Insertion of an intrathecal catheter following accidental dural puncture: a meta-analysis

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ABSTRACT
Background: Inserting an intrathecal catheter after accidental dural puncture in parturients to prevent postdural puncture headache is becoming increasingly popular. We aimed to identify relevant published articles investigating this intervention and subject data to a meta-analysis.

Methods: A systematic literature search was performed, paralleled by a hand search of abstract publications. Studies that reported the dichotomous outcome parameters postdural puncture headache or need for an epidural blood patch were considered eligible. Risk ratios with 95% confidence intervals were calculated.

Results: We identified nine reports investigating placement of intrathecal catheters after accidental dural puncture. The risk ratio for an epidural blood patch after intrathecal catheter insertion was 0.64 (95% CI 0.49–0.84, P = 0.001). The risk ratio for postdural puncture headache was 0.82 (95% CI 0.67–1.01, P = 0.06).

Discussion: Inserting an intrathecal catheter significantly reduced the risk for an epidural blood patch; the incidence of postdural puncture headache was reduced but not significantly. Accidental dural puncture is a rare complication and therefore trials on intervention need to include a large number of patients which is time-consuming and costly. Intrathecal catheterisation is a promising approach for the prevention of postdural puncture headache and should be evaluated further. This intervention has additional benefits including a reduced risk of repeat dural puncture, rapid onset of action and use for anaesthesia.

Introduction
Accidental dural puncture (ADP) is a complication of neuraxial blockade with the reported incidence in obstetric patients varying between 0 and 6.6%. Postdural puncture headache (PDPH) develops in approximately half of the cases of ADP. Numerous interventions for the management of ADP have been proposed. A prophylactic epidural blood patch (EBP) has been favoured by some authors but meta-analysis has not confirmed a positive effect, whereas a therapeutic EBP has been shown to be superior to conservative treatment. Among interventions considered following ADP is intrathecal insertion of the catheter at the time of the dural puncture. The advantages of this manoeuvre are avoidance of a second dural puncture and immediate provision of analgesia. Placement of an intrathecal catheter for the prevention of PDPH has gained popularity and in 2003 was recommended by 59% of UK obstetric units, compared to only 1% in 1993. However, in 2010 a meta-analysis of observational studies of intrathecal catheter placement reported no significant benefit. Because more data have become available, this topic has been re-examined. Our aim was to evaluate the effect of intrathecal catheters on the development of headache, the need for blood patching and the incidence of adverse events.

Methods
We carried out a systematic literature search in PubMed and Embase with the following search terms: “inadvertent dural puncture” OR “accidental dural puncture” OR “unintentional dural puncture” AND “postdural puncture headache” AND “intrathecal catheter”. We employed a broad search strategy in order to be...
inclusive and capture all relevant studies: the PubMed search was conducted without applying Limits; studies published in any language were acceptable. Studies on animals were excluded.

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed where appropriate. We considered any mode of delivery including planned and emergency caesarean section eligible for inclusion. No age restriction was applied. Studies on singleton and multiple gestations were both acceptable. In addition to electronic searching, the reference lists of the retrieved articles were examined to identify further articles. We also hand-searched abstract supplements of the annual congresses of American and European societies of anaesthesiology and regional anaesthesia held over the last 10 years. Furthermore, we searched the controlled trials registry (http://www.controlled-trials.com/) with the following search phrases “postdural puncture headache”, “intrathecal catheter”, “epidural blood patch”. This identified no relevant trials.

We contacted the authors of two abstract publications10,11 and asked for additional information about study design, demographic data of the study groups, and adverse events. We received answers that were incorporated in our results section.

Articles were reviewed by two authors (MH, MvdV) and evaluated for eligibility. Outcome parameters were the incidence of PDPH and the need for EBP, described as dichotomous outcomes. For two studies we combined data from two arms (short-term and long-term catheterisation).12,13

### Statistical Analysis

Review Manager (RevMan; Version 5.1, Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2008) was used for meta-analysis. The random effects model was applied and pooled risk ratios (RR) with 95% confidence intervals (95% CI) were calculated. 

\[ P \text{ values } < 0.05 \] were regarded as statistically significant.

### Results

Our literature search retrieved 49 citations (Fig. 1). Eight articles10–17 were identified as eligible for inclusion. After our initial search was completed, another eligible study by Russell was published.18 Therefore, in total, nine studies were included in our review providing data on 963 parturients with PDPH and on 939 patients for EBP. Details of the studies including indications for epidural catheterisation (labour analgesia and/or caesarean section) and length of intrathecal catheterisation as well as participant demographics are presented in Table 1. The RR of PDPH after intrathecal catheter insertion was 0.82 (95% CI 0.67–1.01, \( P = 0.06 \)) (Fig. 2). The RR for the EBP was 0.64 (95% CI 0.49–0.84, \( P = 0.001 \)) (Fig. 3).

The effect size in the study by Ayad et al.11 was much larger than in the other studies. We therefore repeated our analyses without data from the Ayad study. For the incidence of PDPH we obtained a RR of 0.93 (95% CI 0.84–1.02) and for an EBP a RR of 0.76 (95% CI 0.65–0.88). Therefore, our analyses with and without the report by Ayad et al.13 revealed no significant differences for PDPH and significant differences for EBP, strengthening the robustness of our findings.

Nine studies did not report adverse events. Rutter et al. described one case with a high block after intrathecal catheter placement which resulted in dyspnoea, upper limb weakness and hypotension.14 In response to our request for more information, Kaul reported that one patient in the intrathecal group experienced paraesthesia which disappeared when the catheter was removed.11

### Discussion

In our meta-analysis, which included data from nine studies, we found that insertion of an intrathecal catheter produced a significant reduction in the need for an EBP whereas the incidence of PDPH was not significantly different. In a previous meta-analysis, Apfel et al.9 also failed to find a significant difference in the incidence of PDPH. They reported a RR of 0.88 (95% CI 0.68–1.14, \( P = 0.32 \)) for PDPH for short-term catheterisation and a RR of 0.21 (95% CI 0.02–2.65, \( P = 0.23 \)) for long-term catheterisation, defined as a
<table>
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<tr>
<th>Author</th>
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<tr>
<td>Cohen¹²</td>
<td>Full paper</td>
<td>Caesarean</td>
<td>Catheter removed immediately after caesarean section only vs. catheter in situ &gt;24 h</td>
<td>Repeat epidural</td>
<td>Decided by anaesthetist</td>
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<tr>
<td>Ayad¹³</td>
<td>Full paper</td>
<td>Vaginal</td>
<td>Catheter removed immediately after delivery vs. catheter in situ for 24 h</td>
<td>Repeat epidural</td>
<td>Decided by anaesthetist</td>
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<td>Norris¹²</td>
<td>Full paper</td>
<td>Vaginal</td>
<td>Catheter in situ for at least 2 h</td>
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<td>Allocation by time of enrolment</td>
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<td>Spiegel¹⁰</td>
<td>Abstract</td>
<td>Vaginal</td>
<td>Catheter removed after 24 h</td>
<td>Repeat epidural</td>
<td>Decided by anaesthetist</td>
<td>Age, height, weight, parity, mode of delivery, gestation age, birthweight similar between groups</td>
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<td>Rutter¹⁴</td>
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<td>Vaginal</td>
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<td>Age, weight, parity, mode of delivery similar between groups</td>
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<td>Paech¹⁵</td>
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<td>Vaginal</td>
<td>Catheter in situ for variable duration, but usually removed immediately after delivery</td>
<td>No treatment</td>
<td>Decided by anaesthetist</td>
<td>Data given for all patients, not detailed according to treatment group</td>
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<td>Kaul¹¹</td>
<td>Abstract</td>
<td>Vaginal</td>
<td>Catheter in situ for 24 h</td>
<td>No treatment</td>
<td>Decided by anaesthetist</td>
<td>Age, height, weight, parity, ethnicity similar between groups</td>
</tr>
<tr>
<td>Walters¹⁷</td>
<td>Abstract</td>
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<td>Catheter in situ for 24 h</td>
<td>Repeat epidural</td>
<td>Decided by anaesthetist</td>
<td>Age, height, weight, parity similar between groups</td>
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<tr>
<td>Russell¹⁸</td>
<td>Full paper</td>
<td>Vaginal/caesarean</td>
<td>Catheter in situ for 24–36 h</td>
<td>Repeat epidural</td>
<td>Allocation by time of enrolment</td>
<td>No details given</td>
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Intrathecal catheters following dural puncture
period longer than 24 h. Compared to Apfel and colleagues,9 we identified three additional studies.10,17,18
We challenge the rationale for dividing catheterisation for < or >24 h. It was hypothesised that the intrathecal catheter evokes an inflammatory response that contributes to plugging the dural tear.19 This hypothesis had been derived from one animal study.19 It should be emphasised that this inflammatory response was observed 19–21 days after catheter placement. Moreover, all medical plastics used in humans undergo implant testing to ensure that they are inert and do not cause significant tissue reaction. In general, and especially in this situation, extrapolation from animal data is controversial. It is therefore unclear whether this alleged inflammatory reaction plays any role in humans.

Furthermore, in Apfel’s meta-analysis,9 the attribution of data from two studies14,15 to the short-term catheterisation group is, in our opinion, not justified because both reports emphasised that the period of catheterisation was not standardised and exact documentation was not available. We can only speculate how intrathecal catheter insertion prevents PDPH. The most plausible hypothesis seems that the catheter plugs the dural hole and thereby reduces or stops fluid loss.

The need for EBP was significantly reduced whereas no significant effect was observed on the incidence of PDPH. This finding could be due to the fact that headaches of any severity were recorded but it was probably only parturients with more severe headaches who received an epidural blood patch. Intrathecal catheterisation may have affected more severe headaches, possibly by reducing cerebrospinal fluid loss and milder headaches resolved with expectant management and conservative treatment.

Some limitations of our study need to be discussed. Firstly, we did not formally assess the quality of studies with a scoring tool because both full papers and abstract only publications were eligible for inclusion in this systematic review. Study quality and hence possible bias may, however, have differed between studies and this must be considered as a limitation of our analysis. Of note, our approach was similar to the previous meta-analysis by Apfel et al. who also did not perform a formal quality assessment.

Secondly, there is a potential for bias, for example arising from different methods of allocation to groups and between-group differences in participant baseline characteristics. By searching the clinical trials registry we sought to address publication bias. We did not identify any relevant additional trials. However, publication bias may, of course, still have affected our analysis. We think that randomised controlled trials would be needed to definitively evaluate the effectiveness of intrathecal catheterisation. In this context, we want to emphasise that the meta-analyses6,9 on prophylactic EBP were based on randomised controlled trials. Both of these
meta-analyses were negative, supporting the hypothesis that this measure is not effective in preventing PDPH. In contrast, our study suggests that intrathecal placement is a promising intervention for preventing PDPH.

Thirdly, in agreement with Apfel et al. we analysed data obtained from both labouring parturients and women scheduled for elective caesarean section.9 Contractions probably increase fluid leak through the perforated dura and it cannot be excluded that this affects the incidence and severity of PDPH and the efficacy of prophylactic measures.

PDPH is a clinically relevant problem because it significantly increases the length of hospital stay (by 17 ± 23.8 h) and the number of post-discharge visits to the emergency department compared with women with uneventful labour analgesia.20 It has recently been identified as a risk factor for chronic headache as well as chronic low back pain.21

In conclusion, we present an up-dated meta-analysis that includes recently published data. In contrast to a previous meta-analysis,9 our findings suggest that intrathecal catheter placement significantly reduces the need for an EBP although significant reduction in the incidence of PDPH was not seen. A randomised trial by Russell18 was stopped early and type-2 error cannot be excluded as a cause of the lack of effect of intrathecal catheterisation on PDPH frequency. As ADP is rare, a randomised controlled trial that is sufficiently powered would need to include a large number of patients and would be costly and time-consuming. However, our findings reveal that placement of an intrathecal catheter is a promising intervention; a carefully designed trial ought to be conducted.

References