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REVIEW ARTICLE

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Treatment of obstetric post-dural puncture headache. Part 2: epidural blood patch

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ABSTRACT
The 2009–12 MBRRACE-UK report highlighted the deaths of two women in whom dural puncture had occurred during insertion of a labour epidural catheter. Despite suffering long-term headaches, neither woman was adequately followed-up after discharge from hospital. Death resulted from a cerebral vein thrombosis in one case and a subdural haematoma in the other. Due to significant variation in the treatment of obstetric post-dural puncture headache, an Obstetric Anaesthetists' Association working group was set up to produce evidence-based guidelines to guide clinicians. These guidelines have been condensed into two review articles. In this second review, the role of an epidural blood patch is discussed using a question and answer format.

The guidelines on the treatment obstetric post-dural puncture headache (PDPH) have been produced by an Obstetric Anaesthetists' Association (OAA) working group and approved by the OAA Executive Committee. Recommendations have been made to assist clinicians and patients in making decisions about appropriate treatment for obstetric PDPH. The recommendations are not intended to dictate an exclusive course of treatment; rather they should be used to guide management to meet individual patient needs.

Introduction

Treatment of post-dural puncture headache (PDPH) with an epidural blood patch (EBP) was first described by Gormley in 1960.[1] Using a spinal needle, he injected saline 15 mL into the cerebrospinal fluid (CSF) and withdrew the spinal needle until CSF ceased to flow, at which point he injected 2–3 mL of blood. Since this initial description, the EBP technique has changed significantly. Initial reports claimed very high success rates for an EBP[2–4] but more recent data have been less optimistic.[5] In 2001, the first Cochrane review of the topic suggested that evidence for the efficacy of EBP was so weak it should only be performed in the setting of randomised controlled trials (RCTs).[6] This recommendation did not achieve widespread acceptance but challenged previous beliefs. Many factors can affect the outcome of an EBP and consequently many aspects of its performance need to be considered.

The methodology of this narrative review is described in the review of conservative and pharmacological treatment of obstetric PDPH;[7] use of a prophylactic EBP to prevent PDPH is not included. As with the other review, interpretation of many studies was limited by small sample size, limited details on methodology, variation in outcome measures, heterogeneity in patient populations and variation in the indications for an EBP. Recommendations for each treatment are based on the strength of supporting evidence and were agreed by members of the working group. Where evidence was lacking, the working group produced good practice points based on consensus. Opinions were sought from various groups which included representatives from obstetrics,

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midwifery, neurology, neuroradiology, general practice and the lay public.

What is the role of an epidural blood patch in the management of obstetric post-dural puncture headache?

Postnatal headaches are common and PDPH is one of many potential causes. If PDPH is suspected, review by the anaesthetic team should take place within 24 hours. A medical history should be taken and physical examination carried out. Other causes of headache must be considered and excluded before the diagnosis of obstetric PDPH is made. Features of the headache should be consistent with the IHS definition of PDPH,[8] which states "Headache occurring within 5 days of a lumbar puncture, caused by cerebrospinal fluid (CSF) leakage through the dural puncture. It is usually accompanied by neck stiffness and/or subjective hearing symptoms. It remits spontaneously within 2 weeks, or after sealing of the leak with autologous epidural lumbar patch." A postural component may not be present in up to 5% of cases of PDPH.[9] Furthermore, in one-third of cases, dural puncture may not have been recognised.[10,11] When PDPH is diagnosed, women should receive information on options for management which should include details about efficacy and side effects of various treatments including an EBP.[7]

The intensity of maternal symptoms may dictate the need for an EBP. When PDPH is less severe, which may reflect a smaller dural tear with less CSF leak, conservative therapy may be preferred in the hope that headache resolves without the need for an EBP. If headache is more significant, leading to difficulty with performing activities of daily life and caring for the baby, an EBP is usually considered.

An EBP should not be performed where there is a contraindication to a neuraxial block. Contraindications may include maternal systemic infection or coagulopathy (see below). In particular, as postnatal thromboprophylaxis is common, adequate time must elapse between the last dose of anticoagulant and performance of an EBP.[12]

When conservative therapy is ineffective in the management of obstetric PDPH and the woman experiences difficulty performing activities of daily life and caring for her baby, treatment with an EBP should be considered.

How effective is an epidural blood patch in obstetric post-dural puncture headache?

Establishing the efficacy of an EBP in the obstetric population is difficult. Success rates of >90% reported in the 1970s and 1980s[2–4] have not been reproduced in more recent prospective studies. Interpretation of evidence is problematic since variables are not standardised in many studies and the definition of 'success' varies. Patient populations show marked heterogeneity (most notably, inclusion of both epidural and spinal dural punctures), with other variables such as timing, technique and follow-up differing between reports. The majority of studies reporting the success of EBPs in obstetrics have relied on retrospective case note review rather than prospective data collection.

Banks et al. reported the findings of a prospective assessment of dural puncture with an epidural needle in 100 obstetric patients of whom 58 received an EBP.[13] Complete initial relief of headache with an EBP was seen in 67% with a further 28% obtaining partial relief. Of the women who had complete or partial relief, severe headache returned between 12 and 96 hours in a third and the majority of these women received a second EBP. Overall, only 50% of those receiving one or more EBPs achieved complete relief, 38% gained partial relief and 12% had no relief. The lower success rate compared to previous studies was attributed in part to longer follow-up, but the authors also highlighted factors such as the definition of success, timing of the EBP, volume of blood injected and post-EBP management.

Paech et al. randomised 121 women with PDPH following labour epidural catheter placement to receive 15, 20 or 30 mL of blood.[5] Complete relief after a single EBP ranged from 10% to 32%, while complete and partial relief combined was seen in 61–73%. Success rates were lower when 15 mL of blood was used and when the EBP was performed within 48 hours of dural puncture. The former achieved statistical significance but the latter did not, although the study was not powered to do so.

In a large single-centre North American retrospective study, 394 women received an EBP for PDPH that developed after spinal or epidural blocks.[14] The EBP was repeated in 16.8% of women, but headache severity following the EBP was not reported. In a retrospective Scandinavian study of 129 women who received an EBP (volume 4–23 mL) following spinal or epidural anaesthesia, complete relief of PDPH was observed in 74%, partial relief in 15% and failure in 11%.[15] Again, success was greater with a longer interval between dural puncture and EBP.

In a United Kingdom (UK) single-centre retrospective study of 41 women who received a therapeutic EBP following dural puncture with a 16-gauge epidural needle, 14 (34%) were effective, 22 (54%) partially effective and 3 (7%) ineffective (5% unknown).[16] The partially-effective group included women in whom symptom severity reduced and those who initially had a good result, only for headache to return. Eleven women received a second EBP, of which six were effective, four partially effective and one ineffective. Injected volumes of blood ranged from 12 to 26 mL. In another UK single-centre retrospective study of 105 women who received an EBP after either epidural or spinal block, 74

(61%) were reported as successful, and 13 (12%) were repeated, of which 5 (38%) were successful.[11]

A randomised study of 33 Taiwanese women conducted over seven years reported greater efficacy.[17] Chen et al. compared 7.5 mL with 15 mL of blood for an EBP performed 48 hours after the onset of PDPH.[17] All headaches followed dural puncture with a 16-gauge Tuohy needle. Blood was injected via an epidural catheter rather than directly through the epidural needle. Symptoms improved in all women: 24 hours after the EBP, 71% and 69% reported no headache and by 72 hours, 88% and 81% were symptom-free in the 7.5 mL and 15 mL groups, respectively.

Studies have shown conflicting findings, reflecting the different methodologies and variables that may affect the success of an EBP. It is difficult to predict accurately the likelihood of relief of headache with an EBP. Most recent prospective studies suggest complete and permanent relief of headache after one EBP in up to one third of women with PDPH following dural puncture with an epidural needle, but up to 50–80% if partial relief is included.[5,13] Up to 20% of women receive little or no relief from an EBP, even if repeated.

Multiple factors are likely to affect the success of an EBP. Although success rates of over 90% have been reported in older observational studies, more recent evidence suggests that complete and permanent relief of symptoms following a single EBP is only likely to occur in up to one third of cases where headache follows dural puncture with an epidural needle. Complete or partial relief may be seen in 50–80%. In cases of partial or no relief, a second EBP may be performed after consideration of other causes of headache.

What is the optimum time to perform an epidural blood patch?

A number of retrospective studies have found greater efficacy when an EBP is delayed by more than 48 hours after dural puncture,[13–15,18–20] but there are no randomised studies comparing the efficacy of early or late EBPs in obstetric PDPH. The prospective study by Paech et al. investigating blood volumes for EBP looked at timing as a secondary outcome.[5] The risk of failure was greater when an EBP was performed within 48 hours of dural puncture. This did not reach statistical significance, although the study was not powered to do so.

Studies in vitro have shown both lidocaine and CSF have a detrimental effect on coagulation.[21,22] Increasing concentrations of lidocaine cause hypocoagulability and fibrinolysis,[21] whilst CSF has both procoagulant and clot destabilising effects.[22] These effects are likely to be of less importance than the size of dural puncture and the volume of CSF leak. A large dural tear with significant loss of CSF suggests that severe symptoms are more likely at an earlier stage. Earlier intervention may be considered, and the dural tear itself may be less amenable to treatment with a single EBP, although this explanation requires confirmation in clinical studies.

Delay in performing an EBP has disadvantages. Vilming et al. demonstrated greater patient suffering when blood patching was delayed.[23] Large CSF leaks have occasionally been associated with significant morbidity such as cranial nerve palsies, seizures and intracerebral bleeding (see below). It is unknown whether an EBP reduces the risk of these complications.

In a 2003 UK survey of practice, 125 (71%) of 176 maternity units used conservative measures before proceeding to an EBP.[24] The survey did not state the duration of conservative therapy, although this is likely to have been dictated by its efficacy. A UK survey in 2017 reported that 52 (49%) of 105 units would perform an EBP for treatment of PDPH within 48 hours of a dural puncture, while 53 units (51%) performed EBP after 48 hours.[25] The latter practice is perhaps related to the belief that delaying an EBP improves its efficacy, but high-quality evidence supporting a delay is lacking.

Current evidence is not sufficient to recommend delaying an EBP simply on the grounds that it will improve efficacy. However, an EBP is not without risk, and it would appear reasonable to offer a trial of conservative management, since some headaches may resolve before an EBP is deemed necessary, especially if resulting from dural puncture with a spinal needle.

Women should be informed that performing an EBP within 48 hours of dural puncture is associated with a reduction in its efficacy and a greater requirement for a repeat EBP. However, in severe obstetric PDPH, an EBP within 48 hours of dural puncture may be considered for symptom control, although it may need to be repeated.

What investigations should be performed to aid diagnosis before performing an epidural blood patch?

Post-dural puncture headache has traditionally been a clinical diagnosis. Of note, the postural element considered to be pathognomonic of PDPH has been removed from the IHS definition.[8] Atypical headaches are increasingly recognised as a feature of PDPH,[9] making diagnosis more difficult.

Magnetic resonance imaging (MRI) of the brain and spine may reveal typical features of intracranial hypotension and CSF leak; these may include subdural fluid collections, dural-arachnoid enhancement, engorgement of venous structures, pituitary hyperaemia, sagging of the brain, periradicular leak and epidural fluid collections.[26–28] However, MRI findings can be normal in the presence of known CSF leak[29] and not all patients with evidence of a CSF leak develop headache. Studies looking for a correlation between CSF leakage and the risk of PDPH have shown mixed results.[30] The optimal investigation appears to be whole spine heavily T2-weighted magnetic resonance myelog-

raphy, which is a non-invasive, radiation-free imaging technique that can detect the site and amount of CSF leak.

Transcranial Doppler readings in patients with and without PDPH have been compared in one small study of obstetric patients.[31] Differences were observed between the two populations. This may be valuable in monitoring response to treatment, but is unlikely to aid diagnosis, as no pre-dural puncture readings are measured in those who subsequently develop headache.

Placing patients with headaches in the Trendelenburg position to screen for low CSF pressure was used in a small observational study in non-obstetric patients.[32] If headache improved in the Trendelenburg position, CSF hypovolaemia was presumed. A much larger study is required to validate this test in the diagnosis of obstetric PDPH.

When the diagnosis of PDPH is not thought to be in doubt, imaging is rarely performed and is not recommended. However, a change in the nature of headache, development of focal neurological signs, reduced level of consciousness and/or atypical headaches should prompt further investigation to exclude other causes of headache. Discussion with a senior radiologist and/or neurologist should be considered. Imaging should also be considered in headache unresponsive to treatment, such as after two unsuccessful EBPs.

If the diagnosis of obstetric PDPH is strongly suspected, there is no evidence that imaging is needed before performing an EBP. If the headache changes in nature, neurological signs develop, conscious level reduces, headache is atypical in nature or when two EBPs have been unsuccessful, urgent consideration should be given to further investigation and imaging.

What practical steps should be completed before an epidural blood patch is performed?

Before performing an EBP, written information, such as the OAA leaflet ''Headache after an epidural or spinal injection''[33] should be offered to women to aid the consent process. An EBP is a therapeutic intervention rather than an anaesthetic procedure to facilitate another treatment, and written consent is recommended.[34] The consent process for an EBP should follow the principles of consent for any form of anaesthetic intervention as recommended by the Association of Anaesthetists.[34] Information about the procedure including risks, benefits and alternative treatments must be discussed and documented.

In women receiving anticoagulants, an EBP should be scheduled at an appropriate time after the last dose of anticoagulant.[12] A medical history should be taken and physical examination performed, particularly noting signs of maternal systemic infection and 'red-flag' symptoms that may suggest a different diagnosis, such as change in the nature of headache, development of focal neurological signs, reduced level of consciousness and atypical headache.

It has been suggested that women should lie flat for two hours before a blood patch is performed,[35] in order to reduce headache and minimise the volume of CSF in the epidural space that may dilute injected blood. Ferrante et al. reported a 90% success rate following a single EBP in a cohort study of 106 patients with headache from spontaneous intracranial hypotension.[36] They attributed their success in part to placing patients in a 30° Trendelenburg position for one hour before the procedure. There are no randomised studies investigating the optimum position for patients before an EBP is performed. Of note, a 2017 survey of UK practice found that 42% of responders performed an EBP with women in the sitting position.[25]

Before performing an EBP, written information should be offered to women to aid the consent process. An EBP is a therapeutic intervention and written consent is recommended. An appropriate time should elapse before an EBP is performed in women receiving anticoagulants. Maternal systemic infection and 'red-flag' symptoms suggesting an alternative diagnosis should be excluded.

What are the risks of an epidural blood patch?

Repeat dural puncture

The incidence of dural puncture during insertion of an obstetric epidural catheter in the UK is approximately 1%.[11,16,37] It is usual to quote a similar incidence when discussing the risks of an EBP. There are, however, few reports of repeat dural puncture during an EBP, with only three cases identified.[3,11,15] Although most authors have not commented on the incidence of repeat dural puncture, it cannot be assumed that it did not occur.

Not all dural punctures are identified at the time of identification of the epidural space and the presence of CSF in the epidural space makes diagnosis more difficult. The incidence of dural puncture during an EBP may be <1% as the operator is usually more experienced, the woman is not in labour and the procedure is carried out in a more controlled environment, but the incidence is unknown.

If dural puncture occurs during an EBP, there may be an increased risk of intrathecal blood injection. Continuing with the procedure after repeat dural puncture is at the discretion of the operator. Spinal imaging should be considered when repeat dural puncture occurs during an EBP.

There is a risk of further inadvertent dural puncture during an EBP and this should form part of the consent process.

Back pain

Back pain may occur both during and after an EBP. Reporting of back pain in studies is variable, but is generally better in prospective work. In a study investigating the blood volume injected for an EBP, the incidence of back pain was 37% with 15 mL, 49% with 20 mL and 54% with 30 mL.[5] Median pain scores (maximum 10) ranged from 0–1 with an interquartile range of 0–6. The increase in pain with larger volumes of EBP was not statistically significant, although the study was not powered to detect a difference. Safa-Tisseront et al. reported outcomes of 504 EBPs in both obstetric and non-obstetric populations.[20] Discomfort was experienced by 78% of patients after injection of 19 ± 5 mL (mean $\pm$ standard deviation [SD]), and pain, which was always preceded by discomfort, occurred in 54% after 21 ± 5 mL. Pain was more common in patients aged less than 35 years-of-age, but pain was not related to overall success of the EBP. The pain is thought to be a consequence of increased pressure within the spinal canal resulting from the injection of blood.[38]

Back pain after an EBP was reported by over 80% of patients in Paech et al.'s study, regardless of the volume of blood injected.[5] Mean onset time was 27 hours and in a quarter of patients it was moderate or severe for up to five days. This pain is thought to originate from direct nerve root irritation or the presence of blood in the subcutaneous tissues.

Back pain lasting longer than one week has been reported after an EBP. Unfortunately many studies perform follow-up for only a few days, making it difficult to estimate the duration and severity of post-EBP back pain. In 19 non-obstetric patients with PDPH who received an EBP of 15–20 mL, back pain at seven days was described as mild in 11% and moderate in 16%.[39] Another study of 81 non-obstetric patients who received an EBP with 10–15 mL blood reported that all back pain had resolved four weeks after injection.[40]

Chronic back pain following an EBP has been investigated in two studies.[41,42] Webb et al. reported chronic symptoms lasting up to two years in 40 women who sustained a dural puncture with a 17-gauge epidural needle and 40 matched controls who did not experience dural puncture.[41] In the dural puncture group 33 women developed PDPH and of these 24 received an EBP. Although women in the dural puncture group were significantly more likely to develop chronic back pain than controls (43% versus 15%), treatment with an EBP was not a risk factor for chronic back pain (EBP 32% versus no EBP 60%). The study was not adequately powered to detect a significant difference in outcome for the effect of an EBP. Ranganathan et al. reported chronic postnatal symptoms in 162 women who experienced dural puncture in labour with a 17-gauge needle.[42] Compared with controls who did not experience dural puncture, the incidence of chronic back pain lasting longer than six weeks was significantly increased (58% versus 4%). The incidence of chronic back pain in women who received an EBP was 12.5%.

Back pain during an EBP may occur in 50% of women, and 24 hours after an EBP more than 80% of women may experience back pain. This may continue for several days but severity usually decreases over a few days, with resolution for most women by four weeks. There is no evidence to suggest increased rates of chronic back pain after an EBP. As back pain both during and after an EBP is common, and in some cases severe, it should be discussed as part of the consent process.

Neurological complications

Arachnoiditis

Injection of blood adjacent to nerve tissue is considered to be a risk factor for developing arachnoiditis, yet despite injecting relatively large volumes of blood during an EBP, reports of arachnoiditis are rare. It is unclear whether reports of persistent severe back pain following an EBP represent cases of arachnoiditis.

Four cases of arachnoiditis following an EBP in obstetric patients have been reported.[43–46] All had unusual features. Carlsward et al. described a patient who, having received two EBPs (25 and 30 mL within 48 hours), developed protracted back and leg pain, and reduced mobility which was still present two years later.[43] Arachnoiditis was confirmed on MRI. Riley and Spiegel reported the use of three EBPs (35 mL, 60 mL and 70 mL) in a woman with PDPH.[44] Ten weeks later the patient reported burning pain in her buttocks and left thigh; MRI suggested a diagnosis of arachnoiditis and symptoms had not resolved six months later. Aldrete and Brown performed a prophylactic EBP with 19 mL of blood through a catheter that may have been in the subdural space.[45] Five days later the patient reported back pain radiating to her legs which was still present 18 months later. Subdural and epidural blood collections and signs of arachnoiditis were noted on MRI. Roy-Gash et al. reported intense lower back pain after an EBP of 30 mL.[46] Arachnoiditis secondary to an intrathecal haematoma was diagnosed on MRI. Symptoms resolved after three weeks. Repeated large-volume EBPs were used in two of the four cases of arachnoiditis, but causation is not proven. Since EBP blood volumes greater than 20 mL have not been shown to produce additional benefit, repeated large volumes of blood should be avoided. Specific recommendations are not feasible based on these four cases, but the possibility of neurological complications should form part of the consent process for an EBP.

Spinal haematoma

Space-occupying lesions in the spinal canal have the potential to produce both ischaemic and inflammatory

damage to nerve tissue. A number of obstetric cases of spinal-subdural haematoma[43,47,48] and intrathecal haematoma[45,46,49,50] associated with the performance of an EBP have been reported, and non-obstetric cases have been described.[51–57]

In addition to arachnoiditis, Riley and Speigel reported a spinal-subdural haematoma following a 58 mL EBP.[44] One week after the procedure, the patient complained of back and leg pain with leg weakness. The diagnosis was confirmed with MRI and symptoms resolved within two weeks. Verduzco et al. described a case of spinal-subdural haematoma following a 20 mL EBP.[47] The patient subsequently reported back pain radiating to her legs, with resolution of symptoms over two weeks. Devroe et al. reported a similar case, also following a 20 mL EBP, with symptomatic improvement over two weeks.[48]

Intrathecal haematoma may be associated with arachnoiditis and prolonged neurological symptoms.[45] Kalina et al. described the case of an obstetric patient who presented with increasingly severe back and leg pain after a 27 mL EBP.[49] MRI demonstrated a large intrathecal haematoma, and symptoms improved over several months. In another report, intrathecal haematoma was diagnosed on MRI after a second EBP,[50] and symptoms resolved within two weeks.

Based on these cases, spinal-subdural and intrathecal haematoma may be possible complications of an EBP. In some cases large EBP volumes were used, but in others they were not, so the potential to produce complications when smaller volumes are used still exists. Risk quantification is not possible from these isolated reports.

Other neurological complications

A variety of neurological complications have been reported after an EBP, but it is unclear whether they were the direct result of the EBP, the dural puncture and CSF loss, or were unrelated. None are common and the issue of reporting bias must be considered.

Seizures have been reported in association with an EBP.[58–62] In five case reports (four in obstetric patients) seizures were not thought to result from the EBP despite a temporal relationship. The four obstetric cases had all received caffeine or caffeinated beverages, and seizures were thought to be eclampsia or due to CSF loss and associated subdural haematoma. Based on these cases, it cannot be excluded that seizures are a complication of EBP.

Cerebral venous sinus thrombosis (CVST) after EBP has been reported in five obstetric cases.[63–67] An EBP leads to increased fibroblast activity and collagen formation,[68] but does not explain an increased risk of CVST, the incidence of which increases in pregnancy. A direct link between EBP and CVST is unproven.

Five cases of facial nerve palsy following EBP have been reported[3,69–72] and would appear to be a rare complication that is arguably more likely due to CSF loss.

Bradycardia following an EBP has been described in two case reports.[73,74] It is most likely due to an increase in intracranial pressure (ICP) and supports the need for cardiovascular monitoring and vascular access during and after an EBP.

Infection, either localised to the lower back[75] or meningitis,[76–79] has been reported after an EBP and highlights the need for a meticulous aseptic technique when performing an EBP.

Other complications following an EBP described in case reports include intracerebral haemorrhage,[80–82] visual disturbance,[83,84] incontinence,[85,86] neck and shoulder pain,[87] chronic back pain from calcification of injected blood,[88] monoplegia,[89] cerebral ischaemia[90] and Horner's syndrome.[91]

Neurological symptoms may occasionally develop after an EBP, but their incidence is unknown and the relationship between an EBP and neurological symptoms may not be causative. Given the severity of some neurological symptoms, their development should be discussed as part of the consent process for an EBP.

Are there risks to not performing an epidural blood patch?

A number of complications have been reported when a continued CSF leak is not treated with an EBP.

Chronic headache

In a survey sent to all woman who delivered in a UK maternity unit between 13 months and nine years after childbirth (response rate 38%), 74 women sustained a dural puncture with an epidural needle. Seventeen (23%) of these women had headaches lasting longer than six weeks.[92] No details of the severity of headache or the effect of an EBP were included.

A prospective case-control study looked at chronic headaches in 40 women who suffered a dural puncture with a 17-gauge epidural needle in labour and compared them to a group of 40 women who received uncomplicated neuraxial anaesthesia.[41] Eighteen months after delivery, significantly more women in the dural puncture group (28%) reported headaches compared with controls (5%). In the dural puncture group, the headache rate in those women who received an EBP was 20% compared with 40% in those who did not; this difference was not statistically significant although numbers were small. Using a validated questionnaire, disability resulting from headaches was reported by 8% of women who received an EBP compared with 33% in those who did not; the difference was not statistically significant.

Chronic back pain

Back pain can occur either during or in the first few days after an EBP. The development of chronic back pain following dural puncture or an EBP has not been extensively investigated, but currently there is no evidence to suggest that its incidence is reduced when an EBP is performed.[41,42]

Cranial subdural haematoma

Cranial subdural haematoma is a rare complication of dural puncture.[93,94] A CSF leak causes caudad shift of the brain which may lead to rupture of the fragile subdural bridging veins and bleeding into the subdural space. Cuypers et al. identified 56 published cases in obstetric patients,[95] of whom 19 received an EBP for the treatment of PDPH, 17 before the diagnosis of cranial subdural haematoma was made. The authors speculated that minimising CSF leak with an EBP may reduce the incidence of cranial subdural haematoma, but no randomised studies exist, and performing an EBP in a patient with raised ICP is not recommended. Cranial-subdural haematoma should be included in the differential diagnosis of postpartum headache after dural puncture.

Cerebral venous sinus thrombosis

Cerebral venous sinus thrombosis produces a headache which may be difficult to differentiate from PDPH.[93,96] Hypercoagulability in pregnancy increases the risk of thrombotic complications. Dural puncture may further increase the risk of CVST due to both damage to the cerebral venous endothelium caused by a negative spinal-cranial pressure gradient and stasis from cerebral vasodilation. Wilder-Smith et al. reviewed 66 cases of CVST and found dural puncture was the fourth commonest risk factor.[97] The effects of an EBP on the development of CVST were not assessed. Kueper et al. reviewed five cases of CVST following EBP for the treatment of presumed PDPH.[67] Blood patches were repeated in three of the five cases, with the diagnosis of PDPH being questioned. The authors were unable to comment on whether an EBP was a risk factor for CVST. The possibility of CVST should be included in the differential diagnosis of persistent headache after dural puncture.

Cranial nerve palsy

In a recent review of 43 cases of cranial nerve palsy following central neuraxial blockade, intracranial hypotension was the most frequent cause, with cranial nerves VI and VII most frequently affected.[98] The authors suggested that if other causes of cranial nerve palsy (such as haemorrhage and thrombosis) were excluded, an EBP may be performed. The response to this treatment was mixed, with fewer than half of those experiencing resolution of symptoms within a week. Bechard et al. reviewed 12 cases of VI nerve palsy and found no improvement in symptoms after an EBP if this was performed more than 24 hours after the development of symptoms.[99] Improvement was seen in only two cases when an early EBP was performed. Some authors have advocated performing an EBP after four days if conservative therapy for PDPH is unsuccessful on the basis that this might reduce the number of cranial nerve palsies.[100] Given the small number of cases it is difficult to support this recommendation.[101]

Seizures

Postnatal seizures may result from hypertensive disease, epilepsy, haemorrhage, thrombosis, infection and space occupying lesions, but have also been reported after dural puncture in association with PDPH;[102] and after some modes of treatment, notably caffeine,[58,103–105] Synacthen,[106] sumatriptan[106] and EBPs.[59] The nature of these relationships is uncertain. No studies have examined if an EBP reduces the incidence of seizures in those with PDPH.

There is currently insufficient evidence to suggest that an EBP reduces the risk of chronic headache, chronic back pain, cranial subdural haematoma, CVST or improves outcome in those with cranial nerve palsy in women with obstetric PDPH.

At which level should an epidural blood patch be performed?

Using technetium-labelled red blood cells (range 12–18 mL) Szeinfeld et al. performed EBPs in the lateral position with a 17-gauge Tuohy needle on 10 patients with PDPH.[107] The range of spread was 7–14 spinal segments with mean volume per segment of 1.6 mL. Mean spread of blood was six spinal segments cephalad and three caudad. All EBPs successfully relieved the PDPH.

Beards et al. used MRI to study the spread of blood after an EBP in five patients with PDPH.[38] Procedures were carried out with the patient sitting; 18–20 mL of blood was injected through a 16-gauge Tuohy needle. The range of spread was 9–10 spinal segments, the majority in a cephalad direction. The initial mass effect of the clot, however, was restricted to 3–5 segments around the site of injection. Vakharia et al. used MRI to investigate the spread of a 20 mL EBP performed in the lateral position.[26] Mean (±SD) spread was 4.6 ± 0.9 spinal segments, with most of the blood spreading in a cephalad direction.

The reason for greater cephalad spread of blood, observed with a lumbar EBP performed in both sitting and lateral positions, may be related to the negative pressure gradient within the epidural space, as lower pressure is observed at higher spinal levels.[108] It may also reflect the design of the Tuohy needle with its Huber point directing blood flow in a cranial direction.

The major effect of an EBP appears to be within a few segments of the site of injection. Blood injected during an EBP spreads predominantly cranially. It is therefore recommended that an EBP is performed at the same level or one space lower than that at which the original dural puncture occurred.

Is ultrasound or radiological guidance of benefit when performing an epidural blood patch?

Ultrasound is increasingly used to aid neuraxial blockade and may help identify the lumbar interspace, predict the depth of the epidural space, reduce the number of needle passes and increase the efficacy of blocks.[109] There are no randomised studies comparing the efficacy of EBPs performed with or without ultrasound guidance. Evidence is restricted to case reports that have demonstrated mixed results.[110] Ultrasound can be used to identify the epidural space and confirm placement of blood but there is no evidence that this is superior to a conventional landmark-based loss-of-resistance technique.

Fluoroscopic-guided EBP has been successfully used in a small number of PDPH cases, the majority in the non-obstetric population.[111] There are no studies comparing this approach to a landmark-based loss-of-resistance technique. For treatment of spontaneous intracranial hypotension, CT-guided EBPs have been reported to be successful,[112] but no randomised comparisons with conventional techniques exist.

At present, there is no evidence to suggest that ultrasound and radiological guidance is of benefit when performing an EBP. As identification of the epidural space using ultrasound becomes more popular, its use may supersede landmark techniques. In the rare case in which confirmed PDPH does not respond to an EBP using a conventional landmark-based loss-of-resistance technique, radiological-guided EBP to locate the source of the leak may be of benefit.

There is currently insufficient evidence to recommend the routine use of ultrasound or radiological guidance when performing an EBP.

How much blood should be injected?

In Gormley's original report 2–3 mL of blood was injected.[1] Subsequently, larger volumes of blood were used (usually 5–10 mL), although supporting evidence was only from observational studies.[3,4,113] Crawford reported a 70% success rate using 6–15 mL of blood compared to 96% when 20 mL were used.[2] Larger volumes of blood, greater than 20 mL, have been used but appear to offer no additional benefit and may increase the risk of side effects.

The two accepted mechanisms by which an EBP relieves PDPH, namely increasing CSF pressure and sealing the dural puncture with blood clot, rely on both the volume of blood injected and the pressure this generates within the spinal canal. Patients frequently report pressure and pain as blood is being injected, the incidence increasing with larger volumes of blood.[5,20] This is thought to be a mass effect, with pressure exerted on neurological tissue. The lack of correlation between volume injected, epidural pressure and the success of an EBP is likely to be caused by variability in epidural space anatomy and compliance, and individual pain tolerance.[114]

In the prospective study by Paech et al. 121 obstetric patients were randomised to receive 15, 20 or 30 mL of blood.[5] Only 46% of those in the 30 mL group received the assigned volume due to pain during injection. Over the 48 hours after the EBP, headache scores were highest in those receiving 15 mL, but 30 mL appeared to confer no additional benefit when compared to 20 mL. The authors suggested their findings supported the use of 20 mL blood when performing an EBP.

Chen et al. compared an EBP with either 7.5 or 15 mL in 33 Taiwanese women.[17] No difference in the incidence of headache was observed between groups at either 24 hours (success 71% vs. 69%) or three days (success 88% vs 81%) after the procedure.

The retrospective study by Booth et al. reported the outcome of 466 EBPs performed on 394 obstetric patients.[14] The unit policy was to inject up to 30 mL of blood, although 91% did not receive the full amount. The mean (±SD) volume injected was 20.5 ± 5.4 mL. Increasing the volume of blood injected did not reduce the need for a repeat EBP.

A volume of blood of 20 mL is recommended when performing an EBP. Injection should stop before 20 mL is injected if not tolerated by the patient.

Should blood cultures be sent when performing an epidural blood patch?

Transient bacteraemia is not uncommon at the time of delivery. Blood taken within 30 minutes of delivery may yield positive blood cultures in 1% of women.[2] Fever usually, but not invariably, accompanies bacteraemia and when present represents a contraindication to an EBP. As fever is not invariably present in a patient with sepsis, it has been suggested that blood cultures should be taken at the time of an EBP.[2,115,116] However, practice surveys reveal that blood cultures are sent in fewer than 50% of cases,[24] and their value has been questioned.[76,117] Fortunately, infectious complications of an EBP are rare, although both localised infection[75] and meningitis[76–79] have been reported. There are no studies looking at the effect of antibiotic administration on infectious complications of an EBP. The decision on whether to do so should remain with the individual clinician.

There is currently insufficient evidence to recommend that blood cultures should be sent routinely when performing an EBP. There is insufficient evidence to recommend

the administration of antibiotics when performing an EBP. An EBP should not be performed in the presence of maternal systemic infection.

How should a patient be managed immediately after an epidural blood patch?

There is no evidence to guide management of obstetric patients immediately following an EBP. Maintaining the supine position for a period of time is common practice but there is little evidence regarding the duration. Most authors report lying patients supine for 1–2 hours.

Martin et al. randomised 30 male and female patients to lie supine for 30, 60 or 120 minutes after an EBP for PDPH.[118] Headache was more severe on first standing and at 24 hours in the 30 minute group compared to the 120 minute group. The authors concluded that patients should remain supine for at least 60 minutes and preferably 120 minutes after an EBP.

There are no current evidence-based guidelines on what observations should be made following an EBP, although regular observations of maternal pulse, blood pressure and temperature should be made following the procedure. The frequency and duration of these observations should be decided by individual units and must take into account maternal health.

Women who have received an EBP are often told to avoid straining for several days after the procedure as it is thought that this reduces the risk of dislodgement of the blood clot covering the dural tear.[24] Laxatives may be prescribed to avoid constipation especially when opioids have been used in headache management.[24] In addition, women may be told to avoid twisting and bending and to keep their backs straight as these measures are thought to reduce the risk of headache recurrence.[35] This advice has not been assessed in clinical trials.

There is currently insufficient evidence to guide the duration of bed rest following an EBP or the position that should be adopted. It is recommended that regular observations of maternal pulse, blood pressure and temperature are recorded following an EBP.

What are the indications to perform a repeat epidural blood patch?

An EBP is frequently ineffective in providing complete and permanent cure of PDPH. In some cases complete relief of PDPH is followed by return of symptoms days later, while in others EBPs provide only partial relief of symptoms. Many authors have reported the use of two or more EBPs to treat PDPH but most have not stated whether a second EBP was performed due to return of headache or due to only partial initial relief.[13,14,119] When a second EBP is performed, there is no evidence on the optimum time interval between the first and second EBP.

In a retrospective case series of 129 obstetric patients with PDPH following epidural and spinal blocks, Kokki et al. reported an initial EBP success rate of 89% although headaches returned in 15%.[15] Complete and permanent relief of symptoms was reported by all women after a second EBP. Median times from dural puncture to the first and second EBP were 72 and 96 hours, respectively. In the prospective audit by Banks et al. 55 of 58 EBPs produced complete or partial success.[13] Seventeen women experienced recurrence of moderate or severe PDPH, of whom 11 received a repeat EBP. This produced complete relief of symptoms in seven (64%) women. Timing of the second EBP was not stated. Safa-Tisseront et al. included both obstetric and non-obstetric patients in a prospective observational study, reporting a 7% failure with an EBP.[20] Of these patients 56% had a second EBP, with 53% and 37% obtaining complete or partial relief of headache, respectively. The second EBP was performed a median of five days after the first procedure.

Performance of a third EBP is less frequently reported. Booth et al. described six women (1.5%) in a cohort of 394 who received a third EBP. although no further details were provided.[14] Chan et al. reported five women (2%) of 240 in whom a third EBP was performed.[119] Banks et al. provided more details on four women (7%) of 58 who received a third EBP.[13] In two cases, a prophylactic EBP did not prevent headache and therapeutic EBP provided complete relief only for the headache to return. A third EBP successfully relieved the headache. The third case achieved relief of symptoms after both a first and second EBP, only for the headache to return; the woman requested a third EBP, which provided only partial relief of symptoms. The fourth case achieved complete relief of headache only after the third EBP. The authors recommended that after a failed EBP, alternative causes of headache should be considered.

Stocks et al. reported the case of a woman who developed a headache after dural puncture with an epidural needle in labour.[120] Two EBPs were performed, both of which provided only temporary relief of symptoms. A change in the nature of headache following the second EBP prompted referral to a neurologist and cortical vein thrombosis was subsequently diagnosed on MRI. This case highlights the need to reconsider the aetiology of headache, especially when its nature changes, and the value of seeking advice from other specialties.

A second EBP may be performed once other causes of headache have been excluded. Where the diagnosis of obstetric PDPH is likely and an EBP has produced resolution of symptoms but headache subsequently returns, a second EBP may be offered as it is likely to be of benefit. If an EBP has produced some improvement in symptoms but the headache persists, a second EBP can be considered as it may be of benefit. In cases where an EBP has no

effect on headache, or if the diagnosis of obstetric PDPH is less certain, or the nature of headache has changed, discussion with other specialties including obstetrics, neurology and neuroradiology should take place before a second EBP is performed. If two EBPs have failed to relieve symptoms, other causes of headache must be considered and involvement of other specialties is recommended before performing a third EBP. There is insufficient evidence to state the optimum timing for efficacy and safety of a repeat EBP.

Does an epidural blood patch affect the success of a subsequent neuraxial technique?

Performing an EBP has potential implications for the efficacy of a subsequent neuraxial block. This may be relevant in the days following a blood patch or, more likely, in a future pregnancy. Concerns have been raised about the efficacy of neuraxial blocks and the possibility of side effects. There are several case reports where a neuraxial block has been successful in the first week after an EBP;[121–125] reporting bias cannot be excluded.

Ong et al. published a retrospective analysis of labour epidural analgesia in 46 women who had suffered dural puncture with an epidural needle in a previous labour, of whom 29 had received an EBP.[126] Success rates for subsequent epidurals were 59% in those who received an EBP and 65% in those who did not. This compared to a 90% success rate in those in whom dural puncture had not previously occurred. Several case reports have highlighted failure of epidural analgesia in women who have previously undergone an EBP.[127–129]

In a retrospective study, Hebl et al. looked at outcomes for neuraxial blocks in obstetric and non-obstetric patients who had previously undergone an EBP for PDPH.[130] Each EBP patient was matched with two controls who had previously experienced dural puncture without an EBP and two who had experienced uneventful neuraxial blockade. There was no significant difference in success rates for neuraxial blocks between groups.

Beards et al. reported MRI findings at 30 minutes and 3, 7, 9 and 18 hours after an EBP.[38] Spread from the injection site was predominantly cephalad. A mass effect was observed for three hours. At seven hours a thick layer of clot was observed over the posterior surface of the dura and by 18 hours only small clots on the posterior dura were demonstrated. Studies on goats have shown that 24 hours after an EBP, the blood clot still contained considerable numbers of intact red and white blood cells with no fibrous reaction.[66] At four days clot organisation with immature fibroblasts was observed and by the second week the blood had disappeared to be replaced by mature fibroblasts with collagen deposition. The thickness of the scar was greatest at three weeks but shrank to normal size at three months. It is unclear when small clots fully resolve but it may be assumed that this occurs at a similar rate to an epidural haematoma, with the process complete in four to six weeks.[131]

There is a recognised failure rate of epidural analgesia in those who have not previously undergone an EBP. The evidence to support an increased failure rate of epidural analgesia after an EBP is weak and studies refuting a negative effect are not of high quality. Radiological studies, albeit on relatively few patients, do not indicate prolonged effects of injecting blood into the epidural space.

Evidence of the effect of an EBP on the success of subsequent neuraxial blockade is equivocal. All studies that have assessed the effect have methodological flaws. Current evidence is insufficient to comment on whether an EBP affects the outcome of subsequent neuraxial blockade.

How should patients who have undergone an epidural blood patch be followed-up?

In keeping with the principles of Duty of Candour, when dural puncture occurs during epidural catheter insertion or PDPH develops, women should be provided with a full account of events and an apology for any distress caused by anaesthetic interventions.[132] In addition, women should receive an explanation of the mechanism of PDPH and its treatment options. Any questions about aspects of PDPH and its management should be answered.

Following discharge from hospital, all women who experience a recognised dural puncture with an epidural needle or have a PDPH diagnosed require follow-up, regardless of whether an EBP is performed. Following an EBP, headache may or may not be relieved, or it may temporarily improve only to return when the woman has returned home.[133] Complications of an EBP, although infrequent, may arise immediately or in the days following the procedure when the woman may no longer be in hospital.

In whatever circumstances an EBP is performed, women require appropriate follow-up to ensure treatment has been effective and that side effects are assessed and managed.[134] Women who receive an EBP should be reviewed by an anaesthetist within four hours of the procedure. The effect on headache and presence of side effects should be documented. After the initial review, women may mobilise and, where appropriate, they may be discharged home. Those women who remain in hospital should be reviewed daily until discharge or until symptoms resolve. Information from each consultation should be documented.

Before discharge, women should be given verbal and written advice on when and how to contact the hospital should headache return or other symptoms develop. This should contain information regarding symptoms that should be reported including: recurrent headaches; back pain; nerve root pain; leg numbness or weakness;

difficulty passing urine or opening bowels; fevers; and visual or hearing disturbance.[33]

Women who are discharged home on the day of an EBP should be contacted the following day. If symptom-free, further follow-up should be discussed and agreed between the woman and the anaesthetist. Consideration should be given to offering women who have suffered from PDPH or who have undergone an EBP a follow-up appointment to see the anaesthetist, one to two months after delivery.

The significance of PDPH and side effects of an EBP may not be recognised by general practitioners and community midwives.[135] It is therefore important that the woman's general practitioner and community midwife are informed whenever PDPH is diagnosed or an EBP is performed.[93] Maternal mortality following hospital discharge after dural puncture was reported in the 2009–12 MBRRACE-UK report.[93] Two women died, one from cerebral vein thrombosis and one from subdural haematoma. Failure of hospital follow-up or referral to the general practitioner in women with persistent postnatal headache was highlighted. Routine follow-up should therefore be arranged. Clear instructions should be given to the general practitioner and community midwife, with a copy to the woman describing who to contact in the event of further headaches or the development of red-flag symptoms.

Women who receive an EBP should be reviewed by an anaesthetist within four hours of the procedure. Women who are discharged home on the day of an EBP should be contacted the following day. Women who remain in hospital should be reviewed daily until discharge or until symptoms resolve. Before discharge, women should be given verbal and written advice on when to contact the hospital should their headache return or other symptoms develop. Information on obstetric PDPH and EBP should also be given to the woman's general practitioner and community midwife.

Summary

Although viewed by many as the gold standard for the treatment of obstetric PDPH, high-quality evidence on the management of an EBP is limited. Large randomised studies are required to investigate various aspects of the procedure, most notably its efficacy, optimum timing and the duration of supine positioning following an EBP. The balance of the risks of an EBP versus the potential consequences of non-interventional management is not fully understood. At present, there is no evidence to suggest an EBP mitigates against the potential complications of low-pressure headache such as subdural haematoma or permanent cranial nerve palsy. Randomised studies to evaluate rare complications would be difficult to perform. Few studies have compared the incidence of chronic headache or back pain in obstetric PDPH patients managed with or without an EBP. In addition, the effect of an EBP on the success of subsequent neuraxial blockade is unclear. Further research may help guide informed consent. Guidance on the management of an EBP based on the currently available evidence can be found in the Appendix.

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A complete version of these guidelines is available on the OAA website.

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Appendix. Guidelines on management of an epidural blood patch

Pre-epidural blood patch (EBP) procedure checklist

- Give patient written information to aid consent process (e.g. OAA headache after an epidural leaflet http://www.labourpains.com/assets/_managed/cms/files/Headache_after_epidural.pdf).
- Check when the last dose of anticoagulant was given.
- Check for evidence of maternal systemic infection.
- Check for the absence of 'red-flag' symptoms suggesting a different diagnosis e.g. change in the nature of headache, development of focal neurological signs, reduced conscious level and atypical headaches.

Consent

We recommend that written consent should be obtained and the following may be discussed:

Benefits of EBP

- Efficacy: complete relief of symptoms following a single epidural blood patch is likely to occur in up to one third of cases. Complete or partial relief may be seen in 50–80%. In cases of partial or no relief, a second epidural blood patch may be performed after consideration of other causes of headache.

Risks and side effects of EBP

- Repeat dural puncture.
- Back pain during and for several days after EBP is common and can be significant.
- Rare complications include nerve damage, bleeding and infection.

EBP procedure

- The procedure requires two clinicians. A consultant obstetric anaesthetist or experienced senior trainee should perform the epidural injection and a second clinician take blood.
- Cardiovascular monitoring and intravenous access may be considered to detect and treat bradycardia during the procedure.
- The patient may be placed in the lateral or sitting position, considering the comfort of the patient in relation to her symptoms and the preference of the anaesthetist.
- The epidural injection should be performed at the same space or one space lower than the level at which the original dural puncture occurred.
- A full aseptic technique should be employed for both the epidural component and venesection.
- The epidural space should be located before venesection is performed.
- After venesection blood should be injected immediately into the epidural space through the epidural needle. Volumes of up to 20 mL are recommended if tolerated by the patient.
- There is insufficient evidence to recommend the routine collection of blood for culture. The decision on whether to do so should remain with the individual clinician.

Post-EBP procedure management

Guidance on the management of obstetric patients immediately following an EBP is lacking. The following is suggested:

- Keep patients in the supine position for 1–2 hours.
- Regular observations of maternal pulse, blood pressure and temperature may be made following the procedure. The frequency and duration of these observations should be decided by individual units and must take into account maternal health.
- Consider prescribing laxatives to avoid constipation and advising patients to avoid twisting, bending and straining.
- Women should be reviewed by an anaesthetist within four hours of the procedure. The effect on headache and presence of side effects should be documented. After the initial review, women may mobilise and, where appropriate, they may be discharged home. Those women who remain in hospital should be reviewed daily until discharge or until symptoms resolve.
- For further review and follow-up procedures see the Appendix to part 1.