Epidural Catheter Insertion to 4 cm versus 5 cm for Labour Analgesia: A Patient- and Assessor-Blinded Randomised Controlled Trial

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Background & Hypothesis

- Labor epidural - gold standard, but failure rates are still 10–20%.[1,2]
- At our institution the rate of inadequate analgesia with 5 cm catheter insertion depth is around 20-40%.[3, 4]
- Insertion depth is a modifiable factor - varies widely.
  - Shorter insertion - risk of dislodgement.[5]
  - Deeper insertion - risk of coiling, unilateral block, intravascular placement [5]

Objective: To evaluate the difference in quality of labour analgesia delivered by epidural catheters inserted to either 4 or 5 cm into the epidural space in women with BMI <40 kg/m².

Hypothesis: Insertion of epidural catheter to 4 cm depth would reduce the incidence of inadequate analgesia.

METHODS

Study Design

- Prospective, RCT patient- & assessor-blinded
- Block randomization, 1:1 allocation

Intervention

- Epidural with 17G Tuohy needle, 19G FlexTip Plus catheter, advanced to 15 cm, withdrawn to 4 cm or 5 cm; secured with LockIt Plus
- Inserting anesthetist unblinded; patient, assessors & nurse blinded
- Loading: bupivacaine 0.125% + fentanyl 3.3 µg/mL (3 mL test dose + 12 mL)
- Maintenance: bupivacaine 0.0625% + fentanyl 2 µg/mL (PIEB 10 mL q40 min, PCEA 5 mL

Participants

- Laboring women ≥18 yrs
- BMI <40 kg/m²
- Cervical dilatation 3–7 cm
- Exclusion: prior difficult/failed epidural, planned CSE or DPE

Primary Outcome

Composite Inadequate Analgesia

- VNRS >3 or block below T10 at any time
- Unilateral or patchy block
- Catheter manipulation or replacement
- Abandonment or conversion to alternative

Secondary Outcomes

- Hourly VNRS, Block height
- Motor block, Catheter events
- Top-ups, Adverse events, Fetal bradycardia

Sample size: n = 200 (80% power, α = 0.05), assuming composite outcome rate 25% in 5 cm group and 10% in 4 cm group

Analysis: χ^2 / Fisher's exact, R version 4.2.1

RESULTS

- Consented n=257
- Analyzed n=193
- 4 cm (n=94), 5 cm (n=99)

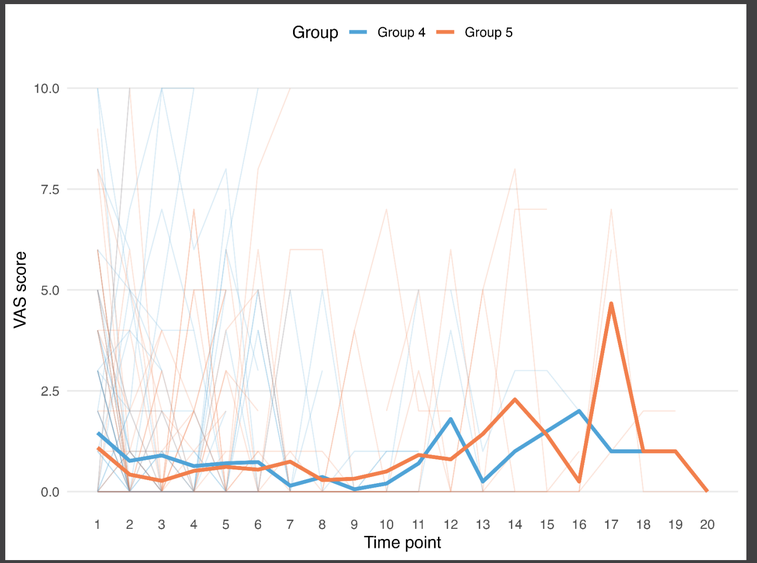
Table 1. Baseline Characteristics

Variable	4 cm (n=94)	5 cm (n=99)
Age, yrs mean (SD)	34.2 (3.9)	33.8 (4.8)
BMI, kg·m² mean (SD)	29.9 (4.3)	29.3 (4.5)
Gestation, wks median [IQR]	39.0 [38.0–40.0]	39.0 [38.1–39.9]
Cervical dilatation, cm median [IQR]	4 [3–4]	4 [3–4]
Baseline VNRS median [IQR]	7 [6–8]	7 [5–8]
Induced labour, N (%)	53 (57.6%)	53 (54.1%)
Insertion site L3–4, N (%)	61 (65.6%)	65 (67.0%)
Skin-to-epidural depth, cm	5.0 [4.5–6.0]	5.0 [5.0–6.0]
Ultrasound-assisted, N (%)	32 (34.0%)	23 (23.2%)
Vaginal delivery, N (%)	64 (68.1%)	61 (61.6%)
Epidural-to-delivery, min	450 [280–672]	459 [288–751]

Table 2. Epidural Performance and Clinical Outcomes

Outcome	4 cm (n=94)	5 cm (n=99)	p
PRIMARY OUTCOME			
Composite inadequate analgesia*	**33 (35.1%)**	**37 (37.4%)**	**0.859**
PAIN AND BLOCK			
VNRS >3 at any time*	30 (31.9%)	32 (32.3%)	1.000
Sensory level below T10*	18 (19.1%)	20 (20.2%)	0.998
Patchy block*	3 (3.2%)	2 (2.0%)	0.676
Unilateral block*	10 (10.6%)	8 (8.1%)	0.717
EPIDURAL MANAGEMENT			
Catheter manipulation*	3 (3.2%)	3 (3.0%)	1.000
Catheter replacement*	3 (3.2%)	3 (3.0%)	1.000
Change in PIEB regimen	3 (3.2%)	3 (3.0%)	1.000
Change in maintenance solution	2 (2.1%)	3 (3.0%)	1.000
Clinician top-ups (≥1)	17 (18.1%)	20 (20.2%)	0.660
Nursing top-ups (≥1)	10 (10.8%)	14 (14.4%)	0.586
ADVERSE EVENTS AND SURGICAL USE			
Motor block	1 (1.1%)	1 (1.0%)	1.000
Fetal bradycardia	0 (0.0%)	3 (3.0%)	0.247
Surgical conversion (successful)	19/21 (90.5%)	30/31 (96.8%)	0.558

Figure 1. Hourly pain score (trajectory



- Grey lines represent individual data, and coloured curves are the averages.
- In both groups, average VAS scores remained generally low over time.
- The 4 cm group showed slightly higher mean VAS (1.09 vs 0.70) and greater overall variability than the 5 cm group.

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DISCUSSION

Main finding

- In laboring women with BMI <40 kg/m², inserting epidural catheters to 4 cm or 5 cm produced similar rates of inadequate analgesia (35.1% vs 37.4%), catheter interventions and adverse events.

Clinical implications

- Small differences for epidural catheter lengths within the 4–5 cm range have limited impact on inadequate analgesia with PIEB techniques, supporting flexible, individualized depth selection in clinical practice.
- A high rate of inadequate analgesia may be attributable to our use of a composite failure metric, suggesting that other factors—such as patient anatomy, physiology, labour progress, epidural technique, and dosing regimen—may also play a role.

Limitations

- Single centre study
- BMI <40 kg/m² only
- Inserting anesthetist unblinded
- May not be generalizable for different epidural regimens

Future Directions

- Multicenter study
- Evaluation of catheter depth in women with BMI ≥40 kg/m²
- Imaging studies of catheter trajectory
- Modification of epidural technique or epidural drug regimens
- Use of robust composite end-point for future work

References

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