A prospective controlled study of continuous spinal analgesia versus repeat epidural analgesia after accidental dural puncture in labour

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ABSTRACT

Background: After accidental dural puncture in labour it is suggested that inserting an intrathecal catheter and converting to spinal analgesia reduces postdural puncture headache and epidural blood patch rates. This treatment has never been tested in a controlled manner.

Methods: Thirty-four hospitals were randomised to one of two protocols for managing accidental dural puncture during attempted labour epidural analgesia: repeating the epidural procedure or converting to spinal analgesia by inserting the epidural catheter intrathecally. Hospitals changed protocols at six-month intervals for two years.

Results: One hundred and fifteen women were recruited but 18 were excluded from initial analysis because of practical complications which had the potential to affect the incidence of headache and blood patch rates. Of the remaining 97 women, 47 were assigned to the repeat epidural group and 50 to the spinal analgesia group. Conversion to spinal analgesia did not reduce the incidence of postdural puncture headache (spinal 72% vs. epidural 62%, \( P = 0.2 \)) or blood patch (spinal 50% vs. epidural 55%, \( P = 0.6 \)). Binary logistic analysis revealed the relative risk of headache increased with 16-gauge vs. 18-gauge epidural needles (RR = 2.21, 95% CI 1.4–2.6, \( P = 0.005 \)), anaesthetist inexperience (RR = 1.02 per year difference in experience, 95% CI 1.001–1.05, \( P = 0.043 \)), and spontaneous vaginal compared to caesarean delivery (RR = 1.58, 95% CI 1.14–1.97, \( P = 0.02 \)). These same factors also increased the risk of a blood patch: 16-gauge vs. 18-gauge needles (RR = 2.92, 95% CI 1.37–3.87, \( P = 0.01 \)), anaesthetist inexperience (RR = 1.06 per year difference in experience, 95% CI 1.02–1.09, \( P = 0.006 \)), spontaneous vaginal versus caesarean delivery (RR = 2.22, 95% CI 1.47–2.63, \( P = 0.002 \)). When all patients were included for analysis of complications, there was a significantly greater requirement for two or more additional attempts to establish neuraxial analgesia associated with repeating the epidural (41% vs. 12%, \( P = 0.0004 \)) and a 9% risk of second dural puncture.

Conclusions: Converting to spinal analgesia after accidental dural puncture did not reduce the incidence of headache or blood patch, but was associated with easier establishment of neuraxial analgesia for labour. The most significant factor increasing headache and blood patch rates was the use of a 16-gauge compared to an 18-gauge epidural needle.

Keywords: Obstetric; Dural puncture; Postdural puncture headache; Epidural blood patch; Spinal catheter

Introduction

Neuraxial analgesia is the most effective form of pain relief for labour and, depending on the individual maternity unit, may be used for between 20% and 96% of labouring women.\(^1,2\) Accidental dural puncture (ADP) is one of the most common complications of epidural blockade in obstetrics with an incidence between 0.5% and 2%. Based on the UK maternity episode statistics for 2008–2009, this represents between 1000 and 2000 ADPs per year.\(^3\) Currently, there are two commonly used immediate treatment options for ADP; either repeating the epidural procedure, or inserting the epidural catheter intrathecally and converting to spinal analgesia.\(^4,5\) However, data on the effect of converting to spinal analgesia on postdural puncture headache (PDPH) and epidural blood patch (EBP) rates are mixed.\(^6–11\) A debate at the Obstetric Anaesthetists’ Association Controversies Meeting in 2001 revealed that 43% and 44% of delegates favoured conversion to spinal analgesia and repeating the epidural, respectively.\(^4,12\) With such equipoise, a controlled prospective study to compare these two treatment options was conducted.
Methods

Following ethical approval from a Multicentre Research Ethics Committee (MREC), the lead anaesthetist in every UK obstetric unit was sent a short synopsis of the study protocol. Those interested were invited to contact the author, after which they were sent the full protocol documentation. The lead anaesthetist presented this documentation to their own Local Research Ethics Committee (LREC) for approval. Women from whom informed consent for data collection could not be obtained or those under 16 years of age were excluded.

Each unit agreeing to take part in the study was randomised by means of computer generated random numbers to one of two management protocols: (a) repeating the epidural; or (b) inserting the epidural catheter intrathecally and converting to spinal analgesia. The study extended over two years with the protocol changing every six months. The protocol order in year two was the reverse of year one. The author reminded the lead anaesthetist in each unit of the need for a protocol change two weeks before the changeover date. Written consent from patients was obtained at a convenient time after the ADP (either when labour pain was controlled, or after delivery if the procedure was performed shortly before delivery) to allow the data collected to be included in the study.

The protocol stated that the spinal catheter should remain in situ for between 24 and 36 h after delivery. There was no stipulation regarding when the epidural catheter should be removed. The study protocol allowed each unit to use whatever drug regimen they felt appropriate for epidural or spinal analgesia. The treatment of headache was at the discretion of the individual unit. Women were followed-up daily for headache while in hospital and were contacted again by telephone at one and three months after delivery.

Primary outcomes were the occurrence of PDPH and the need for EBP. Complications of the two treatment methods were secondary outcomes. These included the number of additional attempts to achieve neuraxial analgesia, difficulties with threading catheters, number of additional ADPs and poor or excessive spread of block.

Statistical Analysis

Sample size calculation was based on 80% power with an alpha error $= 0.05$, from combined available data. For PDPH this indicated 110 patients per group and for EBP 44 patients per group. However, to allow leeway for subgroup analysis a total number of 500 patients was originally intended. For the initial analysis of headache and blood patch rates, patients were excluded if they suffered complications which could affect headache rates such as a second ADP or were not protocol compliant such as electively inserting a spinal catheter if the epidural had been difficult. In addition, further analysis was undertaken with treatment groups based on either the initial assignment group (Intention to Treat, ITT), or reassignment of patients by the author to what seemed the most appropriate group based on both the treatment received and complications of neuraxial analgesia (see Appendix).

Statistical analysis was performed using the Software Statistical Package for the Social Sciences version 17.0.0 (SPSS Inc. Headquarters, Chicago, IL, USA). The relationships between PDPH and EBP and various factors were analysed using binary logistic regression and the odds ratios produced were converted to relative risks to facilitate communication with clinicians. The following factors, which have been implicated previously in the occurrence of PDPH or the need for an EBP were included in the analysis: the immediate treatment of the ADP (repeating the epidural, conversion to spinal analgesia), anaesthetist obstetric experience (years), position of patient for epidural insertion (sitting, lateral), loss-of-resistance technique (air, fluid), when the ADP was recognised (needle, catheter), the opioid used in the local anaesthetic mixture (none, any of – fentanyl, alfentanil, diamorphine, morphine), mode of delivery (spontaneous vaginal, assisted vaginal, caesarean delivery), total spinal catheter duration (min) and spinal catheter duration post delivery (min).

Results

A summary of the study protocol was sent to the lead anaesthetist in 262 UK maternity hospitals: 94 requested more detailed information and of these 34 returned the LREC approval and were randomised to a starting protocol. The starting dates for these units ranged from April 2002 to October 2003. Ultimately, 19 centres contributed data on 115 women. A total of 58 women were randomised to a repeated epidural and 57 to conversion to a spinal catheter (Fig. 1). Of these women, 97 received the appropriate protocol with no complicating factors. Of the remaining 18 women, two received the wrong management by mistake and 16 experienced technical complications during epidural placement which resulted in a decision to use the alternative protocol. These cases, and their subsequent reassignment for analysis, are described in the Appendix.

Of the 97 protocol compliant women, 50 received spinal analgesia and 47 had their epidural resited (Table 1). In this group conversion to spinal analgesia did not reduce the incidence of any headache (spinal 39/50, 78% vs. epidural 31/47, 66%, $P = 0.19$), postdural puncture headache (spinal 36/50, 72% vs. epidural 29/47, 62%, $P = 0.2$) or epidural blood patch (spinal 25/50, 50% vs. epidural 26/47, 55%, $P = 0.6$). No significant differences were observed with either intention to treat or author reassignment analysis.
With all women included in the analysis a total of 79/115 (69%) women developed a headache after ADP. In 72 women there was a clear postural component to the headache. Another woman received a prophylactic EBP before removal of the epidural catheter 21 h after caesarean delivery. This patient went on to develop a severe postural headache and a second curative EBP was performed on day four. In the remaining six cases the headache was non-postural. One of these six women initially presented with a severe non-postural headache with associated dizziness and nausea, as well as clear fluid leaking from the epidural site: she received an EBP 32 h after caesarean delivery which greatly reduced her symptoms but a severe postural headache subsequently developed and 48 h later a second curative EBP was performed. The other cases of non-postural headaches did not require specific treatment. A total of 74 headaches were considered to be PDPH. Of the 115 women recruited, at least one EBP was performed on 59: 51% of the total ADPs, but 75% of those with a headache and 80% of those with suspected PDPH. Nineteen (26%) women required a second EBP.

Complications associated with neuraxial analgesia after ADP are shown in Figs. 2 and 3. In the repeat epidural group over one-third of the women suffered further complications, a rate three times greater than that observed in the spinal analgesia group ($P = 0.0004$).

Binary logistic regression analysis indicated that needle size, number of years obstetric anaesthetic experience and caesarean delivery were statistically
significant factors affecting the incidence of PDPH and the need for an EBP (Tables 2 and 3). Needle size was the major determinant for headache, PDPH, and EBP. All women requiring a second EBP had suffered an ADP with a 16-gauge needle (28% of the women who developed a PDPH after a 16-gauge needle). Neither

Fig. 2 Complications associated with replacing the epidural catheter after accidental dural puncture in the 58 women assigned to repeat epidural insertion. Further details are available in the Appendix. *Intrathecal catheter left in situ while epidural repeated, repeat epidurals ineffective so spinal analgesia via first catheter (n = 2); †Bloody tap on two occasions with subsequent high block (n = 1); ‡Two further ADPs and one bloody tap (n = 1); §Attempted combined spinal-epidural for subsequent caesarean delivery (spinal component unsuccessful).

Fig. 3 Complications associated with spinal catheter placement after accidental dural puncture in the 57 women assigned to the spinal analgesia group. Further details are available in the Appendix. †Locum Registrar ignored protocol. ‡Consultant anaesthetist advised general anaesthesia for caesarean delivery.

Table 2 Analysis of factors thought to affect postdural puncture headache and epidural blood patch rates

<table>
<thead>
<tr>
<th>Factor</th>
<th>Postdural puncture headache</th>
<th>Epidural blood patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthetic experience</td>
<td>0.043</td>
<td>0.006</td>
</tr>
<tr>
<td>Epidural needle size (16- vs. 18-gauge)</td>
<td>0.005</td>
<td>0.012</td>
</tr>
<tr>
<td>Spontaneous vaginal vs. caesarean delivery</td>
<td>0.015</td>
<td>0.002</td>
</tr>
<tr>
<td>Instrumental vaginal vs. caesarean delivery</td>
<td>0.162</td>
<td>0.214</td>
</tr>
<tr>
<td>Spontaneous vaginal vs. instrumental delivery</td>
<td>0.352</td>
<td>0.081</td>
</tr>
<tr>
<td>Recognition of dural puncture (needle vs. catheter)</td>
<td>0.109</td>
<td>0.138</td>
</tr>
<tr>
<td>Position (sitting vs. lateral)</td>
<td>0.581</td>
<td>0.653</td>
</tr>
<tr>
<td>Loss-of-resistance (air vs. fluid)</td>
<td>0.696</td>
<td>0.344</td>
</tr>
<tr>
<td>Neuraxial opioids (used vs. not used)</td>
<td>0.396</td>
<td>0.231</td>
</tr>
<tr>
<td>Repeat epidural/spinal catheter</td>
<td>0.541</td>
<td>0.509</td>
</tr>
<tr>
<td>Postpartum spinal catheter duration</td>
<td>0.392</td>
<td>0.782</td>
</tr>
</tbody>
</table>

Data are P values and are calculated from the protocol compliant group.
spinal analgesia nor its duration affected headache or EBP rates. When only the three factors which had a statistically significant effect on headache and EBP rates were included in the analysis, spinal analgesia still had no effect.

At the one-month follow-up, four women still had intermittent headaches with a postural component. Of these only one had problems at three months: she had a non-postural headache and "ringing in her ears all the time." She took no drugs and these symptoms did not interfere with her daily life. Eight other women had intermittent non-postural headaches of a minor nature at three months. One woman caused concern: at the three-month follow-up she described intermittent pins and needles in her thighs and deteriorating vision. She was seen by a consultant anaesthetist who felt multiple sclerosis needed to be excluded but the patient refused referral to a neurologist. It was agreed that the woman would contact the anaesthetist again if her symptoms did not improve: she made no further contact with the hospital.

**Discussion**

This is the first investigation to use a prospective controlled methodology to compare repeating an epidural with inserting an intrathecal catheter following ADP in labour. The main finding was that inserting an intrathecal catheter had no statistically significant effect on PDPH or EBP rates.

Previous studies on the conversion to spinal analgesia have reached conflicting conclusions.\(^6\)–\(^{11}\) Some support conversion because of an apparent significant reduction in PDPH and EBP rates\(^7\)–\(^9\) but other more recent and larger studies have found no effect from such conversion.\(^10\)–\(^{11}\) All of these studies\(^6\)–\(^{11}\) have limitations in that they are retrospective, non-randomised, observational studies, taking place over many years. One study that demonstrated a highly significant benefit of conversion to spinal analgesia after ADP is that of Ayad et al.\(^9\) This study of 18-gauge needle epidural placement found PDPH and EBP rates in 105 patients of 91\% and 81\% in the repeat epidural group, 51\% and 31\% in the spinal analgesia group when the catheter was removed soon after delivery, and 6\% and 3\% when the spinal catheter remained in situ for 24 h.\(^9\) In contrast, a more recent and larger retrospective study of 334 ADPs, presented only as an abstract, found no benefit from spinal catheters left in situ for 24 h after delivery: PDPH and EBP rates in the control group were 52\% and 32\% compared with 50\% and 32\% in the spinal catheter group.\(^11\) A notable feature in Ayad’s study,\(^9\) was the very high PDPH and EBP rates in the repeat epidural group. These rates are between 1.5 and 2.5 times higher than the figures for 18-gauge needles in the current and other published studies.\(^10\),\(^{11}\),\(^{14}\) Like the current study, the larger studies\(^10\),\(^{11}\) which found no effect of conversion to spinal analgesia on PDPH and EBP rates, were non-selective whereas Ayad et al.\(^9\) recruited only women who had an ADP on the first attempt at placing the epidural and which was then followed by a successful repeat epidural block, or immediate intrathecal placement of the catheter. Furthermore, women with a previous PDPH history were excluded, as were those who ultimately delivered by caesarean delivery.\(^9\) Such selection must exclude many women from analysis. Nevertheless, while it is difficult to reconcile the conflicting results above,\(^6\)–\(^{11}\) the current investigation does indicate the importance of other factors that need to be considered when comparing studies, such as anaesthetist experience, mode of delivery, epidural needle size.

There was extended debate within the MREC on the ethical issues of this study. It was accepted that in clinical practice ADP treatment protocols were often

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### Table 3  Odds ratios and relative risk of factors significantly affecting postdural puncture headache and epidural blood patch rates

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>Relative risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Postdural puncture headache</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per year difference in experience</td>
<td>1.09</td>
<td>1.02</td>
<td>1.00, 1.05</td>
</tr>
<tr>
<td>5 or more years</td>
<td>1.56</td>
<td>1.13</td>
<td>1.00, 1.26</td>
</tr>
<tr>
<td>10 or more years</td>
<td>2.43</td>
<td>1.27</td>
<td>1.01, 1.58</td>
</tr>
<tr>
<td>20 or more years</td>
<td>5.92</td>
<td>1.61</td>
<td>1.02, 2.51</td>
</tr>
<tr>
<td>Epidural needle (16- vs. 18-gauge)</td>
<td>6.5</td>
<td>2.21</td>
<td>1.40, 2.63</td>
</tr>
<tr>
<td>Spontaneous vaginal vs. caesarean delivery</td>
<td>4.55</td>
<td>1.58</td>
<td>1.14, 1.79</td>
</tr>
<tr>
<td><strong>Epidural blood patch</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per year difference in experience *</td>
<td>1.15</td>
<td>1.06</td>
<td>1.02, 1.09</td>
</tr>
<tr>
<td>5 or more years</td>
<td>2</td>
<td>1.31</td>
<td>1.08, 1.56</td>
</tr>
<tr>
<td>10 or more years</td>
<td>4.01</td>
<td>1.71</td>
<td>1.17, 2.43</td>
</tr>
<tr>
<td>20 or more years</td>
<td>16.08</td>
<td>2.92</td>
<td>1.37, 5.92</td>
</tr>
<tr>
<td>Epidural needle (16- vs. 18-gauge)</td>
<td>7.12</td>
<td>2.92</td>
<td>1.37, 3.87</td>
</tr>
<tr>
<td>Spontaneous vaginal vs. caesarean delivery</td>
<td>6.43</td>
<td>2.22</td>
<td>1.47, 2.63</td>
</tr>
</tbody>
</table>

Data are calculated from the protocol compliant group. * Compared to anaesthetists with 12 or less months of experience.
changed day-by-day according to the beliefs of the staff involved and, not infrequently, contrary to the opinion of the consultant of the day. Initially the MREC felt that in a study to compare two different treatment regimens, patients should be randomly allocated to the treatment groups. However, at the time of an ADP, it is not possible to start the patient recruitment process with written information, explanations of risk, randomisation and written consent. To avoid this problem it was suggested that the consent process be undertaken either with every woman in labour or with every woman who requested epidural analgesia. However, after further discussion not only was it agreed that these latter suggestions were impractical, but they had their own ethical problems, forcing delay and/or anxiety on hundreds to thousands of women, with no prospect of gain, for every woman recruited. The MREC accepted that in routine clinical practice no specific written patient consent was required for treatment of an ADP, no matter what the protocol. Neither did a unit require MREC approval or patient consent to change its protocol. The aim of this study was to control how often a unit changed its treatment protocol and the MREC agreed that for the proposed two-year study a six-monthly change of hospital protocol was acceptable and at least 34 other LREC's agreed.

Data analysis has also been debated at length. There were various complications of the epidural or spinal procedures which had the potential to affect the PDPH and EBP rates, such as second dural puncture when repeating the epidural, and protocol violation (almost always in the repeat epidural group) when a conscious decision (treatment bias) was made to limit patient suffering by converting to spinal analgesia. If occluding a single hole in the dura with a catheter is important, then it is illogical to pretend the hole is not occluded or to ignore the effect of a second hole in the dura, whether or not one of the two holes is occluded by a catheter. To address these issues, in the binary logistic analysis patients’ data were analysed on the basis of their original group allocation, but protocol violations and complicated cases were excluded from the analysis of headache and EBP. However, because excluding such patients could change the statistical outcomes, two further analyses were undertaken: intention-to-treat analysis where the patients’ data were analysed according to the original assignment group, irrespective of protocol violations or complications; and assignment of patients to what seemed the most appropriate group by the author (Appendix). Apart from small changes in the risk ratio, neither of these latter two analyses changed the outcomes, despite the fact that in an ITT analysis both of the complications mentioned above would favour the spinal analgesia group.

Although conversion to spinal analgesia did not affect PDPH and EBP rates, three other factors had a significant effect: the experience of the anaesthetist, the size of the epidural needle, the mode of delivery. Several reasons might explain why the experience of the anaesthetist had an effect on PDPH and EBP rates. It is known that obesity significantly reduces the incidence of PDPH and the need for an EBP after an ADP, and it is possible that, compared to a less experienced anaesthetist, one of greater experience was more likely to perform an epidural on an obese woman. Between 25% and 38% of PDPHs occur after an unrecognised ADP, and it may be that a less experienced anaesthetist had already created one or more dural punctures before recognising that an ADP had occurred. The volume of cerebrospinal fluid (CSF) lost at the initial ADP could be important, and an experienced anaesthetist may be quicker to occlude the epidural needle. Finally, it may be that experienced anaesthetists are able to create a better rapport with the mother and provide more positive reassurance. In the current study, data on delay in occluding the epidural needle, patient weight or difficulties with initial epidural placement before the ADP were not collected.

It is well known that the size of the needle has a significant effect on PDPH and EBP rates. Compared to 16-gauge epidural needles, smaller needles can reduce the PDPH rate from 85% to 40%.[14,17,19] This is confirmed in the current study, with a patient twice as likely to develop PDPH and three times more likely to need an EBP after ADP with a 16-gauge compared to an 18-gauge needle. In addition, all 19 women requiring a second EBP suffered an ADP with a 16-gauge needle.

Compared with spontaneous vaginal delivery, previous studies have observed reduced PDPH and EBP rates with either instrumental vaginal[20] or caesarean delivery: bearing-down during the active part of the second stage of labour is generally accepted as the reason. Ravindran et al.,[22] however, observed no association between bearing-down and PDPH or EBP rates, and current practice does not preclude bearing-down nor does it advise instrumental delivery to minimise headache rates. Our data underwent further binary logistic analysis based on whether there was a period of bearing-down in the second stage of labour rather than looking at the actual mode of delivery. This re-analysis indicated no statistically significant relationship between bearing-down and either PDPH ($P = 0.89$) or EBP ($P = 0.310$). Two other retrospective studies of ADP in relation to elective caesarean delivery under attempted epidural anaesthesia suggest another possible reason for reduced PDPH and EBP rates with operative deliveries.[23,24] In one study some patients had an intrathecal catheter placed after the ADP and this remained in situ for more than 24 h.[25] In the other, some patients had the epidural catheter reinserted and this remained in situ for postoperative analgesia. The other patients in this latter study received either general or single-shot spinal

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As for the mode of delivery, it is well established that when the head is delivered before the dural puncture or during the second stage of labour, the incidence of PDPH is reduced. The current study supports these observations, with a patient twice as likely to develop PDPH with either instrumental vaginal[20] or caesarean delivery: bearing-down during the active part of the second stage of labour is generally accepted as the reason. Ravindran et al.,[22] however, observed no association between bearing-down and PDPH or EBP rates, and current practice does not preclude bearing-down nor does it advise instrumental delivery to minimise headache rates. Our data underwent further binary logistic analysis based on whether there was a period of bearing-down in the second stage of labour rather than looking at the actual mode of delivery. This re-analysis indicated no statistically significant relationship between bearing-down and either PDPH ($P = 0.89$) or EBP ($P = 0.310$). Two other retrospective studies of ADP in relation to elective caesarean delivery under attempted epidural anaesthesia suggest another possible reason for reduced PDPH and EBP rates with operative deliveries.[23,24] In one study some patients had an intrathecal catheter placed after the ADP and this remained in situ for more than 24 h.[25] In the other, some patients had the epidural catheter reinserted and this remained in situ for postoperative analgesia. The other patients in this latter study received either general or single-shot spinal
anaesthesia for surgery. Both studies noted a significant reduction in PDPH and EBP rates in patients with a neuraxial catheter, whether epidural or intrathecal. While both sets of authors considered the volume of fluid administered into the spinal canal to be the main reason for the reduced PDPH and EBP rates, there was another common factor: both studies provided postoperative opioid analgesia via either the epidural or subarachnoid catheter. Thus, rather than the physical presence of the catheter or additional neuraxial fluid, it may be the neuraxial opioid which was important. It is possible that in the current study observed differences in PDPH and EBP rates between spontaneous and operative deliveries are related to differences in neuraxial opioid doses or even to differences in other types of post-delivery analgesia.

While the current results do not support insertion of a spinal catheter to reduce the incidence of PDPH or EBP, there is strong evidence that conversion reduces the incidence of multiple repeat epidural attempts, and a second ADP. The 9% risk of a subsequent ADP in association with repeating the epidural is in line with others. The only serious complication noted in this study (total spinal anaesthesia) occurred when it had not been possible to thread a catheter into the CSF and the epidural was repeated.

There are weaknesses within the current study. The investigation was not truly randomised but, compared to retrospective studies, this study with its controlled, prospective, balanced protocol changes, was less likely to be influenced by treatment bias and anaesthetist experience. The final number of patients recruited was much smaller than the 500 anticipated, and so the study may be underpowered to detect some small differences. Some may view the exclusion of patients from the primary analysis as a weakness. However, whether analysed with complex patients excluded, or based on ITT, or author reassignment, there was no change in statistical outcomes, and conversion to spinal anaesthesia did not have any statistically significant benefit on PDPH or EBP rates. Only 18 of the 55 spinal catheters were left in situ for 24 h or longer after delivery, with another 10 remaining in situ for between 12 and 24 h after delivery. While this might be seen as a limitation, it should be noted that more recent studies have likewise found no benefit of leaving catheters in situ for 24 h after delivery.

In summary, although converting to spinal anaesthesia does not appear to affect PDPH or EBP rates significantly, the results do provide support for insertion of a spinal catheter following accidental dural puncture, to minimise patient suffering. For future studies, whether prospective or retrospective, the importance of factors other than simply repeating the epidural or inserting a spinal catheter in the genesis of PDPH or the need for EBP need to be considered. Although the most effective management of ADP is yet to be ascertained, if anaesthetists wish to reduce the incidence and severity of PDPH and requirement for an EBP after ADP, 18-gauge rather than 16-gauge needles should be used.

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Appendix

Author reassignment
Women with complications or who were not treated according to protocol are listed below. For headache and EBP analysis these women were reassigned either according to the treatment they received or whether the complication resulted in a hole in the dura without occlusion from an epidural catheter. For analysis of complications of a particular treatment, women were reassigned on the basis of the treatment received.

Dural tap recognised with needle – should have received a repeat epidural (n = 7)
In one obese woman ADP was recognised with the needle and the catheter was electively inserted into the CSF. This woman was reassigned to the spinal catheter group for both headache and blood patch analysis and complications.

In one woman who was unable to co-operate and keep still due to pain, ADP was recognised with the needle and the catheter electively inserted into the CSF. She was reassigned to the spinal catheter group for both headache and blood patch analysis and complications of technique.

In three women, after an appropriate attempt was made to replace the epidural, all suffered a second ADP. In all three cases the catheter was threaded into the CSF after the second dural puncture. These women remained in the repeat epidural group.

In one woman an appropriate attempt was made to replace the epidural catheter but a second ADP occurred. The anaesthetic trainee removed the epidural and called for assistance. A consultant anaesthetist then attempted to replace the epidural and, after an initial bloody tap a third ADP occurred. The epidural was removed and successfully reinserted. The woman remained in the repeat epidural group.

The wrong protocol was followed in one woman and the catheter was passed electively into the CSF. However, the spinal catheter fell out after 3 h and was replaced by an epidural. After delivery a single-shot spinal was used for suturing an episiotomy. Since the spinal catheter had only been in situ a short time, the patient remained in the repeat epidural group for headache and blood patch analysis but was assigned to the spinal catheter group for analysis of complications.

Dural tap recognised with needle – should have received a spinal catheter (n = 7)
After ADP a spinal catheter was inserted but it stopped working after 4.5 h. A repeat epidural was performed. Since the spinal catheter had only been in situ a short time, the patient was reassigned to the repeat epidural group for headache and blood patch analysis but remained in the spinal catheter group for analysis of complications.

An epidural proved very difficult to site and ADP occurred on the third attempt. The trainee forgot the protocol and repeated the epidural, successfully, on the fourth attempt. The epidural catheter was removed 21 h after delivery but a prophylactic blood patch was given through the catheter before its removal. This patient was reassigned to the repeat epidural group for analysis of both headache and blood patch and complications.
After ADP the catheter would not thread into the CSF. A repeat epidural was attempted but proved impossible. The patient, who had no neuraxial analgesia for labour, was reassigned to the repeat epidural group for headache and blood patch analysis but remained in the spinal catheter group for analysis of complications.

A very distressed woman had an epidural attempted but this was not possible as she was unable to lie still due to pain. A single-shot spinal injection was performed and, after the onset of pain relief, she had an epidural inserted and an ADP occurred. A spinal catheter could not be threaded into the CSF and so a repeat epidural was performed. This provided effective analgesia for labour but, on topping-up for an emergency caesarean section, a total spinal occurred. The patient was reassigned to the repeat epidural group for headache and blood patch analysis but remained in the spinal analgesia group for analysis of complications.

A woman had an elective two-space combined spinal-epidural technique with the epidural inserted after the spinal. An ADP occurred but the catheter could not be threaded into the CSF. The epidural was resited. The patient was reassigned to the repeat epidural group for headache and blood patch analysis but remained in the spinal catheter group for analysis of complications.

An ADP occurred but a catheter could not be threaded into the CSF. The epidural was repeated but did not work and so was repeated again. This woman was reassigned to the repeat epidural group for analysis of headache and blood patch but remained in the spinal group for analysis of complications.

An ADP occurred and a catheter was threaded into the CSF. After 5 h the spinal catheter ceased to provide pain relief and was removed. An epidural catheter was then inserted and used for the remainder of labour. Since the spinal catheter had only been in situ a short time, this patient was reassigned to the repeat epidural group for headache and blood patch analysis but remained in the spinal catheter group for analysis of complications.

Dural tap recognised with catheter – should have received a repeat epidural (n = 4)

In one woman ADP was recognised after the test dose. The epidural was successfully resited as the spinal analgesia from the test dose wore off. The spinal catheter remained in situ unused until 12 h after delivery. She was reassigned to the spinal catheter group for headache and blood patch analysis but remained in the repeat epidural group for analysis of complications.

After a difficult epidural, ADP was recognised with the catheter. Because of the difficulty in placement, it was decided to use the catheter for spinal analgesia. This woman was reassigned to the spinal catheter group for both headache and blood patch, and complications analysis.

An ADP with the catheter was noted at the second attempt at epidural insertion. The first repeated attempt after the ADP also resulted in another ADP with the catheter. This catheter was used for spinal analgesia but failed to work for forceps and a pudendal block was performed. This woman remained in the repeat epidural group for both analysis of headache and blood patch, and complications.

In one woman the first attempted epidural resulted in a bloody tap. On the next attempt an ADP was recognised after catheter insertion. The catheter was left in situ while a further attempt at placing the epidural occurred; this failed. Since the catheter was still in the CSF this was used to provide spinal analgesia. She was reassigned to the spinal catheter group for headache and blood patch analysis but remained in the repeat epidural group for analysis of complications.

Dural tap recognised with catheter – should have received a spinal catheter (n = 0)

No problems and no reassignment required.

Complications associated with reinsertion of the epidural catheter (Fig. 2)

One attempt at reinsertion (n = 6)

In four cases the first attempt at replacing the epidural resulted in a second ADP. In all four cases the ADP was detected after catheter insertion, and the catheter was left in the CSF and used to provide spinal analgesia. In one of these cases the spinal catheter ceased to function and a pudendal block was used for forceps delivery. In another case there was anxiety as regards the use of a spinal catheter for caesarean delivery and a single-shot spinal anaesthetic was attempted. This failed so general anaesthesia was administered.

In two cases, at the initial epidural insertion the catheter was found to be in the CSF. The catheter was left in situ while the epidural was repeated at another space. The repeat epidurals did not work, so the original spinal catheters, still in situ, were used to provide spinal analgesia.

Two attempts at reinsertion (n = 1)

In one case, when first inserting the epidural, a bloody tap occurred and this was followed by an ADP. The first attempt to replace the epidural after the ADP resulted in another bloody tap. The second attempt was successful but a high block (loss of touch sensation to T4) followed 0.1% bupivacaine 15 mL.

Four attempts at reinsertion (n = 2)

On attempting to replace the epidural, one woman suffered two further ADPs and a bloody tap before the epidural was finally inserted at the fourth attempt.

In one case, none of the four attempts (two by a consultant) to replace the epidural worked. Later, when cae-
sarean delivery was necessary, several further attempts to obtain a neuraxial block took place until eventually a combined spinal-epidural was placed. The spinal component did not work but the epidural provided adequate anaesthesia for surgery.

Complications associated with insertion of the spinal catheter (Fig. 3)

In one case, a locum registrar anaesthetist did not attempt the spinal analgesia protocol and replaced the epidural. He also gave a prophylactic blood patch 21 h after delivery.

In one case, spinal analgesia worked normally for labour and for an attempted forceps delivery. The forceps failed. A consultant anaesthetist advised general anaesthetic for caesarean delivery.

One woman had severe labour pain and an initial attempt to insert an epidural failed. A single-shot spinal was given, and after the onset of analgesia the epidural was inserted. An ADP with the needle occurred. The catheter could not be passed into the CSF so the epidural was repeated once more, successfully. The effect of the test dose was normal and an epidural infusion was used uneventfully for labour. A test dose before an epidural top-up for caesarean delivery was normal but after 0.5% bupivacaine 20 mL with fentanyl 5 μg/mL had been given in increments, the woman began to have difficulty breathing and then became unconscious. She was intubated and ventilated and surgery commenced under general anaesthesia.