Epidural blood patch is an iatrogenic epidural hematoma: asymptomatic or symptomatic? This is the question

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Epidural blood patch (EBP) conventionally refers to the injection of autologous blood into the epidural space with the intent to seal off a dural tear and to stop cerebrospinal fluid (CSF) leak. First introduced over half a century ago as a treatment for intractable postural puncture headache (PDPH),[1] indications of epidural patches have expanded over the years to include treatment of headaches associated with spontaneous intracranial hypotension (SIH) due to CSF leak.[2]

In *Regional Anesthesia & Pain Medicine*, Martin and colleagues[3] and similarly in another recent *Regional Anesthesia & Pain Medicine* article, Pagani-Estévez and colleagues[4] concur that larger EBP volumes are more effective in SIH.

Epidural injection of blood into the epidural space produces a mass effect, thus reducing the compliance of the epidural space and pressurizing the spinal compartment of the subarachnoid space causing CSF cephalad shift to the more rostral cranial compartment.[5]

This sustained mass effect has been revealed with MRI.[6] Epidural blood injection produced a focal hematoma mass around the injection site with compression of the thecal sac and nerve roots. Mass effect was present for the first few hours and clot resolution occurred by 7 hours, leaving a thick layer of mature clot over the dorsal part of the thecal sac.[6]

So, EPB is indeed an 'iatrogenic epidural hematoma'. It might not be just the blood volume injected but the reduced compliance of the epidural space or a combination of both that might lead to neurological symptoms.

VOLUME OF BLOOD TO BE INJECTED

Since first described in 1960 with, as little as, 2 mL of autologous blood,[1] the technique of EBP has evolved considerably. A decade later, the first case series of EBP with 10 mL of autologous blood was published reporting a success rate exceeding 90%.[7] It was not until 1980 that a relatively large volume of 20 mL was introduced.[8]

Generally, the volume varies depending on the indication, whether it is PDPH or SIH. For PDPH, the most widespread practice is 15–20 mL.[9] In fact, this practice has been supported by the EPB trial group findings of 20 mL of autologous blood to provide the most relief in the treatment of PDPH after unintentional dural puncture in obstetric patients.[10]

Conversely, consensus is lacking regarding optimal volume of EBP in SIH, as there are too many variables. In view of the uncertainty of the location of dural tears and CSF leak associated with SIH syndrome, injection of large volumes is becoming a common practice in this setting.

Watanabe and colleagues[11] reported the successful outcome of fluoroscopy-guided single EBP with 3–20 mL in 11 out of 13 patients with SIH with identified CSF leak. Others reported injection of 10 to 35 mL of blood for the first EBP, and larger volumes of up to 100 mL if the first one is unsuccessful, in an attempt to improve the efficacy of EBP in patients with indeterminate location of the CSF leak.[12]

In *Regional Anesthesia & Pain Medicine*, Martin and colleagues[3] reported the outcomes of 163 large-volume two-level EPBs in 94 patients with SIH. The mean volume for the first EBP was 45.3±23.2 (range 4–124 mL). The responder rate was 28.7% after the first EBP, improving to 41.5% and 46.8% after a second and third EBP, respectively. They had two patients who developed severe neurological complications. One patient developed transient bilateral paraplegia after receiving two EBPs with a total volume of 87 mL and another patient who developed arachnoiditis and cauda equine syndrome with incontinence after presumed intrathecal blood spread after accidental dural puncture.[3]

Pagani-Estévez and colleagues[4] in the previous issue of *Regional Anesthesia & Pain Medicine* reported a large cohort of 604 EBPs in 202 patients with SIH. The volume, number of spinal levels injected and site-directed strategies significantly correlated with greater likelihood of first EBP efficacy. However, EBP volume remained the only significant predictor of efficacy on multivariate analysis (OR 1.64; 95% CI 1.47 to 1.87; p<0.0001). The median volume of multilevel, bilevel and single-level patches were 90 (59–104) mL, 26.5 (20–30) mL and 19 (12–22) mL, respectively. They had only one patient who developed transient lower limb weakness after a large volume multilevel EBP.[4]

Mehta and colleagues[13] reported severe spinal sac compression after 20 mL of autologous blood was injected at L4–5 (15 mL interlaminar, 5 mL right transforaminal). The patient developed severe back pain and left lower extremity weakness with bowel and bladder incontinence. Lumbar spine MRI demonstrated mass effect at L4–5 from the epidural blood extending from L2 to S1, causing severe canal

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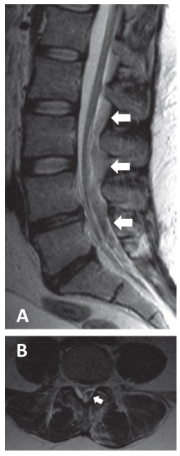

Figure 1 (A) MRI lumbar spine: sagittal view. There is a marked mass effect from epidural blood, with severe canal stenosis and complete effacement of the cerebrospinal fluid (CSF) at L4–5. (B) MRI lumbar spine: axial view. Blood is asymmetrically left sided, with mass effect on the thecal sac, causing complete effacement of the CSF and compromising the left L5 nerve root in the lateral recess (adapted from Yi *et al*[14] with permission).

stenosis at L4–5 (figure 1A–B). The patient underwent an emergent decompressive surgery with L3–L5 laminectomy and the evacuated blood clot was approximately the amount of blood injected during the EBP.[13]

Reviewing the literature on postoperative epidural hematoma will give us valuable insight about the EBP.[14–20] Most postoperative epidural hematomas after spine surgery are small and clinically insignificant epidural hematomas.[14 15] Asymptomatic small epidural hematoma has been identified in 33%–100% after lumbar spine surgery on CT and MRI studies. The incidence of symptomatic hematoma was reported to be in the range of 0.1%–0.24%.[14–17]

There is a big discrepancy between the incidence of symptomatic and asymptomatic postoperative epidural hematoma. Importantly, symptoms may develop within hours of the procedure or may be delayed.[18] This is akin to the behavior of EBP. What distinguishes those who would develop neurological symptoms after EBP from those who remain asymptomatic? Are there any factors that could forecast the development of neurological symptoms?

Epidural hematoma size and mass effect may correlate with varying degrees of symptom development; from back pain to paresthesia and radicular symptoms to neurological deficits.[17 18]

The mean hematoma volumes in asymptomatic patients, symptomatic patients with back pain and patients with cauda equina syndrome were 8.53 mL, 26.5 and 20.9 mL, respectively. Thecal sac compression in asymptomatic patients, symptomatic patients with back pain and cauda equina syndrome was 20%, 50% and 80%, respectively. Thecal sac compression was the only statistically significant measure and all patient with >75% compression developed cauda equine symptoms.[18] Hematoma volume alone may not be a sensitive enough factor for symptom development, rather it is the epidural compliance and the thecal sac compression.

It should be noted that this literature evaluated the development of postoperative epidural hematoma after decompressive spinal surgery. One could envision the effect of a large EBP in a patient with pre-existing spinal stenosis (very prevalent especially in old age). The spread of the injected blood would be restricted, thus leading to localized accumulation producing a confined mass effect.

The Framingham Study[21] showed the prevalence of acquired lumbar spinal stenosis (LSS) is 22.5% (relative LSS, sagittal diameter 10–12 mm) and 7.3% (absolute LSS, sagittal diameter <10 mm). The prevalence of symptomatic LSS is about 10%.[22] Lumbar MRI is the standard procedure for the diagnosis of stenosis and cauda equina compression with a 87%–96% sensitivity and 68%–75% specificity.[23] The plain radiographic image is only helpful for obvious stenosis, facet hypertrophy and spondylolisthesis.[24] Adhering to the Arnoldi classification of lumbar spinal stenosis,[25] one can classify EBP as an iatrogenic acquired lumbar spinal stenosis.

Absolute spinal stenosis is associated with a threefold higher risk of experiencing back pain.[21]Inflammatory reactions in patients with chronic back pain can result in the development of fibrinous membranes in the epidural space limiting spread of the injected blood with EBP.[26]

Likewise, previous surgical and epidural interventions (eg, EPB) may result in inflammatory changes that lead to connective tissue proliferation and adhesions between the dura mater and the ligamentum flavum.[27] Furthermore, previous surgical interventions may be an independent risk factor for the subsequent development of an epidural hematoma secondary to epidural scaring and reduced ability to absorb blood and blood products.[15 19]

Multilevel surgery is associated with increased risk of postoperative epidural hematoma formation.[19 20] It's a possibility that this may pertain to multilevel EBPs as well.

Age could be an influential factor in symptomatic EBP. Advanced age has been shown to be a risk factor for symptom development with epidural hematoma after spinal surgery, but no gender difference.[16 19] Moreover the prevalence of relative and absolute LSS increases from 16.0% to 38.8% and from 4.0% to 14.3% between age <40 years and 60+ years, respectively.[21]

The potential risk factors for developing neurological symptoms post-EBP are summarized in box 1.

WHERE TO INJECT?

Pagani-Estévez and colleagues[4] revealed that targeted EBPs directed at the site of leak were more effective than non-targeted 'empiric' patches (OR 8.35, 95% CI 0.97 to 72.1; p=0.033).

There are conflicting findings in the referenced two reports in regard to the common locations of CSF leaks. One cohort suggested increased CSF leak at the cervicothoracic area and the other one at the thoracolumbar area.[3 4] The caveat is that these two areas—specifically—may have an increased risk of symptomatic epidural hematoma. Analysis of 1010 spinal epidural hematoma cases revealed that the peak incidence occurred at C-6 (31%) and T-12 (22%).[20] The posterior epidural space measuring approximately 0.4 mm at C7–T1, and 4.1 mm at the T11–T12, while it is up to 7 mm in the upper thoracic and lumbar regions.[28]

Box 1 Potential risk factors for developing neurological symptoms post-epidural blood patch

- High volume.
- Age.
- h/o Back pain.
- Spinal stenosis.
- Previous spine interventions.
- Multilevel patches.

EBP side effects and other complications

Although EBP may be regarded as generally safe, the procedure is not without side effects, some of which may be deleterious. By far, backache is the most commonly reported side effect. Back pain has been reported to linger for a mean of 4 weeks (range 3–100 days) in as many as 16% of patients.[29] Chronic back pain was reported due to calcified EBP hematoma.[30]

Other reported complications include spinal subdural hematoma,[31] arachnoiditis,[32 33] epidural scaring,[34] radiculopathy,[35] permanent paraparesis and cauda equina syndrome,[36] epidural abscess and Gram-negative septicemia.[37] There is also one reported case of acute visual loss following EBP due to abrupt increase in subarachnoid pressure compromising retinal venous drainage and leading to retinal hemorrhage.[38]

CONCLUSION

Based on the Martin and colleagues'[3] article and the Pagani-Estévez and colleagues[4] articles in *Regional Anesthesia & Pain Medicine*, there is good support for higher volume EBPs in SIH cases. With attention to complication avoidance, one should consider the following recommendations to keep the iatrogenic hematoma within the safer range.

Recommendations for EBP in SIH

1. Preprocedure check list (box 2).
2. Confirm the diagnosis of SIH with contrast-enhanced brain MRI (pachymeningeal enhancement, brain sag, subdural hematoma or hygroma, pituitary engorgement or venous sinuses distension).[39]
3. Early precise diagnosis of CSF leak site with myelography, digital subtraction myelography, dynamic CT myelography, or positive-pressure myelography, to allow for targeted EBP instead of empiric one.[4] Although, radioisotope cisternography is a sensitive diagnostic test for confirming SIH, it is a relatively invasive test and it poorly marks the leak site.[40]
4. If the CSF leak site remains unidentified, then consider upper lumbar EBP first, and if unsuccessful, consider upper thoracic EBP in order to target the most common sites of CSF leak. It was estimated that 15 mL of blood preferentially spread for six segments cephalad and three segments caudad.[41]
5. EBP should be performed by an experienced physician with image guidance (fluoroscopy or CT/fluoroscopy) and administration of contrast agent to ensure a satisfactory epidurogram and to monitor the spread of the contrast and hence predict the spread of the injectate (blood patch).
6. EBP volume depends on the spread of the contrast/epidurogram and previous imaging. Limit the volume of the first EBP to <20 mL. The goal is not to solicit back pain as the limiting factor for further injection, rather avoid any pain during injection. Abort the procedure, once pain is elicited.
7. Larger volumes may be used if no other risk factors (box 1), if initial EBP was not helpful. Offer multilevel EBP, only after fastidious assessment and shared decision making.
8. Patient education about early neurological symptoms post-procedure which could indicate thecal sac compression.
9. Revisit the diagnosis and consider other differential diagnoses, before attempting repeated EBP.
10. Administration of EBP in the presence of cranial subdural hematoma, as is occasionally associated with SIH syndrome, can be perplexing. There are case reports of expansion of the subdural hematoma with brainstem herniation.[42] Persistence or recurrence of headache after EBP that has no postural element should alert the clinician to this rare yet potentially fatal outcome.

Box 2 Preprocedure checklist /preprocedural planning

- Review history: back pain, spinal problems, previous epidural injections or back surgeries.
- Review available spine images: r/o stenosis, epidural fibrosis/adhesions.
- Informed consent: including risks for symptomatic hematoma, spinal cord compression, back pain, radiculopathy, incontinence, infection, arachnoiditis, paralysis, seizures, increased headaches, cranial spinal subdural hematoma, blindness.
- Mark site of cerebrospinal fluid leak.
- Image-guided epidural blood patches: fluoroscopy or CT/fluoroscopy.

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