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Decreased incidence of headache after unintentional dural puncture in patients with cesarean delivery administered with postoperative epidural analgesia

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Abstract
Purpose. To investigate how subsequent placement of a catheter into the epidural space after unintentional dural puncture for postoperative analgesia for 36–72 h affected the incidence of post-dural puncture headache (PDPH).
Methods. The records of 52 parturients who had had accidental dural puncture in cesarean delivery were reviewed. The parturients were assigned to two groups. Twenty-eight parturients were assigned to the study group, in whom an epidural catheter was inserted and was used for anesthesia and postoperative analgesia. Twenty-four parturients were assigned to the control group, in whom spinal anesthesia ($n = 20$) or general anesthesia ($n = 4$) was applied. For postoperative analgesia in patients with incision pain above visual analog scale (VAS) 3, 3 mg morphine in 15 ml saline was administered through the epidural catheter in the study group, while intramuscular meperidine or tramadol was administered in the control group. Once PDPH was observed, conservative treatment was tried first. If the headache persisted despite conservative treatment, an epidural blood patch was applied through the catheter or a reinserted epidural needle.
Results. The study group demonstrated significant reduction of the incidence of PDPH and reduction in the indication for an epidural blood patch compared to the control group (7.1% vs 58% [$P = 0.000$] and 3.6% vs 37.5% [$P = 0.002$], respectively).
Conclusion. Subsequent catheter placement into the epidural space after unintentional dural puncture in cesarean delivery and leaving the catheter for postoperative analgesia for 36–72 h may reduce the incidence of PDPH.

Key words Cesarean delivery · Post-dural puncture headache · Epidural blood patch · Morphine

Introduction

The use of neuraxial (spinal, epidural, and combined spinal-epidural) anesthesia for cesarean delivery has been increasing over time because of little association with maternal mortality compared to general anesthesia [1]. However, the obstetric population is at high risk of unintentional dural puncture (DP)—varying from 2% when administered by novices or for difficult epidurals to less than 0.26% with good technique and supervision [2,3]—and subsequent post-dural puncture headache (PDPH), ranging from 50% to 80% [4–6], because of the influence of female sex, young adult age, and the widespread use of neuraxial analgesia and anesthesia for labor and cesarean delivery.

PDPH is not only a disabling and incapacitating condition, but it also has a potential for morbidity and important financial, social, and psychological repercussions [7]. So, PDPH remains a significant source of morbidity for patients, and the prevention and treatment of PDPH are always current issues. Therefore, many prophylactic measures and treatment techniques (including theophylline, caffeine, sumatriptan, epidural saline, epidural dextran, and epidural blood patches [EBPs]) to treat PDPH have been tried with variable success, but only the EBP has apparent benefits [7,8,14–17]. On the other hand, some uncommon disastrous complications have been reported to be associated with EBPs, including sagittal sinus thrombosis, subdural hematoma, and cauda equina syndrome [13–15].

Some studies [9–11] have demonstrated that subsequent catheter placement into the subarachnoid space through the dural puncture site after accidental dural puncture and leaving the catheter in place for more than 24 h, decreases the incidence of PDPH.

In this retrospective observational study, we aimed to investigate the incidence of PDPH following the placement of a catheter into the epidural space after inadvertent dural puncture with a large epidural needle and

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administration of local anesthetic and morphine in saline through the catheter for anesthesia and postoperative analgesia for 36–72 h.

Patients, materials, and methods

Following approval by the Ataturk University Hospital Ethics Committee, the records of 52 consecutive American Society of Anesthesiologists (ASA) physical status I-II parturients who had had accidental dural puncture during attempted epidural anesthesia for elective cesarean delivery at Ataturk University Hospital, from January 2001 to January 2006, were retrospectively reviewed. Patients with eclampsia-preeclampsia, history of migraine headache, or patients who required general anesthesia due to inadequate epidural block were excluded prior to data analysis.

After establishing monitoring and infusion of 10–15 $ml \cdot kg^{-1}$ Ringer's lactate intravenously, with the patients in the sitting position, lumbar epidural punctures were performed under aseptic conditions at the L3–4 or L4–5 interspaces, using a midline approach, with an 18-gauge Tuohy needle with its bevel oriented cephalad, and using the loss-of-resistance technique with 1–2 ml saline. Unintentional dural puncture was diagnosed by the free flow of cerebrospinal fluid through the needle. When a dural puncture was seen, either the anesthesia was converted to spinal anesthesia with subarachnoid injection through the needle, the needle was retrieved without any injection and general anesthesia was applied, or an epidural catheter was inserted from a different interspace and epidural anesthesia was applied. The parturients in whom an epidural catheter was inserted and used for anesthesia and postoperative analgesia were assigned to the study group. The others, in whom spinal anesthesia or general anesthesia were applied, were accepted as the control group. For spinal anesthesia, 2 ml of hyperbaric bupivacaine 0.5% (Marcaine Spinal Heavy; AstraZeneca, Sodertalje, Sweden) was administered. General anesthesia was induced by 1.5 $mg \cdot kg^{-1}$ propofol and 0.5 $mg \cdot kg^{-1}$ atracurium and maintained with inhalation of 1.5% sevoflurane in a mixture of 60% oxygen and 40% nitrous oxide. For epidural anesthesia, a 20-gauge multi-orifice epidural catheter (Minipack; Portex, Hythe, UK) was inserted 3–5 cm into the epidural space through the cranially directed tip of the epidural needle. After negative aspiration for blood or cerebrospinal fluid, 3 ml of 1.5% lidocaine with epinephrine 5 $\mu g \cdot ml^{-1}$ was injected through the catheter as a test dose. If no reaction was observed, 15–20 ml of 1.5% lidocaine with epinephrine 5 $\mu g \cdot ml^{-1}$ was injected in three divided doses. The catheter was left in place after operation for postoperative analgesia. For all patients, incisional pain and headache intensity were scored in the postoperative period according to a 100-point visual analog scale (VAS, 0, no pain and 100, the worst pain imaginable). When the incision pain was above VAS 30, 3 mg morphine in 15 ml saline was administered in the study group; intermittent intramuscular injection of meperidine or tramadol 1 $mg \cdot kg^{-1}$ was applied in the control group. Five to eight hours after the operation the parturients were allowed to stand and walk around the ward. All patients were discharged home 36–72 h after cesarean section and the epidural catheters were removed just before discharge. All patients were assessed twice per day until discharge for the development of symptoms of PDPH, and they were called by telephone 2 weeks later and asked about PDPH. If a bifrontal or occipital headache was throbbing and postural in nature, and exaggerated in the upright position and relieved in the supine position, it was accepted as PDPH. If PDPH was observed while the epidural catheter was in situ, saline 15 ml was injected through the catheter at the time of diagnosis and 6 h later. If the headache persisted despite saline injection, 15 ml autologous blood was injected through the epidural catheter. If PDPH was seen in parturients with no catheter, conservative treatments such as bed rest, intravenous fluid, oral drinks containing caffeine, and simple analgesics were tried first. If conservative treatments failed, an epidural blood patch was used.

The primary outcome was the incidence of PDPH. A *post*-hoc power analysis was performed with respect to the observed difference of 7.1%-58%, with the sample size of 28 and 24 in the groups. The power was calculated as 97.5% with a two-tailed ([alpha]) error of 5%.

Statistical analysis was performed using SPSS for Windows (version 10.0) statistical package (SPSS, Chicago, IL, USA). Statistical tests included Student's *t*-test, the χ^2 test, or Fisher's exact test in a 2×2 contingency table analysis, wherever appropriate. A P value of less than 0.05 was considered statistically significant.

Results

Accidental dural puncture was observed in 52 patients. In 28 parturients, a catheter was inserted into the epidural space through a different interspace and left in place for 36–72 h; these patients were accepted as the study group. The other 24 parturients (20 with spinal anesthesia and 4 who underwent general anesthesia) were accepted as the control group.

Demographic data of the parturients were similar; the data are displayed in Table 1. All cesarean deliveries were uneventful and the 1-min Apgar scores of the neonates were all above 8.

Table 1. Patient characteristics

	Study group (n = 28)	Control group (n = 24)
Age (years)	27 ± 6	28 ± 8
Height (cm)	163 ± 7	160 ± 9
Weight (kg)	74 ± 12	71 ± 14
Gestational age (weeks)	36 (range, 32–39)	37 (range, 32–40)

Data values are means ± SD or median

Table 2. Interventions and PDPH details

	Study group (n = 28)	Control group (n = 24)
Duration of epidural catheter placement (h), mean ± SD	44 ± 10	
Amount of epidural morphine (mg), mean ± SD	7.7 ± 3.2	
Number of postoperative epidural injections, median	3 (range, 1–4)	
PDPH incidence, number	2 (7.1%)*	14 (58%)
EBP indication, number	1 (3.6%)**	9 (37.5%)
Pruritus, number	12 (43%)*	0
Nausea-vomiting, number	9 (32%)	7 (29%)

$P < 0.05$ is statistically significant; * $P = 0.000$; ** $P = 0.002$
PDPH, Post-dural puncture headache; EBP, epidural blood patch

Interventions and PDPH details are shown in Table 2. In the study group, the mean duration of the epidural catheter remaining in situ was 44 ± 10 h. The mean dose of morphine administered through the epidural catheter was 7.7 ± 3.2 mg, and the median number of boluses was 3 (range, 1–4). While 26 parturients did not experience any headache after delivery, 2 parturients complained of PDPH. One of them started to complain of a mild headache (VAS, 50 in the upright position and 10 in the supine) 10 h after delivery, despite receiving 3 mg morphine in 15 ml of saline twice; just after the surgery and 18 h later. At 36 h after her surgery, her headache was successfully treated with a single injection of 15 ml of saline through the epidural catheter. Another parturient had a severe headache (VAS, 90 in the upright position and 20 in the supine) 16 h after dural puncture, despite receiving 3 mg morphine in 15 ml of saline three times; just after the surgery, and 18 and 32 h later. She did not respond to 15-ml saline injections (given twice) and conservative treatment. In this patient, an EBP was applied through the catheter 3 days after the dural puncture; an hour later, she was pain free. While no major respiratory depression and no sedation occurred, the most common adverse effects in the study group were pruritus 12/28 (43%) and nausea-vomiting 9/28 (32%).

In the control group, 14/24 (58%) parturients (12 who had spinal anesthesia and 2 who underwent general anesthesia) started to complain of PDPH 10 to 48 h after delivery. Their median VAS pain score was 70 (range, 60–90) in the upright position. With conservative treatments, 3 parturients' VAS scores were reduced below 30 in the upright position, but PDPH persisted in 9 parturients (i.e., EBP was indicated for 9 [37.5%]). While 2 of the 9 parturients rejected the EBP, it was applied to the other 7. All 7 parturients were pain-free 1 h later. The headache in the other 2 patients continued for 6–10 days. In the control group, the only adverse event was nausea-vomiting, in 7 of the 24 (29%). Five of the patients with nausea-vomiting were parturients with PDPH, and their nausea-vomiting was a symptom of the PDPH. Two-week follow-up of the all patients was uneventful. No parturient experienced PDPH.

Compared to the control group, the study group had significantly lower incidences of PDPH and indication for EBP (7.1% vs 58% [$P = 0.000$] and 3.6% vs 37.5% [$P = 0.002$], respectively), but the study group had a significantly higher incidence of pruritus (43% vs 0% [$P = 0.000$]). But the incidence of nausea-vomiting was similar.

Discussion

The incidence of PDPH is reported to range from 50% to as high as 85% in parturients after unintentional dural puncture with a large (16- to 18-gauge) epidural needle [4–6]. In the present study, subsequent placement of a catheter into the epidural space after inadvertent dural puncture with a large epidural needle and the administration of local anesthetic and morphine in saline through the catheter for anesthesia and postoperative analgesia for 36–72 h significantly reduced the incidence of PDPH and the indication for EBP compared to the control group.

In recent years, some studies [16–18] have demonstrated that subsequent catheter placement into the subarachnoid space through the dural puncture site after accidental dural puncture in obstetric patients, and leaving the catheter in place for more than 24 h, decreases the incidence of PDPH to less than 1%. But there are some concerns about prolonged subarachnoid catheter placement, especially related to the microcatheter used, which has been associated with cauda equina syndrome [19] and it has a potential for catastrophic errors if mishandled (i.e., accidental injection of an epidural dose of medication via the subarachnoid catheter) [20]. Also, another concern related to prolonged subarachnoid catheterization is infection. However, our practice, placing and leaving the epidural catheter in the epidural space after dural puncture, is safer than leaving the catheter in the subarachnoid space because of the potential risks related to an intrathecal catheter, such as cauda equina syndrome, mishandling, and infection. As an additional advantage, the leaving of the epidural catheter in situ, in case of necessity, makes it possible to administer an EBP through it without any additional procedure such as reidentification of the epidural space with an epidural needle.

The preemptive mechanism of leaving the epidural catheter in place in the prevention of the PDPH is not clear. But several mechanisms can be postulated. First, the injected solution for epidural anesthesia and analgesia may have a mass effect, resulting in thecal sac compression, thus compensating cerebrospinal fluid (CSF) pressure. But this mechanism only works for the duration of the saline infusion, because the elevation of the epidural/CSF occurs for a limited period of time after epidural saline is administered. Therefore it does not explain the reduction of the PDPH. Second, the injected solution and the catheter may promote an inflammatory process, facilitating closure of the dural defect. This effect would be expected to increase with the time of the catheter remaining in the epidural space and postoperative injections there. Third, it may be postulated that the compression effect of the injected volume on the dural defect may minimize the CSF leakage. Perhaps, "a tin-can-lid phenomenon", described by Dittman et al. [21], may be the most reasonable explanation: a hole formed in the dura with an epidural needle resembles the top of an almost completely opened tin can with the lid hinged at its base. The resulting flap (the lid of the tin can) is opened toward the epidural space due to the pressure gradient between the subarachnoid and epidural spaces, resulting in a delay in the sealing of the defect. However, the flap may fall back into place when the epidural pressure is elevated by the epidural injections. The maintenance of the catheter in place and the repeated injections into the epidural space during 36–72 h may have caused loss of the elasticity of the flap due to the inflammatory process, as mentioned above, so it is not pushed back toward the epidural space so easily. Finally, the low incidence of PDPH may be related to the use of neuraxial opioids for postoperative analgesia in all patients, as suggested in some studies [16,22,23]. In addition, because 90% of the headaches occur within 3 days of the dural puncture [24], leaving of the catheter in place for 3 days is logical for the possible indications of EBP.

Although we applied a prospective protocol, our study was a nonrandom, unblinded and retrospective assessment and it has all the limitations of retrospective studies. Strong clinical conclusions cannot be drawn from this study, and the results should be confirmed by large, prospective, blinded, and randomized studies. But there was a marked reduction in the incidence of PDPH in our series, and its power was calculated as 97.5% with a two-tailed ([alpha]) error of 5%. Because of their potential importance, the present findings could be considered as preliminary data at least.

There could be a concern related to the technique described here about the possibility of leakage of the epidurally administered local anesthetic and morphine through the dural hole into the subarachnoid space, resulting in high and profound spinal anesthesia or analgesia and related side effects. Indeed, this concern is particularly relevant for the combined spinal-epidural technique (CSE), because this technique includes an intentional dural puncture and a bolus epidural injection. There are anecdotal case reports and some studies supporting this concern [25,26]. As a matter of fact, some authors thought that the dural hole created during the CSE technique, without subarachnoid drug administration, might increase the subarachnoid transfer of epidurally administered drugs, thus improving the epidural analgesia. However, the clinical significance of these proposed effects during CSE labor analgesia has not been demonstrated [27–29]. Therefore, this concern seems theoretical more than clinical. All the same, the leakage of epidural drugs through a dural hole must be kept in mind, and perhaps it would be prudent in such a setting to decrease the dose (e.g., by approximately 25%) and be careful to give that dose incrementally, avoiding any injection pressure.

In conclusion, subsequent placement of a catheter into the epidural space after inadvertent dural puncture with a large epidural needle and the administration of local anesthetic and morphine in saline through the catheter for anesthesia and postoperative analgesia for 36–72 h reduced the incidence of PDPH. Furthermore, leaving the catheter in the epidural space made it possible to apply an EBP if PDPH developed.

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