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Review Article

PAIN

Chronic headaches related to post-dural puncture headaches: a scoping review

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Summary

Post-dural puncture headache (PDPH) is a well-recognised complication of neuraxial procedures. Although it is generally considered to be self-limiting, there is mounting evidence suggesting an association between PDPH and chronic headaches. In this review, chronic headache after dural puncture was defined as the reporting of persistent headaches more than 1 month after the index dural puncture. This scoping review aims to: (1) review the relationship between PDPH and chronic headaches, (2) explore the pathophysiology of chronic headache arising from a dural puncture, and (3) make recommendations about the follow-up and treatment of these patients. The pooled relative risk of chronic headache from 15 863 patients reported in 12 cohort studies in patients with an accidental dural puncture compared with those without accidental dural puncture were 1.9 (95% confidence interval [CI], 1.2–2.9), 2.5 (95% CI, 2.0–3.2), and 3.6 (95% CI, 1.9–7.1) at 2, 6, and 12 months, respectively. We also identified 20 case reports of 49 patients who developed chronic headache after a dural puncture. Epidural blood patch and fibrin glue injection and surgery have been used to treat chronic postural headaches. Overall, the level of evidence is low for all reported outcomes (aetiology, intervention and outcome) by virtue of the type of studies available (cohort and case reports) and significant risk of bias in the cohort studies. Based on findings from this review, we recommend that the risk of chronic headache is included in the informed consent discussion for all neuraxial procedures. Patients with PDPH should be closely followed up after hospital discharge.

Keywords: accidental dural puncture; epidural analgesia; headaches; lumbar puncture; neuraxial analgesia; post-dural puncture headache; spinal anaesthesia

Editor's key points

- Accidental dural puncture in the obstetric population is associated with increased risk of chronic headache with a risk of ongoing cerebrospinal fluid leak. However, the pathophysiology and optimal treatment of these headaches are unclear.
- This scoping review summarises the literature relating to chronic headaches following accidental dural puncture.
- When obtaining informed consent for epidural placement, anaesthesiologists should consider disclosure of the risk of chronic headaches.
- Future research is required to clarify the pathophysiology and treatment for post-dural puncture headache.

Post-dural puncture headache (PDPH) is a well-recognised complication of neuraxial procedures such as epidural

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analgesia and lumbar punctures. In the obstetric population, the incidence of accidental dural puncture (ADP) after epidural analgesia is estimated to be 0.7–1.5%, with 60–80% of these patients developing severe PDPH.[1] The exact pathophysiology of PDPH remains uncertain. However, it has been postulated that CSF leakage after dural puncture results in 'sagging' of intracranial structures, intracranial hypotension, and cerebral and meningeal vasodilation, which may cause the postural headache seen in PDPH.[2,3]

Although it is recognised that PDPH can lead to serious neurological sequelae (such as subdural haematoma) in a small minority of patients,[4] for the most part, PDPH is generally thought to be self-limiting. For example, the current International Classification of Headache Disorders (ICHD-3) defines PDPH as a disorder which 'remits spontaneously within 2 weeks, or after sealing of the leak with an epidural blood patch (EBP)'.

In contrast to the ICHD-3 definition, a detailed review of the literature challenges the common narrative that PDPH is always self-limiting. As early as the 1950s, chronic headaches after spinal anaesthesia have been reported. For example in 1956, Vandam and Dripps[5] performed a cohort study on 8460 patients who underwent 10 098 spinal anaesthetics. Of the 1011 patients who developed PDPH, they found that 20% had headaches lasting for more than 14 days, and 4% had headaches with durations exceeding 7 months. The authors thus remarked that, 'time and time again, people have written to us to describe headaches of long duration … Some of the complaints we received were intriguing'. They also included an anecdote 'The mother of a 12-yr-old boy given spinal anaesthesia for an appendectomy reported 6 months later that her child had had headache at least four times weekly and had been unable to use a swing in the backyard because of dizziness'.[6]

Apart from this early study, a growing body of recent studies have likewise reported an association between ADP/PDPH and chronic headaches.[7–11] There is currently a lack of literature to help guide physicians in the management of chronic headache after dural puncture; we therefore conducted a scoping review to: (1) review the relationship between dural puncture and chronic headaches, (2) understand the potential pathophysiology of dural puncture-related chronic headaches, and (3) make recommendations about the follow-up and treatment of these patients. In this review, we defined chronic headache as the reporting of persistent headaches more than 1 month after the index neuraxial procedure.

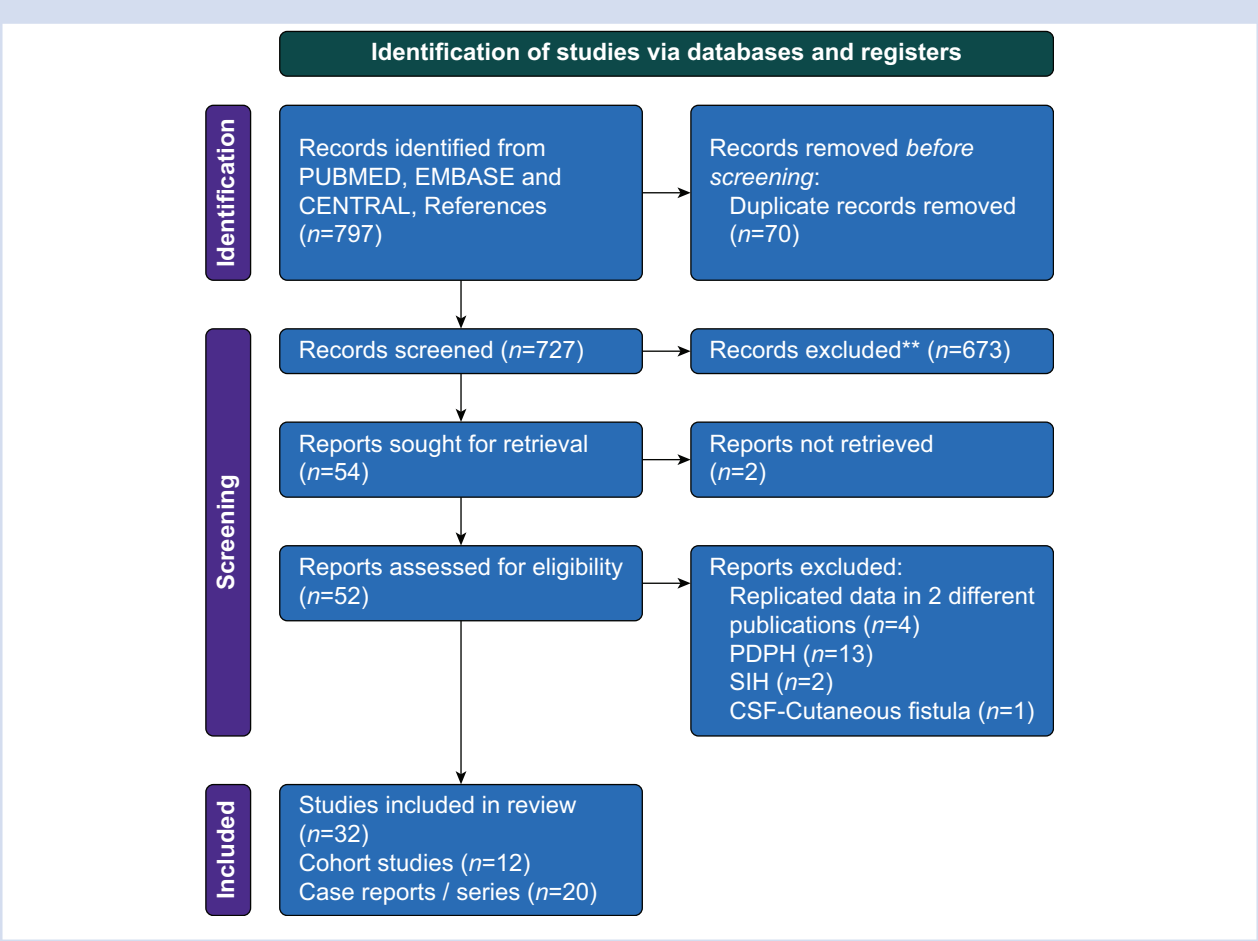

Fig 1. PRISMA flow diagram.[14] PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PDPH, post-dural puncture headache; SIH, spontaneous intracranial hypotension.

Methods

This scoping review was conducted according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for Scoping Reviews using the framework recommended by the Joanna Briggs Institute.[12]

Search methods

An electronic search was conducted on the following databases from the earliest record to April 2022: PubMed, Embase, and Cochrane Central Register of Controlled Trials. The key search terms were 'long-term', 'persistent', 'chronic', 'headache', 'unintentional dural puncture, 'accidental dural puncture', 'lumbar puncture', 'epidural', 'spinal anaesthesia', and 'post dural puncture headache'. No language or article type filters were applied. Abstracts were included in the search. The search keys were joined by Boolean operators. A complete list of the search terms may be found in Appendix A. Apart from the databases, reference lists from the selected studies were examined and relevant publications were added into the final search results.

Any publication that discussed the presentation, investigation or treatment of headache reported more than 1 month after a neuraxial puncture was included. Publications on any other headache condition (including acute PDPH and spontaneous intracranial hypotension [SIH]) were excluded.

Two reviewers (SP and QZ) independently reviewed each title and abstract from all search entries to exclude irrelevant studies. The full texts of the remaining studies were then further examined against the inclusion and exclusion criteria. Disagreements on any study eligibility was arbitrated by a third reviewer (CL).

Quality assessment

Two authors (SP, QZ) independently assessed the quality of each included study. The Risk Of Bias in Non-randomized Studies – of Exposure (ROBINS-E) tool,[13] a risk of bias assessment tool for observational studies, was used to assess methodological quality. It comprises seven domains of bias to determine the risk of bias, predicted direction of bias, and whether the risk of bias is sufficiently high to threaten the study conclusion. Any disagreement was resolved through consultation with a third author (CL).

Data extraction and statistical methods

The following data were extracted into an Excel spreadsheet from the included studies: author, year of publication, and the study design. For cohort studies, data included into the spreadsheet included the study type (prospective or retrospective), sample size, methodology, and results. The incidences of headaches at 2, 6, and 12 months were recorded. For case reports and case series examining patients with chronic headaches after dural puncture, data included in the spreadsheet included patient characteristics, clinical presentation, investigation results, treatment, and outcome of treatments.

Statistical analyses were performed using the 'Meta' package in RStudio version 2022.07.1 (RStudio, Inc., Boston, MA, USA). Random-effects modelling was used for all pooled data.

Table 1 Summary of risk-of-bias assessment for cohort studies using the ROBINS-E tool. ROBINS-E, Risk Of Bias in Non-randomized Studies – of Exposure. Green, low risk of bias; yellow, some concerns; red, high risk of bias; black, very high risk of bias.

Domains of bias	Confounding	Measurement of exposure	Selection of participants	Post-exposure interventions	Missing data	Measurement of outcome	Reported results	Overall risk of bias
Lacombe and colleagues 2022								
Ansari and colleagues 2021								
Binyamin and colleagues 2021								
Niraj and colleagues 2021								
Orbach-Zinger and colleagues 2021								
Hasoon and colleagues 2020								
Gupta and colleagues 2020								
Gauthama and colleagues 2019								
Ranganathan and colleagues 2015								
Webb and colleagues 2012								
Jeskins and colleagues 2001								
MacArthur and colleagues 1993								

Low Risk of Bias | Some Concerns | High Risk of Bias | Very High Risk of Bias

Dichotomous data were pooled and analysed using the Mantel–Haenszel odds ratio with 95% confidence intervals (CIs).

Results

Study selection

A total of 797 articles were identified during the initial search, and 70 duplicates were removed (Fig 1).[14] After screening through the titles and abstracts, 54 studies were identified for full-text review, of which 20 studies were excluded as they did not fulfil the inclusion criteria. Another two studies were not available as they were from now-defunct journals). The final review included 32 publications: 12 cohort studies (five prospective and seven retrospective) and 20 case reports/case series.

Study characteristics

The date of publication ranged from 1974 to 2022. Among the cohort studies, the sample size ranged from 40 to 11 635. Eleven out of the 12 cohort studies looked at obstetric patients who had ADP/PDPH after an epidural anaesthesia.[7–11,15–20] One cohort study (n=49) included the patients that sustained a dural puncture from diagnostic lumbar puncture.[21]

For the cohort studies, four studies[7,10,17,18] were found to have some concerns for bias, five studies[8,9,11,14,16] were at high risk, and three studies[19–21] were at very high risk for bias when assessed by the ROBINS-E tool. The results of the risk of bias assessment is summarised in Table 1. A summary of the cohort studies may be found in Supplementary Table S1.

For the case reports/series, a total of 20 publications were found.[22–41] In these publications, chronic headaches were attributed to lumbar puncture (22 cases), epidural anaesthesia (eight obstetric and five non-obstetric cases), spinal anaesthesia (four non-obstetric cases), lumbar drain placement, epidural steroid injection, spinal cord stimulation trial, and lumboperitoneal shunt (Supplementary Table S2).

Are patients with accidental dural puncture more likely to have chronic headaches?

As shown in Table 2, the question of whether ADP was associated with chronic headaches was examined in 12 publications (comprising five prospective studies[8–10,15,16] and seven retrospective studies).[7,11,17-21]

At 2 months, Ansari and colleagues[8] reported that the incidence of chronic headache was higher in the ADP group compared with a control group that did not have an ADP (73.7% [95% CI, 56.3–96.3%] *vs* 37.9% [95% CI, 26.6–50.8%], relative risk [RR]=1.9 [95% CI, 1.2–2.9]).[8]

At 6 months, all four studies that evaluated at this timepoint reported a positive association between ADP and chronic headaches.[7,8,10,11] The RR for the development of headache at 6 months ranged from 2.1 (95% CI, 1.1–4)[8] to 3.0 (95% CI, 2.1–4.3).[10] When these results were pooled, the RR of developing headaches at 6 months was 2.5 (95% CI, 2.0–3.2).[7,8,10,11] A comparison of the incidence of chronic headaches (ADP *vs* no ADP groups) at 6 months is reflected in Fig 2.

Five studies compared the incidence of chronic headache at 12 months or longer in patients with ADP compared with no ADP.[8–10,18–20] Four of the five studies reported statistically significantly higher chronic headache incidences in the ADP group (RR ranges from 2.6 [95% CI, 0.9–7.3] to 16.2 [95% CI, 2.3–113.7]).[8,17] The study conducted by Ansari and colleagues[8] was the only study that was unable to demonstrate a statistically significant association between ADP and chronic headaches at 12 months (RR=3.6; 95% CI, 1.9–7.1). In the context of a wide confidence interval and a high dropout rate (55.6%) in this study,[8] the lack of a statistically significant association between ADP and chronic headaches at 12 months may be represent a Type 2 error.

Is epidural blood patch associated with decreased incidence of chronic headache after dural puncture?

Seven studies addressed the question of whether EBP was associated with a decreased incidence of chronic headache (Table 3) by performing secondary analyses.[7,9–11,14,18,21] The studies reported conflicting results. Niraj and colleagues[10] reported better outcomes with EBP, whereas Gupta and colleagues[14] reported worse outcomes with EBP. Another five studies reported no difference in the incidence of chronic headache in patients who received an EBP compared with those who were conservatively managed.[7,9,11,18,21] Of note, all five studies were underpowered.

Presentation

The literature is replete with case reports and case series of patients with postural headaches (headaches that are worsened with assuming the upright position and improved/absent with being in the recumbent position) that have lasted for years, with the longest duration being 150 months.[26] A summary of these case reports may be found in Supplementary Table S2.

Apart from headaches, there was also an association between ADP and persistent back ache,[7,16,42] neck ache,[17] auditory impairment,[7,19] nausea,[24,27–29,38] and photophobia.[24] One study estimated that 18% of the chronic headache patients may experience functional limitation as a result of their headaches.[18] It is interesting to note that one retrospective cohort study reported that 91% of patients who endorsed chronic headaches after an ADP were asymptomatic at discharge after their delivery.[20]

Risk factors for chronic headaches after accidental dural puncture

One cohort study investigated the risk factors for developing chronic headache after an ADP.[18] In this small study involving 40 patients with an ADP, there was no statistically significant association between chronic headache and age, height, weight, BMI, parity, history of migraine, scoliosis, or pre-eclampsia. However, a study of 40 patients is unlikely to have enough power to identify risk factors. No study has examined the impact of the needle design and gauge on the incidence of chronic headaches after ADP.

Evaluation of chronic headache

With regard to the further evaluation of chronic headache after a dural puncture, the literature is limited to case reports and case series. In these reports, the authors used a number of investigations with the aim of proving the presence of intracranial hypotension (MRI of the brain, lumbar puncture opening pressure) and identifying the potential site of a CSF leak (MRI spine, CT myelography [CTM], radionuclide scan,

Table 2 Summary of the incidence of chronic headache after dural puncture from cohort studies. *Studies from which data were used to calculate the composite incidence and RR of chronic headache after accidental dural puncture at 6 months. †RR could not be calculated as there was zero incidence of chronic headache in the control group. ‡RR could not be calculated as there was no control group (i.e. no-dural puncture group). §Only data at 18 months were reported in the original article. CI, confidence interval; NA, not available; RR, relative risk.

First author (year of publication)	Study design	Timing of assessment	Sample size	Incidence of chronic headache after dural puncture (%)	RR (95% CI)
Lacombe* (2022)[7]	Retrospective cohort study	At least 6 months after labour epidural anaesthesia	126	9/63 (14.3%)	3.0 (95% CI 0.9–10.6)
Ansari* (2021)[8]	Prospective cohort study	2, 6, and 12 months after labour epidural anaesthesia	99	14/19 (73.7%) at 2 months 9/16 (56.3%) at 6 months 5/11 (45.5%) at 12 months	1.9 (95% CI 1.2–2.9) at 2 months 2.1 (95% CI 1.1–4.0) at 6 months 2.6 (95% CI 0.9–7.3) at 12 months
Binyamin (2021)[9]	Prospective cohort study	1.5–2 yr after labour epidural anaesthesia	232	21/115 (18.3%)	NA†
Niraj* (2021)[10]	Prospective cohort study	6, 12, and 18 months after labour epidural anaesthesia	280	53/89 (59.6%) at 6 months 52/89 (58.4%) at 12 months 52/89 (58.4%) at 18 months	3.0 (95% CI 2.1–4.3) at 6 months 2.8 (95% CI 2.0–4.0) at 12 months 3.4 (95% CI 2.3–4.9) at 18 months
Orbach-Zinger* (2021)[11]	Retrospective cohort study	6 months to 5 yr after labour epidural anaesthesia	408	42/129 (32.6%)	2.1 (95% CI 1.5–3.1)
Hasoon (2020)[21]	Retrospective cohort study	10.3–11 yr after diagnostic lumbar puncture	49	26/49 (53.1%)	NA‡
Gupta (2020)[15]	Prospective cohort study	3 months after labour epidural anaesthesia	1001	51/1001 (5.1%)	NA‡
Gauthama (2019)[16]	Prospective cohort study	6, 12, and 18 months after labour epidural anaesthesia	40	12/40 (30.0%) at 18 months§	NA‡
Ranganathan (2015)[17]	Retrospective cohort study	1–6 yr after labour epidural anaesthesia	208	57/162 (35.2%)	16.2 (95% CI 2.3–113.7)
Webb (2012)[18]	Retrospective cohort study	1–2 yr after labour epidural anaesthesia	40	11/40 (27.5%)	5.5 (95% CI 1.3–23.2)
Jeskins (2001)[20]	Retrospective cohort study	2–7 yr after labour epidural or spinal anaesthesia	177	16/72 (18.2)	10.7 (95% CI 3.2–35.8)
MacArthur (1993)[19]	Retrospective cohort study	13 months to 9 yr after labour epidural anaesthesia	11 635	13/74 (17.6%)	4.1 (95% CI 2.5–6.8)

digital subtraction myelogram [DSM]). However, little is known about the sensitivity and specificity of these tests for detecting evidence of intracranial hypotension or CSF leak in patients with postural chronic headache after dural puncture. A summary of the cases may be found in Supplementary Table S2.

SIH is a secondary headache condition attributed to a spontaneous CSF leak resulting in symptoms similar to PDPH. In this condition, it is common to find stigmata of low intracranial pressure on MRI brain and epidural CSF collection on spine imaging.[43] Among the case reports we reviewed, such imaging modalities often yield normal results in patients with chronic headache after dural puncture.[25,28–30,34,38–40] In a retrospective case series, Schievink and colleagues[26] performed MRI brain, conventional spinal imaging (MRI spine and CTM) and DSM on 27 patients with recalcitrant PDPH. For 18 (66.7%) of them, multiple imaging modalities failed to identify any abnormalities that could account for their ongoing headaches. Only three out of 27 patients exhibited stigmata of low intracranial pressure on their MRI brain. Eight patients demonstrated abnormalities (epidural CSF collection or pseudomeningocoele) in their conventional spinal imaging. DSM was able to localise the site of the leak in all five patients who had a leak identified on MRI spine or CTM. In addition, DSM also led to the diagnosis of CSF-venous fistula in one patient with normal conventional spinal imaging.

Based on the available literature, radionuclide scan is performed much less frequently compared with MRI spine or CTM.[30,39–41] However, there are some case reports where radionuclide scan was able to identify the site of the leak when conventional spinal imaging was unavailable or failed to detect a leak.[30,39–41]

When imaging result was positive, it usually led to a definitive treatment (e.g. targeted EBP, fibrin glue, or surgery) which resulted in complete headache resolution, presumably through the sealing up of the dural leak associated with the index dural puncture.[26,27,29–31,33,39–41]

Treatment of chronic headache after dural puncture

Conservative treatment

There are no studies examining the effects of conservative therapy on chronic headache after dural puncture. Based on the case reports outlined in Supplementary Table S2, conservative treatment including pharmacotherapy and bed rest are generally of limited efficacy in patients with chronic headache after dural puncture.[29,30,32] However, this may be a result of selective reporting of only the most severe and recalcitrant cases.

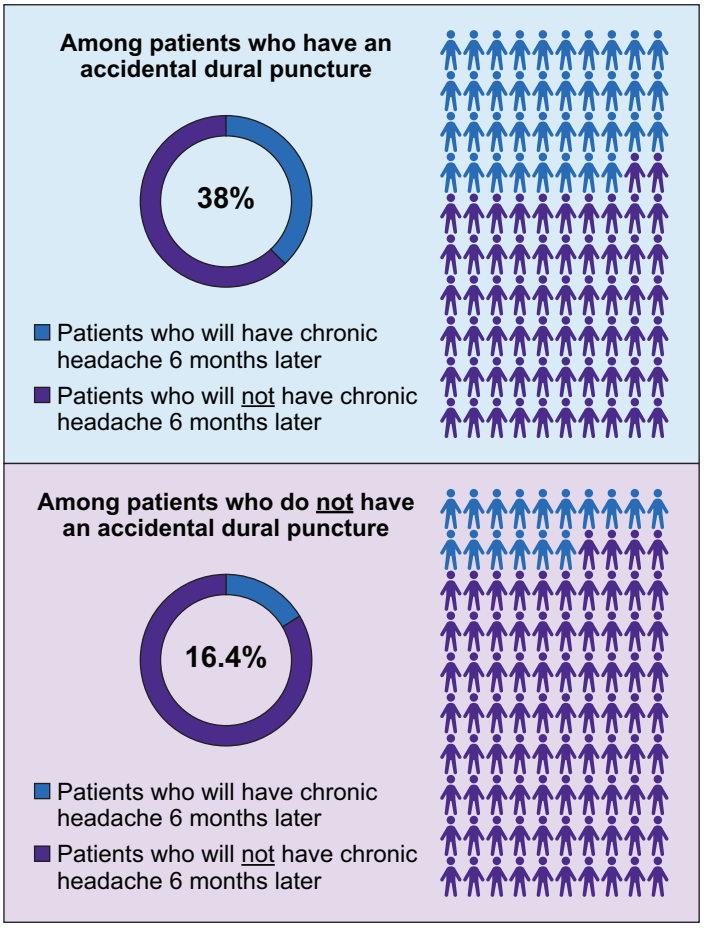

Fig 2. Infographic demonstration of the average incidence of chronic headache at 6 months after accidental dural puncture.

Table 3 Summary of studies that investigated the association between the performance of epidural blood patch and the incidence of chronic headache after dural puncture. *The exact *P*-value was not stated in the original article. †*P*-value at 6 and 12 months were 0.09 and 0.05, respectively (data on incidence at 6 and 12 months were not reported in the original article). ‡*P*-value was not available as there was no comparison (i.e. no-EBP) group. EBP, epidural blood patch; NA, not available; NS, not significant.

First author	Year	Study design	Timing of assessment	Sample size	Incidence of chronic headache in EBP group (%)	Incidence of chronic headache in no-EBP group (%)	*P*-value
Lacombe[7]	2022	Retrospective cohort study	At least 6 months after labour epidural anaesthesia	126	4/15 (26.7%)	5/48 (10.4%)	0.2
Binyamin[9]	2021	Prospective cohort study	1.5–2 yr after labour epidural anaesthesia	232	12/59 (20.3%)	9/56 (16.1%)	NS*
Niraj[10]	2021	Prospective cohort study	6, 12 and 18 months after labour epidural anaesthesia	280	29/52 (55.8%) at 18 months	15/18 (83.3%) at 18 months	0.04†
Orbach-Zinger[11]	2021	Retrospective cohort study	6 months to 5 yr after labour epidural anaesthesia	408	19/59 (32.2%)	24/72 (33.3%)	0.89
Hasoon[21]	2020	Retrospective cohort study	Mean of 10.3–11 yr after diagnostic lumbar puncture	49	14/26 (53.8%)	12/23 (52.2%)	0.91
Gupta[14]	2020	Prospective cohort study	3 months after labour epidural anaesthesia	1001	45/647 (6.9%)	6/354 (1.7%)	<0.001
Gauthama[16]	2019	Prospective cohort study	6, 12 and 18 months after labour epidural anaesthesia	40	10/23 (43.5%)	NA	N.A.‡
Webb[18]	2012	Retrospective cohort study	1–2 yr after labour epidural anaesthesia	40	5/25 (20.0%)	6/15 (40.0%)	0.15

Epidural blood patch and fibrin glue injection

EBP has been used in the treatment of chronic postural headache after dural puncture.[25–32,34–41] In many case reports, patients have experienced a significant improvement or complete resolution of their headaches after receiving an EBP.[27,29,32,34–37,39–41] The reported follow-up durations for these patients were generally short (between 4 weeks and 6 months). An underlying CSF leak was identified in only a few of these cases.[27,39,40] In most of the other cases, EBPs were performed empirically without any spinal radiological studies. Most of the EBPs were not guided by imaging as the level of dural puncture was usually known in this group of patients. D'Souza and colleagues[27] reported a case of ventral CSF leak that failed three blind attempts of EBP. The patient's headache resolved only after a fourth targeted ventral EBP under CT guidance.

Despite some successful cases, EBP is not a panacea. There are several reports of EBP failure in patients with chronic headache after dural puncture.[25,26,28–31,38] In half of these cases, a CSF leak was identified by spinal imaging.[26,30,31] One potential reason for EBP failure may be the failure to deposit blood adjacent to the dural leak. This may be seen from a case series in which three patients had multiple failed EBPs likely because the dural leak was located in the ventral dura.[31] In the event of failed EBP, several authors have attempted fibrin glue injection, all of them reporting excellent outcomes.[23,26,28,38] One of the three patients covered in this review required a repeat injection which was successful at inducing a durable remission of headaches at 7 months. The volume of fibrin glue injected ranged from 3 to 5 ml.[28,38]

Greater occipital nerve block

Greater occipital nerve block (GONB) was reported in one case report.[24] Unlike most of the other reported cases of chronic headache after dural puncture, this patient had a non-postural headache lasting 3 yr after an initial PDPH with classical features. The authors reported that the use of bilateral GONB and pulsed radiofrequency ablation resulted in significant relief of the headaches (50% reduction in headache intensity). The mechanism of action was attributed to the reduction of the central sensitisation of the trigeminal caudalis.

Surgery

When the exact location of the leak can be identified, surgery appears to be a durable long-term solution.[26,30,31] In one case series, eight of nine patients who underwent surgery reported complete remission of their headaches. Four of the patients underwent repair of a dural tear (seen on imaging and intraoperatively). One patient underwent a microsurgical repair of CSF-venous fistulas. The other four patients underwent pseudomeningocoele repair. The follow-up period for these patients ranged from 8 to 21 months.[26] The authors also noted that 'CSF leaks of the longest duration were all located ventrally' and 'ventral leaks, either iatrogenic or spontaneous, have been reported previously to have a tendency of becoming chronic'.

Discussion

PDPH is usually regarded as a benign but self-limiting condition. However, there is now mounting evidence in the form of both retrospective and prospective cohort studies that PDPH is strongly associated with the development of chronic headache. There has been no uniform definition for chronic headache after dural puncture. Nevertheless, most of the literature examined headaches that were present at least 1 month after the index dural puncture. (Supplementary Table S1).[7,17,19,20]

These findings have implications on our consent and follow-up processes. Chronic headache can lead to significant disability – including lost work days, unemployment, and disutility.[44] Given the potential severity of this complication, a reasonable patient would be interested to understand this risk. Consequently, we recommend that the risk of chronic headache should be included in the informed consent discussion for all neuraxial procedures.

Aside from consent, our findings also have implications for the follow-up process. At present, as PDPH is believed to be self-limiting, there is minimal follow-up of patients with PDPH, particularly if it resolves after an EBP. However, an EBP is not always curative.[25,45] About 91% of patients who complain of chronic headache after an EBP were asymptomatic at discharge from the hospital admission during which the dural puncture was made.[20] Taken together, patients with a dural puncture should be followed up after their discharge from the hospital and referred to a headache or pain clinic should they develop debilitating chronic headache.

The pathophysiology of chronic headaches arising from a dural puncture is poorly understood. Based on a small cohort study, 25% of patients present with postural headaches.[16] In these patients, it may be postulated that there is ongoing CSF leak that results in intracranial hypotension, cerebral vasodilatation, brain sagging, and traction of the meningeal nerves when the patient assumes the upright position, resulting in headaches, neck aches, photophobia, and nausea. In some of these patients, radiological investigations may demonstrate ongoing CSF leakage via a CSF fistula, pseudomeningocoele, or CSF-venous fistula. However, a large proportion of patients with postural headaches may not have a radiographically demonstrable CSF leak. We postulate that some of these patients may have a false negative investigation arising from an intermittent or low-grade CSF leak. In the 75% patients who do not develop postural headache, sensitisation of the trigeminocervical complex may explain why these patients may have ongoing headaches months after dural healing has occurred.[10,24]

Chronic headache after dural puncture can be challenging to treat. The best outcomes were noted in patients who demonstrated a dural leak on imaging – because it can lead to definitive treatment either through a targeted EBP, fibrin glue injection, or surgery. Therefore, in a patient with significant headache, it is prudent to order investigations in an attempt to confirm and localise a CSF fistula.

Repeat EBP and fibrin glue injection have been used successfully for the treatment of chronic postural headaches in the short to medium term. It is commonly believed that the deposition of blood or fibrin glue results in an elevation of the intracranial pressure and the occlusion of flow across the CSF fistula. This leads to an almost immediate improvement of the patients' symptoms. Subsequently, the reduction of CSF flow out of the intrathecal sac may also promote healing of the CSF fistula. Nevertheless, the follow-up periods of the included publications in this review were short, and longer-term outcome reporting is encouraged for future publications.

If a CSF leak, CSF-venous fistula or pseudomeningocoele is identified on imaging, surgery appears to be associated with good outcomes in the long term. However, these results may not be generalisable as the related publications mostly came

from one centre.[26,31] Considering this and the risk of surgery, it is reasonable to consider a trial of EBP before considering a surgical option.

Given the difficulty in treating chronic headache after dural puncture, it is important to reduce the risk of PDPH in the first place. This will involve reducing the risk of an ADP (limiting the number of attempts) and also reduce the incidence of PDPH should an inadvertent or deliberate dural puncture be made (smaller needle, altering the needle direction).[46,47]

All the studies identified by this scoping review were either cohort studies or case reports. This limits the conclusions that can be drawn from these studies. It should also be noted as well that there was lack of a standard definition for chronic headache after dural puncture and a number of cohort studies were found to have significant risk of biases. Furthermore, the results of this review pertaining to the RRs of developing chronic headaches after an ADP/PDPH may not be generalisable to the non-obstetric patients as most of the studies examined obstetric patients. Comparatively, obstetric patients are at a higher risk of developing PDPH possibly because of hormonal changes that occur immediately after delivery, sex, and age.

It was noted that many of the case reports had short follow-up durations. This limits our ability to determine if there are longer-term benefits with the use of EBP or fibrin glue. It should also be noted that although fibrin glue has been used extensively during spine surgery to assist with dural sealing,[48] its use in the epidural space is not currently approved by the Food and Drug Administration and therefore, cannot be routinely recommended at this point. More studies are required to demonstrate the safety of fibrin glue when used in the epidural space.

Our understanding of the pathophysiology behind chronic headaches after ADP/PDPH is poor and further research is warranted. At least in a fraction of the cases, a persistent CSF leak may be responsible for the patient's ongoing postural headaches. Further studies are required to understand the pathophysiology of chronic headaches associated with ADP/PDPH and factors that lead to a lack of adequate dural healing in some patients. Given that the incidence of chronic headaches in patients with ADP can be as high as 38%,[7,8,10,11] it is surprising that these patients rarely present to pain clinics. Future studies should consider the avenues to which these patients seek help. Considering the paucity of cases seen in pain clinics, further understanding of the treatment outcomes will be well served by good-quality case reports/series and reporting of longer-term outcomes of these patients. Recently, a closure device for ADP has been designed and studied on animals.[49] If such closure devices are approved for use in humans in the future, it may be helpful to assess if these devices can reduce the risk of chronic headache development.

In conclusion, PDPH should no longer be considered a benign and self-limiting condition. Physicians who perform neuraxial procedures should consider counselling patients about chronic headache as one of the complications of their procedures. Patients with an ADP after an epidural catheter placement should be followed up for at least 3 months after a successful EBP or until resolution of symptoms in the setting of conservative treatment.

Authors' contributions

Study design: QZ, SP, CL
Literature search: QZ, SP, CL
Data extraction and quality assessment: QZ, SP, CL
Writing up of the first draft of the paper: QZ, SP
Final approval of the version to be published: QZ, SP, CL
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All authors agree to be accountable for all aspects of the work thereby ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declarations of interest

The authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2022.08.004.

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