



A prospective observational study on the incidence and risk factors associated with post-dural puncture headache after spinal anaesthesia

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Abstract

Background: Post-dural puncture headache (PDPH) is a common and often disabling complication associated with spinal anaesthesia. It is mainly influenced by factors such as the patient's age, sex, and the size and design of the spinal needle used during the procedure. PDPH usually presents as a severe, positional headache that can significantly impair mobility and hinder daily activities, thereby affecting postoperative recovery and overall patient well-being. Understanding how these risk factors interact is vital for developing preventive strategies and optimising anaesthetic techniques to minimise the occurrence of PDPH.

Objective: This study aimed to evaluate the incidence and risk factors for post-dural puncture headache (PDPH) among patients undergoing spinal anaesthesia in the Operating Theatre and Postoperative Recovery Area of SRM Medical College Hospital and Research Centre, Kattankulathur, Tamil Nadu, India, between June and August 2024.

Methods: This observational study was conducted at SRM Medical College Hospital & Research Centre, Kattankulathur, Tamil Nadu, India, with approval from the Institutional Ethics Committee (IEC No. ST0723-812). A total of 239 adult patients who underwent surgical procedures under spinal anaesthesia between June and August 2024 were included. The study aimed to assess the incidence of post-dural puncture headache (PDPH) and identify associated risk factors. Data were collected from patient records and postoperative assessments. Variables analysed included age, gender, body mass index (BMI), history of headaches, prior PDPH episodes, patient positioning during spinal anaesthesia, number of puncture attempts, and the type and gauge of spinal needle used. The study also examined the type and severity of PDPH and the medications used for its management. Descriptive statistics were used to calculate the incidence of PDPH, while inferential statistical tests, including chi-square, t-test, and logistic regression, were employed to explore the relationship between risk factors and PDPH occurrence, with significance set at $p < 0.05$.

This observational study was approved by the institutional ethics committee (IEC no. ST0723-812) and included 239 adult patients who underwent surgical procedures under spinal anaesthesia and developed post-dural puncture headache (PDPH). The study examined the incidence of PDPH and explored risk factors, including age, gender, body mass index (BMI), history of headaches, prior PDPH episodes, patient position, number of attempts, needle type and size, headache type, PDPH severity, and medications used to mitigate PDPH.

Result: In this study, the overall incidence of post-dural puncture headache (PDPH) was 12.5%. Most PDPH cases occurred within the first 72 hours after spinal anaesthesia, with a gradual decline in frequency after 42 hours ($p < 0.05$). A significant association was found between the type of spinal needle used and the incidence of PDPH; patients who received anaesthesia with a 25-gauge Quincke needle had a higher rate of PDPH ($p = 0.014$). Additionally, the number of needle insertion attempts was significantly linked to PDPH occurrence, with patients undergoing one or two attempts showing a higher incidence than those with three attempts ($p = 0.004$). In contrast, demographic variables such as age and gender, along with surgical factors including prior history of PDPH, patient positioning during the procedure, and needle type, did not show a statistically significant relationship with PDPH incidence.

Conclusion: This study showed that using smaller-gauge spinal needles significantly reduces the incidence of post-dural puncture headache (PDPH) compared with larger cutting needles such as the Quincke type. Frequent lumbar puncture attempts and increased cerebrospinal fluid (CSF) leakage were also identified as contributing factors to PDPH. Based on these results, clinicians are advised to use smaller spinal needles to reduce CSF leakage and to minimise the number of puncture attempts during spinal anaesthesia and lumbar puncture procedures. These measures may help reduce the risk of PDPH and enhance postoperative patient comfort and outcomes.

Keywords: Post-dural puncture headache, spinal anaesthesia, lumbar puncture, spinal needle

Introduction

Neuraxial anaesthesia (NA) is preferred for its effectiveness in delivering anaesthesia, combined with excellent intraoperative neuromuscular paralysis, and its ability to alleviate postoperative pain through continuous infusion.^[1] Because NA techniques are widely used in clinical settings,

post-dural puncture headache (PDPH) often occurs as a common iatrogenic complication caused by spinal taps or accidental dural punctures during epidural blocks, posing a significant challenge for healthcare professionals^[2]. According to the International Classification of Headache Disorders, postdural puncture headache (PDPH) is a

headache that develops within 5 days following a lumbar puncture (LP). It worsens when standing or sitting, but improves when lying down ^[3]. The first case of post-dural puncture headache (PDPH) was reported in 1898. Since then, PDPH has become a major concern for individuals following dural puncture. It remains a key iatrogenic factor affecting patient morbidity in modern medical anaesthesia ^[4]. Associated symptoms include a stiff neck, hearing loss, tinnitus, photophobia, hyperacusis, and nausea. The occurrence of PDPH is more common among pregnant women. ^[5] A frequent complication of lumbar puncture arises from cerebrospinal fluid (CSF) leaking into the epidural space through the dura mater tear. The reported incidence of PDPH ranges from 10% to 40%, depending on age, gender, and needle size ^{[6][7]}. PDPH presents as a dull, throbbing pain in the frontal-occipital area radiating to the neck and shoulders. Recent studies indicate that PDPH occurs within 3-5 days after dural puncture ^[7]. Multiple factors influence the onset of headache following a lumbar puncture, such as the size and design of the needle, the orientation of the bevel, and the number of puncture attempts. Specifically, using smaller-diameter, non-cutting (atraumatic) needles is associated with a decreased risk of post-LP headache. Furthermore, aligning the needle bevel parallel to the dural fibres promotes better sealing of the puncture site and helps limit cerebrospinal fluid leakage ^[8]. Spinal needles commonly used today range from 22 to 27 G, although sizes from 18 to 30 G are also available. The incidence of PDPH after spinal anaesthesia with a Quincke (cutting) needle is 36% with a 22-G needle, 25% with a 25-G needle, 2 to 12% with a 26-G needle, and less than 2% with needles smaller than 26-G. Smaller needle diameter reduces the risk of post-dural puncture headache (PDPH). However, extremely thin spinal needles can pose technical challenges for the operator. Conversely, multiple dural punctures from unsuccessful attempts increase the likelihood of PDPH ^[9]. Prevention and management of PDPH include several strategies, such as using smaller-diameter spinal needles and non-cutting (atraumatic) needles, positioning the needle bevel parallel to the dural fibres, administering prophylactic epidural blood patches, epidural morphine, intrathecal catheters, and epidural or intrathecal saline. Additionally, providing psychological and emotional support is essential, along with conservative treatments such as bed rest, increased hydration, caffeine intake, antiemetics, paracetamol, non-steroidal anti-inflammatory drugs, and peripheral nerve blocks. Nonetheless, if untreated, 75% of cases improve within the first week, and 88% resolve spontaneously within six weeks ^[10].

This study was carried out in the Department of Anaesthesiology at SRM Medical College Hospital and Research Centre, located in Potheri, Kattankulathur, within Kancheepuram District, Tamil Nadu, India. Ethical approval was obtained from the Institutional Ethics Committee (IEC No. ST0723-812) prior to the start of the study. All participants were informed about the nature and aim of the research, and written informed consent was received from each individual before their inclusion, ensuring compliance with ethical standards and respect for patient autonomy.

Methodology

This prospective observational study was conducted over 18 months in the Operating Theatre and Postoperative

Recovery Area of SRM Medical College Hospital and Research Centre in Kattankulathur, Tamil Nadu, India. The study population comprised adult patients scheduled for elective surgical procedures under spinal anaesthesia.

Ethics Clearance No: SRMIEC-ST0723-812

Inclusion Criteria:

- Individuals aged 18 to 65 years
- Patients scheduled for elective procedures in the departments of general surgery, obstetrics, gynaecology, or urology
- Both male and female participants
- Patients with a body mass index (BMI) ranging from 19 to 30
- Classified as American Society of Anaesthesiologists (ASA) Physical Status I or II

Exclusion Criteria:

- Patients who do not give informed consent to participate in the study
- Patients scheduled for orthopaedic surgical procedures

Preoperative

All patients underwent a comprehensive medical history review, physical examination, and routine investigations. After this, detailed information about the procedure was provided, and informed consent was obtained. For elective surgeries, patients were instructed to fast for at least 6 hours before the administration of spinal anaesthesia or analgesia. As part of the premedication protocol, Tablet Alprazolam 0.5 mg was given the night before surgery to reduce anxiety and promote restful sleep.

Anaesthesia Administration and Intraoperative Monitoring

Upon entering the operating theatre, an 18-gauge intravenous cannula will be inserted into the non-dominant hand, and intravenous fluid therapy will be commenced. Patients will be continuously monitored using a pulse oximeter, an electrocardiogram (ECG), and a non-invasive blood pressure (NIBP) monitor. Baseline vital parameters will be recorded prior to the administration of spinal anaesthesia.

The following patient data will be systematically recorded:

- Demographic details: age, sex, height, and weight
- ASA physical status classification
- Type of surgery: elective or emergency
- Spinal needle specifications: type and gauge
- Number of attempts for successful spinal anaesthesia
- Patient positioning during induction: sitting or lateral

Following institutional infection control protocols, the lumbar region will be cleansed and draped. An antiseptic solution will be applied, followed by local infiltration using 2% lignocaine. A central lumbar puncture will be performed at either the L3–L4 or L4–L5 interspace, with the needle's bevel aligned parallel to the dural fibres.

Once entry into the subarachnoid space is confirmed by the presence of clear and free-flowing cerebrospinal fluid (CSF), the needle will be rotated to direct the ejection orifice upwards. After administering the local anaesthetic, CSF will be re-aspirated to verify correct

placement and confirm the presence of the anaesthetic agent within the subarachnoid space. The sensory block level will then be assessed.

If adequate anaesthesia is not achieved within 15 minutes, general anaesthesia will be administered, and such patients will be excluded from the study.

- Post-block monitoring will include:
- Heart rate, oxygen saturation (SpO₂), and NIBP every 2 minutes for the first 20 minutes
- Followed by monitoring every 5 minutes until the completion of surgery.

Postoperative Assessment and Management of Complications

All patients will be closely observed for intraoperative and postoperative adverse events, including hypotension, nausea, vomiting, shivering, drowsiness, analgesia, respiratory depression, and pruritus. These events will be carefully documented. Postoperative monitoring will take place on days 1, 2, and 3 to detect symptoms of post-dural puncture headache (PDPH).

1. PDPH will be diagnosed based on the following clinical criteria:
2. Headache localised to the occipital or frontal regions.
3. Symptoms that worsen when sitting or standing and improve when lying down.

Initial management of PDPH will follow a conservative approach, including:

- Bed rest
- Intravenous fluid administration
- Paracetamol therapy

Patient response to conservative treatment will be assessed. In cases where symptoms continue or worsen, interventional therapies such as a sphenopalatine ganglion block or an epidural blood patch will be considered. Additional postoperative complications, including the need for intensive care unit (ICU) admission and prolonged hospitalisation, will also be documented and analysed.

Sample Size Calculation

Based on findings from a reference study, the prevalence of the condition was estimated to be 29%. The required sample size was calculated using the standard formula:

$$n = Z^2 \cdot P \cdot Q / d^2$$

Where:

- $Z = 1.96$ (standard normal variate for 95% confidence)
- $P = 29\%$ (estimated prevalence)
- $Q = 100 - P = 71\%$
- $d = 5.8\%$ (margin of error)

$$n = (1.96)^2 \cdot 29 \cdot 71 / (5.8)^2 = 235$$

To account for a potential 10% dropout rate, the final sample size was adjusted to 239 patients, who were subsequently recruited for the study

Statistical Analysis

Descriptive statistics were utilised to summarise the data. Continuous variables were presented as means and

standard deviations, whilst categorical variables were expressed as frequencies and percentages.

Comparative analysis was performed using:

- The independent samples t-test for continuous variables
- The Pearson chi-square test for categorical variables

A two-tailed p-value of less than 0.05 was regarded as statistically significant. All data were analysed using IBM SPSS Statistics Trial Version 21.0 (IBM SPSS Inc., Chicago, IL).

Results

Sociodemographic characteristics of the participants

A total of 239 patients participated in this study. Of these, 135 were under 40 years old, 72 were between 40 and 60 years old, and 32 were over 60 years of age [Figure 1]. Of the cohort, 150 [62.8%] were female and 89 [37.2%] were male [Figure 2]. The patient cohort included individuals with a BMI of less than 18 (2.39%), 225 patients with a BMI between 19 and 30 (94.1%), and patients with a BMI over 30 (5.4%) [Table 1].

Intraoperative characteristics of patients

During intraoperative care, 30 patients (12.6%) were positioned laterally, while the majority—209 patients (87.4%)—were positioned in a sitting position. In terms of the number of attempts for successful spinal anaesthesia, 194 patients (81.2%) required only one attempt, 42 patients (17.6%) required two attempts, and 3 patients (1.3%) required three attempts. Regarding the type of spinal needle used, the Quincke needle was employed in 233 cases (97.5%), making it the predominant choice, while the Whitacre needle was used in only 6 cases (2.5%). Analysis of needle gauge distribution revealed that 25G needles were the most commonly used, accounting for 84.9% of cases. This was followed by 23G needles (8.4%), 26G needles (4.2%), and 27G needles (2.5%), indicating a clear preference for the 25G needle in clinical practice.

Among the needle sizes observed, 25G needles were the most commonly used, accounting for 84.9% of the total cases. In comparison, 23G needles made up 8.4%, 26G needles 4.2%, and 27G needles 2.5%. These findings clearly show a preference for the 25G needle size in spinal anaesthesia practice. [Table – 2].

The incidence of PDPH and associated symptoms

During the preoperative assessment, 36 patients (15.1%) reported a history of headaches, while 203 patients (84.9%) did not. Post-dural puncture headache (PDPH) was observed in 19 patients (7.9%) before surgery, whereas 220 patients (92.1%) were asymptomatic. In the postoperative period, headaches localised to the occipital and frontal regions were reported in 30 patients (12.6%) out of 239, while 209 patients (87.4%) did not experience such symptoms. PDPH severity was noted in 31 patients (13.0%), and 208 patients (87.0%) were excluded from this analysis due to the absence of PDPH. Postoperatively, DOLOPAR was administered to 26 patients (10.9%), while 213 patients (89.1%) did not receive the medication. [Table – 3].

Age Distribution Of Participants

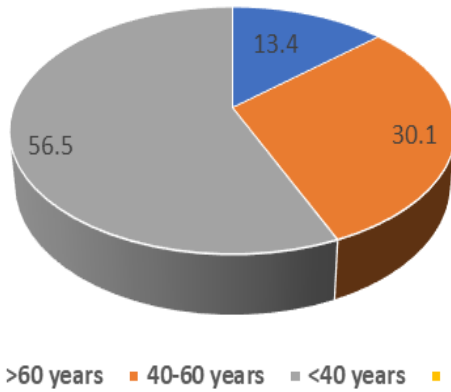


Fig 1: Showing age distribution of study participants

Gender Distribution Of Participants

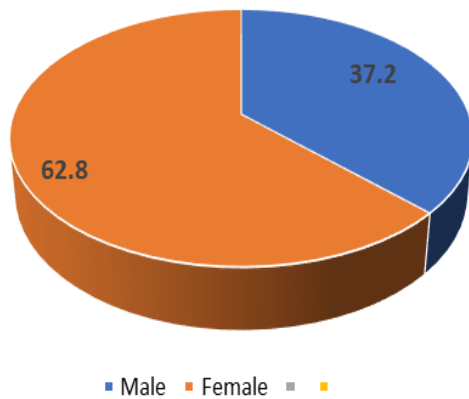


Fig 2: Showing the gender distribution of study participants

Table 1: Demographic Variables of the patients involved in the study

Variables	Category	Frequency	Percentage
Age in years	<40	135	56.5
	40-60	72	30.1
	>60	32	13.4
Gender	Female	150	62.8
	Male	89	37.2
BMI	< 18	1	2.39
	19-29	225	94.1
	>30	13	5.4

Table 2: Intraoperative characteristics of patients

Variables	Category	Frequency	Percentage
Needle size	23G	20	8.4
	25G	203	84.9
	26G	10	4.2
	27G	6	2.5
Position	Lateral	30	12.6
	Sitting	209	87.4
Needle of attempt	1.00	194	81.2
	2.00	42	17.6
	3.00	3	1.3
Type of Spinal Needle used	Quincke	233	97.5
	Whitacre	6	2.5

Table 3: The incidence of PDPH and associated symptoms

Variable	Category	Frequency	Percent
Previous H/O Headache	No	203	84.5
	Yes	36	15.1
Previous PDPH	No	220	92.1
	Yes	19	7.9
Headache Type Occipital and Frontal Area	Yes	30	12.6
	No	209	87.4
PDPH Severity	No	208	87.0
	Yes	31	13.0
Distribution of PDPH Drug	No	26	10.6
	Yes	213	89.1

Discussion

In the present study, the incidence of post-dural puncture headache (PDPH) was observed in 30% of participants. This finding differs from previous studies conducted in various populations. A study from Ethiopia reported a higher prevalence of PDPH at 38% among patients undergoing spinal anaesthesia [11]. Conversely, another study focusing on patients undergoing orthopaedic procedures found a PDPH incidence of 20% [12]. Among parturients, [13] the prevalence was notably lower, with only 7% experiencing PDPH symptoms [14].

This study identifies male gender as a protective factor against post-dural puncture headache (PDPH). Several studies have demonstrated that women are 2–3 times more likely to develop PDPH than men. This gender disparity may be attributed to higher estrogen levels in females, which can influence cerebral vessel tone and lead to increased vascular distension in response to cerebrospinal fluid (CSF) hypotension. These findings are consistent with existing literature. However, it is important to recognise that some studies have found no statistically significant association between gender and PDPH incidence, suggesting that other factors may also contribute role [15,16]. Body mass index (BMI) emerged as a significant sociodemographic factor influencing PDPH outcomes in this study. Patients with a BMI greater than 19 showed a higher risk of developing PDPH compared to those with a BMI below 18, consistent with findings from research conducted at the University of California, San Diego. Furthermore, individuals classified as obese (BMI ≥ 25 kg/m²) exhibited an increased likelihood of experiencing PDPH compared to non-obese patients (BMI < 25 kg/m²) [17]. These observations are supported by multiple studies. [18].

Interestingly, despite earlier literature recognising lower BMI, younger age, and a history of PDPH as potential risk factors, our analysis did not find a statistically significant correlation between these variables and the onset of PDPH in this cohort. This suggests that the relationship between BMI and PDPH may be more complex and affected by additional physiological or procedural factors [19]. In this study, the size of the spinal needle was significantly linked to the incidence of post-dural puncture headache (PDPH). Needle gauge is a well-known factor in the development of PDPH, with smaller-diameter needles generally believed to reduce its occurrence [20]. Our findings showed that patients who underwent spinal anaesthesia (SA) with larger-gauge needles had a higher risk of PDPH compared to those who received smaller-gauge needles. This increased risk is due to the larger dural perforations

caused by thicker needles, leading to more cerebrospinal fluid (CSF) leakage. These results are consistent with existing literature, which supports the protective effect of using finer needles in decreasing PDPH incidence^[21].

Spinal headaches can be associated with modifiable risk factors, such as the size and type of spinal needle, as well as the number of attempts used to perform the subarachnoid block^[22]. Our results align with those of a prior study conducted in a similar setting using a 25G Quincke needle^[23]. Pencil point dural fibre splitting, as seen with the Whitacre needle, is linked to less PDPH than the dura-cutting Quincke needle^[24]. Another important association was identified between the number of attempts and the development of PDPH. Patients whose SA was successful on the first attempt were less likely to develop PDPH than those requiring multiple attempts.

Several studies have reported that the sitting position during spinal anaesthesia is associated with a higher incidence of post-dural puncture headache (PDPH), likely due to increased cerebrospinal fluid pressure contributing to greater dural disruption^[25]. In this study, the sitting position during spinal anaesthesia was linked to a greater incidence of PDPH. Evidence shows that performing dural puncture in the lateral decubitus position results in fewer cases of PDPH. This is because the lower cerebrospinal fluid (CSF) pressure in the lateral position—around 20 cm H₂O—compared to 40 cm H₂O in the sitting position. The higher CSF pressure in the sitting posture may lead to a larger dural tear, allowing prolonged CSF leakage into the epidural space during recovery. These findings emphasise the importance of patient positioning as a modifiable factor in reducing PDPH risk^[26].

Post-dural puncture headache (PDPH) can be classified into mild, moderate, and severe categories based on the level of impairment. Mild PDPH involves a headache that causes slight limitations on daily activities, with the patient still able to get out of bed. Moderate PDPH presents more noticeable symptoms, restricting daily activities and requiring the patient to remain in bed for part of the day. Severe PDPH necessitates complete bed rest due to intense discomfort and an inability to function^[27]. Conservative management remains the primary approach and includes bed rest, adequate hydration either oral or intravenous caffeine intake, use of an abdominal binder, adopting a prone position, and administering analgesic medications. These strategies aim to minimise cerebrospinal fluid leakage and relieve symptoms while avoiding invasive procedures and interventions^[28].

Conclusion

This study's findings indicate that younger individuals and female patients are more susceptible to post-dural puncture headache (PDPH), suggesting a possible demographic predisposition. The use of a 25-gauge Quincke spinal needle was notably associated with a higher occurrence of PDPH, likely because of its cutting tip design, which may cause more dural trauma. Additionally, rates of PDPH increased when spinal needles were utilised during both the first and second attempts, highlighting the impact of multiple punctures on dural integrity. Importantly, postoperative administration of Dolopar 650 mg was found to significantly decrease the incidence of PDPH, pointing to its potential as a prophylactic analgesic measure in reducing this complication.

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