Incidence and risk factors of Postdural Puncture Headache: Prospective cohort study design

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Abstract

Background: Post-dural puncture headache is one of the complications following spinal anaesthesia and accidental dural puncture. Several modifiable risk factors contribute to the development of headache after lumbar puncture which includes needle size, needle design, direction of the bevel and number of LP attempts. This study aimed to assess the incidence and risk of postdural puncture headache.

Methods: This prospective cohort study design was conducted using a consecutive sampling method. Regular supervision and follow up were made. Data was entered in to Epi info version 7 software and transported to SPSS version 20 for analysis. Odd ratio and 95% confidence interval was computed. The findings of the study were reported using tables, figures and narration. Variables that were found to be candidate (p value < 0.25) on binary logistic regression entered into a multiple logistic regression analysis to identify independent predictors of postdural puncture headache.

Results: One hundred fifty eligible study participants were included in our study of which 28.67% had developed postdural puncture headache. This study found that needle size, number of CSF drops and multiple attempts as independent predictors of postdural puncture headache at significant level (p < 0.05). In addition, twenty five needle was identified as strongest pre-operative independent predictor with PDPH (AOR = 4.150, CI = 1.433–12.021)

Conclusions: Recent study revealed that small size pencil-point spinal needle was much better to large size cutting spinal needle regarding the frequency of postdural puncture headache. Besides, frequent attempts during lumbar puncture and increased CSF leakage were associated with the events. In view of this, we recommend the use of small size pencil-point spinal needle; avoid more leakage of cerebrospinal fluid and multiple in spinal anesthesia and lumbar puncture.

Background

Post-dural puncture headache (PDPH) is defined as a headache occurring within 5 days after lumbar puncture which is aggravated when standing or sitting and relived when lying flat on the grounds of the International Classification of Headache Disorder, 3rd edition[1]. Associated symptoms include stiff neck, hearing loss, tinnitus, photophobia and nausea. The prevalence of PDPH is higher in
pregnant women [2]. It is a common complication of lumbar puncture, which is likely due to the loss of cerebrospinal fluid (CSF) into the epidural space through the dural tear. The reported incidence of PDPH varies from 10–40% depending on age, gender and needle size [3–5].

Several factors contribute to the development of headache after lumbar puncture, including needle size, needle design, direction of the bevel and number of LP attempts. Namely, using smaller diameter and non-cutting (atraumatic) needles is correlated with a lower incidence of headache after lumbar puncture. Additionally, insertion of the needle with the bevel parallel to the dural fibers facilitates closure of the hole and minimizes cerebrospinal fluid leakage[6, 7]. Modifiable risk factors of PDPH included the needle size, needle shape, bevel orientation and inserting angle, stylet replacement, and operator experience[8]. Needle size might be the most significant factor in the development of PDPH[9].

Spinal needles generally used today are 22 to 27 G, but sizes ranging from 19 to 30 G are available. The incidence of PDPH after spinal anesthesia performed with Quincke, cutting needle, is 36% with 22 G needle, 25% with 25 G needle, 2–12% with 26 G needle, and less than 2% for smaller than 26 G needles[10, 11]. The smaller needle diameter reduces the incidence of PDPH[12]. However, spinal needle, which is extremely thin, would increase the rate of failure for spinal anesthesia. On the other hand multiple dural punctures caused by unsuccessful puncture would increase the rate of PDPH[12, 13]. Needle design variables, such as the needle size and needle shape, have been modified to enable rapid flow of cerebral spinal fluid (CSF) and injected medications, yet simultaneously limit dural trauma and loss of CSF[14]. The goal of this study was to determine the incidence and risk factors of PDPH.

Materials And Methods
Prospective Cohort study design employed at Wolaita Sodo University from January 2017 to March 2017. All pregnant mothers who gave births by cesarean section were source population and all pregnant mothers who gave births by cesarean section caesarian section under spinal anesthesia at Wolaita Sodo University Teaching referral hospital were study population. Non cooperative patients and Patients with impaired cognitive ability were excluded from the study. Consecutive sampling
technique was used to include study participants.

Structured checklists and questionnaires were prepared in English which included socio-demographic, perioperative data, the severity of pain, and duration of analgesia and total analgesia consumption. On arrival of the patient to the operating room, all standard monitors were attached, and baseline heart rate [HR], mean arterial pressure (MAP) and oxygen saturation [SpO₂] were recorded. IV line was secured with appropriate size cannula and all patients were preloaded with 15 mL/kg of Ringer’s lactate IV before spinal anesthesia. A lumbar puncture was performed at the L2-3, L3-4, or L4-5 intervertebral space with the patient in the sitting position. All patients received a standard spinal anesthetic consisting of bupivacaine 12–14 mg. A T4-6 sensory dermatome level was obtained before surgical incision. Maternal age, height, weight, parity, and history of previous PDPH were noted, as well as the type of needle and the operator training level. Postoperatively, all patients were seen daily by anesthesia unaware of the type of needle used and were questioned for the presence of a headache.

In this study PDPH was defined as an occipital or frontal headache brought on by the erect posture and relieved when the supine posture was assumed. The Quincke needle has a diamond-shaped cutting bevel with terminal eye. The Sprotte, GM, and the Whitacre needles are pencil-point needles, and both have lateral eyes and are thin-walled (Fig. 1).

When a patient complained of an occipital or frontal headache, she was monitored daily until she was discharged from the hospital. All patients received a telephone call 1 wk later to evaluate for any signs or symptoms of a delayed-onset headache. Patients with a headache were evaluated for the duration of the headache.

Data collectors were trained and pretest was done on 10% of sample patients. During data collection, regular supervision and follow up was made appropriately. Each data was cross-checked for completeness and consistency every day.

Statistical data analysis was done using SPSS software version 20. Data was summarized in form of proportions and frequency tables for categorical variables. In the binary logistic regression analysis, Odds ratio together with 95% confidence interval was calculated to test for the association between
the possible predictors and outcome variables. A p-value of less than 0.25 was considered as potential candidate for final model and entered into a multiple logistic regression to determine independent predictors of PDPH. All variables that were found to be statistically significant (p-value < 0.05) on Multiple Logistic Regression analysis were considered as independent predictors of postdural puncture headache.

The primary outcome of this study was incidence and risk factors of postdural puncture. Secondary outcomes measured were severity and duration of PDPH.

Ethical approval and consent

Ethical clearance and approval was obtained from ethical review committee of college of health science and official letter was obtained from anesthesia department, Wolaita Sodo University. Informed written consent was obtained from the children’s parent. Confidentiality and anonymity of information were ensured.

Result

**Socio demographic and preoperative characteristics**

A total of 150 pregnant mothers were enrolled into the study of 43(28.67%) of whom develop postdural puncture headache. Majority of respondents 80(53.33) % of them were found between the age group of 20–25 years. The mean age of respondents was 26.44 + SD (4.019216), (minimum 18 and maximum 40) and the mean BMI of respondents was 22.07533 + SD (2.369831), (minimum 18 and maximum 28). Almost all of the respondents 145(96.67%) were found in ASA class one while about 3.33% of all respondents were found in ASA Class III. Regarding previous history of anesthesia, 79.33% of all respondents had no previous history of anesthesia (Table 1).

Table 1. Sociodemographic and preoperative characteristics of patients who underwent spinal anesthesia, 2017
Variables | Category | Frequency | Percentage
--- | --- | --- | ---
Age in years | 18-24 | 34 | 22.67
 | 25-29 | 80 | 53.33
 | 30-34 | 30 | 20.00
 | 35-39 | 6 | 4.00
Parity | Primigravida | 53 | 35.33
 | Multigravida | 97 | 64.67
ASA Class | Class II | 145 | 96.67
 | Class III | 5 | 3.33
BMI | Underweight | 8 | 5.33
 | Normal | 124 | 82.67
 | Overweight | 18 | 12.00
Previous history of anesthesia | No | 119 | 79.33
 | Yes | 31 | 20.67

Intraoperative characteristics of respondents

About 52.67% of all respondents took spinal anesthesia by large gauge needle while 18% of spinal anesthesia was given by using medium needle. With respect to position of the patients during spinal anesthesia administration, almost all of the patients took spinal anesthesia in sitting position. Majority of spinal anesthesia was administered after three drops and two attempts (Table 2).

Table 2. Intraoperative characteristics of patients who underwent spinal anesthesia, 2017

| Variables | Category | Frequency | Percentage |
| --- | --- | --- | --- |
| Needle size | 18.00 | 39 | 26.0 |
 | 21.00 | 40 | 26.7 |
 | 22.00 | 14 | 9.3 |
 | 24.00 | 13 | 8.7 |
 | 26.00 | 44 | 29.3 |
| Position | Sitting position | 141 | 94.0 |
 | Lateral position | 9 | 6.0 |
| Number of drop | Less than or equal to three | 68 | 45.3 |
 | Greater than three | 82 | 54.7 |
| Number of attempts | One | 50 | 33.3 |
 | Two | 69 | 46.0 |
 | Greater than two | 31 | 20.7 |

Independent Predictors of PDPH

Risk factors associated with PDPH were analyzed further. All factors that turned out with a significant level (p value < 0.25) after binary logistic regression analysis were used to model for final analysis.

Consequently, backward multiple logistic regression analysis was used to determine the association of PDPH. Accordingly, output of multiple logistic regression models revealed that needle size, number of CSF drops and multiple attempts as independent predictors of PONV at significant level (p < 0.05).

Whereas maternal parity, BMI, were not significantly associated with PDPH (p < 0.05). Twenty five needle was identified as strongest pre-operative independent predictor with PDPH (AOR = 4.150, CI = 1.433- 12.021) (Table 3).
| Variable                  | Category    | PDPH | Sig.  | Exp(B) | 95% C.I.for Exp(B) |
|---------------------------|-------------|------|-------|--------|---------------------|
| Maternal parity           | Primigravida| No   | 34    |        |                     |
|                           |             | Yes  | 19    |        |                     |
|                           | Multigravida| No   | 73    |        |                     |
|                           |             | Yes  | 24    |        |                     |
| Needle size               | 18          | No   | 19    | .009   | 1.412               |
|                           |             | Yes  | 20    |        | .611               |
|                           | 21          | No   | 32    | .009   | 1.433               |
|                           |             | Yes  | 8     |        | .141               |
|                           | 22          | No   | 11    | .495   | 6.39                |
|                           |             | Yes  | 3     |        | .177               |
|                           | 24          | No   | 9     | .722   | 7.40                |
|                           |             | Yes  | 4     |        | .141               |
|                           | 26          | No   | 36    | .590   | 1.498               |
|                           |             | Yes  | 8     |        | .344               |
| Number of attempts        | 1           | No   | 38    | .048   |                     |
|                           |             | Yes  | 12    |        |                     |
|                           | 2           | No   | 53    | .131   | 4.43                |
|                           |             | Yes  | 16    |        | .154               |
|                           | >2          | No   | 16    | .033   | 3.36                |
|                           |             | Yes  | 15    |        | .123               |
| BMI                       | Underweight | No   | 7     | .596   |                     |
|                           |             | Yes  | 1     |        |                     |
|                           | Normal      | No   | 89    | .315   | 2.78                |
|                           |             | Yes  | 35    |        | .023               |
|                           | Overweight  | No   | 11    | .757   | 8.20                |
|                           |             | Yes  | 7     |        | .235               |
| Number of CSF drops       | 1           | No   | 10    | .142   |                     |
|                           |             | Yes  | 4     |        |                     |
|                           | 2           | No   | 49    | .021   | 1.80                |
|                           |             | Yes  | 15    |        | .021               |
|                           | 3           | No   | 43    | .025   | 1.38                |
|                           |             | Yes  | 16    |        | .025               |
|                           | 4           | No   | 5     | .024   | 1.35                |
|                           |             | Yes  | 8     |        | .024               |

Discussion

Needle size is the most important reason in the development of PDPH. The smaller needle diameter had been thought effective to reduce the incidence of PDPH [8, 15]. However, very thin spinal needles would increase the rate of failure for spinal anesthesia, resulting in multiple dural punctures and high incidence rate of PDPH[13]. Spinal needle size, spinal needle shape, multiple attempts and amount of CSF drops during lumbar puncture are modifiable risk factors of PDPH.

The result of this study indicated that small size pencil point spinal needle has lower risk of postdural puncture headache which agrees with other similar studies[14, 16]. However, another study conducted to compare 24-gauge Sprotte and 25- gauge Quincke needles and effect of subarachnoid administration of fentanyl found no significant difference in PDPH between the pencil-point Sprotte and Quincke needle inserted parallel to the dural fibers in obstetric patients[17]. But our study was done on different five sizes of spinal needles of different types. A few studies demonstrated that Quincke needles, if introduced with the bevel parallel to the longitudinal axis of the dural fibers could reduce the incidence of PDPH[9, 18].

According to the finding of this study, the incidence of postdural puncture headache is 28.67% which is lower than the study conducted in Gonder University Hospital which showed that 38.8% of PDPH[19]. On contrary to this study, another study conducted on factors associated with the onset and persistence of post–lumbar puncture headache in Network showed incidence of PDPH is 3 immediate post procedural headaches (21.6%)[20]. This difference may be due to
This study found that higher drop in CSF was strongly associated with PDPH which agrees with other similar study[20]. This may be due to an acute decrease in intracranial CSF pressure owing to extraction of larger volumes of CSF, triggering meningeal vasodilatation and positional traction on intracranial structures. If no further leakage of CSF occurs following the procedure, the amount of CSF removed should be replenished within several hours at physiological rates of CSF production[21].

The finding of this study revealed that multiple attempts during spinal anesthesia administration were significantly associated with postdural puncture headache. Another study also found that persistent failure of the dural puncture to causes continues leakage of CSF and contributes for postdural puncture headache. One potential mechanism for the lower rates of PDPH and therapeutic blood patch seen with extraction of higher volumes of CSF may be that transiently lower CSF pressures immediately following the procedure decrease continued leakage through the dural puncture, facilitating dural closure [22]. However, another study found that, there is no significant difference observed in the incidence of PDPH between single shot block and two or more attempts[23]

Conclusion
The finding of this study revealed that small size pencil point spinal needle is significantly superior to large size cutting spinal needle regarding the occurrence of PDPH. In addition multiple attempts and amount of CSF drops were significantly associated with PDPH. In view of this, we recommend the use of small size pencil-point spinal needle, to avoid multiple attempts and frequent CSF drops during spinal anesthesia and lumbar puncture.

Declarations
Consent for publication: Applicable

Availability of data and materials: Available up on request

Competing interests: We declared that we had no competing interests.

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Author’s contribution: BGW and MSO initiated the research, wrote the research proposal, conducted the search, did data entry and analysis and wrote the manuscript KDM and GAA Initiated the research, wrote the research proposal, conducted the research, did data entry and analysis and wrote the manuscript. All authors read and approve the final manuscript.

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