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The Optimal Volume of Epidural Blood Patch in Treating Post-Dural Puncture Headache: a Mini-Review

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**Abstract**

Post-dural puncture headache is the major morbidity after intentional or unintentional dural puncture procedure, with CSF leakage and subsequent decrease intracranial pressure. An autologous epidural blood patch remains the most effective treatment and the option after failure of conservative treatment. The optimal blood volume of the epidural blood patch remains indeterminate, range from 5 to 30 mL. This mini-review aimed to review current evidence and literature of the blood volume injected into epidural space with the highest success rate, low repeated epidural blood patch procedure, and low complication rate.

**Keywords**: Epidural Blood Patch, Headache, Intracranial Hypotension, Cerebrospinal Fluid

**Introduction**

Dural puncture is a common procedure, intentionally or unintentionally, using a needle passing through the dura mater into subarachnoid space full-filled with CSF. The goals include diagnostic purpose as CSF analysis or therapeutic purpose, for example, spinal anesthesia or lumbar drainage before descending aortic surgery. Unintentional dural puncture is a potential complication of epidural anesthesia and analgesia. The subsequent leakage of CSF fluid sometimes causes post-dural puncture headache (PDPH)(Boonmak & Boonmak, 2010).

PDPH remains the major morbidity of dural puncture and increases the duration of hospitalization. The characteristic of PDPH includes postural in nature, worse on standing and relieving by lying flat. It usually occurred within 48 hours after dural puncture, and usually, resolves spontaneously within days. Differential diagnosis includes tension headache, migraine, caffeine withdrawal headache and furthermore, cerebral pathologies(Thew & Paech, 2008). However, symptoms may persist for days to weeks, causing disability and influence the daily activity. The associated symptoms include nausea, vomiting, hearing impairment and tinnitus.

**The pathogenesis, risk factor and the timing of epidural blood patch in PDPH**

The possible pathogenesis is thought to relate to dura defect, CSF leakage into epidural space, and the subsequent decrease intracranial pressure. As a result, downward traction of intracranial veins, meninges that are pain-sensitive as well as cranial nerves induces postural related headache (Boonmak & Boonmak, 2010). The theory supports the temporary hearing loss and PDPH after dural puncture (Candido & Stevens, 2003). Sudden drop of intracranial pressure may induce compensatory vasodilation of intracranial vessels, and the subsequent symptoms may similar to vascular headache (Kwak, 2017).

The obstetric population remains a high-risk group of unintentional dural puncture and PDPH because of the young age, gender and the widespread application of epidural anesthesia (Thew & Paech, 2008). In spinal anesthesia and diagnostic dural puncture, reducing the size of the spinal needle had a great impact on lowering the incidence of PDPH (Turnbull & Shepherd, 2003).

The dural puncture and the post-dural puncture headache are both common, an epidural blood patch is used for either prevention or treatment of refractory headache which is a poor response to conservative treatment. A therapeutic epidural blood patch is effective in treating severe PDPH and decrease the intensity of headache (Boonmak & Boonmak, 2010).

The epidural blood injection as the treatment of post-dural puncture headache was described with Gor mLey in 1960 (Crawford, 1980). The theory of the epidural blood patch is that, as the blood injected into the epidural space, will tamponade, clot then occluded the CSF leakage (Turnbull & Shepherd, 2003). The mass effect of the epidural blood patch is short-lived, as the clot degrades after hours of injection, leaving a mature clot over the dorsal part of theca sac. The rapid increase of subarachnoid pressure offers the immediate relief of headache after injection (Turnbull & Shepherd, 2003), but the long-term effect may relate to inflammatory response induced by blood in dura repair at the cellular level (Booth, Pan, Thomas, Harris, & D'Angelo, 2017). The complications of epidural blood patch are rare, including epidural infection, backache, nerve root irritation and lower limb paresthesia (Boonmak & Boonmak, 2010).

The technical aspect of the epidural blood patch remains a matter of debate, including the timing and the optimal blood volume. The USA anesthesiologists are relatively uniform in practice, most respondents usually wait at least 24 hours after symptom onset (Harrington & Schmitt, 2009), and some units only would consider epidural blood patch after the failure of conservative treatment.

The optimal blood volume of the epidural blood patch also remains indeterminate. We aim to review the literature and previous studies to estimate the blood volume of a high success rate, lesser needs of the repeated procedure and low complication rate.

**The optimal autologous blood volume of epidural blood patch for PDPH**

In 1980, Crawford et al. reported that injection of 6 to 15 mL of autologous blood into epidural space resulted in 70% of the recurrent rate, and 20 to 30 mL of blood is more likely to guarantee success, with success rate of 98% (Crawford, 1980). The prospective investigation in Finland, 1993, allocated the patient with severe PDPH into two groups, either 10 mL or 10-15 mL according to their height. The result showed there is no additional efficacy of the epidural blood volume more than 10 mL (Taivainen, Pitkanen, Tuominen, & Rosenberg, 1993). The following study revealed the average amount of blood spread per spinal segment was 1.6 mL. Thus, the blood volume required for successful epidural blood patch was 14.8 mL, range from 12 to 18 mL, with a mean longitudinal spread of 7 to 14 spinal segments seen in image study (Szeinfeld et al., 1986). Murphy et al. reported the volume of successful epidural blood patch in PDPH ranged from 5 to 25 mL, however, they still recommended to use 20 mL of volume if possible (Tubben, Jain, & Murphy, 2019). In patients with refractory PDPH after intrathecal drug delivery system (IDDS), a large retrospective cohort study also reported an effective epidural blood patch with a mean volume of 18.6 mL, with 80% of successful rate (Bendel et al., 2016).

Complications following autologous epidural blood patch include backache (35%), transient elevated temperature (5%), and neck ache (0.9%) (Candido & Stevens, 2003). The post-epidural blood patch back pain and radicular pain, possibly attribute to direct nerve root irritation or increased pressure of neuraxial canal, revealed no significance between groups of different injected blood volume (Paech, Doherty, Christmas, & Wong, 2011). Bleeding, infection, repeated dural puncture, unintentionally injection of blood into subarachnoid space induced arachnoiditis had been reported (Candido & Stevens, 2003). Long term complications of epidural blood patch are rare.

**The optimal autologous blood volume of epidural blood patch in obstetric population**

In obstetric patients who suffered from severe PDPH, Chen et al. investigate the analgesic efficacy of two groups. This randomized study compared the 7.5 mL of epidural blood volume with 15 mL. In these 33 Taiwanese women, the smaller blood volume of 7.5 mL shared almost the same efficacy with a larger volume group, and the 7.5 mL group reported fewer symptoms of nerve irritation (Chen et al., 2007). Effectiveness was reported in either 7.5 mL or 15 mL of blood were injected into epidural space in obstetric patients with PDPH (Thew & Paech, 2008). Later in 2011, a randomized and multicenter, blinded trial aimed to compare the three volumes of autologous epidural blood patch in 121 obstetric patients suffered from severe PDPH. Between the group of 15 mL, 20 mL and 30 mL, the incidence of partial or permanent relief of headache was 61%, 73%, and 67%. However, the incidence of permanent relief of headache was highest in the 20 mL group (Paech et al., 2011). In 2017, Booth JL et al. published the retrospective study of 466 epidural patches in 394 patients that mean volume of 20 mL may be adequate, as some patients felt uncomfortable and other neurologic symptoms as larger volume injected into epidural space. Increasing the volume to 30 mL did not reduce the rate of repeated epidural blood patch, as some patients could not tolerate 30 mL of volume (Booth et al., 2017). Injection of 15 to 20 mL of blood or until the patient reported back pain was performed in a large Spain prospective study in an obstetric population with PDPH, and the major morbidity of epidural blood patch was chronic low back pain (Martinez et al., 2018). These findings support the attempt of administration 20 mL of blood into epidural space to treat severe PDPH in obstetric patients.

**Conclusion**

Autologous epidural blood volume is effective in severe post-dural puncture headache. Smaller volume ranges from 7 to 15 mL resulted in a higher recurrence rate that may need a repeated injection. 20 mL of blood offers 98% of the success rate, and the complications rate between different volume groups showed no significant difference. Volume greater than 20 mL offers no additional advantage, and the patient may not tolerate the transient backache and nerve compression during the large-volume injection. In conclusion, the optimal volume of epidural blood patch is around 20 mL, within the range from a low success rate to a more confident outcome. The further prospective study enrolled more patients is needed to determine the precise blood volume in epidural blood patch in a patient with severe post-dural puncture headache.

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