CASE REPORT

Lumbar blood patching for proximal CSF leaks: where does the blood go?

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SUMMARY

Epidural blood patching (EBP) is an important therapeutic approach in managing spontaneous cerebrospinal fluid leaks. The mechanism of action of blood patching is likely to be twofold; fluid replacement having an immediate tamponade effect and the proximal flow of blood products having a 'plug' effect. The negative pressure gradient within the epidural space may be important to the rostral flow of injected blood and is possibly increased in intracranial hypotension.

BACKGROUND

Spontaneous cerebrospinal fluid (CSF) leaks are not uncommon and are associated with intracranial hypotension and postural headaches. Although a number of therapeutic approaches exist, first-line treatment generally consists of epidural blood patching (EBP) in the lumbar area, even in the setting of more proximal CSF leaks. We report a case of a cervical fluid leak being successfully managed with lumbar blood patching with follow-up imaging confirming that the blood ascended proximally within the epidural space. This case supports a twofold hypothesis: that the therapeutic response from lumbar blood patching initially results from a tamponade effect leading to immediate symptom relief and subsequently blood products ascending and forming a localised clot. The negative pressure gradient that exists within the epidural space may be essential to the rostral flow of injected blood products and this gradient is possibly augmented in the setting of intracranial hypotension.

CASE PRESENTATION

We present the case of a 41-year-old woman with a 12-month history of increasingly severe postural pressure headaches associated with neck stiffness. Her headaches significantly worsened on standing from recumbence and with prolonged standing, gaining relief on lying flat. The patient also had monthly attacks of severe headaches associated with 'blurred' vision, nausea and vomiting and episodes of intermittent syncope associated with the pain. Treatment for migraines over the preceding 12 months with sandimigran and simple analgesia was ineffective.

The patient had a history of two motor vehicle accidents; one at age 18 associated with a head injury requiring cognitive rehabilitation with good functional outcomes, and a second accident at age 23 also with full resolution.

INVESTIGATIONS

CT and MRI of the brain and spine at presentation demonstrated features of intracranial hypotension. These included pachymeningeal thickening and enhancement, intracranial venous engorgement and sagging of intracranial structures. MRI of the spine revealed epidural venous engorgement, consistent with hypotension, and an epidural CSF intensity fluid collection continuous over four spinal segments; the exact site of CSF leakage was not seen but presumed to be within the level of the fluid collection in the cervical spine (figure 1A, B).

TREATMENT

A 25 mL EBP was performed in the lumbar region with the patient in a sitting position, together with conservative measures including a period of strict bed rest for days with increased hydration and caffeine intake.

OUTCOME AND FOLLOW-UP

The patient reported an immediate symptomatic improvement following blood patching with a reduction in headaches. Ten days following treatment with a lumbar EBP, imaging of the brain and spine was performed including a gradient recalled echo study sensitive to the presence of paramagnetic blood products. The study revealed layering of T2 hypointense material within the anterior cervical epidural fluid collection, new since the pretreatment study (figure 1C–F). This new finding could be accounted for by the presence of blood products, either deoxyhaemoglobin or intracellular methaemoglobin, in the cervical epidural space. Since the injection was lumbar, it follows that this blood must have diffused superiorly within the epidural space.

DISCUSSION

EBP has been employed over the past five decades in the treatment of postdural puncture headache (PDPH) and spontaneous CSF leaks. EBP in the lumbar region is generally considered first line because of the lower risk of complications compared to more proximal injections. Many patients require repeat procedures to obtain a sustained therapeutic effect, especially in the setting of spontaneous leaks which are generally more complex and anterior than simple tears and holes.

EBP therapeutics may involve a two stage process. The 'pressure patch' hypothesis emphasises the impact of injected blood on the pressure dynamics of the central nervous system. The injected fluid transiently (for around 10 min) increases epidural pressure which, in turn,

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Figure 1 (A and B) MRI of the spine revealing an epidural CSF intensity fluid collection at the cervical spine, with epidural venous engorgement and descent 'sagging' of the cranial structures consistent with intracranial. (C–F) MRI 10 days postepidural blood patch with layering of new T2 hypointense material (indicated by the red arrows) within the anterior cervical epidural fluid collection indicating the presence of blood products not previously detected. (C) (MRI T1 sagittal) (D) (MRI T2 sagittal) (E) (MRI T2 axial) (F) (MRI gradient recalled echo sagittal).

compresses the dura, elevating subarachnoid CSF pressure.¹ While this explains why the pain relief from an EBP is often immediate, as in the current case, it does not explain why benefit should then be sustained. The 'plug' theory for symptom resolution proposes that the blood injected during EBP forms a fibrin plug, sealing the dural hole and preventing further CSF leak. In the absence of continued loss, regeneration of CSF restores CSF pressure and alleviates the headache.² The current case illustrates blood products ascending and remaining at the presumed leakage site 10 days postprocedure. However, if epidural blood patching worked only by plugging the dural leak, one would expect that the CSF deficit would take a longer time to be replenished and symptom relief would not be immediate.

Su *et al*³ reported a case series where two spontaneous CSF leaks were treated by EBP in the lumbar area; with spinal MRI performed 1 h later revealing that most of the injected blood had spread rostrally. Ferrante *et al*⁴ looked at a large case series where EBP was performed with trendelenberg positioning and acetazolamide to assist the rostral spread of blood. This series confirmed with imaging that the epidural blood was able to ascend proximally. Beard *et al*⁵ demonstrated that the mean spread of the blood patch in the epidural space was 4.6 ± 0.9 intervertebral levels, with most of the blood moving in the cephalic direction.

Why blood should preferentially travel towards the head is unclear, however, it is well documented that irrespective of the original opening pressure there is a negative pressure gradient within the epidural space. Visser *et al*⁶ confirmed the pressure gradient in the epidural space by recording the pressure at different levels, finding lower pressures at higher spinal segments. Usubiaca⁷ also documented this negative pressure gradient by recording simultaneous epidural punctures at different spinal levels, again with lower pressures proximally.

Intracranial hypotension causes 'sagging' of the brain and increased weight on pain sensitive structures including dura, meninges and venous systems, enhanced further by being upright, giving rise to orthostatic headaches. Intracranial hypotension causes secondary central venous dilation and could increase the negative pressure gradient within the epidural space. The epidural space gets narrower proximally. In the average adult the posterior space is 0.4 mm at the upper thoracic/lower cervical region and 4–7 mm in the lumbar region.⁸ In the current case, the epidural space at C7 level was 0.9 mm on the initial MRI scan and then too small to accurately measure on the 12-month follow-up imaging. The reduction in diameter of the epidural space following correction of intracranial hypotension is consistent with this condition.

Learning points

- ▶ Spontaneous cerebrospinal fluid (CSF) leaks with intracranial hypotension and postural headaches are not uncommon. Lumbar blood patching is an important therapeutic approach. This is usually effective and relatively safe compared to local blood patches for more proximal CSF leaks.
- ▶ The therapeutic effect of a distal blood patch likely results from combination of an initial tamponade effect followed by plugging of the CSF leak by blood moving proximally through the epidural space to assist formation of a fibrin 'plug'.
- ▶ The negative pressure gradient within the epidural space explains how epidural blood patching blood products ascend rostrally. The presence of intracranial hypotension and upright posture could augment this negative pressure gradient.

enhancing the negative pressure gradient. It may be that the rostral flow of blood with EBP is enhanced in intracranial hypotension, particularly with the patient upright.

The therapeutic response obtained from EBP appears to be best explained by a two-stage process of tamponade followed by clot formation on the basis of the available clinical, imaging and experimental data. The negative pressure gradient within the epidural space is consistent with the rostral spread of blood products and we hypothesise that this process is augmented with intracranial hypotension and upright posture.

Contributors CN took part in writing case report including draft through to final version, literature review, primary care of case study. SA participated in reporting of images for case study, writing of draft and final case report, reporting of patients imaging. CC took part in writing of case report and primary care of patient. PB participated in revision of draft and assistance in writing final version.

Competing interests None.

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