

REVIEW ARTICLE

POST DURAL PUNCTURE HEADACHE

GP Deo *

Department of Anaesthesiology and Critical Care, Chitwan Medical College, Bharatpur-10, Chitwan, Nepal

*Correspondence to : Dr Gopendra Prasad Deo, Department of Anaesthesiology and Critical Care, Chitwan Medical College, Bharatpur-10, Chitwan, Nepal.

E-mail: gopendradeo@gmail.com

ABSTRACT

Spinal anaesthesia developed in the late 1800s. In 1891, Wynter and Quincke aspirated cerebrospinal fluid (CSF) from the subarachnoid space for the treatment of raised intracranial pressure associated with tuberculous meningitis. However it was German surgeon, August Bier, probably first gave spinal anaesthesia and also experienced headache. He first reported this headache being related to excessive loss of cerebrospinal fluid (CSF). Recently there are lots of modification in needle size and its tip which lead to sharp decline in the incidence of post dural puncture headache (PDPH). Various conservative, pharmacological and interventional measures are available. Epidural blood patch has high cure rate. Epidural saline, dextran, opioids, tissue glue are also been used to reduce rate of CSF loss. This review considers all these aspect of PDPH.

Key Words: *spinal anesthesia, dural puncture & headache.*

INTRODUCTION

Dural puncture is a commonly performed invasive procedure for various indications like spinal anaesthesia diagnostic lumbar puncture, myelography and intrathecal chemotherapy. However, unintentional dural puncture can also occur while performing epidural anaesthesia or analgesia for various indications, including postoperative and labour pain relief.

Though the most common cause of anaesthesia induced headache is PDPH, but it can be due to many reasons. Literature review suggests that PDPH has been correlated with many other reasons apart from dural puncture but there is definite relation between dural puncture and PDPH.

HISTORY

Spinal anaesthesia developed in the late 1800s. In 1891, Wynter and Quincke aspirated cerebrospinal fluid (CSF) from the subarachnoid space for the treatment of raised intracranial pressure associated with tuberculous meningitis.¹

PDPH was first described by August Bier in 1898. In August 1998, Karl August Bier, a German surgeon, injected cocaine 10-15 mg into the subarachnoid space of seven patients, himself and his assistant.² Dr Bier described the headache as a feeling of very high pressure in the head, accompanied by light dizziness when raising quickly from the chair. He further described that all the symptoms used to disappear when laid horizontally but used to reappear when got upright. Dr Bier surmised that the headache was attributed to loss of CSF.³

Reduction in needle size and development in its design have led to a significant reduction in the incidence of PDPH.

However, it still remains concerned disabling complication of spinal anaesthesia or procedures requiring needle insertion into subarachnoid space.

INCIDENCE

The incidence of post dural puncture headache was 66% in 1898.² This alarmingly high incidence was likely due to large bore needle, medium bevel and cutting spinal needle. Recent literature shows overall incidence of PDPH after intentional dural puncture varies from 0.1-36%, the highest incidence of 36% was found after ambulatory diagnostic lumbar puncture using a 20-22 guage standard quincke spinal needle.⁴

Anaesthesiologists have been active in trying to reduce the incidence of postspinal headache. Reducing the size of the spinal needle has made direct impact on post spinal headache. The incidence is ~40% with a 22g needle, upto 25% with a 25G needle,^{5,6} 2-12% with a 26G Quincke needle^{5,7} and <2% with a 29G needle or smaller ones.⁷ But failure of the affect with 29G or smaller needles are quite common due to technical difficulties.⁸

Introduction of atraumatic (pencil tip) spinal needles by Whitacre and Hart in 1951 further decreases the incidence of post spinal headaches.⁹ Various needle modifications since then such as Sprotte and Atraucan needles, shows further reduction in post spinal headache.

The parturient is at higher risk of dural puncture and subsequent post spinal headache due their sex, age and widespread application of epidural anaesthesia.⁶ Incidence of unintentional

dural puncture varies between 0 to 2.6% in parturient receiving epidural analgesia¹⁰ and its incidence is inversely related to the experience of anaesthesiologists¹¹ and also said to be reduced by the orientation of the needle bevel parallel to the dural fibres.¹² Loss of resistance have higher risk of dural puncture than loss of resistance to fluid.¹³ 70 – 80% of subjects will have post spinal headache after dural puncture with 16G tuohy needle.¹⁴ Carbajal R and group reported PDPH as uncommon in children¹⁵ while few other studies shows having comparable incidences of post spinal headaches in children and young adults.¹⁶

PATHOPHYSIOLOGY

First report of PDPH was reported almost a century ago but still exact mechanism of PDPH is still not fully understood. Excessive loss of cerebro-spinal fluid (CSF) through dural puncture leads to intracranial hypotension and demonstrable decrease in CSF volume and appears to be the main cause of PDPH and was first proposed in 1902.¹⁷ After the development of PDPH, the presence of leak has been confirmed with radionuclide cisternography, radionuclide myelography, manometric studies, epiduroscopy direct visualization at laminectomy. The adult subarachnoid pressure of 5-15 cm H₂O is reduced to 4 cm of water or less.¹⁸ The rate of CSF loss through dural hole is greater than CSF production (0.35ml/min). Majority of investigations support this “leakage theory”, as an explanation for PDPH but is not universally accepted reason of headache. According to this theory, leakage of CSF through the dural hole causes decreased CSF pressure and volume, followed by gravity dependent downward sagging of the brain resulting in traction on the pain sensitive structure around the brain causing headache.^{19,20} Gadolinium enhanced MRI demonstrate sagging of intracranial sagging.²¹ However a recent multi-slice sagittal magnetic resonance imaging (MRI) studies failed to show any evidence of such sagging.²² Mokri et al reported normal CSF pressure in patients having typical features of PDPH.²³ Even with few dispute, most of the studies show loss of CSF and low CSF pressure but the actual mechanism of headache is unclear. The two possible explanations of headache, firstly traction of pain sensitive intracranial structures in upright posture due to low CSF pressure and secondly compensatory vasodilatation due lowering of CSF pressure. But there are few contradicting studies. A consistent feature of PDPH is that jugular vein compression (which causes high CSF pressure) increases the severity of PDPH.²⁴ Intravenous caffeine and theophylline both being adenosine antagonist and potent cerebrovascular constrictors relieve PDPH in upto 70% of cases.^{25,26} If low CSF pressure is the reason of causing PDPH then cerebrovascular constrictors should have increased the severity of PDPH rather than decrease it. In response to loss of CSF, compensatory dilatation of intracranial vessels occurs to restore the intracranial volume. Throbbing and orthostatic nature of headache constitutes an important symptom of cerebral vasodilatation and intracranial congestion of blood and thus supports the hypothesis that the loss of CSF causes compensatory cerebral vasodilatation resulting in PDPH.²⁷ Andra P proposes that PDPH is probably a vascular type headache and epidural blood patch relieves the headache by its vaso-constrictive action.²⁸ Subarachnoid spread of injected blood may cause cerebral

vasoconstriction. Rich innervations of adrenergic, cholinergic, and peptidergic fibers in the duramater may play a role in the management of PDPH with epidural blood patch but it require further researches to know exact mechanism of PDPH.

PRESENTATION

Headache and Backache are predominant symptoms. Headache is characteristically located over frontal and occipital region radiating to the neck and shoulder, aggravated by upright posture and relieved by lying down. The temporal, vertex and nuchal areas are less common site of discomfort, although neck stiffness may be present. The pain is aggravated by neck movement. An increase in severity of the headache on standing position is the sine qua non of PDPH.

Headache might be associated with nausea, vomiting, tinnitus, vertigo, dizziness, paresthesia of scalp and limb pain. Visual disturbances like diplopia, blurring of vision or cortical blindness have been reported. Cranial nerve palsies are not uncommon. Symptoms usually start within 48 hrs in 66% cases and within 3 days in more than 90% cases. In majority of cases, symptoms resolve spontaneously within few days to a week, however there are reports of PDPH persisting for a month to a year.²⁹

DIFFERENTIAL DIAGNOSIS

The diagnosis of post dural puncture headache is frequently clear from the history of dural puncture and presence of severe postural headache. However, diagnosis of PDPH should only be made when other causes of headache are ruled out.

Tension headache, migraine headache, lactation headache, brain tumour, subdural haematoma, subarachnoid haemorrhage, cortical vein thrombosis, meningitis, pneumocephalus, spontaneous intracranial hypotension are important differentials and should be ruled out.

COMPLICATION

Neurological sequelae, following dural puncture are well recognized, the most serious although rare complication is the occurrence of transient cranial nerves palsy, almost all cranial nerve have been implicated. Usually a single nerve palsy has been reported, the nerves effect are 3rd, 4th, 6th, 7th, and 8th. Reported incidence of cranial nerve palsies is 1 to 3.7 per 100,000 cases. The abducent nerve is more susceptible because it is relatively fixed at its entry into the cavernous sinus and at its attachment to the Pons. This nerve is most likely to be stretched due to sagging of the brain because of CSF leak.³⁰

Blindness has been reported, who developed blindness on 1st post partum day and resolved within 48 hours. Although recovered completely within 7 days.³¹

Cases of subdural haematoma or cerebral haemotoma have also been reported in literature. The reduction in CSF volume could lead to brain sagging, with traction on the delicate blood vessels, causing them to rupture and later formation of a haematoma.³²

Factors influencing PDPH

1. Characteristics of patient population
2. Characteristic of needle used
3. Puncture technique

1. Characteristic of Patient Population

Age

Patients' age 20-40 years are most susceptible whereas the lowest incidence occurs after fifth decades. The lesser incidence of PDPH in elderly individual is due to decrease in the elasticity of cranial structures, which occurs as normal aging process, and also reduction in overall pain sensitivity. In the patients younger than 10 years, PDPH is rarely reported suggesting a lower incidence, compared with adults. This could be explained by lower CSF pressure in infants and children than adults and also the lower hydrostatic pressure in lumber regions generated by the upright position in children.³³

Sex

Women have higher incidence of PDPH. Vandane and Dripps reported women had twice the incidence i.e., 14% of PDPH compared with men i.e., 7%.³⁴ Kang et al also had similar results, the incidence of PDPH in women (13.4%) compared with men 5.7%.³⁵ Parturition have the highest risk of PDPH.

2. Characteristic of needle used

Needle size and design

There is direct correlation between needle size and risk of PDPH. Larger needle produces larger dural perforation and higher risk of PDPH. There are enough evidences that both needle size and tip design have direct impact on incidence on PDPH. A meta analysis of 450 articles showed reduction of PDPH when smaller size needle of same type used and non-cutting spinal needle of same size used.³⁶ With quincke needle, the incidence of PDPH is directly related to the size of needle used.³⁷ The pencil point or blunt tip needles like whitacre needle are associated with lower PDPH rates because they are less traumatic to the longitudinal fibers of dura, separating them and this produces a small rent with reduced CSF leakage. Lambert et al reported the rate of PDPH with 25 gauge whitacre needle as 1.2% in comparison to 27 gauge cutting needle as 2.7%.³⁸ A randomized trial showed a significantly lower incidence of PDPH, 8.5% Vs 3% in the 25 G quincke needle versus 25G whitacre needle.³⁹ Cesarini et al performed a randomized trial which showed no cases of PDPH with 24 gauge sprotte while 14.5% with 25 gauge quincke needle in patients receiving spinal anaesthesia for cesarean section.⁴⁰ Even though fine spinal needles, 29G or smaller, have low incidence of PDPH, they are technically difficult to use and are associated with higher failure rate. A balance has to be made between risk of PDPH and technical failure. 25G, 26G and 27G needles probably are the optimum size needles for spinal anaesthesia.⁴¹

Needle tip deformation

Contact of spinal needle with the bone during insertion lead to its tip deformation causing larger subsequent dural perforation and thus increases the risk of PDPH. Cutting type of spinal needles is more likely to be deformed with bone contact.⁴²

3. Puncture technique

Orientation of needle bevel piercing the dura, angle of insertion and number of puncture are imp factors. The orientation of bevel of a spinal needle parallel to the long axis of the spine produced less dural trauma than occurred when the bevel is inserted perpendicularly.⁴³ The dura has been described as longitudinal in direction, however Fink and Walker noted that the dura

consists of multidirectional interlacing collagen fibers and both transverse and longitudinal elastic fibres.⁴⁴ The insertion of the needle with the bevel parallel to the long axis of the spine most likely results in less tension on the dural hole. Fourteen women out of 20 (70%) developed PDPH in perpendicular group and 5 out of 21 women (24%) suffered PDPH in the longitudinal group. These data suggest that the orientation of the epidural needle is not a factor in avoiding an accidental dural puncture but is crucial in diminishing the resultant PDPH.⁴⁵

In a vitro study, it was reported that the insertion of the needle at an acute angle results in decreased leakage of CSF.⁴⁶ An oblique angle of penetration theoretically creates a flap valve that tends to seal the perforation in dura but important clinical studies substantiating this point are lacking. In an prospective study of 8,034 spinal anesthetic patients showed increase in the incidence of PDPH with repeated dural puncture, this confirms the assumption that a second dural puncture increases the risk of PDPH.⁴⁷

Management

PDPH is usually self limiting and lasts for few days. However early treatment is indicated. Treatment options varies from conservativemeasures, pharmacological treatment to invasive approaches.

Conservative measures

Psychological

Patients who develop PDPH may reveal wide range of emotional resposes from misery and tears to anger and panic. So it is very important to discuss about the risk and complications including headache before the procedure. Obstetric patients are particularly unfortunate because they are expected to be happy and take care of new born. They are at high risk of going into depression. Proper counseling should be done regarding reason of headache, expected time course and therapeutic options.

Bed rest

Patients should be encouraged to lie in comfortable position. The prone position had been advocated as it increases intra-abdominal pressure which is transmitted to epidural space and may alleviate the headache but a clinical trial of the prone position following dural puncture failed to demonstrate a reduction in PDPH.⁴⁸ But prone position is very uncomfortable. However, Jawalekar SR et al advocated lateral horizontal position as it produces less tension on the dural rent than supine, and results in less leakage of CSF.⁴⁹

Hydration

No patients with PDPH should be allowed to be dehydrated. Encourage oral fluids, if not intravenous fluids should be given.

Abdominal binder

A tight binder raises intra abdominal pressure which is transmitted to the epidural space and may relieve headache. But they are very uncomfortable and so only few recommends.

Pharmacological treatment

The aim of pharmacological management is relief from headache, replace lost CSF, seal the puncture site and control the cerebral vasodilatation.

Analgesics

Simple analgesics like acetaminophen and non-steroidal anti-inflammatory might help. As most of patients are postsurgical, already on some opioids, would help.

Caffeine

Caffeine, a central nervous stimulant, produces cerebral vasoconstriction and thus reduces cerebral blood flow. In a randomized double blind trial by Sechzer and Abel caffeine sodium benzoate 500mg intravenously had better relief of PDPH compared to placebo.⁵⁰ Similarly, Camann et al. observed that oral caffeine 300mg being superior to placebo for the relief of PDPH.⁵¹ Caffeine is inexpensive, easy to obtain and fairly risk free. It is available in both oral and intravenous form. The oral form is well absorbed with peak levels reached in 30 minutes. Caffeine crosses the blood brain barrier and half life of 3-7.5 hrs allows for infrequent dosing schedules. Both oral and intravenous forms of caffeine having been successful in treating post dural puncture headaches can be used as first option in conservative therapy. The recommended dose of caffeine for the treatment of PDPH is 300-500 mg of oral or intravenous once or twice daily.^{52,53} One cup of coffee contains 50-100 mg of caffeine and soft drinks contain 35-50 mg. However, therapeutic doses have been associated with central nervous system toxicity and atrial fibrillation.

Other Drugs

Theophylline, a methyl xanthine, is a cerebral vasoconstrictor and has been more effective than placebo.⁵⁴

Sumatriptan, a 5-HT_{1D} receptor agonist promotes cerebral vasoconstriction. It is advocated for the management of migraine and recently for PDPH. Carp et al reported the administration of sumatriptan 6 mg to 6 patients with PDPH with complete resolution of headache in four hours.⁵⁵ It is expensive and needed to be given subcutaneously. However, a recent trial found no evidence of benefit from sumatriptan for PDPH.⁵⁶

Adrenocorticotrophic hormone (ACTH) infusion at a dose of 1.5 µg/kg has been reported to provide effective relief in few cases but fails to give any conclusion.⁵⁷

Interventional management of PDPH

Epidural blood patch

The concept of epidural blood patch has developed from the observation of less headache rate with bloody taps. The theory is that the blood, once injected into the epidural space, will clot and occlude the perforation, prevents further CSF leak. Due to high success rate and low complications, epidural blood patch is reliable cure of PDPH.

The patient is positioned in lateral position and the epidural space is located with Tuohy needle at the level of suspected dural puncture or an intervertebral space. With maintaining sterility, up to 30ml of blood drawn from patient's arm and injected slowly through Tuohy needle. If patient starts complaining of lancinating pain of dermatomal origin, the procedure should be stopped. Despite no consensus regarding volume, most practitioners now recognize that 20-30ml of blood is optimum and likely to give more success.⁵⁸ After the procedure, the patient is asked to be in lying posture for 2 hours and then allowed to walk.

The presence of fever, infection on the back, coagulopathy or patient refusal are contraindications, same as applied to epidurals, but also include a raised leucocytes and technical difficulties.

After injection, blood spreads both caudally and cephalad

regardless of direction of Tuohy needle bevel. Blood compresses thecal space causing elevation of subarachnoid pressure. This mass effect lasts for 3 hours and causes immediate relief of symptoms. At 7-13 hours, there is clot resolution leaving a thick layer of mature clot over the dorsal part of the thecal sac.

The success rate is of 70-80%, if done after 24 hours of dural puncture. If this procedure fails in first time, repeating blood patch carries similar success rate.

Epidural saline

Lumbar injection of 20 ml of saline temporarily relieves the pain due to increased CSF pressure and therefore decreases intracranial traction. Some reported successful use of saline infusion for 24 hrs to treat PDPH patients with failed blood patch.⁵⁹

Epidural dextran

Administration of 30-40 ml of dextran 40 or gelatin injected epidurally have also been found effective in PDPH.⁶⁰

Other

Epidural, intrathecal and parenteral opioids and fibrin glue have been tried but fail to reach any conclusion.

Surgery

This is the last option. Persistent CSF leak, unresponsive to other therapies, have been successfully closed surgically.⁶¹

CONCLUSION

PDPH is a complication that should not be treated lightly. Although PDPH is usually self-limiting and non-fatal, its postural nature prevents the patients from performing routine activities. It prolongs hospital stay and cost as well. It might be associated with auditory and visual disturbances, nausea, vomiting and cranial nerve palsy.

These patients require psychological support and therapeutic measures. Preventive measures that decrease incidence of PDPH such as smaller size needle, atraumatic needle and parallel direction of needle bevel in relation to dural fibers should always be considered.

Various pharmacological and interventional measures are available. Epidural blood patch has highest cure rate. Surgically closure of the dural tear is an option of last resort.

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