Regional Anesthesia and Pain

Targeted thoracic epidural blood patch placed under electrical stimulation guidance (Tsui test)

[Le colmatage sanguin épidural thoracique ciblé, guidé par la stimulation électrique (test Tsui)]

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Purpose: This case report describes the use of electrical epidural stimulation (Tsui test) to confirm accurate placement of a thoracic epidural catheter when administering an epidural blood patch for headache management in a patient suffering from spontaneous intracranial hypotension.

Clinical features: A 41-yr-old female presented to the Chronic Pain Clinic with a history of postural headache symptoms worsening in severity over several years. Two previous blood patches performed at T11–12 and T10–11 respectively provided short-term relief only. The presumed diagnosis of a spontaneous dural tear was confirmed by a nuclear flow test to be at T2–T4. The epidural site was accessed at T6 with a Tuohy needle. To accurately place the epidural blood patch at the level of the dural tear, the Arrow catheter with electrode adapter was advanced under nerve stimulation guidance to T4. Ten millilitres of autologous blood injected through the catheter was confirmed on magnetic resonance imaging, one hour postprocedure, to lie between T3 and T9. Sustained headache relief was achieved.

Conclusion: The use of electrical stimulation guidance may be useful when precise epidural blood patch placement is required.

Objectif : Décrire l'usage de la stimulation électrique épidurale (test Tsui) pour confirmer la bonne position d'un cathéter épidural thoracique dans le traitement de céphalées au moyen d'un colmatage sanguin épidural chez une femme souffrant d'hypotension intracrânienne spontanée.

Éléments cliniques : Une femme de 41 ans s'est présentée à la Chronic Pain Clinic pour des symptômes de céphalées posturales de sévérité progressive depuis quelques années. Deux colmatages sanguins antérieurs réalisés à T11–12 et à T10–11 n'avaient produit qu'un soulagement temporaire. Une rupture dural spontanée a été présumée, et confirmé en médecine nucléaire par un test de débit à T2–T4. L'accès épidural à T6 s'est fait avec une aiguille Tuohy. Pour un colmatage sanguin épidural au niveau exact de la rupture dural, le cathéter Arrow, avec raccord pour l'électrode, a été guidé par neurostimulation jusqu'à T4. L'injection de dix millilitres de sang autologue dans le cathéter a été confirmée entre T3 et T9 par les images de la résonance magnétique, une heure plus tard. Un soulagement prolongé des céphalées a suivi.

Conclusion : La stimulation électrique peut guider la mise en place précise d'un colmatage sanguin épidural nécessaire.

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THE clinical syndrome of spontaneous intracranial hypotension (SIH) originally described by Schaltenbrand in 1938 is characterized by low cerebrospinal fluid (CSF) pressure with no history of dural puncture or trauma.¹ It is usually caused by CSF leak from a tear in a spinal nerve root sheath, a perineural cyst, or a spinal arachnoid diverticulum.² Precise determination of the spinal level of the leak is important in the diagnosis and treatment of SIH. Several different imaging modalities may be used to assist in making the diagnosis, such as spinal magnetic resonance imaging (MRI)³ isotope cisternogram,⁴ computed tomography (CT) with contrast,⁴ CT myelography,⁵ and MRI myelography.^{6,7}

Epidural blood patch (EBP) is the treatment of choice for persistent postural headache.⁸ Fluoroscopic and CT guidance have been used to ensure that the blood is deposited at the correct level.^{8,9} However, the equipment required for such techniques is cumbersome and not readily available in many outpatient pain clinics. The use of low current epidural stimulation to confirm and guide epidural catheters to specific spinal locations (Tsui test) has been recently described.¹⁰⁻¹² This technique confirms the location of the epidural catheter tip by eliciting motor responses corresponding to the specific myotome level of the stimulating catheter tip. This report describes the application of the Tsui test to assist with the accurate placement of an EBP via a thoracic epidural catheter in a patient with SIH after two previous unsuccessful blood patches. This report met institutional guidelines regarding privacy of personal health information.

Clinical features

A 41-yr-old 60 kg female presented to the Chronic Pain Clinic with a history of severe postural headaches associated with nausea and vomiting. Her symptoms had started spontaneously in 1995. The headaches were relieved within 15 min by lying supine. She had no visual complaints. Her past medical history included Hashimoto's disease for which she was on L-thyroxine and polycystic ovary disease. She was allergic to penicillin, sulfa and clarithromycin, all of which caused hives.

The presumed diagnosis of spontaneous dural tear had been suggested by a CSF isotope flow study which demonstrated an extrathecal radioactivity at T2–4. The patient's pain was managed for a short period of time with a blood patch inserted at T11–12 level, but soon recurred. In the ensuing eight years, her pain was treated with analgesics, antidepressants, naturopathic remedies, acupuncture, chiropractic treatment and massage. In 2002, the severity of the headaches

FIGURE 1 Computed tomography myelogram at the T3–4 level prior to epidural blood patch. There is bright white contrast in the subarachnoid space around the spinal cord. There is a cerebrospinal fluid leak in the ventral epidural space, containing contrast at a lower concentration (arrow) compared with the subarachnoid space.

increased. They would radiate from the thoracic spine to the occiput and around to the frontal area. Pain developed slowly over the day, especially with prolonged standing, and was associated with decreased hearing and tinnitus. On two occasions, she demonstrated self-limited episodes of paresthesia and weakness in both legs lasting approximately four hours.

In 2003, repeat investigations of CT myelogram and MRI demonstrated a CSF collection in the ventral epidural space extending from C6–L1. The spinal cord was displaced posteriorly but not distorted (Figure 1). Magnetic resonance imaging revealed inferior displacement of the brainstem and cerebellar tonsils suggesting intracranial hypotension, although there was no meningeal enhancement. A nuclear flow study (Indium 111-DPTA) carried out in February 2004 showed no definite evidence of CSF leak, but there was delayed ascent of tracer to cerebral convexities suggesting spinal CSF leak and resorption. She was referred to the Pain Clinic for consideration of EBP. In April 2004, a blood patch was performed with 10 mL autologous blood as a single-shot technique at the level of T10–11, since the blood patch at that level had previously seemed effective. However, this time it provided only three days of pain relief.

FIGURE 2 Sagittal T2 weighted magnetic resonance imaging of the thoracic spine obtained following epidural blood patch. There is blood in the dorsal epidural space which extends from T3–4 to T8–9 (large white arrows). This effaces the ventral cerebrospinal fluid leak (small white arrow identifies the spinal cord).

In June 2004, a "targeted" EBP was performed via an epidural catheter under the guidance of the Tsui test. The patient was placed in the sitting position and the T6–7 interspace was identified using surface landmarks. Under sterile technique, and a left paramedian approach, the epidural space was identified with a 17-G Tuohy needle via loss of resistance to air. The epidural catheter (Arrow International Inc, Reading, PA, USA) was advanced into the epidural space with the bevel of the Tuohy needle directed cephalad. Using an electrode adapter (Johan electrocardiogram adapter, Arrow International Inc, Reading, PA, USA) the anode lead of the nerve stimulator was connected to a grounding electrode on the patient's abdomen. The cathode lead of the stimulator was connected to the metal hub of the Johan's adapter. Initial motor twitch movement of the bilateral T6 intercostals was obtained with a current of 6 mA. The epidural catheter was then advanced until the patient reported

twitches in the axilla. Bilateral T4 intercostal twitches were observed just inferior to the axilla. The stylet was removed from the catheter without resistance and the motor response rechecked via the saline-filled catheter.

Ten millilitres of autologous blood were then injected through the single-lumen catheter without difficulty. An MRI at six hours following the EBP demonstrated blood lying in the dorsal epidural space from T3–9 (Figure 2). The ventral epidural fluid collection as noted earlier was still demonstrable extending from C5–6 to T3, but was effaced. Over the next six weeks, the patient's headaches steadily improved and she was able to seek employment.

Discussion

We have described the first successful delivery of a targeted EBP using the Tsui test in a patient with SIH to ensure precise placement of the patch. The post-procedure MRI scan confirmed correct placement of the blood patch.

Most cases of SIH resulting from spontaneous CSF leaks are usually found at either the thoracic spine or the cervicothoracic junction.¹³ Meningeal diverticula or cysts are the usual cause of such leaks.^{2,13} The presenting complaint of SIH is postural headache caused by tension on pain-sensitive structures in the meninges. Other symptoms include blurred vision, diplopia, retro-orbital pain, neck pain and tinnitus.^{2,14}

The reduction of CSF volume through the dural mater is counteracted by increased cerebral venous blood volume which contributes further to the headache. Increased dural blood volume is demonstrated on MRI as diffuse pachymeningeal enhancement.¹³ Additional MRI findings include subdural fluid collection and descent of the brain on upright positioning. Rarely, tonsillar displacement into the spinal canal occurs, simulating Chiari I malformation.⁴

Bed rest is frequently recommended for SIH. However, to be successful, the duration of this treatment may last from weeks to months. Simple treatments such as caffeine, corticosteroids, or abdominal binders may be helpful. Other techniques described are epidural/intrathecal saline infusions¹⁶ and fibrin glue placed at surgical exploration.¹⁷ Surgical repair of the leak has been performed in cases that have failed EBP, provided the site of the CSF leak can be identified.

The most effective treatment of SIH is injection of autologous blood into the epidural space.⁴ Although blood injected into the epidural space can spread to multiple levels, most of the clot concentrates in the area surrounding the injection site.¹⁸ Since the anterior and posterior epidural space are in continuity

with each other, blood injected posteriorly spreads anteriorly.²¹ Prone positioning of our patient for an hour post-procedure would have facilitated anterior movement of injected blood.

In this case, the spontaneous dural tear was initially suspected by Indium CSF flow study to be at T2–4. Since the patient had already experienced two failed blood patches, it was desirable to maximize therapeutic effectiveness of this blood patch by placing it in as close proximity to the suspected dural tear site as possible. A recent study showed that the cervical and upper thoracic ligamentum flavum above T4 frequently fails to fuse in the midline.²³ The clinical implication of this finding is that the distinct elastic resistance offered by the ligamentum flavum before entering the epidural space may be blunted or even absent in the upper thoracic region at or above the T4 level, making the risk of a dural puncture higher. For this reason, we chose to insert the needle at the more easily-identified T6–7 interspace, and thread the catheter up to the desired T2–4 level.

Fluoroscopy and CT have both been used to guide EBP placement.^{8,9} However, such techniques require additional setup, can incur increased expense, and, most importantly, can increase exposure to ionizing radiation.^{8,9}

This case report illustrates that the Tsui test can accurately guide an epidural catheter to a specific spinal location. Using this technique we produced an effective “targeted” blood patch lying in the dorsal epidural space from T3–9 with an injection of 10 mL of autologous blood via the precisely placed catheter at T4. This electrical epidural stimulation technique should be considered in other cases of acute and chronic pain management where accurate placement of the catheter tip is desired at a site distal to the insertion point.

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