*RESEARCH*

# Risk Factors of Post Dural Puncture Headache in Cesarean Section Patients: A Multivariate Analysis Study

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**ABSTRACT**
**Background:** The use of spinal anesthesia in patients undergoing cesarean section (CS) is at risk of experiencing post-dural puncture headache (PDPH). This is influenced by several factors.
**Objective:** This study aimed to assess the effect of risk factors on the occurrence of PDPH in patients undergoing CS under spinal anesthesia.
**Methods:** The study design is a nested case-control study with independent variables influencing the incidence of PDPH in CS with spinal anesthesia. Samples were taken from CS patients with spinal anesthesia at the Central Surgical Installation of Dr. Kariadi General Hospital, who met the inclusion and exclusion criteria.
**Result:** A total of 74 patients were included in the multivariate analysis, which showed that neurological disorders with p-value = 0.069; OR= 9,306; 95% CI = 0.842-102.828 and the number of punctures with p = 0.060; OR= 4.798; 95% CI = 0.997-23.075 is the most significant risk factor for the incidence of PDPH in CS patients. There was an additive effect which indicated that mobilization of more than 6 hours mutually reinforces the occurrence of PDPH in CS patients.
**Conclusion:** Preoperative risk factors such as a history of neurological disorders increase the incidence of PDPH in CS patients. Intraoperative risk factors in this study were total puncture and needle size, increasing the incidence of PDPH in CS patients. Post-operative risk factors, in this case, immobilization, increase the incidence of PDPH in CS patients. Preoperative, intraoperative, and post-operative risk factors, together or separately, increase the incidence of PDPH in patients undergoing CS.

**Keywords:** cesarean section; early mobilization; post-dural puncture headache; risk of post-dural puncture headache; risk of spinal anesthesia

## INTRODUCTION

Caesarean section (CS) is an artificial birth in which the fetus is born through an incision in the abdominal and uterine wall, provided that the uterus is intact and the fetus weighs above 500 grams.[1] Currently, most cesarean sections are performed during labor. The neuraxial anesthesia technique is one of the most frequently performed anesthetic methods during cesarean sections. Neuraxial anesthesia for CS has become more popular over time due to its lower association with maternal mortality than general anesthesia.[2]

A neuraxial block is a type of regional anesthesia in which the procedure can be performed by epidural, caudal, spinal/subarachnoid block.[3] Spinal anesthesia is one of the most popular and widely used anesthetic procedures due to its simple, cost-effective, and efficient technique, which provides complete sensory and motor block and a high success rate of post-operative analgesia.[4]

Complications of a spinal block are divided into major and minor complications. Major complications are infrequent, whereas minor complications are more frequent and should not be disregarded. Both unsuccessful spinal blocks and post-dural puncture headaches (PDPH) are serious yet frequent side effects of spinal anesthesia.[4] PDPH is a headache due to cerebrospinal fluid (CSF) leakage from a dural puncture, which can develop five days following a lumbar puncture.[5]

According to the literature, the incidence of PDPH after spinal anesthesia ranges from 0.3% to 40% and is influenced by factors such as age, sex, body mass index, history of headache, history of spinal anesthesia, size and type of needle, bevel orientation, effort repeated punctures, blood pressure, and immobilization.[6,7,8] Research in the United Kingdom (UK) showed that the incidence of PDPH in midwifery practice ranges from 0.18-3.6%.[9] Another study revealed that the PDPH ranges from 50% to 80%, and the obstetric population at high risk for unintentional dural puncture varies from 2% to less than 0.26%.[2] Pregnant women are considered to be at high risk of experiencing PDPH because of high estrogen levels, which can affect cerebral vascular tone, thus increasing the response of vascular distension to cerebrospinal fluid hypotension (CSF).[10]

Over time, more cesarean sections are being performed under neuraxial anesthesia. Despite being a minor consequence, PDPH increases morbidity since it is uncomfortable and interferes with daily life. The incidence of PDPH is strongly influenced by many interrelated factors, whether modifiable or non-modifiable.[10] Therefore, this study aims to assess the effect of risk factors on the occurrence of PDPH in patients undergoing cesarean section under spinal anesthesia.

## METHODS

A nested case-control study was performed from June to August 2022 at Dr. Kariadi General Hospital, Indonesia. The inclusion criteria are patients undergoing a cesarean section under spinal anesthesia; physical status American Society of Anesthesiologists (ASA) 1-2; women of all ages who underwent cesarean section; and glasgow coma scale (GCS) 15. Meanwhile, the exclusion criteria of this study are patients who; have an allergy to spinal anesthetic drugs; have signs of increased intracranial pressure or impending eclampsia; have complicating factors during surgery that change regional anesthesia to general anesthesia or post-operative care in the intensive care unit; have complications in spinal anesthesia, namely high spinal, total spinal. This study obtained ethical clearance from the institutional review board of Diponegoro University. Informed consent was obtained from every patient before the study was performed. The patients were collected consecutively during the study period.

Spinal anesthesia was performed by injecting bupivacaine 0.5% hyperbaric at L3-4. PDPH was evaluated five days after surgery. In this study, the incidence of PDPH was analyzed by the following potential factors, namely: preoperative factors (body mass index status, age, history of neurological disorders, history of spinal anesthesia); intra-operative factors (blood pressure or mean atrial pressure, spinal needle size, bevel orientation, number of punctures); and post-operative factors (mobilization).

Chi-square and independent sample T-tests were employed to analyze the data. If both tests yielded a p-value of < 0.25, the variables underwent further analysis using logistic regression. Data resulting in a p-value of < 0.05 are considered significant.

Multivariate analysis in this study was conducted through multiple logistic regression using the backward conditional method at a significance level of 95%. All data were analyzed using the SPSS program for Windows.

**RESULTS**

The final group of participants included 74 women who underwent cesarean sections, of which 37 had PDPH and 37 did not (as a control).

The patient characteristics were dominated by non-obese patients 49 (66.2%), with no history of neurological disorders 64 (86.5%), spinal history 40 (54.1%), single puncture 66 (89.2%), horizontal bevel orientation 66 (89.2%), needle size, 26 G 56 (75.7%), and mobilization 45 (60.8%). (Table 1)

The age of the cases and controls is almost similar (28 years). In addition, the case and control groups had systolic and diastolic pressures as well as the mean arterial pressure (MAP) within normal limits. (Table 2)

There is significance in the variables of history of neurological disorders, total punctures, needle size, and mobilization. Patients with a history of neurological disorders are at risk of suffering from PDPH 11.571 times more than patients without previous neurological disorders (OR = 11.571, p = 0.017). In intraoperative factors, patients with multiple total punctures are at risk of suffering from PDPH 11.571 times more than patients with fewer total punctures (OR= 11.571, p < 0.001). Patients with a needle size of 25 G are at risk of suffering from PDPH 9.931 times more than patients with a needle size of 26/27 G (OR= 9.931, p = 0.014). Significant differences were also found in mobilization (p <0.001), but the OR value only showed 0.118. (Table 3)

No significant difference was found in MAP and age (p>0.05). (Table 4)

Regarding the ROC curve, the cut-off value of age is 27 years (AUC, an area under curve = 63% (good); sensitivity 62.2%; and specificity 73.1%). The age results are considered positive if they are less than or equal to the cut-off value and negative when they are more than the cut-off value. Based on the cut-off value, it was found that there were 32 samples (43%) who were less than 27 years old and those who were more than 27 years old in 74 samples (56%). (Figure 1)

Based on the ROC curve, the cut-off value of MAP was 69 mm Hg (AUC, an area under curve = 50% (weak); sensitivity 62.2%; and specificity 62.2%). The results of the MAP examination are considered positive if they are less than or equal to the cut-off value and are considered negative when they are more than the cut-off value. Based on the cut-off value, 37 samples (50%) have 69 mmHg of MAP, and 37 samples (50%) have >69 mmHg of MAP. (Figure 1)

Multivariate analysis showed neurological disorders with p = 0.069; OR= 9.306; 95% CI = 0.842-102.828 and the number of punctures with a value of p = 0.060; OR= 4,798; 95% CI = 0.997-23.075 are the most significant risk factor for the incidence of PDPH in cesarean section patients. The Nagelkerke r square value in the ninth model is 0.7, so the combination of variables in the multivariate contributes as much as 70% of the variation to the incidence of PDPH. The Hosmer Lemeshow value indicates that this model can predict actual conditions. (Table 5)

There is an additive effect (bivariate < multivariate OR), which indicates that mobilization > 6 hours mutually reinforces the occurrence of PDPH in patients with cesarean section. The equation probability event can calculate the probability of an influential risk factor, and the result was 89.5472%. (Table 6)

**Table 1.** Patient characteristics (categorical data)

| Variable | | PDPH/Case (n= 37) | | No PDPH/Control (n= 37) | | Total (n= 74) | |
|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % |
| BMI | Obesity | 15 | 60 | 10 | 40 | 25 | 33.8 |
| | Non obesity | 22 | 44.9 | 27 | 55.1 | 49 | 66.2 |
| Neurological disorders | Yes | 9 | 90 | 1 | 10 | 10 | 13.5 |
| | No | 28 | 43.8 | 36 | 56.3 | 64 | 86.5 |
| Spinal history | Yes | 6 | 66.7 | 3 | 33.3 | 40 | 54.1 |
| | No | 31 | 47.7 | 34 | 52.3 | 34 | 45.9 |
| Total punctures | Multiple | 30 | 75 | 10 | 25 | 8 | 10.8 |
| | Single | 7 | 20.6 | 27 | 79.4 | 66 | 89.2 |
| Bevel orientation | Sagittal | 2 | 25 | 6 | 75 | 8 | 10.8 |
| | Horizontal | 35 | 53 | 31 | 47 | 66 | 89.2 |
| Needle size | 25 G | 8 | 88.9 | 1 | 11.1 | 9 | 12.2 |
| | 26 G | 26 | 46.4 | 30 | 53.6 | 56 | 75.7 |
| | 27 G | 3 | 33.3 | 6 | 66.7 | 9 | 12.2 |
| Mobilization | Yes | 14 | 31.1 | 31 | 68.9 | 45 | 60.8 |
| | No | 23 | 79.3 | 6 | 20.7 | 29 | 39.2 |

PDPH: post-dural puncture headache; BMI: body mass index

**Table 2.** Patient characteristics (numerical data)

| Variable | PDPH (n= 37) | Without PDPH (n= 37) | Total (n= 74) |
|---|---|---|---|
| | Mean ± SB<br>Median<br>Min-max | Mean ± SB<br>Median<br>Min-max | Mean ± SB<br>Median<br>Min-max |
| Age (years) | 28.22 ± 0.78<br>28.00<br>19-44 | 28.05 ± 4,83<br>27.00<br>17-44 | 28.14 ± 4.89<br>28<br>17 – 44 |
| Systolic (mmHg) | 126 ± 2.16<br>130.00<br>105-150 | 121.92 ± 1,74<br>120.00<br>110-150 | 124.34 ± 12.14<br>120<br>(105 – 150) |
| Diastolic (mmHg) | 81.92 ± 1,46<br>83.00<br>60-90 | 77.51 ± 1,12<br>80.00<br>60-90 | 79.72 ± 8.18<br>80<br>60 – 90 |
| MAP (mmHg) | 69.18 ± 1,24<br>69.00<br>63-72 | 70.18 ± 1,28<br>70.00<br>64-80 | 69.19 ± 0.87<br>72.00<br>65 - 78 |

**Table 3.** Factors influencing PDPH (categorical data)

| Variable | PDPH | | p | OR | 95% CI | |
|---|---|---|---|---|---|---|
| | Yes (n = 37) | No (n = 37) | | | lower | upper |
| BMI | | | | 1.841 | 0.692 | 4.897 |
| obesity | 15 (60%) | 10 (40%) | 0.326¥ | | | |
| non obese | 22 (44.9%) | 27 (55.1%) | | | | |
| Neurological disorders | | | | 11.571 | 1.383 | 96.808 |
| Yes | 9 (90%) | 1 (10%) | 0.017¥* | | | |
| No | 28 (43.8%) | 36 (56.3%) | | | | |
| Spinal history | | | | 2.194 | 0.505 | 9.530 |
| Yes | 6 (66.7%) | 3 (33.3%) | 0.240£ | | | |
| No | 31 (47.7%) | 34 (52.3%) | | | | |
| Total punctures | | | | 11.571 | 3.864 | 34.656 |
| Multiple | 30 (75%) | 10 (25%) | <0.001¥* | | | |
| Single | 7 (20.6%) | 27 (79.4%) | | | | |
| Bevel orientation | | | | 0.295 | 0.055 | 1.571 |
| Sagittal | 2 (25%) | 6 (75%) | 0.131£ | | | |
| Horizontal | 35 (53%) | 31 (47%) | | | | |
| Needle size | | | | 9.931 | 1.174 | 84.038 |
| 25 G | 8 (88.9%) | 1 (11.1%) | 0.014£* | | | |
| 26 G | 26 (46.4%) | 30 (53.6%) | | | | |
| 27 G | 3 (33.3%) | 6 (66.7%) | | | | |
| Mobilization | | | | 0.118 | 0.039 | 0.353 |
| Yes | 14 (31.1%) | 31 (68.9%) | <0.001¥* | | | |
| No | 23 (79.3%) | 6 (20.7%) | | | | |

*Significant ($p < 0.05$); ¥Yates Correction; £Fisher's exact test

**Table 4.** Factors influencing PDPH (numerical data)

| Variable | PDPH<br>Mean ± SD<br>Median<br>Min-max | No PPDH<br>Mean ± SD<br>Median<br>Min-max | P |
|---|---|---|---|
| MAP (mmHg) | 69.18 ± 1,24<br>69.00<br>63-72 | 70.18 ± 1,28<br>70.00<br>64-80 | 0,311[MW] |
| Age (years) | 28.22 ± 0.78<br>28.00<br>19-44 | 28.05 ± 4,83<br>27.00<br>17-44 | 0,261[t] |

MAP (mean arterial pressure); SD (standard deviation); min (minimal); max (maximal); *signif (p<0.05); [MW]Mann Whitney; [t]Independent t-test.

**Tabel 5.** Multivariate analysis

| No | Variable | B | SE | Wald | df | Sig | Exp (B) | CI 95% | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | p | OR | lower | upper |
| 1 | Neurological disorders | 1,172 | 0,790 | 4,161 | 1 | 0,069 | 9,306 | 0,842 | 102,828 |
| 2 | Total punctures | 1,468 | 0,801 | 3,829 | 1 | 0,060 | 4,798 | 0,997 | 23,075 |
| 3 | Needle size | 3,982 | 0,916 | 11,675 | 1 | 0,074 | 3,362 | 0,891 | 12,684 |
| 4 | Mobilization | 2,731 | 0,947 | 7,729 | 1 | 0,002* | 0,162 | 0,051 | 0,518 |

Nagelkerke r square= 0,70 ; Hosmer Lemeshow= 0,656.

**Table 6.** The interaction effect based on the results of bivariate and multivariate analysis

| No | Variable | Bivariate OR | Multivariate OR | Interaction effect |
|---|---|---|---|---|
| 1 | Neurological Disorders | 11,591 | 9,306 | Multiplicative |
| 2 | Total Puncture | 11,571 | 4,798 | Multiplicative |
| 3 | Needle Size | 9,931 | 3,362 | Multiplicative |
| 4 | Mobilization | 0,118 | 0,162 | Additives |

OR, odd ratio; if OR bivariate>multivariate: multiplicative; if OR multivariate>bivariate: additive

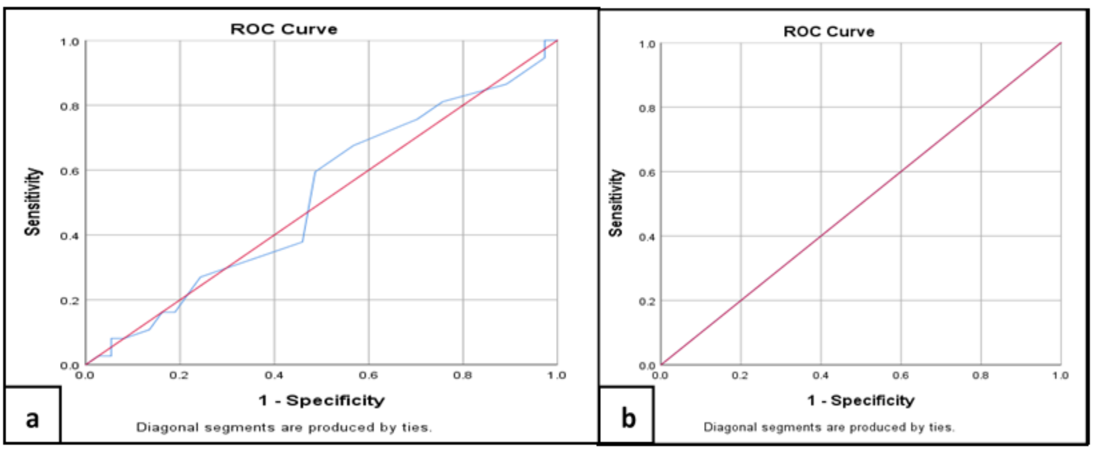


**Figure 1.** Receiver Operating Characteristics (ROC) of age [**a**] and mean arterial pressure (MAP) [**b**] towards post-dural puncture headache (PDPH)

**DISCUSSION**

Our study showed that 37/78 (47.43%) patients had PDPH. This data is in accordance with the research by Basazinew Chekol et al., which said the incidence of PDPH was between 0.3% and 40%, depending on the risk factors. At the same time, Karsten Skovgaard's study found that the incidence of PDPH could occur between 2 and 36% after spinal anesthesia.[10,11]

Preoperative risk factors in this study data were divided into four factors, namely BMI, history of neurological disorders, spinal history, and age. No significant difference was found in obesity (OR 1.841 95% CI = 0.692–4.897; p = 0.326). This finding aligns with a study by Demilew, which stated that there is no significant difference between BMI and PDPH (p = 0.3). In contrast, the study by Jha et al. found a significant relationship between PDPH and BMI; the proportion of PDPH was higher in the BMI ≤ 31kg/m2 group than in the BMI ≥31kg/m$^2$ group. PDPH risk can be 8.1 times higher among patients with a BMI ≤ 31kg/m$^2$ (P=0.004). In addition, according to Faure et al., it has been found that the incidence of PDPH will be lower in obese pregnant women. This finding occurs because, in these patients, there is an increase in intra-abdominal pressure, which can suppress the flow of the CSF, thereby causing a reduction in cerebrospinal fluid leakage. Nevertheless, because the approach and markings are less obvious with more obese participants, spinal anesthesia is more difficult to administer. As a result, some patients require numerous punctures and a bigger spinal needle size.[10,12,13]

This study did not show a significant age difference (p = 0.261). This finding is in line with a study by Khraise et al., which stated that the age of women who underwent spinal anesthesia at the cesarean section for the risk of PDPH was not statistically significant (p =0.120).[14] Study by Vandam et al. on 9277 patients who had received spinal anesthesia found that the incidence of PDPH in the age group 20-29 years was (16%), age 30-39 (14%), age 40-49 years (11%), age 50 -59 years (8%) and in the 60-69 group (4%).[15] Similarly, in a study by Lybecker et al. in 1021 patients undergoing spinal anesthesia, PDPH was most common between the ages of 20-30 years, and the incidence of PDPH began to decline after the age of 40.[16] This study could be because pregnant women have almost the same age range, namely during the productive period between the ages of 20-35 years.

The history of neurological disorders in this study significantly affected PDPH (OR 11.571 95% CI = 1.383–96.808; p = 0.017). This finding is in line with a study by Khraisedkk, which stated that patients with a history of tension-type headaches affect the occurrence of PDPH (p = <0.001).[14] According to Clark et al., almost 40% of patients had a history of chronic headaches with PDPH. In contrast, Kuntz et al. found that the group of patients with headaches one week before the procedure had a PDPH incidence rate close to 70% compared to a 30% incidence of PDPH in the group without a history of headaches.[17,18,19]

Spinal anesthesia history showed no significant difference in PDPH (OR 2.194 95% CI = 0.505–9.530; p = 0.240). This finding is in accordance with a study by Khraise et al. which stated that a history of previous spinal anesthesia did not significantly affect the occurrence of PDPH with a p-value of 0.736.[14] However, these findings differ from a study conducted by Demilew et al. which showed that patients with a history of spinal anesthesia were more likely to develop PDPH (AOR = 7.028; 95% CI = 2.377–20.781; p = 0.0001). Likewise, the study of Philo Nambooze et al. stated that PDPH was strongly associated with a history of previous spinal anesthesia (AOR = 1.3; 95% CI = 1.0-1.6; p = 0.04).[10]

In this study, blood pressure did not have a significant relationship with the occurrence of PDPH in patients undergoing cesarean section (p=0.311). This finding is supported by the study of Chung et al., who stated that PDPH after knee surgery occurs more frequently in female patients and is unaffected by their perioperative blood pressure.[20] This may be because cesarean-section patients are frequently young women, making it easier for them to adjust to hemodynamic changes.

Patients who experienced repeated or multiple spinal punctures (>2) had a significant risk with PDPH (OR 11.571 95% CI = 3.864 – 34.656; p = <0.001). This finding aligns with a study by Demilew et al., which stated that repeated puncture attempts could increase the incidence of PDPH (AOR = 4.699; 95% CI = 1.594-13.872; p = 0.05).[10] Research by Khraise et al. also stated a similar thing (AR = 2.55; 95% CI = 1.09-5.93; p = 0.03).[14]

The bevel orientation with PDPH was insignificant (OR 0.295 95% CI = 0.055 – 1.571; p = 0.131). A meta-analysis study by Richman et al. demonstrated that PDPH occurs less frequently when the bevel is oriented parallel (sagittal) to the long axis of the spine than perpendicular (horizontal) to the level of PDPH. [21] In this study, it was found that there were more horizontal stabbing orientations (89.2%); this was related to the operator's habits.

Spinal needle size had a significant risk with the occurrence of PDPH (OR 9.931 95% CI = 1.174 – 84.038; p = 0.014). In this study, it was divided into three different spinal needles. Regarding the risk factor for this needle size, nine research samples used a 25G spinal needle size, with 8 (88.9%) experiencing PDPH. In comparison, 56 research samples used a 26G spinal needle size, with 26 (46.4%) experiencing PDPH, and nine samples with a spinal needle size of 27G, with 3 (33.3%) experiencing PDPH. Therefore, a larger spinal needle leads to a higher risk for PDPH. This finding aligns with a study conducted by Ataur Rahman et al., which stated that the incidence in the group using 25G spinal needles was higher than in the group using 27G needles (26% compared to 10%, p <0.05).[22] Likewise, Demilew et al. stated that using larger needles (20 and 22 G) could increase the incidence of PDPH (AOR = 4.206; 95% CI = 1.247–14.187; p = 0.021). Spinal needles with a larger size also make it easier for the operator to perform the puncture compared to a smaller size, especially when there are difficulties in performing spinal anesthesia.[10]

Early mobilization in the study had a significant protective relationship to the incidence of PDPH (OR 0.118 95% CI = 0.039 – 0.353; p = <0.001). These results align with a study by Arevalo-Rodriguez et al., who stated that immobilization might increase the risk of headaches in people undergoing lumbar puncture.[23] Study by Tejavanija et al. stated that although the PDPH rate was higher in the group that received 6 hours of bed rest, statistically, the relationship between bed rest and PDPH did not differ significantly between the group that received 6 hours of bed rest and the group that received early ambulation or 1 hour of bed rest. PDPH prevalence was 16.9% (overall), 18.2% (6 hours), and 15.6% (early ambulation).[24] Tai et al. stated that bed rest of>30 minutes did not prevent PDPH. The study noted no significant difference in the incidence of PDPH between groups that underwent bed rest >30 minutes and non-bed rest (Pearson's Chi-squared test, $x^2 = 3.109$, p = 0.07).[25]

The risk factor profile in multivariate analysis was 0.162 times (95% CI 0.051 to 0.518) experiencing PDPH in the group with early mobilization (<6 hours). Mobilization >6 hours is a risk factor for PDPH, while mobilization <6 hours can be a protective factor for PDPH. These results are in accordance with Tien et al. that in early mobilization (in that study <8 hours), the incidence of PDPH was five people, compared to mobilization > 8 hours for 12 people with the results of multivariate analysis p = 0.090 and OR = 2.426. Arevalo Rodriguez et al. showed the same results; patients with mobilization >6 hours showed a relative risk of 1.6. Early mobilization can provide better distribution of CSF and better closure of CSF leaks to prevent intracranial hypotension.[23,26]

The number of punctures in this study was not significant in multivariate analysis (p = 0.060; OR = 4.798). This result is in accordance with the study of Bedilu et al., where single, double, or repeated punctures in spinal patients who underwent multivariate analysis found that the number of punctures 2x was not significantly different (p=0.131). In contrast, in punctures> 2x, the results were significant (p=0, 03). LCS leak is the cause of PDPH not only from the number of punctures but also from other independent factors that can influence it, such as MAP, needle size, neurological disorders, age, and others.[27,28]

Needle size in this multivariate study showed insignificant results with p = 0.916 and OR 3.362. These results are in accordance with the study of Lybecker et al., the use of needles alone or bivariate is a factor that is significantly related to the incidence of PDPH; the multivariate results show that needle size is not significant with a value of p = 0.105.[16] Vandam et al. study explained this incident, the reduction in the incidence of PDPH by using 24 and 20 needles decreased from 14% to 16% for CSF leaks and did not significantly reduce the incidence of PDPH.[15] The study by Dongen et al. CSF leaks caused by needles number 20 and 22 reached 5 ml in 3 minutes and 5 minutes, respectively, but these leaks were not associated with complaints that arose in patients in the form of headaches, nausea, or vomiting. Those results prove that the use of multivariate needle sizes does not affect the incidence of PDPH and symptoms associated with PDPH.[29]

Neurological disorders in the multivariate test showed no significant result (p = 0.069 and OR 9.306). This result is in accordance with the study of Oosterhout et al., who stated that a multivariate analysis of a history of neurological disorders such as epilepsy (p=0.823), headache (p=0.057), and family history of migraine (p=0.667) did not significantly influence the incidence of PDPH. The occurrence of PDPH has a different mechanism from a history of neurological disorders such as headaches, migraine types, tension, and others. It explains that a history of previous neurological disorders does not affect the incidence of PDPH because the mechanism is different and vice versa.

The study explained that CSF leakage did not trigger migraine exacerbations.[30]

This study had several limitations, particularly in the sample size and the involvement of more than one anesthesiologist. However, it is essential to note that the anesthesiologists who performed spinal anesthesia in this study had similar training and experience and used the same puncture technique and approach.

## CONCLUSION

Preoperative risk factors (neurological disorders), intraoperative risk factors (total punctures and needle size), and post-operative risk factors (immobilization) alone or together increase the incidence of PDPH in patients undergoing cesarean section surgery—further study on the ambulation of PDPF after surgery and its significant risk factor warrants further investigation.

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