TPM Vol. 32, No. S1, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

COMPARISON OF DURAL PUNCTURE EPIDURAL VS. CONVENTIONAL EPIDURAL TECHNIQUE FOR LABOR ANALGESIA: A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: Effective labor analgesia is vital for ensuring maternal comfort and safety. While conventional epidural (CE) analgesia remains widely used, the dural puncture epidural (DPE) technique has been proposed to enhance analgesic onset without the risks associated with combined spinal-epidural (CSE) techniques. This study aims to compare DPE and CE techniques in terms of onset and duration of effective analgesia, motor block, hemodynamic stability, patient satisfaction, and neonatal outcomes.

Methods: A prospective, randomized controlled trial was conducted on 100 laboring women aged 18–40 years with singleton pregnancies at term and requesting neuraxial labor analgesia. Participants were randomly assigned to two groups (n=50 each): Group CE received standard epidural, and Group DPE received a dural puncture with a 25G spinal needle prior to epidural catheter placement. All patients received 10 ml of 0.25% ropivacaine bolus followed by Programmed Intermittent Epidural Bolus (PIEB) maintenance. Primary outcome was the time to effective analgesia (VAS ≤3). Secondary outcomes included duration of analgesia, motor block (modified Bromage scale), maternal hemodynamics, VAS scores at various intervals, satisfaction (Likert scale), and neonatal Apgar scores.

Results: The mean time to effective analgesia was significantly faster in Group DPE (10.00 ± 3.81 min) compared to Group CE (12.33 ± 3.40 min; $p<0.05$). Duration of effective analgesia was slightly longer in Group DPE (100.37 ± 23.18 min) compared to CE (99.77 ± 24.96 min), but this was not statistically significant. VAS scores at 5, 10, and 15 minutes were lower in the DPE group. No significant differences were found in the need for top-ups, motor block, hemodynamic parameters, or neonatal outcomes. Patient satisfaction was marginally higher in the DPE group.

Conclusion: DPE provides a faster onset of effective analgesia than CE without increasing adverse outcomes. These findings support the use of DPE as a valuable alternative for labor analgesia.

Keywords: Dural puncture epidural, labor analgesia, epidural, onset time, VAS score, PIEB, maternal satisfaction

INTRODUCTION

Labor pain is a complex physiological and psychological process, recognized as one of the most severe forms of pain experienced by women. Neuraxial analgesia, particularly epidural anesthesia, remains the gold standard for labor analgesia due to its effectiveness and flexibility in dose modulation. The conventional epidural technique (CE), though effective, is sometimes associated with delayed onset of analgesia, patchy block, or inadequate spread.

Recent innovations in neuraxial techniques aim to overcome these limitations. The Dural Puncture Epidural (DPE) technique, a modification of the traditional epidural, involves puncturing the dura with a spinal needle without injecting drugs intrathecally. This maneuver is hypothesized to enhance the spread of local anesthetics administered epidurally, leading to faster onset and potentially better analgesic quality, while minimizing the complications associated with spinal injections.

Despite theoretical advantages, data comparing DPE with CE remains limited. This study evaluates the efficacy and safety of DPE versus CE in achieving rapid and sustained labor analgesia while also evaluating maternal and neonatal safety outcomes.

MATERIALS AND METHODS

This prospective randomized controlled trial was conducted after obtaining ethical clearance from the Institutional Ethics and Human Committee. A total of 100 laboring women aged 18–40 years, with singleton pregnancies in active labor (cervical dilation ≥4 cm) and requesting neuraxial analgesia, were recruited. Written informed consent was obtained.

Inclusion criteria:

- Age 18–40 years
- Singleton pregnancy
- Active labor (cervical dilation ≥4 cm)
- ASA physical status I–II

Exclusion criteria:

- Contraindications to neuraxial anesthesia
- Spinal deformities or prior spinal surgeries
- Coagulopathy or infection at the puncture site
- Fetal distress at enrollment.

Participants were randomly allocated into two groups using computer-generated randomization:

- **Group CE (n=50):** Received standard epidural analgesia
- **Group DPE (n=50):** Underwent dural puncture using a 25G spinal needle prior to epidural catheter placement

All procedures were performed with the patient in the left lateral position. Epidural space was identified at L2-L3 or L3-L4 using the loss of resistance technique. In the DPE group, a 25G spinal needle was inserted through the Tuohy needle to puncture the dura; no intrathecal drug was injected. A multi-orifice epidural catheter was then inserted and fixed at 4 cm into the epidural space.

A 10 ml bolus of 0.25% ropivacaine was administered to all patients. Maintenance was provided using Programmed Intermittent Epidural Bolus (PIEB) with ropivacaine 0.1%.

Outcome Measures:

- **Primary Outcome:** Time to effective analgesia (VAS ≤3)
- **Secondary Outcomes:**
    - Duration of analgesia after bolus
    - VAS scores at 5, 10, 15, and 30 minutes post-dose
    - Number of top-ups required
    - Motor blockade (Modified Bromage Scale)
    - Maternal hemodynamic parameters (BP and HR)
    - Patient satisfaction (5-point Likert scale)
    - Neonatal Apgar scores at 1 and 5 minutes

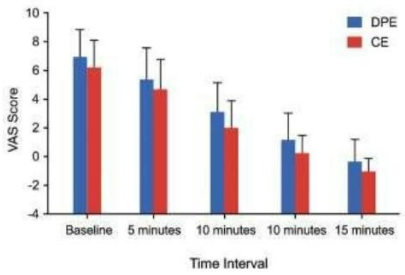
Statistical Analysis:
Data were analyzed using SPSS v25. Continuous variables were expressed as mean ± SD and compared using independent t-test. Categorical variables were analyzed using Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

Demographics and Obstetric Characteristics:
No significant differences were noted in age, BMI, gestational age, parity, or cervical dilation between the groups (Table 1).

Table 1. Demographic and Obstetric Data

Variable	Group CE (n=50)	Group DPE (n=50)	p-value
Age (years)	27.8 ± 3.5	28.1 ± 3.2	0.62
BMI (kg/m²)	26.5 ± 2.4	26.3 ± 2.6	0.74
Gestational age (weeks)	39.1 ± 0.9	39.0 ± 0.8	0.55
Cervical dilation (cm)	4.3 ± 0.6	4.4 ± 0.5	0.41



Block Characteristics:
(Table 2)

Parameter	CE	DPE	p-value
Onset to VAS ≤3 (min)	12.33 ± 3.40	10.00 ± 3.81	0.01*
Duration of analgesia (min)	99.77 ± 24.96	100.37 ± 23.18	0.89
Top-up requests	2.1 ± 1.2	2.0 ± 1.1	0.78

VAS Scores Over Time:
(Table 3)

Time (min)	CE	DPE	p-value
Baseline	8.6 ± 0.5	8.5 ± 0.6	0.45
5	5.3 ± 1.2	4.0 ± 1.0	<0.01*
10	3.8 ± 1.0	2.3 ± 0.9	<0.01*
15	2.9 ± 0.8	1.6 ± 0.7	<0.01*
30	2.4 ± 0.7	1.5 ± 0.6	<0.01*

Motor Block and Neonatal Outcomes:

Parameter	CE	DPE	p-value
Modified Bromage Score ≥1	4 (8%)	3 (6%)	0.67
Apgar Score (1 min)	8.3 ± 0.5	8.4 ± 0.4	0.52
Apgar Score (5 min)	9.2 ± 0.3	9.3 ± 0.4	0.34

Patient Satisfaction:
Group DPE reported slightly higher satisfaction scores (mean 4.7 ± 0.4) than CE (4.5 ± 0.6), though not statistically significant (p=0.09).

DISCUSSION

This study demonstrated that the DPE technique results in a significantly faster onset of effective analgesia compared to CE, with improved VAS scores at all measured time intervals post-initiation. The faster onset may be attributed to the small dural puncture allowing better drug dispersion in the subarachnoid and epidural spaces. However, the duration of analgesia, top-up requirements, and cumulative dose of ropivacaine were comparable, suggesting no compromise in duration of effect.

The DPE group also experienced excellent analgesia with minimal motor blockade, an essential factor in obstetric settings where active maternal participation during the second stage of labor is vital. Hemodynamic stability and neonatal outcomes remained similar between both techniques, reinforcing the safety of the DPE approach. Overall, the technique appears beneficial in optimizing labor analgesia without additional risk.

CONCLUSION

Dural puncture epidural is a safe and effective technique for labor analgesia, offering a significantly faster onset of pain relief compared to the conventional epidural method. Given its comparable duration of analgesia, minimal motor blockade, and favorable maternal and neonatal outcomes, DPE can be recommended as a superior alternative to standard epidural in routine obstetric anesthesia practice.

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