



## COMPARISON OF LUMBAR PUNCTURE SUCCESS RATES IN SITTING AND LATERAL DECUBITUS POSITIONS AMONG CHILDREN AGED <12 YEARS: A RANDOMIZED CONTROLLED TRIAL

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### Abstract

**Background:** Lumbar puncture (LP) is a common and essential paediatric procedure. Patient positioning may influence first-attempt success and the likelihood of traumatic taps, but comparative evidence across paediatric age groups remains limited.

**Objectives:** To compare LP success rates between the sitting and lateral decubitus positions in children aged <12 years and to evaluate secondary outcomes including number of attempts, traumatic taps and post-procedure complications.

**Methods:** This randomized controlled trial was conducted over 18 months (July 2023–December 2024) in a tertiary care hospital. Eighty-eight children requiring LP were randomized to undergo the procedure in either the lateral decubitus position (n=44) or the sitting position (n=44). The primary outcome was successful LP, defined as obtaining an adequate, non-traumatic CSF sample on the first attempt. Categorical variables were compared using the chi-square test;  $p < 0.05$  was considered statistically significant.

**Results:** Successful LP was achieved in 34/44 (77.3%) in the sitting group compared with 28/44 (63.6%) in the lateral decubitus group ( $p = 0.161$ ). First-attempt completion was higher in the sitting group (86.4%) than in the lateral group (77.3%,  $p = 0.269$ ). Non-traumatic LPs occurred in 84.1% of sitting procedures versus 77.3% in lateral decubitus ( $p = 0.418$ ). Post-procedure headache was rare and similar in both groups (2.3% each) and 97.7% of children in each group remained clinically stable post-procedure. Age-stratified success favoured sitting in <1 month (73.7% vs 56.3%) and 6–12 years (87.5% vs 50.0%) categories.

**Conclusion:** In children under 12 years, the sitting position demonstrated consistently higher LP success rates with a comparable safety profile to lateral decubitus positioning, although differences were not statistically significant. Position choice should be individualised based on age, cooperation and clinical context.

**Keywords (5):** lumbar puncture; sitting position; lateral decubitus; paediatrics; success rate

## Introduction

Lumbar puncture (LP) remains a cornerstone procedure in paediatric practice, providing critical diagnostic and therapeutic access to the cerebrospinal fluid (CSF). It is routinely performed to evaluate suspected central nervous system infections, inflammatory conditions, CSF pressure assessment and targeted intrathecal therapies. Although technically straightforward in principle, LP in children can be challenging due to age-related anatomical considerations, patient movement and procedural distress, all of which can influence the likelihood of obtaining an adequate sample and can increase the risk of traumatic taps and other complications [1,6].

The clinical value of LP depends not only on the ability to access the subarachnoid space but also on the quality of CSF obtained. Standardised CSF analysis is essential for guiding clinical decisions in acute and chronic neurological disorders and contemporary guidance emphasises the importance of appropriate technique, asepsis and systematic interpretation of CSF parameters [2,4]. In addition, best-practice recommendations highlight pre-procedural assessment and the need to recognise contraindications and patient-specific risk factors that may affect safety and diagnostic yield [2,4].

Beyond technical considerations, the consent process is particularly important in paediatric LP. Documentation of informed consent helps ensure that caregivers understand the indication, expected benefits and potential adverse events—including traumatic tap, post-dural puncture headache and rare neurological or infectious complications—and reinforces ethical and medicolegal standards for invasive procedures in acute care settings [3]. Despite adherence to protocol, post-procedural symptoms and complications continue to be reported, underscoring the importance of optimising modifiable factors that may improve overall success and reduce harm [1,6].

One potentially modifiable factor is patient positioning. The sitting and lateral decubitus positions are both widely used, yet their relative effectiveness in children—particularly across different age groups—remains variably described in the literature. Positioning may affect spinal flexion, landmark identification, CSF flow and the ability to stabilise the child, all of which can influence first-attempt success and the likelihood of traumatic CSF sampling [1,4,6]. Given the importance of achieving a successful, non-traumatic LP on the first attempt, comparative evaluation of these two commonly used positions is clinically relevant.

Therefore, this study was undertaken to compare the success rate of lumbar puncture performed in the sitting versus lateral decubitus position in children under 12 years of age and to assess secondary procedural outcomes including number of attempts, traumatic taps and post-procedure complications

## Methods

### Study design and setting

A prospective, parallel-group randomized controlled trial was conducted over an 18-month period (July 2023 to December 2024) in the Department of Paediatrics at Kempegowda Institute of Medical Sciences Hospital and Research Centre, Bengaluru, India.

### Participants

Children aged 0 to <12 years who required a lumbar puncture (LP) as part of their clinical management were eligible.

### Inclusion criteria

- All admitted children <12 years requiring LP as part of the treatment/diagnostic plan.

### Exclusion criteria

- Previous LP for the same indication

- Congenital anomalies, wounds/obvious trauma to the lumbar spine, or skin breakdown/infection/rash over the lumbar region (L2–S1)
- Children on mechanical ventilation or clinical conditions not permitting the procedure
- Failure to obtain CSF even after two attempts

Written informed consent was obtained from parents/guardians prior to enrolment. Baseline details including age, sex and diagnosis/indication were recorded.

### **Randomization and allocation concealment**

Participants were randomized in a 1:1 ratio to:

- **Group I:** Lateral decubitus position
- **Group II:** Sitting position

Randomization was implemented using sealed opaque envelopes containing group assignments. Allocation concealment was maintained by opening the envelope immediately before the procedure. Blinding of caregivers/parents, data collectors, and outcome assessors was not feasible due to the nature of the intervention (positioning).

### **Procedure protocol**

All LPs were performed by trained paediatric residents under supervision using a standardized technique with strict aseptic precautions and appropriate analgesia/pain management.

- Positioning was per allocation: either standard sitting with maximal lumbar flexion or standard lateral decubitus with spinal flexion. Neck flexion was avoided to reduce airway compromise risk.
- The L4–L5 interspace was identified using the intercrystal (iliac crest) line, and the midline entry point was marked.
- An appropriately sized spinal needle was inserted perpendicularly with the bevel oriented cephalad.
- Approximately 0.5–1 mL CSF was collected for routine laboratory evaluation (biochemistry, cytology, culture).
- If CSF was not obtained on the first attempt at L4–L5, a second attempt at L3–L4 was performed.
- If CSF appeared blood-stained, the operator assessed for traumatic tap based on clearing of blood with successive collection (as per protocol).

Vital signs and clinical status were monitored during the procedure. After LP, pressure was applied at the puncture site, a sterile dressing was placed, and children were kept supine without a pillow for 4–6 hours, with monitoring for complications.

### **Outcomes**

#### **Primary outcome**

- Successful lumbar puncture, defined as obtaining an adequate, non-traumatic CSF sample on the first attempt.

#### **Secondary outcomes**

- Number of attempts (1 vs 2)
- Spinal level used (L4–L5 vs L3–L4)
- CSF appearance (clear, blood-stained, turbid)
- Traumatic vs non-traumatic LP
- Post-procedure complications (e.g., headache) and clinical stability

### **Sample size estimation**

Sample size was calculated using an expected success rate of 0.79 for sitting and 0.57 for lateral decubitus (risk difference 0.22), with 95% confidence, 80% power, and margin of error 0.10,

yielding a minimum of 40 participants per group (80 total). The final analysed sample was 88 (44 per group).

### Statistical analysis

Data were analysed using SPSS version 23.0. Categorical variables were summarised as frequency and percentage. Group comparisons for categorical outcomes were performed using the Chi-square test. Statistical significance was set at  $p < 0.05$ .

### Ethical considerations

The study protocol received approval from the institutional ethics committee. Written informed consent was obtained from parents/guardians prior to participation, and confidentiality of participant data was maintained.

## Results:

### 1. Participant flow and analysis population

Over the 18-month study period (July 2023 to December 2024), a total of 88 children meeting the inclusion and exclusion criteria were included in the study. Participants were allocated equally to the two intervention arms: lateral decubitus position ( $n=44$ ) and sitting position ( $n=44$ ). The results section reports outcomes for all 88 participants across both groups, implying that analyses were conducted on 44 per group with no additional post-allocation losses/exclusions.

### 2. Baseline characteristics

Baseline characteristics by position are presented in Table 1. Among the 88 participants, the largest age category was <1 month (39.8%), followed by 1–6 years (31.8%), 1–12 months (14.8%), and 6–12 years (13.6%). Overall, 51 (58.0%) participants were male and 37 (42.0%) were female.

The most frequent indications/diagnoses for lumbar puncture were neonatal seizures (18.2%), complex febrile seizures (14.8%), and febrile status epilepticus (14.8%), followed by late onset sepsis (11.4%), early onset sepsis (9.1%), and meningitis (9.1%).

**Table 1. Baseline characteristics of participants by position (N = 88)**

Values are n (% within group column).

| Characteristic                | Lateral decubitus (n = 44) | Sitting (n = 44) | Total (N = 88) |
|-------------------------------|----------------------------|------------------|----------------|
| <b>Age group</b>              |                            |                  |                |
| <1 month                      | 16 (36.4%)                 | 19 (43.2%)       | 35 (39.8%)     |
| 1–12 months                   | 3 (6.8%)                   | 10 (22.7%)       | 13 (14.8%)     |
| 1–6 years                     | 21 (47.7%)                 | 7 (15.9%)        | 28 (31.8%)     |
| 6–12 years                    | 4 (9.1%)                   | 8 (18.2%)        | 12 (13.6%)     |
| <b>Sex</b>                    |                            |                  |                |
| Female                        | 21 (47.7%)                 | 16 (36.4%)       | 37 (42.0%)     |
| Male                          | 23 (52.3%)                 | 28 (63.6%)       | 51 (58.0%)     |
| <b>Indication/diagnosis</b>   |                            |                  |                |
| Complex febrile seizures      | 8 (18.2%)                  | 5 (11.4%)        | 13 (14.8%)     |
| Early onset sepsis            | 1 (2.3%)                   | 7 (15.9%)        | 8 (9.1%)       |
| Febrile status epilepticus    | 9 (20.5%)                  | 4 (9.1%)         | 13 (14.8%)     |
| Guillain–Barré syndrome (GBS) | 3 (6.8%)                   | 1 (2.3%)         | 4 (4.5%)       |
| Late onset sepsis             | 5 (11.4%)                  | 5 (11.4%)        | 10 (11.4%)     |
| Meningitis                    | 2 (4.5%)                   | 6 (13.6%)        | 8 (9.1%)       |
| Meningoencephalitis           | 1 (2.3%)                   | 1 (2.3%)         | 2 (2.3%)       |

|                             |                 |                 |                 |
|-----------------------------|-----------------|-----------------|-----------------|
| Neonatal seizures           | 9 (20.5%)       | 7 (15.9%)       | 16 (18.2%)      |
| Seizure disorder            | 4 (9.1%)        | 2 (4.5%)        | 6 (6.8%)        |
| Simple febrile seizures     | 0 (0.0%)        | 3 (6.8%)        | 3 (3.4%)        |
| Status epilepticus          | 0 (0.0%)        | 3 (6.8%)        | 3 (3.4%)        |
| <b>Other / Not recorded</b> | <b>2 (4.5%)</b> | <b>0 (0.0%)</b> | <b>2 (2.3%)</b> |

Indication/diagnosis was not recorded for 2 participants in the lateral decubitus group and is shown as “Other / Not recorded.” Percentages are calculated within each column.

### 3. Procedural characteristics

Procedural characteristics are presented in Table 2. The L4–L5 interspace was used for the majority of lumbar punctures (71/88; 80.7%), while L3–L4 was used less frequently (17/88; 19.3%). Most CSF samples were clear (70/88; 79.5%), with blood-stained CSF observed in 17/88 (19.3%) procedures and turbid CSF recorded in 1/88 (1.1%).

**Table 2. Procedural characteristics by position (N = 88)**

Values are n (% within group column).

#### A. Spinal interspace used

| Spinal interspace | Lateral decubitus (n = 44) | Sitting (n = 44) | Total (N = 88) |
|-------------------|----------------------------|------------------|----------------|
| L4–L5             | 33 (75.0%)                 | 38 (86.4%)       | 71 (80.7%)     |
| L3–L4             | 11 (25.0%)                 | 6 (13.6%)        | 17 (19.3%)     |

#### B. CSF appearance

| CSF appearance | Lateral decubitus (n = 44) | Sitting (n = 44) | Total (N = 88) |
|----------------|----------------------------|------------------|----------------|
| Clear          | 33 (75.0%)                 | 37 (84.1%)       | 70 (79.5%)     |
| Blood-stained  | 10 (22.7%)                 | 7 (15.9%)        | 17 (19.3%)     |
| Turbid         | 1 (2.3%)                   | 0 (0.0%)         | 1 (1.1%)       |

### 4) Primary outcome

The primary outcome—successful lumbar puncture (defined as obtaining an adequate, non-traumatic CSF sample on the first attempt)—was achieved in 34/44 (77.3%) children in the sitting group compared with 28/44 (63.6%) in the lateral decubitus group ( $p = 0.161$ , chi-square). The risk difference was +13.6% (95% CI −5.2% to +32.5%) and the risk ratio was 1.21 (95% CI 0.92 to 1.60) in favour of the sitting position.

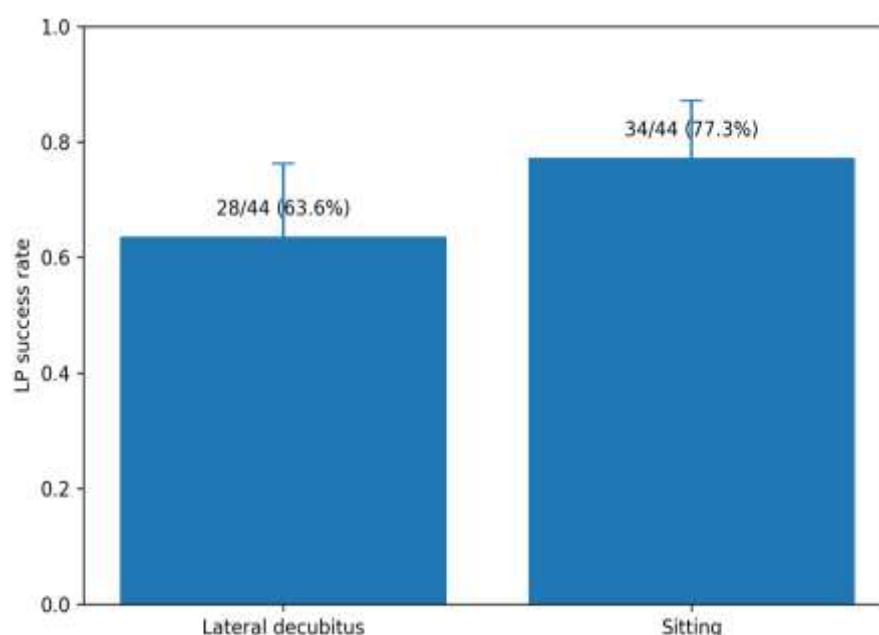
**Table 3. Primary and secondary outcomes by position (N = 88)**

Values are n (% within group). Risk ratios are Sitting vs Lateral decubitus.  $p$ -values from chi-square tests as reported in the dissertation results tables.

| Outcome                   | Lateral decubitus (n = 44) | Sitting (n = 44) | Effect (Sitting vs Lateral) | p-value |
|---------------------------|----------------------------|------------------|-----------------------------|---------|
| <b>Primary outcome</b>    |                            |                  |                             |         |
| Successful LP (Yes)       | 28 (63.6%)                 | 34 (77.3%)       | RR 1.21 (95% CI 0.92–1.60)  | 0.161   |
| Successful LP (No)        | 16 (36.4%)                 | 10 (22.7%)       | —                           | —       |
| <b>Secondary outcomes</b> |                            |                  |                             |         |
| First attempt achieved    | 34 (77.3%)                 | 38 (86.4%)       | RR 1.12 (95% CI 0.92–1.36)  | 0.269   |
| Required 2 attempts       | 10 (22.7%)                 | 6 (13.6%)        | —                           | 0.269   |

|                                  |            |            |                            |       |
|----------------------------------|------------|------------|----------------------------|-------|
| Traumatic LP                     | 10 (22.7%) | 7 (15.9%)  | RR 0.70 (95% CI 0.29–1.67) | 0.418 |
| Non-traumatic LP                 | 34 (77.3%) | 37 (84.1%) | —                          | 0.418 |
| Post-procedure headache          | 1 (2.3%)   | 1 (2.3%)   | RR 1.00 (very imprecise)   | —     |
| Clinically stable post-procedure | 43 (97.7%) | 43 (97.7%) | —                          | —     |

**Figure 1.** Lumbar puncture (LP) success rate by position.



Bars represent success proportions in the lateral decubitus (28/44) and sitting (34/44) groups. Error bars indicate 95% confidence intervals (Wilson method).

## 6) Subgroup analyses (age and sex)

Age-stratified success rates suggested a consistent numerical advantage for the sitting position in select age groups. Among infants <1 month, success was 73.7% in the sitting group versus 56.3% in the lateral decubitus group and among children 6–12 years, success was 87.5% versus 50.0%, respectively. Success rates were similar in children aged 1–6 years (71.4% in both groups).

Sex-stratified success also favoured the sitting position, with higher success observed among females (75.0% vs 52.4%) and males (78.6% vs 73.9%) compared with the lateral decubitus position.

These subgroup findings should be interpreted cautiously, as several strata contained small numbers and the study was not powered for subgroup comparisons.

**Table 4. Success rates by age group and sex (subgroup analyses)**

### A. Age group

| Age group   | Lateral decubitus (Success/Total, %) | Sitting (Success/Total, %) |
|-------------|--------------------------------------|----------------------------|
| <1 month    | 9/16 (56.3%)                         | 14/19 (73.7%)              |
| 1–12 months | 2/3 (66.7%)                          | 8/10 (80.0%)               |
| 1–6 years   | 15/21 (71.4%)                        | 5/7 (71.4%)                |
| 6–12 years  | 2/4 (50.0%)                          | 7/8 (87.5%)                |
| Overall     | 28/44 (63.6%)                        | 34/44 (77.3%)              |

## B. Sex

| Sex    | Lateral decubitus (Success/Total, %) | Sitting (Success/Total, %) |
|--------|--------------------------------------|----------------------------|
| Female | 11/21 (52.4%)                        | 12/16 (75.0%)              |
| Male   | 17/23 (73.9%)                        | 22/28 (78.6%)              |

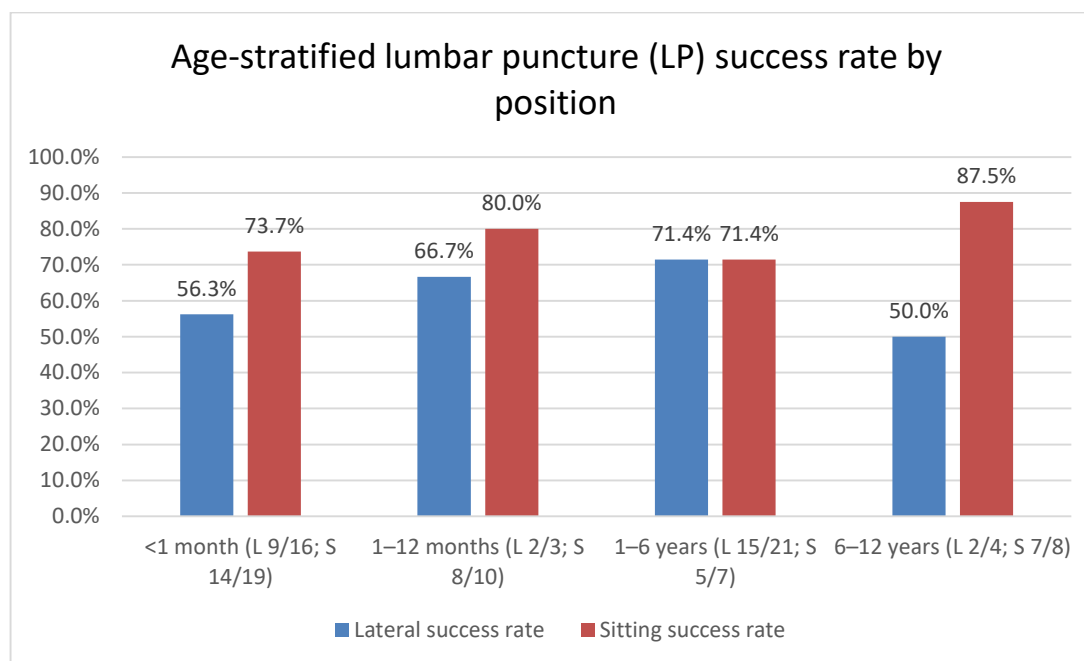


**Figure 2.** Age-stratified lumbar puncture (LP) success rate by position. Success rates are shown for lateral decubitus versus sitting position across four age categories. <1 month: 9/16 vs 14/19; 1–12 months: 2/3 vs 8/10; 1–6 years: 15/21 vs 5/7; 6–12 years: 2/4 vs 7/8.

## Discussion:

Our trial found a numerically higher overall LP success rate in the sitting position (77.3%) than in the lateral decubitus position (63.6%), with comparable safety outcomes (post-procedure headache 2.3% in each group). Although our work focused on paediatrics, the broader safety context is consistent with Portuguese et al. (2020), who evaluated bedside LP safety in thrombocytopenic adults and concluded that—with appropriate risk stratification—serious bleeding complications are uncommon; this supports the principle that procedural safety is strongly shaped by *patient selection and optimisation* rather than positioning alone, particularly when complication rates are low (in our cohort, clinically relevant complications were rare) [7].

When bedside conditions are suboptimal, imaging-assisted approaches can improve technical success: Cauley (2015) described fluoroscopically guided LP as a strategy to increase access success in difficult anatomy, typically achieving high completion rates (often in the >85–95% range in procedural radiology practice), underscoring that “position” is one of several modifiable determinants of success alongside guidance and operator control [8]. Similarly, Kishawi et al. (2020) emphasised pre-procedural risk assessment and optimisation (e.g., haemostasis, physiological stability, and preparation) as key to preventing avoidable failure and complications; in our study, the very low adverse event rate and high stability rate (97.7%) are compatible with a well-optimised procedural pathway [9].

From a paediatric technique standpoint, Schulga et al. (2015) highlighted that LP success in children is tightly linked to restraint, landmarking, analgesia/sedation and minimising movement—factors that can plausibly interact with positioning: sitting can improve midline visualisation and gravity-assisted CSF flow, whereas lateral positioning can improve immobilisation in some infants

[10]. That framework matches our pattern: sitting yielded a higher proportion of single-attempt procedures (86.4% vs 77.3%), which is clinically meaningful even when not statistically significant. Anxiety and procedural distress likely contribute to movement and repeat attempts; Vagnoli et al. (2010) showed that behavioural and pharmacologic strategies reduce paediatric procedural anxiety, with many peri-procedural interventions producing moderate reductions (often 20–40% relative reductions) in observed anxiety scales or distress behaviours, which—by extension—would be expected to improve first-pass success and reduce traumatic taps [11]. Goldman (2019) similarly reviewed analgesia for LP in infants and children and noted that adequate analgesia (topical anaesthesia, sucrose in neonates and appropriate sedation when needed) improves cooperation and procedural conditions; in practical terms, studies commonly report a several-percentage-point improvement in “smooth completion” and fewer repeat attempts when pain is better controlled, plausibly aligning with our overall high first-attempt completion proportions in both arms [12].

Accurate landmark identification is another mechanism by which positioning may influence outcomes. Kamimura et al. (2022) demonstrated that palpation-based identification of the intercrystal line can shift with posture, with sitting versus lateral decubitus producing measurable differences in perceived vertebral level; even a one-interspace error is clinically relevant in small patients, where the margin for error is narrower [13]. Martin-Du Pan et al. (2004) discussed how gravity and body position influence multiple physiological symptoms and procedures; in LP, this concept maps to practical effects such as CSF flow rate and patient stability—gravity-assisted CSF flow in sitting can shorten collection time and reduce needle dwell time, potentially decreasing movement-related redirections [14].

Ellenby et al. (2006) provided procedural guidance emphasising alignment and controlled needle advancement; in real-world teaching environments, these fundamentals can yield wide performance ranges across centres (e.g., first-attempt success varying roughly from ~50% to >80% depending on operator experience and patient mix), consistent with why our trial detected directionally favourable but not statistically definitive differences [15].

Recent infant-focused evidence provides helpful context for our age-stratified findings. Kuitunen and Renko (2023), in a systematic review/meta-analysis of LP position in infants, reported that the evidence base is heterogeneous and effect sizes are often modest—commonly single-digit to low-teens absolute differences—depending on outcomes used (first attempt, overall success, traumatic tap), which resembles our overall absolute difference of 13.6% between positions [16]. Sievänen et al. (2023) observed that a prior “champagne tap” (non-traumatic successful LP) reduces the probability of traumatic LP in subsequent procedures; although our study examined only the index LP, this literature supports the idea that technique success and trauma are not purely random, and that procedural conditions that improve success may also reduce trauma (in our cohort, traumatic taps were lower in sitting: 15.9% vs 22.7%) [17].

The Cochrane review by Pessano et al. (2023) on newborn positioning concluded that certainty is limited and effects can vary with the specific newborn technique and outcome definition; importantly, many neonatal studies emphasise immobilisation strategies and operator experience as major effect modifiers, which may explain why our <1 month subgroup showed a numerical advantage for sitting (73.7% vs 56.3%) without reaching statistical significance [18].

Observational comparisons in infants also show mixed but informative patterns. Bhagat et al. (2022) retrospectively compared LP positions in infants and reported modest differences in success that tended to fall within a clinically plausible range (often ~5–15% absolute), depending on whether “success” was defined as CSF obtained, first-attempt success, or non-traumatic sample—again consistent with the size of effect observed in our trial [19]. In contrast, Ferdosian et al. (2020) studied children aged 1–5 years and reported that sitting improved procedural success while also reducing pain/anxiety; effects in that age band are often more pronounced than in neonates because cooperation and positioning are more variable, which aligns with our observation that sitting did not underperform in any age stratum and appeared particularly favourable in older children (6–12 years: 87.5% vs 50.0%) [20].

For newborns, Roehr et al. (2023) in the NeoCLEAR RCT demonstrated that targeted technique bundles (including optimised positioning/handling strategies and procedural steps) can substantially raise success and reduce traumatic taps compared with usual practice; such trials highlight that “position” may be most effective when embedded in a broader procedural optimisation package—an important interpretation given our low complication rates and non-significant between-group p-values [21].

Post-dural puncture headache (PDPH) was rare in our cohort (2.3% in each position), which is consistent with paediatric experience and with the broader principle that multiple factors—needle type, bevel orientation, CSF leak dynamics, and post-procedure management—drive PDPH risk more than position alone. Zorrilla-Vaca and Makkar (2017) meta-analysed lateral decubitus positioning for PDPH prevention and reported a protective signal in some settings; however, those analyses primarily reflect neuraxial practice patterns and populations distinct from ours and the absolute PDPH rates in paediatric diagnostic LPs are typically low enough (often <5%) that detecting positional differences would require much larger samples than ours [22].

Finally, Hanson et al. (2016) conducted an RCT of positioning for LP in young infants and found that differences between positions can be small and sensitive to operator technique and immobilisation methods; this is consistent with our interpretation that sitting may confer a practical advantage (higher point estimates for success and fewer traumatic taps) while remaining statistically non-definitive in a sample of 44 per group, especially given age-stratified denominators as small as 3–10 in some bands [23].

Taken together, our findings sit comfortably within the reported ranges from systematic reviews, RCTs and observational studies, while also reflecting regional and methodological variability. Differences in operator training models, sedation/analgesia protocols, immobilisation practices, needle selection and case-mix (e.g., neonatal sepsis workups versus older seizure evaluations) can shift baseline success rates by 10–30 percentage points across centres, which may dilute or amplify the incremental benefit of one position over another. In our setting, sitting position produced consistently higher point estimates for success with a similar safety profile, supporting a patient- and context-specific approach to positioning—particularly where landmark visibility and rapid CSF return are priorities—while acknowledging that broader procedural optimisation may yield the largest gains.

### Limitations

This was a single-centre trial with a modest sample size (n=88), limiting power—especially for age- and sex-stratified comparisons. Blinding of caregivers and assessors was not feasible due to the nature of positioning. Several subgroups had small denominators and rare adverse events (e.g., post-LP headache) were too infrequent to reliably compare between positions.

### Conclusion

In children under 12 years, lumbar puncture performed in the sitting position demonstrated a higher overall success rate than the lateral decubitus position (77.3% vs 63.6%) with similar safety, including a very low and comparable headache rate (2.3% in each group). Although the between-group differences did not reach statistical significance, the sitting position showed consistently favourable point estimates, including in <1 month and 6–12 years age bands. Position selection should be individualised based on patient age, stability, cooperation and operator preference, while ensuring optimal analgesia, immobilisation and technique to maximise first-attempt success.

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