



Original Article

Lumbar epidural blood patch: An effective treatment for intracranial hypotension

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ABSTRACT

Background: The literature has demonstrated the efficacy of lumbar epidural blood patch (LEBP) in the management of spontaneous intracranial hypotension (SIH). However, the underlying pathophysiology of such management remains unclear. In this study, we aim to evaluate the utility of LEBP injections in the management of SIH and develop a potential management algorithm used in the triage and management of SIH patients.

Methods: We retrospectively examined the clinical case notes of 14 patients with SIH (age: 25–69 years) who were managed with LEBP injections during the year of 2016–2021. We evaluated the presenting symptoms of each selected patient and radiological findings as well as treatment outcomes. Our aim is to evaluate the effectiveness of LEBP in the treatment of SIH patients through follow-up clinical and imaging assessment.

Results: About 93% of patients describe the presence of headache at presentation, while 43% describe it as being of an orthostatic nature. All patients demonstrated typical findings on magnetic resonance imaging brain. Treatment success assessed through symptomatic improvement and radiological resolution was found in 85% of our patients at a 2-month interval.

Conclusion: LEBP injection is an effective method of management in patients with a diagnosis of SIH. It should be considered in all SIH patients irrespective of whether a “dural leak” can be localized through radiological investigations.

Keywords: Cerebrospinal fluid leakage, Epidural blood patch, Postural headache, Spontaneous intracranial hypotension

INTRODUCTION

Spontaneous intracranial hypotension (SIH) continues to pose a diagnostic and therapeutic challenge to practicing clinicians.^[2,20,31] Classically, SIH is presumed to originate from the leakage of cerebrospinal fluid (CSF) through a dural defect along the craniospinal axis.^[24] This may occur spontaneously, that is, due to rupture of Tarlov cysts, or may be precipitated by trauma^[3] and iatrogenic causes such as lumbar puncture.^[13,19] Recent etiological studies have also found that patients with connective tissue disease are at greater risk of developing SIH.^[8,29,32] Alternatively, the literature has suggested that the development of SIH may be associated with the presence of a negative pressure gradient of the inferior vena cava (IVC).^[11]

Clinically, the condition is primarily described as a postural headache,^[25] which worsens in an upright position after a few seconds, minutes, or even hours of the patient being upright. The

pain may be improved on resumption of a supine position, although an orthostatic component may not be found in all patients.^[2,28,30,34] In certain cases, the headache is associated with other clinical complaints such as nausea, vomiting, meningism, and cochlear-vestibular signs.^[25] Common cochlear-vestibular signs include vertigo, tinnitus, dizziness, sound distortion, hearing change, and hypoacusia.^[9,10] Rarer manifestations may include facial pain or numbness, weakness or facial spasm, dysgeusia, and transient diplopia associated with cranial nerve palsy.^[6] Unfortunately, the heterogeneity and nonspecific presentation of SIH often delays early identification and subsequent timely management of the patient.^[9]

Radiologically, pathognomonic magnetic resonance imaging (MRI) findings of the brain include venous engorgement, diffuse dural thickening, and intracranial pachymeningeal gadolinium enhancement, reactive hyperemia of the pituitary gland, subdural collections, and hematomas, and brain sagging.^[18] The finding of brain sagging includes a group of features, consisting of decreased dimensions of the suprasellar cistern, displacement of the suprasellar and perimesencephalic cistern, hindbrain herniation, and optic chiasma bowing.^[22] Commonly, MRI cisternography or myelography may also be included in the workup of suspected SIH patients.^[16] Reported abnormalities include extra-arachnoid fluid collections, pachymeningeal enhancement, and meningeal diverticula.^[22]

Current practice in the management of patients with SIH includes both conservative and surgical modalities. In general, patients are advised to begin with conservative methods, where many improve without any further intervention. Other methods of management include rest with Trendelenburg positioning, rehydration with oral and intravenous fluids, caffeine intake, and abdominal binder.^[2,23] In patients with persistent or progressive development of neurological symptoms, surgical drainage may be considered in those who develop subdural hematomas of >1 cm², decreased level of consciousness, and/or focal neurological deficits.^[4] Recently, the use of an epidural blood patch (EBP) in the treatment of SIH has also been gaining traction.^[1,7,12,21,27] The injection of 10–20 ml of autologous blood into the epidural space at the thoracolumbar level has proven successful in the treatment of SIH patients. At present, it is believed by many clinicians that the use of EBP aims to seal off any potential spinal leakages of CSF.^[15] Yet, the use of EBP appears to be successful in treating patients without any identifiable dural defect,^[11] posing queries toward the underlying pathophysiology of developing SIH.

Our retrospective study aims to examine the presenting symptoms of SIH and to validate the use of lumbar epidural blood patch (LEBP) in the treatment of SIH within a Chinese-based cohort.

MATERIALS AND METHODS

Patients

We retrospectively identified all patients who were given an EBP between January 2016 and December 2021 at the Prince of Wales Hospital, Hong Kong. All patients were aged above 18 years old and received a LEBP based on the suspicion of a diagnosis of SIH. Cases must have received a preinjection MRI brain. Obstetrics and gynecology patients who received spinal/epidural anesthesia and received LEBP injections as treatment for intracranial hypotension were excluded from the study. In total, 14 patients met the above inclusion criteria (six females, eight males, mean age: 46.5 years, range: 25–69 years). Cases were reviewed through the analysis of clinical notes, where details including radiological images, follow-up consultation notes as well as the effectiveness of treatment were subjectively evaluated. The study protocol was approved by the CUHK-PWH CREC (CREC No. 2021–527).

Radiological findings

MRI findings of the brain were considered positive when any of the following findings were identified within the radiological report: Subdural hygroma, enhancement of pachymeninges, engorged veins, pituitary hyperemia, and sagging of the brain. Classical MRI brain findings of SIH are shown in Figure 1. MRI myelogram findings, as shown in Figure 2, were considered positive if radiological reporting highlights feature of contrast-enhancement and thickened dura along the spinal canal.

Delivery of LEBP

The LEBP was delivered by a team of neurosurgeons and/or anesthetists, through a midline approach at the lumbar spine region (L2–L5). 20 ml of autologous blood was taken from the patient's arm and injected into the patient's spinal region, and patients were monitored postoperatively both through inpatient and outpatient care.

Treatment success

We aimed to measure the presence and degree of treatment success within our patients after LEBP injections. Treatment success was evaluated by two means, first the alleviation of symptoms defined as any symptomatic improvement noted at the first postinjection outpatient follow-up with the neurosurgical team and second through radiological resolution. Symptomatic improvement was reported as resolution (total cessation with no further episodes), moderate (partial cessation +/- minimal further episodes), and worsened (worsening of symptoms). Symptoms such as headache, orthostatic headache, nausea, vomiting, meningism, tinnitus, and dizziness were accounted for. Improvements in characteristic radiological features, that is, resolution of

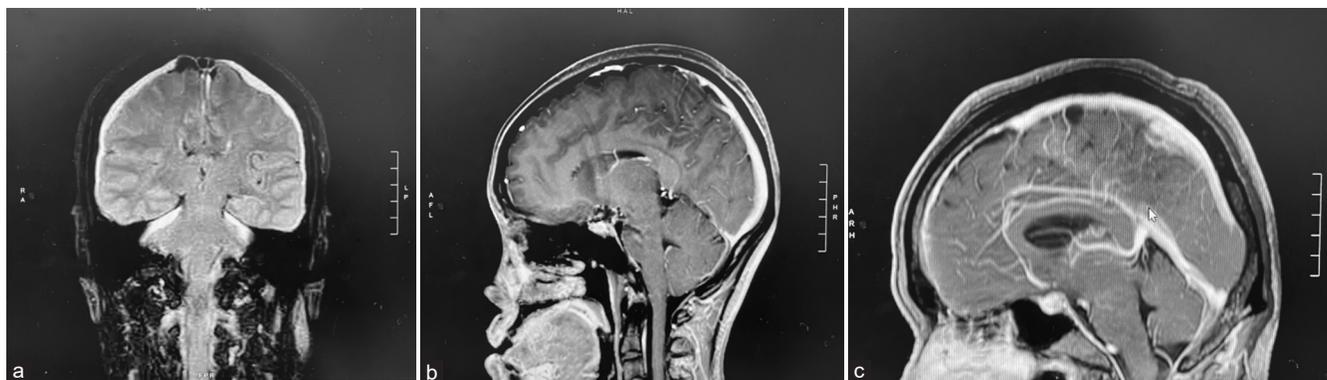


Figure 1: Classical MRI brain findings of spontaneous intracranial hypotension. (a) Enhancement of pachymeninges, (b) brain sagging, and (c) pituitary hyperemia.

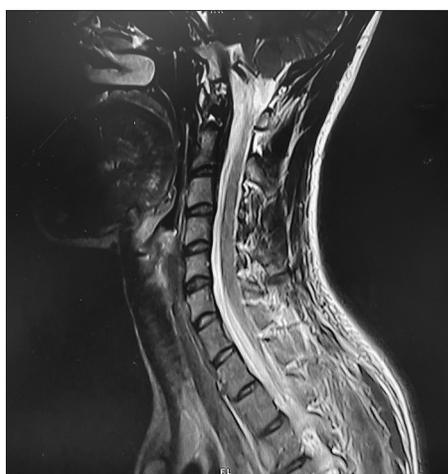


Figure 2: Classic MRI myelogram findings showing contrast-enhancement and thickened dura along the spinal canal.

subdural hygromas on CT or resolution of classic MRI findings were also recorded. All results obtained within a 2-month interval post-LEBP injection were taken into account of.

RESULTS

We first assessed the clinical manifestations of all patients who were diagnosed with SIH. About 43% of patients described the features of a postural headache, while 93% of patients mentioned the presence of a generalized headache. About 50% of patients reported symptoms of nausea and vomiting, 43% had dizziness or tinnitus, and 14% reported features of meningism [Figure 3]. All patients demonstrated typical MRI imaging findings of the brain, while only 7% of patients reported positive findings of SIH on MRI myelogram. None of our patients demonstrated an identifiable dural leak site. About 29% of patients recalled an episode of head trauma preceding the event. No patients recalled a history of connective tissue disease.

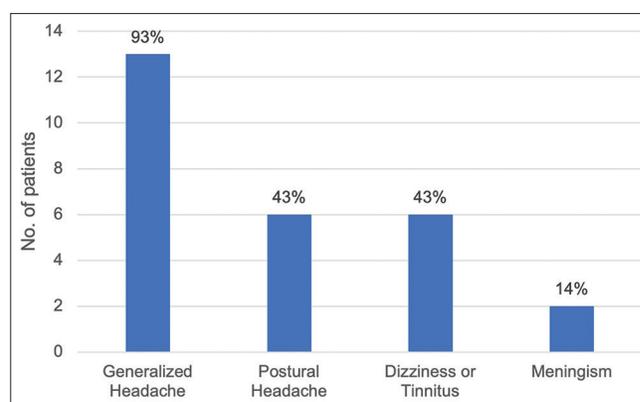


Figure 3: Chart illustrating symptomatology of lumbar epidural blood patch patients.

The mean admission duration to the hospital was 16 days, where 11 patients were admitted under the neurosurgery service and three patients under the medical service. All patients received one LEBP injection, with a median volume of 26 ml (range: 20–30ml). The LEBP injections were most often completed at the spinal levels of L3/L4 (50%), followed by L2/L3 (36%) and L4/L5 (14%). Five patients received burr hole drainages for their subdural hematomas, while one attempted aggressive intravenous fluid replacement for 2 weeks before further management. In terms of treatment response to LEBP, patients were seen for a follow-up duration of between 2 months and 2 years. Symptomatic improvement was achieved in 85% of our patients, with 64% demonstrating complete resolution of symptoms and 21% attaining moderate improvement in symptoms. About 15% complained of further worsening in symptoms [Figure 4]. Symptom relief mainly appeared within the 1st week post treatment. Among those patients whom achieved symptomatic improvement, all patients demonstrated resolution of radiological features, including resorption of subdural hygromas on CT and/or resolution of classical MRI features. In patients whom demonstrated worsening of symptoms during the follow-

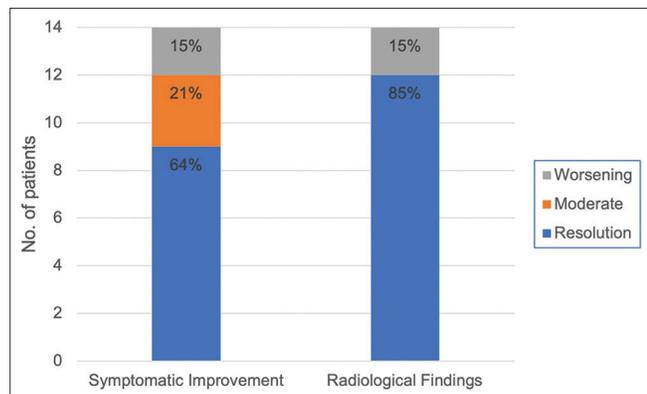


Figure 4: Chart illustrating post lumbar epidural blood patch treatment success through symptomatic improvement and radiological findings. Symptomatic improvement was reported as resolution (total cessation with no further episodes), moderate (partial cessation +/- minimal further episodes), and worsened (worsening of symptoms). Improvements in characteristic radiological features, that is, resolution of subdural hygromas on CT and/or resolution of classic MRI findings.

up period, all demonstrated deterioration of radiological features in first follow-up CT with subsequent improvement after further treatment [Figure 4].

DISCUSSION

In this retrospective study, we evaluated the use of LEBP in the management of patients with SIH, who were initially diagnosed with supporting clinical and radiological evidence. Existing literature recommends that all symptomatic SIH patients receive an EBP injection, with an existing efficacy rate ranging between 30 and 60%.^[17] Repeated EBPs have also been said to improve the efficacy rate of symptom resolution in existing literature.^[6,14,26]

Our results show that one LEBP injection led to the resolution of symptoms and radiological features within 85% of patients [Figure 4]. This corresponds with existing literature figures and indicates that LEBP injections are indeed suitable and advantageous for the treatment of patients with SIH within the local Chinese-based population.

Pathophysiology of SIH

Despite the poorly understood pathophysiology of SIH, two general schools of thought are found within the existing literature. Classically, clinicians believe that a spontaneous or traumatic dural leak and its associated CSF hypovolemia are responsible for the presentation of SIH. Yet, existing literature fails to explain why certain patients respond to LEBP treatment despite the lack of CSF leak. This has led to the development of an alternative hypothesis, suggesting that SIH is associated with the over drainage of venous blood from the epidural

spinal vein network of the brain.^[11] During the normal physiological venous return, the movement of large limb muscles and heart aspiration is known to generate negative pressure within the IVC. This results in the overdrainage of venous blood from the epidural spinal network through large lumbar collectors, altering the epidural gradient, and facilitating CSF aspiration into the epidural space and veins. Therefore, the mechanism of CSF hypotension is induced by a CSF aspiration and may explain why SIH can develop in the absence of neuroradiological evidence of CSF leak. We believe that our results support this alternative hypothesis, indicating that all patients, with or without a radiologically identifiable CSF leakage will benefit from the use of LEBP injections. In existing literature, the use of LEBP primarily focuses on patients with an identifiable dural leak. As reflected among our patient population, none of our SIH patients were found to have a radiologically identifiable dural leak, hinting on a potentially dated hypothesis. The adopting of the alternative hypothesis will widen the patient population whom are enabled to receive such treatment.

Dangers of a targeted EBP

In patients with an identifiable dural leak on MRI myelogram, studies have indicated that a targeted EBP was more advantageous in improving patient outcome relative to a blind EBP.^[5] However, one major downside of a targeted EBP is the procedural-related risk of EBP injections, especially when the dural leak is located within the cervical and thoracic regions of the spine.^[33] Due to the anatomical location of the spinal cord and branching spinal nerve roots at these levels, the risk of injuring nearby structures during a target EBP may be higher. In contrast, our approach with a below-conus LEBP avoids the risk of damaging spinal neural structures and demonstrates similar efficacy to targeted EBPs.

Proposed management algorithm

Characteristically, the presence of a generalized headache with a postural component raises our clinical suspicion for a potential case of SIH. Within our cohort, 90% of patients described the presence of a generalized headache, though only 43% of patients mentioned a postural or orthostatic component to the headache. Other suggestive features include tinnitus and/or dizziness, nausea, and/or vomiting. About 23% of patients also recalled some form of head trauma before the event. Very often, this indicates that clinical features may not be particularly sensitive for the detection of SIH. However, we found that an MRI brain was crucial for the diagnosis of SIH. Typical radiological features of SIH were seen in all of our patients, indicating that radiological evidence may indeed be the most reliable method of diagnosis for SIH. MRI myelogram can be considered when needed and available, although the added information may not necessarily

benefit the management outcome of patients. In all patients diagnosed with SIH, we recommend the first LEBP injection between the levels of L2–L5, with target sites aimed past the conus medullaris. Directed by either the neurosurgical or anesthetic team, 20–30 ml of autologous blood will be inserted into the epidural space, or until the patient complains of a headache. In patients with evidence of an identifiable CSF leak on radiological investigations, a targeted EBP may be considered as a second-line treatment. The previous literature has supported the evidence of targeted EBP injections, although not without its own risk. Postoperatively, the duration and frequency of follow-up will depend on the initial treatment response, and further investigation and treatment may be warranted in those who fail to respond to a LEBP. The proposed algorithm is summarized in Figure 5.

Examining treatment failures in LEBP

Despite the success of LEBP injections in the symptomatic improvement of patients, 15% of our sampled population also demonstrated worsening of symptoms. Interestingly, both patients were found to receive an LEBP injection after first burr hole drainage of their chronic subdural hematomas. Both patients were also found to develop worsening signs and symptoms, along with radiological progression of their chronic subdural hematomas on follow-up imaging. Repeated burr hole drainages were then completed, with long-term

follow-ups demonstrating improvement in clinical condition. Both patients were found to demonstrate deterioration of condition within a 2-month follow-up period. This reinforces the importance of long-term follow-up after administration of LEBP, through both in-person clinical evaluation as well as collection of radiological evidence.

CONCLUSION

We believe that LEBP is indeed a successful and effective way of managing patients who have a suspected diagnosis of SIH. Our results support that LEBP is an integral part in the reversal of epidural hypotension, allowing for a change in CSF-hematic gradient, and therefore improvement in the condition of SIH. Therefore, we believe that the recipients of LEBP should not be limited to those who have an identifiable dural leak as other existing literature may indicate.

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Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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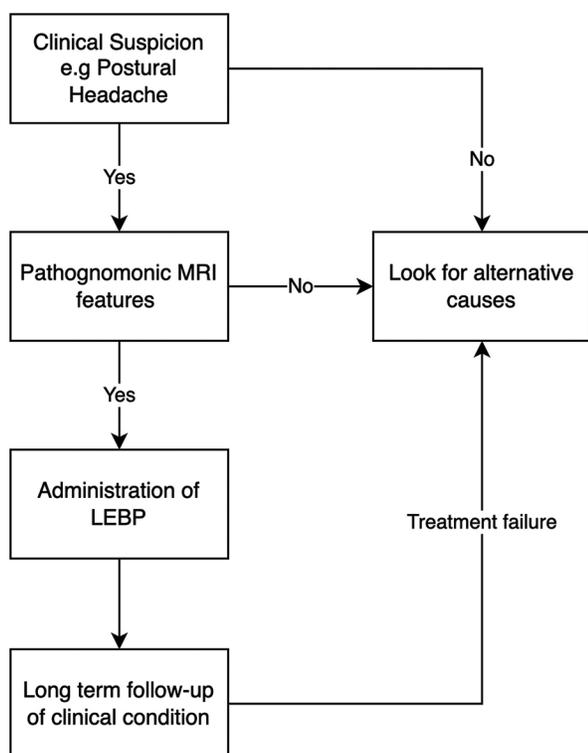


Figure 5: Diagnostic and management flowchart for spontaneous intracranial hypotension.

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