Positioning of infants in the neonatal intensive care unit for lumbar puncture as determined by bedside ultrasonography

Selim Öncel, Ayla Günlemez, Yonca Anık, Müge Alvur

ABSTRACT
Realising the paucity of data in the standardisation of the optimal position for lumbar puncture (LP) in hospitalised neonates, we have designed an observational study to measure the interspinous distance in infants in a hospital setting. The infants were placed in two lateral recumbent and two upright positions (lateral recumbent without flexing the hips, lateral recumbent with maximal hip flexion, sitting without flexing the hips and sitting with maximal hip flexion) with concomitant heart rate (HR), transcutaneous oxygen saturation (OS) and interspinous distance (with ultrasonography) measurements. Having the patient sit with maximal hip flexion provided the largest interspinous space for the grand majority of the infants. Sitting positions with/without flexion have resulted in significant increases in HR with respect to lateral recumbent position without flexion. Although statistically significant drops in OSs have been observed between lateral recumbent and sitting with flexion, lateral recumbent with flexion and sitting without flexion, and lateral recumbent with flexion and sitting with flexion positions; no adverse hypoxic events occurred during positioning. Sitting flexed position, which seems to be sufficiently safe and serve to enhance the success rate of a LP, should be favoured for sick neonates whenever the infant’s condition permit a spinal tap.

BACKGROUND
Performing a lumbar puncture (LP) for diagnosing or ruling out meningitis in neonates is a standard of care despite the ongoing debate on whether LP is required in every workup for suspected sepsis.1–3 The clinician seeks ways to avoid a traumatic tap and to get sufficient amount of cerebrospinal fluid, which should be feasible in a still infant with the widest interspinous space (the space between the spinous processes of two adjacent vertebrae) possible.

The positioning of the infant undergoing LP, which include lateral recumbent or sitting positions with the neck or hip flexed or neutral, has not been standardised and is at the physician’s disposal. In adults, studies have been conducted and uniformly showed that the maximal interspinous distance can be obtained with maximal hip flexion.4,5 Most neonatologists prefer placing the infant in lateral recumbent position with the knees drawn up to the chest.6

Although there are studies looking at either positioning of hospitalised neonates without ultrasound or positioning and ultrasound in the emergency department, to our knowledge and as evidenced by a Pubmed search with keywords ‘LP’ and ‘ultrasound’, there are no studies assessing the optimum LP position for hospitalised neonates.7–9 Safety, as well as the ease of the LP is a very important issue in this age group, especially considering the vulnerability of infants hospitalised in neonatal intensive care units.

Realising the paucity of data in this common field of pediatric infectious diseases and neonatology, we have designed a study to measure the interspinous distance in infants in various positions with concomitant heart rate (HR) and transcutaneous oxygen saturation (OS) measurements.7

PATIENTS AND METHODS
This prospective and observational study of convenience sample of sick neonates was carried out in the Neonatal Intensive Care Unit of the Kocaeli University Research and Practice Hospital from November 2010 to February 2011. A patient in the neonatal intensive care unit was enrolled if her/his clinical condition does not pose a risk for the positioning manoeuvres described below and if she/he did not undergo any spinal taps previously. After obtaining of parental consent, transcutaneous baseline OS

What is already known on this topic

- In adults, the position providing the significantly greatest interspinous space for lumbar puncture (LP) was obtained with the so-called ‘sitting, feet supported’ position.
- Recumbent position with maximal hip flexion provides wider interspinous spaces compared with recumbent without flexing the hips.

What this study adds

- Sitting position with the legs flexed is sufficiently safe for LP of sick newborns.
- Since sitting position with the legs flexed provides the widest interspinous spaces, it will serve to enhance the success rate of LPs in neonates.
and HR were measured. The infants were enrolled and held in two lateral recumbent and two upright positions by a neonatologist (AG). The lateral recumbent positions were (1) lateral recumbent without flexing the hips, in which the infant lies on her left side with hips and knees in neutral position and (2) lateral recumbent with maximal hip flexion, in which the infant lies on her left side with hips and knees flexed till the point of resistance. The upright positions were (1) sitting without flexing the hips, in which the infant sits with knees in neutral position and (2) sitting with maximal hip flexion, in which the infant sits with hips and knees flexed till the point of resistance (figure 1). Measurements of OS, HR and interspinous distances were made at these four positions. Care was taken to avoid neck flexion as this manoeuver is known to be associated with a significant decrease in OS and a higher risk for potential morbidity.9

Measurements were made digitally in the four positions by a paediatric radiologist (YA) on the digital still images on-screen obtained via a Toshiba Diagnostic Ultrasound System Model SSA-660A ultrasound device with a high-frequency (10 MHz) linear transducer, that was placed on the spine in the sagittal plane at the level of an imaginary line between right and left posterior superior iliac crests, which corresponds to L3-L4 and L4-L5 interspaces and has been reported as the appropriate sites for LP in all ages.10 The interspinous space was ensured to be the same place in all four positions by putting a mark with a pen on that imaginary line and not lifting the probe between the positions. The distance between the points of maximal curvature of the two adjacent spinous processes was measured as the interspinous (interspace) distance, since these points are the landmarks palpated by the physician performing the LP (figure 2). Simultaneous HR and OS readings were recorded with each of the four positions.

Statistical analysis
Data were analysed with SPSS software (licensed under GPLv3). Descriptive figures were given as median/mean (SD or (minimum–maximum)). The differences between positions were examined using a paired t test. p Values less than 0.05 were considered statistically significant.

The study was approved by the Research Evaluation Committee of the Kocaeli University Faculty of Medicine (approval no.: 2010/24).

RESULTS
Fifty-one infants (22 girls and 29 boys) with postnatal ages 1–83 days were enrolled in the study. The median/mean (minimum–maximum) postnatal and corrected ages of the patients were 10/17.82 (1–83) and 35.70/36.47 (31.43–45.90), respectively. Eleven (21.6%) patients' postnatal ages were beyond the neonatal period (>28 days). The birth weights of 4 infants were measured. The infants were enrolled and held in two lateral recumbent and two upright positions by a neonatologist (AG). The lateral recumbent positions were (1) lateral recumbent without flexing the hips, in which the infant lies on her left side with hips and knees in neutral position and (2) lateral recumbent with maximal hip flexion, in which the infant lies on her left side with hips and knees flexed till the point of resistance. The upright positions were (1) sitting without flexing the hips, in which the infant sits with knees in neutral position and (2) sitting with maximal hip flexion, in which the infant sits with hips and knees flexed till the point of resistance (figure 1). Measurements of OS, HR and interspinous distances were made at these four positions. Care was taken to avoid neck flexion as this manoeuver is known to be associated with a significant decrease in OS and a higher risk for potential morbidity.9

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<table>
<thead>
<tr>
<th>Position</th>
<th>Distance (mm)</th>
<th>Heart rate (per minute)</th>
<th>Oxygen saturation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Minimum–maximum</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Lateral recumbent without flexing the hips</td>
<td>3.18 (0.57)</td>
<td>2.2–4.4</td>
<td>95 (3)</td>
</tr>
<tr>
<td>Lateral recumbent with maximal hip flexion</td>
<td>3.45 (0.64)</td>
<td>2.4–5.6</td>
<td>95 (3)</td>
</tr>
<tr>
<td>Sitting without flexing the hips</td>
<td>3.86 (0.72)</td>
<td>2.8–5.9</td>
<td>94 (4)</td>
</tr>
<tr>
<td>Sitting with maximal hip flexion</td>
<td>4.08 (0.75)</td>
<td>3.0–6.3</td>
<td>94 (4)</td>
</tr>
</tbody>
</table>

Means and SDs of HR and OS were rounded off to the nearest whole number.

Table 1  The means of interspinous distances with simultaneous heart rate and oxygen saturation readings according to the four infant positions

![Figure 1](A) lateral recumbent without flexing the hips, (B) lateral recumbent with maximal hip flexion, (C) sitting without flexing the hips lower right, (D) sitting with maximal hip flexion positions.

![Figure 2](Interspinous (interspace) distance.)
that although PO2 decreased and the HR increased with each position for LP, the decrease was significantly greater in the recumbent position with maximal hip flexion.2 Cadigan et al, in their study assessing the recumbent without flexing the hips and recumbent with maximal hip flexion positions in healthy newborns in their well-child visits, also found that the latter position provided wider interspinous spaces.5

HR and OS differed significantly with positioning of the infants in our study; however, this did not result in any apparent changes in clinical status.

Although there are few infants weighing less than 1500 g in our study population, our results show that sitting flexed position is a safe alternative to traditional flexed recumbent position.

The limitations of our study may include small sample size, convenience sample, patients’ exclusion if they had spinal taps or were too ill for positioning, absence of performed LPs, paucity of low (1000–1500 g) and very low weight (<1000 g) infants in the study population, which prevented us from making satisfactory statistical comparisons, observers’ unblindness to patient position during the procedure, and measurement of spinous processes from the point of maximal curvature although the interspinous space is truly the space between adjacent vertebrae.

CONCLUSIONS

Sitting flexed position, which seems to be sufficiently safe and serve to enhance the success rate of a LP, should be favoured for sick neonates whenever the infant’s condition permit a spinal tap. Studies enrolling infants necessitating an LP in real-life conditions, especially those with low and very low weights will further enlighten the field and confirm our conclusions.

Contributors Selim Öncel designed, co-operated during the study process and wrote the manuscript. Ayla Günlemez contributed to the study design and to the manuscript. She also enrolled and positioned the infants during imaging and wrote the manuscript. Ayla Günlemez contributed to the study design and to the manuscript. She also enrolled and positioned the infants during imaging with ultrasound. Yonca Anık made the imaging (ultrasound) assessments and contributed to the Methods section of the manuscript. Müge Alvur made the statistical calculations and analysis. She also made contributions concerning the integrity of the manuscript.
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