Original Research

Comparing the Incidence of Postdural Puncture Headache (PDPH) between Median and Paramedian Approaches in Nephrolithotripsy under Spinal Anesthesia

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Abstract:

Background: Spinal anesthesia is one of the safest anesthetic procedures with low complications. The most common complication is a headache after surgery or Postdural Puncture Headache (PDPH). It is important to know the factors that effect on PDPH. The aim of this study was to compare the median and paramedian methods in the incidence of PDPH in patients undergoing nephrolithotripsy by spinal anesthesia.

Methods: This clinical trial study was performed on 50 patients who underwent percutaneous nephrolithotomy (PCNL) or nephrolithotripsy referred to Jahrom Peymanieh Hospital in 2019. The patients were randomly divided into two groups of 25 patients. PDPH is defined as bilateral headache in the frontal or occipital region, or neck pain, aggravated by sitting or standing. The data were collected once a day for 7 days after surgery by an uninformed person and then the incidence and prevalence of PDPH were recorded. Patients were followed up by telephone. Data analysis was performed using descriptive and inferential statistics.

Result: No statistically significant distinctions were observed between the two groups in relation to age, gender, and weight. Both the median and paramedian groups exhibited a decrease in the occurrence of postdural puncture headache (PDPH), with a slight elevation noted in the paramedian group. However, no noteworthy variations between the two groups were found on any of the assessed days ($p>0.05$).

Conclusion: The results of this study showed that there was no difference in the incidence of PDPH incidence in both groups; however, paramedian approach is better than median approach in the frequency of PDPH. Therefore, it is recommended that the paramedian method will be used for spinal anesthesia in patients undergoing PCNL.

Keywords: Paramedian, Median, Spinal anesthesia, PCNL, PDPH

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Introduction

Subcutaneous nephrolithotomy or nephrolithotripsy (PCNL) is a minimally invasive procedure to remove kidney stones greater than 2 cm (1). In 1976, Fernstorm et al reported for the first time that the removal of calcium kidney stones through a nephrostomy tract (2). Since then, PCNL has been the most common treatment performed for the management of renal stones. This technique is less traumatic than open surgery and therefore requires high surgical expertise. There have been many modifications to minimize complications, reduce the need for analgesics, and reduce hospitalization, such as regional block, single-step dilatation, Mini-Perc technique, tubeless PCNL and sandwich therapy (3-5). Nephrolithotripsy can be performed using either general or spinal anesthesia. The utilization of spinal anesthesia offers numerous advantages, including procedural ease, a high success rate, the patient's consciousness during the procedure, reduced postoperative pain, decreased reliance on analgesics, earlier discharge, and avoidance of potential risks associated with general anesthesia and intubation (6-7). Nonetheless, spinal anesthesia carries the potential for certain neurological deficits, such as cauda equina syndrome, hypotension, bradycardia, back pain, shoulder pain, and headaches (7-8). Postdural puncture headache (PDPH) is a major complication of spinal anesthesia that occurs due to inadvertent dural puncture and cerebrospinal fluid leakage and reduced cerebrospinal fluid pressure. Sex, pregnancy, young age, and the common use of neuraxial blocks are risk factors for PDPH (9-10). During epidural anesthesia, inadvertent dural puncture occurs in 1.5% of cases and more than half of these patients develop PDPH (11). Two commonly employed techniques for spinal anesthesia are the median and paramedian approaches, each presenting its own set of advantages and disadvantages. The median approach, while being the more frequently utilized technique, can pose technical difficulties, particularly in elderly individuals who may exhibit degenerative changes in the structural components of their spine. On the other hand, the paramedian technique is often favored due to its swifter catheter insertion (12), reduced effort required for needle insertion (13), and the ability to administer anesthesia in an unflexed position (14). Additionally, identifying the epidural space is typically easier with the paramedian technique, and it is associated with fewer osteoarthritic changes in elderly patients. However, challenges arise with the oblique position when inserting the epidural needle. It is worth noting that while the paramedian technique reduces the risk of postdural puncture headache (PDPH), its effectiveness has not yet been confirmed in clinical trials (15- 16). Although the use of smaller diameter needles for subarachnoid blocking decreases the likelihood of PDPH, employing such needles for spinal anesthesia can be demanding and result in a lower success rate (17). We typically use spinal needle 25 G in both median and paramedian methods in our hospital. So far, several studies have been performed to compare the median and paramedian methods in terms of PDPH incidence and their results are inconsistent. In the study of Singh B. et al. paramedian technique was significantly preferred technique for reducing PDPH in patients (10). While in Nisar A. et al. study, the incidence of PDPH in the paramedian method was higher than the median, this was not statistically significant (18). Nevertheless, certain studies have reported no significant disparity in the occurrence of postdural puncture headache (PDPH) between the median and paramedian approaches (19). In line with the aforementioned information, our objective was to evaluate and compare the incidence of PDPH in patients undergoing nephrolithotripsy with

spinal anesthesia, specifically focusing on the median and paramedian approaches.

Method

This double-blind randomized clinical trial encompassed the entire patient population referred to Jahrom Peymanieh Hospital in 2019 who underwent percutaneous nephrolithotomy (PCNL). Following approval from the Ethics Committee of the Jahrom University of Medical Sciences, the study aimed to assess and compare the impact of both the median and paramedian approaches to spinal anesthesia on the incidence of postdural puncture headache (PDPH) in patients undergoing nephrolithotripsy. Inclusion criteria included hemodynamic stability (no blood pressure fluctuations), no chronic pain, no use of antihypertensive drugs, no use of anxiolytic and analgesic drugs, no infection at the needle insertion site, no increased Intracranial Pressure (ICP), no coagulation disorders, no hearing problems, and completion of informed consent form for participation in the research. The patients were randomly assigned to one of two groups: 1) Median and 2) Paramedian. Prior to surgery, all patients adhered to the NPO (nil per os) status and received 500 ml of Ringer solution. ECG and pulse oximetry were conducted to monitor blood pressure and heart rate. Measurements of blood pressure and heart rate were recorded at various time points: before spinal anesthesia, immediately following spinal anesthesia, as well as at 5 minutes, 15 minutes, and 30 minutes post-spinal anesthesia. After rinsing with Betadine and alcohol, and topical injection of 1 ml of 2% Lidocaine; anesthesia drug (12.5 mg of bupivacaine 0.5%) was injected in sitting position by 25G spinal needle to the subarachnoid space at the L3-4 interspace within 5 seconds, in either median or paramedian method; and immediately after removal of the needle, the patient was in supine position and facial oxygen mask was turned on, 6 liters per minute. According to the International Headache Association, patients with bilateral headache in the frontal or occipital region or neck pain, which is exacerbated by sitting or standing position and lasts for less than 7 days, were considered as PDPH. PDPH-related data were collected once a day after surgery for 7 days by an uninformed person and the incidence and prevalence of headache were recorded. Patients were followed up by telephone. Inclusion criteria were defined as patients aged 20 to 50 years, interest in study participation, lack of chronic pain and cancer, hemodynamic stability, no anxiety and mental illness, no chronic pain, lack of infection at the needle site, lack of intracranial pressure, and no coagulation disorders. Exclusion criteria also included patients who required medication or other non-routine care during surgery, and patients who did not meet the inclusion criteria. Data were analyzed using descriptive statistics (mean and standard deviation) and inferential tests (chi-square and t-test) using SPSS software version 21. The level of statistical significance was set at 0.05.

Result

Fifty patients undergoing spinal anesthesia for nephrolithotripsy were divided into two groups: median (25 patients) and paramedian (25 patients). 35 men (70%) and 15 women (30%) were included in the study. The mean age of patients in the median group was 46.88 ± 12.49 and in the paramedian group 52.48 ± 12.25 years. There was no significant difference between the two groups. The mean weight of patients in the median group was 77.68 ± 14.29 kg and in the paramedian group was 77.16 ± 9.26 kg. Patients' weight distribution was almost the same in both groups. Percentage of patients with PDPH in median and paramedian groups in the first to seventh days after surgery are showed in the table1. Results showed no significant difference between the two groups in any of the days (P> 0.05), (Table 1).

Changes in systolic blood pressure were compared in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery in table 2. According to the results, systolic blood pressure was significantly higher in the paramedian group before spinal anesthesia, immediately after spinal anesthesia, 5 minutes and 15 minutes after spinal anesthesia (P <0.05) with no significant difference between the two groups at 30 minutes after spinal anesthesia and in recovery (P> 0.05).

Patients' diastolic blood pressure changes were compared in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery in table 3.

According to the results, diastolic blood pressure was significantly higher in the paramedian group before the spinal anesthesia, immediately after the spinal anesthesia, 5 minutes and 15 minutes after the spinal anesthesia (p <0.05). No significant difference happened between the two groups at 30 minutes after spinal anesthesia and in recovery (p> 0.05).

Patients' heart rate changes were compared in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery in table 4. Results showed that the patients' heart rate was significantly higher in the paramedian group only after 5 minutes of spinal anesthesia (p <0.05). But no significant difference was observed between the two groups in other stages (p> 0.05),(Table 4).

Arterial oxygen saturation changes were compared in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery in table 5. According to the results, arterial oxygen saturation was significantly higher in the median group before spinal anesthesia, immediately after spinal anesthesia, and 5 minutes after spinal anesthesia (p <0.05). However, there was no significant difference between the two groups at 15 min and 30 min after spinal anesthesia (p> 0.05). In the recovery, arterial oxygen saturation was significantly higher in the paramedian group (p = 0.047). Arterial oxygen saturation in the median group is decreasing, but this is the ascending in the paramedian group. Although arterial oxygen saturation in paramedian group before spinal anesthesia was higher than paramedian group, this was higher in paramedian group in the recovery phase than median group. (Table 5).

At the end of, the percentage of men and women with PDPH in the median and paramedian groups in the first to seventh days after surgery is showed in table 6 and table 7. According to the results, no significant difference was observed between PDPH rate in both men and women in the median and paramedian groups (p> 0.05). (Table 6).

The study also found that the most frequent use of ephedrine and atropine was in the 5 minutes after spinal anesthesia. In the median group, the most frequent use of ephedrine and atropine was in the 5 minutes after spinal anesthesia. But in the paramedian group, the most frequent use of ephedrine and atropine was in the 15th minute after spinal anesthesia.

In our study, the duration of discharge from recovery was also compared in the median and paramedian groups. There was no significant difference between the two groups in terms of recovery time (p> 0.05). (Table 7).

Discussion

The precise mechanism underlying postdural puncture headache (PDPH) has not yet been fully understood. However, several factors, including the patient's age and gender, can influence its occurrence. PDPH typically arises

from dural leakage of cerebrospinal fluid (CSF) resulting from needle insertion during spinal anesthesia (20-21). In the median approach, the needle traverses the supraspinal and interspinal ligaments, as well as the ligamentum flavum. Conversely, in the paramedian method, the needle directly crosses the ligamentum flavum after passing through the paraspinal muscles, without traversing the supra- and intraspinal ligaments (22). The paramedian approach appears to be simpler than the median approach, particularly in older patients who may have sclerotic ligaments and degenerative changes in the spine and intervertebral spaces (23-24). Singh et al.'s study conducted in India, involving 100 patients undergoing elective surgery, demonstrated no significant difference in the incidence of PDPH between the median and paramedian approaches. They concluded that the paramedian approach significantly reduced the incidence of PDPH, particularly in elderly patients, making it the preferred technique for older individuals (25). Conversely, a study by Nisar et al. in 2016, comprising 100 patients in Pakistan, reported a significantly higher incidence of PDPH in the paramedian technique compared to the median technique (18). In our study, the incidence of PDPH decreased in both the median and paramedian groups, with a slight increase observed in the paramedian group, although no significant difference was found between the two groups. These findings are consistent with the results obtained by Firdous et al. Their study also suggested that the paramedian approach was superior to the median approach in reducing PDPH, albeit without statistical significance (26). In our study, there was no significant difference between the two groups in terms of age, weight, and sex, which aligns with the findings of Singh et al.'s study (25). As mentioned earlier, gender is considered a risk factor for PDPH. Some studies have reported no significant difference in the incidence of PDPH between men and women (20, 27-28), which corresponds with our study's results. However, a study conducted by DelPizzo et al. in 2017, involving 300 patients undergoing knee surgery in New York, indicated a higher incidence of PDPH in women compared to men (29). Our study revealed that systolic and diastolic blood pressure were significantly higher in the paramedian group before anesthesia, immediately after anesthesia, as well as at 5 minutes and 15 minutes after anesthesia. Nonetheless, Chong et al.'s study found that PDPH was unaffected by hypertension (30). In a study by Kim et al. in 2013, the results demonstrated a decrease in blood pressure and heart rate following spinal anesthesia (31), which is consistent with our study's findings concerning systolic and diastolic blood pressure. However, in our study, the heart rate increased 15 minutes after anesthesia compared to before anesthesia but then decreased from 30 minutes after anesthesia in both the median and paramedian groups.

Conclusion

The results of this study showed that there was no difference in the incidence of PDPH incidence in both groups; however, paramedian approach is better than median approach in the frequency of PDPH. Therefore, it is recommended that the paramedian method will be used for spinal anesthesia in patients undergoing PCNL.

Ethical Code

This project has been approved by the research ethic committee, as well as, supported with grant number of "IR.JUMS.REC.1397.132" by Jahrom University of Medical Sciences in Jahrom, Iran.

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Tables

Table 1: The incidence of PDPH in patients in the median and paramedian groups in the first to seventh days

Group	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Median	42.1%	40%	25.0%	10.0%	10.0%	5.0%	5.0%
Paramedian	50%	50%	14.3%	0.0%	0.0%	0.0%	0.0%
P_{value}	.923	.820	.742	.632	.632	1.000	1.000

Table 2: Systolic blood pressure changes in median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery

Group		before	after	5 minutes	15 minutes	30 minutes	recovery
Median	Mean	135.00	128.84	116.20	117.24	118.72	118.17
	SD	21.89	28.18	21.17	16.91	18.04	18.28
Paramedian	Mean	148.24	144.52	133.44	133.00	115.00	123.73
	SD	18.66	15.43	18.96	19.44	17.53	12.95
P value		.026	.018	.004	.004	.463	.248

Table 3: Diastolic blood pressure changes in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes, and 30 minutes after spinal anesthesia and in recovery

Group		Before	After	5 minutes	15 minutes	30 minutes	recovery
Median	Mean	87.12	79.84	72.80	76.04	75.88	72.96
	SD	15.64	18.27	13.22	11.57	14.84	12.74
Paramedian	Mean	95.48	90.08	86.48	149.48	75.44	72.36
	SD	7.67	8.45	14.88	173.17	12.74	10.36
P value		.020	.014	.001	.040	.911	.865

Table 4: Heart rate changes in the median and paramedian groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes and 30 minutes after spinal anesthesia and in recovery

Group		Before	After	5 minutes	15 minutes	30 minutes	recovery
Median	Mean	83.52	91.20	80.56	98.08	85.76	78.30
	SD	11.20	19.60	14.62	1.85	17.42	15.72
Paramedian	Mean	88.08	94.04	99.12	97.24	85.68	81.82
	SD	12.58	17.01	17.48	2.37	13.41	14.04
P value		.182	.587	<0.001	.168	.986	.434

Table 5: Arterial oxygen saturation changes in the median and paramedine groups before spinal anesthesia, immediately after spinal anesthesia, 5 minutes, 15 minutes and 30 minutes after spinal anesthesia and in recovery

Group		Before	After	5 minutes	15 minutes	30 minutes	recovery
Median	Mean	98.88	98.80	98.60	98.08	98.40	96.17
	SD	1.27	1.19	1.47	1.85	1.55	7.20
Paramedian	Mean	96.60	97.96	97.28	97.24	97.88	100.18
	SD	2.57	1.31	1.95	2.37	4.36	5.85
P value		<0.001	.022	.009	.168	.577	.047

Table 6: The incidence of PDPH in median group on day 1 to day 7 by sex

Group	Sex	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Median	Male	38.5%	42.9%	28.6%	7.1%	7.1%	7.1%	7.1%
	Female	50.0%	33.3%	16.7%	16.7%	16.7%	0.0%	0.0%
P value		1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 7: The incidence of PDPH in paramedian group on day 1 to day 7 by sex

Group	Sex	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Median	Male	63.6%	63.6%	18.2%	0.0%	0.0%	0.0%	0.0%
	Female	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
P value		.193	.193	1.000	---	---	---	---