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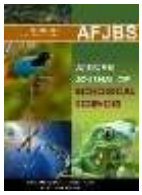

Evaluation of factors Affecting Post-Dural Puncture Headache Incidence After Spinal anesthesia

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Abstract

Background: Dural puncture headache is a condition that occurs post-dural puncture headache (PDPH), especially in the context of cesarean delivery, and can affect the patient's comfort and mobility. In this study, we examined the effect of different spinal needle sizes on individuals undergoing surgical procedures.

Objective: The objective of this study was to examine the impact of spinal anesthesia needle size on the incidence of postoperative headache.

Method: In a cross-sectional descriptive study, we surveyed 100 patients who underwent spinal anesthesia. Participants were divided into two groups: Group A (with headache) and Group B (without headache). Their ages ranged from 20 to 82 years, and their weight varied between 50 and 115 kg. The study took place at both the Preventive Medicine Hospital (Maitika) and Al Zahraa Hospital between February and May 2024.

Result: There was a statistically significant link between PDPH incidence with larger needle sizes, female sex and younger age. PDPH severity significant with average surgery time ($p = 0.024$). Patients with the longest surgery times (52.1 ± 4.39 minutes) reported the most severe headaches, the severe headaches only occurred with 22-gauge needles (100%). In contrast, 73.1% of 27-gauge needle users reported no headaches, compared to 25.0% of 25-gauge needle users.

Conclusion: In our study, gender significantly influenced headache presence. Females experienced more headaches than males. Additionally, headache occurrence and severity correlated with surgery duration and anesthesia needle size. Longer surgeries were associated with more severe headaches, and larger needles increased the likelihood and severity of headaches.

Keywords: Cesarean section, Post-dural puncture headache, Spinal needle.

Introduction:

Spinal anesthesia, a most common type of regional anesthesia, involves injecting an anesthetic agent into the subarachnoid space. This technique is currently the preferred method due to its improved safety relative to general anesthesia, [1] lower complication rate, and advantages such as reduced costs and easier patient management. However, despite the overall lower complication rate, post-dural puncture headache (PDPH) remains the most frequent complication. As defined by the International Classification of Headache Disorders, PDPH is characterized by a headache that develops within five days following a lumbar puncture procedure.[2,3]

This type of headache is typically exacerbated when the patient is sitting or standing upright but improves when the patient lies flat.[4] Accompanying symptoms may include a stiff neck, hearing loss, tinnitus, photophobia, hyperacusis, and nausea.[5] PDPH is a common complication of lumbar puncture, most likely caused by a tear in the dura mater that allows cerebrospinal fluid (CSF) to leak into the epidural space. Depending on factors such as the patient's age, gender, and the size of the needle used, the reported incidence of PDPH can range from 10% to 40%.[6,7,8]

The occurrence of headache following a lumbar puncture procedure can be attributed to various factors, including needle size, needle design, bevel orientation, and the number of LP attempts. Specifically, the use of non-cutting (atraumatic) needles with a smaller diameter has been associated with a decreased incidence of post-lumbar puncture headaches. Additionally, inserting the needle with its bevel parallel to the dural fibers can help to close the puncture site and reduce the amount of CSF leakage, among these contributing factors, the most critical component in the development of PDPH appears to be the size of the needle used.[9,10]

The use of smaller needle diameters can reduce the incidence of headache. However, spinal needles that are extremely thin can create technical difficulties for the operator. Conversely, multiple unsuccessful dural punctures would increase the rate of PDPH. [11]

When the risk of PDPH is substantial, the use of larger spinal needles will inevitably lead to more significant dural perforations. Conversely, employing smaller needles to create minor dural perforations carries a lower risk of headache. [12,13]

Dural puncture headache resulting from spinal anesthesia is a major contributor to patient ill health in the postoperative period, resulting in prolonged hospital stay, increased healthcare costs, and delayed discharge times.[14] This study aimed to investigate the effect of spinal anesthesia needle size on the incidence of postoperative headache, known as PDPH.

Methodology:

This study was approved by the the Department of Anesthesia, Faculty of Medical Technology- Al Zahra, Al Jafara University, Libya and written informed consent was obtained from all participants.

Study design:

This was a descriptive and cross-sectional study. The study method included surveying a sample of patients who underwent spinal anesthesia, and participants were divided into two groups. Group A (with Headache) and Group B (without Headache). The questionnaire collected data on patients' demographic characteristics, the size of anesthesia needles used, and the severity of any headaches experienced.

Population and sample

The study population included (100) patients of both genders between 20 and 82 years of age, and weighing 60–90 kg, who underwent spinal anesthesia in both the Preventive Medical Hospital (Maitiga) and Al-Zahraa Hospital, from January to 18th June 2024. Patients with a history of headache, backache, or any neurological disease were excluded from the study.

Data analysis

Data analysis was conducted using the IBM SPSS Statistics 24 software. Descriptive statistics, including frequencies and percentages, were calculated. Pearson correlation analysis was performed to assess the relationships between variables. To evaluate the statistical significance of the findings, independent t-tests, one-way ANOVA, and chi-square tests were utilized. A p-value less than 0.05 was considered evidence of statistical significance.

Result

A total of 100 participants were included in the study with 20 males and 80 females in this study, recorded 52 with PDPH while 48 did not have PDPH (Table 1). The percentage of females with headaches (58.8%) is more than double the percentage of males with headaches (25.0%). There is strong evidence that gender is significantly (p-value of 0.007) associated with the presence or absence of headaches. This shows that females are more affected by headaches compared to males.

The mean age of group A was 32.81 years (± 9.01 SD), while the mean age of group B was slightly higher at 38.39 years (± 14.20 SD). The p value associated with this comparison was 0.020, indicating a trend toward a statistically significant difference. On the other hand, the mean age of Group A was 74.32 kg (±12.49 SD) and Group B was slightly higher at 38.39 kg (±14.20 SD), and the difference in mean weight between the two groups was not statistically significant. In other words, the results suggest that there is no significant difference in weight between individuals who experience headaches and those who do not.

Regarding medical history, the results showed that those with no medical history were more likely to suffer from headaches, while those with a medical history were associated with a lower likelihood of developing headaches. There was also no specific difference between those with a medical history who reported having headaches, compared to those without a medical history. In addition to having previously undergone surgery, the results showed that most of the participants in Group A had previously undergone surgery, but there was no difference compared to those who did not suffer from headaches.

The mean duration of the surgical procedure for patients who experienced postoperative headaches was 52 minutes (SD = 11.3), whereas the mean duration for patients who did not report headaches was 44 minutes (SD = 8.4). This difference in mean operation time between the two groups approached, but did not reach, statistical significance (p = 0.337).

Table 1. The demographic characteristics of participants

Items		**Group A**	**Group B**	**p-value**
Number of cases		52	48	0.532
Gender	**Male** n (%)	5 (9.6)	15 (31.25)	0.007* [c]
	Female n (%)	47 (90.4)	33 (68.75)	
Age (yr) (Mean ± std)		32.81 ± 9.01	38.39±14.20	0.020* [t]
Weight (kg) (Mean ± std)		74.32 ±12.49	76.13 ±11.05	0.454 [t]
Medical history	Yes	13	12	1.000 [c]
	No	39	36	
Previous Operation	Yes	40	41	0.279[c]
	No	12	7	
Time of operation (minute) (Mean ± std)		52 ± 11.3	44 ± 8.4	0.337 [t]

Note: [t]: intendent t- test, [c]: chi square, *: p-value < 0.05 significant.

An analysis of the distribution of anesthesia administration among patients with and without postoperative headaches is presented in Table 2. The most common frequency of anesthesia administration was 2 times, which occurred in 28.8% of patients who experienced headaches and 39.6% of those who did not. Additionally, 25.0% of patients with headaches received anesthesia 1 time, compared to 16.7% of those without headaches. There was no significant difference in the distribution of anesthesia administration between the two groups (p = 0.474).

Table 2. Distribution of Times Patients Received Anaesthesia by Presence of Headaches

Times get anaesthesia	Group A	Group B
1.00	13 (25)	8 (16.7)
2.00	15 (28.8)	19 (39.6)
3.00	10 (19.2)	9 (18.8)
4.00	9 (17.3)	9 (18.8)
5.00	2 (3.8)	2 (4.2)
6.00	3 (5.8)	0 (0.0)
7.00	0 (0.0)	1 (2.1)
p-value	0.474	

The Chi-square statistic is significant at the .05 level.

The data in Table 3 shows the distribution of recent surgical procedures between patients with and without postoperative headaches. Cesarean section was most common in the headache group (84.6%) compared to the non-headache group (62.5%). Conversely, procedures like kidney stent installation, lithotripsy, and hemorrhoid surgery were more prevalent in the non-headache group. Which did not find a significant difference in the distribution of the type of operation between the two groups (p = 0.096).

Table 3. Distribution of Type of Recent Operation by Presence of Headaches

Type of recent operation	Group A	Group B
Cesarean Section	44 (84.6)	30 (62.5)
Installation of a kidney stent	1 (1.9)	4 (8.3)
Lithotripsy	2 (3.8)	5 (10.4)
Herniation	0 (0.0)	1 (2.1)
Hemorrhoids	0 (0.0)	4 (8.3)
Prostate operation	2 (3.8)	3 (6.3)
Urinary Tract Operation	2 (3.8)	1 (2.1)
Hysterectomy	1 (1.9)	0 (0.0)

p-value (chi square)	0.096

The Chi-square statistic is significant at the .05 level.

The results presented in Table 4 indicate a statistically significant association between the severity of postoperative headaches and mean operation time. The mean operative time for patients with mild headache was 36 ±3.47 minutes, while the mean operative time for patients with moderate headache was 41.3 ±2.06 minutes. Patients who reported severe headache had the longest operative duration of 52.1 ±4.39 minutes.

Table 4. Association between Headache Severity and Operation Time

Severity of PDPH	**Operation Time** (Mean ± std)	p-value
Mild	36 minute ±3.47	0.024
Moderate	41.3 minute±2.06	
Severe	52.1minute ±4.39	

One Way ANOVA statistic is significant at the .05 level.

The severity of the headache was divided into three levels, each level having a specific category of values to measure the severity of the headache. The relationship between values for each level along with the operation time. The Table 5 shows a positive correlation between postoperative headache severity and surgical operation time. For mild headaches, the correlation coefficient was 0.29 (p=0.041). This increased to 0.43 (p=0.017) for moderate headaches and 0.492 (p=0.003) for severe headaches. These statistically significant findings indicate that longer procedures are associated with greater headache intensity.

Table 5. Correlations between Headache Severity and Operation Time

Severity of PDPH	**Operation Time (r)**	**p-value**
Mild	0.29	0.041
Moderate	0.43	0.017
Severe	0.492	0.003

The Person correlation

Table 6 shows the association between headache severity and needle size (p=0.001). Severe headaches occurred with 22-gauge needles (100%). Moderate headaches were common with 25-gauge (33.3%) and 26-gauge (20.4%). Mild headaches were most frequent with 26-gauge (20.4%) and 27-gauge (19.2%). No headaches were reported in 73.1% using 27-gauge needles vs 25.0% with 25-gauge. Larger needle sizes appear linked to increased headache severity.

Table 6: Relationship between the severity of headache and the needle size used

Severity of headaches	The size of the needles			
	22 gauge	**25 gauge**	**26 gauge**	**27 gauge**
Mild n (%)	0 (0)	1 (8.3)	11 (20.4)	5 (19.2)
Moderate n (%)	0 (0)	4 (33.3)	11 (20.4)	1 (3.8)
Severe n (%)	8 (100)	4 (33.3)	6 (11.1)	1 (3.8)
None	0 (0)	3 (25.0)	26 (48.1)	19 (73.1)
p-value	0.001*			

The Chi-square statistic is significant at the .05 level.

Table 7 shows the relationship between timing of headache onset and needle size (p = 0.030). Immediate postoperative headache was more common with 22-gauge needles (100%) versus 75.0% for 25-gauge needles, 42.6% for 26-gauge needles, and 23.1% for 27-gauge needles. Delayed headache (2 hours) occurred in 7.4 % with 26 and 3.8% with 27, but nothing happened with 22/25. Very few (1.9%) experienced a 5-hour headache, only with the 26 gauge. Larger needles are associated with a more immediate headache.

Table 7: relationship between the start of headache and the needle size used

Start headaches	The size of the needles			
	22 gauge	**25 gauge**	**26 gauge**	**27 gauge**
After operation	8 (100%)	9 (75.0%)	23 (42.6%)	6 (23.1%)
2 hr After operation	0 (0.0%)	0 (0.0%)	4 (7.4%)	1 (3.8%)
5 hr After operation	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)
p-value	0.030			

The Chi-square statistic is significant at the .05 level.

The data presented in Table 8 provides insight into the distribution of headache termination periods based on the specific medication used for treatment. Diclofenac proved to be the most effective, with 100% of headaches resolving in under 30 minutes. Acopan I.M., Voltarin I.V., and Paracetamol I.V. also exhibited relatively high proportions of headaches resolving within the first 30 minutes, at 40.0%, 27.3%, and 18.6% respectively. For headaches resolving within 31-60 minutes, coffee, Paracetamol I.V., and Tramadol 100mg I.V. had the highest percentages at 37.5%, 37.2%, and 40.0% respectively. Profen was most effective for headaches lasting 61-120 minutes, with 50% of cases falling in this duration range. Prolonged headaches lasting over 301 minutes were most common with Tramadol 100mg I.V. (60.0%), followed by Paracetamol I.V. (23.3%) and Acopan I.M. (20.0%). The differences in headache termination periods were statistically significant for Paracetamol I.V., Profen, and Tramadol 100mg I.V., but not for the other medications.

Table 8: The distribution of headache termination periods on drug used for treatment

Time to end the headache	Drink coffee N (%)	Paracetamol I.V N (%)	Voltarin I.V N (%)	Acopan I.M N (%)	Diclofenac N (%)	Profen N (%)	Tramadol 100mh I.V N (%)
<30 min	1(12.5)	8 (18.6)	3 (27.3)	2 (40.0)	1 (100.0)	0 (0.0)	0 (0.0)
31 - 60 min	3 (37.5)	16 (37.2)	3 (27.3)	1 (20.0)	0 (0.0)	1 (25.0)	2 (40.0)
61 - 120 min	1 (12.5)	4 (9.3)	1 (9.1)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)
121 - 300	0 (0.0)	1 (2.3%)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)
> 301 min	0 (0.0)	10 (23.3)	1 (9.1)	1 (20.0)	0 (0.0)	0 (0.0)	3 (60.0)
p-value	0.620	0.001	0.621	0.542	0.287	0.001	0.011

The Chi-square statistic is significant at the .05 level.

Discussion

The existing literature has extensively examined the factors that contribute to the development and severity of PDPH. These studies have established that various patient characteristics, such as age and gender, as well as the technical aspects of the spinal procedure, including the type and size of the needle used, play a significant role in the incidence of PDPH. Particularly, the design of the needle, including its gauge and tip configuration, have been identified as important modifiable factors that can influence the likelihood and intensity of PDPH experienced by patients. This body of research highlights the multifactorial nature of PDPH and the need to carefully consider both patient-specific and procedural factors when attempting to mitigate the occurrence and impact of this complication.

In this study out of a total of 100 participants, 52 (52%) PDPH incidence, with a significantly higher proportion of females (47, 90.4%) experiencing headache compared to males (5, 9.6%). This finding is consistent with previous studies that have shown a higher prevalence of headache among females are in accordance with previous study found that females were more likely to experience headache than males [15]. The study also found that the average age of participants without headaches was marginally higher compared to those with headaches. Specifically, the difference in mean age between the two groups was statistically significant ($p = 0.020$) [15]. This has been attributed to the increased elasticity of the dural fibers in this younger age group. The more elastic dural tissue tends to allow dural defects to remain patent, contributing to the higher PDPH rates observed in younger individuals. In contrast, older patients were found to have lower baseline CSF pressures. This lower CSF pressure in the older patient population may help explain the relatively lower incidence of PDPH seen in this age group[15].

On the other hand, the current study found that the mean weight of individuals who PDPH incidence was 74.32 ± 12.49 kg, which was slightly lower than the mean weight of 76.13 ± 11.05 kg for those PDPH [15]. However, the difference in weight between the two groups was not statistically significant (p = 0. 454) [15,16]. Additionally, no significant correlation (p = 1.0) was observed between participants' medical histories and the incidence of PDPH.

Furthermore, the findings of this study indicate that there was no significant correlation between the occurrence of headaches and the patient's history of previous operations (p = 0.279)[14] or the number of times they had been exposed to anesthesia (p = 0.474) [17].

Moreover, the current study found that cesarean sections were the most common recent operation[18], with a higher percentage of patients who experienced PDPH having undergone a cesarean section (84.6%) compared to the group without PDPH. However, the difference in the distribution of recent operations between the two groups was not statistically significant (p = 0.096).

The current study investigated the relationship between headache severity and operation time, which demonstrated a statistically significant association (p = 0.024). Specifically, the average operation time for patients with mild headaches was about half an hour, for those with moderate headaches it was more than half an hour, and for those with severe headaches it was about an hour. These findings indicate a clear variation in operation time across the three levels of headache severity. Furthermore, the study also examined the associations between headache severity and operation time, revealing positive and statistically significant correlations for all three levels of headache severity. These findings suggest that longer operation times are consistently associated with increased headache severity.

The current study investigated the relationship between headache severity and the size of the spinal needle used. The results revealed a statistically significant correlation between the severity of the headache and the size of the needle (p = 0.001) [15]. Based on these findings, the size of the needle used during the procedure appears to be an important factor in determining the severity of the headache experienced by patients.

The current study revealed that the use of larger needles is associated with more severe headaches. This finding is consistent with previous research, which has shown that larger needles can cause greater tissue trauma and CSF leakage [19], which is likely the main cause of PDPH. In contrast, the use of smaller needles may be associated with decreased headache severity producing smaller tears in the dura mater, thus reducing cerebrospinal fluid leakage and risk of PDPH [20].

The study findings indicate that the severity of PDPH is relatively distributed across the range of needle sizes used for spinal anesthesia. Larger needle sizes, such as the 22-gauge[21], were more likely to be associated with severe headaches, while the 25- and 26-gauge needles were more often linked to milder headaches. Conversely, the use of smaller needles, such as 27-gauge[9], was less likely to result in PDPH, corroborating previous research. Moreover, the data showed that the onset of headache occurs immediately after the surgical procedure for most patients. These results underscore the significant impact that needle size can have on the severity of PDPH experienced by patients undergoing spinal anesthesia.

In particular, the treatment used for PDPH was found to have a significant relationship between the time of headache resolution and certain medications such as Paracetamol IV [18], Profen, and Tramadol 100mg IV. In contrast, other treatments evaluated, including drinking coffee[18,22], Voltaren IV, Acupan IM, and Diclofenac, did not show a significant association with time to headache resolution.

This study had several limitations, including a small sample size that may limit the generalizability of the findings, as well as a patient population drawn solely from public and private healthcare facilities, rather than a more diverse representation. However, despite these constraints, the researchers deemed the study's outcome measures to be satisfactory for meeting the intended research objectives, having implemented rigorous protocols to ensure the validity and reliability of the data.

Conclusion:

Our study showed that gender is significantly associated with the presence or absence of headaches, as females were more affected by headaches than males, and the occurrence and severity of headaches were also associated with the average time of surgery, as the longer the surgery, the more severe the headache, as well as the size of the anesthesia needle, as the larger the size of the needle, the greater the chance of headaches and their severity.

These findings have implications for clinical practice, suggesting that healthcare providers should consider using smaller needles to minimize the risk of headache and discomfort in patients receiving injections.

Recommendation:

- Healthcare providers should consider using smaller needles, such as 27-gauge, to reduce the risk of headache and discomfort in patients receiving injections.

- During spinal anesthesia needle insertion, consider the patient's position. Lying on the side is a viable option to prevent PDPH. Also, inserting the needle perpendicularly (rather than parallel to the spine's long axis) significantly increases the risk of PDPH.
- Since pencil-point spinal needles are associated with a lower frequency and severity of PDPH, we recommend that medical centers use alternatives to Quincke-type needles when dispensing needles.
- We hope that further studies will be conducted to investigate strategies for reducing the incidence of post-procedure headaches.

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