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Research Article

Sequential higher epidural catheter re-insertion after accidental dural puncture ameliorates the frequency and severity of post-dural puncture headache

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KEYWORDS

Epidural;
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Abstract *Objectives:* This cohort study aimed to evaluate the outcome of a hypothesis to use higher level for epidural catheter insertion and activation when an epidural tap was encountered at a lower level during epidural analgesia for labor pain.
Methods: Epidural analgesia for labor pain was conducted using a mixture of 0.125% bupivacaine and fentanyl 5 μg/ml (10–15 ml) in 5-ml increments and maintained using continuous epidural infusion of 0.125% bupivacaine and fentanyl 2 μg/ml at rate of (5–15 ml/h), subsequently adjusted according to the patients needs. All cases had accidental dural puncture (ADP) were managed immediately with re-insertion of the needle at a higher level and completion of the procedure and maintained using continuous epidural infusion of 0.0625% bupivacaine and fentanyl 2 μg/ml at rate of (6–12 ml/h) for 24 h after delivery. Postpartum follow-up was conducted for 30 days to comment on the occurrence and severity of post-dural puncture headache (PDPH). All patients developed PDPH were followed daily until resolution of their headache.
Results: About 4800 parturient were enrolled in the study, ADP occurred in 24 patients with a frequency of 0.5%. All cases were immediately managed by re-insertion of the needle at a higher level and the procedure was successfully completed without new dural puncture, with 100% re-insertion success rate, and patients were maintained on continuous epidural infusion for 24 h. Throughout 30-day follow-up; only six of 24 patients developed PDPH with a success rate of re-insertion

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procedure as a prophylactic modality for PDPH after ADP of 75%. PDPH was relieved with bed rest, liberal fluids and paracetamol for 4 days in four patients, while the 5th patient continued to complain but the patient refused to undergo epidural blood patch (EBP) and headache started to subside and patient stopped to complain by the 10th day, and the last patient agreed to undergo EBP; and headache was relived immediately after 2 h.

Conclusion: It could be concluded that re-insertion of epidural catheter at higher level of accidental dural puncture with epidural continuous infusion for 24 h could be considered as an efficient prophylactic modality to safe guard against PDPH with success rate of 75% and minimizes its severity if occurred.

1. Introduction

In the last two decades, changes have occurred in the obstetric patients' expectations and their care. In developed countries, the number of women requesting labor neuroaxial analgesia is increasing and in some communities, an effective pain relief for childbirth is in great demand [1]. Approximately 20% of women in United Kingdom [2] and almost 60% in the United States of America receive epidural for childbirth every year [3].

There was discrepancy among scientific options regarding advantages and disadvantages and complications of epidural labor analgesia; increased need for instrumental delivery and higher number of cesarean sections was one of the important obstacles for increased applicability of epidural labor analgesia; however, Hess et al. [4] and Main et al. [5] documented that patients' factors as having mal-positioned fetuses, slow rate of labor progression, earlier severe labor pain, aged pregnancies and/or pregnancy related diseases and not neuroaxial analgesia per se are the most likely causative factors of operative deliveries. Moreover, Leighton and Halpern [6] showed that epidural analgesia did not affect the incidence of instrumental vaginal delivery for dystocia and Marucci et al. [7] conducted a meta-analysis that demonstrated no effect of early epidural analgesia on $<$4–5 cm dilated cervix on the frequency of operative vaginal delivery.

Post-dural puncture headache (PDPH) can be seen after any trauma to the dura. This may include spinal or epidural anesthesia, spine surgery, diagnostic lumbar puncture, or myelography. Ninety-nine percent of PDPH patients present symptoms within 3 days of dural puncture. Symptoms are described as frontal and occipital headache worsened with assuming the upright position and improved with lying down. Other symptoms include neck and shoulder pain, nausea, vomiting, hearing loss, cranial nerve deficits, and dizziness. Postural features remain the key diagnostic feature of PDPH [8].

Two prevailing hypotheses attempt to explain why PDPH occurs. First, it is known that dural trauma leads to cerebrospinal fluid (CSF) leak and decreased CSF volume, causing intracranial hypotension. Lowered CSF pressure causes traction on intracranial structures. These structures are pain sensitive and become stretched when assuming the upright position leading to pain. Second, intracranial volume is constant and equal to the sum of CSF, intracranial blood and brain matter. A compensatory increase in venodilation is seen after a loss in CSF volume. Some speculate that this venodilation causes pain [9].

The treatment of PDPH begins with simple conservative measures since most headaches will resolve without intervention. A number of simple therapies are used to alleviate symptoms. They include lying in a comfortable position, rehydration, caffeine intake, oral analgesics, and caffeine sodium benzoate 500 mg intravenously. Further intervention requiring epidural blood patch (EBP) is seen in a subset of patients. Epidural blood patch is a safe and effective treatment of PDPH [10]. The success rate is 92% following acute lumbar puncture. It is believed that the introduction of blood into the epidural space immediately increases the intrathecal pressure, and also forms a clot occluding the CSF leak. Patients may complain of immediate back pain, neckache, and radicular pain that are usually short-lived. Radicular pain is likely due to nerve root compression from lateral spread of blood within the epidural space [11].

Despite the success of the epidural blood patch, it is not free of complications and failures; Ho and Gan [12] reported a case of persistent PDPH in a patient despite two EBP but using a "directed" CT-guided blood patch was then performed successfully with resolution of the headache. Also, Eede et al. [13] reported a parturient complaining of headache after spinal and epidural labor analgesia with neurological deterioration following an epidural blood patch.

Post-dural puncture headache is a debilitating result of dural puncture and cerebrospinal fluid leakage and badly impacts quality of life; and despite numerous in vitro and in vivo studies that have identified predictors associated with PDPH, debate continues on the best technique to reduce CSF leak after dural puncture [14]. A survey form was sent to each practicing USA member of the American Society of Regional Anesthesia and Pain Medicine. Major findings were as follows: the preferred method of immediately dealing with an unintentional dural puncture (UDP) when providing analgesia for labor is to reattempt the epidural at another level (73.4%); various measures, many poorly supported by the literature, are used prophylactically after UDP but remains largely nonstandardized [15]. Thus, the present study was designed to evaluate the outcome of a hypothesis to use higher level for epidural catheter insertion and activation when an epidural tap was encountered at a lower level during epidural analgesia for labor pain.

2. Methods

After obtaining study protocol approval from the Local Ethics Committee and written informed patients' consents, all consented healthy ASA I–II laboring parturient with $\leqslant$6 cm dilatation attending Obstetric Department in the last five years, were recruited to participate in the study. Patients had contraindication to regional anesthesia; pregnancy-induced hypertension or significant maternal or fetal illness, morbid obesity were excluded off the study.

Under aseptic technique, with the patient in the lateral decubitus position an 18-gauge Tuohy epidural needle was inserted in the posterior midline at the level of L3–4 or L4–5 interspace; the lumbar epidural space was identified by means of a loss-of-resistance technique. An 18-G epidural catheter was threaded from 3 to 5 cm into the epidural space in all patients through the Tuohy needle. After a test dose of 3 ml of 2% lidocaine with epinephrine 1:200,000, with repeated aspiration, guided by the sensory effect, was given to exclude intravascular or intrathecal injection, the catheter was fixed and the patient was repositioned supine. Epidural analgesia was established using a mixture of 0.125% bupivacaine and fentanyl 5 μg/ml (10–15 ml) in 5-ml increments and maintained using continuous epidural infusion of 0.125% bupivacaine and fentanyl 2 μg/ml at rate of 10 ml/h, subsequently adjusted according to the patients needs (range 5–15 ml/h).

All cases of failure of block initiation defined as failure of either needle or catheter placement, or failure of the block itself within the first 30 min of drug administration via the catheter were excluded off the study. Cases developed any complications without concomitant epidural wet tap were also excluded off the study so as to define the frequency of the occurrence of accidental dural puncture (ADP) as a complication either occurred in combination with other complications or as the sole one. All cases had ADP were managed immediately with re-insertion of the needle at an upper level and completion of the procedure and maintained using continuous epidural infusion of 0.0625% bupivacaine and fentanyl 2 μg/ml at rate of 6–12 ml/h. for 24 h after delivery.

Postpartum follow-up was conducted indirectly throughout a period of 30 days to comment on the occurrence and severity of PDPH. All patients developed PDPH were followed daily until resolution of their headache including headache severity evaluated using a visual analog scale (VAS), the 100-mm scale included 0 as an indication of "no pain at all", and 100 as an indication of "the worst possible pain", pain location (head only, neck only, both head and neck), associated symptoms (nausea and vomiting, double vision, photophobia, and phonophobia), use of analgesics, and treatment with epidural blood patch (EBP).

3. Results

After application of exclusion criteria; 4800 parturient were enrolled in this cohort study. Study participants had mean age of 26.6 ± 2.7; range: 24–31 years and mean body mass index of 32.8 ± 2.2; range: 28.6–35.7 kg/m^2, (Table 1).

Accidental dural puncture occurred in 24 of the enrolled patients with a frequency of 0.5%. All of the 24 patients were diagnosed at time of puncture and no case was missed. All cases were immediately managed by re-insertion of the needle at a higher level and the procedure was successfully completed without new dural puncture, with 100% re-insertion success rate, and maintained using continuous epidural infusion of 0.0625% bupivacaine and fentanyl 2 μg/ml at rate of 6–12 ml/h. for 24 h after delivery. Throughout 30-day follow-up of enrolled patients only six patients developed PDPH, while the other 16 patients did not develop PDPH, thus the re-insertion procedure and activation of epidural could be considered as a prophylactic modality for PDPH after ADP with success rate of 75% (Table 2).

Patients had PDPH reported the time of onset of symptoms at 2.3 ± 1; range: 1–3 days with a mean VAS pain severity score of 51 ± 18.9; range: 30–73. The PDPH was mainly occipital and associated with neck pain in only two patients; another two patients commented on having nausea but no vomiting was reported. No patient complained of photophobia, double vision or phonophobia (Table 3). The PDPH was relieved with liberal fluids and paracetamol for 4 days in four patients, while two patients continued to complain and epidural blood patch (EBP) was advocated; but one patient refused to undergo and preferred to continue conservatively; fortunately, headache started to subside and patient stopped to complain by the 10th day. And the second patient agreed to undergo EBP; and headache was relived immediately after 2 h.

Table 1 Baseline characteristics.

Character	Data
Age (years)	26.6 ± 2.7 (24–31)
Weight (kg)	86.2 ± 4.4 (75–91)
Height (cm)	162.1 ± 2.3 (158–166)
BMI (kg/m^2)	32.8 ± 2.2 (28.6–35.7)

Data were presented as mean ± SD, ranges are in parenthesis.

4. Discussion

Post-dural puncture headache (PDPH) also known as spinal (or post-spinal) headache still remains a disabling complication of needle insertion into the subarachnoid space. Pregnant women are at particular risk of dural puncture, and the subsequent headache, because of sex, young age, and the widespread application of regional anesthesia [16]. The current study aimed

Table 2 Procedure outcome.

Outcome	Data
No ADP	4776 (99.5%)
ADP	
Succeeded re-insertion	
PDPH	6 (0.125%)
No PDPH	18 (0.375%)
Total	24 (0.5%)
Failed re-insertion	0

Data were presented as numbers and percentages are in parenthesis.

Table 3 PDPH data.

Data	
Time of onset (days)	2.3 ± 1 (1–3)
VAS pain score	51 ± 18.9 (30–73)
Other symptoms	
Nausea	2 (8.3%)
Photophobia	0
Double vision	0
Phonophobia	0
Pain in the head	2 (8.3%)
Pain in the neck	0
Pain in the head and neck	2 (8.3%)

Data were presented as mean ± SD and numbers, ranges and percentages are in parenthesis.

to determine the frequency of PDPH in parturient accepted to receive labor pain management using epidural analgesia.

The study was constructed on survey screening-basis and included 4800 parturient consented to receive epidural analgesia and developed no complications or only accidental dural tap. Only 24 cases of ADP were recorded and no case was missed for a frequency of ADP of 0.5%. The reported figure for the frequency of ADP was in the range recently defined by Kuczkowski [16] who reviewed literatures concerning the accidental dural puncture as a complication of epidural anesthesia and reported that ADP varies in incidence from 0.19% to 4.4% and coincided with that reported by Rutter et al. [17] who analyzed the records of 15,030 labor epidural blocks and reported 72 ADP (0.479%) at the time of the procedure and by Angle et al. [18] who reported a frequency of ADP of 0.363%. However, the currently reported figure was superior to that reported by Douglas et al. [19] who found an overall incidence of post-dural puncture headache of 2.5% among the studied 1009 parturient and Pan et al. [20] reported that unintended dural puncture occurred in 1.2% of labor neuraxial analgesia.

Owing to the distressing nature of PDPH and its impact on quality of life; and despite the epidural blood patch is accepted as the treatment of choice for PDPH, randomized, controlled data is scarce [21]. Various studies tried to provide an urgent treatment for ADP so as to minimize the frequency and/or severity of PDPH and in turn minimize the need for epidural blood patch. Cohen et al. [22] examined the effects of prolonged ($>$24 h) intrathecal catheterization with the use of postoperative analgesia on the incidence of PDPH in 45 obstetric patients who had ADP following attempts at epidural block and reported that indwelling spinal catheterization for $>$24 h with continuous intrathecal analgesia following accidental dural puncture in parturient may for some patients be a suitable method for providing PDPH prophylaxis and postoperative analgesia. Also, Dennehy and Rosaeg [23] found immediate intrathecal insertion of the epidural catheter after accidental dural puncture during labor proved to be an effective prophylactic technique to prevent PDPH.

As another policy for immediate management of ADP, Charsley and Abram [24] investigated the effect of injection of 10 ml of normal saline into the subarachnoid space following ADP on the incidence of PDPH and the need for epidural blood patch and reported that among those patients who experienced ADP and received immediate saline injection through the epidural needle 32% developed a headache and only one patient required EBP.

Kuczkowski and Benumof [25] described seven cases complicated by an unintentional dural puncture during epidural anesthesia in parturients and were managed by (i) injection of the CSF in the glass syringe back into the subarachnoid space through the epidural needle, (ii) insertion of a epidural catheter into the subarachnoid space, (iii) injection of a small amount of preservative free saline (3–5 ml) into the subarachnoid space through the intrathecal catheter, (iv) administration of bolus and then continuous intrathecal labor analgesia through the intrathecal catheter and then (v) leaving the intrathecal catheter in situ for a total of 12–20 h. PDPH occurred in only one of these cases (14%).

The policy applied through the current study for immediate management of ADP included re-insertion of the epidural needle at an higher spinal level and administration of the epidural infusion for 24 h, such policy was successful in 18 patients (75%) who did not complain of PDPH and only six patients (25%) had PDPH that was mild and resolved with conservative treatment in four patients by the 4th day of treatment but moderate and continued till the 10th day in the 5th patients who refused to undergo epidural blood patch, and the last patient agreed to undergo EBP; and headache was relived immediately after 2 h. The used policy was advantageous compared to the previously stated policies [22,23,25] as regards the avoidance of intrathecal catheterization and subsequently the avoidance of maintenance of the intrathecal catheter for further 24 h. Also, the applied policy avoided the need for immediate injection of saline into the subarachnoid space [24] and provided nearly the same frequency of PDPH but with lesser severity and no need for epidural blood patch.

In support of the applied policy, Puolakka et al. [26] compared the outcome of double-segment technique inserting the epidural catheter one interspace higher than the level of the spinal puncture versus a single-segment needle-through-needle technique for combined spinal–epidural anesthesia and reported significantly higher block performance with lesser frequency and severity of PDPH after the double-segment technique. Also, Saitoh et al. [27] compared the usefulness of combined spinal epidural anesthesia (CSEA) in emergency cesarean section with conventional spinal anesthesia and reported significantly higher frequency of post-dural puncture headache in spinal group than in CSEA group. These findings spot light on the advantages of epidural catheter insertion after dural puncture for giving the spinal anesthesia for the minimization or prevention of PDPH.

The beneficial effects of the applied policy could be attributed to multiple factors; firstly, epidural continuous infusion for 24 h induced increased epidural pressure comparative to CSF pressure thus slowing the speed of CSF leakage through the dural hole and consequently minimized CSF loss with its worst sequale, PDPH and gives time for natural healing of epidural hole to occur. Secondly, the continuous epidural infusion of analgesia minimized pain sensation. Thirdly, the presence of catheter as foreign body in epidural space may initiates and activates the healing process. In support of such assumptions, the reported success rate of applied policy and the short-life minimal headache reported in six cases.

It could be concluded that re-insertion of epidural catheter at higher level after accidental dural puncture could be considered as an efficient prophylactic modality to safeguard against PDPH with success rate of 75% and minimizes its severity if occurred.

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