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Review Article

A Narrative Review on Prevention and Treatment Strategies of Post Spinal Anesthesia Headache

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ABSTRACT

Background: Post spinal anesthesia headache (PSAH) is a headache occurring after spinal anesthesia induction due to Dura and arachnoid puncture and has a significant effect on the patients' post operative well being.
Methods: We run a cross sectional descriptive study on patient under spinal anesthesia that suffer from post spinal anesthesia headache parallel with a review on observational and experimental studies in the medical databases of PubMed, Scopus, Embase, Cochrane for preparing a strategy in prevention and treatment of post spinal anesthesia headache. Aim of this study was adapting different treatment method and prevention system of Post Spinal Anesthesia Headache (PSAH) according to our facilities base on our observation and experiences.
Results: The overall incidence of post-Spinal Anesthesia headache has a very wide range. Its incidence obtained 17.3% by spinal needle 25G Quincke in our observation. Under hydration and tension headaches could be a factor influencing the incidence of PSAH. Intravenous administration of caffeine may be effective for prophylaxis of PSAH. Pregabalin has also been shown to alleviate PSAH. Drugs that have been used to treat PSAH include caffeine, NSAIDs, vasopressin, hydrocortisone, dexamethasone, theophylline, sumatriptan, gabapentin and adrenocorticotropic hormone (ACTH).
Conclusion: A combination of keeping patients normovulemic during the spinal anesthesia induction and prophylaxis prescription of caffeine and Dexamethone before and; Aminophylline and NSAIDS after the procedure could have a main role in keeping and treatment of the patient from PSAH.

The first accidental spinal anesthetic was delivered by James Leonard Corning and the first spinal anesthesia was done by August Bier on 1898. Even at that time, he reported associated the leak of cerebrospinal fluid (CSF) with post spinal headache [1-3]. Post spinal anesthesia headache (PSAH) is a headache occurring after spinal anesthesia induction due to dura and arachnoid puncture and has a significant effect on the patients' post operative well being [3-4]. PSAH also called Post dural puncture headache (PDPH), post lumbar puncture headache and in brief spinal headache [5-6].
We performed a review of experimental research and observational studies on patient's surgery under spinal anesthesia. We attempted to identify all relevant studies

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regardless of language or publication status. Search strategies were developed from first PSAH report until present time. We search main data base including, web of science, web of knowledge, Scopus, pub med and Cochrane Database initially. The Internet was searched through public search engines such as Google Scholar for relevant studies, and a reference list of available studies was reviewed. Besides; we conduct a cross-sectional descriptive-analytical study at the same time as our review. Written consent form was signed and accepted by all patients candidate for different types of surgeries (General surgery, Neurosurgery, Orthopedic surgery, urology and Obstetrics procedures) admitted to our university affiliated hospitals whereas, spinal anesthesia was considered as the preferred method of anesthesia. About Eight hundred patients were enrolled during 27 months through simple random sampling method. The study period extended from January, 2010, to march, 2012. Clinical anesthesia resident physicians at the I, II and III levels performed spinal anesthesia under the supervision of an expert senior Clinical anesthesia resident physician also; the procedures were closely supervised by an attending anesthesiologist. We applied 25-gauge Quincke as a cutting needle for induction of spinal anesthesia. Postoperatively, all patients were examined by a resident physician and interrogated for headache and associated symptoms, such as low back pain, neurological defects, nausea, vomiting, blurred vision, and tinnitus. Patients with headache were evaluated for pain intensity, duration of headache, related symptoms, patients' preferential treatment of choice, and their response to treatment.

Methods

The design of this study was a review of the literature in the PubMed medical database, ISI, ISC, Scopus, Embase, Cochrane besides, simultaneously We run a cross sectional descriptive study on patient under spinal anesthesia that suffer from post spinal anesthesia headache. Aim of this study was adapting different treatment method and prevention system of Post Spinal Anesthesia Headache (PSAH) according to our facilities base on our observation and experiences.

Definition: Post spinal anesthesia headache (PSAH) is a bilateral headache that develops within 7 days after surgery and disappears within 14 days and has a clear relationship with the patient's position. Its diagnosis is mainly based on the presence of a headache that is more severe in sitting or standing position and decreases or disappears in horizontal position. It is sometimes associated with nausea, vomiting, and vision and hearing problems, and is usually located in the forehead and occipital regions and sometimes spreads to the neck and shoulders [1, 3-7].

Diagnosis: Confirmation of PSAH is based on ruling out other possible diagnosis. Top of the other headache types which must be excluded in differential diagnosis list are Meningitis, Tension headache, cluster headache, neuralgia, Rebound headache (medication overuse headache), Hangover, systemic hypertension, Cerebro vascular accident ,intra cranial hemorrhage, Postpartum cerebral angiopathy, Subdural Hematoma, Subarachnoid Hemorrhage, intra cranial arterio-venus malformation(AVM), Benign intra cranial hypertension, Cortical or intracranial vein thrombosis, Space occupying lesion, , Dehydration, Lactation Headache, Preeclampsia, Caffeine withdrawal [1,2, 8-10].

Pathophysiology: The exact pathophysiology of PSAH is unclear however, there is no doubt that dura and arachnoid puncture initiates the syndrome. CSF leakage appears to lead to PSAH by drilling away and reducing CSF pressure. The widely accepted theory, which explains the pathophysiology of PSAH, assumes continuous CSF leakage through a hole created by a spinal or epidural needle and a reduction in CSF volume or pressure, or both, leading to changes in intracranial contents and stretches Pain-sensitive structures. CSF loss leads to a drop in intracranial pressure and a significant reduction in CSF volume and pressure; however, the relationship between lower CSF pressure and volume and PSAH is unclear. CSF loss due to dura and arachnoid puncture as trigger for producing the PSAH is not disputed [1-3, 7].

One theory suggests that decreased CSF volume may directly activate adenosine receptors, dilating cerebral arteries and stretching pain-sensitive brain structures, resulting in headaches after spinal anesthesia. [1-4, 7, 9].

The low volume of CSF drains the fluid-supporting cushion of the brain and covers the meningeal arteries, resulting in gravitational pull on pain-sensitive intracranial structures, causing the classical headache, which worsens in the patient's upright position and is relieved while lying down. [1, 7, 11]

According to Monroe Kelly's hypothesis, exaggerated cerebrovascular dilatation is one of the possibilities of post-spinal anesthesia headache (PSAH). [1, 3, 11]. Hence, it concludes that a vasoconstrictor may alleviate PDPH through a means other than replacement of lost CSF volume or sealing of dural insult. [1, 12, 13]

Incidence: The estimated incidence of post-dural puncture headache after 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 PDPH is about 25%, but its incidence obtained 17.3% by spinal needle 25G Quincke in our observation. [1, 3-7]

Outcome: PSAH is a self limiting complication of spinal anesthesia. The onset of PSAH is usually after 24-

48 hours and may be delayed for several days; Patients should be warned before discharge, especially if they are released immediately after the operation. The physician usually expects the headache to go away within a few days, but the longest reported headache after a lumbar puncture lasted for 19 months. [1, 13]. Vandam and Dripps reported that in 72% of patients, the headache disappears within 7 days and in 87% within 6 months. [14].

Prevention: Prevention of PSAH is aimed at limiting the CSF leakage following a lumbar puncture. Prolonged bed rest in the recumbent position following a spinal anesthesia induction has been used to prevent PSAH. However, multiple studies have suggested that there is no benefit from this practice [15-16].

Based on their observations, some researchers believe that; under hydration can be an effective factor in the occurrence and development of PSAH [1, 17-19]. Maintaining the normovolemic status of the patient could be a wise advice so; perispinal anesthesia induction, prescription 3-5 mlit/kg isotonic serum for compensation the vessel expansion due to sympathic block after spinal anesthesia is recommendable [5, 17-19].

One recent study suggested that intravenous administration of caffeine may be effective for prophylaxis of PSAH [1,19].

Recently; Alpha2-delta type voltage-dependent calcium channels have become a prevention and treatment target for some chronic pain conditions such as PSAH [20-24]. Taylor mentioned that connection to alpha2-delta type voltage- dependent calcium channels is necessary and sufficient for the analgesic effects of Gabapentin and Pregabalin [25]. In addition to chronic pain, migraine and PSAH has also been shown to be alleviated by pregabalin [26-27]. The time to reach the maximum plasma concentration is 2 or 3 hours for Gabapentin and one hour for Pregabalin, therefore, for prophylactic purposes, they should be prescribed 2-3 hours before induction of spinal anesthesia. [28].

Treatment: Post spinal anesthesia headache (PSAH) treatment depends upon its severity. PSAH could be classified into three groups respect to its severity. Slight and tolerable headache (49%) does not conflict with the normal activities of patients, moderate headache (35%) is so annoying that it causes periodic returns to recumbence for pain relief and back to normal state and more; severe headache (15%) which is so painful that the patient cannot sit long enough to eat. [29-30] Generally, PSAH is initially treated conservatively with prescription caffeine, analgesics and bed rest. Although, under hydration is to be avoided in such patients, we do not recommend over hydration because Increased oral fluid intake does not increase CSF production. Recently, intravenous fluid use has been questioned. Taking appropriate volume of fluids orally is a logical advice because of the self-limiting nature of PSPH. Bed rest as a part of PSAH treatment is a logical advice because it temporarily relieves the symptoms. Analgesics, possibly in combination with sedatives, can reduce the symptoms of mild to moderate PSAH while not influencing the physiological course of the dura mater injeries [31-33].

Some studies and a few case reports have suggested oral or intravenous caffeine as a treatment option, although recurrence of headache after caffeine treatment is frequent. Regarding the treatment of patients with PSAH, some authors state that there is no rational pharmacological reason for caffeine as an analgesic agent for PSPH. The number of these studies is small, small in sample size, weak in method or defective however, no well-designed, adequately powered, randomized clinical trials or experimental studies have been conducted to demonstrate the effect of caffeine [1, 2, 34]. Recent studies, however, have concluded that caffeine is effective in treating PSAH and reduces the proportion of participants with persistent PSAH and the need for additional interventions treatment compared with placebo. [35-37]. According to our review on article we could summarized that Caffeine as cerebral vasoconstrictor, has been applied successfully for PSAH treatment, but the effects appear to be transient. This method is less invasive than the remaining treatments. Caffeine sodium benzoate treatment is 70 to 80% effective. This treatment contains 500 mg of caffeine sodium benzoate in 1 liter of ringer solution for 1 hour. [35-39]. Caffeine therapy seems to be more effective when the headache is caused by smaller needles rather than larger ones. One of the collateral effect of caffeine treatment is that patients may feel anxious and Sleep deprivation. Convulsions and cardiac arrhythmias have been reported after caffeine prescription. [19, 39 ,40]

Pain severity scores after PSAH appearance is lower when theophylline, gabapentin and hydrocortisone or dexamethasone were prescribed. Medications used to treat PSAH include: caffeine, NSAIDs, vasopressin, hydrocortisone, dexamethasone, theophylline, sumatriptan, gabapentin and adrenocorticotropic hormone (ACTH). Theophylline, which is a cerebral vasoconstrictor may be useful in the pharmacologic treatment of PSAH [1, 4, 19, 40].

Cosyntropin (Cortrosyn) is a synthetic derivative of the adrenocorticotropic hormone (ACTH) used in the ACTH stimulation test to evaluate and diagnose cortisol disorders in internal medicine. [29, 30]. ACTH has likewise been anecdotally reported as a treatment of PSAH [23,41].

Sumatriptan is a synthetic drug belonging to the triptan class that is used to treat migraines and cluster headaches. Sumatriptan is structurally similar to serotonin (5HT), and is a 5-HT receptor agonist; [30, 42] has been applied in the treatment of PSAH, although not all studies support

this prescription [43-45]. There are specific subtypes of receptors that it activates in the arteries and veins of the skull, and activation of these receptors causes vascular contraction. Sumatriptan, which acts as an agonist in these receptors, reduces migraine-related vascular inflammation and cluster headaches. It seems that it has a similar effect on PSAH. It is routinely used to treat migraine headaches. There is no linear and direct relationship between sumatriptan blood concentration and its anti-migraine effect [29, 42-45].

Pregabalin is a pharmacological product that exerts antiepileptic, anxiolytic and analgesic effects. It acts by slowing down impulses in the neurons that cause seizures besides affects chemicals in the brain that send pain signals [46]. Pregabalin, a voltage-dependent calcium channel ligand of the alpha2-delta, reduces calcium influx at nerve endings and reduces the release of glutamate, substance P, and norepinephrine at synapses. [28,30, 47-48]. No detailed study has been performed on the effect of pregabalin on PSAH, but gabapentin, which is structurally similar to pregabalin and is also a ligand for alpha 2 delta-sensitive calcium channels, has been reported to be effective. [49-50]. Pregabalin and Gabapentin may alter the release of several neurotransmitters, including noradrenaline, glycine, substance P, glutamate and the peptide of the calcitonin gene [51-52]. A clinical trial on patients who suffered from post spinal headache shown the useful effect of pergabaline (150–300 mg/day) on PSAH management. The need for nonsteroidal anti-inflammatory drugs (NSAIDs) was significantly reduced in patients treated with pregabalin, so they concluded that pregabalin is a promising drug for the management of PSAH. [53].

Mirtazapine (30 mg PO bedtimes continued 3 days) as a prophylactic treatment for migraine headache; used for treatment of headache following spinal anesthesia induction. Activation of 5-HT1 receptors by Mirtazapine possibly treats PSAH by constriction of dilated cerebral vessels. It might act as a 5-HT2 and 5-HT3 receptor antagonist and potentiate endogenous opioid systems [54-56].

The concept of the epidural blood patch (EBP) was developed after the observation made on patients who had “bloody tap”, who had a low incidence of headache. The EBP was first described more than 40 years ago by Gormley and it continues to be the most effective treatment of PSAH [55-56]. When blood enters the epidural space, it clots and closes the hole, thus preventing further CSF leakage. It was noted that after the treatment of blood patch, the symptoms disappeared quickly, which cannot be explained simply by the effect of sealing on the hole. Recommended amounts range from 2 ml to 20 ml, with recent studies suggests for using larger amounts. The presence of fever, local infection in the lumbar region and hemeostasis disorder are the main contraindications to this method [30, 44,57-58].

Although early reports suggested immediate and permanent cure of PSAH after an EBP and its safety and efficacy have been documented more than 90% per EBP [59]; It has recently been suggested that the overall success rate is approximately 75% and the effect of EBP is reduced if the dural puncture is caused by a large needle. The success of an EBP is probably not as simple as the clotted blood obstructing the dural tear because; CSF volume replacement is not rapid but headache resolve almost immediately after blood patch procedure [60-61].

The patient is asked to lie down on his side in a curled-up position and using a proper aseptic technique, an epidural needle is inserted into the epidural space of the lumbar region. Then; about 20-30 ml of blood is taken from a large vein and is immediately but slowly injected into the epidural space through an epidural needle. As blood will distribute into the epidural space through few spinal segments superiorly and inferiorly, it is not necessary to introduce the blood into the exact location at which the dura matter was punctured. After the procedure, the patient is asked to lie on her back for 1 to 2 hours and then could move. If it could not resolve the symptoms on the first try, it could be repeated [56,60-62].

It has been found that the success rate will decrease if blood patch is performed after the first 24 hours of lumbar puncture and PDPH onset. This could be because a large amount of CSF leaks out during the first 24 hours, which could interfere with blood clotting. Successful application of spinal anesthesia necessitates the early use of epidural blood patching (EBP) when indicated so, some investigatore recommended an EBP as early treatment of PSAH if the resources are available, and considered it as an appropriate treatment modality for pharmacologic treatment failures. [1,56 ,60-63].

Epidural saline patch considered as an alternative for EBP. It means isotonic saline injection into the epidural space after lumbar puncture. Epidural saline patch brought the concept of possible compression of the thecal sac space with presumed increase in subarachnoid pressure owing to the volume of isotonic saline introduced [12,63].

Epidural dextran 40 has not been studied for the treatment of PSAH, carefully. In a study on 56 patients with PSAH who did not respond to common treatment, including epidural blood patches, headache relief was obtained in all patients within 24 hours after injection with 20 ml of dextran40 in epidural space [64].

Closing the dorsal tear through surgery is the last classic treatment if other treatments have failed [63].

Despite the few anesthesiologists are proficient and skilled in acupuncture, there are reports of its successful use. When the patient is not ready to accept EBP, it can

be used to treat PSPH. It seen that, Analgesia is achieved by increasing the pain threshold [65-66].

Conclusion

It is important knowing all the variables resulting in an increased incidence of PSAH and its conservative palliative treatment, as well as understanding how and when carry out the invasive methods for PSAH treatment [57].

In addition to traditional prescription, new pharmacological treatments and invasive treatment methods are used for the management of established PSAH [12,58,68] however, current treatments are sometimes inadequate and recovery may be temporary with side effects. [38,67,69-71]. Therefore, to avoid the need for more invasive methods that require special techniques and experience, guidance for a systematic approach to the management of pharmacological and invasive PSAH treatment is essential.

High risk group for PSAH such young pregnant women with past history of chronic headache and a low body mass index could be protecting by prescription adequate dose of Benzodiazpine and Propranolol (non selective beta blocker) as appropriate.

Prescription of Hydroxyzine (25mg), Diazepam (5mg) and Propranolo (20mg) as premedication 4-6 hours before operation had a considerable effect on incidence of PSAH, base on our observation. We do not prescribe Gabapentin or pregabalin for prevention of PSAH routinely but in patient with positive past history for sever PSAH they could be an alternative effective option.

We find out patient who have unstable and fluctuated hemodynamic parameter after spinal anesthesia induction are more predispose to PSAH than other and incidence of PSAH in patient who received prophylactic Ephedrine (5mg 1-2 minutes before procedure) is lower than other, although we could not found any supportive study in the literatures but we could explain this finding base on pathophysiology of PSAH and pharmacological effect of Ephedrine. Perhaps, Vasoconstrictor effect of Ephedrine restricted the PSAH progression.

Based on our experience, if patients who suffer from post spinal anesthesia maintained NPO due to their medical problem or under lying disease; we recommended 10% added to their serum maintenance if it is not contraindicated. Intra venous fluid of choice is normal saline. In hypertensive patients or patient who prescribed diuretic, half saline could be a wise choice and if patient have vomiting as associated symptom of PSAH, we recommend lactated ringer.

We prescribed a single dose 8mg Dexamethosone intravenously as antiemetic and anti inflammatory drug to reduce inflammation in arachnoid and dura fiber and decrease in cytotoxine release which identified trigger of headache.

Caffeine apparently acts as a cerebrovascular constrictor by blocking adenosine receptors, which is involved in the pathogenesis of headache after spinal anesthesia. Caffeine is available orally (Nawafen) which is well tolerated and absorbed besides the maximum amount of serum blood concentration is obtained in 30 minutes. Novafen capsule that is combination of 325mg Acetaminophen, 200mg Ibuprifen plus 40mg caffeine is another first line drug.

We recommended that patients who suffer from PSAH be medically managed with either Novafen (Acetamonophen, Ibuprofen, cofffeine) and methilgezantin including Theophylline or Aminophylline and corticosteroid like Dexamethasone, Hydrocortisone or Methyprednisolone in the first line.

Gabapentin, pregabalin and sumatriptan could be considered as second line in pharmacological treatment of PSAH; but we do not prescribe each of them as a sole agent. Their Combination by the first line drug used for severs PSAH.

We do not have experience for mirtazapine and ACTH (cosyntropin) prescription and their efficacy.

Although, none of our patients needed blood epidural patch (BEP), it could be a logical advice as a third and end line treatment of PSAH. We do not consider BEP for prevention of PSAH or as a pioneer in PSAH therapy.

Authors want to emphasize that their conclusions should be interpreted due to lack of sufficient information needed to allow comparison our finding to similar domestic and international investigations and insufficient patients follow up as participants who belong to middle or low socio economic level was uncooperative besides.

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References

[1] Jabbari A, Alijanpour E, Mir M, Banihashem N, Rabiea S M, Rupani M A. Post spinal puncture headache, an old problem and new concepts: review of articles about predisposing factors. Caspian J Intern Med. 2012; 4(1): 595-602.

[2] Corning JL. A further contribution on local medication of the spinal cord, with cases. Med Rec. 1888; 33(11): 291–3.

[3] Aamodt A, Vedeler C. Complications after LP related to needle type: pencilpoint versus Quincke. Acta Neurol. Scand. 2001; 103(6):396–8.

[4] Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2003; 91(5):718–29.

[5] Jabbari A, Hasanjani Roushan MR. Impact of postdural puncture headache after diagnostic lumbar puncture. Caspian J Intern Med. 2014; 5(2): 56-58.
[6] Kuczkowski KM. Post-dural puncture headache in the obstetric patient: an old problem. New solutions. Minerva Anestesiol. 2004; 70(12):823–30.
[7] Cook TM, Counsell D, Wildsmith JAW. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. Br J Anaesth. 2009; 102(2): 179–90
[8] Halpern S, Preston R. Postdural puncture headache and spinal needle design. Metaanalyses. Anesthesiology. 1994; 81(6):1376–83.
[9] Vallejo MC, Mandell GL, Sabo DP, Ramanathan S. Postdural Puncture Headache: A Randomized Comparison of Five Spinal Needles in Obstetric Patients. Anesth Analg. 2000; 91:916–20
[10] Hatfalvi BI. Postulated mechanisms for postdural puncture headache and a review of laboratory models. Reg Anaesth. 1995; 20:329–36.
[11] Mokri B. The Monro-Kellie hypothesis: applications in CSF volume depletion. Neurology. 2001; 56:1746–8
[12] Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2003; 91:718–29
[13] Wilton NC, Globerson JH, de Rosayro AM. Epidural blood patch for postdural puncture headache: it's never too late. Anesth Analg. 1986; 65(8):895-6.
[14] Vandam LD, Dripps RD. Long-term follow-up of patients who received 10,098 spinal anesthetics; syndrome of decreased intracranial pressure (headache and ocular and auditory difficulties). J Am Med Assoc. 1956; 161(7): 586-91.
[15] Morewood GH. A rational approach to the cause, prevention prevention and treatment of postdural puncture headache. CMAJ. 1993; 149:1087–93.
[16] Thoennissen J, Herkner H, Lang W, Domanovits H, Laggner AN, Müllner M. Does bed rest after cervical or lumbar puncture prevent headache? A systemic review and meta-analysis. CMAJ. 2001; 165:1311–6.
[17] Evans RW, Armon C, Frohman EM, Goodin DS. Assessment: Prevention of post-lumbar puncture headaches: Report of the therapeutics and technology assessment subcommittee of the American Academy of Neurology. Neurology 2000; 55(7):909-14.
[18] Echevarria M, Caba F, Rodriguez R. The influence of the menstrual cycle in postdural puncture headache. Reg Anesth Pain Med 1998; 23(5): 485-90.
[19] Yücel A, Ozyalçin S, Talu GK, Yücel EC, Erdine S. Intravenous administration of caffeine sodium benzoate for postdural puncture headache. RegAnesth Pain Med. 1999; 24(1):51-54.
[20] Buvanendran A, Kroin JS, Della Valle CJ, Kari M, Moric M, Tuman KJ. Perioperative oral pregabalin reduces chronic pain after total knee arthroplasty: a prospective, randomized, controlled trial. Anesth Analg. 2010; 110(1):199–207.
[21] Jokela R, Ahonen J, Tallgren M, Haanpää M, Korttila K. A randomized controlled trial of perioperative administration of pregabalin for pain after laparoscopic hysterectomy. Pain. 2008; 134:106–12.
[22] McKeage K, Keam SJ. Pregabalin: in the treatment of post herpetic neuralgia. Drug Aging. 2009; 26:883–92.
[23] Rosenstock J, Tuchman M, LaMoreaux L, Sharma U. Pregabalin for the treatment of painful diabetic peripheral neuropathy: a double-blind, placebo-controlled trial. Pain. 2004; 110:628–38.
[24] Vondracek P, Oslejskova H, Kepak T, Mazanek P, Sterba J, Rysava M, et al. Efficacy of pregabalin in neuropathic pain in paediatric oncological patients. Eur J Paediatr Neurol. 2009; 13:332–6.
[25] Taylor CP. Mechanisms of analgesia by gabapentin and pregabalin – calcium channel alpha2-delta [Cavalpha2-delta] ligands. Pain. 2009; 142:13–6.
[26] Calandre EP, Garcia-Leiva JM, Rico-Villademoros F, Vilchez JS, Rodriguez-Lopez CM. Pregabalin in the treatment of chronic migraine: an open-label study. Clin Neuropharmacol. 2010; 33:35–9.
[27] Masdrakis VG, Oulis P, Karakatsanis NA, Potagas C, Kouzoupis AV, Soldatos CR. Remission of migraine attacks in a patient with depression who is taking pregabalin. Clin Neuropharmacol. 2008; 31:238–40.
[28] Chiechio S, Zammataro M, Caraci F, Rampello L, Copani A, Sabato AF, et al. Pregabalin in the treatment of chronic pain: an overview. Clin Drug Invest. 2009; 29:203–13.
[29] Gielen M. post dural puncture headach (PDPH): A review. Reg Anesth. 1989;14: 101-106.
[30] Hess JH. Postdural puncture headache; a literature review. AANA J. 1991; 59: 549-555
[31] Choi PT, Galinski SE, Takeuchi L, Lucas S, Tamayo C, Jadad AR. PDPH is a common complication of neuraxial blockade in parturients: a meta-analysis of obstetrical studies. Can J Anaesth. 2003; 50(5):460-9.
[32] Carter BL, Pasupuleti R. Use of Intravenous Cosyntropin in the Treatment of Postdural Puncture Headache. Anesthesiology. 2000; 92: 272-4.
[33] Cánovas L, Barros C, Gómez A, Castro M, Castro A. Use of Intravenous Tetracosactrin in the Treatment of Postdural Puncture Headache: Our Experience in Forty Cases. Anesth. Analg. 2002; 94:1369.
[34] Halker RB, Demaerschalk BM, Wellik KE, Wingerchuk DM, Rubin DI, Crum BA and Dodick DW. Caffeine for the prevention and treatment of postdural puncture headache: debunking the myth. Neurologist. 2007; 13(5): 323–327.
[35] Younggren BN; Zeger W, Nolan R. Cosyntropin vs. caffeine for post-dural puncture headaches. Acad

Emerg Med. 2005; 12:52-3.
[36] Basurto Ona X, Martı´nez Garcı´a L, Sola` I and Bonfill Cosp X. Drug therapy for treating post-dural puncture headache. Cochrane Database Syst Rev 2011; (8):CD007887.
[37] Camann WR, Murray RS, Mushlin PS, Lambert DH. Effects of oral caffeine on postdural puncture headache: A double-blind placebo-controlled trial. Anesth Analg. 1990;70(2):181-4
[38] Baumgarten RK. Should coffeine become the first-line treatment for postdural puncture headache? Anesth Analg. 1987; 66(9):913-4.
[39] Ryu JE: Effect of maternal caffeine consumption on heart rate and sleep time of breast fed infants. Dev Pharmacol Ther. 1985; 8(6):353-63.
[40] Bani-Hashem N, Hassan-Nasab B, Pour EA, Maleh PA, Nabavi A, Jabbari A. Addition of intrathecal Dexamethasone to Bupivacaine for spinal anesthesia in orthopedic surgery. Saudi J Anaesth. 2011; 5(4):382-6.
[41] Kshatri AM, Foster PA: ACTH infusion as a novel treatment for postdural puncture headache. Reg Anesth. 1997; 22(5):432-4.
[42] Razzaque Z, Heald MA, Pickard JD, Maskell L, Beer MS, Hill RG, et al. Vasoconstriction in human isolated middle meningeal arteries: determining the contribution of 5-HT1B- and 5-HT1F-receptor activation". Br J Clin Pharmacol 1999; 47(1):75–82.
[43] Hodgson C, Roitberg HA. The use of sumatriptan in the treatment of postdural puncture headache. Anaesthesia. 1997; 52(8):808.
[44] Paech M, Banks S, Gurrin L. An audit of accidental dural puncture during epidural insertion of a Tuohy needle in obstetric patients. Int Obstet Anesth. 2001; 10(3):162-7.
[45] Freidank-Mueschenborn E, Fox AW. "Resolution of concentration-response differences in onset of effect between subcutaneous and oral sumatriptan". Headache. 2005; 45(6): 632-7.
[46] Tassone DM, Boyce E, Guyer J, Nuzum D. Pregabalin: a novel gamma-aminobutyric acid analogue in the treatment of neuropathic pain, partial-onset seizures, and anxiety disorders. Clin Ther. 2007; 29(1):26-48.
[47] Kim L, Lipton S, Deodhar A. Pregabalin for fibromyalgia: some relief but no cure. Cleve Clin J Med. 2009; 76(4):255-61.
[48] Luszczki JJ. Third-generation antiepileptic drugs: mechanisms of action, pharmacokinetics and interactions. Pharmacol Rep. 2009; 61(2):197–216.
[49] Erol DD. The effect of oral gabapentin on postdural puncture headache. Acute Pain 2006; 8:169–73.
[50] Lin YT, Sheen MJ, Huang ST, et al. Gabapentin relieves post-dural puncture headache – a report of two cases. Acta Anaesthesiol Taiwan. 2007; 45(1):47–51.
[51] Cheng JK, Chiou LC. Mechanisms of the antinociceptive action of gabapentin. J Pharmacol Sci. 2006; 100:471–86.
[52] Dooley DJ, Taylor CP, Donevan S, Feltner D. Ca2+ channel alpha2delta ligands: novel modulators of neurotransmission. Trends Pharmacol Sci. 2007; 28(2):75–82.
[53] Huseyinoglu U, Huseyinoglu N, Hamurtekin E, Aygun H, Sulu B. Effect of pregabalin on post-dural-puncture headache following spinal anesthesia and lumbar puncture. J Clin Neurosci. 2011; 18(10): 1365-8.
[54] de Boer T. The effects of mirtazapine on central noradrenergic and serotonergic neurotransmission. Int Clin Psychopharmacol. 1995; 10:19–23
[55] Levy E, Margolese HC. Migraine headache prophylaxis and treatment with low-dose mirtazapine. Int Clin Psychopharmacol. 2003; 18(5):301–3
[56] Safa-Tisseront V, Thormann F, Malassine P, Henry M, Riou B, Coriat P, et al. Effectiveness of epidural blood patch in the management of post-dural puncture headache. Anesthesiology. 2001; 95(2):334-9
[57] Harrington BE. Postdural puncture headache and the development of the epidural blood patch. Reg Anesth Pain Med. 2004; 29(2):136-63.
[58] Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, et al. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results of overview of randomized trials. Br Med J. 2000; 321:1493.
[59] Ghoname ES, Craig WF, White PF, Ahmed HE, Hamza MA, Gajraj NM, et al. The effect of stimulus frequency on the analgesic response to percutaneous electrical nerve stimulation in patients with chronic low back pain. Anesth. Analg. 1999; 88(4):841-6.
[60] Taivainen T, Pitkänen M, Tuominen M, Rosenberg PH. Efficacy of epidural blood patch for postdural puncture headache. Acta Anaesthesiol Scand. 1993; 37(7):702-5.
[61] Ylönen P, Kokki H. Epidural blood patch for management of postdural puncture headache in adolescents. Acta Anaesthesiol. Scand. 2002; 46(7):794-8.
[62] Ravindran RS. Epidural autologous blood patch on an outpatient basis. Anesth Analg. 1984; 63(10):962.
[63] Stevens RA, Jorgensen N. Successful treatment of dural puncture headache with epidural saline infusion after failure of epidural blood patch. Case report. Acta Anaesthesiol Scand. 1988; 32(5):429-31.
[64] Barrios Alarcon-J, Aldrete J-A, Paragas Tapia-D. Relief of post lumbar puncture headache with epidural dextran 40. Regional anaesthesia 1989; 14:78–80.
[65] Sharma A, Cheam E. Acupuncture in the management of post-partum headache following neuraxial analgesia. Int J Obstet Anesth. 2009; 18(4):417-9.
[66] Mahendra Perera S. Acupuncture: an alternative treatment for post dural-puncture headaches

following obstetric epidural or spinal. Acupunct Med. 1998; 16: 77-79

[67] Davignon KR, Dennehy KC. Update on postdural puncture headache. Int Anesthesiol Clin. 2002; 40(4):89-102.

[68] Ergün U, Say B, Ozer G, Tunc T, Sen M, Tüfekcioglu S, et al. Intravenous theophylline decreases post-dural puncture headaches. J Clin Neurosci. 2008; 15(10):1102-4.

[69] Candido KD, Stevens RA. Post-dural puncture headache: pathophysiology, prevention and treatment. Best Pract Res Clin Anaesthesiol. 2003; 17(3):451–69.

[70] Cohen SM, Laurito CE, Curran MJ. Grand mal seizure in a postpartum patient following intravenous infusion of caffeine sodium benzoate to treat persistent headache. J Clin Anesth. 1992; 4:48–51.

[71] Connelly NR, Parker RK, Rahimi A, Gibson CS. Sumatriptan in patients with postdural puncture headache. Headache. 2000; 40(4):316-9.