Effective Epidural Blood Patch Volumes for Postdural Puncture Headache in Taiwanese Women

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Background/Purpose: Epidural blood patch (EDBP) is the most commonly used method to treat postdural puncture headache (PDPH). The optimal or effective blood volume for epidural injection is still controversial and under debated. This study compared the therapeutic efficacy of 7.5 mL blood vs. 15 mL blood for EDBP via epidural catheter injection.

Methods: Thirty-three patients who suffered from severe PDPH due to accidental dural puncture during epidural anesthesia for cesarean section or epidural analgesia for labor pain control were randomly allocated into two groups. EDBP was conducted and autologous blood 7.5 mL or 15 mL was injected via an epidural catheter in the semi-sitting position in Group I (n = 17) and II (n = 16), respectively. For all patients in both groups, the severity of PDPH was registered on a 4-point scale (none, mild, moderate, severe) and assessed 1 hour, 24 hours and 3 days after EDBP.

Results: There was no significant difference between the two groups of patients at all time points with respect to the severity of PDPH. Two patients in Group I and nine in Group II developed nerve root irritating pain during blood injection (p < 0.05). No systemic complications were noted in both groups of patients throughout EDBP injection.

Conclusion: We conclude that injection of 7.5 mL autologous blood into the epidural space is comparable to 15 mL blood in its analgesic effect on PDPH, but with less nerve root irritating pain during injection.


Key Words: autologous blood, epidural blood patch, postdural puncture headache

Postdural puncture headache (PDPH) occurs in 10–40% of patients who undergo diagnostic or therapeutic lumbar puncture, spinal anesthesia, or experience accidental dural puncture during epidural anesthesia.1 The diagnosis of PDPH includes a history of dural puncture, characteristic orthostatic headache and ruling out other life-threatening diseases, such as intracranial hemorrhage or tumor. The headache is, typically, bilateral, frontal or retro-orbital, occipital and extending to the neck and may be throbbing or constant. The hallmark of the headache is orthostatic, aggravated by sitting or standing and relieved by lying down flat. It is frequently associated with neck, vestibular, cochlear, and ocular symptoms. These symptoms result from cerebrospinal fluid (CSF) leakage from the dura faster than its production, leading to decreased intracranial pressure, which

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provokes a shift of intracranial contents and traction on pain-sensitive structure in the upright position. Besides headache, the patient may complain of diplopia, tinnitus, dizziness, and myalgia. PDPH may occur immediately after spinal tap, but it usually occurs within 48 hours after the procedure in more than 90% of patients. PDPH is usually self-limited, lasting only for a few days and spontaneously resolves after consistent bed rest and aggressive hydration. But, if severe, it may last for several weeks or months. Such a prolonged incapacitating symptom is a physical and psychologic burden on patients and results in disability in daily activities.

Different prophylactic measures such as small needle size, the use of Sprotte’s needle, reinsertion of the stylet before withdrawing the needle, and direction of the bevel perpendicular to the dura, have all been shown to reduce the occurrence of PDPH.\textsuperscript{2–5} Despite the prophylactic measures, epidural blood patch (EDBP) for the treatment of PDPH was first introduced in 1960 by Gormley.\textsuperscript{6} He noticed that inadvertent bloody spinal taps were less often complicated by PDPH. He theorized that the epidural bleeding might lead to clot formation over the dural rent, preventing CSF leakage into the epidural space. He therefore continued to treat six subjects suffering from PDPH with EDBP, locating the epidural space with the hanging-drop or loss of resistance method. All six were relieved of their complaints. Since then, the injection of autologous blood into the epidural space has become the most accepted method for the treatment of PDPH, with high success rate and low incidence of complications.\textsuperscript{7–10} There are at least two possible mechanisms to explain the treatment effect of EDBP. The first is that autologous blood injected into the epidural space increases CSF pressure and, subsequently, prevents the traction of pain sensitive structure.\textsuperscript{11} The second is that the blood clot in the epidural space seals the dural puncture hole and prevents CSF leaking from the dural puncture hole. Its symptoms can be severe and incapacitating.

The optimal blood volume to be injected remains controversial. The recommended blood volumes range from 2–3 mL to 20 mL and tend to increase with time.\textsuperscript{6,7,9,12,13} Rarely, complications due to EDBP have been reported, but root irritating pain is a common problem during blood injection and associated with increased injection blood volume.\textsuperscript{14} In the West over the past decade, a blood volume of 15 mL has been highly recommended and is accepted as the optimal EDBP volume to treat PDPH. Considering the side effects and effectiveness of EDBP, is 15 mL also the optimal EDBP volume to treat PDPH in Taiwanese women? This study was thus designed to evaluate whether or not half the blood volume, 7.5 mL, for EDBP could provide almost the same effect to treat PDPH in Taiwanese women, but with a lower incidence of nerve root irritating pain compared with the conventional blood volume of 15 mL.

**Methods**

Between October 1998 and November 2005, 33 patients who suffered from intractable PDPH (conservative treatment had failed for at least 48 hours for those patients) in two medical centers (National Taiwan University Hospital, En-Chu-Kon Hospital) were included in this study. This prospective, randomized and observer-blind clinical trial study was approved by the both hospitals’ ethics committee. The randomization procedure was carried out by one of the investigators by choosing the sealed envelope. A trial with 20 patients in each treatment group would provide us with a power \((1 - \beta)\) of 80% to detect a relative reduction in number of patients with persisting PDPH after 24 hours of 50% and a power of 99% to detect a relative risk reduction of 80%. For those patients with PDPH after dural puncture, conservative treatment or EDBP injection to relieve PDPH was explained first and informed consent was obtained from all 33 patients suffering from severe PDPH before EDBP injection. Those patients were admitted for cesarean section under epidural anesthesia or for epidural labor analgesia. Most of those procedures were conducted by well-trained residents and some performed by attending doctors.
Accidental dural puncture by 16-gauge Tuohy needle during epidural insertion was detected in 74 patients during the 7 years (incidence of dural puncture by 16-gauge Tuohy needle during epidural insertion was about 0.58%, 74/12,800). For those 74 patients with dural puncture by 16-gauge Tuohy needle, 59 patients (59/74) complained of PDPH 24 hours after dural puncture. Conservative treatment with consistent bed rest, aggressive hydration (fluid intake at least 3 liters/day) and oral caffeine or other painkillers were prescribed for all 59 patients first; 26 patients with mild PDPH gradually recovered with 2 days of conservative treatment. For the remaining 33 patients with severe PDPH, 2-day conservative treatment failed and advanced EDBP treatment was recommended to relieve their severe PDPH. Patients with relative contraindications for lumbar puncture, such as hemorrhagic diathesis, space-occupying intracranial lesions or body temperature >38°C were excluded. All 33 patients were randomly allocated to receive 7.5 mL autologous blood (Group I, n = 17) or 15 mL autologous blood (Group II, n = 16) for EDBP.

Every EDBP procedure was conducted by experienced staff anesthesiologists. All participants were placed in the lateral decubitus position, sterilized and draped. Under strict aseptic technique, 16-gauge Tuohy needle was inserted into the epidural space, by loss of resistance technique with air at the previous dural puncture site or one intervertebral space below. Then, a 16-gauge epidural catheter was inserted 2–2.5 cm into the epidural space. Autologous venous blood was withdrawn by another assistant via antecubital vein by strict aseptic technique. We let every patient’s back up 30–45 degrees before autologous blood injection. Subsequently, 7.5 mL or 15 mL autologous blood was injected slowly into the epidural space. If the patient complained of a painful sensation over the back, buttocks, and legs, the injection speed was slowed down. If the patient could not tolerate the discomfort even under very slow injection speed, we stopped and recorded the total volume injected and documented the episode of painful sensation during PDPH. Finally, all patients were held in the supine position for at least 30 minutes, and then allowed to go back to normal activity.

The primary and secondary outcomes for all patients were evaluated and recorded. Follow-up visits and evaluations were carried out by a research nurse. The research nurse was kept blind to the treatment allocation. The primary outcome was to detect the presence and severity of headache before EDBP, 1 hour, 24 hours and 72 hours after EDBP. Average 10-cm visual analog scale (VAS) for PDPH at the same time period was also recorded simultaneously. Headache was classified on a 4-point scale (none, mild, moderate, severe). Mild headache was defined as: postural headache slightly restricting daily activities, the patient is not confined to bed and there are no associated symptoms. Moderate headache was defined as: postural headache confining the patient to bed for part of the day, and associated symptoms are not necessarily present. Severe headache was defined as: postural headache causing the patient to be bedridden for the entire day and associated symptoms are always present. The associated symptoms were: nausea, vomiting, dizziness, hearing loss, hyperacusis, tinnitus, photophobia, diplopia, stiffness of the neck and scapular pain. Secondary outcome measures were the presence of headache at day 3 after the start of EDBP. The rates of complete relief, incomplete relief and failure were recorded for all patients in both groups. Complete relief was defined as no headache at all. Incomplete relief was defined as mild recurrent PDPH after EDBP that could be tolerated, and a second EDBP with 7.5 mL or 15 mL blood would not be needed. Failure meant was defined as severe recurrent PDPH after EDBP, and a second or even third EDBP with 7.5 mL or 15 mL blood would be needed. Any systemic complications or side effects (especially nerve root irritating pain during EDBP injection) during or after EDBP injection were also recorded by one of the investigators. For each patient, age, body weight, height and time from dural puncture to EDBP treatment were also recorded.

Data are presented as mean ± standard deviation. The \( \chi^2 \) test was used to test associations.
among dichotomous parameters, and Yate’s correction was applied when necessary. Analysis of variance was used to compare continuous variables between groups and \( p < 0.05 \) was considered statistically significant.

**Results**

There were 17 patients in Group I and 16 patients in Group II, with no significant differences between groups with regard to age, height, body weight and time from dural puncture to EDBP treatment (Table 1). The immediate (1 hour after EDBP treatment) responses for all 33 patients were obvious and dramatic, with a sharp drop in average 10-cm VAS, which continued to decrease over the time points evaluated (Table 2). There were no significant differences between the two groups in 10-cm VAS values. The rates of different severity of PDPH (none, mild, moderate, severe) before EDBP and after EDBP are shown in Table 3. There were no significant differences between Groups I and II for the rates of different severity of PDPH at different time periods.

Only four patients in Group I (2 had recurrent headache within 24 hours, 2 within 72 hours) and three patients in Group II (2 had recurrent headache within 24 hours, 1 within 72 hours) had recurrent headache within 72 hours after EDBP. For those seven patients, only one patient in Group I and one patient in Group II requested and needed a second EDBP with 7.5 mL or 15 mL autologous blood. No patient in either group requested or needed a third EDBP. The rates of complete relief, incomplete relief and failure are

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<th>Table 1. Clinical characteristics of patients*</th>
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*Data are presented as mean ± standard deviation.

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*Data are presented as mean ± standard deviation. There were no significant differences between the two groups (\( \chi^2 \) test). EDBP = epidural blood patch.

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<th>Table 3. Rates of different severities of postdural puncture headache at different time periods in Group I (n = 17) and Group II (n = 16)</th>
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<td>Before EDBP</td>
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<td>Group I</td>
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<td>Severe, n (%)</td>
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EDBP = epidural blood patch.
shown in Table 4. There were no statistically significant differences between groups.

No special side effects or systemic complications occurred in any patient in the two groups during or after EDBP injection, except for two patients (11.8%) in Group I who complained of nerve root irritating pain during 7.5 mL blood injection for EDBP and nine patients (56.3%) in Group II during 15 mL blood injection for EDBP, with a statistically significant difference ($p < 0.05$) between groups (Table 4). Four patients (23.5%) in Group I and three (18.8%) in Group II suffered from low back pain (LBP) within 3 days of observation. Nevertheless, in all seven patients, LBP gradually subsided to complete relief after 3 days of hot pack treatment.

**Discussion**

Our study showed that EDBP had a complete relief rate of 76.5–81.3%. Two patients (one in Group I and one in Group II) needed a second EDBP. The complete relief rates between the two groups were not statistically different. This result showed that injecting 7.5 mL blood was as effective as 15 mL, and patients in Group I suffered less discomfort (incidence of nerve root irritating pain was much lower in Group I patients) during EDBP injection.

The mechanisms of EDBP to treat PDPH might be the mass effect of blood to increase CSF pressure and the sealing effect of blood clotting to reduce CSF loss. The first one may be associated with immediate effect to release headache and the latter may be associated with long-term effect. For the immediate effect, Kroin et al used an animal model to demonstrate the mechanism of intracranial pressure (ICP) modulation by EDBP. Their results showed that the mass effect of injected materials could rapidly increase CSF pressure and only whole blood or fibrin glue could sustain increased CSF pressure. They concluded that ICP modulation may be the key point of immediate effect of EDBP to release headache. For the long-term effect, Griffiths et al demonstrated the sequential appearance of EDBP from 30 minutes to 18 hours using magnetic resonance imaging (MRI). The main bulk of the epidural clot extended three to five spinal segments from the injection site, principally cephalad. According to these sequential MRI findings, the mass effect of blood clots gradually declined 7 hours after injecting and had almost returned to baseline levels by 18 hours. Most PDPH relapse within 24 hours after EDBP. The reason might be due to blood clot resolution or the continuous leakage of CSF from the puncture hole, inducing the disappearance of the tamponade effect.

Answers to two questions were still needed for further elucidation. The first one is, “How much blood is needed to conduct EDBP?” The blood volume should be able to provide enough tamponade effect and cover the puncture hole by sealing it. When Gormley first introduced this method in 1960, only 2–3 mL autologous blood was injected into the epidural space, with very good dramatic results. Since then, several similar studies have been reported and a higher failure rate was noted with blood volume < 10 mL. There was a tendency to use larger blood volumes to achieve higher success rates. Crawford reported a 96% success rate by using a blood volume of 20 mL.
Taiwainen et al compared different volumes (10–15 mL) and could not detect any advantage of larger volumes. Safa-Tisseront et al reported a 93% success rate with 20–25 mL. In our study, we performed EDBP by injecting blood through an epidural catheter with all patients in the semi-sitting position. The failure rates for EDBP pain relief using 7.5 mL or 15 mL were not significantly different. It was obvious that fewer patients in Group I (7.5 mL) suffered from nerve root irritating pain during blood injection for EDBP. We may speculate that nerve root irritating pain during EDBP is related to the volume of blood injection for EDBP, but the exact and definite causes need to be elucidated. Thus, we may conclude that conducting EDBP to treat PDPH, by slowly injecting 7.5 mL blood via an epidural catheter with the patient in the semi-sitting position, is as effective as a larger blood volume (15 mL), but with a lower incidence of side effects (nerve root irritating pain during EDBP injection).

The second question is, "How does the injected blood distribute?" Vakharia et al demonstrated the tamponade effect of blood patch by using MRI, and the mean spread of 20 mL blood for EDBP was 4.6 intervertebral spaces. Djurhuus et al used computed tomography-epidurography to show 7–14 segments of craniocaudal distribution of EDBP in the epidural space. Szeinfeld et al used technetium-99m-pyrophosphate mixed with whole blood to evaluate the volume and spread of blood injected into the epidural space. An average of 5–9 segments of distribution by injecting 15–20 mL whole blood seemed too much. In general practice, we usually choose the same level or one level below the previous puncture site to perform EDBP. This is based on the cephalad spread tendency and we hoped to cover or seal the dural puncture hole as near as possible. Only 2–3 segments of distribution is enough to cover the previous puncture site, and 5–9 segments is really not required. Thus, we let patients’ back up 30–45 degrees and slowly inject via an epidural catheter in order to have a relatively caudal spread of EDBP.

Furthermore, in our study, for different blood volumes in EDBP injection, we used an epidural catheter to inject blood instead of directly injecting blood with an epidural needle. The reasons for this are as follows. First, we could ensure that all the blood was injected into the epidural space and not into subcutaneous tissue. If we inject blood for EDBP with a 16-gauge Tuohy needle, there would be a higher probability of inducing hematomas outside the epidural space. Vakharia et al had demonstrated some hematomas in subcutaneous tissue by directly injecting blood with an epidural needle on post-EDBP MRI. Second, the smaller gauge epidural catheter theoretically has a lower flow rate of blood out of the catheter tip than the larger gauge epidural needle, with less caudal spread of EDBP expected. Third, the epidural catheter could help us to confirm the correct epidural space for blood patch injection. In this study, we particularly chose the semi-recumbent position for EDBP injection. The reason for this was we tried to elicit PDPH symptoms by positioning patients in the semi-recumbent position and then to assess if EDBP injection could relieve PDPH immediately.

From the results of our prospective, randomized and double-blind study, we conclude that the smaller blood volume of 7.5 mL for EDBP injection provides almost the same treatment efficacy for PDPH when compared with the larger blood volume of 15 mL, but with a much lower incidence of side effects or systemic complications, such as nerve root irritating pain, during EDBP injection in Taiwanese women with PDPH.

References


