Original Article

Combined spinal-epidural vs. dural puncture epidural techniques for labour analgesia: a randomised controlled trial*

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Summary

Background The dural puncture epidural technique is a modification of the combined spinal-epidural technique. Data comparing the two techniques are limited. We performed this randomised study to compare the quality of labour analgesia following initiation of analgesia with the dural puncture epidural vs. the combined spinal-epidural technique.

Methods Term parturients requesting labour epidural analgesia were allocated randomly to receive either dural puncture epidural or combined spinal-epidural. Analgesia was initiated with 2 mg intrathecal bupivacaine and 10 μg fentanyl in parturients allocated to the combined spinal-epidural group and with 20 ml ropivacaine 0.1% with 2 $\mu g.ml^{-1}$ fentanyl in parturients allocated to the dural puncture epidural group. Analgesia was maintained using patient-controlled epidural analgesia with programmed intermittent epidural boluses. The primary outcome of the study was the quality of labour analgesia, which was defined by a composite of five components: asymmetric block after 30 min of initiation (difference in sensory level of more than two dermatomes); epidural top-up interventions; catheter adjustment; catheter replacement; and failed conversion to neuraxial anaesthesia for caesarean delivery, requiring general anaesthesia or replacement of the neuraxial block.

Results One hundred parturients were included in the analysis (48 combined spinal-epidural, 52 dural puncture epidural). There were no significant differences between the two groups in the primary composite outcome of quality of analgesia (33% in the combined spinal-epidural group vs. 25% in the dural puncture epidural group), risk ratio (95%CI) 0.75 (0.40–1.39); p = 0.486. Median (IQR [range]) pain scores at 15 min were significantly lower in patients allocated to the combined spinal-epidural group compared with the dural puncture epidural group (0 (0–1[0–8]) vs. 1 (0–4 [0–10]); p = 0.018).

Conclusions There were no significant differences in the quality of labour analgesia following initiation of a combined spinal-epidural compared with a dural puncture epidural technique.

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Introduction

The combined spinal-epidural (CSE) technique is used widely for labour analgesia, offering advantages of more rapid onset, greater sacral spread and less risk of unilateral block than the traditional epidural technique [1, 2]. The use of CSE has also been associated with a lower risk of failed catheters compared with the epidural technique [3]. This may be related to the indirect confirmation of correct and midline placement when cerebrospinal fluid (CSF) is successfully obtained while passing a spinal needle through the epidural needle [4]. However, there are concerns about the CSE technique due to associated adverse effects such as maternal pruritus and fetal heart rate changes [1, 5, 6]. The latter is hypothesised to occur secondary to rapid onset of analgesia and reduction of beta-adrenergic activity. The remaining α-adrenergic activity can subsequently lead to uterine tachysystole and cause a decrease in utero-placental blood flow, resulting in fetal bradycardia [7].

The dural puncture epidural (DPE) technique is a modification of the needle-through-needle CSE technique, where the dura is also punctured by a spinal needle following identification of the epidural space with the Tuohy needle. It differs from the CSE technique in that, after puncturing the dura, the spinal needle is removed without any intrathecal medication administration. Neuraxial analgesia is subsequently initiated by administering medication through the epidural catheter. The purported advantages of the DPE technique are that it maintains the advantage of the CSE technique in terms of indirect confirmation of midline and correct position of the Tuohy needle with the return of CSF through the spinal needle and creates a conduit that allows translocation of some epidural medications intrathecally, therefore improving block quality [8, 9]. At the same time, this technique is suggested to reduce the adverse effects associated with the injection of the spinal dose. There are limited data, however, comparing the CSE with the DPE technique, with inconsistent results being reported [10–12]. We therefore performed this double-blind randomised controlled study to compare the quality of labour analgesia following initiation of analgesia with the CSE or the DPE technique. We hypothesised that the quality of analgesia would be improved with the DPE compared with the CSE technique.

Methods

Following institutional review board approval, this randomised controlled trial took place at Duke University Medical Center, Durham, NC, USA. A convenience sample of women admitted to the Duke Birthing Center for spontaneous or induced labour was screened for enrolment in the study. After a standard of care consultation with the anaesthesia team was completed and consent for anaesthesia services obtained, eligible patients were approached by a member of the study team. We included English-speaking women with singleton, vertex presentation foetuses at 37–41 weeks gestation, requesting neuraxial labour analgesia, with cervical dilatation 2–7 cm and with a pain numeric rating score (0–10, where 0 indicates no pain and 10 indicates the worst possible pain) of ≥ 4. We did not study women with major cardiac disease, chronic pain, chronic opioid use and those with BMI ≥ 50 $kg.m^{-2}$.

After obtaining written informed consent, parturients were allocated randomly in a 1:1 ratio by computer-generated random sequence to CSE or DPE groups, stratified by parity (nulliparous vs. multiparous) and class of obesity (BMI < 40 vs. 40–50 $kg.m^{-2}$). Allocation was concealed in sequentially numbered opaque envelopes. When a participating parturient requested labour analgesia, the neuraxial block was placed by an anaesthesia provider under the supervision of a fellowship-trained attending anaesthetist. Before entering the patient room, the anaesthesia provider opened the sealed envelope with the patient's randomised assignment and retrieved the appropriate medications. Parturients, obstetricians, nurses and anaesthesia providers involved in follow-up of labour analgesia and data collection were blinded to group allocation. The anaesthesia provider placing the neuraxial block and the supervising attending anaesthetist were not involved in data collection or follow up of labour analgesia.

Before neuraxial placement, all patients had an intravenous catheter placed with automated non-invasive blood pressure, pulse oximetry and external tocodynamometry monitors applied. All parturients received a 500 ml intravenous bolus of crystalloid solution immediately before the initiation of neuraxial analgesia. The epidural space was identified using a 17-gauge Tuohy needle with the patients in the seated position at the estimated L3–4 or L4–5 interspace, via a midline approach using a loss of resistance to saline technique. After identification of the epidural space, a needle-through-needle technique was performed using a 25-G Whitacre needle, placed into the shaft of the previously sited epidural needle to create a single dural puncture. After confirmation of free flow of CSF, initial dosing consisted of 2 mg (0.8 ml) intrathecal bupivacaine 0.25% and 10 μg (0.2 ml) fentanyl in the parturients allocated to the CSE group. Subsequently, the spinal needle was removed and the epidural catheter (19-gauge Duraflex wire-reinforced multiport catheter (Smith Medical, Saint Paul, MN, USA)) was

advanced 5 cm into the epidural space and secured with the parturient in the sitting upright position, using Tegaderm clear occlusive dressing (3M, Maplewood, MN, USA). In parturients allocated to the DPE group, after confirmation of free flow of CSF, the spinal needle was withdrawn and the epidural catheter advanced 5 cm into the epidural space. After negative aspiration for blood and CSF, initial dosing consisted of 20 ml ropivacaine 0.1% plus 2 $\mu g.ml^{-1}$ fentanyl (premixed) administered in divided doses of 5 ml every 2 min. In both groups, analgesia was maintained using programmed intermittent epidural boluses of 8 ml ropivacaine 0.1% with 2 $\mu g.ml^{-1}$ fentanyl every 45 min starting 30 min after the initial spinal or epidural loading dose, with patient-controlled epidural analgesia (10 ml bolus, lockout of 10 min and maximum dose of 50 $ml.h^{-1}$).

If analgesia was inadequate (defined as a patient request for supplemental analgesia beyond self-administered PCEA boluses), an anaesthesia provider blinded to group assignment assessed and, if warranted, administered top-up doses according to a predefined algorithm. If a patient had an uneven block, defined as > 2 dermatomal levels difference between left and right side, the catheter was withdrawn 1 cm from the skin (if at least 4 cm was in the space), and 5–10 ml ropivacaine 0.2% administered manually. During this time, the patient lay in a lateral position with the unblocked side in the dependent position (as fetal heart rate would allow). In situations where patients had low sensory levels, defined as dermatomal coverage below T10 or sacral sparing, a manual bolus of 5–10 ml ropivacaine 0.2% was administered. Lastly, if a patient experienced inadequate density as defined by dermatomal coverage at or above T10 with persistent breakthrough pain, they were given one or both of the following interventions: 5–10 ml manual bolus ropivacaine 0.2% and/or 100 μg (2 ml) epidural fentanyl. For all interventions, patients were re-evaluated after 20–30 min to assess improvement. If the patient's pain was not improved, consideration was given to repeating the interventions or replacing the epidural catheter.

The end time of administration of the loading dose (end of spinal dose injection in the CSE group or epidural medication administration in the DPE group) was designated time 0 (t = 0). A blinded investigator collected data at 15 and 30 min and subsequently at 2-h intervals from time zero until delivery. Analgesia was evaluated at all time-points using the verbal numeric pain rating scale for the last contraction (0 = no pain, 10 = worst possible pain). The upper and lower sensory levels were evaluated at 15 min and 30 min using temperature discrimination to ice. Motor blockade was assessed at all time-points using the modified Bromage score (1, unable to flex feet or knees; 2, able to flex feet only; 3, able to flex knees; 4, detectable weakness in hip flexion; 5, no weakness in hip flexion) [13].

The following additional data were recorded every 2 h until delivery: presence of pruritus; nausea; hypotension (defined as systolic blood pressure ≤ 20% from the patient's admission blood pressure); need for physician top-up; catheter adjustment; and catheter replacement. We also assessed for the presence of asymmetric blockade, defined as a difference > 2 dermatomal sensory levels between the left and right side as assessed at 15 min and 30 min or at any time that sensory levels were checked because of complaints of pain. An obstetrician blinded to group assignments accessed the electronic medical record to review tocometry and continuous fetal monitoring strips and extract uterine contraction and fetal heart rate monitoring patterns in 10-min epochs, for 1 h before and 1 h after the initial spinal (CSE group) or epidural (DPE group) dosing. Baseline heart rate was the mean of the six 10-min epochs before epidural catheter placement. Quantitative assessment of fetal heart tracings included decelerations (early, late or variable). The obstetrician also assigned a category to the fetal heart tracings before and after the epidural catheter placement based on the three-tier National Institute of Child Health and Human Development system [14]. On the first postpartum day, we assessed for postdural puncture headache and satisfaction with labour analgesia (0–10, 0 = very dissatisfied, 10 = very satisfied).

The primary outcome of the study was the quality of labour analgesia, which was defined by a composite of five components: asymmetric block after 30 min of initiation (difference in sensory level of more than two dermatomes); epidural top-up interventions; catheter adjustment; catheter replacement; and failed conversion to neuraxial anaesthesia for caesarean delivery, requiring general anaesthesia or replacement of the neuraxial block. All five components were treated as binary measures. The presence of one or more of the five components was considered positive for the primary outcome. Secondary outcomes included: pain scores; Bromage scores; sensory levels at 15 min and 30 min; adverse events (hypotension, nausea, pruritus, postdural puncture headache, fetal heart rate changes); duration of second stage of labour; mode of delivery; total anaesthetic dose; PCEA use; and overall satisfaction with analgesia.

Based on the study by Chau et al. [10] a sample size of 50 patients per group had an 80% power at α 0.05 to detect a reduction in the composite primary outcome from 50% in

the CSE group to 22.5% in the DPE group. To account for dropouts, we aimed to enrol up to 60 patients per group to have complete data on 100 subjects. The primary composite outcome was compared between exposure groups using a χ^2 test and an effect size was reported as a risk ratio. Secondary outcomes were assessed using χ^2 or Fisher's exact tests as appropriate, with associated risk ratios for categorical measures and univariate log-linear regression with mean ratios for continuous measures. Analysis of post-neuraxial block fetal heart rate decelerations was adjusted for the presence of pre-block decelerations in a generalised linear model with binomial outcome and log link, and the adjusted risk ratio is reported. Each effect size is reported with an associated 95%CI. All p values for the secondary outcomes were adjusted for multiple comparisons using the Bonferroni-Holm method to control family-wise error rate and adjusted p values are reported. Only p values and adjusted p values < 0.05 were considered statistically significant. Analysis was performed using R version 4.3.1 (R Foundation, Vienna, Austria), with the power calculation performed using NQuery (Statsols, Boston, MA, USA).

Results

Between December 2021 to December 2023, a total of 268 parturients were screened for eligibility, of whom 113 were enrolled and 101 received the allocated intervention (49 in the CSE group and 52 in the DPE group). During labour, one

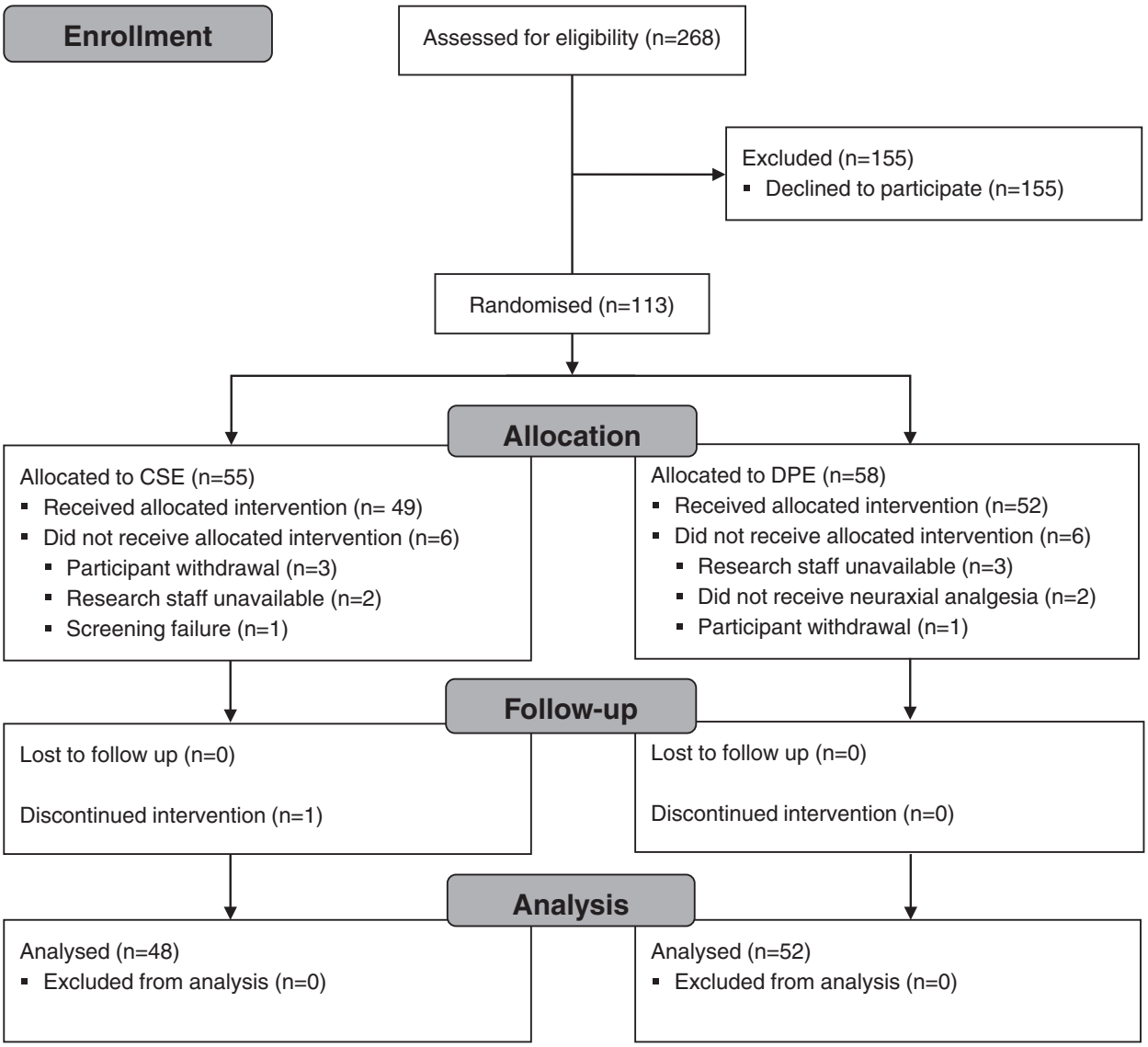

Figure 1 Study flow diagram.

catheter in the CSE group was replaced due to disconnection and this parturient was excluded from the analysis, leaving a total of 100 (Fig. 1).

Baseline characteristics are summarised in Table 1. There were no clinically important differences between the groups in demographics or pre-block characteristics. There were no statistically significant differences between the CSE and the DPE groups in the primary composite outcome of the quality of labour analgesia (16/48, 33% vs. 13/52, 25%), risk ratio (95%CI) 0.75 (0.40–1.39); p = 0.486. The primary

Table 1 Baseline and obstetric characteristics of parturients receiving combined spinal-epidural (CSE) or dural puncture epidural (DPE) for labour analgesia. Values are mean (SD), number or median (IQR [range]).

	CSE group n = 48	**DPE group n = 52**
Age; y	31 (5)	32 (4)
Race		
American Indian or Alaska Native	1	0
Asian	4	5
Black	9	12
White	29	30
Unknown	5	5
Ethnicity		
Hispanic	6	4
Non-Hispanic	41	4
Unknown	1	1
Height; cm	162 (7)	163 (7)
Weight; kg	90 (16)	88 (18)
BMI; $kg.m^{-2}$	34 (6)	33 (6)
BMI stratum		
< 40 $kg.m^{-2}$	42	43
> 40 $kg.m^{-2}$	6	9
Baseline blood pressure; mmHg		
Systolic	120 (111–134 [101–147])	125 (119–135 [99–148])
Diastolic	76 (71–82 [50–93])	78 (72–86 [56–97])
Gravidity	2 (1–3 [1–6])	2 (1–3 [1–6])
Parity	1 (0–1 [0–5])	0 (0–1 [0–4])
Gestational age; weeks	39 (38–39 [37–41])	39 (39–40 [37–41])
Spontaneous labour	12	14
Pre-epidural placement pain score	7 (6–8 [2–10])	8 (7–9 [3–10])
Pre-epidural placement cervical dilation; cm	5 (4–5 [2–8])	5 (4–5 [2–7])
Pre-placement maternal blood pressure; mmHg		
Systolic	130 (119–138 [104–153])	126 (118–133 [103–161])
Diastolic	78 (73–83 [50–103])	77 (71–84 [58–97])
Pre-placement fetal heart tracing		
Baseline heart rate; bpm	135 (128–145 [110–172])	139 (129–146 [116–163])
Decelerations	8	16
Early	3	5
Variable	6	11
Late	0	3
NICHD fetal heart rate classification		
1	41	39
2	6	13

NICHD, National Institute of Child Health and Human Development.

composite outcome and its individual components are summarised in Table 2.

Secondary outcomes are shown in Table 3 and online Supporting Information Table S1. Pain scores at 15 min were significantly lower in parturients allocated to the CSE group compared with the DPE group, but there were no significant differences between the groups in pain scores at 30 min or maximum pain scores during labour. There were also no significant differences between the two groups in any of the secondary outcomes including Bromage scores; sensory levels; duration of neuraxial analgesia; duration of second stage of labour; mode of delivery; PCEA use; local anaesthetic consumption; adverse events; fetal heart rate changes; or satisfaction with labour analgesia.

Discussion

We found no statistically significant differences in the quality of analgesia between the CSE and DPE techniques when used for initiation of labour analgesia. There were also no significant differences between the groups in any of the secondary outcomes, except that pain scores were lower at 15 min in parturients allocated to the CSE group.

Previous studies comparing the CSE and DPE techniques are limited and have reported inconsistent results. Chau et al. initiated analgesia with 20 ml bupivacaine 0.125% with 2 $\mu g.ml^{-1}$ fentanyl in the DPE group and with 1.7 mg bupivacaine and 17 µg fentanyl in the CSE group (n = 40 per group) [10]. Analgesia was maintained with continuous infusion of 1.25 $mg.ml^{-1}$ bupivacaine with 2 $\mu g.ml^{-1}$ fentanyl, and with PCEA. Onset of analgesia was quicker in parturients allocated to the CSE (median 2 min) compared with the DPE group (median 11 min). The need for physician top-ups (22.5% vs. 50%), hypotension, pruritus and conversion from National Institute of Child Health and Human Development category 1 to 2 following block placement were significantly lower in parturients allocated to the DPE group. These benefits of the DPE over CSE were not confirmed in a study by Bakhet et al., in which analgesia was initiated with 2.5 mg intrathecal bupivacaine in the CSE group and 10 ml bupivacaine 0.1% with 2 $\mu g.ml^{-1}$ fentanyl in the DPE group (n = 40 per group) [11]. Analgesia was maintained with continuous infusion of bupivacaine 0.1% with fentanyl 2 $\mu g.ml^{-1}$ and with PCEA. Local anaesthetic consumption (the primary outcome) was lower in parturients allocated to the CSE group compared with the DPE group. Onset of analgesia was also quicker (median 2 min and 10 min in the CSE group and DPE groups, respectively) and pain scores in the first hour following initiation were lower in the CSE compared with the DPE group. The need for physician top-ups (25% DPE vs. 20% CSE) and adverse effects including nausea, pruritus and fetal bradycardia were not significantly different between the groups. In a non-randomised pilot study, Okahara et al. prospectively enrolled 151 patients using labour analgesia initiated with a DPE technique and retrospectively obtained information about 151 patients who received CSE for initiation of labour analgesia [12]. Parturients allocated to the DPE group had analgesia initiated with 15 ml levobupivacaine 0.125% with fentanyl 2.5 $\mu g.ml^{-1}$, while analgesia was initiated with 2.5 mg intrathecal bupivacaine and 10 µg fentanyl in those allocated to the CSE group. Analgesia was maintained with PCEA without basal infusion with levobupivacaine 0.08% and 2 $\mu g.ml^{-1}$ fentanyl. The primary outcome was the incidence of prolonged fetal heart rate deceleration within 90 min of induction of neuraxial labour analgesia. Prolonged fetal heart rate decelerations occurred more commonly in parturients allocated to the CSE group compared with the DPE group, but there were no differences between the groups in the mode of delivery or need for emergency caesarean delivery. Similar to the study by Chau et al., the need for physician top ups was higher in parturients allocated to the CSE group compared with the DPE group (60% vs. 34%).

Table 2 Primary outcome of block quality in parturients receiving combined spinal-epidural (CSE) vs. dural puncture epidural (DPE) for labour analgesia. Values are number.

	CSE group n = 48	DPE group n = 52	Effect size (95%CI)	p value
Poor block quality composite	16	13	0.75 (0.40–1.39)	0.486
Asymmetric block after 30 min	4	5	1.15 (0.33–4.05)	
Top-up intervention	14	10	0.66 (0.32–1.34)	
Catheter adjustment	2	3	1.38 (0.24–7.93)	
Failed catheter requiring replacement	1	0	N/A	
Failed epidural requiring general anaesthesia or replacement neuraxial block for caesarean birth	0	1	N/A	

Table 3 Secondary outcomes in parturients receiving combined spinal-epidural (CSE) or dural puncture epidural (DPE) for labour analgesia. Values are median (IQR [range]) or number.

	CSE group n = 48	DPE group n = 52	Effect size (95%CI)	p value	Adjusted p value
Pain score					
15 min	0 (0–1 [0–8])	1 (0–4 [0–10])	1.70 (0.72–2.67)	0.001	0.018
30 min	0 (0–0 [0–7])	0 (0–2 [0–8])	0.83 (0.12–1.53)	0.023	0.345
Maximum pain score during labour	1 (0–5 [0–10])	3 (0–7 [0–10])	1.13 (-0.12–2.37)	0.080	0.880
Side effects					
Hypotension	8	11	1.14 (0.74–1.78)	0.752	> 0.999
Postdural puncture headache	1	0	N/A	0.480	> 0.999
Nausea	13	16	1.09 (0.73–1.62)	0.853	> 0.999
Pruritus	38	30	0.64 (0.45–0.92)	0.037	0.444
Fetal heart tone interpretation					
Pre-block any deceleration	8	16	1.39 (0.96–2.01)	0.174	> 0.999
Post-block any deceleration	17	23	1.05 (1.44–0.67)	0.786	> 0.999
Pre-block variable or late deceleration	6	13	1.40 (0.96–2.05)	0.198	> 0.999
Post-block variable or late deceleration	15	18	0.97 (0.48–1.46)	0.901	> 0.999
Fetal heart tone NICHD category					
Pre-block category 1/2	41 /6	39/13	1.40 (0.96–2.05)	0.198	> 0.999
Post-block category 1/2	33/15	33/19	1.12 (0.76–1.64)	0.729	> 0.999
Change from category 1 fetal heart tone to category 2*	11	10	0.99 (0.59–1.66)	> 0.999	> 0.999
Duration of neuraxial analgesia; min	443 (304–738 [153–1365])	534 (292–747 [57–1759])	1.04 (0.80–1.35)	0.778	> 0.999
Total anaesthetic dose; ml	108 (81–143 [8–260])	108 (65–162 [8–361])	0.97 (0.93–1.30)	0.860	> 0.999
PCEA used	40	41	0.81 (0.52–1.25)	0.551	> 0.999
PCEA dose; ml	20 (10–38 [0–110])	20 (10–40 [0–184])	1.12 (0.79–1.60)	0.522	> 0.999
Satisfaction with labour analgesia	10 (8–10 [0–10])	10 (8–10 [0–10])	1.03 (0.86–1.22)	0.776	> 0.999

NICHD, National Institute of Child Health and Human Development; PCEA, patient-controlled epidural analgesia.
*Excludes 19 parturients with category 2 tracing at baseline.

Our study differs from previous work in that we used a composite primary outcome of the quality of labour analgesia and programmed intermittent epidural boluses for maintenance of analgesia. Our composite primary outcome captures clinically relevant outcomes that reflect the quality of analgesia and the workload required from the anaesthesia provider to troubleshoot breakthrough pain throughout labour. This composite outcome was also used for comparing labour analgesia initiated with the CSE vs. the DPE technique [9]. The programmed intermittent epidural bolus regimen has been shown previously to reduce breakthrough pain and local anaesthetic consumption when compared with a continuous infusion regimen [15]. Furthermore, when used in conjunction with DPE, programmed intermittent epidural boluses are associated with less breakthrough pain and lower total local anaesthetic consumption compared with continuous infusions [16]. This might account for the reduced need for physician top-ups in our study, compared with previous work [10, 12].

A potential suggested benefit of the DPE technique compared with CSE, is the reduction in adverse effects associated with intrathecal medication. Chau et al. reported a reduction in nausea and pruritus with the DPE compared with the CSE [10], while Bahket reported no difference [11]. Bakhet did not include opioids with the spinal dose, which would explain the lack of difference in the incidence of pruritus. While the incidence of pruritus was higher in parturients allocated to the CSE group in our study in unadjusted analysis, the difference between the groups was not statistically significant when adjusted for multiple comparisons of the secondary outcomes. We also used a lower intrathecal fentanyl dose (10 μg) in our study, which might explain the difference seen with the study by Chau et al. where a dose of 17 μg was used. A previous study reported that doses of intrathecal fentanyl as low as 5 μg provide a similar local anaesthetic sparing effect and less pruritus as the higher doses of 15 μg and 25 μg, but with a shorter duration of analgesia [17].

In contrast to the findings of Chau et al. [10] and Okahara et al. [12], we did not observe significant differences between the groups in fetal heart rate changes following initiation of analgesia. This could be related to the reduced dose of fentanyl used in our study. While some studies suggested a higher risk of fetal heart rate changes with higher compared with lower doses of intrathecal sufentanil [18–20], this has not been reported with intrathecal fentanyl doses ranging from 5–25 μg [17, 21]. We also used a lower dose of intrathecal bupivacaine (2 mg vs. 2.5 mg used by Okahara et al. [12]). It is possible that the higher dose of intrathecal bupivacaine results in more hypotension, leading to higher risk of fetal heart rate changes. Of note, when combined with 15 μg intrathecal fentanyl, the effective dose of plain bupivacaine to achieve labour analgesia in 95% of patients was reported as 1.75 mg [22]. Furthermore, in addition to the non-randomised nature of the study by Okahara et al. [12], and the incorporation of both prospectively and retrospectively enrolled patients, it is important to note that the obstetricians interpreting the fetal heart rate tracings were not blinded to group assignments. All those studies, as well as our study, reported no difference between groups in the mode of delivery or need for emergency caesarean delivery because of fetal heart rate changes.

The strengths of our study include its randomised, double-blind design and the use of modern techniques for maintenance of labour analgesia, incorporating programmed intermittent epidural boluses and PCEA with low concentrations of ropivacaine. We used a clinically relevant composite primary outcome to assess analgesia, including components which impact workload such as top-ups, catheter adjustments and catheter replacements. Some limitations of the study include the fact that, while the primary composite outcome is clinically relevant, the study might not have been adequately powered for its individual components or for adverse effects. We assessed pain scores at 15 min and 30 min following initiation of the block and therefore could not accurately assess onset of analgesia. However, this was assessed in previous studies and was not the focus of this work. Our results might not be generalisable to centres that use different doses for initiation of analgesia or different maintenance techniques.

In conclusion, we found no significant differences in the quality of analgesia or incidence of adverse effects between CSE and DPE techniques when used for the initiation of labour analgesia.

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References

1. Collis RE, Davies DWL, Aveling W. Randomized comparison of combined spinal-epidural and standard epidural analgesia in labor. *Lancet* 1995; **345**: 1413–6. https://doi.org/10.1016/S0140-6736(95)92602-X.

2. Heesen M, Van de Velde M, Klöhr S, Lehberger J, Rossaint R, Straube S. Meta-analysis of the success of block following combined spinal-epidural vs epidural analgesia during labour. *Anaesthesia* 2014; **69**: 64–71. https://doi.org/10.1111/anae.12456.
3. Booth JM, Pan JC, Ross VH, Russell GB, Harris LC, Pan PH. Combined spinal epidural technique for labor analgesia does not delay recognition of epidural catheter failures: a single-center retrospective cohort survival analysis. *Anesthesiology* 2016; **125**: 516–24. https://doi.org/10.1097/aln.0000000000001222.
4. Pan PH, Bogard TD, Owen MD. Incidence and characteristics of failures in obstetric neuraxial analgesia and anesthesia: a retrospective analysis of 19,259 deliveries. *Int J Obstet Anesth* 2004; **13**: 227–33. https://doi.org/10.1016/j.ijoa.2004.04.008.
5. Hattler J, Klimek M, Rossaint R, Heesen M. The effect of combined spinal-epidural versus epidural analgesia in laboring women on nonreassuring fetal heart rate tracings: systematic review and meta-analysis. *Anesth Analg* 2016; **123**: 955–64. https://doi.org/10.1213/ane.0000000000001412.
6. Simmons SW, Taghizadeh N, Dennis AT, Hughes D, Cyna AM. Combined spinal-epidural versus epidural analgesia in labour. *Cochrane Database Syst Rev* 2012; **10**: CD003401. https://doi.org/10.1002/14651858.CD003401.pub3.
7. Segal S, Csavoy AN, Datta S. The tocolytic effect of catecholamines in the gravid rat uterus. *Anesth Analg* 1998; **87**: 864–9. https://doi.org/10.1097/00000539-199810000-00022.
8. Heesen M, Rijs K, Rossaint R, Klimek M. Dural puncture epidural versus conventional epidural block for labor analgesia: a systematic review of randomized controlled trials. *Int J Obstet Anesth* 2019; **40**: 24–31. https://doi.org/10.1016/j.ijoa.2019.05.007.
9. Tan HS, Reed SE, Mehdiratta JE, et al. Quality of labor analgesia with dural puncture epidural versus standard epidural technique in obese parturients: a double-blind randomized controlled study. *Anesthesiology* 2022; **136**: 678–87. https://doi.org/10.1097/ALN.0000000000004137.
10. Chau A, Bibbo C, Huang CC, Elterman KG, Cappiello EC, Robinson JN, Tsen LC. Dural puncture epidural technique improves labor analgesia quality with fewer side effects compared with epidural and combined spinal epidural techniques: a randomized clinical trial. *Anesth Analg* 2017; **124**: 560–9. https://doi.org/10.1213/ANE.0000000000001798.
11. Bakhet WZ. A randomized comparison of epidural, dural puncture epidural, and combined spinal-epidural without intrathecal opioids for labor analgesia. *J Anaesthesiol Clin Pharmacol* 2021; **37**: 231–6. https://doi.org/10.4103/joacp.JOACP_347_19.
12. Okahara S, Inoue R, Katakura Y, et al. Comparison of the incidence of fetal prolonged deceleration after induction of labor analgesia between dural puncture epidural and combined spinal epidural technique: a pilot study. *BMC Pregnancy Childbirth* 2023; **23**: 182. https://doi.org/10.1186/s12884-023-05473-0.
13. Breen TW, Shapiro T, Glass B, Fosterpayne D, Oriol NE. Epidural-anesthesia for labor in an ambulatory patient. *Anesth Analg* 1993; **77**: 919–24. https://doi.org/10.1213/00000539-199311000-00008.
14. Parer JT, Quilligan EJ, Boehm FH, et al. Electronic fetal heart rate monitoring: research guidelines for interpretation. *Am J Obstet Gynecol* 1997; **177**: 1385–90.
15. Tan HS, Zeng Y, Qi Y, et al. Automated mandatory bolus versus basal infusion for maintenance of epidural analgesia in labour. *Cochrane Database Syst Rev* 2023; **6**: CD011344. https://doi.org/10.1002/14651858.CD011344.pub3.
16. Song Y, Du W, Zhou S, et al. Effect of dural puncture epidural technique combined with programmed intermittent epidural bolus on labor analgesia onset and maintenance: a randomized controlled trial. *Anesth Analg* 2021; **132**: 971–8. https://doi.org/10.1213/ane.0000000000004768.
17. Stocks GM, Hallworth SP, Fernando R, England AJ, Columb MO, Lyons G. Minimum local analgesic dose of intrathecal bupivacaine in labor and the effect of intrathecal fentanyl. *Anesthesiology* 2001; **94**: 593–8. https://doi.org/10.1097/00000542-200104000-00011.
18. Van de Velde M, Teunkens A, Hanssens M, Vandermeersch E, Verhaeghe J. Intrathecal sufentanil and fetal heart rate abnormalities: a double-blind, double placebo-controlled trial comparing two forms of combined spinal epidural analgesia with epidural analgesia in labor. *Anesth Analg* 2004; **98**: 1153–9. https://doi.org/10.1213/01.Ane.0000101980.34587.66.
19. Vercauteren M, Bettens K, Van Springel G, Schols G, Van Zundert J. Intrathecal labor analgesia: can we use the same mixture as is used epidurally? *Int J Obstet Anesth* 1997; **6**: 242–6. https://doi.org/10.1016/s0959-289x(97)80031-3.
20. Van de Velde M, Vercauteren M, Vandermeersch E. Fetal heart rate abnormalities after regional analgesia for labor pain: the effect of intrathecal opioids. *Reg Anesth Pain Med* 2001; **26**: 257–62. https://doi.org/10.1053/rapm.2001.22258.
21. Wong CA, Scavone BM, Slavenas JP, et al. Efficacy and side effect profile of varying doses of intrathecal fentanyl added to bupivacaine for labor analgesia. *Int J Obstet Anesth* 2004; **13**: 19–24. https://doi.org/10.1016/s0959-289x(03)00106-7.
22. Whitty R, Goldszmidt E, Parkes RK, Carvalho JC. Determination of the ED95 for intrathecal plain bupivacaine combined with fentanyl in active labor. *Int J Obstet Anesth* 2007; **16**: 341–5. https://doi.org/10.1016/j.ijoa.2007.06.004.

Supporting Information

Additional supporting information may be found online via the journal website.

Table S1. Secondary outcomes of Bromage score, sensory levels and mode of delivery in patients receiving combined spinal-epidural or dural puncture epidural techniques for initiation of labour analgesia.