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Comparison of success rates in performing lumbar puncture and reduction of its anxiety and pain between standard sitting and lateral decubitus positions in 1 to 5-year-old children

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Abstract

Background: Lumbar puncture (LP) is a worth procedure in diagnosis of oncological diseases and intrathecal administration of antineoplastic drugs. The effort should be to minimize pain of LP in children with cancers. This clinical trial was done to compare success rates in performing LP and reducing anxiety and pain of LP in sitting and lateral decubitus positions in 1 to 5-year-old children.

Materilas and Methods: In a not-blinded clinical trial, 80 children aged 1-5 years, undergoing LP in Pediatric Ward of Shahid Sadoughi Hospital, Yazd, Iran, from May to September 2019, were randomly allocated to two groups. Intravenous 0.5mg/kg midazolam was injected in all patients five minutes before LP, and LP was performed in sitting position in group I and in lateral decubitus position in group II. Primary outcomes included rate of successful LP, anxiety and pain scores before LP and during needle insertion to skin for LP, and secondary outcomes comprised of success rates in decrease of anxiety (anxiety score of four and more) and pain (pain score of less than three) when the needle was inserted to skin for LP.

Results: Thirty-eight girls and 42 boys with the mean age of 2.51 ± 0.32 years were evaluated. Success rates in performing LP (70 % in sitting vs. 65% in decubitus position, P=0.5), decrease of LP anxiety (77 % in sitting vs. 75% in decubitus groups, P=0.8) and reduction of pain during skin needle insertion for LP (72 % in sitting vs. 67% in decubitus position, P=0.7) were not significantly different between the two positions.

Conclusion: Rates of success in performing LP and reduction of its pain and anxiety in children were equal in lateral decubitus and sitting posi¬tions and, in 1 to 5-year-old sick children with or without cardiorespiratory difficulties, LP can be done in lateral decubitus or sitting position.

Keywords: Spinal Tap, Position, Child, Sitting, Decubitus

Introduction

Lumbar puncture (LP) and examination of cerebrospinal fluid (CSF) is a worth procedure in diagnosis of hematological-oncological diseases, such as central nervous leukemia or lymphoma, brain tumors, and intracranial neo¬plasms. Sometimes, it is used to instill intrathecal administration of antineoplastic drugs or antimicrobial agents. In addition, it can help in detection of meningitis, encephalitis, inflammatory disease, such as transverse myelitis, demyelinat¬ing-degenerative disorders, collagen vascular diseases, metabolic disorders, hemorrhage in the area around the brain or spinal cord, and measurement of intracranial pressure to roll out idiopathic intracra¬nial hypertension. To have successful LP, an expert assistant should position the patient in a comfortable situation, with straightness of the patient's shoul¬ders without spine rotating. LP can be done in lateral decubitus or sitting posi¬tion. For prevention of cardiorespiratory problems in ill newborns, it should be done in sitting position lumbar puncture (1, 2). In children and infants, sedative usage and pain control managements before lumbar puncture decrease incidence of traumatic spinal tap (3) and intravenous midazolam as a safe, short-acting, potent and hypnotic

drug with rapid action onset at a dosage of 0.5 mg/kg, was an effective anxiolytic in 90% of children. (4) Intravenous midazolam in dosage of 0.5mg/kg was effective in sedation induction before LP in Iranian 6 to 24-month-old children (5).

The effort should be to minimize discomfort and pain of LP in children with cancers and also to increase rate of successful and painless LP. Majority of lumbar puncture in children are performed in lateral decubitus posi¬tion. Flexion or extension of knees in this position does not result in a clinically significant change in CSF opening pressure (6). In two studies on infants of less than 12 months, success rate of performing non-traumatic LP was not significantly different in sitting and lateral positions (7, 8). However, rate of taking CSF on the first attempt was higher in sitting flexed position (7).

A study in China showed that when LP was performed in lateral recumbent position, successful LP was more frequent as right-handed physicians were performing LP and patients were in the left lateral recumbent position, and vice versa (9).

A study in USA showed that in less than four months infants, subarachnoid space width at the site of LP was not significantly different in flat lateral decubitus, 45-degree tilt lateral decubitus, and sitting positions (10).

In a study in Turkey on 25 to 85-year-old patients, successful LP in lateral decubitus, knee-chest position with a 45-degree head-up tilt was significantly more frequent than in lateral decubitus, knee-chest position, or sitting position (11).

In a Spanish study, needle-induced paresthesiae during spinal anesthesia in lateral decubitus position was more frequent than that in sitting position (12).

Sitting position may be better tolerated by the patient and children experience less respiratory problems. However, lateral position is further chosen by physicians (13). Since no comprehensive study in evaluation of effect of positioning in success rate of lumbar puncture in infants and children has been carried out in Iran yet, this clinical trial was done to compare success rates in performing LP, reducing anxiety and pain during skin needle insertion for LP in standard sitting flexed and lateral decubitus positions in 1 to 5-year-old children.

Materials and Methods

In this randomized, not-blinded, parallel-group clinical trial, all the consecutive 1 to 5 year-old children who were admitted to the Pediatric Ward of Shahid Sadoughi Hospital, Yazd, Iran from May to September 2019 and LP was to be done in them based on the clinical judgment of pediatricians, enrolled in the study.

Based on Z formula and with a confidence interval of 95%, power of 80%, type one error of 5%, success rate in performing LP of 70% for sitting position in our pilot study and an effect size (difference in success rate between the two groups) of 20% for this primary outcome, the sample size was calculated to be 40 children in each group.

The inclusion criteria included children aged 1-5 years, with the American Society of Anesthesiologists (ASA) physical status I-II, undergoing lumbar puncture based on the clinical judgment of a pediatrician and not having received sedative hypnotic or systemic analgesic drugs (acetaminophen or ibuprofen) within the past 48 hours.

The exclusion criteria consisted of having neurodevelopmental delay or mental retardation, loss of consciousness (Glasgow Coma Scale of less than 12), and symptoms of increased intracranial pressure.

The developmental status of the children was assessed using the Denver II Developmental Screening Test. We used computer-generated equal simple randomization by random numbers, and the allocation ratio was 1:1 for the two groups.

Since the position of LP was different and the pediatric resident of research who

assessed the primary and secondary outcomes and gathered the data, and the pediatric resident of research who did LP, were seeing the position of patients; blinding of the participating mothers, pediatric resident, data collector and outcome assessor was not possible, and only the data analysts were kept blinded to the allocation. However, concealment was performed by placing the group number for each serially participating child in a numbered and sealed opaque envelope which was opened by the pediatrician immediately before LP, Randomization and concealment were done by a researcher with no clinical involvement in the trial.

In both groups, 0.5 mg/kg midazolam was injected intravenously five minutes before LP and the children were randomly assigned to two groups. In group I, LP was performed in standard lateral decubitus position, and in group II, lumbar puncture was performed in standard sitting position. The midazolam used in the research was 5 mg/ml vial from Aburaihan Co. Tehran, Iran, and in all the children, midazolam was injected under similar conditions, by similar needles and by a trained pediatric ward nurse. All lumbar punctures were performed by an expert right-handed pediatric resident, and during lumbar puncture, the resident who performed LP was behind the child.

Primary and secondary outcomes were evaluated by the pediatric resident of research. The primary outcomes included rate of successful LP, baseline anxiety and pain scores before skin needle insertion and anxiety and pain scores while the needle was being inserted in to the skin for LP. A successful and non- traumatic LP was considered as the free flow of CSF was observed upon the first attempt and sufficient amount of nonbloody CSF was collected.

The secondary outcomes included success rate in reducing anxiety during skin needle insertion (anxiety score of four and more) and success rate in reducing pain when the needle was inserted to the skin for LP (pain score of less than three).

Anxiety score was evaluated by anxiety score scale (5), and pain score was assessed based on the modified Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) (14).

An anxiety score of four or more during needle insertion for LP was considered as success in reducing anxiety and obtaining a pain score of less than three, based on the CHEOPS during needle insertion, was considered as success in pain reduction.

Data were analyzed using SPSS (version 19). The recorded data were assessed for normal distribution using the Kolmogorov-Smirnov test, and Chi-square test was used for the analysis of categorical variables. In addition, continuous variables and means were compared between the two groups using independent t-test. Differences were considered significant at P-value of less than 0.05.

Informed consent was obtained from parents of the children before enrollment and the study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran. This research was registered at Iranian Registry of Clinical Trials under registration number: IRCT20091027002639N22.

Results

The design and conduct of this trial was straightforward, and we did not have any losses or exclusions from the analysis and 38 girls and 42 boys with the mean age of 2.51 ± 0.32 years were evaluated in two groups. Based on the Kolmogorov-Smirnov test, the data had normal distribution.

Comparison of some characteristics of the children in the two groups is shown in Table.I, which indicates that no significant differences were seen in terms of gender distribution, mean age, mean anxiety and pain scores before LP, and mean anxiety and pain scores during LP.

Table II shows comparison of success rates in performing LP as well as reducing

anxiety (obtaining an anxiety score of four and more) and pain (pain score of less than three) during skin needle insertion for LP in the two groups which indicates that successful LP was performed in 65% in lateral decubitus position and in 70% in sitting position and all of success rates were not significantly different between the two positions.

Table.I: Comparison of some characteristics of children in the two groups

Data	Groups	Sitting position	Lateral decubitus position	P. Value
Sex	Girl	17	21	**0.8**
	Boy	23	19	
Age in year (mean ±SD)		2.78 ± 0.78	2.49 ± 0.89	**0.8**
Anxiety score before lumbar puncture (mean ±SD)		1.15 ± 0.51	1.64 ± 0.21	**0.4**
Pain score before lumbar puncture (mean ±SD)		1.01 ± 0.12	1.21 ± 0.05	**0.7**
Anxiety score during lumbar puncture (mean ±SD		3.2 ± 1.09	3.64 ± 09	**0.7**
Pain score during lumbar puncture (mean ±SD)		**3.55 ± 0.98**	**3.58 ± 1.03**	**0.8**

Table.II. Comparison of success rates in performing spinal tap, anxiety reduction and decrease of pain during needle insertion for lumbar puncture in both groups

Data	Groups	Sitting position	Lateral decubitus position	P. Value
Successful and non- traumatic lumbar puncture	Yes	28	26	**0.5**
	No	12	14	
Success in anxiety reduction	Yes	31	30	**0.8**
	No	9	10	
Success in pain reduction	Yes	29	27	**0.7**
	No	**11**	**13**	

Discussion

LP of children can be performed in a lateral decubitus or seated position. However, in sick newborns, it should be done in a sitting position (13). On the other hand, majority of LP of children are performed in lateral decubitus position (15).

A research on less than four months old infants showed that subarachnoid space width did not change in different positions and some other factors could increase rate of successful LP in flat lateral decubitus, 45-degree tilt lateral decubitus, or sitting positions (10).

A meta-analysis on more than 18-year-old adults (16) and a study in Tehran, Iran, showed that incidence of post-dural puncture headache was lower in lateral decubitus than in sitting position (17).

Based on the results of this randomized clinical trial on 1 to 5-year old children, rate of successful LP was not significantly different in lateral decubitus or sitting flexed position. Moreover, in Hanson et al.'s studies, success rate in obtaining of CSF for cell count, culture and non-traumatic lumbar puncture in sitting flexed position or lateral flexed position was not significantly different in infants of less than 12 months (7, 8).

In the present study, 35% of children in lateral decubitus position and 30% in sitting position had traumatic LP. However, In Glatstein et al.'s study, traumatic LP occurred in 12.5% of children in lateral decubitus position and

in 26.2% in sitting position (3). In Boston, USA study, 35% of children LP was unsuccessful on the first attempt. However, the effect of child position was not evaluated, but most important risk factors of traumatic LP in their study were less physician experience, no use of local anesthetic agent, and advancement of the spinal needle with stylet in place versus stylet removed and increased child movement (18). In Izmir, the effect of four positions (lateral recumbent without flexing the hips, lateral recumbent with maximal hip flexion, sitting without flexing the hips, and sitting with maximal hip flexion) on LP of sick neonates was evaluated. No adverse hypoxic effects occurred during these four positions, and they concluded that the best and the safest position for LP of ill newborn was sitting flexed position (19). In Konya, the success rate of LP in children of less than 12 months, who underwent spinal anesthesia, in lateral decubitus, knee-chest position with 45-degree head up tilt was more than in standard lateral decubitus, knee-chest position (20).

In the present study, mean of pain score during LP was not significantly different in both positions, and LP was tolerable in 1-5 -year-old children. In a study in New York, USA, the mean of pain score of LP in 47 healthy adult volunteers who underwent research LP was 1.5 ± 1.3 and they well tolerated lumbar puncture (21).

In a study on adults in Birmingham, UK, the mean of pain score based on Verbal Rating Score was seven and during LP, 40% of patients experienced severe pain (score 8 or more) and 47% of them were extremely anxious (22).

Conclusion

Based on the results of this randomized clinical trial, rates of success in performing LP and reduction of its pain and anxiety in children were equal in lateral decubitus or sitting posi¬tion and in 1 to 5-year old sick children who have cardiorespiratory problems, LP can be done in lateral decubitus or in sitting posi¬tion.

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Conflict of interest

Authors declared no conflict of interest.

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