

# Modified 45-degree head-up tilt increases success rate of lumbar puncture in patients undergoing spinal anesthesia

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## Abstract

**Purpose** Lumbar puncture (LP) is one of the most common procedures performed in medicine. The aim of this prospective study is to determine the success rate of LP in lateral decubitus with 45-degree head-up tilt position, and compare it with traditional positions like sitting and lateral decubitus.

**Methods** Three hundred and thirty patients between 25 and 85 years of age who had undergone abdominal, urologic, and lower limb extremities surgeries were enrolled and 300 patients were divided into three different groups. The LP was performed with a 25-G atraumatic needle, either in the standard sitting position (group S,  $n = 100$ ), lateral decubitus, knee-chest position (group L,  $n = 100$ ) or lateral decubitus, knee-chest position with a 45-degree head-up tilt (group M,  $n = 100$ ). The free flow of clear cerebrospinal fluid (CSF) upon first attempt was considered to be evidence of a successful LP.

**Results** Total LP success rate was significantly higher in group M (85 %) than in groups S and L (70 and 65 %, respectively) ( $p = 0.004$ ). When the significance between the groups was evaluated according to age, the increase in the LP success rate was not significant for  $\leq 65$  and  $> 65$

age groups. There were no differences among the three groups in terms of bloody CSF ( $p = 0.229$ ) and the number of attempts before dural puncture ( $p = 0.052$ ).

**Conclusions** The lateral decubitus in knee-chest position with a 45-degree head-up tilt may be the preferred position for spinal anesthesia in young and elderly patients, due to the high success rate.

**Keywords** Lumbar puncture · Spinal anesthesia · Technique · Patient position

## Introduction

Lumbar punctures (LP) are generally performed for spinal anesthesia, and also to diagnose neurological diseases with cerebrospinal fluid (CSF) examination. The sitting and lateral decubitus positions are commonly used for LP [1, 2]. Although neither of these positions is superior to the other, proper positioning is essential for a successful lumbar puncture. In the sitting position, a patient is positioned with the neck and back fully flexed. Flexion facilitates the course of the needle by widening the gap between adjacent lumbar spinous processes [3]. However, the sitting position can be difficult for several reasons. For instance, the patient may not understand the physician's instructions or cannot sit due to the patient's posture [4]. In such a situation, the lateral decubitus position may be useful. In order to make the lateral decubitus position more useful and advantageous, we can incline the table to a 45-degree head-up tilt while a patient is in the lateral decubitus position. Apiliogullari et al. [1] reported that the success rate of LP was significantly higher in a 45-degree head-up tilt lateral position compared to a horizontal lateral position in children, especially  $< 12$  months of age. By doing so, it is

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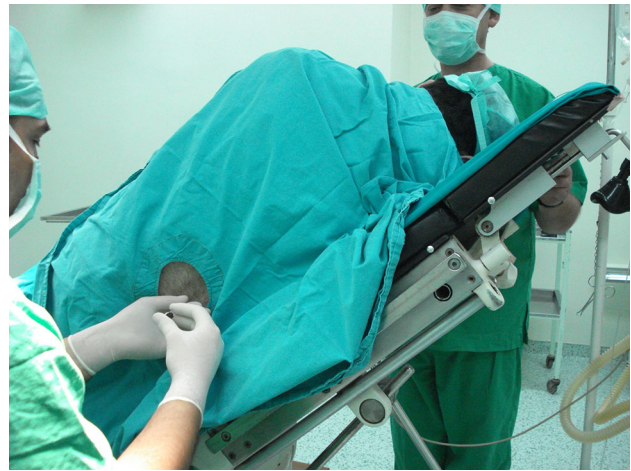
assumed that this position may increase the CSF pressure and, therefore, it may widen the subarachnoid space, similar to the sitting position [1]. The bony landmarks are more prominent and the CSF hydrostatic pressure increases, thus allowing faster detection of CSF [3]. Only one of these studies evaluated the effects of the modified sitting position technique on successful LP in small groups of adults [5]. In elderly patients, the intervertebral spaces are not well-defined, because it is often calcified [3]. This condition may not allow the application of LP. The aim of our study was to examine our hypothesis that lateral decubitus with a 45-degree head-up tilt will have higher success rate of LP compared to lateral decubitus or sitting in patients for ages  $\leq 65$  and  $>65$  groups undergoing spinal anesthesia.

### Patients and methods

This single-center, prospective, randomized study was conducted on patients who sought evaluation at the Trakya University Medical Faculty, between June 2009 and 2010. The local ethics committee approved the study. All the patients were informed about the study, and written consent was obtained. The study was conducted on 330 adult patients, with American Society of Anesthesiologists (ASA) physical status I–III, 25–85 years old, who were scheduled for elective urologic, lower abdominal, and lower limb extremities surgeries under spinal anesthesia. Patients were excluded from the study only if they met one of the following conditions: spinal anesthesia was contraindicated, they were pregnant, spinal anatomy was deformed (assessed subjectively by inspection and examination), osteoarthritis, ankylosing spondylitis, kyphoscoliosis, previous spinal surgery, and degenerative disc disease.

For premedication, intramuscular midazolam 0.07 mg/kg was administered 45 min before the surgical procedure. Upon arrival at the anesthetic room, 500 ml lactated Ringer's solution was infused in 20 min. The monitored parameters included three-lead electrocardiogram, heart rate (beats per minute, HR), noninvasive blood pressure (mmHg, NIBP), and pulse oximetry ( $\text{SpO}_2$ , as %) (Cato PM 8040R; Dräger, Lübeck, Germany). The patients were randomly assigned to one of three groups using a computer-generated random number assignment: the standard sitting position (group S), the lateral decubitus (group L), or the lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position (group M) (Fig. 1). A goniometer was used to measure the tilt angle of the table from the horizontal plane.

The most readily palpable interspace, L3 to L5 vertebra, was chosen for the LP. The lumbar puncture was performed by anesthesiologists with at least 3 years (more



**Fig. 1** The lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position. A goniometer was used to measure the tilt angle of the table from the horizontal plane

than 100 spinals) of work experience, with a midline approach, using a 25-G atraumatic needle (Spinocan, B. Braun Melsungen AG, Melsungen, Germany). Three milliliters of isobaric levobupivacaine (0.5 %) (Chirocaine, Abbott Scandinavia AB, Solna, Sweden) was intrathecally injected into the patients after local infiltration with 2 ml of 2 % lidocaine.

The correct placement of the needle was verified by a free flow of clear CSF. The success of LP was defined as a dural puncture achieved on the first attempt with free flow of clear CSF without redirection of the needle. Unsuccessful lumbar punctures were defined as: (1) the free flow of clear CSF was observed when the needle was withdrawn and redirected, or repeated attempts for the 2nd, 3rd, 4th and 5th times, (2) free CSF flow was not observed, (3) CSF was manifested with blood that did not become clear.

The patients were immediately turned into a supine position after spinal injection. Sensory and motor blocks were assessed with the pinprick test (1 = hypoalgesia, 2 = analgesia, 3 = analgesia plus hypoaesthesia, 4 = anesthesia), and a modified Bromage Scale (0 = no motor block; 1 = ability to move knees only, inability to raise extended legs; 2 = inability to flex knees; 3 = full motor block), respectively. When the sensory block reached the T10 level, the surgical procedure was initiated. The patients intraoperatively received 10 ml/kg/h of a lactated Ringer's solution. A maximum limit of five needle passes were accepted, otherwise general anesthesia was induced.

Before attempting the spinal anesthesia, the anesthesiologist recorded the following patient data: sex, age, height, weight, ASA physical status, and anatomical landmarks (good = easily palpable dorsal spinous processes, poor = difficult to palpate spinous processes,

none = unable to positively identify spinous processes) [6].

### Statistical analysis

We based success rate in LP in order to sample size calculation. The sample size calculation for this study was based on the success rate of lumbar puncture in Apilio-gullari et al. [1] The difference between success rate in LP = 16 % (74 vs 90 %), with an alpha error = 0.05, and with a power = 80 %, 90 patients would be required for each group. But we examined 100 patients in each group to the probably missing values.

Results are expressed as mean  $\pm$  standard deviation or number (percentage). Normal distribution of variables was tested using a one-sample Kolmogorov–Smirnov test. Differences in age, height, and weight among groups were compared using a one-way ANOVA test. Categorical variables were compared using a chi-square test. A *p* value <0.05 was considered to be statistically significant. Statistica 7.0 (StatSoft Inc., Tulsa, OK, USA) statistical software was used for statistical analyses.

### Results

Of the 330 patients included and randomized in this study, 30 patients were excluded from analysis because an anesthesiologist who was not involved in the study gave spinal anesthesia to the recruited patients. Therefore, 300 patients were analyzed according to protocol. There were no significant differences in sex, age, height, weight or ASA physical status between groups (Table 1).

The LP success rates of the three study groups are shown in Table 2. The total LP success rate in group M was significantly higher than in groups S and L (*p* = 0.004). However, there were no significant differences between the groups S and L (*p* = 0.546). There was no significant difference between  $\leq 65$  age and  $>65$  age groups in the demographic data and the number of patients among the groups. When the significance between the groups was evaluated according to age, the increase in the LP success rate was not significant between the  $\leq 65$  and  $>65$  age groups (*p* = 0.536; Table 2). The number of attempts before dural puncture in patients whose initial attempt failed were not significantly different among the groups (*p* = 0.052; Table 2). In addition, there were no significant differences among the groups in terms of bloody CSF (group S = 4, group L = 8, group M = 3; *p* = 0.229).

None of the patients required supplementary analgesia. All of the operations conducted on patients under spinal anesthesia were successful. The complaints of patients connected to the spinal anesthesia such as vomiting (group S = 2, group

**Table 1** Patient characteristics

	Group S ( <i>n</i> = 100)	Group L ( <i>n</i> = 100)	Group M ( <i>n</i> = 100)	<i>P</i>
Age (years)	56.7 $\pm$ 18.7	56.8 $\pm$ 18.3	56.4 $\pm$ 18.7	0.982
Sex (M/F)	54/46	53/47	56/44	0.910
Height (cm)	170.9 $\pm$ 8.0	171.2 $\pm$ 7.7	171.6 $\pm$ 8.7	0.853
Weight (kg)	71.1 $\pm$ 12.5	70.5 $\pm$ 12.2	69.6 $\pm$ 12.3	0.704
ASA I/II/III	35/47/18	30/50/20	29/49/22	0.885
Landmarks				
Good	60	65	63	0.965
Poor	18	15	16	
None	22	20	21	

Values are numbers or mean  $\pm$  SD

No significant differences were noted between the groups

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**Table 2** Success rates of the groups and number of attempts for lumbar puncture

	Group S ( <i>n</i> = 100)	Group L ( <i>n</i> = 100)	Group M ( <i>n</i> = 100)	<i>P</i>
Success rate <i>n</i> (%)	70*	65*	85	0.004
$\leq 65$ years	43 (61.4 %)	45 (69.2 %)	52 (61.2 %)	
$>65$ years	27 (38.6 %)	20 (30.8 %)	33 (38.8 %)	
Number of attempts for lumbar puncture. (Unsuccessful lumbar puncture)				
2 attempts	15	10	9	
3 attempts	6	8	2	
4 attempts	6	9	2	0.052
5 attempts	2	3	1	
6 $\geq$ attempts	1	5	1	

Values are numbers

No significant differences were noted between the groups

\* *p* < 0.05 compared with group M

L = 1, group M = 1; 4 patients), backache (group S = 2, group L = 2, group M = 1; 5 patients) and headache (group S = 2, group L = 2, group M = 2; 6 patients) were recorded, but there were no significant differences among the groups in terms of the rate of complications.

### Discussion

In this study we demonstrated that the success rate of LP significantly increased in the lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position compared to either the sitting or lateral decubitus positions. There were no observed differences in the number of attempts before the dural puncture of patients whose initial attempt failed, between the patients' positions.

Several factors determine the success of LP in spinal anesthesia, such as older age, spinal needle size, years of training, spinal anatomical landmarks of spinal distance, and body position. The demographic and anatomical landmark characteristics of the patients in the three groups were investigated for comparability; however, there was no difference between groups.

The impact of positioning on a patient during spinal anesthesia has been studied, and these have primarily involved either pediatric or radiological studies [1, 3, 5, 7]. The young and elderly patients for spinal anesthesia positions have not been compared in terms of LP success. The success rate of LP according to position has been widely described in radiological studies [2, 3]. Fisher et al. [2] compared the measurements of the interspinous space widths radiologically in the sitting position, with and without the use of hip flexion. The anatomic advantages of using hip flexion in the sitting position were confirmed and documented by those measurements. Sandoval et al. [4] reported that the interspinous space was significantly greater in the sitting, feet supported position than in either the lateral recumbent or the sitting, feet unsupported position, as measured by ultrasound. These two studies have shown that the sitting position, in addition to hip flexion, increases the success of LP since hip flexion is believed to contribute to maximum flexion of the lumbar spine and opening of the natural lumbar lordosis [8]. Furthermore, pediatric studies have shown that the modified version of the sitting position as the lateral decubitus position with inclination of a 45-degree head-up tilt might increase the CSF pressure by widening the subarachnoid space [1]. Thus, it provides faster detection of CSF [1, 3]. Our study shows that the lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position provides advantages over sitting and hip flexion positions. However, radiological studies are warranted in order to assess the influence of a lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position on the subarachnoid space, as well as the LP success rate in patients.

In young patients, the vertebral anatomy is well-defined, consistent, and it is easy to locate the intervertebral spaces [9]. Boon et al. [10] claimed that the interlaminar area reduces in height and width due to the age of patients, according to the measurements made by antero-posterior lumbar spine radiographs. In addition, the ligament may provide significant resistance in elderly patients, because it is often calcified [3]. Eventually, this condition may make the application of LP more difficult in elderly patients. In our study, the LP success rate was not significant between the patients' positions for  $\leq 65$  years and  $>65$  years of age. The reason for this may be that osteoarthritis, ankylosing spondylitis, kyphoscoliosis, previous spinal surgery, and

degenerative disc disease with collapse of the intervertebral space, were excluded from the study [11].

Our study was limited by several factors, particularly the evaluation of blockade and the supports to circulatory changes. The hemodynamic changes based on the position can be observed after spinal anesthesia and these changes may lead to mortality and morbidity. The aim of study was to evaluate the rate of successful LP in various positions. Evaluation of circulatory variables and sensory and motor block were not intended. Another limitation was that although the lumbar puncture was performed by anesthesiologists with at least 3 years (more than 100 spinal) of work experience, the results may be influenced by the anesthesiologist's personal experience and/or preferences. In addition, it is impossible to make this kind of study blind.

LPs are occasionally complicated by bloody CSF. Blood may be introduced to the CSF at multiple points during an LP procedure, as the needle must pass through many layers of vascular tissue to reach the subarachnoid space. The often-cited 20 % incidence of traumatic LP is likely to be overestimated [12]. Eskey and Ogilvy [13] reported that the frequency of traumatic lumbar punctures is 10.1 % for bedside lumbar punctures. However, the proportion of bloody LPs observed in this study varied 3–8 % in each group. In addition, we made several novel observations in this study. The results of bloody CSF in patients were evaluated according to the position at induction of spinal anesthesia.

In conclusion, the lateral decubitus knee-chest position with the table inclined to a 45-degree head-up position may be the preferred position due to the high success rate when performing lumbar punctures in both  $\leq 65$  age and  $>65$  age patients undergoing spinal anesthesia.

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**Conflicts of interest** None of the authors has any conflicts of interest or competing interests in the research performed in this study.

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