Original Research

Lidocaine With Epinephrine Versus Bupivacaine With Epinephrine as Local Anesthetic Agents in Wide-Awake Hand Surgery: A Pilot Outcome Study of Patient's Pain Perception

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A R T I C L E   I N F O

Purpose: Wide-awake local anesthesia hand surgery has many advantages over other forms of anesthesia, including faster recovery, lower cost, and improved patient safety; however, few studies compare postoperative pain and analgesic consumption after long- and short-acting anesthetics. This is important because surgeons seek to minimize opioid consumption during the opioid epidemic.
Methods: This was a double-blinded, prospective, randomized, parallel design pilot study. We randomized 61 patients to receive carpal tunnel surgery with a short-lasting regional anesthetic (lidocaine, 29 patients) or a long-lasting one (bupivacaine, 32 patients). Primary outcomes were pain levels over the first and second 24 hours. Secondary outcomes were postoperative consumption of acetaminophen and opioids over the first and second 12 hours after surgery.
Results: Pain intensity and acetaminophen consumption were significantly less in the bupivacaine group over the first 24 and 12 hours after surgery, respectively. The bupivacaine group consumed less opioids in the first 12 hours and delayed consumption of the first medication after surgery, but these results were not statistically significant. There was no difference in pain intensity or analgesic consumption between 24 and 48 hours after surgery.
Conclusions: The use of a long-term anesthetic (bupivacaine) over a short-term one (lidocaine) in awake carpal tunnel release surgery decreases postoperative pain over the initial 12 hours after surgery and delays the initiation of analgesic consumption; however, this difference is small. The amount of opioid consumption was not significantly different between groups, but both groups consumed less than 10% of the prescribed opioids. It is important to reevaluate the need for opioids in minor hand surgery and favor the use of alternatives such as nonsteroidal anti-inflammatory drugs and acetaminophen.
Type of study/level of evidence: Therapeutic I.

The field of hand surgery grew considerably over the past several decades. Studies showed a steady increase in the volume of elective hand surgery by 36% over the course of a single decade in the United Kingdom.[1–4] Wide-awake local anesthesia no tourniquet (WALANT) technique hand surgery was popularized over general anesthesia or sedation by Lalonde[5] and Lalonde et al.[6] Advantages of this technique include faster recovery, absence of risks related to general or regional anesthesia or sedation, and lack

of tourniquet discomfort.[7–9] Cost-effectiveness is demonstrated by permitting ambulatory surgery and obviating the need for anesthetists, preassessment visits, and extensive preoperative investigations.[10] The most commonly used local anesthetic agents for ambulatory hand surgery are lidocaine and bupivacaine.[11,12] Lidocaine has a moderate potency and duration of action, whereas bupivacaine has a more prolonged duration of action.[11,13–16]

The choice of local anesthetic used in awake hand surgery may influence the use of postoperative opioid analgesic consumption. In our institution, some surgeons prescribe fewer analgesics if a long-term anesthetic is used, because of the delayed onset of pain. This is of prime importance given the current opioid epidemic. Physicians have a role in reducing the use of opioids by conscientious prescription writing and by selecting anesthetic modalities that minimize the need for postoperative opioids. The choice of local anesthesia in hand surgery may also have a role in minimizing the use of opioids. Therefore, the goal of this study was to determine whether one anesthetic agent provides superior pain relief or reduces opioid consumption compared with the other. In this study, we compared lidocaine versus bupivacaine as local anesthetic agents in wide-awake carpal tunnel release (CTR) surgery. Primary outcomes were pain levels over the first and second 24 hours after surgery. Secondary outcomes were consumption of acetaminophen and opioids over the first and second 12 hours after surgery. Time from surgery to the intake of the first medication after surgery was also measured.

Materials and Methods

Design

This was a double-blinded, prospective, randomized, parallel design pilot study. Stratified randomization was performed based on sex and preoperative carpal tunnel syndrome (CTS) severity. This study compared patient-reported pain levels as well as the amount and timing of analgesic consumption after CTR surgery. A single surgeon performed all surgeries.

Participants

Inclusion criteria were age greater than 18 years, diagnosis of primary CTS requiring CTR surgery (moderate or severe CTS on nerve conduction study), CTR surgery by the senior author, and CTR performed under local anesthetic. Exclusion patients were those who consumed analgesics or anesthetics before CTR (eg, for chronic pain); those undergoing surgery under general anesthesia, regional block, or sedation; those having combined surgery (eg, CTR plus trigger finger release), those unable to understand the questionnaire or the implications of study participation; those with narcotic or acetaminophen intolerance or medical contraindications, those allergic to lidocaine, bupivacaine, epinephrine, or their constituents; those with end-stage kidney or liver disease; and those who were pregnant.

Study settings

We obtained institutional review board approval. Patients who met inclusion criteria between January, 2015 and November, 2017 were recruited by the research assistant. Informed consent for the study was signed separately from the surgical consent.

Intervention

Patients underwent stratified randomization and a patient identifier was generated. The statistician provided the randomization sequence to the hospital's pharmacy before beginning the patient recruitment procedure. The pharmacy replaced the anesthetic instruction with an unlabeled 10-mL syringe containing the assigned medication. The syringe was labeled with the patient's name and study number and sent to the surgeon for use. The surgeon, who was blinded to the type of local anesthetic (either 1% lidocaine with epinephrine or 0.25% bupivacaine with epinephrine), performed a median nerve block and CTR surgery. The local anesthetic syringe accompanied the patient to the procedure in case the surgeon required additional anesthetic during surgery. The research assistant met all patients included in the study on the morning of surgery and reviewed the process of filling the outpatient questionnaire and medication log. Upon completion of surgery, all patients received a questionnaire, medication log, and standard analgesic prescription (morphine 5 mg orally, every 4 hours as needed (30 tablets) and acetaminophen 1 g orally, every 6 hours as needed). When morphine was contraindicated, an alternative narcotic was prescribed (hydromorphone 0.5 mg or oxycodone 2.5 mg, based on the equianalgesic conversion ratios). Postoperative instructions were given to patients with a suggestion to take morphine if there was no relief of pain 1 hour after taking the acetaminophen.

Data collection

We collected patients' age and sex, the study ID number, the time from anesthetic administration to surgery, the amount of excess anesthetic required during the procedure, and complications (anesthetic, surgical, and postoperative). Postoperative analgesic consumption over the first 24 and 48 hours, as well as patient pain perception at 24 and 48 hours after surgery were obtained through the medication log and study questionnaire.

Outcome measures

Primary outcomes included pain levels over the first and second 24 hours after surgery. Secondary outcomes included postoperative consumption of acetaminophen and opioids over the first and second 12 hours after surgery. In addition, time from surgery to the intake of the first medication after surgery was calculated from the medication log.

Measurements and study instruments

Questionnaire
We designed a questionnaire to assess patients' pain level at 24 and 48 hours after surgery. The level of pain was measured using a numeric rating scale instrument. The questionnaire was handed to patients after surgery with instructions on how to rate their pain level.

Medication log
A medication log was designed to identify the exact time, type, and amount of analgesics consumed over the 48 hours after surgery. These data were summarized as the total number of each analgesic consumed at 12-hour intervals over 48 hours after surgery.
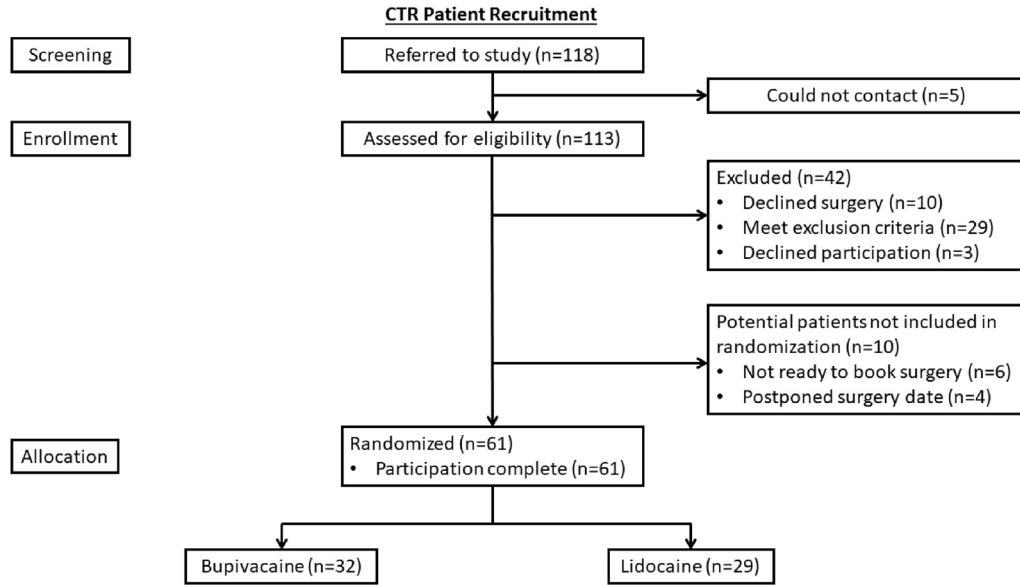
CTR Patient Recruitment

Figure 1. Participant flow.

Sample size

Based on a priori power analysis, we determined 30 patients in each group to be a sufficient sample size. We aimed to detect a 3.3 minimum difference on the 0- to 10-point numeric rating scale using 2-sided *t* test with a power of 80% and a 5% level of significance. This was calculated assuming an SD of the difference of less than 4.5. No adjustment for baseline imbalance in sample calculation was needed given stratified randomization of patients.

Randomization

A computer-generated randomization schedule stratified by gender (male vs female) and preoperative CTS severity (moderate vs severe, based on nerve conduction and electromyographic studies, according to the classification proposed by Padua et al[17]) was created using random block sizes of 2 or 4 with an allocation ratio of 1:1. Randomization was performed with SAS software (version 9.4, SAS Institute, Cary, NC). The statistician sent the electronic file with the randomization sequence to the hospital's pharmacy before the patient recruitment procedure began.

Blinding

The study design was double-blinded. All study investigators, personnel, and patients were blinded to the type of anesthetic given. Only the statistician (who performed the randomization sequence) and the pharmacy (that prepared the medication and envelope with the patient identifier) were not blinded.

Statistical methods

Patient baseline characteristics (age, gender, preoperative CTS severity, and affected side) and randomized blocks proportions across the 2 study groups were accessed descriptively and compared using Wilcoxon test for continuous variables (because normality could not be demonstrated); Pearson chi-square test was employed for categorical variables.

Kolmogorov-Smirnov test of normality was performed for all continuous outcomes. Normality was demonstrated only for pain variables. We compared daily pain levels at 0 to 24 hours and 24 to 48 hours for the 2 study groups using linear regression. For the outcomes at 0 to 12 and 12 to 24 hours, the number of acetaminophen pills and opioid pills for the 2 study groups were compared using Poisson regression. The overdispersion parameter was tested and added in the model when necessary. The group difference and relative risk (RR) were extracted from the linear and Poisson regression, respectively. No adjustments were made for the predictive model. Wilcoxon test was performed for the time of the first

Table 1
Demographic Characteristics by Lidocaine and Bupivacaine Groups

Variable	Bupivacaine, n (%) (n = 32)	Lidocaine, n (%) (n = 29)	P Value
Age, median (interquartile range); (minimum, maximum)	55 (52−62); (27; 79)	55 (51−63); (32; 82)	.857
Gender			
Female	19 (59.4)	18 (62.1)	.830
Male	13 (40.6)	11 (37.9)	
Preoperative CTS severity			
Mild to moderate	1 (3.1)	2 (6.9)	.914
Moderate	16 (50.0)	14 (48.3)	
Moderate to severe	4 (12.5)	4 (13.8)	
Severe	11 (34.4)	9 (31.0)	
Side			
Left	15 (46.9)	13 (44.8)	.872
Right	17 (53.1)	16 (55.2)	
Bloc			
Bloc 1 (male, moderate)	6 (18.8)	5 (17.2)	.993
Bloc 2 (male, severe)	7 (21.9)	6 (20.7)	
Bloc 3 (female, moderate)	11 (34.4)	11 (37.9)	
Bloc 4 (female, severe)	8 (25.0)	7 (24.1)	

Chi-Square and Wilcoxon tests were performed for all categorical and age variables, respectively.

Table 2
Outcome Characteristics by Lidocaine Versus Bupivacaine Groups

Variable	Descriptive Statistics		Parameter Estimate	P Value
	Bupivacaine, n = 32	Lidocaine, n = 29		
Pain			Difference (95% CI)	
Pain intensity (0–24 h)[*]	4.7 (2.7); (0; 10)	6.2 (2.3); (1; 10)	−1.5 (−2.8 to −0.2)	**.03**
Pain intensity (24–48 h)[*]	3.1 (2.4); (0; 8)	2.9 (1.9); (0; 7)	0.2 (−0.9 to 1.4)	.67
Medication			RR (95% CI)	
Acetaminophen (0–12 h)[†]	2.3 (1.3); (0; 6)	3.1 (1.5); (0; 6)	0.7 (0.57 to 0.97)	**.03**
Acetaminophen (12–24 h)[†]	2.6 (2.0); (0; 8)	2.5 (1.5); (0; 6)	1.0 (0.7 to 1.5)	.40
Opioid (0–12 h)[†]	0.4 (0.8); (0; 3)	1.1 (2.2); (0; 11)	0.4 (0.1 to 1.1)	.08
Opioid (12–24 h)[†]	0.8 (0.9); (0; 3)	0.7 (1.0); (0; 4)	1.1 (0.6 to 2.3)	.70
Time of first medication after surgery, h[‡]	8 (5–9); (2; 11)	5.9 (4.0–7.4); (2; 13)		.06
Medication consumption profile, n (%)[§]				
None	3 (9.4%)	1 (3.4%)		.60
Acetaminophen only	11 (34.4%)	12 (41.4%)		
Acetaminophen and opioid	18 (56.3%)	16 (55.2%)		

Normality assumptions were confirmed only for pain variables. Data are expressed as means (SD); (minimum; maximum) or median (interquartile range Q1–Q3); (minimum; maximum) or n (%), as appropriate. Bold text indicates statistical significance.

[*] Linear model.
[†] Poisson model.
[‡] Wilcoxon test.
[§] Chi-square test.

medication. We used Pearson chi-square test for categorical outcomes.

To show the distribution of time to first medication by study group, the probability density function with a nonparametric kernel estimator is presented.[18]

Differences in daily pain level, 12-hour number of acetaminophen pills, and 12-hour number of opioid pills are represented by scatterplots with standard errors at each point.

All tests were performed at the .05 significance level. Statistical software SAS was used for all calculations.

Results

Of 118 patients assessed for study eligibility, 61 completed the study (32 in the bupivacaine cohort and 29 in the lidocaine cohort). We started recruitment after obtaining institutional review board approval in January, 2015 and terminated it in November, 2017 (Fig. 1). No statistically significant differences were noted in demographic variables (Table 1).

Table 2 summarizes study outcomes and estimated parameters with 95% confidence intervals (CIs) from the statistical modeling. The study demonstrated that pain intensity (measured on a scale from 0 to 10) was significantly less in the bupivacaine group compared with the lidocaine group during the first 24 hours after surgery (4.7 vs 6.2; P = .03). The bupivacaine group also consumed significantly less acetaminophen during the first 12 hours after surgery (average of 2.3 vs 3.1 doses; RR (95% CI) = 0.7 (0.57–0.97); P = .03). Although not statistically significant, the amount of opioid consumption in the first 12 hours after surgery in the bupivacaine group was less (average of 0.4 vs 1.1 doses; RR (95% CI) = 0.4 (0.1–1.1); P = .08). There was a tendency to delay consumption of the first medication after surgery in the bupivacaine group (median of 8.0 vs 5.9 hours; P = .06). The distribution of time of the first medication and the variations in pain, acetaminophen, and opioid consumption over time are shown in Figures 2 and 3, respectively.

Discussion

The current pilot study showed better pain control in the first 12 to 24 hours after WALANT CTR was performed using bupivacaine compared with lidocaine. The bupivacaine group demonstrated a trend to less and delayed opioid consumption, which did not meet

statistical significance (0.4 vs 1.1 doses, P = .08; and 8.0 vs 5.9 hours, P = .06) and was of small clinical importance. Although bupivacaine is commonly known for its longer onset of action compared with lidocaine, multiple clinical studies failed to demonstrate a difference in the onset of action among bupivacaine, lidocaine, and their mixture.[19,20] With these results, and the published body of literature, there may be minimal clinical benefit to using bupivacaine over lidocaine as the anesthetic of choice in WALANT hand surgery. Additional variables, not collected in this study, may need to be analyzed in future studies to determine whether there are clinically important differences between long- and short-acting regional anesthetics. Examples of these could be the study of liposomal bupivacaine, or analyzing disadvantages possibly associated with long-duration anesthetics (such as the inability to use the hand on the day of surgery or the inability to feel a dressing that is too tight). In addition, it is difficult to determine whether it is preferable to have a shorter-acting anesthetic and earlier use of the hand with the caveat of more oral analgesic consumption, or to have prolonged anesthesia with delayed use of the hand without requiring oral analgesia.
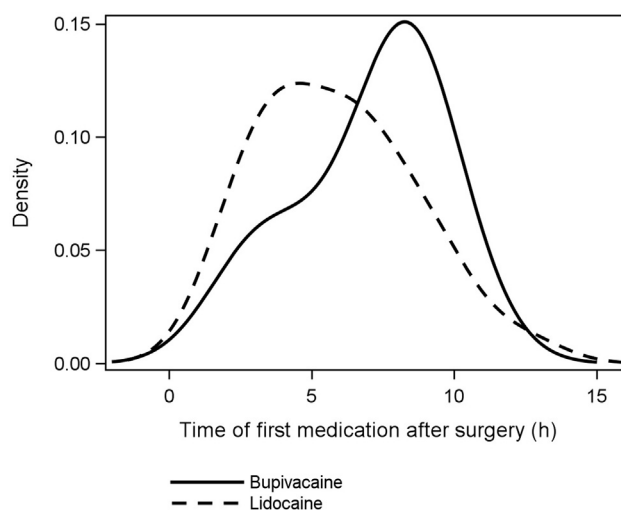

Figure 2. Distribution of time of first medication after surgery: density curve. Note: Kernel estimator was used to plot the density function.
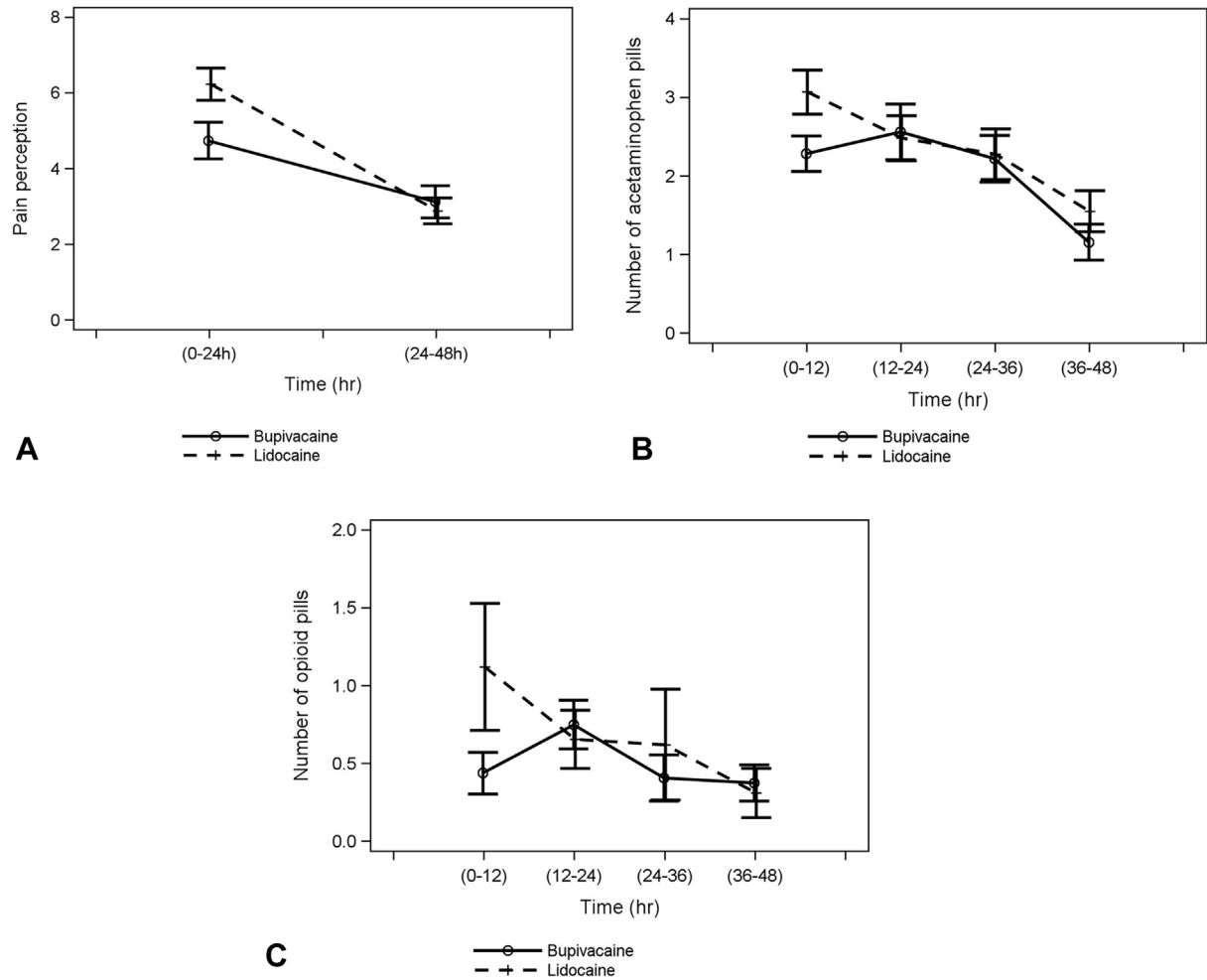
Figure 3. Outcomes variation as a function of time (simple mean ± standard error). **A** Pain perception. **B** Number of acetaminophen pills. **C** Number of opioid pills.

The overprescription of opioids identified in this study is of primary importance given current increasing concerns regarding opioid abuse in North America. All of the patients in the current study were given a standard prescription of 30 morphine tablets. On average, patients consumed only 2 tablets in the bupivacaine group and 2.8 in the lidocaine group. This means that 91% to 93% of the opioid prescription was unused in the study. In their study of 49 patients, Peters et al[21] showed that patients consumed only 25% of their opioid prescription, and half of all patients consumed only 5% of their opioid prescription. In the United States, opioid abuse is becoming a national threat; studies showed a US consumption rate of 66% of the world's opioid supply in a country that has 4.6% of the world's population.[22] In Canada, 21% of high school seniors aberrantly used opioids in 2014; 70% were obtained from home.[23] Of heroin users, 80% were first exposed to opioids through a medical prescription, and prescription opioid overdose caused more deaths in 2007 than heroin and cocaine combined.[24–26] Furthermore, Johnson et al[27] observed that 13% of opioid-naive patients continued to fill opioid prescriptions 90 days after hand surgery procedures.

Several studies showed no statistically significant or clinically important difference in pain reduction with acetaminophen or nonsteroidal anti-inflammatory drugs compared with opioids. In patients presenting to the emergency department with acute extremity pain, no differences in pain reduction were noted in patients treated with 400 mg ibuprofen/1,000 mg acetaminophen versus 5 mg oxycodone/325 mg acetaminophen, 5 mg hydrocodone/300 mg acetaminophen, or 30 mg codeine/300 mg acetaminophen.[28] Similarly, in outpatient breast surgery, 650 mg acetaminophen/400 mg ibuprofen has been identified as being safer, having a more tolerable adverse effect profile, and having analgesia equivalent to 600 mg acetaminophen/30 mg caffeine/60 mg codeine.[29]

This study had several limitations. The number of opioids consumed over the first 12 hours after surgery was not statistically different between groups, which may have been subject to a type II error. This may be addressed by performing a randomized controlled trial with a larger sample size. The sample population may have also been subject to the Hawthorne effect, and outcomes may have been different in the unobserved population. Moreover, the consumption habits of patients may have been modified by the need to report analgesic consumption in a medication log. In addition, differences identified between groups were clinically small. The recovery of hand function in the first 2 days was also not assessed in this study.

The use of a long-term anesthetic (bupivacaine) in WALANT CTR decreases postoperative pain over the initial 12 hours after surgery and delays the initiation of analgesic consumption; however, this difference is clinically small. Furthermore, minor hand surgery (such as CTR) has minimal opioid requirements and may potentially be managed without routine opioid prescriptions.

Acknowledgments

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