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ORIGINAL ARTICLE

Need for additional anesthesia after single injection spinal analgesia for labor: a retrospective cohort study

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ABSTRACT
Background: There is little information about the use and efficacy of single injection spinal blocks for labor analgesia; specifically, how frequently subsequent analgesia or anesthesia is needed. This study determined how frequently an additional anesthetic intervention was needed in women who received single injection spinal analgesia.
Methods: This retrospective study examined electronic medical records to find all single injection spinal analgesic blocks for labor analgesia over a 14-year (2003–2016) period. Patient and block characteristics and patient outcomes were recorded. The primary outcome was need for an additional anesthetic intervention following single injection spinal for labor analgesia.
Results: Four-hundred-and-twenty-eight patients received single injection spinal blocks for labor and 60 (14.0%) needed an additional anesthetic either for labor analgesia (n=49) or an unexpected procedure (n=11). Two of these (0.5%) required general anesthesia. Parity of zero (nulliparous), a low cervical dilation at the time of the spinal injection, and induction of labor status, were associated with an increased risk of needing an additional anesthetic intervention.
Conclusions: This retrospective review provides evidence that single injection spinal anesthesia may be used for multiparous women with spontaneous labor and more advanced cervical dilation.

Keywords: Spinal; Spinal analgesia; Labor analgesia; Single injection spinal; Neuraxial anesthesia

Introduction

Most women who choose neuraxial analgesia for labor receive a continuous epidural or combined spinal-epidural technique.[1] Although single injection spinal anesthesia is routinely used as primary anesthesia for cesarean delivery, the single injection technique is employed less frequently for labor analgesia.[2] The inability to extend the duration of analgesia is one of the major drawbacks to using it for women with labor pain. Data on the use and efficacy of single injection spinal analgesia for labor are sparse.

Despite its relatively low usage, the single injection spinal technique has been shown to provide reliable analgesia for labor,[3–5] but the duration of analgesia is limited because no catheter is placed for continuous infusion. If labor is prolonged beyond the intrathecal drug duration or a surgical procedure is needed, an additional anesthetic intervention may be required, which may include general anesthesia in the event of an emergency cesarean delivery. One study of women who received single injection spinal blocks for labor analgesia reported that 26% required additional anesthetic intervention.[3] It is possible that, in appropriately selected patients, this percentage might be lower. The purpose of this retrospective study was to determine the incidence of additional anesthetic interventions in parturients for whom an anesthesiologist chose to perform single injection spinal block for labor analgesia.

Methods

Following approval of the Mayo Clinic Institutional Review Board (IRB), all patients admitted to the Family Birth Center at Mayo Clinic Hospital in Rochester, Minnesota from April 28, 2003 to March 31, 2016 were retrospectively identified using the Mayo Clinic Department of Anesthesiology Quality Database and the elec-

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tronic medical record (EMR). The requirement for written informed consent was waived by the IRB. This manuscript adheres to the STROBE guidelines. Patients with evidence of a dural puncture with an epidural needle, with intra-uterine fetal demise or who declined research authorization, were excluded. In addition, patients receiving single injection spinal analgesia immediately prior to epidural catheter placement during a two-step single procedure (spinal injection before epidural) were excluded.

The medical records of identified patients were manually reviewed. Patient demographics and characteristics including age, sex, gestational age, parity, body mass index (BMI), induction or spontaneous labor, cervical dilation at the time of single injection spinal analgesia, and mode of delivery, were recorded. Anesthetic characteristics including date and time of single injection spinal block, type and dose of intrathecal medication administered, need for additional analgesia or anesthesia, and time from spinal placement to additional anesthetic intervention, were noted. Patients' pain rating prior to and after completion of neuraxial analgesia (on a numeric rating scale (NRS) of 0–10) was noted. Any complication from single injection spinal analgesia was noted. Only the first spinal for each unique patient was analyzed.

The primary outcome variable was the need for an additional anesthetic intervention after single injection spinal block for labor analgesia. This was defined as requirement for spinal, epidural, combined-spinal epidural or general anesthetic, or for intravenous sedation – either for labor pain or for an unplanned procedure (e.g. cesarean delivery). Secondary outcomes included the difference in pain scores before and after single injection spinal placement, the impact of intrathecal medication type on pain scores, and the frequency of complications from single injection spinal analgesia.

Statistical analysis

Patient demographics, obstetric characteristics, and outcomes are presented as number and percentage for categorical variables and median (Q1, Q3) for continuous variables. Characteristics predicted to be associated with the primary outcome were selected a priori and analyzed with univariable logistic regression for predicting the primary outcome. For presentation, risk factors measured on a continuous scale were categorized, and numbers and percentages of patients requiring additional anesthetic intervention are presented according to risk factor categories. All a priori risk factors were included in a multivariable logistic regression to assess their association with the primary outcome, after adjustment. The model was assessed for multicollinearity by inspection of variance inflation factors. Model fit was assessed using the Hosmer and Lemeshow goodness-of-fit test and area under the curve (AUC) was reported. Results from the multivariable model are presented as odds ratios (ORs) with corresponding 95% confidence intervals (CIs) and *P*-values. Reduction of pain score following spinal block placement was compared across types of intrathecal medications using a Wilcoxon rank-sum test, with pairwise group comparisons adjusted using the Bonferroni correction for multiple comparisons to maintain an overall type I error rate of $\alpha=0.05$. The percentage of patients requiring additional anesthesia is presented with exact 95% binomial confidence limits. All *P*-values presented are two-sided and values <0.05 were considered significant. When complete information was not available, complete-case analyses were performed. Analyses were performed with SAS® statistical software Version 9.4 (TS1M3); SAS Institute Inc., Cary, NC, USA.

Results

A total of 494 single injection spinal blocks in 478 patients were performed during labor. Twenty-six patients were excluded because they received single injection spinal analgesia to facilitate positioning and cooperation for immediate subsequent epidural placement. After all exclusion criteria were applied, 428 patients were included in the analysis. Single injection spinal placements were primarily performed by anesthesia residents under direct supervision of an attending anesthesiologist. There were 47 different attending anesthesiologists identified in the time period, with 16 responsible for 10 or more single injection spinal placements. Participant flow is summarized in Fig. 1.

Patient characteristics and outcomes are described in Tables 1 and 2, respectively. Intrathecal medications included: 1) bupivacaine alone, 2) opioid (fentanyl or sufentanil) alone, or 3) a combination of bupivacaine plus opioid. Most patients (90%) received a combination of opioid and local anesthetic for single injection spinal analgesia. Only 5% of patients received intrathecal opioid and 5% intrathecal local anesthetic without opioid.

There were 60 (14.0%, 95% exact binomial CI 10.9% to 17.7%) cases in which an additional anesthetic intervention was administered following single injection spinal analgesia for labor. The median (Q1, Q3) time for additional anesthetic intervention following single injection spinal block was 115 (90, 167) min. Fifty-two patients received additional labor analgesia and of those, 28 received epidural analgesia, eight received combined spinal-epidural analgesia and 15 received a second single injection spinal block. One received intravenous analgesia. Patients in whom epidural placement had been attempted prior to single injection spinal placement were more likely to require additional analgesia (23.3% vs 11.4%, $P=0.011$). The median time from single injection spinal placement until delivery was longer for patients who needed an additional anesthetic inter-

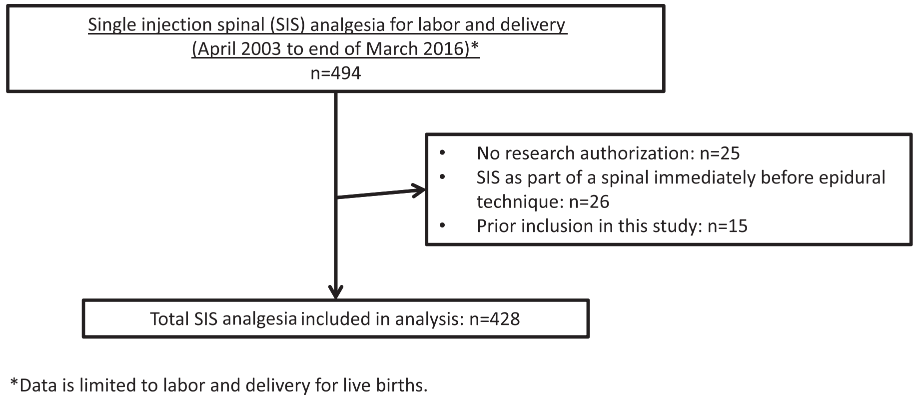

Fig. 1 Diagram showing participant flow with reasons for study exclusion

Table 1 Demographic and Obstetric Information*

	n=428
Demographics and timing of spinal	
Age (y)	30 (26, 33)
Body mass index (kg/m^2) (n=419)	28.5 (25.6, 31.4)
Years	
2003–2009	225 (53%)
2010–2016	203 (47%)
Epidural attempted prior to spinal	
No	372 (87%)
Yes	56 (13%)
Time from spinal injection to delivery (min)	58 (25, 114)
Obstetric characteristics	
Parity	
Median (Q1, Q3)	1 (1, 2)
≥1	329 (77%)
0	99 (23%)
Gestational age (weeks)	
Median (Q1, Q3)	39 (38, 40)
≥37	391 (91%)
≤36 + 6/7	37 (9%)
Cervical dilation (cm)	8 (6, 9)
Induction status	
SOL	360 (84%)
IOL	68 (16%)

*Continuous variables have been summarized as median (Q1, Q3). Categorical variables are summarized as n (%). SOL: spontaneous onset labor. IOL: induction of labor.

vention (222 (156.5, 306) min vs. 48 (22, 87) min, $P<0.001$)

There were 177 patients with a pain score recorded both prior to, and following, single injection spinal analgesia (n=159, 10 and 5 with opioid and local anesthetic, opioid only and local anesthetic only, respectively). Reduction in pain scores was not the same among intrathecal medication types (P=0.010), with opioid and local anesthetic showing greater reduction in pain scores. After Bonferroni correction, only the comparison between opioid and local anesthetic, and opioid alone, met the criterion for statistical significance (P=0.007, threshold for significance 0.017).

Table 3 shows the association between patient characteristics and the need for an additional anesthetic intervention. Parity of zero, lower cervical dilation at the time of placement, an attempt to place an epidural catheter prior to single injection spinal placement, and induced labor, were associated with an increased likelihood of needing an additional anesthetic intervention. In multivariable analysis, increased age, nulliparity, and lower cervical dilation were significantly associated with requiring additional anesthesia (full model AUC=0.683, Hosmer and Lemeshow goodness-of-fit test P=0.068, Table 4). All variance inflation factors were fewer than two, and there was no evidence of multicollinearity. Amongst this cohort, 13 patients (3.1%) had platelet counts lower than 100 000/µL (range 63 000–96 000/µL); the records indicated single injection spinal analgesia was performed due to thrombocytopenia in these patients. The causes of thrombocytopenia were immune thrombocytopenic purpura (n=3), gestational thrombocytopenia (n=6), pre-eclampsia (n=1) and unknown (n=3).

Eleven patients underwent unanticipated surgical procedures for which they required additional anesthesia (Table 5), of which eight underwent cesarean delivery (three of whom were managed with epidural catheters that had been placed for re-establishment of labor analgesia, three of whom had a spinal anesthetic, and two of whom had general anesthesia). Therefore, 0.5% (2/428) of all patients who received single injection spinal analgesia for labor ultimately underwent cesarean delivery requiring general anesthesia.

Complications were limited to post-dural puncture headaches (PDPH). Nine (2.1%) patients were diagnosed with a PDPH and five (55.6%) received successful epidural blood patches. For the 361 patients for whom data on needle type and size were available, 96% had single injection spinal placement with a 25- or

Table 2 Patient outcomes following single injection spinal analgesia*

	n=428	
Additional anesthetic required	60	(14%)
NRS pain score prior to spinal (n=219)	10	(9, 10)
NRS pain score after spinal (n=196)	0	(0, 3)
Change in NRS score (n=177)	−9	(−10, −7)
Delivery type		
- spontaneous vaginal	386	(90%)
- forceps assisted	20	(5%)
- vacuum assisted	14	(3%)
- cesarean	8	(2%)
Post-dural puncture headache	9	(2%)
Epidural blood patch†	5	(1%)

*Values are n (%) for categorical variables and median (Q1, Q3) for continuous variables. NRS: numerical rating score (0–10). Numbers of patients with complete data are presented.
†Of the nine patients experiencing post-dural puncture headache, five underwent an epidural blood patch.

Table 3 Univariable association with additional anesthetic requirement*

	N	Events	(%)	*P*
Age (y)				
<25	73	5	(7%)	
25–29	137	19	(14%)	
30–34	151	24	(16%)	
≥35	67	12	(18%)	0.113
Body mass index (kg/m^2) (n=419)				
<25	86	8	(9%)	
25–29.9	181	25	(14%)	
30–34.9	98	20	(20%)	
≥35	53	6	(11%)	0.187
Parity				
≥1	329	38	(12%)	
0	99	22	(22%)	0.008
Gestational age (weeks)				
≥37	391	57	(15%)	
≤36 + 6/7	37	3	(8%)	0.718
Cervical dilation (cm)				
9–10	154	15	(10%)	
6–8	197	30	(15%)	
≤5	77	15	(19%)	0.025
Induction status				
SOL	360	44	(12%)	
IOL	68	16	(24%)	0.016

*Results are from univariable logistic regression. Continuous variables have been categorized for this summary. *P*-values for age, body mass index, parity and cervical dilation are from analysis of the continuous values. SOL: spontaneous onset labor. IOL: induction of labor.

27-gauge Whitacre needle (our routine practice). Three of the patients who developed PDPH had multiple neuraxial procedures and in another woman a 22-gauge Whitacre needle had been used. No patient received treatment for pruritus and there were no infectious, neurologic or bleeding complications.

Discussion

This retrospective review of patients who received single injection spinal blocks for labor analgesia at a single institution over a 13-year time period found that fewer than one in seven patients required additional anesthesia

Table 4 Association with additional anesthetic requirement[*]

	OR (95% CI)	*P*
Age (per 5 years)	1.41 (1.04–1.90)	0.025
Body mass index (per 1 kg/m^2)	1.03 (0.98–1.09)	0.256
Parity 0	3.33 (1.72–6.43)	<0.001
Gestational age (per 1 week)	1.03 (0.89–1.19)	0.685
Cervical dilation (per 1 cm)	0.87 (0.76–1.00)	0.045
Induction of labor	1.57 (0.78–3.17)	0.212

CI: confidence interval.
[*]Multivariable logistic regression predicting additional anesthesia requirement. Odds ratio (OR) >1 indicates increased likelihood of additional anesthetic requirement. Ten patients were excluded from the multivariable analysis due to missing data for body mass index.

Table 5 Patients undergoing an additional procedure requiring anesthesia

Patient	Gravidity, Parity	Cervical dilation (cm)	Spinal medications	Additional procedure	Additional anesthetic
1	G1P0	10	Bupivacaine 2.5 mg Sufentanil 10 μg	CD	Spinal
2	G1P0	10	Bupivacaine 1.25 mg Fentanyl 25 μg	Labial hematoma evacuation	Spinal
3	G2P0	9	Bupivacaine 3.75 mg Fentanyl 40 μg Morphine 200 μg	CD	Spinal
4	G4P3	7	Bupivacaine 2.5 mg Fentanyl 20 μg	Laceration repair	IV Sedation
5	G1P0	9	Fentanyl 25 v	CD	Spinal
6	G1P0	7	Bupivacaine 3.125 mg Fentanyl 25 μg	CD	General
7	G2P0	8	Bupivacaine 5 mg Fentanyl 20 μg	CD	General
8	G1P0	4	Bupivacaine 5 mg Fentanyl 25 μg	CD	Epidural[a]
9	G1P0	9	Bupivacaine 2.5 mg Fentanyl 20 μg	CD	Epidural[a]
10	G5P4	9	Not documented	CD	Epidural[a]
11	G2P1	4	Fentanyl 25 μg Morphine 200 μg	Laceration repair	IV Sedation

[a]Epidural placed during labor following termination of spinal analgesic effect. CD: cesarean delivery. IV: intravenous.

during labor and delivery. Although complete data for pain scores could not be obtained for most patients, nearly all patients with recorded pain scores reported excellent immediate analgesia (median pain score reduction of nine, Table 2).

Single injection spinal analgesia for labor is not widely studied in comparison with conventional epidural, combined spinal-epidural (CSE) or dural-puncture epidural analgesia (in which the dura is punctured with a spinal needle as in a CSE, but no intrathecal medication is administered prior to placing the epidural catheter). Small studies by Eriksson et al. and Kuczkowski et al. demonstrate that the majority of patients receiving single injection spinal analgesia for labor report excellent pain relief and high satisfaction.[4,5] Our study found that, while single injection spinal analgesia was highly effective, 60 (14.0%) patients eventually needed additional anesthesia. Of these patients, 52 (12.1%) requested additional labor analgesia signifying that the duration of labor outlasted the duration of spinal analgesia. A previous prospective study of multiparous patients reported that 26% of patients who received a single injection spinal analgesia of 2.5 mg bupivacaine and 25 μg fentanyl requested additional labor analgesia.[3] In contrast, in a study of parturients in a Ghanaian hospital who received single injection spinal analgesia (consisting of 2.5 mg bupivacaine, 25 μg fentanyl, and 0.2 mg morphine) only 8.4% received a second spinal analgesia block.[6]

Some women may be more suitable candidates for single injection spinal analgesia. For example, patients near delivery who need adequate sacral coverage may benefit from a single injection spinal block, particularly when it is anticipated that a CSE technique will be difficult and time-consuming. In our cohort, patients whose labor was induced were more likely to need an additional anesthetic intervention, as were patients with lower parity and those with lower cervical dilation at the time of spinal placement. These three factors appear to be major predictive determinants in predicting whether a single injection spinal analgesic will be sufficient as the sole anesthetic for delivery.

Eleven patients (2.6%) underwent an additional procedure requiring anesthesia. Two (0.5%) patients required a general anesthetic for cesarean delivery. Avoiding general anesthesia in pregnancy avoids airway manipulation, minimizes potential aspiration and improves postoperative analgesia and maternal satisfaction. Using a well-functioning labor epidural catheter may mitigate the need for general anesthesia in a laboring patient. Therefore, single injection spinal analgesia for labor may not be optimal for patients with non-reassuring airway examinations or those at increased risk for cesarean delivery.

While epidural analgesia effectively relieves labor pain and provides a catheter for continuous drug administration, there are facilities without appropriate infrastructure to support continuous epidural analgesia for labor. The use of single injection spinal analgesia in Indonesia has been shown to provide high maternal satisfaction and effective labor analgesia. Eighty-one percent of women stated they were highly satisfied with spinal analgesia from bupivacaine 2.5 mg, morphine 250 μg and clonidine 45 μg.[5] The current study did not specifically assess patient satisfaction. Even though 14% of patients needed additional analgesia, this does not necessarily mean that 86% of patients were satisfied with their analgesia. Some of those that did not receive additional analgesia may not have been satisfied, or alternatively, some of the 14% who needed additional analgesia may have been very satisfied with their analgesia. In a Ghanaian hospital, the implementation of a labor analgesia service offering single injection spinal analgesia was well received by midwives and patients.[7] In addition, rural areas and small community hospitals in the United States may not have epidural services always available. Although an indwelling epidural catheter is likely to represent optimal care for most patients, this study provides evidence that the single injection spinal analgesia for labor can be a practical alternative.

Epidural catheter placement can be technically challenging and may not be possible in some patients. In our study, patients who had epidural placement attempted prior to single injection spinal placement were twice as likely to require additional analgesia. For these cases, it is likely that the anesthesiologist resorted to a single injection spinal block when epidural placement could not be achieved. However, even though this subset of patients was more likely to receive additional analgesia, over 75% did not require additional analgesia. Therefore, single injection spinal analgesia may be a reasonable alternative when an epidural catheter cannot be placed. The only complication noted from single injection spinal analgesia in this cohort was PDPH (in 2%). Although this value is higher than the 1% risk typically quoted to patients undergoing neuraxial procedures,[8] it is similar to the incidence of PDPH observed by Douglas et al. in parturients having spinal anesthesia with a 25-gauge Whitacre needle.[9]

The most common reason for administering single injection spinal analgesia in this cohort of patients was a combination of a perceived lack of time to place an epidural catheter due to the rapid progression of labor and/or a hypothesis that labor would not extend beyond the duration of single injection spinal analgesia. Unfortunately, in many cases the reason was not recorded. Single injection spinal analgesia may also be used if there are relative contraindications to epidural analgesia such as prior spinal instrumentation surgery or thrombocytopenia. In our cohort, two patients had Harrington rods in place. Epidural placement may be more challenging in these patients as the epidural space may be scarred or obliterated, which can limit epidural analgesia efficacy.[10] Single injection spinal blocks may be technically easier and prove effective in this population. In our cohort, 14 patients had platelet counts less than 100 000/μL and the records indicated single injection spinal blocks were used instead of epidural techniques because of thrombocytopenia. Spinal techniques may be associated with a lower risk of hematoma than epidural techniques,[11,12] explaining these clinical choices. Of note, there is growing evidence for the safety of neuraxial placement in thrombocytopenia.[13] When a patient has a contraindication to epidural analgesia they are often offered nitrous oxide or intravenous opioid for labor analgesia. Although these are efficacious, they are not as effective as neuraxial analgesia.[14,15] This study provides evidence that single injection spinal analgesia is also effective and may be a reasonable alternative for these patients.

A combination of opioid and local anesthetic was more effective in reducing labor pain than either drug used alone. This is consistent with prior research indicating that a combination of opioid and local anesthetic is more effective than either drug alone, provides a longer duration of analgesia and reduces the effective dose of each drug required for adequate pain relief.[16–18] The results of our study suggest that single injection spinal analgesia is optimized when both local anesthetic and an opioid are administered together.

This study has the limitations of a retrospective study such as charting omissions and uncertainty about the reasons for management decisions. Many patients had missing data for pain scores before and after the single injection spinal placement, and not all had updated cervical examinations prior to spinal placement. Additionally, the dose of medication used was not the same in each case. It is possible that the spinal dose used influenced its effectiveness. We were also unable to assess subjective variables such as patient satisfaction which is an important determinant when considering labor analgesia. Although this study showed that single injection spinal blocks provide excellent immediate analgesia, this analgesia decreases with time. In contrast, epidural analgesia can be increased as the pain of labor intensifies during the second stage of labor and during delivery. Pain scores at the time of birth were not available. Further study of efficacy of this technique will require quantifying the analgesic efficacy of single injection spinal blocks at the time of delivery. In addition, as there was no control group in this study we cannot assess the effectiveness of single injection spinal analgesia treatment relative to other treatments.

In summary, single injection spinal analgesia may be an effective labor analgesic technique in appropriately selected patients or when an epidural technique is not possible. It appears to have the greatest analgesic benefit when a local anesthetic is combined with an opioid. Ideal candidates for single injection spinal analgesia are parous, have advanced cervical dilation and present in spontaneous labor. When appropriate patients are chosen for the technique, as few as 14% of patients may require another anesthetic intervention, either for labor analgesia or for an unplanned procedure.

Disclosure of interests

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