary retention which can delay postoperative recovery [6].

One common choice for spinal anesthesia in THA is bupivacaine, a long-acting amino amide local anesthetic that can be associated with prolonged block effects [7] as well as unpredictable anesthetic effects, long duration of action, and hemodynamic instability when given in higher doses [7-10]. Shorter-acting local amino amides such as lidocaine and mepivacaine are being used, but there have been repeated reports of transient neurologic symptoms (TNSs) by multiple groups [11-16] and side effects that are both undesirable and avoidable for these specific medications. Chloroprocaine, an aminoester local anesthetic with a short half-life, has been an efficient

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choice for anesthesia, in addition to having a superior recovery profile when compared with other short-acting agents [15-18]. To date, chloroprocaine's use has been limited to short-duration ambulatory procedures, such as knee arthroscopy, given its short half-life. The use of chloroprocaine in THA has not been investigated.

Fast-track and same-day THA are a reality in both the hospital and ambulatory surgery center setting. As modern anesthesia protocols facilitate this shift, studies are needed to guide best practices and procedure optimizations. In our experience, prolonged spinal effects can derail a patient's postoperative progress, and it may be difficult to influence anesthesiologists, as goals and perceptions may differ. This study seeks to compare length of stay (LOS) and perioperative outcomes (including operative times, estimated blood loss [EBL], postanesthesia care unit [PACU] LOS, intraoperative hypotension, and number of missed physical therapy [PT] sessions) of patients undergoing THA using chloroprocaine, a short-acting spinal anesthesia, with those using bupivacaine, a longer-acting spinal anesthesia. It is intended to offer insights into a newer spinal anesthetic for THA and shed light on potential best practices.

Material and methods

After institutional review board approval was obtained, the electronic medical record was used to retrospectively identify patients who received either chloroprocaine (60 mg) spinal anesthesia or bupivacaine (8-15 mg) spinal anesthesia for primary THAs. All patients were treated at a single urban tertiary academic center by 3 arthroplasty surgeons between November 2018 and July 2019. During this time, bupivacaine was the institutional standard of care for spinal anesthesia, and the choice for chloroprocaine was made on a case-by-case basis by the surgical and anesthesia teams in select patients. The inclusion criteria were any patient undergoing an elective, primary THA under spinal anesthesia. There were no conversions to general anesthesia (neither from failed spinal at the outset nor inadequate spinal duration). Patients having conversion arthroplasty or revision arthroplasty were excluded.

All patients underwent uncemented THAs. One surgeon in this cohort used the direct anterior approach for THA without the use of a specialized table, and 2 surgeons used the mini-anterolateral approach as described by Berger [19]. All patients were scheduled for PT on the day of surgery, and no restrictions on weight bearing or range of motion are enforced for any patients who underwent THA. In addition, all patients had the same multimodal analgesia protocol postoperatively consisting of nonsteroidal anti-inflammatory drugs, gabapentin, acetaminophen, and narcotics used for severe or breakthrough pain.

Demographic data including age, sex, body mass index, and American Society of Anesthesiologists score were collected. Information about operative time, EBL, LOS in the PACU, hospital LOS, and discharge disposition (home vs post–acute care facility) was collected. Episodes of intraoperative hypotension (defined as 3 consecutive readings in the operating room (OR) lower than 80% of the baseline preoperative systolic blood pressure), missed PT sessions due to postoperative symptoms of hypotension, and need for additional antiemetic medication to control postoperative nausea and vomiting (PONV) were also collected. PACU discharge criteria are defined and enforced by the anesthesia staff at our institution. Criteria for a patient to be ready for transfer out of the PACU include stable vital signs off of any vasopressor support, tolerating intake of fluids, and control of postoperative pain. In addition to these factors, for ambulatory patients, all home services such as outpatient PT, prescriptions, and distribution of durable medical equipment are also carried out in the PACU before discharge to home. To be deemed safe for discharge to home, patients need to be able to ambulate 100 feet, ascend and descend stairs, and get into and out of bed and on and off a commode safely.

To achieve similar groups for comparative analysis, baseline demographic data from the chloroprocaine cohort were matched 1:1 from the larger cohort of patients receiving bupivacaine. A Student *t* test was used for continuous variables, and a chi-squared test was used for categorical variables. Statistical significance was set a priori to $P < .05$.

Results

Thirty-seven patients underwent chloroprocaine (60 mg) and 105 underwent bupivacaine (median 10 mg, range 8 to 15 mg) spinal anesthesia. All 143 cases were completed under spinal anesthesia without requiring conversion to general anesthesia. No cases of TNSs were observed with either anesthetic.

Of the total 105 eligible patients, a 1:1 matched cohort of 37 patients receiving bupivacaine (7.5-15 mg) were matched for baseline demographics to the 37 available patients who received chloroprocaine at the time of data analysis. Using this matched cohort, there were no differences in age (61.3 vs 60.7 years; $P = .82$), sex (32.4% vs 37.8% men; $P = .63$), American Society of Anesthesiologists score (2.1 vs 2.1; $P = .82$), or body mass index (26.9 vs 26.1 kg/m^2; $P = .56$) (Table 1).

Perioperative outcomes in patients who received chloroprocaine spinal anesthesia compared with those who received bupivacaine are displayed in Table 2. LOS was significantly shorter for the chloroprocaine group overall (0.9 vs 1.2 days; $P = .03$). When stratified to exclude ambulatory procedures, hospital LOS remained significantly shorter (1.1 vs 1.3 days; $P = .05$) for patients admitted to the hospital postoperatively.

A higher proportion of patients receiving chloroprocaine were discharged to home than those in the bupivacaine group (100% vs 89.2%; $P = .04$). Operative time was shorter in the chloroprocaine group (68.2 vs 83.6 minutes; $P = .03$), and EBL was lower as well (184.7 vs 218.9 mL; $P = .02$). The chloroprocaine group had a shorter PACU LOS (139.4 vs 194.9 minute; $P = .04$).

Fewer patients in the chloroprocaine group experienced episodes of intraoperative hypotension (59.5% vs 83.8%; $P = .04$). In addition, fewer patients in the chloroprocaine group required intraoperative bolus doses of vasopressors (64.9% vs 75.7%; $P = .31$). The chloroprocaine group was less likely to miss their first PT session on post-operative day 0 because of symptomatic hypotension (2.7% vs 13.5%; $P = .09$) and experienced less PONV (13.5% vs 29.7%; $P = .09$), but none of these secondary outcomes achieved statistical significance with the number of patients available.

Discussion

To our knowledge, this is the first study to assess the role of chloroprocaine spinal anesthesia in fast-track THA, comparing it with

Table 1
Patient demographics of matched cohorts.

Variable	Chloroprocaine group (n = 37)	Bupivacaine group (n = 37)	*P* value
Age (y, SD)	61.3 (12.5)	60.7 (9.2)	.82
Sex			
Male (#, %)	12 (32.4)	14 (37.8)	
Female (#, %)	25 (67.6)	23 (62.2)	.63
ASA score (mean, SD)	2.1 (0.5)	2.1 (0.5)	.82
BMI (kg/m^2) (mean, SD)	26.9 (4.4)	26.1 (4.0)	.56

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

Table 2
Comparison of perioperative outcomes between matched cohorts.

Study variable	Chloroprocaine group (n = 37)	Bupivacaine group (n = 37)	*P* value
Hospital length of stay (days, SD)			
Total (inpatients and ambulatory)	0.9 (0.4)	1.2 (0.7)	.03*
Inpatients only	1.1 (0.3)	1.3 (0.6)	.05*
Postoperative disposition			
Inpatient stay (#, %)	28 (75.7)	31 (83.8)	
Ambulatory surgery (#, %)	9 (24.3)	6 (16.2)	.39
Operative time (min, SD)	68.2 (16.1)	83.6 (20.8)	.03*
Estimated blood loss (mL, SD)	184.7 (59.3)	218.9 (66.0)	.02*
PACU length of stay (min, SD)			
Total (inpatients and ambulatory)	139.4 (103.8)	194.9 (124.0)	.04*
Discharge disposition			
Home (#, %)	37 (100)	33 (89.2)	
Post–acute care institution (#, %)	0 (0)	4 (10.8)	.04*
Intraoperative hypotension			
Yes (#, %)	22 (59.5)	31 (83.8)	
No (#, %)	15 (40.5)	6 (16.2)	.02*
Need for intraoperative vasopressor bolus			
Yes (#, %)	24 (64.9)	28 (75.7)	
No (#, %)	13 (35.1)	9 (24.3)	.31
Missed PT session			
Yes (#, %)	1 (2.7)	5 (13.5)	
No (#, %)	36 (97.3)	32 (86.5)	.09
PONV			
Yes (#, %)	5 (13.5)	11 (29.7)	
No (#, %)	32 (86.5)	26 (70.3)	.09

PACU, postanesthesia care unit; PONV, postoperative nausea and vomiting; PT, physical therapy; SD, standard deviation.
Values marked with an asterisk (*) represent statistical significance, $P < .05$.

the longer-acting bupivacaine spinal to assess hospital LOS and other perioperative outcomes. Most importantly, this study found that chloroprocaine can be used safely and effectively for THA in selected patients, without concerns of TNSs. When used in this population, we found that chloroprocaine spinal anesthesia is associated with shorter hospital LOS, even when controlling for ambulatory status. It is also associated with shorter operative time, lower EBL, less intraoperative hypotension, shorter PACU LOS, and a higher likelihood to be discharged home vs a post–acute care facility.

Given the push for cost-effective healthcare and fast-track THAs' promising results, the popularity of fast-track THAs will only continue to grow [1-3,5,20]. This study illustrates that using chloroprocaine spinal anesthesia may play a role in expediting safe and effective discharge to home after THA. The patients receiving chloroprocaine in this cohort left the hospital, on average, about 8 hours sooner than those receiving bupivacaine. This was corroborated upon subgroup analysis, as inpatients alone also had a shorter hospital LOS. This trend is in agreement with that of the study by Teunkens et al. [16] who noted a shorter LOS in patients undergoing knee arthroscopy using chloroprocaine.

In this cohort, chloroprocaine use was associated with increased OR efficiency, as seen by the shorter operative time for patients who received chloroprocaine. These findings mirror those found in knee arthroscopy studies where chloroprocaine was compared with other short-acting local anesthetics [15]. As discussed by Gebhardt et al. [15], the shorter operative time in the chloroprocaine cohort may be a reflection of an improved interdisciplinary team effort and increased effort by surgeons to keep operative times as short as possible, as the shorter duration of action of the spinal may inspire surgeons to perform cases more efficiently, with less teaching. The shorter operative times may also reflect a lower case complexity in the group selected to receive chloroprocaine, which was not reflected in the comparison of baseline demographics of matched groups. The lower EBL for the chloroprocaine cohort is likely directly related to the shorter operative time seen in this cohort.

Early mobilization is key to achieving success in fast-track total joint arthroplasty. Getting patients up safely and quickly after surgery allows earlier discharge and prevents venous stasis. Symptoms of hypotension and PONV from a lingering spinal can be detrimental to that goal and can thwart plans for a safe ambulatory discharge. In this cohort, we noted that fewer patients receiving chloroprocaine missed their first session with PT because of hypotension and had less PONV, which in turn expedited PACU discharge and, ultimately, discharge to home. Only 1 patient (2.7%) in the chloroprocaine group missed their post-operative day 0 PT session, compared with 5 (13.5%) patients of the bupivacaine group. Patients who received chloroprocaine experienced PONV about half as often as patients who received bupivacaine. Collectively, these factors correlated with an overall average decrease in PACU LOS of 55.5 minutes. Although some of these data points did not achieve statistical significance with the numbers available, the trend is clear. In our experience, this difference was related largely to the offset of the spinal anesthesia, which was fairly immediate after leaving the OR in the chloroprocaine cohort but could extend several hours into the PACU stay in the bupivacaine cohort.

Compared with the bupivacaine cohort, the chloroprocaine cohort had less intraoperative hypotension as well. This difference may be confounded by not controlling for bupivacaine dose; lower-dose bupivacaine combined with regional anesthesia has been associated with fewer clinically significant intraoperative hemodynamic changes [21], but other literature shows no difference in rates of intraoperative hypotension comparing fixed doses of 2-chloroprocaine (40 mg), bupivacaine (7.5 mg), and lidocaine (40 mg) in outpatient knee arthroscopy [16]. In the end, a similar-sized subset, and the majority of each group, received intraoperative bolus doses of vasopressor medications from the supervising anesthesiologist. This may be more reflective of the standard of practice among the anesthesiologists at our institution rather than out of clinical necessity.

An integral part of advancing fast-track THA protocols is the selection of the optimal anesthetic: one that provides sufficient analgesia and simultaneously has a favorable postoperative recovery profile. Although research comparing the costs of general anesthesia to short- and medium-acting spinal anesthetics has

illustrated the superiority of spinal anesthesia in outpatient surgery [15,22,23], further research comparing long- and short-acting local spinal anesthetics, such as bupivacaine and chloroprocaine, is needed. Although a formal cost analysis is beyond the scope of this study, chloroprocaine's faster recovery, earlier discharge times, and better likelihood to be discharged home all have favorable cost-saving implications. Future directions that may expedite discharge and improve patient care include using lower doses of spinal anesthesia and providing unilateral spinal anesthesia [24].

This study has several limitations. First, this is a retrospective study, and there may be confounders and biases that are unrecognized here, particularly with patient selection. The operative times for the chloroprocaine cohort were shorter than those for the bupivacaine cohort, which may suggest that the chloroprocaine cohort had more straightforward cases, which could confound the primary outcome of hospital LOS. In addition, surgeons were not blinded to the choice of anesthetic and may have operated with more alacrity knowing that a shorter-acting spinal anesthetic was used. With that said, this study is a good first step in investigating the effectiveness of chloroprocaine and certainly showed non-inferiority to bupivacaine in these select patients. Owing to the results of this study, a prospective, randomized trial of chloroprocaine vs bupivacaine is underway at our institution to further evaluate this question. Second, the study size for the cohort with patients who received chloroprocaine was small owing to the fact that chloroprocaine has only recently begun to be used as a spinal anesthetic for THA at our institution; still, the cohort was certainly large enough for the results observed. To our knowledge, this is the largest number of patients to date in the published literature receiving chloroprocaine spinal anesthesia for THA. In addition, given that bupivacaine's duration of action has also been found to be dose dependent, it is possible that our findings were confounded by not controlling for dose effect.

Conclusions

In this cohort, chloroprocaine was a safe and effective medication for spinal anesthesia in a selected fast-track THA population where operative times are predictable. Compared with bupivacaine, chloroprocaine was associated with shorter hospital LOS after primary THA. It was also associated with shorter operative time, lower EBL, less intraoperative hypotension, shorter PACU LOS, and higher likelihood to be discharged home. Chloroprocaine may represent a safe and viable option for mobilizing and discharging patients rapidly after fast-track, primary THA. Further prospective, randomized studies ought to be performed to fully evaluate this relationship and continue to optimize patient care.

Conflict of interest

The authors declare there are no conflicts of interest.

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