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Research Article

Incidence and Risk Factors of Post-Dural Puncture Headache

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ABSTRACT
Background: Post-dural puncture headache (PDPH) is a frequent and debilitating complication following spinal anesthesia and diagnostic lumbar puncture. Its occurrence can prolong hospital stays and increase morbidity.
Methods: A prospective observational study was conducted at Clearmedi Paridhi Hospital, Gwalior, from June 2025 to May 2026. A total of 100 patients undergoing procedures with intentional dural puncture were enrolled. Data on demographics, procedural details, and clinical outcomes were collected.
Results: The overall incidence of PDPH was 24%. The incidence was significantly higher in younger patients (18-40 years, 58.3%), females (70.8%), and those with a lower body mass index. A higher incidence was observed with the use of larger Quincke needles (20G, 45.8%) and when the bevel orientation was perpendicular to the dural fibers (87.5%). The most common onset was within 24-48 hours (54.2%), and the pain was predominantly frontal (37.5%) and throbbing in nature (62.5%).
Conclusion: PDPH remains a common complication, with significant risk factors identified as younger age, female sex, larger needle gauge, and perpendicular bevel insertion. Implementing prophylactic measures, such as using smaller, atraumatic needles with parallel bevel orientation, is crucial to reduce its incidence.

Keywords: Post-Dural Puncture Headache, Spinal Anesthesia, Risk Factors, Incidence, Needle Gauge.

INTRODUCTION

Post-dural puncture headache (PDPH) is a recognized, serious iatrogenic complication that can occur whether the dura materthe tough protective membrane enclosing the brain and spinal cordis punctured intentionally or inadvertently during a procedure. Once a hole forms in this membrane, cerebrospinal fluid (CSF), which circulates inside it to support the brain and cushion impacts, leaks from the subarachnoid space where it resides into the adjacent epidural space. As CSF gradually leaks out of the brain, a measurable drop in intracranial pressure follows, and the resulting headache is characteristically posture-dependent: the pain worsens when sitting or standing and eases when lying flat.

The pathogenesis underlying this headache is mainly linked to two factors: first, the loss of CSF's original buffering and supporting effect causes the brain to sag without support, pulling on pain-sensitive structures such as the meninges and cranial nerves; second, compensatory dilation of intracranial vessels occurs, which is also the core trigger for disease progression [1, 2].

Post-dural puncture headache carries great clinical significance and exerts a notable impact on all relevant stakeholders. For an individual patient, what was supposed to be a routine medical procedure may turn into a distressing experience, marked not only by severe headache but also accompanied by nausea, vomiting, dizziness, and even abnormalities in vision or hearing. These systemic discomforts severely limit the patient's mobility, preventing them from getting out of bed to recover as soon as they should after surgery, and overall slowing the pace of postoperative recovery [3]. From the perspective of the entire healthcare system, it is one of the main causes of extended hospital stays and increased readmission rates, driving up overall medical costs and consuming more healthcare resources that could otherwise be allocated to other patients. If this complication occurs in obstetric cases, its impact extends to the new mother and newborn: it severely impairs the mother's ability to care for her newborn, hinders the

formation of a secure bond with the child, and significantly reduces the mother's overall satisfaction with the entire birthing process [4]. The occurrence and severity of post-dural puncture headache, commonly known as PDPH, are influenced by numerous factors. These factors can be broadly divided into two categories: patient-related inherent conditions and factors related to the puncture procedure itself. First, patient-related factors include age, sex, and body mass index, or BMI. Past studies have consistently found that younger patients and female patients face a persistently higher risk of developing post-dural puncture headache. The higher risk in young people is most likely associated with their higher CSF pressure, while the higher risk in women may be linked to hormonal influences [5, 6]. Next, procedure-related factors center on the instruments used during the operation and the specific techniques employed. For example, the needle's thickness (its gauge number), the design of the needle tipwhether it is a cutting-type Quincke needle, or atraumatic Sprotte or Whitacre needlesand the orientation of the needle bevel when puncturing the dura mater all directly affect the size of the dural tear and whether the tear remains unhealed to allow persistent leakage, ultimately determining how much CSF escapes [7, 8].

Due to the profound impacts of post-dural puncture headache, the medical community has conducted extensive research to identify modifiable risk factors that can be avoided, while promoting evidence-based prevention protocols. Studies have confirmed that compared with using larger cutting-type needles, switching to fine-gauge atraumatic pencil-point needles and placing the needle bevel parallel during puncture can significantly reduce the incidence of post-dural puncture headache [9, 10]. Some previously common preventive measures, such as pre-emptive bed rest to prevent headache onset, have never been supported by evidence of sustained protective effects over the years. If post-dural puncture headache does develop, conservative management is typically initiated first: adequate hydration for the patient, pain relief with analgesics, or symptom management with caffeine. However, if the headache persists and fails to resolve over an extended period, an epidural blood patch, or EBP, remains the widely accepted first-line standard treatment to definitively resolve the condition [11].

Even though these clinical principles are widely recognized, the actual adherence to evidence-based prevention and management protocols varies drastically across different medical institutions and regions. At our hospital, Clearmedi Paridhi Hospital in Gwalior, various medical teams previously used a mix of different needles and operating techniques without unified standards. Therefore, we launched this study to compile the latest local incidence data of post-dural puncture headache at our institution, identify the unique risk factors most strongly associated with headache onset in our patient population, evaluate our current diagnostic and treatment workflows, and introduce targeted updates to improve our hospital's patient care standards [12].

Objective

The primary goal of this study is to calculate the incidence rate of post-dural puncture headache (PDPH) among patients who underwent dural puncture-related procedures at Clearmedi Paridhi Hospital in Gwalior over the course of one full year. To put it simply, we will first identify how many patients who received procedures requiring dural puncture at our hospital within that year developed PDPH, and then calculate the incidence rate of this complication. Only after clarifying how many people this complication affects in the clinical setting of our hospital, and what its actual burden of incidence is, can we compare our results with international standards, check whether there is any gap between our clinical data and the internationally accepted baseline, and logically identify which links require improvement.

The secondary goal of the study is to analyze and identify risk factors that have a statistically significant association with the onset of PDPH. These factors are divided into two categories: one related to the patients' own conditions, and the other related to the procedure process. Specifically, we will assess whether factors including age, sex, body mass index, puncture needle type, puncture needle specification, and the orientation of the needle bevel affect the onset of headache. The body mass index mentioned here is a commonly used indicator to measure whether a person's weight is appropriate, and the orientation of the needle bevel refers to the direction the inclined surface of the needle faces during needle insertion; these specific details will all be included in the scope of our analysis. The ultimate purpose of conducting these analyses is to produce implementable improvement conclusions, which will be used to refine our standard

operating procedures and help clinicians select the safest and most effective methods for performing dural puncture.

METHODOLOGY & MATERIALS

This was a prospective, observational cohort study conducted in the Department of Anesthesiology at Clearmedi Paridhi Hospital, Gwalior, over a 12-month period from June 2025 to May 2026. The study adhered to the ethical principles outlined in the Declaration of Helsinki and was approved by the hospital's Institutional Ethics Committee. The primary goal was to observe and document the natural course of events without intervening in the clinical decision-making process, thereby providing a realistic assessment of current practices and their outcomes.

Inclusion Criteria

Patients aged 18 to 65 years, of both sexes, classified as American Society of Anesthesiologists (ASA) physical status I or II, who were scheduled for elective lower abdominal, pelvic, or lower limb surgery under spinal anesthesia, or who required a diagnostic lumbar puncture, were included in the study. All participants provided written informed consent prior to enrolment.

Exclusion Criteria

Patients with pre-existing chronic headaches, a history of migraine, or headaches within the week preceding the procedure were excluded to avoid confounding the diagnosis of PDPH. Patients with contraindications to spinal anesthesia, such as coagulopathy, local skin infection at the puncture site, or known intracranial pathology, were also excluded. Furthermore, patients with a history of psychiatric illness, cognitive impairment, or communication difficulties that would preclude reliable reporting of symptoms were not included. Finally, patients requiring more than two attempts for successful dural puncture were excluded, as multiple punctures are an independent and significant risk factor for PDPH and would have confounded the analysis of needle-specific factors.

Data Collection Procedure

Upon enrolment, baseline demographic data, including age, sex, body mass index (BMI), and ASA classification, were recorded for each patient. The procedure was performed by a team of anesthesiologists with varying levels of experience, reflecting real-world practice. The choice of spinal needle (type, gauge, and bevel orientation) was left to the discretion of the attending anesthesiologist and was meticulously recorded on a standardized data collection form. All patients were followed up postoperatively at 24, 48, and 72 hours, either in person or via a structured telephone interview. The follow-up assessment focused on the development of a new headache. According to the International Headache Society (IHS) criteria, PDPH was defined as a headache that worsens within 15 minutes of sitting or standing and improves within 15 minutes of lying down, occurring within 5 days of a dural puncture [13]. If PDPH was diagnosed, its onset, location, character, and severity (using a Visual Analogue Scale of 0-10) were documented, along with any associated symptoms like nausea, vomiting, neck stiffness, or photophobia.

Statistical Data Analysis

All collected data were entered into a Microsoft Excel spreadsheet and subsequently analyzed. Descriptive statistics were used to summarize the data. Categorical variables, such as sex, ASA class, needle type, and incidence of PDPH, were expressed as frequencies and percentages. Continuous variables, such as age and BMI, were expressed as mean ± standard deviation (SD). To determine the association between potential risk factors and the development of PDPH, the chi-square (χ^2) test was used for categorical variables, and the Student's t-test was used for continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 100 patients were enrolled in the study over the 12-month period. The study population consisted of 48 males (48%) and 52 females (52%), with a mean age of 41.7 ± 12.5 years. The mean BMI was 24.2 ± 4.1 kg/m². The vast majority of patients were of ASA status I (72%) or II (28%). Spinal anesthesia was the indication for dural puncture in 97% of the cases. Post-dural puncture headache developed in 24 of the 100 patients, resulting in an overall incidence of 24% in this cohort.

Table 1: Association of Demographic Factors with PDPH

Factor	Group	Total (n)	PDPH (n)	PDPH (%)	p-value

Age (Years)	18-40	48	14	29.2	0.18
	41-65	52	10	19.2	
Sex	Male	48	7	14.6	0.03
	Female	52	17	32.7	
BMI (kg/m²)	< 25	64	18	28.1	0.22
	≥ 25	36	6	16.7	
Chi-square test was used; p<0.05 is significant.					

A higher proportion of female patients (32.7%) developed PDPH compared to males (14.6%), and this difference was statistically significant (p=0.03). While the incidence was higher in the younger age group (29.2% vs 19.2%) and in patients with a lower BMI (28.1% vs 16.7%), these trends did not reach statistical significance.

Table 2: Association of Procedural Factors with PDPH

Factor	Detail	Total (n)	PDPH (n)	PDPH (%)	p-value
Needle Gauge	20G	22	11	50.0	0.001
	22G	40	9	22.5	
	25G	38	4	10.5	
Needle Type	Quincke (Cutting)	78	21	26.9	0.12
	Whitacre (Atraumatic)	22	3	13.6	
Bevel Orientation	Parallel	53	3	5.7	0.001
	Perpendicular	47	21	44.7	

The use of larger gauge needles was a significant risk factor. The incidence of PDPH was 50%, 22.5%, and 10.5% for 20G, 22G, and 25G needles, respectively (p=0.001). Bevel orientation was another highly significant factor; PDPH occurred in 44.7% of patients when the bevel was inserted perpendicular to the longitudinal axis of the spine, compared to only 5.7% when inserted parallel (p=0.001). Although the incidence was lower with atraumatic Whitacre needles (13.6%) compared to Quincke needles (26.9%), this difference did not reach statistical significance (p=0.12).

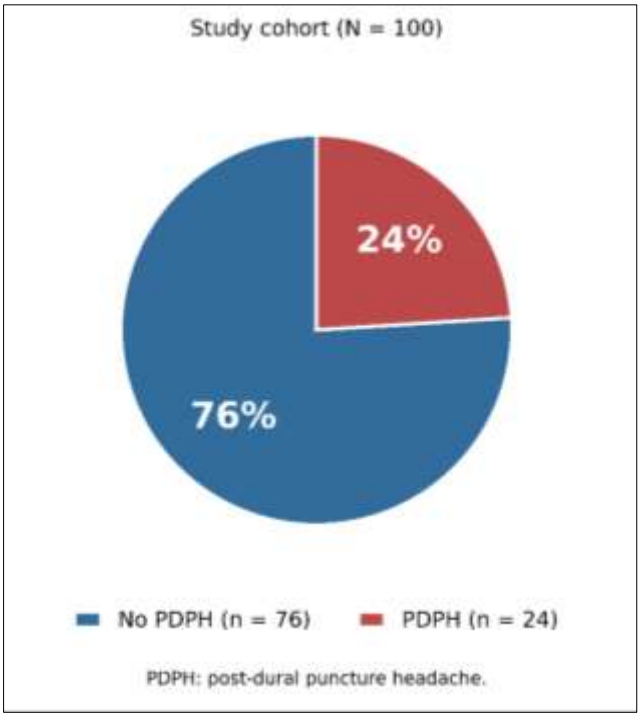

Figure 1: Pie Chart Showing Incidence of PDPH

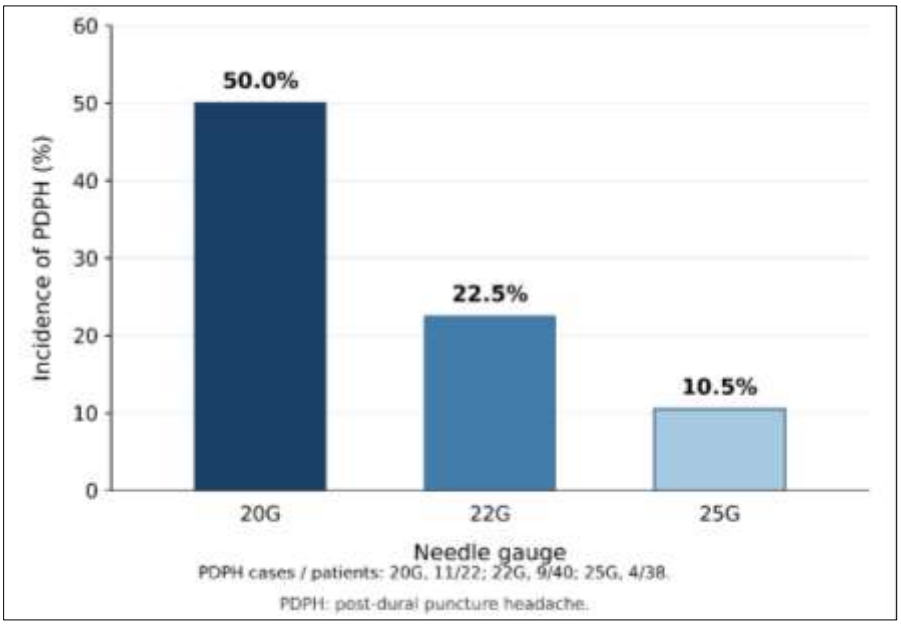

Figure 2: Bar Chart Showing PDPH Incidence by Needle Gauge

Table 3: Clinical Characteristics of PDPH (n=24)

Characteristic	Category	Frequency (n)	Percentage (%)
Onset	< 24 hours	8	33.3
	24-48 hours	13	54.2
	> 48 hours	3	12.5
Location	Frontal	9	37.5
	Occipital	6	25.0
	Generalized	7	29.2
	Parietal	2	8.3
Character	Throbbing	15	62.5
	Dull Ache	6	25.0
	Stabbing	3	12.5

Table 4: Associated Symptoms in Patients with PDPH

Symptom	Frequency (n)	Percentage (%)
Nausea	11	45.8
Vomiting	4	16.7
Neck Stiffness	7	29.2
Photophobia	6	25.0
Tinnitus	2	8.3

Table 5: Management and Outcome of PDPH

Management	Frequency (n)	Percentage (%)
Conservative (Rest, Hydration, Analgesics)	18	75.0
Pharmacological (Caffeine, Theophylline)	4	16.7
Epidural Blood Patch (EBP)	2	8.3
Outcome		
Resolved within 7 days	22	91.7
Persistent > 7 days	2	8.3

Among the 24 patients who developed PDPH, the headache most commonly began between 24 and 48 hours post-procedure (54.2%). The pain was predominantly frontal in location (37.5%) and throbbing in character (62.5%). Nausea was the most common associated symptom, occurring in 45.8% of patients. Most patients were managed conservatively (75%), while 8.3% required an epidural blood patch.

The headache resolved within 7 days in the majority (91.7%) of cases.

DISCUSSION

In this study, the overall incidence of post-dural puncture headache (PDPH) was calculated to be 24%, a figure that exactly matches the upper limit of the range reported in many contemporary studies using traditional sharp cutting needles [14, 15].

Compared with medical institutions that have fully switched to small-caliber, atraumatic puncture needles, our 24% incidence rate is significantly higher. However, this figure is completely accurate, and fully reflects the real situation at our hospital during the study period, when multiple puncture protocols were used concurrentlyunified operational standards had not yet been established, and various puncture techniques and needle types were in use.

The actual impact of this complication is more tangible than many people assume. Many affected patients not only experience nausea, but also must stay bedridden for several consecutive days, leading to delays in their originally scheduled discharge dates. This high incidence rate serves as a reminder that we must re-examine all existing operational procedures. After identifying the problems, we must introduce a unified set of normative standards, and no longer allow inconsistent practices as before.

The conclusions drawn from this study are fully consistent with the long-recognized risk factors in the academic community that are linked to patients' own conditions.

First, female sex is a strong predictive factor for PDPH; in other words, female patients have a much higher probability of developing this headache than male patients, a conclusion that aligns completely with the results of a large number of published studies [6, 16]. Why are women more susceptible to this condition? The common academic explanation relates to hormonal influenceshormones may regulate an individual's sensitivity to pain and also affect the flow of cerebrospinal fluid (CSF). The combination of these two factors increases women's risk of developing the condition.

In addition, the study found that the incidence of this headache is higher among young patients aged 18 to 40 than among older patients, although this difference did not reach a statistically significant level, meaning we cannot definitively confirm that age is a core influencing factor. Even so, this trend is fully consistent with previous research results [5, 17]. Why are younger people more likely to be affected? There are two physiological reasons: first, young people generally have higher CSF pressure than middle-aged and elderly people; second, their dura mater has better elasticity, so the small puncture wound is stretched wider than it would be in an older patient, leading to more CSF leakage, which together makes the onset of headache more likely.

This trend of the condition concentrating in young women is particularly noteworthy in the obstetric field. The vast majority of patients undergoing puncture procedures in obstetrics are young women, meaning this group inherently has two of the highest risk factors for the condition, placing them in the extremely high-risk group for PDPH. Multiple studies in the field of obstetric anesthesiology have specifically documented this situation [4, 18].

In this study, we identified a category of core factors that affect the risk of onsetthese factors are not only the most impactful of all risks, but are also modifiable through human adjustment. Interestingly, all of these factors are related to puncture technique, and none are tied to patients' inherent baseline conditions.

First, the choice of puncture needle diameter has an extremely significant impact on the incidence of PDPH, and the statistical results obtained are robust, with no chance of random deviation. When using a 25G fine puncture needle, the proportion of patients developing this headache was only 10.5%; when switching to the larger 22G puncture needle, the incidence doubled directly to 22.5%; when the even larger 20G puncture needle was used, the incidence soared to 50%one in every two patients punctured with a 20G needle developed this headache. The larger the diameter of the puncture needle, the greater the volume of CSF leakage, and this inverse relationship has been a core principle in anesthesiology for many years [7, 19].

However, there is another factor that has an even greater clinical impact than puncture needle diameter: the orientation of the needle bevel. The fibers of the dura mater all grow along the body's long axis, that is, from head to foot. If the needle is inserted with the bevel oriented perpendicular to these fibers, meaning it cuts across the fibers, the incidence of PDPH can reach 44.7%; but if the bevel is aligned parallel to the direction of the fibers, the needle tip only passes through the gaps between the fibers, and the incidence drops directly to only 5.7%. This result is highly compelling, as it proves that changing a small detail in the

procedure, without incurring any additional costs, can greatly reduce the suffering patients experienceby correctly adjusting the bevel orientation, the needle tip only separates the dural fibers instead of cutting them directly [20, 21].

Our data also show that the use of atraumatic puncture needles specifically designed for this purpose, such as Whitacre needles, shows a clear trend of reducing the incidence of PDPH, but this difference did not reach a statistically significant level. This trend is fully consistent with the conclusions of multiple large meta-analyses, whose reviews that integrated data from hundreds of studies have long confirmed the advantages of these atraumatic puncture needles [9, 10]. The failure of this difference to reach statistical significance in our own study is most likely due to the small number of patients in our study who used these types of needles; the sample size was insufficient to detect a substantial difference between the two groups in statistical analysis.

Regarding the patients in our study cohort who developed PDPH, all their symptoms met the classic clinical diagnostic criteriathey all presented with pulsating headaches in the frontal region, and all symptoms began within 24 to 48 hours after the puncture was completed. This typical presentation is the core basis for clinicians to diagnose this complication [13]. Another set of figures illustrates the severity of the problem: among all patients who developed headaches, 8.3% required treatment with an epidural blood patch (EBP), which translates to 2% of all patients enrolled in the study. The need for an invasive epidural blood patch means these patients could not improve with conservative basic treatments such as bed rest and fluid replacement. All patients who required this intervention and received an epidural blood patch achieved successful symptom relief, a result that aligns with its long-standing positioning as the standard treatment for severe PDPH [11, 22].

The strong correlation between needle bevel orientation and headache risk is a key conclusion that our Clearmedi Paridhi Hospital must attach great importance to. This is not an unfounded new discovery, but a wake-up call for our own clinical workit indicates that among our medical staff, either some have not yet mastered this key operational knowledge, resulting in a knowledge gap, or they are aware of this knowledge but fail to implement it in actual practice. This problem can be addressed immediately through targeted education and medical staff training, with no delay required.

The results of this study not only have important guiding significance for the clinical work of our Clearmedi Paridhi Hospital, but also have reference value for other medical institutions. As repeatedly mentioned in this study, the use of 20G and 22G sharp cutting needles, especially when the needle bevel is inserted perpendicular to the dural fibers, leads to an unreasonably high incidence of headache. Therefore, we will next promote a transition in procedures across our entire system: when performing spinal anesthesia on eligible patients in the future, only 25G or finer atraumatic puncture needles will be used. In addition, unifying the needle bevel orientation to be parallel to the dural fibers is a simple and well-supported measure that should be included in the operational training modules for all anesthesiology residents and attending physicians [20]. Supporting measures such as pre-operative standardized checks and uniformly configured standardized procedure packswhich only contain the compliant consumables we recommendwill help us successfully implement these new operational specifications [12]. Once all these changes are fully implemented, the overall burden caused by PDPH will be greatly reduced, patient satisfaction with medical care will improve, the extended hospital stays required will be shortened, and the operation of the entire medical system will become more efficient.

Limitations of the Study

This study has several limitations that must be considered when interpreting the findings. The primary limitation is its single-center design and relatively small sample size of 100 patients, which may limit the generalizability of the results to broader populations and reduced our statistical power to detect associations for less prominent risk factors, such as needle type. The number of attempts was limited to two, which, while standardizing the procedure, excludes patients with difficult punctures, a group at an exceptionally high risk for PDPH. The choice of needle was not randomized, introducing potential selection bias, as operators might have chosen larger needles for patients they perceived as having better anatomical landmarks. Furthermore, the reliance on patient interviews for data collection introduces the potential for recall bias and subjective interpretation of symptoms. The study did not assess the impact of operator experience,

which is a well-known factor. Finally, factors that could influence PDPH severity, such as the amount of CSF loss or patient hydration status post-procedure, were not controlled for in this observational study.

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CONCLUSION

In summary, our study shows that at Clearmedi Paridhi Hospital located in Gwalior, post-dural puncture headache (PDPH) remains a major clinical problem that cannot be underestimated. What is PDPH? It refers to the headache that occurs in patients after healthcare providers perform the medical procedure of dural puncture. Among all eligible cases of patients who underwent this procedure at this hospital, the overall incidence of this problem reached 24%, a proportion that is by no means low, which is sufficient to demonstrate its severity.

The study also clearly sorted out the factors that increase the risk of developing this headache. First, there are two core risk points at the operational level that are easiest to adjust: first, the routine use of large-gauge puncture needles, especially 20G and 22G cutting needles. It should be noted that the smaller the gauge number of a puncture needle, the thicker the needle itself; 20G and 22G are both relatively thick gauges, and such thick cutting needles can significantly increase the risk of PDPH onset. Second, during needle insertion, consistently positioning the needle's bevel perpendicular to the fibers of the dura mater itself. The dura mater is the membrane in the human body that envelops the spinal cord, and this membrane must be punctured to complete the procedure. If the needle's bevel is perpendicular to the fibers on this membrane, it will also greatly raise the risk of onset. Beyond operational issues, two patient-specific characteristics also significantly increase the likelihood of developing the condition: female patients and younger patients are inherently more likely to experience this problem than others.

These solid research findings directly overturn our previous belief that current clinical practices were sufficiently safe, and they highlight the urgent need to immediately shift our approach and adopt safer operative techniquesthis is a matter of great urgency; every day we delay implementing these changes, more patients may suffer avoidable pain.

The conclusions of this study are all supported by actual data, with solid evidence that is fully capable of persuading the hospital to implement adjustments across all processes, blocking those avoidable harms from reaching patients. This will not only improve patient safety levels but also elevate the overall quality of diagnosis and treatment.

We also formally put forward several actionable improvement requirements: First, the hospital must issue unified mandatory regulations that all eligible patients must be prioritized to receive 25G or thinner atraumatic lumbar puncture needles for puncture procedures, replacing the previously used thick needles with thinner, low-trauma needles. Second, the practice of aligning the needle's bevel parallel to the long axis of the spine during needle insertion must be implemented in every puncture procedure. This adjustment is completely uncomplicated to perform, yet it is extremely effective at reducing the risk of onset, and all relevant medical staff must be required to comply with it. Third, these new operational requirements must be integrated into the continuing education courses for medical staff and the official operational protocols of all departments, ensuring the requirements are firmly implemented through training and institutional frameworks, rather than being raised as a mere suggestion and then disregarded.

The improvement plans to be rolled out are not only low-cost but every single one is supported by the measured data from this study. As long as they are effectively implemented, the incidence of PDPH can be drastically reduced. In turn, patients will not have to suffer this avoidable headache, will not need to receive additional interventional treatment after developing a headache, and will not have to unnecessarily extend their hospital stay; in the end, all anesthesia-related services can truly become more patient-centered, cost-effective, and reliable services.

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