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RESEARCH

Postdural puncture headache: evidence-based review for primary care

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The promotion of epidural and spinal blocks as preferred and safe techniques for Caesarean section and the use of lumbar puncture for diagnostic and therapeutic purposes place patients at risk of developing postdural puncture headache (PDPH). This article reviews the literature for evidence that provides an approach to diagnosis and management of this condition for the primary care physician.

A dull and throbbing, bilateral headache associated with changes in posture (worsened by sitting and standing, and better lying down), that develops within seven days of a lumbar puncture or an inadvertent dural puncture must raise the suspicion of PDPH. The exact causative mechanism is unclear but symptoms of PDPH are generally attributed to excessive loss of cerebrospinal fluid (CSF). The risk of PDPH is increased with the use of cutting and large-bore needles, and with horizontal orientation of the needle bevel. Given that symptoms overlap, other organic causes of headache such as intracerebral/subdural haemorrhage, pneumocephalus, central nervous system infections, adverse effects of anticoagulants and functional headaches such as migraine must be excluded.

Although the initial management of PDPH comprises several conservative interventions, evidence is only available for the effectiveness of the usage of caffeine, analgesics, gabapectin, hydrocortisone, dexamethasone and cosyntropin. Epidural blood patch (EDBP) offers the most favourable outcomes for patients who fail to respond to conservative management. However, given the lack of skills for performing EDBP in primary care, such patients should be referred to secondary or tertiary level of care.

Keywords: headache, management, post-dural puncture, primary care

Introduction

Postdural puncture headache (PDPH) is the commonest complication of dura puncture and presents hours to days later with a characteristic dull or throbbing headache that is worsened when the patient assumes an upright posture and better when supine.[1] It was first reported in the late nineteenth century after Bier used himself as a subject to demonstrate spinal block. The following day, he developed headache, which he attributed to loss of cerebrospinal fluid (CSF).[2] While the use of large-bore cutting spinal needles during this period led to a high incidence of PDPH, the introduction of better designs and smaller bore spinal needles has dramatically reduced the incidence of PDPH — from over 50% with 16 gauge needles to less than 2% with more recently designed 29 gauge needles.[2,3]

In most African countries, primary care physicians perform lumbar puncture for diagnosis, treatment and spinal anaesthesia. This procedure places patients in primary care at risk of PDPH — a complication that is very distressing to patients and which increases the costs of hospitalisation by prolonging the length of hospital stay.[4] In this article, we review the literature and provide primary care physicians with an evidence-based approach to the diagnosis and management of PDPH.

Clinical presentation and diagnosis

Any headache that starts within hours up to a few days after a spinal tap (intentional or inadvertent) must raise the suspicion of PDPH.[1] The classical presentation is that of a dull and throbbing, bilateral headache associated with changes in posture (worsened by sitting and standing, and better lying down), that typically develops within 7 days after lumbar puncture and resolves within 14 days.[5] Lybecker and colleagues confirmed this, reporting that 92% of patients who developed PDPH in their study did so within 48 hours.[6] However, there are outstanding cases of PDPH developing and resolving outside of this time range: One reported by Lomax et al. in which PDPH developed 20 minutes after dural puncture[7] and another by Reamy that presented 12 days post dural puncture.[8] While most PDPH resolve within 14 days, a case of PDPH that lasted 19 months after the dura puncture was reported by Wilton et al.[9] Surprisingly, this headache was managed successfully with an epidural blood patch (EDBP) 19 months later.

The International Classification of Headache Disorders' (ICHD) criteria[10] for the diagnosis of PDPH are given in Table 1. While the majority of patients with PDPH present with many of the symptoms listed, a study that investigated the validity of the diagnostic criteria for PDPH found that up to 29% of patients suffered none of the other symptoms except the headache.[11] This suggests that the key diagnostic symptom is the characteristic headache. Given the overlap between the clinical features of PDPH and other common central nervous system (CNS) conditions, it is important to ensure that the diagnosis is correct. First, PDPH is always preceded by a breech in the dura (intentionally or inadvertent). Second, the headache is typically worsened by assuming the upright position, coughing, sneezing or straining. Third, features such as fever, leucocytosis and neurological deficits are absent in PDPH. Their presence must alarm the clinician to the possibility of other sinister neurological conditions such as meningitis, cerebral thrombosis/infarction and intracranial haemorrhage. Such suspicion must prompt the clinician to perform septic screen, co-axial tomography (CT) scan and request a neurology consult as deemed necessary. Pneumocephalus, hypertensive encephalopathy, severe pre-eclampsia and functional headaches such as migraine must also be excluded.[12–14]

Table 1: The international classification of headache disorders criteria for the diagnosis of PDPH[10]

A.	Headache that worsens within 15 minutes after sitting or standing and improves within 15 minutes after lying down, with at least one of the following and fulfilling criteria C and D.
1.	Neck stiffness
2.	Tinnitus
3.	Hypacausia
4.	Photophobia
5.	Nausea
B.	Dural puncture has been performed
C.	Headache develops within five days after dural puncture
D.	Headache resolves either
1.	Spontaneously within one week
2.	Within 48 hours after effective treatment of the spinal fluid leak; usually by epidural blood patch

Pathogenesis

The exact causative mechanism of PDPH is unclear but symptoms are generally attributed to excessive loss of CSF from the dural puncture site which results in reduced CSF pressure.[15] The lowered CSF pressure reduces the cushioning effect provided by the CSF to the brain and results in traction on intracranial pain-sensitive structures such as meningeal vessels, upper cervical and cranial nerves.[15] The release of adenosine consequent to the sudden drop in CSF volume is also thought to cause vasodilatation of intracranial vessels.[1,16] Other factors that influence the incidence of PDPH are discussed below and include:

Needle design and bore size

Table 2 shows the reported incidences of PDPH with needle sizes and designs, and highlights the direct relationship between bore size and incidence of PDPH. Cutting spinal needles such as the Quincke (Figure 1)[17] cut across the longitudinal fibres of the dura and prevent the retracting dural fibres from sealing the puncture site when removed. They are therefore associated with a higher incidence of PDPH than non-cutting needles such as the pencil point (Whitacre) and the Sprotte spinal needles (Figure 1).[17] Schmittner et al. and Gisore et al. confirmed this same finding in their studies in which the use of the Quincke cutting needle was associated with a higher incidence of PDPH compared with the pencil-point needle (6.6% vs 1.7%; p = 0.02 and 24.2% vs 4.5%; p = 0.042).[18,19]

Several studies have affirmed that the bigger the bore size of a spinal needle, the larger the dural tear and the greater the incidence of PDPH.[1,2,5,20] However, Schmittner et al. failed to demonstrate a significant difference in the incidence of PDPH between 29 G and 25 G Quincke needles (p = 0.6870),[18] suggesting that at very small bore sizes the needle design may be a more important predictor of PDPH than bore size.

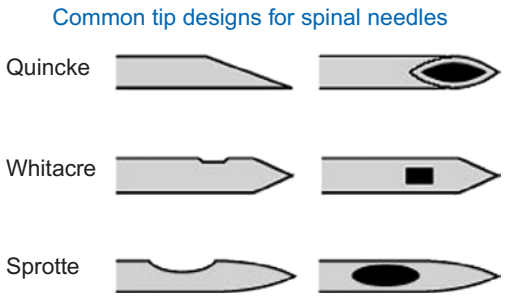

Figure 1: Common spinal needle tip designs (Reproduced from Anaesthesia UK)[17]

Despite evidence supporting the use of small-bore size spinal needles for spinal taps,[21] a survey found that 21% of neurologists used spinal needles with bore sizes bigger than 22 G and 74% used cutting needles,[22] possibly because it is easier to collect CSF samples and the 'give' is better appreciated with larger bore needles.

Orientation of the needle bevel

Introducing the needle bevel parallel to the dural fibres separates them and allows the fibres to return to their position when the needle is removed, closing the slit in the dura.[23] This longitudinal bevel orientation reduces CSF leakage and has been shown to reduce the risk of PDPH compared with perpendicular bevel orientation.[3,24,25] However, given the reduced risk of PDPH with non-cutting and small-bore spinal needles, the role played by bevel orientation may be a less important one.[2]

Replacing the needle stylet

Evidence is available to suggest that replacing the needle stylet before removing the spinal needle reduces the incidence of PDPH.[3,26] A lower incidence of PDPH was reported in a study conducted by Strupp et al. when the needle stylet was replaced before needle withdrawal compared with when it was not (5% vs 16%; p < 0.005).[27] It is thought that a strand of arachnoid matter may be reintroduced into the CSF when the needle is withdrawn without stylet replacement, thereby prolonging the CSF leakage. The replacement of the stylet prevents this.

Table 2: Incidence rate of PDPH with needle sizes[2,3,5]

Needle bore size		Approximate incidence rate	
		Quincke (cutting)	Whitacre (non-cutting)
Size decreases ⇩	16-19 G	>70%	–
	20G	40%	2–5%
	22G	36%	0.63–4%
	24G	0–9.6% (Sproute needle)	
	25G	3–25%	0–14.5%
	26G	0.3–20%	2.5–4%
	27G	1.5–5.6%	0
	29G	0–2%	–

Technique used in continuous spinal anaesthesia

Continuous spinal anaesthesia provides opportunities for prolonged spinal block and is usually performed using either a catheter-through-needle or catheter-over-needle technique.[28] In Britain, a randomised controlled trial of young adults that examined the influence of these techniques on the incidence of PDPH found no difference between the two techniques (p = 0.26). However, the duration of PDPH (2.4 vs 5.1 days; p = 0.05) and the pain intensity (score of 3.1 vs 7.3; p = 0.014) were significantly reduced in the catheter-over-needle technique.[29]

Patient characteristics

The risk of PDPH varies with certain patient characteristics. Young adults have a higher risk of developing PDPH compared with the elderly (14% vs 7%)[28] while obstetric patients with a low body mass index are particularly at risk.[5] Young men have also been shown to have lower risks of developing PDPH compared with young non-pregnant women (OR = 0.55; CI 0.44–0.67) but this disparity is lost among the elderly, among whom both sexes are equally susceptible.[15,30]

In a retrospective study that assessed the influence of cigarette smoking on the risk of PDPH among patients who had continuous CSF sampling via catheter, cigarette smokers were found to have a lower incidence of PDPH compared with non-smokers (13.7% vs 34.1%; p = 0.009).[31] Although the mechanism is unclear, the authors proposed that the clot-promoting properties of smoking may facilitate the occlusion of the dural puncture by clot. Nicotine also stimulates the production of dopamine, the CNS-reward property of which limits the severity of PDPH. Lastly, dopamine is converted to noradrenaline, a substance whose vasoconstriction effect counteracts the intracranial vasodilatation associated with PDPH.

The reported associations between patient characteristics and the incidence of PDPH need to be interpreted with caution in that healthcare providers' experience, fatigue and the technique used during spinal block could also influence the reported associations. Furthermore, functional headaches are commoner among females and obstetric patients require spinal anaesthesia more often than non-pregnant women. These may modulate or confound some of the reported associations.

Other possible risk factors for PDPH

Other studies examined the relationships between factors related to leak in CSF and low CSF pressure, and PDPH. These studies found that the amount of CSF removed during spinal tap, the CSF opening pressure and the length of time of bed rest after dural puncture do not influence the incidence of PDPH.[5,32] The position in which lumbar puncture is performed and the time in sitting position after injection of local anaesthetics were also found not to influence the incidence of PDPH.[33] Similarly, there appears to be no evidence that antiseptic agents used for cleaning the skin and the types of local anaesthetic agents have any role in the pathogenesis of PDPH.[15] While under current understanding it stands to reason that the higher the number of attempts at dural puncture the more the likelihood of dural puncture damage, CSF leak and PDPH, there is no available study that has examined this relationship.

Management

Pre-emptive considerations

Given the debilitating effects on patients, the risk of PDPH should be discussed with patients before and after lumbar puncture. Non-pharmacological considerations to minimize the risk of PDPH include:

- Using the smallest possible bore size and a non-cutting/atraumatic needle.
- Introducing the needle bevel parallel to the dura fibres and replacing the stylet before removing the needle.
- Paying due attention to anatomical landmarks and the 'give' feeling that signifies entry into the subarachnoid space in order to prevent inadvertent dural puncture (during epidural) and repeated attempts during spinal taps.
- In the eventuality of the patient developing PDPH, symptoms should be matched to the ICHD diagnostic criteria for PDPH (see Table 1) to confirm the diagnosis. Other possible complications of spinal tap such as CNS infections and subarachnoid haemorrhage should be excluded.

Conservative management

After excluding CNS complications and confirming the diagnosis of PDPH, the initial treatment should be conservative for the first 24 to 48 hours because more than 85% of PDPH will resolve with conservative treatments.5 Conservative management may include:

- *Bed rest:* Bed rest in the supine position may improve patient's comfort and avoids the aggravating effect of the upright position on the headache. However, a systematic review found no evidence that bed rest prevents PDPH.[34] Lying in the prone position also increases intra-abdominal pressure, which in turn is transmitted to the subarachnoid space to increase the CSF pressure[1] but this position is not practical for many patients in the postoperative period.
- *Fluid therapy:* Patients should be well hydrated to limit the aggravating effect of dehydration on the severity of PDPH. There is no conclusive evidence, however, that over-hydration (practised commonly with the hope of replacing lost CSF volume) is effective.[34]

Drug therapy

- *Analgesic therapy:* Simple analgesics should be given.[35] Opioids could also be used but nausea and vomiting from opioids may aggravate the PDPH. Epidural and intrathecal morphine have also been shown to be effective in preventing PDPH and reducing the need for EDBP.[36,37] It should, however, be noted that intrathecal or epidural morphine may cause delayed respiratory depression that may occur several hours after injection. Patients who have had intrathecal or epidural morphine therefore need to be closely monitored and when necessary an opioid antagonist (e.g. naloxone) and respiratory support should be given. Although i ntrathecal morphine is doable in primary care, the patient may not be willing to undergo yet another lumbar puncture after the initial one. Furthermore, except where epidural skills are available, epidural morphine is not practical in primary care. So, despite the above evidence, oral and parenteral analgesics are favoured in primary care.
- *Caffeine:* Caffeine provides temporary but non-sustained relief of the headache by inducing cerebral vasoconstriction which counteracts the vasodilatation associated with adenosine release in PDPH.[3] While a randomised control trial (RCT) conducted in Egypt found that a single intravenous bolus of caffeine sodium benzoate reduced the incidence of PDPH in young patients undergoing knee surgery under spinal anaesthesia,[38] a Cochrane systematic review also found that both oral and intravenous caffeine were effective compared with placebo in reducing the proportion of patients with persistent PDPH and those needing additional conservative interventions.[39]
- *Sumatriptan:* Sumatriptan is a triptan class of anti-migraine drugs and has been suggested for treatment of PDPH. However,

a recent Cochrane review of RCTs did not find conclusive evidence that sumatriptan is effective in the prophylaxis or treatment of PDPH.[39]

- *Gabapectin:* This is a structural analogue of gamma-aminobutyric acid and modulates the release of excitatory neurotransmitters by binding to voltage-dependent calcium channels.[40] Gabapectin reduces the severity of post-dural puncture headache either as primary therapy or as adjunct therapy in obstetric patients with severe headache and those unresponsive to epidural blood patch (EDBP).[41,42] In addition to reducing pain, nausea and vomiting were also reduced compared with Cafergot® (ergotamine tartrate and caffeine).[41] Although the small sample size in the Erol study and the case-series design in Wagner's study limit the generalisation of their findings, similar findings have been reported in two other studies.[39,43]
- *Dexamethasone and hydrocortisone:* The mechanism of action of these glucocorticoids in the management of PDPH is unclear but the effects are thought to result from sodium and water retention.[13] Studies on the use of dexamethasone and hydrocortisone in the prevention of PDPH are inconclusive but most point in the direction of possible benefit. In one study, the severity of PDPH was reduced with prophylactic intravenous administration of dexamethasone but its incidence was not significantly affected.[44] In another single blinded randomized control trial, the incidence of PDPH was found to be significantly lower compared with controls at 24 hours (2.5% vs 12.5%; p = 0.016) and at one week post dural puncture (11.3% vs 32.5%; p = 0.001) respectively.[45] Yousefshashi et al. also found a reduced incidence of PDPH with dexamethasone at 24 hours (p = 0.046) but this effect was lost by the second day.[46]

Intravenous hydrocortisone 200 mg stat, followed by 100 mg three times daily for 48 hours was shown to be effective in reducing the severity of PDPH among a sample of obstetric patients.[47] Similar effectiveness of hydrocortisone was also demonstrated by Alam and colleagues among non-obstetric patients.[48]

Although findings from studies have not been consistent on whether dexamethasone or hydrocortisone is effective in preventing PDPH, they may at least reduce the severity of PDPH, especially in the first few days post dural puncture.

- *Cosyntropin:* Cosyntropin is a synthetic analogue of adrenocorticotrophin that causes the release of aldosterone, resulting in salt and water retention.[49] It is postulated that the resultant increased circulating volume causes dural oedema and increases CSF production, both of which promote the closure of the dural puncture. There may also be an associated increased beta-endorphin production which decreases pain perception.[16] In a randomised controlled trial, cosyntropin was found to reduce the incidence of PDPH (33% vs 68.9%, p = 0.001) and the need for EBDP (11% vs 28.9%, p = 0.035).[49] The time from accidental dural puncture to development of PDPH was also prolonged by cosyntropin (27.2 hrs vs 17.5 hrs; p < 0.001). These findings have been confirmed in a Cochrane systematic review.[37]

Invasive treatments

Patients who do not respond to conservative management within 48 hours require more aggressive and invasive interventions which are discussed below:

- *EDBP:* This is the intervention of choice when PDPH is unresponsive to conservative treatment and produces resolution of PDPH in up to 95% of cases.1 However, another report suggests that the cure rate of PDPH after the first EDBP is roughly 50% and that up to 40% of patients will require a second EDBP.[14] EDBP involves injecting sterile autologous blood into the epidural space at the same lumbar interspace where the dural puncture was performed initially (preferably not beyond two levels from the original site).[35] The mechanism through which EDBP works is unclear but may involve the sealing of the dural puncture site by clot from the injected autologous blood. This reverses the pressure gradient created by the CSF leak, induces cerebral vasoconstriction and reverses the vasodilation and traction on pain-sensitive structures.[50] EDBP is effective when performed 48 hours or more after the initial dural puncture, suggesting that an inflammatory response is required at the punctured dural site to achieve favourable outcomes.[5] While the exact volume of blood required for successful EDBP is not known, volumes varying from 5 ml to 30 ml have been reported[51,52] but the volume at which significant pressure occurs in the back, buttock or leg during injection of the blood is generally accepted as the optimal volume needed.[35,53]

Although EDBP is an effective treatment for PDPH, evidence in support of prophylactic EDBP is not clear. Some studies have found that prophylactic EDBP did not reduce the incidence of PDPH or the need for criteria-directed epidural blood patch among parturients after inadvertent dural puncture.[54,55] However, in these studies, the length and severity of symptoms were decreased. The failure of prophylactic EDBP to reduce the incidence of PDPH after inadvertent dural puncture may be due to the absence of an inflammatory response at the dura puncture site and since not every patient who has had an accidental dural puncture will develop PDPH, prophylactic EDBP cannot be recommended.[50]

Blood is an irritant and there is a risk of arachnoiditis, nerve-root irritation, epidural space fibrosis and transmission of blood-borne infections with EDBP.[56–58] Careful clinical evaluation of the patient for fever and other signs of sepsis is therefore recommended.[59] However, there is no evidence to support routine blood culture after EDBP.

It is not known whether it is safe to inject the autologous blood of an HIV-infected patient into his/her CNS or whether being on antiretrovirals reduces the risks of HIV-related CNS infections in this context. Bevacqua and Slucky[56] reported a patient where they had used autologous blood in an HIV-infected patient who had PDPH with complete resolution of headache and no CNS sequelae, even after 19 months of follow up. The level of evidence in a case report is low and until there is clear evidence in support of this practice, alternative practices such as epidural saline or dextran or the use of HIV-negative donor blood should be considered. Hunningher and Bell[57] raised the issue of using autologous blood for EDBP among Jehovah's Witnesses but there is no clarity about whether this procedure is acceptable or not in this patient population. As expected in other clinical situations, EDBP needs to be discussed with the patient and consent obtained prior to performing the procedure. Where it is not consented to, alternative interventions such as epidural saline injections/infusions and catheter insertion should be offered.

- *Epidural saline or dextran 40 infusion:* Epidural infusion of saline or dextran 40 is thought to increase subarachnoid space pressure by compressing the thecal sac and decreasing CSF leakage. This has been used for the management of PDPH with variable success.[5] A study of the effect of repeated caudal saline injection showed that the severity of PDPH was reduced in the majority of patients with each injection of saline, though the headaches were not completely eliminated.[60] A systematic review has also failed to demonstrate statistically significant benefit.[51]
- *Intrathecal catheters:* This involves threading a catheter through the hole created by the dural puncture. It is thought to work by

plugging the punctured site or by inducing an inflammatory response that promotes dural tear healing and reduced CSF leak.[51] Studies have not, however, demonstrated its effectiveness. While a systematic review and meta-analysis suggest a reduction in PDPH when the catheter was left in situ for at least one day, a similar trial with a larger sample did not confirm any statistically significant beneficial effect (RR = 0.21, 0.002–2.65).[51]

- *Surgical closure of dural puncture:* This is a last resort when all interventions have failed.[3]

Take home message

(1) PDPH is the commonest complication of lumbar tap.
(2) A headache preceded by a recent dural puncture, worsened by assuming the upright position and alleviated by lying down, must raise a suspicion of PDPH.
(3) The young, females, obstetric patients and non-smokers are particularly at risk.
(4) The risk of PDPH is reduced by using a non-cutting and small-bore spinal needle. To balance the need for fast collection of CSF specimen with reducing the risk of PDPH, non-cutting needles not larger than 22 G appear optimal for diagnostic lumbar puncture[4] while non-cutting needles, 25 G or smaller, appear appropriate for spinal anaesthesia.[2]
(5) Initial management of PDPH involves conservative interventions including:
(6) avoiding dehydration;
(7) simple analgesics. Note that opioids may accentuate nausea and vomiting and should be given with antiemetics;
(8) oral or intravenous caffeine;
(9) gabapectin;
(10) dexamethasone or hydrocortisone or cosyntropin.
(11) If there is no improvement with conservative interventions after 48 hours, patient should be referred for EDBP by a skilled anaesthesiologist at secondary or tertiary levels of care. Where EDBP is contraindicated, alternative interventions such as epidural saline or dextran 40 should be considered.

Conclusions

A recent history of dural puncture in a patient with headache must prompt the primary care physician to use the ICHD criteria for prompt diagnosis of PDPH. Functional headaches and organic causes of headache should also be excluded. Conservative management should be tried first in primary care settings but patients who do not respond after 48 hours should be referred for EDBP or other appropriate invasive interventions.

References

1. Ghaleb A, Khorasani A, Mangar D. Post-dural puncture headache. Int J General Med. 2012;5:45–51.
2. Kuczkowski KM. Post-dural puncture headache in the obstetric patient: an old problem. New solutions. Minerva Anestesiol. 2004;70:823–30.
3. Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. BJA. 2003;91:718–29. doi:10.1093/bja/aeg231.
4. Angle P, Thompson D, Szalai JP, et al. Expectant management of postdural puncture headache increases hospital length of stay and emergency room visits. Can J Anesth. 2005;52:397–402. http://dx.doi.org/10.1007/BF03016283
5. Ahmed SV, Jayawarna C, Jude E. Post lumbar puncture headache: diagnosis and management. Postgrad Med J. 2006;82:713–6. doi: 10.1136/pgmj.2006.044792.
6. Lybecker H, Djernes M, Schmidt JF. Postdural puncture headache (PDPH): onset, duration, severity, and associated symptoms: an analysis of 75 consecutive patients with PDPH. Acta Anaesthesiologica Scandinavica. 1995;39:605–12. doi:10.1111/j.1399-6576.1995.tb04135.x.
7. Lomax S, Qureshi A. Unusually early onset of post-dural puncture headache after spinal anaesthesia using a 27G Whittacre needle. Br J Anaesth. 2008;100:707–8. http://dx.doi.org/10.1093/bja/aen039
8. Reamy BV. Post-epidural headache: how late can it occur? J Am Board Fam Med. 2009;22:202–5. http://dx.doi.org/10.3122/jabfm.2009.02.080064
9. Wilton NCT, Globerson JH, de Rosayro AM. Epidural blood patch for postdural puncture headache: it's never too late. Anesth Analg. 1986;65:895–6.
10. The international classification of headache disorders 2003. 2nd ed. Cephalgia. 2004;24:1–160.
11. Amorim JA, Gomes de Barros MV, Valenca MM. Post-dural (post-lumbar) puncture headache: risk factors and clinical features. Cephalalgia. 2012;32:916–23. http://dx.doi.org/10.1177/0333102412453951
12. Bleeker CP, Hendriks IM, Booij LHD. Postpartum post-dural puncture headache: is your differential diagnosis complete? Br J Anaesth. 2004;93:461–4. http://dx.doi.org/10.1093/bja/aeh198
13. Kuczkowski KM, Eisenmann UB. Hypertensive encephalopathy mimicking postdural puncture headache in a parturient beyond the edge of reproductive age. Anesth Analg. 2004 Dec;99(6):1873–4.
14. Campbell NJ. Effective management of the post dural puncture headache. Anaesthesia UK. 2010 [cited 2014 May 05]. Available from: http://www.frca.co.uk/Documents/181%20Post%20dural%20puncture%20headache.pdf
15. Morewood GH. A rational approach to the cause, prevention and treatment of postdural puncture headache. Can Med Ass J. 1993;149:1087–93.
16. Hlongwane TN. What's new in obstetric anaesthesia? S Afr Fam Pract. 2012;54(3):S11–S13. http://dx.doi.org/10.1080/20786204.2012.10874229
17. Technique of lumbar puncture. Anaesthesia UK. 2004 [cited 2014 March 03]. Medicine Publishing. Available from: http://www.frca.co.uk/article.aspx?articleid=100449
18. Schmittner MD, Terboven T, Dluzak M, et al. High incidence of post-dural puncture headache in patients with spinal saddle block induced with Quincke needles for anorectal surgery: a randomised clinical trial. In J Colorectal Dis. 2010;25:775–81. Epub 2010 Feb 11. http://dx.doi.org/10.1007/s00384-010-0888-7
19. Gisore E, Mung'ayi V, Sharif T. Incidence of post dural puncture headache following caesarean section under spinal anaesthesia at the Aga Khan University Hospital, Nairobi. East Afr Med J. 2010;87:227–30.
20. Fyneface-Ogan S, Mato CN, Odagme MT. Post-dural puncture headache following caesarean section in Nigerian parturients: a comparison of two spinal needles. Niger Postgrad Med J. 2006;13:200–2.
21. Shaikh JM, Memon MA, Memin MA, et al. Post dural puncture headache after spinal anaesthesia for caesarean section: a comparison of 25G Quincke, 27G Quincke and 27G Whitacre spinal needles. J Ayub Med Coll Abbottabad. 2008;20:10–3.
22. Stendell L, Fomsgaard JS, Olsen KS. There is room for improvement in the prevention and treatment of headache after lumbar puncture. Dan Med J. 2012;59:A4483.
23. Richman JM, Joe EM, Cohen SR, et al. Bevel direction and postdural puncture headache. Neurologist. 2006 Jul;12(4):224–8. http://dx.doi.org/10.1097/01.nrl.0000219638.81115.c4
24. Oedit R, van Kooten F, Bakker SL, et al. Efficacy of the epidural blood patch for the treatment of post lumbar puncture headache BLOPP: a randomized, observer-blind, controlled clinical trial [ISRCTN 71598245]. BMC Neurol. 2005;5:12. http://dx.doi.org/10.1186/1471-2377-5-12
25. Norris MC, Leighton BL, DeSimone CA. Needle bevel direction and headache after inadvertent dural puncture. Anesthesiology. 1989;70:729–31. http://dx.doi.org/10.1097/00000542-198905000-00 002
26. Sagadai S. Postdural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2004;92:767–70.
27. Strupp M, Brandt T. Should one reinsert the stylet during lumbar puncture? N Eng J Med. 1997;336:1190. http://dx.doi.org/10.1056/NEJM199704173361616
28. Di Cianni S, Rossi M, Casati A, et al. Spinal anesthesia: an evergreen technique. Acta Biomed. 2008;79:9–17.
29. Gosch UW, Hueppe M, Hallschmid M, et al. Post-dural puncture headache in young adults: comparison of two small-gauge spinal

catheters with different needle design. B J Anaesth. 2005;94:657–61. http://dx.doi.org/10.1093/bja/aei100
30. Wu CL, Rowlingson AJ, Cohen SR, et al. Gender and post-dural puncture headache. Anesthesiology. 2006;105:613–8. http://dx.doi.org/10.1097/00000542-200609000-00027
31. Dodge HS, Ekhator NN, Jefferson-Wilson L, et al. Cigarette smokers have reduced risk for post-dural puncture headache. Pain Physician. 2013;16:E25–E30.
32. Kim SK, Chae HS, Yoon MJ, et al. No effect of recumbency duration on the occurrence of post-lumbar puncture headache with a 22G cutting needle. BMC Neurology. 2012 [cited 2013 Apr 02];12:1. Available from http://www.biomedcentral.com/1471-2377/12/1
33. Schmittner MD, Urban N, Janke A, et al. Influence of the pre-operative time in upright sitting position and the needle type on the incidence of post-dural puncture headache (PDPH) in patients receiving a spinal saddle block for anorectal surgery. Int J Colorectal Dis. 2011;26:97–102. http://dx.doi.org/10.1007/s00384-010-1012-8
34. Sudlow C, Warlow C. Posture and fluids for preventing post-dural puncture headache. Cochrane Database Sys Rev. 2002;2:CD0001790.
35. Pardo M, Sonner JM. Manual of anesthesia practice. Cambridge: Cambridge University Press; 2007. p. 832–4. http://dx.doi.org/10.1017/CBO9780511586019
36. Al-metwalli RR. Epidural morphine injections for prevention of post dural puncture headache. Anaesthesia. 2008;63:847–50. http://dx.doi.org/10.1111/ana.2008.63.issue-8
37. Barsuto Ona X, Uriona Tuma SM, Martinez GL, et al. Drug therapy for preventing post-dural puncture headache. Cochrane Database Syst Rev. 2013;2:CD001792. doi: 10.1002/14651858.CD001792.pub3.
38. Ragab A, Facharzt KN. Caffeine: is it effective for prevention of postdural puncture headache in young adult patients? Egyptian J Anaes. 2014;30:181–6. http://dx.doi.org/10.1016/j.egja.2013.11.005
39. Basurto Ona X, Martinez GL, Sola I, Bonfill CX. Drug therapy for treating post-dural headache. Cochrane Database Syst Rev. 2011 Aug 10;(8):CD007887. doi: 10.1002/14651858.CD007887.pub2.
40. Beal B, Moeller-Bertram T, Schilling JM, et al. Gabapectin for once-daily treatment of post-herpetic neuralgia: a review. Clin Interv Aging. 2012;7:249–55.
41. Erol DD. The analgesic and antiemetic efficacy of gabapentin or ergotamine/caffeine for the treatment of postdural puncture headache. Adv Med Sci. 2011;56:25–9. http://dx.doi.org/10.2478/v10039-011-0009-z
42. Wagner Y, Storr F, Cope S. Gabapectin in the treatment of post-dural puncture headache: a case series. Anaesth Intensive Care. 2012;40:714–8.
43. Lin YT, Sheen MJ, Huang ST, et al. Gabapectin relieves post-dural puncture headache - a report of two cases. Acta Anaesthesiol Taiwan. 2007;45:47–51.
44. Doroudian MR, Norouzi M, Esmailie M, et al. Dexamethasone in preventing post-dural puncture headache: a randomized, double blind, placebo-controlled trial. Acta Anaesthesiol Belg. 2011;62:143–6.
45. Hamzei A, Basiri-Moghadam M, Pasban-Noghabi S. Effect of dexamethasone on incidence of headache after spinal anesthesia in caesarean section. A single blind randomized controlled trial. Saudi Med J. 2012;33:948–53.
46. Yousefshahi F, Dahmardeh AR, Khajavi M, et al. Effect of dexamethasone on the frequency of postdural puncture headache after spinal anesthesia for cesarean section: a double-blind randomized clinical trial. Acta Neurol Belg. 2012;112:345–50. doi:10.1007/s13760-012-0065-6.
47. Noyan Ashraf MA, Sadeghi A, Azarbakht Z, et al. Evaluation of intravenous hydrocortisone in reducing headache after spinal anaesthesia: a double blind controlled clinical study. Middle East J Anesthesiol. 2007;19:415–22.
48. Alam MR, Ershad R, Rahman MA. Role of very short-term intravenous hydrocortisone in reducing postdural puncture headache. J Anaesthesiol Clin Pharmacol. 2012;28:190–3. http://dx.doi.org/10.4103/0970-9185.94840
49. Hakim SM. Cosyntropin for prophylaxis against postdural puncture headache after accidental dural puncture. Anesthesiology. 2010;113:413–20. http://dx.doi.org/10.1097/ALN.0b013e3181dfd424
50. Aldrete JA, Barrios-Alacron J. Post-dural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2004;92:767–70. http://dx.doi.org/10.1093/bja/aeh558
51. Afpel CC, Saxena A, Cakmakkaya OS, et al. Prevention of postdural puncture headache after accidental dural puncture: a quantitative systematic review. BJA. 2010;103:255–63.
52. Paech MJ, Doherty DA, Christmas T, et al. The volume of blood for epidural blood patch in obstetrics. Anesth Analg. 2011;113:126–33. http://dx.doi.org/10.1213/ANE.0b013e318218204d
53. Pruszkowski O, Gonclaves O, Lentschener C, et al. Why does prophylactic epidural blood patch fail to demonstrate efficacy in preventing post-dural puncture headache in parturients after dural puncture? Anesthesiology. 2005;103:900. http://dx.doi.org/10.1097/00000542-200510000-00032
54. Scavone BM, Wong CA, Sullivan JT, et al. Efficacy of a prophylactic epidural blood patch in preventing post dural puncture headache in parturients after inadvertent dural puncture. Anesthesiology. 2004;101:1422–7. http://dx.doi.org/10.1097/00000542-200412000-00024
55. Boonmak P, Boonmak S. Epidural blood patching for preventing and treating post-dural puncture headache. Cochrane Database Syst Rev. 2010 Jan 20;(1):CD001791. doi: http://dx.doi.org/10.1002/14651858.CD001791.pub2
56. Bevacqua BK, Slucky AV. Epidural blood patch in a patient with HIV infection. Anaesthesiology. 1991;74:952–3. http://dx.doi.org/10.1097/00000542-199105000-00028
57. Hunningher A, Bell R. Postdural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2004;92:767–70.
58. Collier CB. Blood patches may cause scarring in the epidural space: two case reports. Int J Obstet Anesth. 2011;20:347–51. http://dx.doi.org/10.1016/j.ijoa.2011.07.011
59. Sharma R, Bailey A, Bamber J. Post-dural puncture headache. Br J Anaesth. 2004;92:449. http://dx.doi.org/10.1093/bja/aeh528
60. Abdullah S, Abdullah W, Eckhardt R. Caudal normal saline injections for the treatment of post-dural puncture headache. Pain Physician. 2011;14:271–9.

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