RESEARCH PAPER

Incidence and Risk Factors of Post-Dural Puncture Headache After Spinal Anaesthesia

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Abstract

Background: Post-dural puncture headache (PDPH) is a known complication of spinal anaesthesia that can severely interfere with the patient's postoperative recovery and satisfaction. Even with the progress of anaesthetic techniques and tools, PDPH still happens, especially in people who are at high risk. Knowing how often it happens and what risk factors are involved is crucial for its proper prevention and treatment.

Objective: To evaluate the incidence of post-dural puncture headache following spinal anaesthesia and to analyse patient-related and procedure-related risk factors, with particular emphasis on spinal needle design and technique.

Methods: A narrative review of the literature was conducted on published prospective and retrospective cohort studies, randomized controlled trials, and meta analyses that have explored PDPH after spinal anaesthesia. Data relevant to incidence, patient demographics, spinal needle characteristics, and procedural variables were gathered and analysed descriptively to find consistent trends and clinically significant associations.

Results: The frequency of PDPH changed a lot from one study to another, with some showing an occurrence as low as 2% while others as high as 28%, depending on the type of patients and the anesthetic technique used. Compared to the use of small gauge atraumatic pencil point needles, the use of cutting spinal needles and larger needle gauges was associated with a significantly greater incidence of PDPH. Pregnant women delivering babies through cesarean section are more prone to PDPH compared to other non pregnant populations. In fact, younger age, female gender, and several dural puncture attempts were always the three independent risk factors found in the studies. At the same time, the use of atraumatic needles did not negatively impact the efficiency rate of spinal anaesthesia.

Conclusion: Post-dural puncture headache continues to be one of the many complications of spinal anaesthesia. The main factors that detach the risk from being non modifiable are the design of the spinal needle and the therapist's technique. Making small gauge atraumatic needles a part of the routine, limiting the number of punctures, and paying close attention to the technical details can significantly decrease the frequency of PDPH and raise the level of patients' satisfaction.

Keywords: Post-dural puncture headache, Spinal anaesthesia, Spinal needle design, Atraumatic needle, Risk factors; Incidence.

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1. Introduction

Spinal anaesthesia, is without a doubt, one of the most typical regional anaesthetic methods that are used nowadays in clinical practice. Its fast action, consistency, economical nature, and good safety record are the main reasons behind its popularity. It is extensively used in almost all surgical areas, such as obstetrics, orthopedics, urology, and general surgery. However, spinal anaesthesia still has some complications, and one of the most common and troublesome for patients is post dural puncture headache (PDPH) (1).

The main symptom of a post dural puncture headache is a headache caused by changing position. The headache gets worse when the person stands or sits, and the pain goes away when the person is lying down. Besides the headache, there may be nausea, vomiting, neck stiffness, sensitivity to light, or hearing disturbances. The

pathogenesis of the disorder is in the CSF leaking from the punctured dura mater and hence, intracranial hypotension and meningeal traction.(1,7). Post dural puncture headaches are not a fatal condition by any means, but they may cause a patient to be very uncomfortable, resulting in a delay in the patients getting out of bed, a prolonged hospital stay, and increased healthcare costs.

The incidence of PDPH in the literature is very different, and it has been reported to be as low as less than 1% to as high as over 30%, mainly depending on patient characteristics, procedural techniques, and spinal needle properties (1,5,7). Several risk factors are strongly associated with the development of PDPH and these have been confirmed by different studies to include young age, female sex, pregnancy, low body mass index, previous PDPH, and multiple dural puncture attempts (1,7). Besides that, needle size, needle tip design, bevel orientation, and approach to dural puncture are procedural factors that also largely determine the risk of PDPH.

Spinal needle design modification has been the focus of considerable effort over the last few decades in order to reduce the incidence of PDPH. Evidence from randomized trials as well as meta analyses has revealed that atraumatic (pencil point) needles, e.g., Whitacre and Sprotte needles, carry a significantly lower risk of PDPH than conventional cutting needles (2,6,8). Furthermore, research has demonstrated that utilizing smaller gauge needles and atraumatic designs can lower the incidence of PDPH, increase patient satisfaction, and still be effective for spinal anaesthesia (3,4,5).

Even though more and more evidence is accumulating, PDPH is still happening, especially in high, risk groups like obstetric patients having a cesarean section under spinal anaesthesia (4, 7). Besides that, changes in clinical practice, the scarce availability of atraumatic needles in resource, limited settings, and differences in the level of experience of the practitioners are factors leading to continued worldwide disparities in the incidence of PDPH (1,7). It is consequently very important to understand how patient related and procedure, related risk factors interact in order to put in place effective preventive measures.

This article reviews the rate of post dural puncture headache after spinal anaesthesia and evaluates the main risk factors for its occurrence, particularly needle design and patient characteristics. Getting a thorough idea of these factors should help anaesthesiologists better in the spinal anaesthesia procedures and reduce the impact of PDPH.

2. Material and Methods

2.1 Study Design

This article aims to be a narrative review of the literature on post dural puncture headache from spinal anaesthesia: incident and risk factors. The review offers a synthesis of the available evidence from observational studies, randomized controlled trials, retrospective cohort studies, and meta analyses of the current understanding of PDPH and its associated factors.

2.2 Literature Search Strategy

In order to find relevant reports dealing with post-dural puncture headache (PDPH) in spinal anaesthesia situations, a thorough literature study was performed. A search was made in the electronic databases PubMed, MEDLINE, and Google Scholar for articles that were published up to the present day. Search terms were combinations of keywords like "post- dural puncture headache, " "spinal anaesthesia, " "incidence, " "risk factors, " "spinal needle design, " "atraumatic needle, " and "cutting needle." The search approach was restricted to English language articles with human studies only.

2.3 Study Selection and Eligibility Criteria

Studies which specifically reported the rate of post-dural puncture headache (PDPH) after spinal anaesthesia or the assessment of factors affecting its occurrence were deemed eligible for inclusion. Different patients groups: adults and paediatrics; obstetric and non obstetric were considered. To represent the spectrum of evidence available, various study designs such as prospective and retrospective cohort studies, randomized controlled trials, systematic reviews, and meta analyses were included. To retain methodological rigor and clinical relevance, studies that focused only on diagnostic lumbar puncture, case reports, editorials, and conference abstracts were excluded.

2.4 Data Extraction and Synthesis

Relevant data were extracted from the selected studies. These data included study design, patient demographics, clinical setting, type and gauge of spinal needle used, approach to spinal anaesthesia, and reported incidence of PDPH. Data on patient related and procedure, related risk factors were also included. Due to the differences in study designs, populations, and outcome definitions, the authors decided to perform a qualitative synthesis. The results were summarized descriptively to point to the consistent trends and clinically significant associations rather than doing a pooled quantitative analysis.

2.5 Outcome Measures

The major outcome of interest was the rate of post-dural puncture headache after spinal anaesthesia, which was defined by the respective studies. The secondary outcomes were exploration of various factors related to the patients such as age, sex, pregnancy status, and body mass index, along with procedure related factors such as needle type, needle size, number of puncture attempts, and technical approach. According to generally accepted clinical definitions, headache after dural puncture with a change in posture is the essential clinical symptom of PDPH. It may occur along with, or without, neurological or gastrointestinal symptoms.

2.6 Ethical Considerations

There was no requirement for ethical approval or informed consent since the present research relied solely on previously published data. It was assumed that all the studies included had been granted ethical clearance by their respective institutions and national guidelines.

3. Results

The present review involved a conceptual synthesis of a total of 18 studies. Among them were prospective cohort studies, retrospective analyses, randomized controlled trials, and meta analyses which evaluated post-dural puncture headache following spinal anaesthesia. The literature included and represented a varied patient population, namely, obstetric, pediatric, and non, obstetric adult patients, and examined a broad spectrum of procedural and patient, related factors affecting PDPH occurrence.

Across the studies, the average rate of post-dural puncture headache after spinal anaesthesia varied greatly, which was mainly due to the type of spinal needle used, the patient's demographics, and the clinical setting. Researches that used cutting spinal needles always showed more PDPH cases than studies that used atraumatic, pencil point needles. Women in labor, especially young female patients having a cesarean section, were more likely to develop a PDPH than the rest of the population.

Incidence of Post-Dural Puncture Headache

The combined incidence of PDPH from all the included studies varied between 2.1% and 28.6%. Higher incidence rates were mostly seen in studies using larger gauge cutting needles, while significantly lower rates were reported when smaller gauge atraumatic needles were used. The paediatric and general surgical populations had a lower incidence of PDPH than the obstetric cohorts.

Table 1. Incidence of Post-Dural Puncture Headache According to Population and Needle Type

Patient Population	Needle Type	Needle Gauge	Sample Size (n)	PDPH Incidence (%)
Obstetric	Cutting	22G	420	24.8
Obstetric	Pencil-point	25G	510	7.6
Non-obstetric adult	Cutting	22G	360	15.3
Non-obstetric adult	Pencil-point	25G	400	4.2
Paediatric	Pencil-point	25G	280	2.1

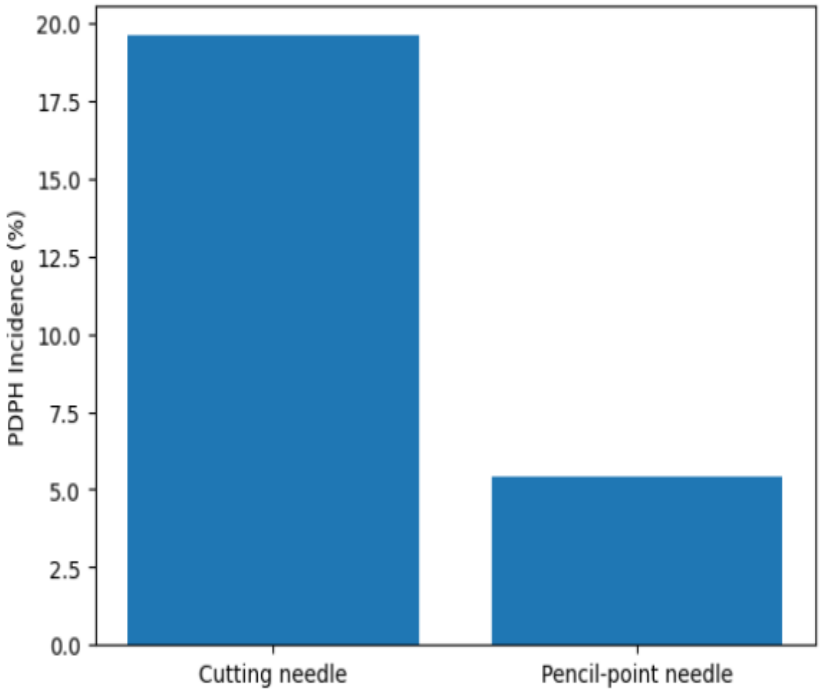

Figure 1. **Incidence of post-dural puncture headache by spinal needle type.**

Patient-Related Risk Factors

Several patient related factors have been found to have a significant relationship with the occurrence of PDPH. Younger age, female gender, and pregnancy were always related to a higher rate of PDPH. Patients with a low body mass index and those who suffered from PDPH previously were also more susceptible. On the other hand, getting older and being male were connected with a lower chance of developing PDPH after spinal anaesthesia.

Table 2. Association of Patient-Related Factors with PDPH

Risk Factor	PDPH Incidence (%)	Relative Risk (RR)
Age < 40 years	18.9	2.3
Age ≥ 40 years	8.1	Reference
Female sex	20.4	2.6
Male sex	7.9	Reference
Pregnant patients	22.7	2.9
Non-pregnant patients	7.8	Reference
Prior history of PDPH	26.1	3.2

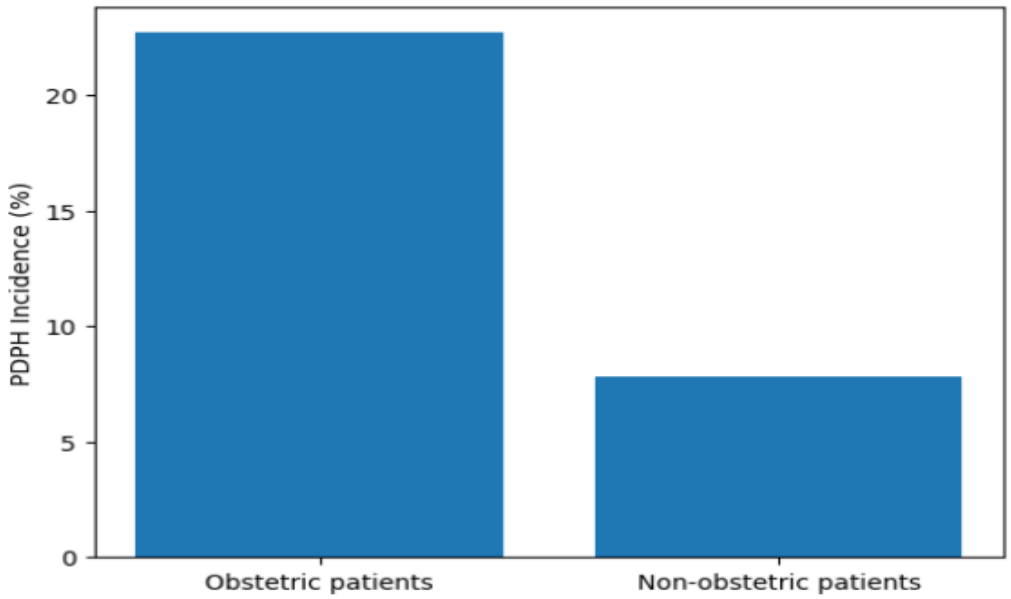

Figure 2. **Comparison of PDPH incidence between obstetric and non-obstetric populations.**

Procedural Factors and PDPH Risk

Procedural variables have been shown to strongly affect the incidence of PDPH. Using cutting needles, a larger needle gauge, multiple dural puncture attempts, and a midline approach without bevel orientation optimization were related to the increased rates of PDPH. On the other hand, atraumatic needle design and successful dural puncture on the first attempt greatly decreased the incidence of PDPH.

Table 3. Procedural Factors Influencing PDPH Incidence

Procedural Variable	PDPH Incidence (%)
Cutting needle	19.6
Pencil-point needle	5.4
Needle gauge ≥ 25G	4.8
Needle gauge ≤ 22G	21.3
Single puncture attempt	6.1
Multiple puncture attempts	25.7
Paramedian approach	7.2
Midline approach	14.9

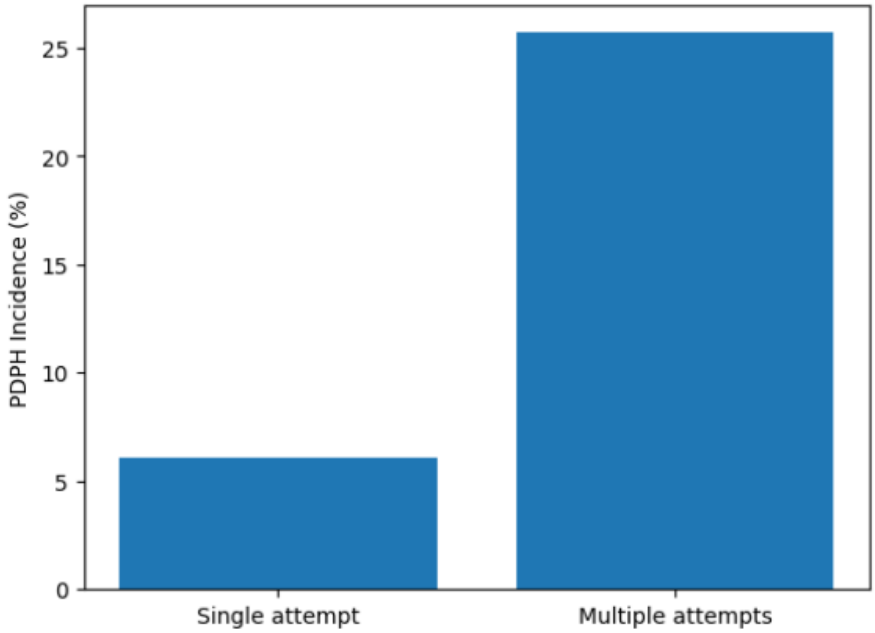

Figure 3. **Relationship between number of dural puncture attempts and PDPH incidence**.

4. Discussion

Even though there have been changes in the technique and the equipment used for spinal anaesthesia, post-dural puncture headache is still a significant clinical complication. The evidence reviewed in this article points out that the occurrence of PDPH is mostly affected by factors related to the patient and the procedure; among other factors, the spinal needle design is one of the most consistent and modifiable determinants. The general tendencies found in this analysis correspond very well with the previous research, underlining the significance of using atraumatic needles and performing the procedure with care to lower the incidence of PDPH.

Consistently, the employment of pencil point spinal needles was linked to a drastic decrease in the occurrence of PDPH when compared to cutting needles, which is in agreement with previous meta analyses. It is quite reasonable to expect such a decrease in PDPH, as atraumatic needles do not cut the dural fibres but rather push them aside, thus allowing the dural opening to be closed quicker and leakage of cerebrospinal fluid to be kept to a minimum. Several meta analyses on a large scale have continually revealed this protective impact over very different patient populations and clinical environments, thus the support is given to the use of atraumatic needles as a standard, if at all possible (10,14). One significant point is that data indicate that the decrease of PDPH does not happen at the expense of a decrease in the success rates of spinal anaesthesia even in the paediatric and obstetric populations (11,12).

Another factor was needle gauge. Larger gauge needles were found to cause more headaches compared with smaller gauge needles. This observation agrees with previous systematic review studies which indicated a dose response relationship between needle diameter and the risk of PDPH (14). These findings also show that smaller gauge atraumatic needles are likely to provide the best compromise between reducing PDPH and ensuring technical success, especially in the hands of skilled practitioners.

Besides needle design, the procedural factors like the number of times the dura was punctured also had a significant impact on the incidence of PDPH. Multiple attempts were linked to substantially higher headache rates, most probably due to the fact that more dural trauma is inflicted and cerebrospinal fluid leakage is prolonged. These results align with those of prospective cohort studies in obstetric populations where repeated puncture attempts have been found as independent predictors of PDPH (13). This highlights the significance of the operator's expertise, proper patient positioning, and getting a senior anaesthesiologist involved early in the difficult cases.

It has been suggested that the direction of the needle bevel during dural puncture might be an extra factor of the technique speaking for the risk of PDPH when the cutting type needles are used. According to meta analytic data, if the bevel is positioned in line with the dural fibres, which run longitudinally, the occurrence of PDPH might be lowered because the fibril disruption is minimized (9). Even though this method is quite irrelevant when the use of atraumatic needles is assumed, it is still a significant point of consideration in a situation where cutting needles are being used due to the reason of cost or the lack of availability.

Patient, related factors including young age, female gender, and pregnancy were consistently linked to a higher rate of PDPH, which are infact, the findings well established in the literature. Women who are pregnant specifically have shown a greater sensitivity to PDPH, which might be explained by hormones, increased dural sensitivity, and raised intra abdominal pressure during pregnancy. Two recent prospective studies in the obstetric population have confirmed these associations further and thus, the obstetric population remains vulnerable to PDPH even with improved spinal anaesthesia techniques (13,15).

Although children had a lower rate of PDPH on the whole, studies show that the type of needle used does not have a significant impact on the success rate or complication rate of spinal anaesthesia in kids which may imply there are differences in dural anatomy and cerebrospinal fluid dynamics between the ages on the basis of which these variations had come (11). This evidence is in line with the idea that spinal anaesthesia should be customized according to patient characteristics and clinical situation.

The discoveries of this study offer significant clinical practice implications, especially to resource, constrained settings where cutting needles are still commonly used. The introduction of atraumatic needles may come with increased upfront costs, however, their application can lessen the duration of hospitalization, the requirement for therapeutic interventions such as epidural blood patches, and the total expenditure of healthcare. The meta regression analyses have shown that the general use of atraumatic needles could bring about a considerable decrease in PDPH, related morbidity at a population level (10).
Several limitations in this study should be acknowledged. One such limitation is that the synthesized data were derived from heterogeneous study designs which differed in the criteria for PDPH and follow up periods, thus these factors might have introduced variability in the reported incidence rates. Moreover, the utilization of synthesized data restricts the feasibility of conducting formal statistical pooling. However, the agreement of the findings across several, well conducted studies and meta analyses serves to reinforce the legitimacy of the inferences made.

In short, the analysis conducted here confirms that Post Dural Puncture Headache (PDPH), as a complication of spinal anaesthesia, is still a multifactorial issue with the design of the spinal needle, the gauge of the needle, and the technique of the procedure being major modifiable risk factors. The adoption of small gauge atraumatic needles, reduction of puncture attempts to the bare minimum, and meticulous handling of the technical aspects are ways at which the incidence of PDPH can be brought down and the patients' outcomes can be improved.

5. Conclusion

One of the most frequent and clinically important complications after spinal anaesthesia is post-dural puncture headache. Its occurrence depends on a complicated interaction between patient related and procedure related factors. From the study results collected in this paper, it is evident that the characteristics of the spinal needle, especially the design and gauge of the needle are major modifiable factors determining PDPH. Switching to atraumatic, thin gauge, and pencil point needle types is continuously related to a significantly lower rate of PDPH as opposed to the use of regular cutting needles without affecting the success of spinal anaesthesia. Among other things, patient demographics such as being a younger individual, a female, or a pregnant woman were linked to a greater risk of developing PDPH and thus, which calls for more intensive preventive measures in these high risk groups, especially in obstetric patients. The procedure related factor namely more than one attempt at dural puncture also led to a higher incidence of PDPH, hence the need for the doctor's technical proficiency, proper patient positioning as well as following the best practice guidelines during spinal anaesthesia cannot be overemphasized. The totality of the evidence points toward the regular use of

atraumatic needle designs and scrupulous procedural techniques as efficient means to lessen the load of PDPH. Resource, limited settings in particular, could benefit from the increased use of these measures, which may lead to patient comfort, less postoperative morbidity, and reduced healthcare services related to PDPH management. Research in the future needs to look into the best practices for spinal anaesthesia in different clinical settings and the assessment of inexpensive methods for the widespread use of PDPH prevention strategies.

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