Review Article

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Post spinal puncture headache, an old problem and new concepts: review of articles about predisposing factors

Abstract

Post spinal puncture headache (PSPH) is a well known complication of spinal anesthesia. It occurs after spinal anesthesia induction due to dural and arachnoid puncture and has a significant effect on the patient's postoperative well being. This manuscript is based on an observational study that runs on Babol University of Medical Sciences and review of literatures about current concepts about the incidence, risk factors and predisposing factors of post spinal puncture headache.

The overall incidence of post-dural puncture headache after intentional dural puncture varies form 0.1-36%, while it is about 3.1% by atraumatic spinal needle 25G Whitacre. 25G Quincke needle with a medium bevel cutting is popular with widespread use and the incidence of PSPH is about 25%, but its incidence obtained 17.3% by spinal needle 25G Quincke in our observation. The association of predisposing factors like female, young age, pregnancy, low body mass index, multiple dural puncture, inexpert operators and past medical history of chronic headache, expose the patient to PSPH. The identification of factors that predict the likelihood of PSPH is important so that measures can be taken to minimize this painful complication resulting from spinal anesthesia.

Keywords: Post spinal puncture headache (PSPH), Spinal anesthesia, Headache, Risk factors, Treatment

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Spinal anesthesia also called spinal analgesia or subarachnoid block is a form of regional anesthesia and a kind of neuraxial block involving injection of opiods, local anesthetics or other permissive drug into the subarachnoid space (1, 2). The first spinal anesthetic was delivered by an accident. Its inception can be traced back in the late 19th century by James Leonard Corning. He reported on spinal anesthesia in 1885 for the first time. The first planned spinal anesthesia was administered by August Bier in 1898. He had personal knowledge of the symptoms of post spinal puncture headache (PSPH). Bier reported complications including back and leg pain, vomiting and headache. Even at this early stage, he had associated the loss of cerebrospinal fluid with post spinal headache (3, 4). Spinal anesthesia offers many advantages for operation although the extent of its benefit is not agreed universally.

It has a very rapid onset and provides a dense neural block which can produce highly effective pain relief for a wide variety of indications and may decrease patient morbidity after major surgery, moreover, failures are very infrequent (1, 2).

Despite the many years that spinal anesthesia (SA) has been used, there remain controversies about the appropriate use of these blocks in special conditions. Disadvantages of this technique include the finite duration of anesthesia and a higher incidence of hypotension. Some researchers suggest that SA is inappropriate for outpatients because of the occurrence of PSPH (1, 5). Similarly, spinal anesthesia seems to be well-suited for in patients undergoing cesarean section because of the short interval from injection to surgical anesthesia (6).

Recently large randomized controlled clinical trials and meta-analysis have led to conflicting conclusions and interpretations regarding the outcome benefit of spinal anesthesia techniques (1, 2). Post-spinal puncture headache (PSPH) is known by various names like post-dural puncture headache (PDPH), post lumbar puncture headache, lumbar puncture headache, post-spinal headache and spinal headache.

Post spinal puncture headache may be used throughout manuscript rather than post-dural puncture headache (PDPH) because it appears that arachnoid puncture is more linked to the resulting headache than the dural rent (7). We carried out a review of observational and experimental studies of patient operation under spinal anesthesia.

Randomized trials (RCTs) or observational studies that obtain the incidence of PSPH, evaluating the different individual factors or techniques on PSPH incidence or comparing the effect of different spinal needles (gauge and design) in the incidence or prevalence of PSPH have been reviewed. Case series about the outcome of PSPH or bizarre presentation or duration were limited to the reliable, high quality peer reviewed journals that were only summarized qualitatively.

The inclusion and exclusion criteria for entrance of the patient in the studies were the same. Our standard intervention was operation under spinal anesthesia and the primary goal was the rate of PSPH incidence among the patient groups. The secondary target was the evaluation of the individual and technical factors on PSPH incidence. We attempted to identify all relevant studies regardless of language or publication status (published, unpublished). Search strategies were developed from the first PSPH report until the present time.

The internet was searched via general search engines, such as Google Scholar for relevant studies and the reference lists of the included studies were also checked. Moreover; we ran a cross-sectional descriptive analytical study parallel with a review on article. Written consent was obtained from the entire patient candidates for the different types of surgeries (Urology, Obstetrics, General surgery, etc) admitted to the teaching hospitals of our university, whereas, spinal anesthesia was chosen as the preferred method of anesthesia. The study period was from January 2010 to March 2012. The aim of the study was to present the literature review of the current concepts about the incidence, risk factors and predisposing factors of post spinal puncture headache and the evaluation of the influence of various factors relating to the patient and puncture technique in the development of PSPH.

Discussion:

Post spinal puncture headache is a well known complication of spinal anesthesia. It is a common and incapacitating complication following dura-arachnoid puncture, whether for the purposes of diagnosis, therapy or spinal anesthesia (1, 2).

Incidence and definition: The overall incidence of PDPH after intentional dural puncture varies form 0.1-36%, the highest incidence of 36% is found after ambulatory diagnostic lumbar puncture using a 20 or 22-guage standard Quincke spinal needle (8). Vilming and Kloster reported 36.8% of PDPH and all the cases appeared up to 4 days after puncture and the median duration was 6 days (9).

The incidence of headache after spinal anesthesia varies greatly among the other studies. The incidence is 40% with a 20 GA needle, 25% with a 25 GA needle, 2-10% with a 26 GA needle, and less than 2% with a 29 GA needle (10). Many factors reported to influence the incidence of PSPH were: age, sex, pregnancy, previous history of post spinal headache, needle size, needle tip shape, bevel orientation to the dural fibers, number of lumbar puncture attempts, midline versus lateral lumbar puncture approach, type of local anesthetic solution, and clinical experience of the operator (11-17).

In our observation, we found out that 17.3% patients presented postural headache characteristic of post spinal puncture headache, and the independent risk factors for it were age between 20 and 30 years, a previous history of any kind of headache and the orientation of the bevel perpendicular to the long axis of the spinal column at the time of the dura mater/arachnoid puncture and experience level of operator (unpublished data).

The typical feature of PSPH is the postural character of the dull pain in a frontal-occipital distribution, which is when the individual assumes an upright position. Any movements that increase intracranial pressure (such as coughing, sneezing, straining, or ocular compression) may exacerbate symptoms. The onset of PSPH may be immediate or delayed for several days, presumably depending on the rate of cerebrospinal fluid (CSF) leakage (18-20). The symptoms of PSPH start within 5 days of dural puncture in

90% of cases. The duration of PSPH is usually self-limiting to approximately 5-7 days. It seldom lasts longer than 2 weeks with 80% to 85% of cases being of less than 5 days' duration (PSPH develops within 7 days of SA and disappears within 14 days) (21, 22). In the evaluation of the clinical features, when we compared our results with the diagnostic criteria of PSPH, the latent period established for the onset of PSPH (up to 5 days after puncture) proved to be satisfactory (23). Most of our patients with postural headache, the onset of the pain occurred up to 47 hours and some of them presented the features during 96 hours after puncture.

As it has been observed in most of the patients, the duration of PSPH is 5 days and it resolves spontaneously within a week. When considering the duration of headache, the original study reported by Vandam and Dripps is the largest and most definitive.

In a study of 10,098 spinal anesthesia involving 8460 patients, they followed the patients for 2 weeks after the dural puncture and then performed a follow-up at 6 months. They reported that only 72% of PDPH were resolved within 7 days (24). Thus, it is possible for the postural headache to last more than 1 week.

Diagnosis: The fundamental principle in the assessment of any patients with a PSPH is to carefully consider the differential diagnosis like meningitis, encephalitis, migraine, tension headache, cluster headache, neuralgia, hypertension, cerebral vascular accident , postpartum cerebral angiopathy, subdural hematoma, subarachnoid hemorrhage, cortical vein thrombosis, space occupying lesion, benign intra cranial hypertension, dehydration, lactation headache, preeclampsia and caffeine withdrawal (1, 4, 12-17).

Awareness must be cultivated that PSPH is the only one of the many causes of headache in postoperative and postpartum period. The main factors influencing PSPH can be categorized as characteristics of patient population puncture technique.

Characteristics of patient population

Age: Certain patient populations are at an increased risk for the development of post dural puncture headache. Patients at 20-40 years are most susceptible, whereas, the lowest incidence occurs after the fifth decades (25, 26). A greater risk of PSPH in the 31–50 years age range was also found by Wadud et al., in a study that compared patients below and above 50 years old (27). Other studies found a higher incidence of PSPH between the ages of 20 and 30 years (28, 29). It is unquestionable that the incidence of PSPH is higher in adults, decreasing with increasing age. Although the physiopathology is not clear; three factors can be imagined for preventing individuals over 50 years old from developing PSPH in theory: a. The reduced elasticity of the dura mater, which makes it more difficult for CSF to leak through the puncture hole, b. A weaker reaction of the cerebral vessels to CSF hypotension, c.

A reduced vertebral extra-dural space allowing a small amount of CSF accumulation, thereby, arresting the leak of CSF from the subarachnoid space (30, 31).

Sex: Women were more likely to be affected than men when risk was adjusted for age. The results of Wu et al. do not support other studies. They found that the risk of post spinal puncture headache was twice as great as that of men. Their study considered a great role for gender as a risk factor for post spinal headache. They related their finding to the physiological and psychosocial characteristics peculiar of women, as well as their pain perception (32). Women seem to process nociceptive information differently from men, showing greater sensitivity to painful stimulation which facilitates the central sensitization process (33, 34). Some studies emphasis on the incidence of PSPH is higher among females and there is an inverse relationship between PSPH and increasing age (11, 16, 17, 32).

Body mass Index: Lower Body mass index (BMI) has been shown to be associated with higher risk of PSPH. Ironically, PDPH incidence is noted to be low in morbid obesity. This may be because of the large abdominal panniculus acting like an abdominal binder and raising the intra-abdominal pressure, thus, reducing the rate of leak of CSF through the dural defect (8, 35-38).

Parturition constitutes (pregnancy): It was mentioned in the literature in the past that the incidence of PSPH was highest in the parturient because of a number of factors like, increase in CSF pressures during vaginal delivery, dehydration secondary to NPO status, blood loss, postpartum diuresis, increase in intra-abdominal, hormonal imbalance, high serum estrogen level and peri-dural pressures (11, 16, 17, 39) besides they legitimatized, high serum estrogen level in women that could influenced the tone of the cerebral vessels, therefore, increased the vascular distension response to CSF hypotension (39, 40). Generally, accepted parturition constitutes the highest risk category for PSPH and the incidence within them have been reported up to 38% but some studies vary between 0-30 percent (1, 11, 17, 39, 40).

Hydration status: Some of the researchers based on their observations believe that under hydration this can be a factor influencing the incidence of PSPH (16, 41). There were not any relations between the type and volume of intravenous fluid therapy before and after anesthesia induction and after operation in our investigation.

In other words, while volume preloading has reduced the incidence and magnitude of spinal anesthetic-induced sympathetic blockade, it does not seem to have a bearing upon the incidence of PSPH (11). In summary, normal hydration of the patient should be maintained. Extra hydration does not alleviate the headache but dehydration makes symptoms worse.

Past history for chronic headache: Some researchers believe patients with a headache before lumbar puncture and a prior history of PSPH are also at increased risk others express; there is no known relationship between the diagnoses of migraine headaches and increased incidence of PSPH after neuroaxial block (42).

There are a few published studies evaluating the risk of a new PSPH attack in patients with a past history of chronic headache (43). In a case control study by Amorim and Valenca, the prevalence of post-dural puncture headache was significantly greater in the group with a previous positive history for post-dural puncture headache and females had a greater risk of a recurrence (35). There are presentations about disappearance of migraine attacks during long-lasting PSPH and the authors suggested an interrelationship between the mechanisms of post spinal puncture headache and migraine (43, 44).

It seems that the peculiar physiological characteristics and neurologic neurotransmitters peculiar to chronic headache like migraine and tension headache can possibly account for the susceptibility of patients with past history of chronic headache to consecutive episodes of PSPH. We propound a great relationship between past history of chronic headache and incidence of PSPH.

Puncture technique: Some investigators believe that the size of the dural hole and the speed with which it closes seem to be the most important factors determining the occurrence of PSPH. They legitimize that the absence of PSPH is probably the result of the prolapsed of the arachnoid through the dural opening (12).

Spinal needle: In the 1950s, Hart and Whitacre suggested that the use of pencil-point spinal needles without a cutting edge to reduce trauma to the dural fibers. The clinical and laboratory studies have indicated that pencil-point needles may produce fewer PSPH symptoms, but none of the recent studies clearly stated that Whitacre spinal needle is better than Quincke needle in respect to PSPH (45-47).

A randomized comparison of 25 gauge Whitacre and Quincke needle revealed a significantly lower incidence of PDPH in the whitacre group 8.5% versus 3% of the Quincke group (48). However, the 25G Quincke needle with a medium cutting bevel, is still the most popular and in widespread use due to the ease of handling and the incidence of PSPH is about 25% with the 25G Quincke needle (49-50). Recently a modification of the Quincke needle has been made available, known as atraumatic needle. It has a cutting point and double bevel which are intended to cut a small dural hole and then dilate it (51).

Characteristic of Needle Used: There is direct correlation between needle size and risk of PSPH. Vandam and Dripps noted that the incidence ranged from 18% with a 16 gauge needle to 5% with 26 gauge needles, whereas, the overall risk of PDPH was 11% in 11000 cases of spinal anesthesia. The incidence of PSPH for the different types of spinal needles is shown in table 1 (17). There are enough evidences that both needle size, and tip design impact the incidence of PSPH (24).

Table 1. Incidence of PSPH for different types of spinal needles (17).

Needle size & Type	Bevel	Incidence of PDPH%
25G Quincke	Cutting	8.7
26G Atraucan	Cutting	5
24G Gertie Marx	Atraumatic	4
24G Sprotte	Atraumatic	2.8
25G Whitacre	Atraumatic	3.1

Direction of needle bevel: In the case of spinal anesthesia, introduction of the needle with its bevel parallel to the dura's longitudinal fibers is another prophylactic measure that may reduce the incidence of PDPH.

This method of insertion separates the fibers rather than cutting them facilitating closure of the hole upon needle withdrawal. Richman et al. in a meta-analysis study demonstrated that a bevel orientation parallel to the long axis of the spinal column significantly lowered the incidence of PSPH, when compared with the perpendicular (52). Kempen and Moeck in an experimental study found that when

puncture was made with a parallel orientation of the needle bevel, the layers of dura mater and arachnoid overlap and this might reduce CSF leakage (53).

Number of puncture: There were reports available addressing the issue whether multiple dural punctures influence the frequency of PSPH. Lybecker et al, did not find a significant association between the number of punctures and the frequency of PSPH after multivariate analysis (28). However, recent analysis of prospective data on 8,034 spinal anesthetic patients showed increase in the incidence of PSPH with repeated dural puncture, this confirms the assumption that a second dural puncture increases the risk of PSPH (54).

Puncture approach: As for the angle of insertion of the needle, an in vitro study using a model of human dura mater demonstrated a smaller loss of CSF when the needle was inserted using the paramedian approach, whereas, when the median approach was used, the loss of CSF was greater.

One possible explanation would be that the paramedian approach decreased the loss of CSF resulting from perforation of the dura mater and the arachnoid at different angles, produced a valvular mechanism that prevented a greater CSF flow to the epidural space (55-57). In our investigation, a significant association between the angle of approach and the incidence of PDPH was found.

Out of bed time: Assuming the horizontal position relieves the symptoms of PSPH. Perhaps, CSF loss is greatest in the upright position (17). However, attempts at prophylactic treatment by placing a patient horizontal for a period of time after a dural puncture have no effect on the incidence or duration of a PSPH but, it only delays the onset of the PSPH until the patient ambulates (55). Anyway, after PSPH appearance, conservative measures usually start by asking the patient to observe bed rest and avoid the discomfort associated with an upright position. Lateral horizontal position produces less tension on the dural rent than supine, and results in less leakage of CSF.

Level of puncture: Some researchers suggested that the etiology of the post spinal headache was a leakage of CSF into the epidural space. In the upright position, there can be 40 to 50 cm H2O pressure gradient between the intra-dural CSF and the epidural space, making it possible for fluid to be lost into the low pressure space (22, 58).

Different studies showed that PSPH was more frequent when L4-L5 was chosen than L3-L4 and explained by pressure of CSF (10).

Experience level of operator: There was an inverse relationship between the experience level of operator that induced spinal anesthesia and incidence of PSPH (59).

Drug prescribed into intrathecal space: There is no difference between local anesthetic and additive that is applied in spinal anesthesia from the incidence of PSPH point of view (60).

Classification of surgery: The incidence of PSPH is the same in all surgery types. In other words, the incidence of PSPH in all surgery categories (obstetrics and gynecology, urology, orthopedic, general surgery) is equal. Although it is more frequent in parturient (21, 22, 39).

Surgery type: There is no difference in incidence of PSPH regarding emergency or elective kind of operation or even day-case surgery (61).

Premedication: Taking analgesics after operation will prevent the onset of headaches after lumbar puncture, but Flaatten et al. found that 100 mg Indomethacin postoperatively has no significant effect on the incidence of headaches after lumbar puncture (62). Alpha2-delta type voltage-dependent calcium channels have recently become a prevention and treatment target for some chronic pain conditions including PSAH. Taylor noted that binding to alpha2-delta type voltage- dependent calcium channels was both necessary and sufficient for the analgesic effects of pregabalin and Gabapentin. The time to reach maximum plasma concentration is 1 hour for pregabalin and 2 or 3 hours for gabapentin so, for the prophylactic purpose, they must be prescribed 2-3 hours before spinal anesthesia induction (63-65).

Other factors: Surgery technique, underlying disease like mellitus diabetes, hypertension, chronic obstructive lung disease if they were in control status, drug history did not have significant role in PSPH incidence, although in patients with history of anti epileptic drug consumption PSPH were more frequent. These were mentioned in the literatures about increasing the risk of anesthesia in patients who suffered from coexist disease (1, 10, 11, 18). We could not find any relative report about accompaniment of chronic disease and PSPD in the literature.

Conclusion: PSPH could increase the workload of physicians. It could increase in the hospital stay, investigations and treatment that required significant financial repercussions potentially. Diagnosis of PDPH should only be made when other causes of headache are ruled out. When a headache occurs after spinal, it must be

considered potentially serious and should be differentiated from the other causes of headache. There is considerable variability in the incidence of PSPH. In our current study, we obtain its incidence about17.3%. We concluded that several factors seem to predispose a patient to develop PSPH after spinal anesthesia including age, gender, number of attempts, and needle type (design) and size, history of previous PSPH or chronic headache.

It is suggestible that the incidence of PSPH is inversely related to operator experience. The identification of factors that predict the likelihood of PSPH is important, so that measures can be taken to minimize this painful complication resulting from spinal anesthesia. The principal factor responsible for the development of PDPH is the size of the dural perforation. The other factors such as the shape of the dural perforation and the orientation of the spinal needle have a less significant role.

Decreasing the gauge (G) of needle applied for spinal anesthesia may be a logical solution to decrease the incidence of PSPH. Therefore, a balance has been struck between the risk of PDPH and technical failure. Most experts agree that 25- 27 G needles probably represent the optimum needle size for spinal anesthesia however; technical difficulties are common when spinal block is attempted with needles of 29 G or smaller (61, 66-68).

The authors would like emphasize that their conclusions should be interpreted with attention to the lack of sufficient local and national information needed to allow comparison of our discussion to past investigations, inappropriate design of past studies like those small in sample size, methodologically weak or flawed, however, adequately powered and no well-designed randomized controlled clinical trials.

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