Effect of Intrathecal Bupivacaine Dose on the Success of External Cephalic Version for Breech Presentation

A Prospective, Randomized, Blinded Clinical Trial

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ABSTRACT

Background: Breech presentation is a leading cause of cesarean delivery. The use of neuraxial anesthesia increases the success rate of external cephalic version procedures for breech presentation and reduces cesarean delivery rates for fetal malpresentation. Meta-analysis suggests that higher-dose neuraxial techniques increase external cephalic version success to a greater extent than lower-dose techniques, but no randomized study has evaluated the dose–response effect. We hypothesized that increasing the intrathecal bupivacaine dose would be associated with increased external cephalic version success.

Methods: We conducted a randomized, double-blind trial to assess the effect of four intrathecal bupivacaine doses (2.5, 5.0, 7.5, 10.0 mg) combined with fentanyl 15 μg on the success rate of external cephalic version for breech presentation. Secondary outcomes included mode of delivery, indication for cesarean delivery, and length of stay.

Results: A total of 240 subjects were enrolled, and 239 received the intervention. External cephalic version was successful in 123 (51.5%) of 239 patients. Compared with bupivacaine 2.5 mg, the odds (99% CI) for a successful version were 1.0 (0.4 to 2.6), 1.0 (0.4 to 2.7), and 0.9 (0.4 to 2.4) for bupivacaine 5.0, 7.5, and 10.0 mg, respectively ($P = 0.99$). There were no differences in the cesarean delivery rate ($P = 0.76$) or indication for cesarean delivery ($P = 0.82$). Time to discharge was increased 60 min (16 to 116 min) with bupivacaine 7.5 mg or higher as compared with 2.5 mg ($P = 0.004$).

Conclusions: A dose of intrathecal bupivacaine greater than 2.5 mg does not lead to an additional increase in external cephalic procedural success or a reduction in cesarean delivery. **(Anesthesiology 2017; 127:625-32)**

THE cesarean delivery rate in the United States has increased by more than 50% in the last two decades without measurable improvements in maternal or neonatal outcomes.[1] Collaborative approaches between obstetricians and anesthesiologists should be used to address this public health problem.[2] Breech presentation contributes significantly to the incidence of cesarean delivery, with a 3.8% prevalence of breech presentation among singleton pregnancies at term.[3] Most of these deliveries are managed by cesarean delivery due to the higher neonatal morbidity associated with vaginal breech delivery.[4,5] Unfortunately, cesarean delivery carries a higher incidence of serious maternal complications for current and subsequent pregnancies, including death, hemorrhage, infection, and embolism.[1] External cephalic version is a noninvasive procedure used to manually rotate the fetus into a vertex position to facilitate vaginal delivery.[6,7] Neuraxial blockade for external cephalic version improves maternal pain and satisfaction[8] but more importantly leads to increased procedural success (relative risk = 1.58; 95% CI, 1.29 to 1.93)[9] and fewer cesarean deliveries (relative risk = 0.83; 95% CI, 0.71 to 0.97).[10] Meta-analysis of randomized controlled trials of the use of neuraxial anesthetic blockade for external cephalic version suggested that administering higher doses of local anesthetic, *via* either intrathecal

What We Already Know about This Topic

- Neuraxial anesthesia facilitates external cephalic version for breech presentations
- The effect of local anesthetic dose on version success remains unknown
- The authors thus randomized 240 patients to 2.5, 5.0, 7.5, or 10.0 mg spinal bupivacaine

What This Article Tells Us That Is New

- The success of cephalic version was approximately 50% in each group
- Spinal anesthetic dose does not influence the success of cephalic version

This article is featured in "This Month in Anesthesiology," page 1A. Corresponding article on page 596. This article has an audio podcast. Part of the work presented in this article has been presented as an abstract at the Best of Abstracts Clinical Science session at the American Society of Anesthesiologists meeting in Chicago, Illinois, October 22, 2016.

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or epidural route, resulting in presumably denser blockade, leads to increased external cephalic version success, although a best practice has not been defined.[8] The aim of this study was to determine the optimal degree of neuraxial blockade required to facilitate external cephalic version success and reduce the cesarean delivery rate. Our hypothesis was that increased intrathecal bupivacaine dose, administered as part of a combined spinal–epidural anesthetic technique, would be associated with superior external cephalic version success rates.

Materials and Methods

This study was approved by the Northwestern University Institutional Review Board (Chicago, Illinois; No. STU00050371), and the protocol was registered with the National Institutes of Health (Bethesda, Maryland) clinical trial registry (clinicaltrials.gov No. NCT01991743). This article adheres to the Consolidated Standards of Reporting Trials guidelines. The study was a double-blind, randomized, four-arm controlled trial conducted at a single, academic institution, Prentice Women's Hospital of Northwestern Medicine (Chicago, Illinois). A total of 469 parturients with a singleton fetus admitted for external cephalic version were approached for enrollment at their anesthetic interview. Breech presentation was confirmed by ultrasound. Parturients who were less than 18 yr of age or 37 weeks' estimated gestational age, had greater than 40 kg/m^2 body mass index, were non-English speaking, or had transverse lie, ruptured membranes, or a contraindication to neuraxial anesthesia were excluded from participation. Eligible women (obstetrician willing to participate) were screened and approached by an authorized study team member at their anesthetic interview. Patients provided written, informed consent and were randomly allocated (1:1:1:1) to one of four study groups defined by the intrathecal dose of bupivacaine administered: 2.5, 5.0, 7.5, and 10.0 mg. Before the study commencement, four-group block randomization was performed by one of the investigators (R.J.M.) using a computer-generated allocation list with randomly selected block sizes of 4, 8, and 12.[11] Group allocations were concealed in sequentially numbered, opaque envelopes, which were opened by the anesthesiologist just before the version procedure. The patient, obstetrician, and research nurse were blinded to group assignment. Patient variables including gravidity and parity status, estimated gestational age, body mass index, placental location, and obstetrician identity were documented.

Baseline blood pressure was measured from an upper arm using a noninvasive cuff and heart rate from a digital pulse oximeter. Time was recorded at the initiation of a standardized administration of a low-lumbar, combined spinal-epidural anesthetic performed in the sitting position. Lactated Ringer's solution (500 ml) was administered during the procedure *via* a peripheral intravenous catheter. The epidural space was identified with a 17-gauge Tuohy needle using a loss-of-resistance technique. A 27-gauge noncutting needle was advanced through the Tuohy needle to puncture the dura. After return of cerebrospinal fluid was observed, the assigned dose of intrathecal isobaric bupivacaine 0.5% and fentanyl 15 μg were administered. A 19-gauge flexible catheter was then advanced 5 cm into the epidural space. No epidural test dose was administered. The catheter was secured using an occlusive sterile dressing and the patient was immediately placed in the lateral decubitus position. Maternal blood pressure was recorded every 2.5 min from initiation of the anesthetic until the version procedure was completed but not for less than 20 min. The incidence of hypotension was defined as a single recorded instance of decrease in systolic blood pressure of 20% from baseline. Heart rate was monitored continuously and vasopressor (phenylephrine and/or ephedrine intravenous boluses) administered at the discretion of the anesthesiologist with total doses recorded. Ten minutes after the intrathecal dose administration, a bilateral sensory level to cold was assessed. When hemodynamic stability was established, fetal position was reconfirmed by ultrasound, the patient received intramuscular terbutaline (0.25 mg) for uterine relaxation, and the external cephalic version procedure was initiated. Fetal heart rate was monitored per obstetric protocol and the anesthesiologist remained present during the version procedure.

Time was recorded at the initiation and termination of transabdominal manipulation. Obstetricians terminated the procedure according to their judgment of patient intolerance, persistent, severe fetal bradycardia, or after several manipulation attempts were performed without progress in repositioning the fetus. External cephalic version success was confirmed by ultrasound examination after the procedure. Patient pain score and overall satisfaction with the experience, as well as obstetrician assessment of abdominal relaxation, were recorded by a research nurse blinded to group allocation using 100-mm visual analog scales.

Procedure and anesthetic recovery were monitored with continuous fetal heart rate tracing and maternal blood pressure measurement every 15 min until lower extremity motor strength recovered enough to meet labor and delivery discharge criteria. The duration from anesthetic initiation to patient discharge was recorded. Mode of delivery and indication for cesarean delivery were obtained by subsequent chart review.

Statistical Analysis

The primary outcome variable was the incidence of external cephalic version procedural success. The average procedural success rates in published randomized control trials at the time of study design were 56% using neuraxial anesthesia and 36% without neuraxial anesthesia.[9] Extrapolating from these data, we estimated that, for each 2.5-mg increase in

spinal bupivacaine dosing, the success rate for version would increase 10%. Based on the expected proportion of successful versions for the four study doses (44%, 54%, 64%, and 74%), a sample size of 226 (57 per group) would achieve 80% power to detect an effect size Cramér's ω of 0.23 using a four degree of freedom chi-squared test with a significance level P value of 0.05. To account for subject dropout and protocol violations, 60 subjects were recruited and randomly assigned for each group.

The primary outcome, successful external cephalic version, was compared among groups by constructing a 2×4 cross-tabulation matrix and chi-squared test. Odds ratios and 99% CIs for a successful version were calculated for intrathecal bupivacaine doses of 5.0, 7.5, and 10.0 mg, with a bupivacaine dose of 2.5 mg as a reference. Secondary nominal outcomes, mode of delivery, indications for cesarean delivery, hypotension requiring treatment, gravida and parity status, and placental location were analyzed using a chi-squared test. If the initial 2×4 cross-tabulation was significant ($P < 0.05$), paired comparisons between groups were evaluated by a chi-squared test at a P value of 0.01 to control for multiple comparisons. Interval data, including obstetrician rating of abdominal relaxation, pain during the procedure, patient satisfaction, blood pressure, vasopressor equivalent doses, highest cephalic sensory level, time to discharge, interval from version procedure to delivery, and estimated gestational age, were compared among groups using the Kruskal–Wallis test. Multiple *post hoc* comparisons were performed using Dunn's test with Bonferroni correction for 12 comparisons. Kaplan–Meier curves were constructed for time to discharge for each group. Intention-to-treat analysis was used. A $P < 0.05$ was required to reject the null hypothesis. Binomial CIs were calculated using the Clopper–Pearson method. Data analysis was performed using SPSS version 24.0.0.1 (SPSS Inc., Chicago, Illinois), RStudio version 1.0.44: Integrated Development for R (RStudio, Inc., Boston, Massachusetts), and R version 3.3.2 (https://www.r-project.org/. Accessed October 31, 2016).

Results

A total of 469 patients were assessed for eligibility, and 240 were enrolled between August 29, 2011, and September 30, 2015, and allocated to one of the four bupivacaine dose groups. The flow of subjects through the study is shown in figure 1. The external cephalic version procedure was not performed in one subject in the bupivacaine 7.5-mg group because the fetus was determined to be in the vertex position after intrathecal drug administration. There were eight protocol violations evenly distributed among the four groups. Six of the subjects received an epidural test dose after placement of the epidural catheter, and in two subjects the fetus was found to be in the transverse position on ultrasound examination after study drug administration. The epidural

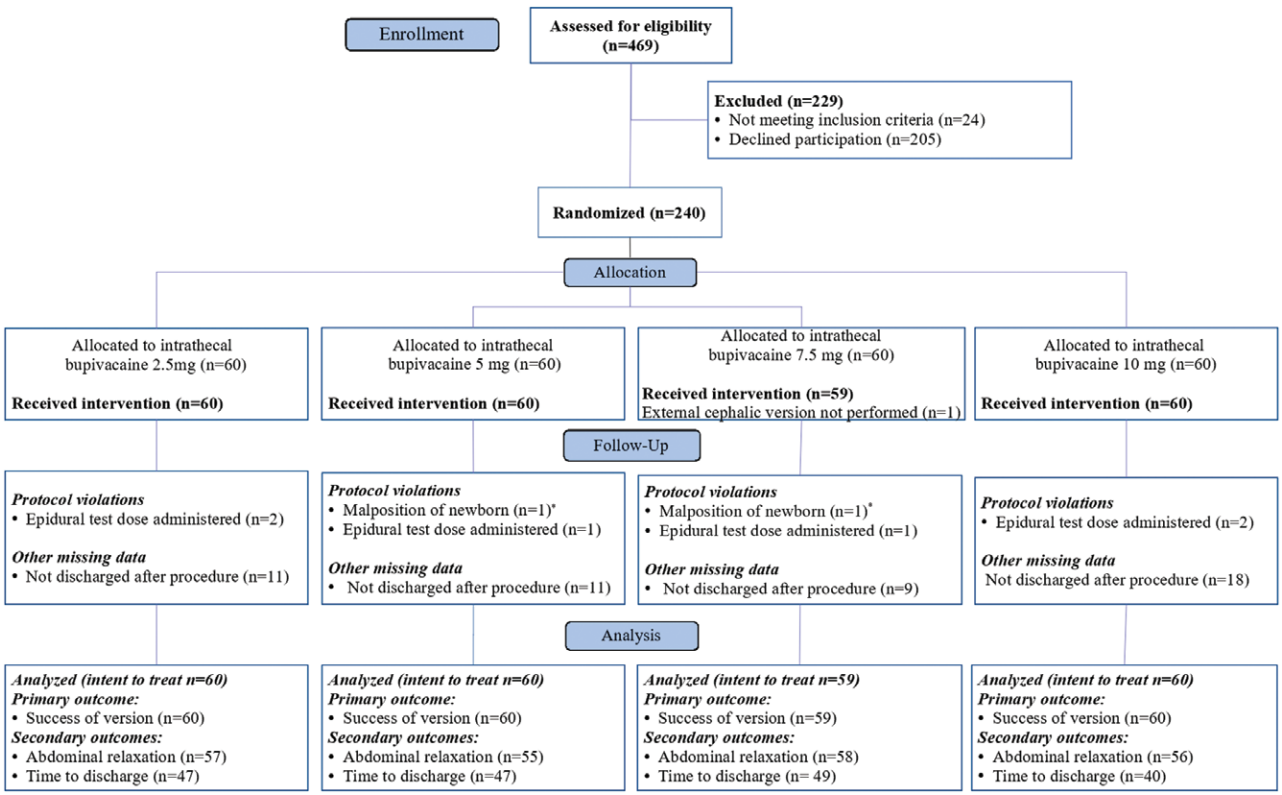

Fig. 1. Consolidated Standards of Reporting Trials diagram of participant flow in the study. *Transverse presentation.

Table 1. Subject Characteristics and Obstetricians

	Bupivacaine Intrathecal Dose, mg				
	2.5 (n = 60)	5.0 (n = 60)	7.5 (n = 59)	10.0 (n = 60)	*P* Value
Height, cm	164 (160–170)	165 (160–170)	167 (167–173)	163 (160–167)	0.16
Weight, kg	77 (70–81)	73 (68–83)	78 (71–87)	77 (70–88)	0.39
Body mass index, kg/m^2	29 (25–32)	27 (26–30)	28 (26–30)	29 (26–32)	0.43
Gravida					0.29
1	27 (45)	32 (53)	31 (52)	31 (52)	
2	12 (20)	15 (25)	14 (23)	14 (23)	
3	8 (13)	9 (15)	4 (7)	10 (17)	
≥ 4	13 (22)	4 (7)	11 (18)	5 (8)	
Parity					0.11
0	34 (57)	38 (63)	39 (65)	38 (63)	
1	14 (24)	19 (32)	13 (22)	14 (24)	
≥ 2	12 (19)	3 (5)	8 (13)	8 (13)	
Estimated gestational age, days	263 (260–266)	261 (259–265)	261 (259–264)	261 (259–266)	0.11
Obstetricians, n	39	40	45	33	
Procedures performed per obstetrician					
Median (interquartile range)	1 (1–2)	1 (1–2)	1 (1–1)	1 (1–1)	0.11
Maximum per single provider	5 (8)	5 (8)	6 (10)	5 (8)	0.97
Placental location					0.14
Fundal	16 (27)	18 (30)	12 (20)	14 (24)	
Anterior	22 (37)	18 (30)	28 (47)	19 (32)	
Posterior	12 (22)	15 (25)	16 (27)	23 (38)	
Lateral	8 (13)	6 (10)	2 (3)	2 (3)	
Not recorded	1 (1)	3 (5)	2 (3)	2 (3)	
Duration of procedure (min)	7 (11–15)	7 (4–14)	11 (5–17)	8 (4–15)	0.10

Data are presented as n (% of group) or median (interquartile range).

catheter was not used during the version procedure except for the aforementioned test dose administrations in six subjects.

Subject characteristics did not differ among study groups (table 1). Eighty-one obstetricians performed the version procedures. The median number (interquartile range) of procedures per obstetrician was two (one to four). Between 33 and 45 obstetricians performed versions in each of the bupivacaine dose groups. There were no among-group differences in the median number of procedures per obstetrician or the greatest fraction of procedures performed by a single obstetrician. Median version procedure times did not differ among groups.

Overall external cephalic version was successful in 123 (51.5%) of 239 patients, and there were no differences in success rates ($P = 0.99$) or cesarean delivery rates ($P = 0.76$) among the four intrathecal bupivacaine dose groups (fig. 2). Compared with bupivacaine 2.5 mg, the odds (99% CI) for a successful version were 1.0 (0.5 to 2.6), 1.0 (0.4 to 2.7), and 0.9 (0.4 to 2.4) for bupivacaine 5.0, 7.5, and 10.0 mg, respectively. Of the 123 successful version procedures, 98 (78%) delivered vaginally compared with only 3 (2.6%) of the version procedure failures (difference = 75.4%; 95% CI of the difference, 67% to 84%; $P < 0.001$). Cesarean delivery occurred in 138 (57.7%) of 239 patients, and emergency cesarean delivery occurred in 8 women (3.3%). The indications for cesarean delivery and rates of emergent delivery were not different among groups ($P = 0.82$; table 2).

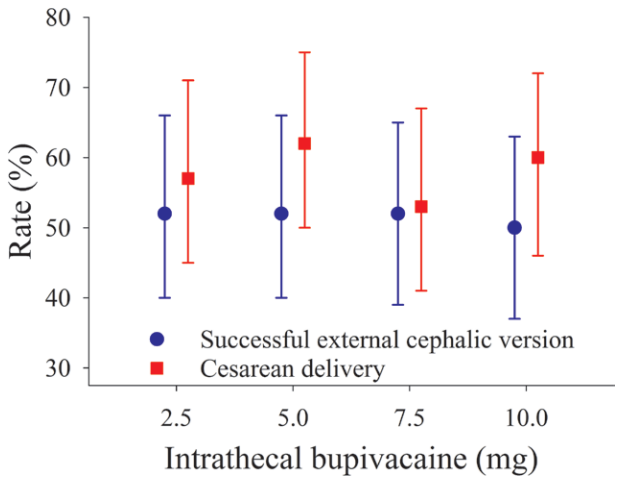

Fig. 2. Rate of external cephalic version success and cesarean delivery by intrathecal bupivacaine dose. Rates are shown by the *symbol* and the 95% CI by the *whisker bars*. There was no difference in the rate of successful external cephalic version or cesarean delivery among groups.

Regarding anesthetic outcomes, median difference (99.6% CI of the difference) in sensory level at 10 min was two (one to three) dermatome levels more cephalad with 7.5- and 10.0-mg bupivacaine doses than with 2.5 mg (table 3).

Table 2. Effect of Intrathecal Bupivacaine Dose on External Cephalic Version Outcomes

	Bupivacaine Intrathecal Dose, mg				
	2.5 (n = 60)	5.0 (n = 60)	7.5 (n = 59)	10.0 (n = 60)	*P* Value
Successful version	31 (52)	31 (52)	31 (52)	30 (50)	0.99
Interval from version to delivery, days	12.0 (2.5–14.0)	13.0 (5.0–18.0)	14.0 (7.0–19.0)	12.0 (1.0–18.0)	0.36
Mode of delivery					0.76
Vaginal	26 (43)	23 (38)	28 (47)	24 (40)	
Cesarean	34 (57)	37 (62)	31 (53)	36 (60)	
Indication of cesarean delivery*					0.82
Malposition	27 (79)	26 (70)	25 (81)	25 (69)	
Arrest of labor	4 (12)	4 (11)	2 (6)	4 (11)	
Nonreassuring fetal status	1 (3)	4 (11)	3 (10)	5 (14)	
Emergency	2 (6)	3 (8)	1 (3)	2 (6)	
Obstetrician rating of abdominal relaxation (0–100 scale)†	78 (63–91)	83 (71–92)	84 (77–94)	88 (73–95)	0.14
Pain during procedure (0–100 scale)‡	12 (3–25)	5 (1–18)	4 (0–9)‖	4 (0–10)‖	0.004
Patient satisfaction (0–10)§	10 (9–10)	10 (9–10)	10 (8–10)	10 (8–10)	0.64

Data are presented as n (%) of group or median (interquartile range) unless otherwise stated.

*Data are presented as n (%) of number of cesarean deliveries per group. †Data show the obstetrician assessment of abdominal relaxation where 0 equals poor relaxation and 100 equals optimal relaxation. ‡Data show pain during the procedure where 0 equals no pain to 100 equals worst imaginable pain. §Data show patient satisfaction where 0 equals completely dissatisfied and 10 equals completely satisfied. ‖Data are different from bupivacaine 2.5-mg group, $P < 0.05$ corrected for 12 comparisons.

Table 3. Effect of Intrathecal Bupivacaine Dose on Sensory Blockade, Blood Pressure, and Vasopressor Administration

	Bupivacaine Intrathecal Dose, mg				
	2.5 (n = 60)	5.0 (n = 60)	7.5 (n = 59)	10.0 (n = 60)	*P* Value
Cephalad sensory level to cold at 10 min					
Right	T6 (T5 to T7)	T5 (T4 to T6)	T4 (T3 to T6)‡	T4 (T5 to T4)‡	< 0.001
Left	T6 (T5 to T7)	T6 (T4 to T7)	T4 (T3 to T6)‡	T4 (T5 to T4)‡	< 0.001
Preprocedure blood pressure					
Systolic	121 (114–133)	120 (117–129)	121 (113–133)	121 (117–132)	0.96
Diastolic	75 (71–82)	73 (67–78)	73 (67–78)	74 (66–80)	0.30
Mean	91 (86–98)	89 (85–94)	89 (82–96)	91 (83–99)	0.50
Lowest blood pressure during procedure					
Systolic	96 (87–105)	90 (80–96)	86 (78–92)‡	86 (78–94)‡	< 0.001
Diastolic	54 (50–60)	51 (44–56)	51 (34–54)‡	51 (42–54)‡	0.001
Mean	67 (64–76)	64 (57–70)	63 (56–67)‡	63 (54–68)‡	< 0.001
Hypotension requiring treatment*	27/57 (47)	43/56 (77)‡	53/58 (91)‡	50/58 (86)‡	< 0.001
Phenylephrine					
Number treated	7	27	46	43	
Dose, μg	300 (200–300)	300 (100–400)	350 (150–512)	500 (300–900)	
Ephedrine					
Number treated	24	32	45	36	
Dose, mg	20 (10–30)	10 (10–20)	20 (15–30)	20 (11–30)	
Vasopressor equivalents, mg ephedrine†	16 (10–24)	12.5 (5–21)	25 (14–31)	21 (12–32)	0.07

*Data are presented as n/N (% of complete data) or median (interquartile range). †Data were calculated using a phenylephrine:ephedrine ratio of 80:1. ‡Data are different from bupivacaine 2.5-mg group, $P < 0.05$ corrected for 12 comparisons.

There was an increased incidence of hypotension in the 5.0-, 7.5-, and 10.0-mg groups compared with the 2.5-mg group ($P < 0.001$). Compared with the 2.5-mg bupivacaine dose, the odds (99% CI) of being treated for hypotension for women receiving 5.0, 7.5, or 10.0 mg bupivacaine were 3.6 (1.3 to 10.6), 11.8 (2.9 to 47.0), and 6.9 (2.1 to 22.9), respectively ($P < 0.001$). Nonetheless, the vasopressor equivalent dose used to treat hypotension did not differ among the groups. The median difference (99.6% CI of the difference) in obstetrician-rated abdominal relaxation (100-mm visual analog scale) compared with bupivacaine 2.5 mg was 5 (–5 to 17), 6 (–3 to 20), and 10 (–3 to 23) for bupivacaine 5.0, 7.5, and 10.0 mg, respectively ($P = 0.14$). There was a decrease in maternal pain with 7.5 and 10.0 mg *versus* 2.5 mg (median difference = –8 (99.6% CI, –1 to –15) on a 0 to 100 visual analog scale; $P < 0.004$), but satisfaction was high and

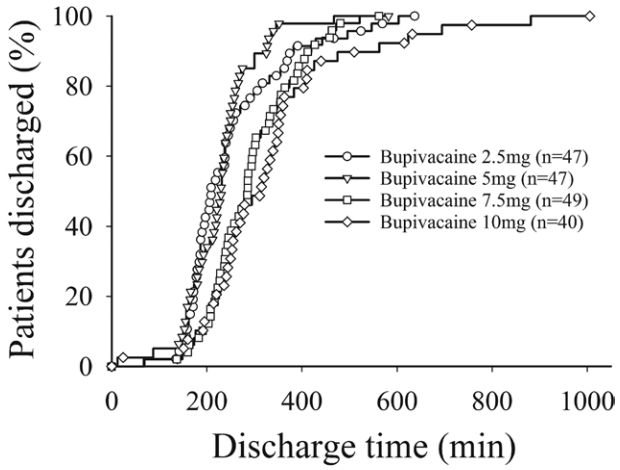

Fig. 3. Percentage of patient discharged by time (min) after intrathecal bupivacaine administration. Median differences (99.6% CI of the difference) between bupivacaine 7.5 and 10.0 mg *versus* bupivacaine 2.5 mg were 77 (6 to 128) min and 106 (8 to 164) min, respectively. Median differences (99.6% CI of the difference) between bupivacaine 7.5 and 10.0 mg *versus* bupivacaine 5.0 mg were 56 (3 to 121) min and 85 (6 to 144) min, respectively.

did not differ among groups ($P = 0.62$). Time from initiation of the neuraxial anesthetic to hospital discharge was longer in the 7.5- and 10.0-mg dose groups than it was in the 2.5-mg dose group. Compared with bupivacaine 5.0 mg or higher, median (99.6% CI of the difference) hospital discharge time increased 60 min (16 to 116 min) with bupivacaine 7.5 mg or higher ($P = 0.004$; fig. 3).

Discussion

This is the largest published randomized controlled trial of the effect of neuraxial anesthetic technique on external cephalic version success and the first to directly examine the effect of neuraxial anesthetic blockade dose. Our results refute assumptions inferred from seven published randomized trials, which suggest that higher-dose neuraxial techniques (*e.g.*, spinal bupivacaine 7.5 mg), with presumably more sensory and motor blockade, were associated with increased external cephalic version success than lower-dose techniques (*e.g.*, spinal bupivacaine 2.5 mg).[12] Those previous trials compared version outcomes with and without administration of neuraxial anesthesia and included five trials that used intrathecal routes of anesthetic administration[8,12–15] and two trials that used epidural anesthetic techniques.[16,17] Although external cephalic version success rates are increased overall by the use of neuraxial anesthetic techniques, the present trial challenges the belief that additional success can be achieved by increasing blockade density with greater intrathecal local anesthetic dose. Possible explanations for these unexpected results include limitations of blinding in previous trials and differences in obstetric and other institutional practices.

Group allocation concealment is challenging in investigations of neuraxial anesthesia for external cephalic version and may have led to greater observed differences in version success between higher intrathecal dose techniques and comparison groups who received no analgesia or systemic opioid. External cephalic version, like the decision to perform a cesarean delivery, is an outcome greatly dependent on obstetrician judgment and can similarly be influenced by numerous factors, several of which are intangible. The obstetrician's assessment of procedural success likelihood, maternal pain and anxiety, and fetal status may prejudice the decision to proceed or persist with external cephalic version. Unlike binary trials comparing neuraxial anesthesia *versus* no neuraxial anesthesia, we believe that group assignment in this dose–response trial was not clear to the obstetrician and patient and may have diminished bias. We did not, however, evaluate either the obstetrician or patient assessment of group assignment after the trial, which would have supported this assertion.

The cesarean delivery rate observed for patients in this trial was 57.7% and not different among groups. Although we did not find improved external cephalic version success with increasing bupivacaine dosing, previous studies have found that using any neuraxial anesthetic technique improves version success by an average of 15.3% compared with not using a neuraxial technique (relative risk = 1.44; 95% CI, 1.27 to 1.64) and reduces cesarean delivery rates by 9.3% (relative risk = 0.83; 95% CI, 0.71 to 0.97).[10] Our previous trial comparing a low-dose neuraxial anesthetic technique (identical to this trial's bupivacaine 2.5 mg, fentanyl 15 μg group) with a systemic opioid technique (intravenous fentanyl 50 μg) showed that the neuraxial group had a cesarean delivery rate of 64% (46% version success), whereas the systemic opioid group had a cesarean delivery rate of 75% (30% external cephalic version success; $P = 0.14$).[8] From an economic perspective, it has been estimated that an increase of 11% in external cephalic version success would justify using a neuraxial anesthetic intervention.[18] Although we did not independently assess the incremental cost of anesthetic services in this trial, previous cost-effectiveness analysis assumptions likely remain valid and applicable for this trial.

There were differences in several secondary outcomes among dosing groups, but the clinical importance of each of these is debatable. Although maternal pain was less in the two higher bupivacaine dose groups than it was in the lowest-dose group, overall pain scores were low in all of the groups, and satisfaction was very favorable. Hypotension and vasopressor administration were more prevalent in the three highest bupivacaine dose groups compared with the lowest-dose group, which was consistent with more cephalad sensory levels, yet these variables did not appear to be associated with adverse maternal or neonatal outcomes. A prophylactic vasopressor strategy (*e.g.* phenylephrine infusion) may have eliminated most hypotension regardless of bupivacaine dosing. Lengths of stay for the 76% of patients discharged

for this outpatient obstetric procedure were longer for the 7.5- and 10.0-mg groups than they were for the 2.5-mg dose group. Certainly, many of the patients in the higher-dose groups were discharged much later than would be deemed optimal from a resource use standpoint, but it is not possible to determine whether the anesthetic technique impacted the decision to admit patients. With no differences observed in external cephalic version success or cesarean delivery rate and without meaningful differences in secondary outcomes, it seems reasonable to support use of the lowest-dose neuraxial technique, which remains our institutional practice.

Numerous factors could limit the external validity of our results. These factors include differences in patient populations, preprocedural patient selection biases, obstetrician training and expertise, tocolytic practice, manipulation techniques, thresholds for procedure termination, and variables that affect fetal well-being, including maternal positioning and hemodynamic support. Our institutional external cephalic version success rate (40%; institutional data) is below that of the average of extrainstitutional published rates (53%).[19] From the results of this study, it appears that achieving the highest published external cephalic version success rates are related to variables unmeasured by this study, most likely variations in obstetric practices. Our study methodology did not include additional exploration of obstetric practice differences, and the sample size does not allow for meaningful interpretation of the primary outcome based on individual obstetrician success rates.

The incidence of emergent delivery in this trial (3.30%) was higher than in previous trials (0.43%) with and without the use of neuraxial anesthesia.[20] The most concerning risk in conducting external cephalic version procedures is compromising maternal–fetal blood flow either through the creation of placental abruption or umbilical cord accident. It has been a theoretical concern that creating motor and sensory blockade *via* neuraxial techniques may increase these risks by perhaps allowing an obstetrician to use more force during the procedure and/or removing a patient's protective ability to detect the pain of a developing placental abruption leading to procedure termination. Despite the higher incidence of emergency deliveries, it was reassuring that no pattern of increased emergent delivery was observed with escalating dose. Note, however, that neither this trial nor any others conducted have been powered to address fetal safety as an outcome.

The limitations of this study include group allocation concealment methodology and lack of a control group. We blinded patient and obstetrician to group assignment but not the anesthesiologist. Some members of our research team had reservations about using high-dose neuraxial anesthetics outside of the operating room and the effect of blinding on subsequent decision-making in the setting of an emergency. In addition, there were concerns about the influence of baricity on blockade characteristics if equivolume intrathecal injectates were used with varied bupivacaine doses. This study did not include a control group, which could have consisted of either a fentanyl-only intrathecal dose or a nonneuraxial anesthetic group. Although this would have represented a more ideal study design, there were concerns about its effect on recruitment and anticipated length of the trial, which took 4 years to complete. Our previous investigation, with very similar methodology, included a systemic opioid group with an external cephalic version success rate of 31% (*vs.* 47% in bupivacaine 2.5-mg dose group), which could be used for comparison.[8]

We conclude that escalating intrathecal local anesthetic dose to achieve more block density does not alter the success rate of external cephalic version and thus further reduce the cesarean delivery rate. We predictably observed that increasing intrathecal bupivacaine dose resulted in marginally improved pain scores, as well as a higher incidence of hypotension and prolonged length of stay.

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Competing Interests

The authors declare no competing interests.

Reproducible Science

Full protocol available at: sullivan@northwestern.edu. Raw data available at: sullivan@northwestern.edu.

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